UNITED STATES SECURITIES AND EXCHANGE COMMISSION
WASHINGTON, D.C. 20549

Form 10-K

(MARK ONE)

☒ **ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934**

For the fiscal year ended December 31, 2018

or

☐ **TRANSITION REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934**

For the transition period from to

Commission File number 0-23621

MKS INSTRUMENTS, INC.

(Exact Name of Registrant as Specified in Its Charter)

Massachusetts	**04-2277512**
(State or other Jurisdiction of Incorporation or Organization)	*(IRS Employer Identification No.)*
2 Tech Drive, Suite 201, Andover, Massachusetts	**01810**
(Address of Principal Executive Offices)	*(Zip Code)*

(978) 645-5500

(Registrant's Telephone Number, including area code)

Securities registered pursuant to Section 12(b) of the Act:

Title of class	**Name of exchange on which registered**
Common Stock, no par value	NASDAQ Global Select Market

Securities registered pursuant to Section 12(g) of the Act: None

Indicate by check mark if the registrant is a well-known seasoned issuer, as defined in Rule 405 of the Securities Act. Yes ☒ No ☐

Indicate by check mark if the registrant is not required to file reports pursuant to Section 13 or Section 15(d) of the Act. Yes ☐ No ☒

Indicate by check mark whether the registrant (1) has filed all reports required to be filed by Section 13 or 15(d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the registrant was required to file such reports), and (2) has been subject to such filing requirements for the past 90 days. Yes ☒ No ☐

Indicate by check mark whether the registrant has submitted electronically every Interactive Data File required to be submitted pursuant to Rule 405 of Regulation S-T (§ 232.405 of this chapter) during the preceding 12 months (or for such shorter period that the registrant was required to submit such files). Yes ☒ No ☐

Indicate by check mark if disclosure of delinquent filers pursuant to Item 405 of Regulation S-K (§ 229.405 of this chapter) is not contained herein, and will not be contained, to the best of registrant's knowledge, in definitive proxy or information statements incorporated by reference in Part III of this Form 10-K or any amendment to this Form 10-K. ☒

Indicate by check mark whether the registrant is a large accelerated filer, an accelerated filer, a non-accelerated filer, a smaller reporting company, or an emerging growth company. See the definitions of "large accelerated filer," "accelerated filer," "smaller reporting company," and "emerging growth company" in Rule 12b-2 of the Exchange Act. (Check one):

Large accelerated filer ☒ Accelerated filer ☐ Non-accelerated filer ☐ Smaller reporting company ☐ Emerging growth company ☐

If an emerging growth company, indicate by check mark if the registrant has elected not to use the extended transition period for complying with or any new or revised financial accounting standards provided pursuant to Section 13(a) of the Exchange Act. ☐

Indicate by check mark whether the registrant is a shell company (as defined in Rule 12b-2 of the Exchange Act). Yes ☐ No ☒

Aggregate market value of the voting and non-voting common equity held by nonaffiliates of the registrant as of June 30, 2018 based on the closing price of the registrant's common stock on such date as reported by the Nasdaq Global Select Market: $5,217,380,580.

Number of shares outstanding of the issuer's common stock, no par value, as of February 19, 2019: 54,197,726

DOCUMENTS INCORPORATED BY REFERENCE

Portions of the definitive Proxy Statement for MKS' Annual Meeting of Stockholders to be held on May 8, 2019 are incorporated by reference into Part III of this Form 10-K.

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PART I

SPECIAL NOTE REGARDING FORWARD-LOOKING STATEMENTS

This Annual Report on Form 10-K contains “forward-looking statements” within the meaning of the Private Securities Litigation Reform Act of 1995, Section 27A of the Securities Act and Section 21E of the Securities Exchange Act. When used herein, the words “believe,” “anticipate,” “plan,” “expect,” “estimate,” “intend,” “may,” “see,” “will,” “would” and similar expressions are intended to identify forward-looking statements although not all forward-looking statements contain these identifying words. These forward-looking statements reflect management’s current opinions and are subject to certain risks and uncertainties that could cause actual results to differ materially from those stated or implied. MKS assumes no obligation to update this information. Risks and uncertainties include, but are not limited to, those discussed in the section entitled “Risk Factors” of this annual report on Form 10-K.

PART I

Item 1. *Business*

MKS Instruments, Inc. (“MKS” or the “Company”) was founded in 1961 as a Massachusetts corporation. We are a global provider of instruments, subsystems and process control solutions that measure, monitor, deliver, analyze, power and control critical parameters of advanced manufacturing processes to improve process performance and productivity. Our products are derived from our core competencies in pressure measurement and control, flow measurement and control, gas and vapor delivery, gas composition analysis, residual gas analysis, leak detection, control technology, ozone generation and delivery, RF & DC power, reactive gas generation, vacuum technology, lasers, photonics, sub-micron positioning, vibration control, and optics. We also provide services relating to the maintenance and repair of our products, installation services and training.

Recent Events

Acquisition of Electro Scientific Industries, Inc.

On February 1, 2019, we completed our previously announced acquisition of Electro Scientific Industries, Inc., an Oregon corporation (“ESI”), pursuant to the Agreement and Plan of Merger (the “ESI Merger”). ESI is an innovator in laser-based manufacturing solutions for micro-machining applications. Micro-machining applications are used extensively in the manufacture of mobile devices, electronic components, thin film devices and semiconductor packaging. At the effective time of the ESI Merger and pursuant to the terms and conditions of the Agreement and Plan of Merger, each share of ESI’s common stock issued and outstanding as of immediately prior to the effective time of the ESI Merger was converted into the right to receive $30.00 per share in cash, without interest and subject to deduction for any required withholding tax. We paid to the former ESI stockholders aggregate consideration of approximately $1 billion, excluding related transaction fees and expenses. We funded the payment of the aggregate consideration with a combination of our available cash on hand and proceeds from our term loan facility described below.

In connection with the completion of the ESI Merger, we entered into an amendment (“Amendment No. 5”) to our Term Loan Credit Agreement with Barclays Bank PLC as administrative agent and collateral agent, that provided additional tranche B-5 term loan commitment in the principal amount of $650.0 million, which we used to partially fund the ESI Merger.

Also, in connection with the completion of the ESI Merger, we terminated our $50.0 million asset-based credit agreement with Deutsche Bank AG New York Branch as administrative and collateral agent, and we entered into an asset-based credit agreement with Barclays Bank PLC, as administrative agent and collateral agent, that provides senior secured revolving credit financing of up to $100.0 million, subject to a borrowing base limitation.

Other Dispositions and Acquisitions

Sale of Data Analytics Solutions Business

In April 2017, we completed the sale of our Data Analytics Solutions business for total proceeds of $72.5 million, net of cash sold and recorded a pre-tax gain of $74.9 million. This business, which had net revenues in 2016 of $12.7 million and was included in our Vacuum & Analysis segment, was no longer a part of our long-term strategic objectives. The business did not qualify as a discontinued operation as this sale did not represent a strategic shift in our business, nor did the sale have a major effect on our operations. Therefore, the results of operations for all periods are included in our income from operations. The assets and liabilities of this business have not been reclassified or segregated in the consolidated balance sheet or consolidated statements of cash flows as the amounts were immaterial.

Acquisition of Newport Corporation

On April 29, 2016, we completed our acquisition of Newport Corporation ("Newport") pursuant to an Agreement and Plan of Merger dated as of February 22, 2016 (the "Newport Merger"). At the effective time of the Newport Merger, each share of Newport's common stock issued and outstanding as of immediately prior to the effective time of the Newport Merger was converted into the right to receive $23.00 in cash, without interest and subject to deduction for any required withholding tax. We paid to the former Newport stockholders aggregate consideration of approximately $905 million, excluding related transaction fees and expenses, and repaid approximately $93 million of Newport's U.S. indebtedness outstanding as of immediately prior to the effective time of the Newport Merger. We funded the payment of the aggregate consideration with a combination of our available cash on hand of approximately $240 million and the proceeds from the senior secured term loan facility in the principal amount of $780 million (see Note 13 to Notes to Consolidated Financial Statements in Item 8 of this Annual Report on Form 10-K).

Newport was a global supplier of advanced-technology products and systems to customers in the scientific research and defense/security, microelectronics, life and health sciences and industrial manufacturing markets.

Reportable Segments

Effective April 29, 2016, in conjunction with our acquisition of Newport, we changed the structure of our reportable segments based upon our organizational structure and how our Chief Operating Decision Maker utilizes information provided to allocate resources and make decisions. Our two reportable segments are the Vacuum & Analysis segment and the Light & Motion segment. The Vacuum & Analysis segment represents primarily the legacy MKS business and the Light & Motion segment represents the remaining legacy Newport business. With the acquisition of ESI, we will be adding a third segment.

The Vacuum & Analysis segment provides a broad range of instruments, components and subsystems which are derived from our core competencies in pressure measurement and control, flow measurement and control, gas and vapor delivery, gas composition analysis, residual gas analysis, leak detection, control technology, ozone generation and delivery, RF & DC power, reactive gas generation and vacuum technology. The Light & Motion segment provides a broad range of instruments, components and subsystems which are derived from our core competencies in lasers, photonics, sub-micron positioning, vibration control, and optics.

We group our products into six product groups based upon the similarity of the product function, type of product and manufacturing processes. These six groups are: Analytical and Controls Solutions Products; Power, Plasma and Reactive Gas Solutions Products; Vacuum Solutions Products; Photonics Products; Optics Products; and Laser Products. The Analytical and Controls Solutions Products, the Power, Plasma and Reactive Gas Solutions Products and the Vacuum Solutions Products are included in the Vacuum & Analysis segment and the Photonics Products, Optics Products and Laser Products are included in the Light & Motion segment.

For further information on our segments, see Note 19 to the Notes to the Consolidated Financials contained in this Annual Report on Form 10-K.

Where You Can Find More Information

We file reports, proxy statements and other documents with the Securities and Exchange Commission ("SEC"). Our SEC filings are available to you on the SEC's internet site at http://www.sec.gov.

Our website is http://www.mksinst.com. We are not including the information contained in our website as part of, or incorporating it by reference into, this annual report on Form 10-K. We make available free of charge through our internet site our Annual Reports on Form 10-K, Quarterly Reports on Form 10-Q, Current Reports on Form 8-K and amendments to these reports filed or furnished pursuant to Section 13(a) or 15(d) of the Securities Exchange Act of 1934, as amended (the "Exchange Act"), as soon as reasonably practicable after we electronically file such materials with, or furnish them to, the SEC.

Markets and Applications

Since our inception, we have focused on satisfying the needs of our customers by establishing long-term collaborative relationships. We have a diverse base of customers and our primary served markets are manufacturers of capital equipment for semiconductor manufacturing, industrial technologies, life and health sciences, as well as research and defense. Approximately 55%, 57% and 56% of our net revenues for the years 2018, 2017 and 2016, respectively, were from sales to semiconductor capital equipment manufacturers and semiconductor device manufacturers.

Approximately 45%, 43% and 44% of our net revenues in the years 2018, 2017 and 2016, respectively, were from advanced manufacturing applications. These include, but are not limited to, industrial technologies, life and health sciences, as well as research and defense.

A significant portion of our net revenues are from sales to customers in international markets. For the years 2018, 2017 and 2016, international net revenues accounted for approximately 51%, 50% and 48% of our total net revenues, respectively. A significant portion of our international net revenues were in South Korea, Japan, Germany and Israel. We expect that international revenues will continue to account for a significant percentage of total net revenues for the foreseeable future, and that in particular, the proportion of our sales to Asian customers will continue to increase, due in large part to our acquisition of ESI, as approximately ninety percent of ESI's customers are located in Asia. Long-lived assets, located in the United States, were $147 million, $125 million and $123 million as of December 31, 2018, 2017 and 2016, respectively, excluding goodwill and intangibles and long-term tax-related accounts. Long-lived assets, located outside of the United States, were $77 million, $78 million, and $78 million as of December 31, 2018, 2017 and 2016, respectively, excluding goodwill and intangibles and long-term tax-related accounts.

Semiconductor Manufacturing Applications

A significant portion of our sales are derived from products sold to semiconductor capital equipment manufacturers and semiconductor device manufacturers. Our products are used in the major semiconductor processing steps such as depositing thin films of material onto silicon wafer substrates, etching, cleaning, lithography, metrology and inspection.

We anticipate that the semiconductor manufacturing market will continue to account for a substantial portion of our sales. While the semiconductor device manufacturing market is global, major semiconductor capital equipment manufacturers are concentrated in China, Japan, South Korea, Taiwan, and the United States.

Advanced Markets

In addition to semiconductor manufacturing, our products are used in the industrial technologies, life and health sciences, as well as research and defense markets.

Industrial Technologies

Industrial Technologies encompasses a wide range of diverse applications such as glass coating, laser marking, measurement and scribing, natural gas and oil production, environmental monitoring and electronic thin films. Electronic thin films are a primary component of numerous electronic products including flat panel displays, light emitting diodes, solar cells and data storage media.

Industrial Technologies manufacturers are located in developed and developing countries across the globe.

Life and Health Sciences

Our products for Life and Health Sciences are used in a diverse array of applications including bioimaging, medical instrument sterilization, medical device manufacturing, analytical, diagnostic and surgical instrumentation, consumable medical supply manufacturing and pharmaceutical production. Our Life and Health Sciences customers are located globally.

Research and Defense

In addition, our products are sold to government, university and industrial laboratories for applications involving research and development in materials science, physical chemistry, photonics, optics and electronics materials. Our products are also sold for monitoring and defense applications including surveillance, imaging and infrastructure protection. Major equipment providers and research laboratories are concentrated in China, Europe, Japan, South Korea, Taiwan and the United States.

Product Groups

Vacuum &Analysis Segment

The Vacuum & Analysis segment includes Analytical and Control Solutions Products; Vacuum Solutions Products; and Power, Plasma and Reactive Gas Solutions Products.

Analytical and Control Solutions. Our Analytical and Control Solutions Products include gas analyzers, automation control products, I/O modules, automation software, and precision machined components and electromechanical assemblies.

Vacuum Solutions. Our Vacuum Solutions Products consist of two primary product offerings: Pressure and Vacuum Measurement Solutions Products and Materials Delivery Solutions Products.

- *Pressure and Vacuum Measurement Solutions Products*. Our Pressure and Vacuum Measurement Solutions Products consist of direct and indirect pressure measurement and integrated process solutions. Each of our pressure measurement and vacuum product lines consist of products that are designed for a variety of pressure ranges and accuracies.
- *Materials Delivery Solutions Products*. Our Materials Delivery Solutions Products include flow and valve technologies as well as integrated pressure measurement and control subsystems to provide customers with precise control capabilities that are optimized for a given application.

Power, Plasma and Reactive Gas Solutions. Our Power, Plasma and Reactive Gas Solutions Products include power delivery, plasma and reactive gas products used in semiconductor and other thin film applications and in medical imaging equipment applications.

- *Power Delivery Products*. We design and manufacture microwave, direct current and radio frequency power delivery systems as well as radio frequency matching networks and metrology products. In the semiconductor, industrial technologies and other market sectors, our power supplies are used to provide energy to various etching, stripping and deposition processes. Our power amplifiers are also used in medical imaging equipment.
- *Plasma and Reactive Gas Products*. We design and manufacture reactive gas products, which create reactive species. A reactive species is an atom or molecule in an unstable state, which is used to facilitate various chemical reactions in the processing of thin films (deposition of films, etching and cleaning of films and surface modifications). A number of different technologies are used to create reactive gas including different plasma technologies and barrier discharge technologies.

Light and Motion Segment

The Light and Motion segment includes Laser Products; Photonics Products; and Optics Products.

Lasers. Our Laser Products include lasers and laser-based systems including ultrafast lasers and amplifiers, fiber lasers, diode-pumped solid-state lasers, high-energy pulsed lasers and tunable lasers. In addition to providing a wide range of standard and configured laser products and accessories to our end-user customers, we also work closely with our original equipment manufacturer (“OEM”) customers to develop lasers and laser system designs optimized for their product and technology roadmaps.

Photonics. Our Photonics Products include optical components, lens assemblies and vibration isolation solutions as well as three-dimensional non-contact measurement sensors and equipment. We also design, develop and manufacture subsystems and subassemblies that integrate our broad portfolio of products and technologies into solutions that meet the specific application requirements of our OEM and select end-user customers. Our Photonics Products also includes our instruments and motion products which includes high-precision motion stages and controls, hexapods, photonics instruments for measurement and analysis, and production equipment for test and measurement customers.

Optics. Our Optics Products include precision optics, thin-film filters and coatings, replicated mirrors and ruled and holographic diffraction gratings.

Customers

We sell our products to thousands of customers worldwide, in a wide range of end markets. Our largest customers include leading semiconductor capital equipment manufacturers such as Applied Materials, Inc. and Lam Research Corporation. Revenues from our top ten customers accounted for approximately 41%, 43% and 39% of net revenues for the years 2018, 2017 and 2016, respectively. Applied Materials, Inc. accounted for 12%, 13% and 14% and Lam Research Corporation accounted for 11%, 12% and 11% of our net revenues for the years 2018, 2017 and 2016, respectively.

Sales, Marketing, Service and Support

Our worldwide sales, marketing, service and support organization is critical to our strategy of maintaining close relationships with semiconductor capital equipment and device manufacturers and manufacturers of advanced applications. We market and sell our products and services through our global direct sales organization, an international network of independent distributors and sales representatives, our websites and product catalogs. As of December 31, 2018, we had 475 sales employees worldwide, located in the United States, United

Kingdom, China, Japan, Israel, South Korea, Germany, France, Taiwan, Singapore, Netherlands and Italy. We maintain a marketing staff that identifies customer requirements, assists in product planning and specifications, and focuses on future trends in semiconductor and other markets.

As semiconductor device manufacturers have become increasingly sensitive to the significant costs of system downtime, they have required that suppliers offer comprehensive local repair, field service and customer support. Manufacturers require close support to enable them to repair, modify, upgrade and retrofit their equipment to improve yields and adapt new materials or processes. To meet these market requirements, we provide technical support from offices located in China, Germany, Japan, South Korea, Singapore, Taiwan, the United Kingdom, Israel and the United States. We provide repair and calibration services at internal service depots and authorized service providers located worldwide. We typically provide warranties for periods ranging from one to three years, depending upon the type of product, with the majority of our products ranging from one to two years. We typically provide warranty on our repair services for periods ranging from 90 days to up to one year, depending upon the type of repair.

Research and Development

Our products incorporate sophisticated technologies to measure, monitor, deliver, analyze, power and control complex semiconductor and advanced manufacturing processes, thereby enhancing uptime, yield and throughput for our customers. Our products have continuously advanced as we strive to meet our customers' evolving needs. We have developed, and continue to develop, new products to address industry trends, such as the shrinking of integrated circuit critical dimensions and technology inflections, and, in the flat panel display and solar markets, the transition to larger substrate sizes, which require more advanced process control technology. In addition, we have developed, and continue to develop, products that support the migration to new classes of materials, ultra-thin layers, and 3D structures that are used in small geometry manufacturing. We involve our marketing, engineering, manufacturing and sales personnel in the development of new products in order to reduce the time to market for new products. Our employees also work closely with our customers' development personnel, helping us to identify and define future technical needs on which to focus research and development efforts. We support research at academic institutions targeted at advances in materials science and semiconductor process development.

As of December 31, 2018, we had 663 research and development employees, primarily located in the United States, France and Israel. Our research and development expenses were $135.7 million, $132.6 million and $110.6 million for the years 2018, 2017 and 2016, respectively. Our research and development efforts include numerous projects, none of which are individually material, and generally have a duration of 3 to 30 months depending upon whether the product is an enhancement of existing technology or a new product. Our current initiatives include projects to enhance the performance characteristics of older products, to develop new products and to integrate various technologies into subsystems.

Manufacturing

Our manufacturing facilities are located in Austria, China, France, Germany, Israel, Italy, South Korea, Mexico, Romania, the United Kingdom and the United States. Manufacturing activities include the assembly and testing of components and subassemblies, which are integrated into our products. We outsource some of our assembly work. We purchase a wide range of electronic, optical, mechanical and electrical components, some of which are designed to our specifications. We consider our lean manufacturing techniques and responsiveness to customers' significantly fluctuating product demands to be a competitive advantage. As of December 31, 2018, we had 3,109 manufacturing-related employees, located primarily in North America (United States) and Asia (primarily China and Israel).

Backlog

At December 31, 2018, our backlog of unfilled orders for all products and services was $400 million, compared to $464 million at December 31, 2017. The decrease in backlog of $64 million in 2018 compared to

2017 is primarily attributed to a decrease in business levels throughout our company in the second half of 2018. As of December 31, 2018, approximately $391 million of our consolidated backlog was scheduled to be shipped on or before December 31, 2019. In general, we schedule production of our products based upon our customers' delivery requirements. Our lead times are very short, as a large portion of our orders are received and shipped within 90 days. While backlog is calculated on the basis of firm orders, orders may be subject to cancellation or delay, in many cases, by the customer with limited or no penalty. Our backlog at any particular date, therefore, is not necessarily indicative of actual sales which may be generated for any succeeding period. Historically, our backlog levels have fluctuated based upon the ordering patterns of our customers and changes in our manufacturing capacity.

Competition

The market for our products is highly competitive. Principal competitive factors include:

- historical customer relationships;
- product quality, performance and price;
- breadth of product line;
- manufacturing capabilities; and
- customer service and support.

Although we believe that we compete favorably with respect to these factors, there can be no assurance that we will continue to do so.

We encounter substantial competition in most of our product lines, although no single competitor competes with us across all product lines. Certain of our competitors may have greater financial and other resources than we do. In some cases, competitors are smaller than we are, but are well established in specific product niches.

For example, Advanced Energy Industries, Inc. offers products that compete with our power delivery and reactive gas generator products. Hitachi Ltd. and Horiba Ltd. products compete with our product line of mass flow controllers. Inficon, Inc. offers products that compete with our vacuum measurement and gas analysis products and our vacuum gauging products. Nor-Cal Products, Inc. and VAT, Inc. offer products that compete with our vacuum components.

Ametek, Inc. offers products that compete with our optics and photonics products. Coherent, Inc. offers products that compete with our lasers and photonics instruments. Excelitas Technologies Corp. offers products that compete with our laser and optics products. IDEX Corporation offers products that compete with our lasers, optics, and photonics subsystems. IPG Photonics, Inc. offers products that compete with our laser products. Jenoptik AG offers products that compete with our laser, optics, and photonics products. PI miCos GmbH offers products that compete with our photonics products. Thorlabs, Inc. offers products that compete with our optics, lasers and photonics products. Trumpf Group offers products that compete with our laser products.

Patents and Other Intellectual Property Rights

We rely on a combination of patent, copyright, trademark and trade secret laws and license agreements to establish and protect our proprietary rights. As of December 31, 2018, we owned 510 U.S. patents and 984 foreign patents that expire at various dates through 2038. As of December 31, 2018, we had 82 pending U.S. patent applications. Foreign counterparts of certain U.S. applications have been filed or may be filed at the appropriate time.

We require each of our employees, including our executive officers, to enter into standard agreements pursuant to which the employee agrees to keep confidential all of our proprietary information and to assign to us all inventions while they are employed by us.

Employees

As of December 31, 2018, we employed 4,851 persons. We believe that our ongoing success depends upon our continued ability to attract and retain highly skilled employees. Outside of the United States, there are certain countries where our employees are represented by works counsel or trade unions, as is common practice or required by law. We believe that our employee relations are good.

Item 1A. ***Risk Factors***

The following describes certain risks we face in our business. Additional risks that we do not yet know of or that we currently believe are immaterial may also impair our business. If any of the events or circumstances described in the following risks actually occurs, our business, financial condition or results of operations could suffer, and the trading price of our common stock could decline. In assessing these risks, investors should also refer to the other information contained or incorporated by reference in this report and our other filings with the Securities and Exchange Commission.

Our business depends substantially on capital spending in the semiconductor industry, which is characterized by periodic fluctuations that may cause a reduction in demand for our products.

Approximately 55%, 57% and 56% of our net revenues for the years 2018, 2017 and 2016, respectively, were from sales to semiconductor capital equipment manufacturers and semiconductor device manufacturers. While our acquisition of Newport Corporation, ("Newport") in 2016, has reduced our concentration of customers in these markets and we expect some additional reduction as a result of our February 2019 acquisition of Electro Scientific Industries, Inc. ("ESI"), we anticipate that sales to such customers will continue to account for a substantial portion of our net revenues. Our business depends upon the capital expenditures of semiconductor device manufacturers, which in turn depends upon the demand for semiconductors.

The semiconductor industry is characterized by rapid technological change, frequent product introductions, changing customer requirements and evolving industry standards. Because our customers face uncertainties with regard to the growth and requirements of these markets, their products and components may not achieve, or continue to achieve, anticipated levels of market acceptance. If our customers are unable to deliver products that gain market acceptance, it is likely that these customers will not purchase our products or will purchase smaller quantities of our products. We often invest substantial resources in developing our products and subsystems in advance of significant sales of these products and subsystems to such customers. A failure on the part of our customers' products to gain market acceptance, or a failure of the semiconductor market to sustain current sales levels or to grow would have a significant negative effect on our business, financial condition and results of operations.

The semiconductor industry has historically been characterized by cyclical variations in product supply and demand. These sometimes sudden and severe cycles may result from a number of factors, including overall consumer and industrial spending and demand for electronic products that drive manufacturer production, as well as the manufacturer's capacity utilization, timing of new product introductions and demand for customers' products, inventory levels relative to demand and access to affordable capital. The timing, severity and duration of these market cycles are difficult to predict, and we may not be able to respond effectively to these cycles. The cyclicality of the semiconductor market is demonstrated by the changes in sales to semiconductor capital equipment and device manufacturers in past years. For example, our sales to semiconductor capital equipment manufacturers and semiconductor device manufacturers increased compared to the prior year by 4%, 52% and 29% in 2018, 2017 and 2016, respectively. While we experienced strong sales to these customers during the first half of 2018, we saw moderation in capital spending in the semiconductor capital equipment industry in the third and fourth quarters of 2018 with a similar effect on our semiconductor-related revenue, and we expect that to continue into the first half of 2019. The 52% increase in 2017, compared to 2016, was mainly attributable to an increase in volume from our semiconductor customers and from the full year effect of net sales from Newport, which we acquired in April 2016.

During semiconductor market downturns, periods of overcapacity have resulted in rapid and significantly reduced demand for our products, which may result in lower gross margins due to reduced absorption of manufacturing overhead, as our ability to rapidly and effectively reduce our cost structure in response to such downturns is limited by the fixed nature of many of our expenses in the near term. Further, our ability to reduce our long-term expenses is constrained by our need to continue our investment in next-generation product technology and to support and service our products. In addition, due to the relatively long manufacturing lead times for some of the products and subsystems we sell to this market, we may incur expenditures or purchase raw materials or components for products we are unable to sell. Accordingly, downturns in the semiconductor capital equipment market may materially harm our business, financial condition and operating results. Conversely, when upturns in this market occur, we may have difficulty rapidly and effectively increasing our manufacturing capacity to meet sudden increases in customer demand. If we fail to do so, we may lose business to our competitors and our relationships with our customers may be harmed. In addition, many semiconductor manufacturers have operations and customers in Asia, a region that in past years has experienced serious economic problems including currency devaluations, debt defaults, lack of liquidity and recessions.

The acquisition of ESI involves numerous risks, including the inability to effectively integrate ESI's business and operations or realize the expected benefits from the acquisition, which could materially harm our operating results.

Our February 2019 acquisition of ESI has increased our product offerings, end markets, and number of employees and facilities. ESI's products and certain of its technology, markets and customer base are significantly different from our historical experience. Combining our businesses could make it more difficult to maintain relationships with customers, employees or suppliers. Integrating ESI's business and operations with ours will require significant management attention, efforts and expenditures, and we may not be able to achieve the integration in an effective, complete, timely or cost-efficient manner.

Potential risks related to our acquisition of ESI include our ability to:

- expand our financial and management controls and reporting systems and procedures to integrate and manage ESI;
- integrate our information technology systems to enable the management and operation of the combined business;
- realize expected synergies and cost savings resulting from the acquisition;
- maintain and improve ESI's operations while integrating our combined manufacturing organization;
- avoid lost revenue due to customer confusion, alienation or misinformation regarding the transaction, and retain and expand ESI's customer base while aligning our sales efforts;
- avoid lost revenue resulting from the distraction or confusion of our personnel as a consequence of the acquisition and ongoing integration efforts;
- identify and retain key ESI personnel;
- recognize and capitalize on anticipated product sales and technology enhancement opportunities presented by our combined businesses;
- adequately familiarize ourselves with ESI's products and technology and certain of its markets and customer base such that we can manage ESI's business effectively; and
- successfully integrate our respective corporate cultures such that we achieve the benefits of acting as a unified company.

Other potential risks related to our acquisition of ESI include:

- the assumption of unknown or contingent liabilities, or other unanticipated events or circumstances; and

- the potential to incur or record significant cash or non-cash charges or write down the carrying value of intangible assets and goodwill obtained in the ESI acquisition, which could adversely impact our cash flow or lower our earnings in the period or periods for which we incur such charges or write down such assets.

Further, some very significant customers of our laser and motion products compete with ESI. ESI will initially remain a separate division from our Light & Motion segment that supplies these laser and motion products, and we have implemented internal measures intended to segregate competitively sensitive information that we receive from these customers from our ESI business, however, these customers may choose to source their laser and motion products from alternate suppliers, which could result in a potentially significant loss of revenue for our laser and motion business.

If we are unable to successfully or timely integrate the operations of ESI's business into our business, we may be unable to realize the revenue growth, synergies and other anticipated benefits resulting from the acquisition and our business could be adversely affected. Additionally, we have incurred and will continue to incur transaction-related costs, including legal, regulatory and other costs associated with implementing integration plans, including facilities and systems consolidation costs and employment-related costs. Although we expect that the elimination of duplicative costs, as well as the realization of other efficiencies related to the integration of the businesses, should allow us to offset transaction and integration-related costs over time, this net benefit may not be achieved in the near term, or at all. Further, we may not realize the expected benefits from the acquisition. ESI's business and operations may not achieve the anticipated revenues and operating results. We may in the future choose to close or divest certain sectors of ESI, which could require us to record losses and/or spend cash relating to such closures or divestitures. Any of the foregoing risks could materially harm our business, financial condition and results of operations.

The terms of our term loan credit facility and asset-based revolving credit facility impose significant financial obligations and risks upon us, limit our ability to take certain actions, and could discourage a change in control.

In February 2019, we amended our existing term loan credit facility and obtained a new revolving credit facility in connection with financing our acquisition of ESI. The term loan credit facility, as amended, provided us with additional senior secured financing in the principal amount of $650 million as of February 1, 2019, with a term of seven years. Together with this additional financing, we have $998 million in total outstanding debt as of February 1, 2019. The revolving credit facility provides us with senior secured financing of up to $100 million, subject to a borrowing base limitation.

Our indebtedness under these credit facilities has increased our interest expense and could have the effect, among other things, of reducing the funds available to flexibly respond to changing business and economic conditions. Our indebtedness could also reduce funds available for working capital, capital expenditures, acquisitions and other general corporate purposes and may create competitive disadvantages relative to other companies with lower debt levels. If we do not achieve the expected benefits from the acquisition, or if the financial performance of the combined company does not meet current expectations, then our ability to service our indebtedness may be adversely impacted.

A significant portion of the amounts outstanding under the credit facilities bear interest at variable interest rates. Although we hedge some of that exposure, if interest rates increase, variable rate debt will create higher debt service requirements, which could adversely affect our cash flows. In addition, our credit ratings could affect the cost and availability of future borrowings and, accordingly, our cost of capital. Our ratings of our indebtedness reflect each nationally recognized statistical rating organization's opinion of our financial strength, operating performance and ability to meet our debt obligations. There can be no assurance that we will achieve a particular rating or maintain a particular rating in the future. Moreover, we may be required to raise substantial additional financing to fund working capital, capital expenditures, acquisitions or other general corporate requirements. Our ability to arrange additional financing or refinancing will depend on, among other factors, our financial position and performance, as well as prevailing market conditions and other factors beyond our control. There can be no assurance that we will be able to obtain additional financing or refinancing on terms acceptable to us or at all.

Our term loan credit facility, as amended, uses LIBOR as a reference rate for our term loans, such that the interest due pursuant to such loans may be calculated using LIBOR (subject to a stated minimum value). On July 27, 2017, the United Kingdom's Financial Conduct Authority, which regulates LIBOR, announced that it intends to phase out LIBOR by the end of 2021. LIBOR borrowings may become unavailable before that date. It is unclear if at that time LIBOR will cease to exist or if new methods of calculating LIBOR will be established such that it continues to exist after 2021. The future of LIBOR at this time is uncertain. If the method for calculation of LIBOR changes, if LIBOR is no longer available or if lenders have increased costs due to changes in LIBOR, we may have to modify our term loan credit facility, or the loans using LIBOR as a reference rate will convert to the base rate (calculated by reference to the higher of the federal funds effective rate plus 50 basis points or the prime rate, subject to a stated minimum value) which could result in higher interest rates.

The term loan credit facility and the revolving credit facility contain a number of negative covenants that, among other things and subject to certain exceptions, restrict our ability and/or our subsidiaries' ability to:

- incur additional indebtedness;
- pay certain dividends on our capital stock or redeem, repurchase or retire certain capital stock or certain other indebtedness;
- make certain investments, loans and acquisitions;
- engage in certain transactions with our affiliates;
- sell assets, including capital stock of our subsidiaries;
- materially alter the business we conduct;
- consolidate or merge;
- incur liens; and
- engage in sale-leaseback transactions.

These covenants restrict our ability to engage in or benefit from these actions, thereby limiting our flexibility in planning for, or reacting to, changes and opportunities in the markets in which we compete, such as limiting our ability to engage in mergers and acquisitions. This could place us at a competitive disadvantage. If the matters described in our other risk factors result in a material adverse effect on our business, financial condition or results of operations, we may be unable to comply with the terms of our credit facilities or experience an event of default.

The term loan credit agreement and the revolving credit agreement contain customary events of default, including:

- failure to make required payments;
- failure to comply with certain agreements or covenants;
- materially breaching any representation or warranty made or deemed made in connection with the respective credit facility;
- failure to pay, or cause acceleration of, certain other indebtedness;
- certain events of bankruptcy and insolvency;

- failure to pay certain judgments; and
- a change in control of us.

The amount of cash available to us for repayment of amounts owed under these credit facilities will depend on our usage of our existing cash balances and our operating performance and ability to generate cash flow from operations in future periods, which will be subject to financial, business and other factors affecting our operations, many of which are beyond our control. We cannot provide any assurances that we will generate sufficient cash flow from operations to service our debt obligations. Any failure to repay these obligations as they become due would result in an event of default under the credit facilities.

Further, because a change in control of us constitutes an event of default under these credit facilities, this would likely be a deterrent to a potential acquirer, as any potential acquisition would trigger an event of default, unless the lenders agreed to waive such event of default. We cannot guarantee that any such waiver would be obtained.

If an event of default occurs, the lenders may end their obligation to make loans to us under the credit facilities, and may declare any outstanding indebtedness under the credit facilities immediately due and payable. In such case, we would need to obtain additional financing or significantly deplete our available cash, or both, in order to repay this indebtedness. Any additional financing may not be available on reasonable terms or at all, and significant depletion of our available cash could harm our ability to fund our operations or execute our broader corporate objectives. If we were unable to repay outstanding indebtedness following an event of default, then in addition to other available rights and remedies, the lenders could initiate foreclosure proceedings on substantially all of our assets. Any such foreclosure proceedings or other rights and remedies successfully implemented by the lenders in an event of default would have a material adverse effect on our business, financial condition and results of operations.

Our quarterly operating results have fluctuated, and are likely to continue to vary significantly, which may result in volatility in the market price of our common stock.

A substantial portion of our shipments occurs shortly after an order is received, and therefore we generally operate with a relatively low level of backlog. As a result, a decrease in demand for our products from one or more customers could occur with limited advance notice and could have a material adverse effect on our results of operations in any particular period. Further, with respect to certain of our business lines, we often recognize a significant portion of net revenues in the last month of each fiscal quarter, due in part to the tendency of some customers to wait until late in a quarter to commit to purchase certain of our products as a result of capital expenditure approvals and budgeting constraints occurring at the end of a quarter, or the hope of obtaining more favorable pricing from a competitor seeking the business. Thus, variations in timing of sales can cause significant fluctuations in our quarterly sales, gross margin and profitability. Orders expected to ship in one period could shift to another period due to changes in the timing of our customers' purchase decisions, rescheduled delivery dates requested by our customers, manufacturing capacity constraints or logistics delays. Our operating results for a particular quarter or year may be adversely affected if our customers, particularly our largest customers, cancel or reschedule orders, or if we cannot fill orders in time due to capacity constraints or unexpected delays in manufacturing, testing, shipping or product acceptance. Also, we base our manufacturing plans on our forecasted product mix. If the actual product mix varies significantly from our forecast, we may not be able to fill some orders, which would result in delays in the shipment of our products and could shift sales to a subsequent period. All of these risks have a disproportionately high impact on our ESI business, which derives substantial revenue from a few significant customers and the sale of a relatively small quantity of products. A significant percentage of our expenses are fixed and based in part on expectations of future net revenues. The inability to adjust spending quickly enough to compensate for any shortfall would magnify the adverse impact of a shortfall in net revenues on our results of operations. Factors that could cause fluctuations in our financial results include:

- a worldwide economic slowdown or disruption in the global financial markets;

- fluctuations in our customers' capital spending, industry cyclicality (particularly in the semiconductor industry), market seasonality (particularly in the research and defense market), levels of government funding available to our customers (particularly in the life and health sciences and research and defense markets) and other economic conditions within the markets we serve;
- the timing of the receipt of orders within a given period and the level of orders from major customers;
- demand for our products and the products sold by our customers;
- shipment delays;
- disruption in sources of supply;
- production capacity constraints;
- specific features requested by customers;
- the timing and level of cancellations and delays of orders in backlog for our products;
- the timing of product shipments and revenue recognition within a given quarter;
- variations in the mix of products we sell;
- changes in our pricing practices or in the pricing practices of our competitors or suppliers;
- our timing in introducing new products;
- engineering and development investments relating to new product introductions, and significant changes to our manufacturing and outsourcing operations;
- market acceptance of any new or enhanced versions of our products;
- timing of new product introductions by our competitors;
- timing and level of inventory obsolescence, scrap and warranty expenses;
- the availability, quality and cost of components and raw materials we use to manufacture our products;
- changes in our effective tax rates;
- changes in our capital structure, including cash, marketable securities and debt balances, and changes in interest rates;
- changes in bad debt expense based on the collectability of our accounts receivable;
- timing, type, and size of acquisitions and divestitures, and related expenses and charges;
- fluctuations in currency exchange rates;
- our expense levels;
- impairment of goodwill and amortization of intangible assets; and
- fees, expenses and settlement costs or judgments against us relating to litigation.

As a result of the factors discussed above, among others, it is likely that we may in the future experience quarterly or annual fluctuations, and that, in one or more future quarters, our operating results may fall below the expectations of public market analysts or investors. In any such event, the price of our common stock could fluctuate or decline significantly. Consequently, we believe that quarter-to-quarter and year-to-year comparisons of our results of operations, or any other similar period-to-period comparisons, may not be reliable indicators of our future performance.

The loss of net revenues from any one of our major customers would likely have a material adverse effect on us.

Our top ten customers accounted for approximately 41%, 43% and 39% of our net revenues for the years 2018, 2017 and 2016, respectively. One customer, Applied Materials, Inc., accounted for approximately 12%, 13% and 14% of our net revenues for the years 2018, 2017 and 2016, respectively, and another customer, Lam Research Corporation, accounted for 11%, 12% and 11% of our net revenues for the years 2018, 2017 and 2016, respectively. In any one reporting period, a single customer or several customers may contribute even a larger percentage of our consolidated revenues. Further, our recently-acquired ESI business also depends on a few significant customers for a large portion of revenue in any given quarter. The loss of a major customer or any reduction in orders by these customers, including reductions due to market or competitive conditions, would likely have a material adverse effect on our business, financial condition and results of operations. None of our significant customers has entered into an agreement with us requiring it to purchase any minimum quantity of our products. Because our largest customers are semiconductor capital equipment manufacturers, we are particularly susceptible to the cyclicality of the semiconductor market.

Attempts to lessen the adverse effect of any loss or reduction of net revenues through the rapid addition of new customers could be difficult because a relatively small number of companies dominate the semiconductor equipment market. Further, prospective customers typically require lengthy qualification periods prior to placing volume orders with a new supplier. Our future success will continue to depend upon:

- our ability to maintain relationships with existing key customers;
- our ability to attract new customers and satisfy any required qualification periods;
- our ability to introduce new products in a timely manner for existing and new customers; and
- the successes of our customers in creating demand for their capital equipment products that incorporate our products.

We face significant risks from doing business internationally.

Our business is subject to risks inherent in conducting business globally. International revenues account for a significant portion of total net sales, with a substantial portion of such sales originating in Asia (especially South Korea, Japan, Israel, China and Taiwan) and Europe (especially Germany). We expect that international revenues will continue to account for a significant percentage of total net sales for the foreseeable future, and that in particular, the proportion of our sales to Asian customers will continue to increase, due in large part to our acquisition of ESI, as approximately ninety percent of ESI’s customers are located in Asia. Additionally, we have substantial international manufacturing, sales and administrative operations, with significant facilities and employee populations in Europe and Asia, and a substantial portion of our manufacturing in China, Israel, Mexico and Singapore. Our international operations expose us to various risks, which include:

- adverse changes or instability in the political or economic conditions in countries or regions where we manufacture or sell our products, for example, the uncertainty associated with the pending exit of the United Kingdom from the European Union;
- challenges of administering our diverse business and product lines globally;
- the actions of government regulatory authorities, including embargoes, executive orders, import and export restrictions, tariffs, currency controls, trade restrictions and trade barriers (including retaliatory actions), license requirements, environmental and other regulatory requirements and other rules and regulations applicable to the manufacture, import and export of our products, all of which are complicated and potentially conflicting, often require significant investments in cost, time and resources for compliance, and may impose strict and severe penalties for noncompliance;
- greater risk of violations of applicable U.S. and international anti-corruption and trade laws by our employees, sales representatives, distributors or other agents;

- longer accounts receivable collection periods and longer payment cycles;
- overlapping, differing or more burdensome tax structures;
- adverse currency exchange rate fluctuations;
- reduced or inconsistent protection of intellectual property;
- shipping and other logistics complications;
- the imposition of restrictions on currency conversion or the transfer of funds;
- compliance costs and withholding taxes associated with the repatriation of our overseas earnings;
- the expropriation of private enterprises;
- more complex and burdensome labor laws and practices in countries where we have employees;
- cultural and management style differences;
- preference for locally-produced products;
- changes in labor conditions and difficulties in staffing and managing foreign operations, including, but not limited to, the formation of labor unions;
- difficulties in staffing and managing each of our individual international operations; and
- increased risk of exposure to civil unrest, terrorism and military activities.

If we experience any of the risks associated with international business, our business, financial condition and results of operations could be significantly harmed.

In particular, we have significant facilities and operations and a considerable number of employees in Israel. A number of our products are manufactured in facilities located in Israel. The Middle East remains a volatile region, and the future of peace efforts between Israel and neighboring countries remains extremely uncertain. Any armed conflicts or significant political instability in the region is likely to negatively affect business conditions and could significantly disrupt our operations in Israel, which would negatively impact our business. Further, many of our employees in Israel are subject to being called for active duty under emergency circumstances. If a military conflict or war arises, these individuals could be required to serve in the military for extended periods of time, and our operations in Israel could be disrupted by the absence of one or more key employees or a significant number of other employees for a significant period of time. Any such disruption could adversely affect our business.

Recently, the United States government has taken actions against certain of our customers, particularly in Asia, including indictments for various criminal charges, and in some cases, restrictions on doing business with such customers. In the event we are unable to do business with any such customer, we will lose the anticipated revenue from these product sales, the amount of which could be significant. In addition, such customers could also elect to purchase products from unaffected non-U.S. competitors, even when trade restrictions are not in place, jeopardizing our future long-term relationship with them. Further, compliance with regulatory restrictions may cause us to breach contractual obligations, which would result in costs, penalties and litigation.

As part of our business strategy, we have entered into and may enter into or seek to enter into business combinations and acquisitions that may be difficult to identify and complete, challenging and costly to integrate, disruptive to our business and our management, and/or dilutive to stockholder value.

Since our inception, we have made acquisitions and, as a part of our business strategy, we may enter into additional business combinations and acquisitions. Our most recent acquisitions of Newport in April 2016 and ESI in February 2019 have significantly increased our size, including with respect to revenue, product offerings, number of employees and facilities. Our ability to successfully identify suitable acquisition targets, complete acquisitions on acceptable terms, and efficiently and effectively integrate our acquired businesses, including our recent acquisitions, into our organization is critical to our growth. We may not be able to identify target companies that meet our strategic objectives or successfully negotiate and complete acquisitions with companies we have identified on acceptable terms. Further, we may incur significant expense in pursuing acquisitions that cannot be completed due to regulatory or other restrictions. Additionally, our credit facilities only permit us to make acquisitions under certain circumstances, and also restrict our ability to incur additional indebtedness in certain circumstances. Further, the process of integrating acquired companies into our operations requires significant resources and is time consuming, expensive and disruptive to our business. We may not realize the benefits we anticipate from these acquisitions because of the following significant challenges:

- the difficulty of integrating the operations, technology and personnel of the acquired companies;
- the potential disruption of our ongoing business and distraction of management;
- possible internal control weaknesses of the acquired companies;
- significant expenses related to the acquisitions, including any resulting shareholder litigation;
- the assumption of unknown or contingent liabilities associated with acquired businesses;
- the potential to incur or record significant cash or non-cash charges or write down the carrying value of intangible assets and goodwill obtained in the acquisition, which could adversely impact our cash flow or lower our earnings in the period or periods for which we incur such charges or write down such assets;
- potentially incompatible cultural differences between the two companies;
- incorporating the acquired company’s technology and products into our current and future product lines, and successfully generating market demand for these expanded product lines;
- potential additional geographic dispersion of operations;
- the difficulty in achieving anticipated synergies and efficiencies;
- the difficulty in leveraging the acquired company’s and our combined technologies and capabilities across our product lines and customer base;
- potential sales disruptions as a result of integrating the acquired company’s sales channels with our sales channels; and
- our ability to retain key customers, suppliers and employees of an acquired company.

We may also be placed at a competitive disadvantage by selling products in markets and geographies that are new to us. In addition, if we are not successful in completing acquisitions that we may pursue in the future, we may be required to re-evaluate our growth strategy, and we may incur substantial expenses and devote significant management time and resources in seeking to complete proposed acquisitions that may not generate benefits for us.

In addition, with future acquisitions, we could use substantial portions of our available cash as all or a portion of the purchase price. We could also issue additional securities as consideration for these acquisitions, which could cause significant stockholder dilution, or obtain additional debt financing, which could reduce our future cash flow, without achieving the desired accretion to our business. For example, in 2019, we used approximately $400 million of our available cash and obtained approximately $650 million of additional debt financing in order to acquire ESI. Further, our prior acquisitions and any future acquisitions may not ultimately help us achieve our strategic goals and may pose other risks to us.

As a result of our previous acquisitions, we have several different decentralized operating and accounting systems. We will need to continue to modify our accounting policies, internal controls, procedures and compliance programs to provide consistency across all of our operations. In order to increase efficiency and operating effectiveness and improve corporate visibility into our decentralized operations, we continue to review opportunities to integrate Enterprise Resource Planning (“ERP”) systems where practical. We expect to continue to integrate the ERP systems in phases over the next few years. Any future implementations may risk potential disruption of our operations during the conversion periods and the implementations could require significantly more management time and higher implementation costs than currently estimated.

An inability to convince semiconductor device manufacturers to specify the use of our products to our customers that are semiconductor capital equipment manufacturers would weaken our competitive position.

The markets for our products, in particular the semiconductor capital equipment market, are highly competitive. Our competitive success often depends upon factors outside of our control. For example, in some cases, semiconductor device manufacturers may direct semiconductor capital equipment manufacturers to use a specified supplier’s product in their equipment. Accordingly, for such products, our success will depend in part on our ability to have semiconductor device manufacturers specify that our products be used at their semiconductor fabrication facilities. In addition, we may encounter difficulties in changing established relationships of competitors that already have a large installed base of products within such semiconductor fabrication facilities.

If our products are not designed into successive generations of our customers’ products, we will lose significant net revenues during the lifespan of those products.

New products designed by capital equipment manufacturers typically have a lifespan of five to fifteen years. Our success depends on our products being designed into new generations of equipment. We must develop products that are technologically advanced so that they are positioned to be chosen for use in each successive generation of capital equipment. If customers do not choose our products, our net revenues may be reduced during the lifespan of our customers’ products. In addition, we must make a significant capital investment to develop products for our customers well before our products are introduced and before we can be sure that we will recover our capital investment through sales to the customers in significant volume. We are thus also at risk during the development phase that our products may fail to meet our customers’ technical or cost requirements and may be replaced by a competitive product or alternative technology solution. If that happens, we may be unable to recover our development costs.

Many of the markets and industries that we serve are subject to rapid technological change, and if we fail to introduce new and innovative products or improve our existing products, or if the adoption or applications we serve is not successful, our business, financial condition and results of operations will be harmed.

Many of our markets are characterized by rapid technological advances, evolving industry standards, shifting customer needs, new product introductions and enhancements, and the periodic introduction of disruptive technology that displaces current technology due to a combination of price, performance and reliability. For example, our recently acquired ESI division is largely dependent upon the mobile phone market (which we include within our industrial technologies market), which is subject to rapid technological changes. As a result, many of the products in our markets can become outdated quickly and without warning. We depend, to a significant extent, upon our ability to enhance our existing products, to anticipate and address the demands of the marketplace for new and improved and disruptive technologies, either through internal development or by acquisitions, and to be price competitive. If we or our competitors introduce new or enhanced products, it may cause our customers to defer or cancel orders for our existing products. If we or our competitors introduce disruptive technology that displaces current technology, existing product platforms or lines of business from which we generate significant revenue may be rendered obsolete. Further, if our customers or the industries we serve shift to technologies that do not utilize our platform of products, our business, financial condition and results of operations could be harmed.

Because many of our products are sophisticated and complex, they can be difficult to design and manufacture, and we may experience delays in introducing new products or enhancements to our existing products. If we do not introduce our new products or enhancements into the marketplace in a timely fashion, our customers may choose to purchase our competitors' products. Certain of our markets, such as the semiconductor capital equipment market and the mobile phone market, experience cyclicality and unevenness in capital spending, so if we fail to introduce new products in a timely manner we may miss market upturns, or may fail to have our products or subsystems designed into our customers' products. We may not be successful in acquiring, developing, manufacturing or marketing new products and technologies on a timely or cost-effective basis. If we fail to adequately introduce new, competitive products and technologies on a timely basis, our business, financial condition and results of operations will be harmed.

Further, we are constantly investing in products for emerging applications, and we expect to generate increasingly significant revenue levels from sales of products for these applications. These applications are evolving, and the extent to which they achieve widespread adoption or significant growth is uncertain. Many factors may affect the viability of widespread adoption or growth of these applications, including their cost-effectiveness, performance and reliability compared to alternatives. If these applications or our products for these applications are not widely adopted or fail to grow as we project, we will not generate the revenue growth we anticipate from sales of our products for these emerging applications, and our results of operations could be harmed.

Because the sales cycle for some of our products is long and difficult to predict, and certain of our orders are subject to rescheduling or cancellation, we may experience fluctuations in our operating results.

Many of our products are complex and customers for these products require substantial time to qualify our products and make purchase decisions. In addition, some of our sales to defense and security customers are under major defense programs that involve lengthy competitive bidding and qualification processes. These customers often perform, or require us to perform, extensive configuration, testing and evaluation of our products before committing to purchasing them, which can require a significant upfront investment by us. The sales cycle for these products from initial contact through shipment varies significantly, is difficult to predict and can last more than a year. If we fail to anticipate the likelihood, costs, or timing associated with sales of these products, or the cancellation or rescheduling of orders for these products, our business and results of operations would be harmed.

Our orders are generally subject to rescheduling without penalty or cancellation without penalty other than reimbursement for certain labor and material costs. We from time to time experience order rescheduling and cancellations, which can result in fluctuation of our operating results from period to period.

Certain of our markets, sales regions and customers may be adversely affected by a lack of government funding and the availability of credit.

Our worldwide sales to customers in the research and defense markets rely to a large extent on government funding for research and defense-related programs. Any decline in government funding as a result of reduced budgets in connection with fiscal austerity measures, revised budget priorities or other causes would likely result in reduced sales of our products that are purchased either directly or indirectly with government funding, which would have an adverse impact on our results of operations.

Concerns regarding the global availability of credit also may make it more difficult for our customers to raise capital, whether debt or equity, to finance their projects and purchases of capital equipment. Delays in our customers' ability to obtain such financing, or the unavailability of such financing, could adversely affect sales of our products and systems, including, but not limited to, high-value lasers and systems, and therefore harm our business and operating results.

We offer products for multiple markets and must face the challenges of supporting the distinct needs of each of the markets we serve.

We offer products for a number of very diverse markets. Because we operate in multiple markets, we must work constantly to understand the needs, standards and technical requirements of many different applications within these markets, and must devote significant resources to developing different products for these markets. Product development is costly and time consuming. We must anticipate trends in our customers' industries and develop products before our customers' products are commercialized. If we do not accurately predict our customers' needs and future activities, we may invest substantial resources in developing products that do not achieve broad market acceptance. Our growth prospects rely in part on successful entry into new markets, which depends on our displacing entrenched competitors who are more familiar with these markets and better known to customers. In many cases, we are attempting to enter or expand our presence in these new markets with newly-introduced products that are not yet proven in the industry. Our decision to continue to offer products to a given market or to penetrate new markets is based in part on our judgment of the size, growth rate and other factors that contribute to the attractiveness of a particular market. If our product offerings in any particular market are not competitive, our analyses of a market are incorrect or our sales and marketing approach for a market is ineffective, our business, financial condition and results of operations would be harmed.

Further, serving diverse markets requires an understanding of different sales cycles, and the development and maintenance of a complex global sales team and sales channels to support the markets' differing needs. It also requires dynamic operations that can support both complex, customized product builds as well as quick turn-around for commercial off-the-shelf sales. If we fail to provide the sales and operational support for our diverse markets, our business, financial condition and results of operations would be harmed.

Manufacturing interruptions or delays could affect our ability to meet customer demand and lead to higher costs, while the failure to estimate customer demand accurately could result in excess or obsolete inventory.

Our business depends on its timely supply of equipment, services and related products that meet the rapidly changing technical and volume requirements of our customers, which depends in part on the timely delivery of parts, components and subassemblies from suppliers, including contract manufacturers. Cyclical industry conditions and the volatility of demand for manufacturing equipment increase capital, technical, operational and other risks for us and for companies throughout our supply chain. We may also experience significant interruptions of our manufacturing operations, delays in our ability to deliver products or services, increased costs or customer order cancellations as a result of:

- volatility in the availability and cost of materials, including rare earth elements;
- information technology or infrastructure failures; and
- natural disasters or other events beyond our control (such as earthquakes, floods or storms, regional economic downturns, pandemics, social unrest, political instability, terrorism, or acts of war), particularly where we or our subcontractors and contract manufacturers conduct manufacturing.

In addition, if we need to rapidly increase our business and manufacturing capacity to meet increases in demand or expedited shipment schedules, this may exacerbate any interruptions in our manufacturing operations and supply chain and the associated effect on our working capital. Moreover, if actual demand for our products is different than expected, we may purchase more/fewer parts than necessary or incur costs for canceling, postponing or expediting delivery of parts. If we purchase inventory in anticipation of customer demand that does not materialize, or if our customers reduce or delay orders, we may incur excess inventory charges. Any or all of these factors could materially and adversely affect our business, financial condition and results of operations.

A material amount of our assets represents goodwill and intangible assets, and our net income would be reduced if our goodwill or intangible assets become impaired.

As of December 31, 2018, our goodwill and intangible assets, net, represented approximately $906.8 million, or 35% of our total assets. Goodwill is generated in our acquisitions when the cost of an acquisition exceeds the fair value of the net tangible and identifiable intangible assets we acquire. As a result of the ESI acquisition, we expect to add in excess of $500 million of additional goodwill and intangible assets. Goodwill is subject to an impairment analysis at least annually based on the fair value of the reporting unit. Intangible assets relate primarily to the developed technologies, customer relationships and patents and trademarks acquired by us as part of our acquisitions of other companies and are subject to an impairment analysis whenever events or changes in circumstances exist that indicate that the carrying value of the intangible asset might not be recoverable. We will continue to monitor and evaluate the carrying value of goodwill and intangible assets. If market and economic conditions or business performance deteriorate, the likelihood that we would record an impairment charge would increase, which impairment charge could materially and adversely affect our results of operations.

We operate in highly competitive industries.

The markets for our products are intensely competitive, and we believe that competition from both new and existing competitors will increase in the future. Principal competitive factors include:

- historical customer relationships;
- continued technological advancement;
- product quality, performance and price;
- breadth of product line;
- manufacturing capabilities; and
- customer service and support.

Although we believe that we compete favorably with respect to these factors, we may not be able to continue to do so. We encounter substantial competition in most of our product lines. Certain of our competitors may enjoy greater name recognition and have greater financial, technical, marketing and other resources than we have, and some may have lower material costs than ours due to their control over sources of components and raw materials. In some cases, competitors are smaller than we are, but well established in specific product niches. We may encounter difficulties in changing established relationships of competitors with a large installed base of products at such customers' fabrication facilities. In addition, our competitors can be expected to continue to improve the design and performance of their products. Competitors may develop products that offer price, performance or technological features superior to those of our products. If our competitors develop superior products, we may lose existing customers and market share. Further, technological advances in our served markets may cause one or more of our portfolio of products to be displaced over time. We also face competition in some of our markets from our existing and potential customers who have developed or may develop products that are competitive to ours, or who engage subcontract manufacturers or system integrators to manufacture products or systems on their behalf.

Increased pressure on price may result in pricing concessions, extended payment terms and decreased margins.

We have experienced and continue to experience pricing pressure from both competitors and customers in the sale of our products. New entrants to our markets have offered aggressive price and payment terms in an attempt to gain market share. Some competitors, particularly in China, also develop low-cost competitive products. Pricing pressures typically have become even more intense during cyclical downturns in the semiconductor industry, when competitors seek to maintain or increase market share, reduce inventory or introduce more technologically advanced or lower-cost products. In addition, we may agree to pricing concessions or extended payment terms with our customers in connection with expanding into new markets or gaining volume orders, or to improve our customer cost of ownership in highly competitive applications. Our business, financial condition, gross margins or results of operations may be materially and adversely affected by competitive pressure and price-based competition.

If significant additional tariffs or other trade restrictions are placed on our products made in China and/or the components that we or our suppliers source from China, our business, financial condition and results of operations may be materially harmed.

General trade tensions between the U.S. and China have been escalating throughout 2018 and into 2019, with one round of U.S. tariffs on Chinese goods taking effect in July 2018, and a second round implemented in September 2018. Although we do not anticipate a material impact on our products made in China from the first and second rounds of U.S. tariffs, a third round of tariffs has been proposed by the U.S. In July 2018, the Trump Administration proposed a new list of thousands of categories of goods, including electronics, that could face tariffs of 10%. The Trump Administration subsequently proposed that the third round tariffs be increased from 10% to 25%. If the proposed new tariff list remains unaltered and these additional tariffs are placed on our products made in China and/or the components that we or our suppliers source from China, or any related counter-measures are taken by China, as we ship certain of our products from the U.S. into China, our business, financial condition and results of operations may be materially harmed. We will explore all of our options to reduce the potential impact of these proposed tariffs on our business, including but not limited to, seeking alternative sources for our components, modifying other business practices, raising our prices, and shifting production outside of China. Additionally, the Trump Administration continues to signal that it may alter trade agreements and terms between China and the United States, including limiting trade with China, and may impose additional tariffs on imports from China. Even if the currently proposed tariffs are not imposed on our products or on the components that we or our suppliers source from China, it is possible further tariffs will be imposed on imports of our products or the components used in our products, or that our business will be impacted by retaliatory tariffs imposed by China or other countries in response to existing or future tariffs, causing us to seek alternative suppliers, raise prices or make changes to our operations, any of which could materially harm our business, financial condition and results of operations.

Key personnel may be difficult to attract and retain.

Our ability to maintain and grow our business is directly related to the service of our employees in each area of our business. Our future performance will be directly tied to our ability to hire, train, motivate and retain qualified personnel, including highly skilled technical, financial, managerial and sales and marketing personnel. Competition for personnel in the technology marketplace is intense, particularly in certain geographies where we are located, and we cannot be certain that we will be successful in attracting and retaining such personnel. In addition, many of our product manufacturing processes require deep technical expertise, and these positions can be particularly challenging to fill. We have from time to time in the past experienced attrition in certain key positions, and we expect to continue to experience this attrition in the future. If we are unable to hire sufficient numbers of employees with the experience and skills we need or to retain and motivate our existing employees, our business and results of operations would be harmed.

Our failure to successfully manage our offshore manufacturing locations or the transition of certain of our manufacturing operations to other locations and/or to contract manufacturers could harm our business, financial condition and results of operations.

As part of our continuous cost-reduction efforts, we continue to relocate the manufacture of certain of our existing product lines and subassemblies to, and initiate the manufacture of certain new products in, our facilities in China, Israel, Singapore and Romania, as well as to our significant subcontracted operations in Mexico and selected contract manufacturers in Asia. In the future, we may expand the level of manufacturing, administrative and certain other operations that we perform offshore in order to take advantage of cost efficiencies available to us in those countries. However, we may not achieve the significant cost savings or other benefits that we would anticipate from moving manufacturing and other operations to a lower cost region. Additionally, if we are unable to successfully manage the relocation, initiation or oversight of the manufacture of these products, our business, financial condition and results of operations could be harmed.

In particular, transferring product lines to other manufacturing locations and/or to our contract manufacturers' facilities often requires us to transplant complex manufacturing equipment and processes across a large geographical distance and to train a completely new workforce concerning the use of this equipment and these processes. In addition, certain of our customers may require the requalification of products supplied to them in connection with the relocation of manufacturing operations. If we are unable to manage this transfer and training smoothly and comprehensively, or if we are unable to complete the requalification of products in a timely manner, we could suffer manufacturing and supply chain delays, excessive product defects, harm to our results of operations and our reputation with our customers, and loss of customers. Further, the utilization of overseas contract manufacturers may require additional customs tariffs or may require export licenses, which may be difficult or costly to obtain. We also may not realize the cost savings that we currently anticipate from locating operations in Mexico, China, Israel, Romania and Singapore. For example, we are experiencing rising material, labor and shipping costs in China and the potential for new tariffs on our products manufactured in China and Mexico.

Additionally, qualifying contract manufacturers and commencing volume production are expensive and time-consuming activities, and there is no guarantee we will continue to do so successfully. Further, our reliance on contract manufacturers reduces our control over the assembly process, quality assurance, production costs and material and component supply for our products. If we fail to manage our relationship with our contract manufacturers, or if any of the contract manufacturers experience financial difficulty, or delays, disruptions, capacity constraints or quality control problems in their operations, our ability to ship products to our customers could be impaired and our competitive position and reputation could be harmed. Further, if we or our contract manufacturers are unable to negotiate with suppliers for reduced component costs, our operating results could be harmed.

In addition, our contract manufacturers may terminate our agreements with them upon prior notice to us or immediately for reasons such as if we become insolvent, or if we fail to perform a material obligation under the agreements. If we are required to change contract manufacturers or assume internal manufacturing operations for any reason, including the termination of one of our contracts, we will likely suffer manufacturing and shipping delays, lost revenue, increased costs and damage to our customer relationships, any of which could harm our business, financial condition and results of operations.

Our products could contain defects, which would increase our costs and seriously harm our business, operating results, financial condition and customer relationships.

Many of our products are inherently complex in design and, in some cases, require extensive customization and/or ongoing regular maintenance. Further, the manufacture of these products often involves a highly complex and precise process and the utilization of specially qualified components that conform to stringent specifications. Several of our products require highly skilled labor. As a result of the technical complexity of these products, design defects, skilled labor turnover, changes in our or our suppliers' manufacturing processes or the inadvertent use of defective or nonconforming materials by us or our suppliers could adversely affect our manufacturing yields and product reliability. This could in turn harm our business, operating results, financial condition and customer relationships.

We provide warranties for our products, and we accrue allowances for estimated warranty costs at the time we recognize revenue for the sale of the products. The determination of such allowances requires us to make estimates of product return rates and expected costs to repair or replace the products under warranty. We establish warranty reserves based on historical warranty costs for our products. If actual return rates or repair and replacement costs differ significantly from our estimates, our results of operations could be negatively impacted. In particular, ESI's system products are extremely complex, and have historically had much higher warranty costs as a percentage of revenues than our other products. As a result, our overall warranty costs as a percentage of revenues will likely increase as a result of our acquisition of ESI.

Our customers may discover defects in our products after the products have been fully deployed and operated under peak stress conditions. In addition, some of our products are combined with products from other suppliers, which may contain defects. Furthermore, some of our customers use our products in ways other than their intended purpose. As a result, should problems occur, it may be difficult to identify the source of the problem. If we are unable to identify and fix defects or other problems, we could experience, among other things:

- loss of customers;
- increased costs of product returns and warranty expenses;
- increased costs required to analyze and mitigate the defects or problems;
- damage to our reputation;
- failure to attract new customers or achieve market acceptance;
- diversion of development and engineering resources; and/or
- legal action by our customers.

The occurrence of any one or more of the foregoing factors could seriously harm our business, financial condition and results of operations.

We are exposed to various risks related to legal proceedings, including product liability claims and intellectual property infringement claims, which if successful, could have a material adverse effect on our business, financial condition and results of operations.

From time to time, we may be involved in legal proceedings or claims regarding product performance, product liability, patent infringement, intellectual property rights, antitrust, environmental regulations, securities, contracts, unfair competition, misappropriation of trade secrets, employment, workplace safety, and other matters.

For example, some of our products, such as certain ultrafast lasers, are used in medical applications where malfunctions could result in serious injury. In addition, certain of our products may be hazardous if not operated properly or if defective. We are exposed to significant risks for product liability claims if death, personal injury or property damage results from the use of our products. We may experience material product liability losses in the future. We currently maintain insurance for certain product liability claims. However, our insurance coverage may not continue to be available on terms that we accept, if at all. This insurance coverage also may not adequately cover liabilities that we incur. Further, if our products are defective, we may be required to recall or redesign these products. A successful claim against us that exceeds our insurance coverage level or that is not covered by insurance, or any product recall, could have a material adverse effect on our business, financial condition and results of operations.

In addition, we are currently involved in securities class action litigation in connection with the acquisitions of Newport and ESI. In each case, the plaintiffs have alleged, among other things, that the then-current directors of each such acquired company breached their fiduciary duties to their respective shareholders by agreeing to sell such company through an inadequate and unfair process, leading to inadequate and unfair consideration, by agreeing to unfair deal protection devices, and by omitting material information from the proxy statement.

Regardless of the outcome, securities class action litigation such as this can be time-consuming, result in significant expense to the Company and divert attention and resources of our management and other key employees. Costs and expenses, or an unfavorable outcome in such cases, could exceed applicable insurance coverage, if any. Any such unfavorable outcome could have a material adverse effect on our business, financial condition, results of operations and cash flows.

With respect to our intellectual property, we have from time to time received claims from third parties alleging that we are infringing certain trademarks, patents or other intellectual property rights held by them. Such infringement claims have in the past and may in the future result in litigation. Any such litigation could be protracted and costly, and we could become subject to damages for infringement, or to an injunction preventing us from selling one or more of our products or using one or more of our trademarks. Such claims could also result in the necessity of obtaining a license relating to one or more of our products or current or future technologies, which may not be available on commercially reasonable terms or at all. Any intellectual property litigation and the failure to obtain necessary licenses or other rights or develop substitute technology may divert management's attention from other matters and could have a material adverse effect on our business, financial condition and results of operations. In addition, the terms of our customer contracts typically require us to indemnify the customer in the event of any claim of infringement brought by a third party based on our products. Any claims of this kind may have a material adverse effect on our business, financial condition or results of operations.

We also on occasion receive notification from customers who believe that we owe them indemnification or other obligations related to other claims made against such customers by third parties. Legal proceedings and claims, whether with or without merit, and associated internal investigations, may be time-consuming and expensive to prosecute, defend or conduct; divert management's attention and other of our resources; inhibit our ability to sell our products; result in adverse judgments for damages, injunctive relief, penalties and fines; and negatively affect our business. There can be no assurance regarding the outcome of current or future legal proceedings, claims or investigations.

We are subject to international trade compliance regulations, and violations of those regulations could result in fines or trade restrictions, which could have a material adverse effect on us.

We are subject to trade compliance laws in both the United States and other jurisdictions where we operate. For example, exports of our products and technology developed or manufactured in the U.S. are subject to export controls imposed by the U.S. Government and administered by the U.S. Departments of Commerce, State and Treasury. Similar export regulations govern exports of our products and technology developed or manufactured in certain other countries, including Austria, France, Germany, Israel, Romania and Singapore. In certain instances, these regulations may require obtaining licenses from the administering agency prior to exporting products or technology to international locations or foreign nationals, including foreign nationals employed by us in the United States and abroad. For products and technology subject to the U.S. Export Administration Regulations administered by the U.S. Department of Commerce's Bureau of Industry and Security, the requirement for a license is dependent on the type and end use of the product and technology, the final destination and the identity and nationality of the end user. Virtually all exports from the United States of defense articles subject to the International Traffic in Arms Regulations, administered by the Department of State's Directorate of Defense Trade Controls, require a license. The Israeli Ministry of Economy and the Defense Export Control Agency of the Israeli Ministry of Defense administer similar export regulations and license requirements, which apply to many of our products and technology developed or manufactured in Israel. In addition, the Romanian Ministry of Foreign Affairs and the Department for Export Controls administer similar export regulations and license requirements, which apply to many of our products and technology developed or manufactured in Romania. Obtaining export licenses can be difficult and time-consuming, and we may not be successful in obtaining them. Failure to obtain export licenses to enable product and technology exports could reduce our revenue, harm our relationships with our customers and could adversely affect our business, financial condition and results of operations. Compliance with export regulations may also subject us to additional fees and costs. The absence of comparable export restrictions on competitors in other countries may adversely affect our competitive position. In addition, if we or our international representatives or distributors fail to comply with any of these export regulations, we or they could be subject to civil and criminal, monetary and non-monetary penalties, disruptions to our business, restrictions on our ability to export products and technology and damage to our reputation, and our business and results of operations could be significantly harmed. While we have implemented policies and procedures to comply with these laws, we cannot be certain that our employees, contractors, suppliers or agents will not violate such laws or our policies. For example, as a result of a 2012 U.S. Government investigation, a former employee of our Shanghai office and a third party not affiliated with us were imprisoned for export violations relating to the sale of certain of our products. We were not a target of the government's investigation and we cooperated fully with the government's investigation. In addition, although we conducted our own internal investigation and took corrective human resources actions and have, since 2012, implemented additional export compliance procedures, we cannot be certain these efforts will be sufficient to avoid similar situations in the future.

Unfavorable currency exchange rate fluctuations may lead to lower operating margins or may cause us to raise or reduce prices, which could result in reduced sales.

A significant portion of our net revenues are from customers in international markets. For the years 2018, 2017 and 2016, international net revenues accounted for approximately 51%, 50% and 48% of our total revenues, respectively. Currency exchange rate fluctuations could have an adverse effect on our net revenues and results of operations and we could experience losses with respect to our hedging activities. Unfavorable currency fluctuations could require us to increase or decrease prices to foreign customers, which could result in lower net revenues from such customers. Alternatively, if we do not adjust the prices for our products in response to unfavorable currency fluctuations, our results of operations could be adversely affected by declining net revenues or profit margins for our products in international markets when the sales are translated into U.S. dollars. Such exchange rate fluctuations could also increase the costs and expenses of our non-U.S. operations when translated into U.S. dollars or require us to modify our current business practices. In addition, most sales made by our foreign subsidiaries are denominated in the currency of the country in which these products are sold and the currency they receive in payment for such sales could be less valuable at the time of receipt as a result of exchange rate fluctuations. We enter into forward foreign exchange contracts to reduce a portion of our currency exposure arising from intercompany sales of inventory as well as intercompany accounts receivable and intercompany loans. However, we cannot be certain that our efforts will be adequate to protect us against significant currency fluctuations or that such efforts will not expose us to additional exchange rate risks.

Changes in tax rates or tax regulation could affect results of operations.

As a global company, we are subject to taxation in the United States and various other countries. Significant judgment is required to determine and estimate worldwide tax liabilities. Our future annual and quarterly effective tax rates could be affected by numerous factors, including changes in the applicable tax laws; composition of pre-tax income in countries with differing tax rates; and/or valuation of our deferred tax assets and liabilities.

The enactment of the Tax Cuts and Jobs Act (the "Act") in December 2017 significantly affected U.S. tax law by changing how the U.S. imposes tax on multinational corporations. The U.S. Department of Treasury has broad authority under the Act to issue regulations and interpretive guidance. No proposed or final regulations have been issued for significant provisions of the Act, and other provisions may require corrective action by Congress. In addition, some of the proposed and final regulations that have been issued have been challenged in court. We have applied available guidance to estimate our tax obligations, but new guidance issued by the U.S. Treasury Department may cause us to make adjustments to our tax estimates in future periods. The Securities and Exchange Commission has issued Staff Accounting Bulletin No. 118 ("SAB 118") acknowledging that companies will potentially encounter situations for which the analysis of certain income tax effects of the Act will be incomplete by the time financial statements are required to be issued for reporting periods that include the enactment date. In these situations, SAB 118 provides that reasonable estimates may be made for certain effects of the Act up to one year from enactment. We recorded provisional amounts with respect to the Act at December 31, 2017 and for the nine months ended September 30, 2018. During the quarter ended December 31, 2018, we completed our analysis and finalized the provisional amounts that were previously recorded. The ultimate impact of this Act is based upon our understanding and interpretation of the regulatory guidance that has been issued regarding the Act.

In addition, we are subject to regular examination by the United States Internal Revenue Service and state, local and foreign tax authorities. We regularly assess the likelihood of favorable or unfavorable outcomes resulting from these examinations to determine the adequacy of our provision for income taxes. Although we believe our tax estimates are reasonable, there can be no assurance that any final determination will not be materially different from the treatment reflected in our historical income tax provisions and accruals, which could materially and adversely affect our financial condition and results of operations.

We are exposed to risks related to cybersecurity threats and incidents.

We rely on various information technology networks and systems, some of which are managed by third parties, to process, transmit and store electronic information and to carry out and support a variety of business activities, including manufacturing, research and development, supply chain management, sales and accounting. This information includes confidential information belonging to us, our customers and our business partners as well as personally-identifiable information of individuals. We have experienced, and expect to continue to be subject to, cybersecurity threats and incidents ranging from employee error or misuse to individual attempts to gain unauthorized access to information systems to sophisticated and targeted measures known as advanced persistent threats, none of which have materially affected our financial condition or results of operations to date. While we devote significant resources to network security, data encryption and other measures to protect our systems and information from unauthorized access or misuse, a failure in or a breach of our operational or security systems or infrastructure, or those of our suppliers and other business partners, including as a result of cyber-attacks, could disrupt our business; result in the disclosure, misuse or loss of confidential information and critical data; damage our reputation; cause data privacy issues; decrease the value of our investment in research, development and engineering; cause losses; result in litigation with third parties; and increase our cybersecurity protection and remediation costs.

Changes in laws and regulations governing data privacy and data protection could have a material adverse impact on our business.

We are subject to data privacy laws and regulations that apply to the collection, transmission, storage and use of personally identifiable information, as well as numerous other countries, federal and state privacy and breach notification laws, including the California Consumer Privacy Act, which gives California residents rights with respect to the nature, sources and uses of their personal information by companies. We are also subject to many international data protection laws and regulations, including the General Data Protection Regulation, which imposes robust European Union (“EU”) data protection requirements and provides for significant penalties for noncompliance. The EU regulations also established a prohibition on the transfer of personal information from the EU to other countries whose laws do not protect personal data to an adequate level of privacy or security. While we have utilized certain permitted approaches for transferring personal information from the European Union to the United States, these approaches may be reviewed and invalidated by the EU courts or regulatory bodies and we may be required to ascertain an alternative legal basis for such transfers. In addition, certain countries have and will continue to modify or adopt more stringent data protection standards.

While we continue to assess and address the implications of existing and new domestic and foreign regulations relating to data privacy, the evolving regulatory landscape presents a number of legal and operational challenges, and our efforts to comply may be unsuccessful. We may also face audits or investigations by one or more government agencies relating to our compliance with these regulations that could result in the imposition of penalties or fines, significant expenses in facilitating and responding to the investigations, and overall reputational harm or negative publicity. The costs of compliance with, and other burdens imposed by, such laws, regulations and policies that are applicable to us including, restrictions on marketing activities, could have a material adverse effect on our business, financial condition and results of operations.

Our proprietary technology is important to the continued success of our business. Our failure to protect this proprietary technology may significantly impair our competitive position.

Our success and ability to compete depend in large part upon protecting our proprietary technology. We rely on a combination of patent, trademark and trade secret protection and nondisclosure agreements to protect our proprietary rights. The steps we have taken may not be sufficient to prevent the misappropriation of our intellectual property, particularly in countries outside the United States, where the laws may not protect our proprietary rights as fully as in the United States. For example, the patent prosecution and enforcement systems within China, where we have a significant customer base and manufacturing presence, are less robust than these systems in other international jurisdictions and as a result, we may be limited in our ability to enforce our intellectual property rights there. We would also likely be at a disadvantage in any enforcement proceeding in China as a foreign entity seeking protection against a Chinese company. Patent and trademark laws and trade secret protection may not be adequate to deter third party infringement or misappropriation of our patents, trademarks and similar proprietary rights. In addition, patents issued to us may be challenged, invalidated or circumvented. Our rights granted under those patents may not provide competitive advantages to us, and the claims under our patent applications may not be allowed. The loss or expiration of any of our key patents could lead to a significant loss of sales of certain of our products and could materially affect our future results of operations. We have in the past and may in the future be subject to or may initiate interference proceedings in the United States Patent and Trademark Office, which can demand significant financial and management resources. The process of seeking patent protection can be time consuming and expensive and patents may not be issued from currently pending or future applications. Moreover, our existing patents or any new patents that may be issued may not be sufficient in scope or strength to provide meaningful protection or any commercial advantage to us. We may initiate claims or litigation against third parties for infringement of our proprietary rights in order to determine the scope and validity of our proprietary rights or the proprietary rights of our competitors, which claims could result in costly litigation, the diversion of our technical and management personnel and the assertion of counterclaims by the defendants, including counterclaims asserting invalidity of our patents. We will take such actions where we believe that they are of sufficient strategic or economic importance to us to justify the cost.

The market price of our common stock has fluctuated and may continue to fluctuate for reasons over which we have no control.

The stock market has from time to time experienced, and is likely to continue to experience, extreme price and volume fluctuations. Prices of securities of technology companies have been especially volatile and have often fluctuated for reasons that are unrelated to the operating performance of the companies. Historically, the market price of shares of our common stock has fluctuated greatly and could continue to fluctuate due to a variety of factors. In the past, companies that have experienced volatility in the market price of their stock have been the objects of securities class action litigation. If we were the object of such securities class action litigation, it could result in substantial costs and a diversion of our management’s attention and resources.

We may not pay dividends on our common stock.

Holders of our common stock are only entitled to receive such dividends when and if they are declared by our Board of Directors. Further, our credit facilities restrict our ability to pay dividends on our capital stock under certain circumstances. Although we have declared cash dividends on our common stock since 2011, and occasionally increased the dividends from prior quarters, we are not required to do so and we may reduce or eliminate our cash dividend in the future. This could adversely affect the market price of our common stock.

Our dependence on sole and limited source suppliers, and international suppliers, could affect our ability to manufacture products and systems.

We rely on sole and limited source suppliers and international suppliers for some of our components and subassemblies that are critical to the manufacturing of our products due to unique component designs as well as specialized quality and performance requirements needed to manufacture our products. This reliance involves several risks, including the following:

- the potential inability to obtain an adequate supply of required components;
- quality and reliability problems with components, which in turn adversely affects our products' quality and reliability;
- reduced control over pricing and timing of delivery of components; and
- the potential inability of our suppliers to develop technologically advanced products to support our growth and development of new products.

We believe we could obtain and qualify alternative sources for most sole and limited source and international supplier parts; however, the transition time may be long if we were required to obtain alternative sources. Seeking alternative sources for these parts could require us to redesign our systems, resulting in increased costs and likely shipping delays. In such an event, any inability to redesign our systems could result in further costs and shipping delays. These increased costs would decrease our profit margins if we could not pass the costs to our customers. Further, shipping delays could damage our relationships with current and potential customers and have a material adverse effect on our business and results of operations.

In addition, we obtain some of the critical capital equipment we use to manufacture certain of our products from sole or limited sources due to the unique nature of the equipment. In some cases, such equipment can only be serviced by the manufacturer or a very limited number of service providers due to the complex and specialized nature of the equipment. If service and/or spare parts for such equipment become unavailable, such equipment could be rendered inoperable, which could cause delays in the production of our products, and could require us to procure alternate equipment, if available, which would likely involve long lead times and significant additional cost, and could harm our results of operations.

We are subject to environmental regulations. If we fail to comply with these regulations, our business could be harmed.

Our operations are subject to various federal, state, local and international regulations relating to the protection of the environment, including those governing discharges of pollutants into the air and water, the management and disposal of hazardous substances and waste and the cleanup of contaminated sites. In the United States, we are subject to the federal regulation and control of the Environmental Protection Agency ("EPA"), and we are subject to comparable authorities in other countries. Some of our operations require environmental permits and controls to prevent and reduce air and water pollution, and these permits are subject to modification, renewal and revocation by issuing authorities. Future developments, administrative actions or liabilities relating to environmental matters could have a material adverse effect on our business, results of operations or financial condition.

Although we believe that our safety procedures for using, handling, storing and disposing of such materials comply with the standards required by state and federal laws and regulations, we cannot completely eliminate the risk of accidental contamination or injury from these materials. We have been, and may in the future be, subject to claims by employees or third parties alleging such contamination or injury, and could be liable for damages, which liability could exceed the amount of our liability insurance coverage (if any) and the resources of our business.

Certain portions of the soil at the former facility of our Spectra-Physics business, located in Mountain View, California, and certain portions of the aquifer surrounding the facility, through which contaminated groundwater flowed, are part of an EPA-designated Superfund site and are subject to a cleanup and abatement order from the California Regional Water Quality Control Board. Spectra-Physics, which we acquired as part of the Newport acquisition in April 2016 and which had been acquired by Newport in 2004, along with other entities with facilities located near the Mountain View, California facility, were identified as responsible parties with respect to this Superfund site, due to releases of hazardous substances during the 1960s, 1970s and 1980s. Spectra-Physics and the other responsible parties entered into cost-sharing agreements covering the costs of remediating the off-site groundwater impact. The site is mature, and investigations, monitoring and remediation efforts by the responsible parties have been ongoing for approximately 30 years.

We have certain ongoing costs related to investigation, monitoring and remediation of the site that have not been material to us as a whole in the recent past. However, while we benefitted from the indemnification of certain costs by a third party in the past, that indemnification is now in a transition period, and we will become subject to a greater portion of future costs of remediation going forward. Our ultimate costs of remediation and other potential liabilities are difficult to predict. In the event that the EPA and the California Regional Water Quality Control Board determine that the site cleanup requires additional measures to ensure that it meets current standards for environmental contamination, or if they enhance any of the applicable required standards, we will likely become subject to additional remediation obligations in the future. In addition to our investigation, monitoring and remediation obligations, we may be liable for property damage or personal injury claims relating to this site. While we are not aware of any material claims at this time, such claims could be made against us in the future. If significant costs or other liability relating to this site arise in the future, our business, financial condition and results of operations could be adversely affected.

The environmental regulations that we are subject to include a variety of federal, state, local and international environmental regulations that restrict the use and disposal of materials used in the manufacture of our products or require design changes or recycling of our products. If we fail to comply with any present or future regulations, we could be subject to future liabilities, the suspension of manufacturing or a prohibition on the sale of products we manufacture. In addition, such regulations could restrict our ability to equip our facilities or could require us to acquire costly equipment, or to incur other significant expenses to comply with environmental regulations, including expenses associated with the recall of any non-compliant product and the management of historical waste.

For example, the European Union has enacted the Restriction on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Directive, which regulates the use of certain hazardous substances in certain products, and the Waste Electrical and Electronic Equipment Directive, which requires the collection, reuse and recycling of waste from certain products. Compliance with such laws requires significant resources. These regulations may require us to redesign our products or source alternative components to ensure compliance with applicable requirements, for example by mandating the use of different types of materials in certain components. Any such redesign or alternative sourcing may increase the cost of our products, adversely impact the performance of our products, add greater testing lead-times for product introductions, or in some cases limit the markets for certain products. Further, such environmental laws are frequently amended, which increases the cost and complexity of compliance. For example, such amendments have in the past, and may in the future, result in certain of our products falling in the scope of the directive, even if they were initially exempt. In addition, certain of our customers, particularly OEM customers whose end products may be subject to these directives, may require that the products we supply to them comply with these directives, even if not mandated by law. Because certain directives, for example, those issued from the European Union are implemented in individual member states, compliance is particularly challenging. Our failure to comply with any of such regulatory requirements or contractual obligations could result in our being directly or indirectly liable for costs, fines or penalties and third-party claims, and could jeopardize our ability to conduct business in certain countries.

Some provisions of our restated articles of organization, as amended, our amended and restated by-laws and Massachusetts law could discourage potential acquisition proposals and could delay or prevent a change in control.

Anti-takeover provisions could diminish the opportunities for stockholders to participate in tender offers, including tender offers at a price above the then current market price of our common stock. Such provisions may also inhibit increases in the market price of our common stock that could result from takeover attempts. For example, while we have no present plans to issue any preferred stock, our Board of Directors, without further stockholder approval, may issue preferred stock that could have the effect of delaying, deterring or preventing a change in control of us. The issuance of preferred stock could adversely affect the voting power of the holders of our common stock, including the loss of voting control to others. In addition, our amended and restated by-laws provide for a classified Board of Directors consisting of three classes. Our classified board could also have the effect of delaying, deterring or preventing a change in control of our Company.

Item 1B. ***Unresolved Staff Comments***

None.

Table of Contents

Item 2. *Properties*

The following table provides information concerning MKS' principal and certain other owned and leased facilities as of December 31, 2018:

Country	City	Sq. Ft.	Activity	Reportable Segment	Lease Expires
CHINA	Shenzhen	302,000	Manufacturing	Vacuum & Analysis	August 31, 2025
	Wuxi	64,500	Manufacturing	Light & Motion	October 31, 2021
FRANCE	(1)	183,000	Manufacturing, Research and Development	Light & Motion	Owned
ISRAEL	Jerusalem	118,000	Manufacturing, Sales, Research and Development	Light & Motion	(2)
MEXICO	Nogales	174,700	Manufacturing, Service	Vacuum & Analysis and Light & Motion	(3)
UNITED STATES	Andover, MA	158,000	Corporate Headquarters, Manufacturing, Research and Development	(4)	(4)
	Boulder, CO	86,000	Manufacturing, Customer Support, Service, Research and Development	Vacuum & Analysis	(5)
	Franklin, MA	55,600	Manufacturing, Customer Support, Research and Development	Light & Motion	January 31, 2026
	Irvine, CA	254,900	Manufacturing, Research and Development	Light & Motion	(6)
	Longmont, CO	60,900	Manufacturing, Customer Support, Service, Research and Development	Vacuum & Analysis	February 29, 2020
	Methuen, MA	85,000	Manufacturing, Customer Support, Service, Research and Development	Vacuum & Analysis	Owned
	Rochester, NY	46,000	Manufacturing, Customer Support, Research and Development	Light & Motion	(7)
	Rochester, NY	156,000	Manufacturing, Sales, Customer Support, Service, Research and Development	Vacuum & Analysis	Owned
	Santa Clara, CA	139,500	Manufacturing, Customer Support, Research and Development	Light & Motion	March 31, 2021
	Wilmington, MA	118,000	Manufacturing, Customer Support, Service, Research and Development	Vacuum & Analysis	Owned

(1) MKS owns two facilities, one in Beaune-la-Rolande with 57,000 square feet and one in Brigueil with 126,000 square feet.

(2) MKS owns one facility with 70,000 square feet and leases two other facilities with 38,000 square feet and 10,000 square feet, both with a lease expiration date of December 31, 2020.

(3) MKS Vacuum & Analysis leases a facility with 124,200 square feet with a lease expiration date of September 1, 2023 and also leases another facility for Light & Motion with 50,500 square feet with a lease expiration date of July 31, 2028.

(4) MKS owns one facility with 82,000 square feet and leases another facility with 76,000 square feet with a lease expiration date of November 30, 2026. In addition to the Company's Corporate Headquarters, manufacturing and research and development activities for Vacuum & Analysis take place in Andover, MA.

(5) MKS owns two facilities which aggregate to 47,000 square feet and leases another facility with 39,000 square feet with a lease expiration date of May 31, 2020.

(6) MKS leases a facility with 212,300 square feet with a lease expiration date of February 28, 2022, of which 20,000 square feet is vacant. MKS leases another facility with 42,600 square feet with a lease expiration date of February 28, 2022, which is currently vacant.

(7) MKS leases one facility with 6,000 square feet with a lease expiration date of September 27, 2184 and leases another facility with 40,000 square feet with a lease expiration date of July 31, 2021.

In addition to the material manufacturing and other operations conducted at the above listed leased or owned facilities, MKS also provides manufacturing, worldwide sales, customer support and services from various other leased and owned facilities throughout the world not listed in the table above. See "Business—Sales, Marketing, Service and Support."

Item 3. *Legal Proceedings*

Newport Litigation

In March 2016, two putative class actions lawsuit captioned Dixon Chung v. Newport Corp., et al., Case No. A-16-733154-C and Hubert C. Pincon v. Newport Corp., et al., Case No. A-16-734039-B were filed in the District Court, Clark County, Nevada on behalf of a putative class of stockholders of Newport Corporation ("Newport") for claims related to the Merger Agreement between the Company, Newport, and Merger Sub. The lawsuits named as defendants the Company, Newport, Merger Sub, and certain then current and former members of Newport's board of directors. Both complaints alleged that Newport directors breached their fiduciary duties to Newport's stockholders by agreeing to sell Newport through an inadequate and unfair process, which led to inadequate and unfair consideration, by agreeing to unfair deal protection devices and by omitting material information from the proxy statement. The complaints also alleged that the Company, Newport, and Merger Sub aided and abetted the directors' alleged breaches of their fiduciary duties. The complaints sought injunctive relief, including to enjoin or rescind the Merger Agreement, and an award of attorneys' and other fees and costs, among other relief. On April 14, 2016, the Court consolidated the actions.

On October 19, 2016, plaintiffs in the consolidated action filed an amended complaint captioned In re Newport Corporation Shareholder Litigation, Case No. A-16-733154-B, in the District Court, Clark County, Nevada, on behalf of a putative class of Newport's stockholders for claims related to the Merger Agreement. The amended complaint contained substantially similar allegations related to Newport's former board of directors' alleged breaches of their fiduciary duties to Newport's stockholders. The amended complaint sought monetary damages, including pre- and post-judgment interest. On June 22, 2017, the Court granted Defendants' motion to dismiss and dismissed the amended complaint against all defendants but granted plaintiffs leave to amend.

On July 27, 2017, plaintiffs filed a second amended complaint containing substantially similar allegations but naming only Newport's former directors as defendants. On August 8, 2017, the Court dismissed the Company and Newport from the action. The second amended complaint seeks monetary damages, including pre- and post-judgment interest. The Court granted a motion for class certification on September 27, 2018, appointing Mr. Pincon and Locals 302 and 612 of the International Union of Operating Engineers—Employers Construction Industry Retirement Trust as class representatives. On June 11, 2018, plaintiff Dixon Chung was voluntarily dismissed from the litigation. Discovery is ongoing in this action.

ESI Litigation

On November 29, 2018, a complaint captioned Brian Morris et. al. v. Electro Scientific Industries, Inc. et al. was filed in the U.S. District Court for the District of Oregon by alleged former stockholders of ESI in connection with the acquisition of ESI by the Company. The complaint named the Company's subsidiary, Electro Scientific Industries, Inc. ("ESI"), and the former members of ESI's board of directors as defendants. Five additional complaints were subsequently filed, two in the U.S. District Court for the District of Oregon and three in the Multnomah County Circuit Court in the State of Oregon. The cases filed in the U.S. District Court were dated December 6, 2018 and December 12, 2018 and captioned Melvyn Klein et. al. v. Electro Scientific Industries, Inc. et al. and Donald Mager et. al. v. Electro Scientific Industries, Inc. et al., respectively. The complaints filed in Multnomah County Circuit Court were dated December 5, 2018, December 5, 2018 and December 13, 2018 and captioned Michael Kent et. al v. Electro Scientific Industries, Inc. et al., Christopher Stanley et. al v. Electro Scientific Industries, Inc. et al. and Eduardo Colmenares et. al. v. Electro Scientific Industries, Inc., MKS Instruments, Inc., et al., respectively (collectively with Brian Morris et. al. v. Electro Scientific Industries, Inc. et. al., the "Lawsuits"). On February 16, 2019, the parties came to an agreement on a settlement in principle that would resolve the Lawsuits, which is subject to the execution of a settlement agreement and dismissal of the Lawsuits with prejudice.

These lawsuits are purported class actions brought on behalf of former ESI stockholders, asserting various claims against the former members of the ESI board of directors, ESI, MKS, and MKS' merger subsidiary, including breach of fiduciary duty and aiding and abetting the breach of fiduciary duty. The lawsuits allege that the consideration paid to the ESI shareholders did not appropriately value ESI, and that ESI's merger related disclosures failed to disclose certain material information regarding the merger. These complaints purport to seek unspecified damages.

The Company believes that the claims in these complaints are without merit and intends to vigorously defend this litigation. ESI provided supplemental merger related disclosures to eliminate the burden and expense of litigation and to avoid any possible disruption to the merger that could result from further litigation.

We are subject to various legal proceedings and claims, which have arisen in the ordinary course of business. In the opinion of management, the ultimate disposition of these matters will not have a material adverse effect on our results of operations, financial condition or cash flows.

Item 4. ***Mine Safety Disclosures***

Not applicable.

PART II

Item 5. ***Market for the Registrant's Common Equity, Related Stockholder Matters and Issuer Purchases of Equity Securities***

Common Stock

Our common stock is traded on the Nasdaq Global Select Market under the symbol MKSI.

On February 19, 2019, we had 89 stockholders of record.

Dividend Policy and Cash Dividends

Holders of our common stock are entitled to receive dividends when and if they are declared by our Board of Directors. During 2018, our Board of Directors declared a cash dividend of $0.18 per share during the first quarter of 2018 and $0.20 per share for the second, third and fourth quarters of 2018, which totaled $42.4 million or $0.78 per share. During 2017, our Board of Directors declared a cash dividend of $0.175 per share during the first, second and third quarters of 2017 and $0.18 per share during the fourth quarter of 2017, which totaled $38.2 million or $0.71 per share.

On February 11, 2019, our Board of Directors declared a quarterly cash dividend of $0.20 per share to be paid on March 8, 2019 to shareholders of record as of February 25, 2019.

Future dividend declarations, if any, as well as the record and payment dates for such dividends, are subject to the final determination of our Board of Directors. The Board of Directors intends to declare and pay cash dividends on our common stock based on our financial conditions and results of operations of the Company, although it has no obligation to do so. Our credit facilities contain covenants that restrict our ability to grant cash dividends in certain circumstances.

Purchase of Equity Shares

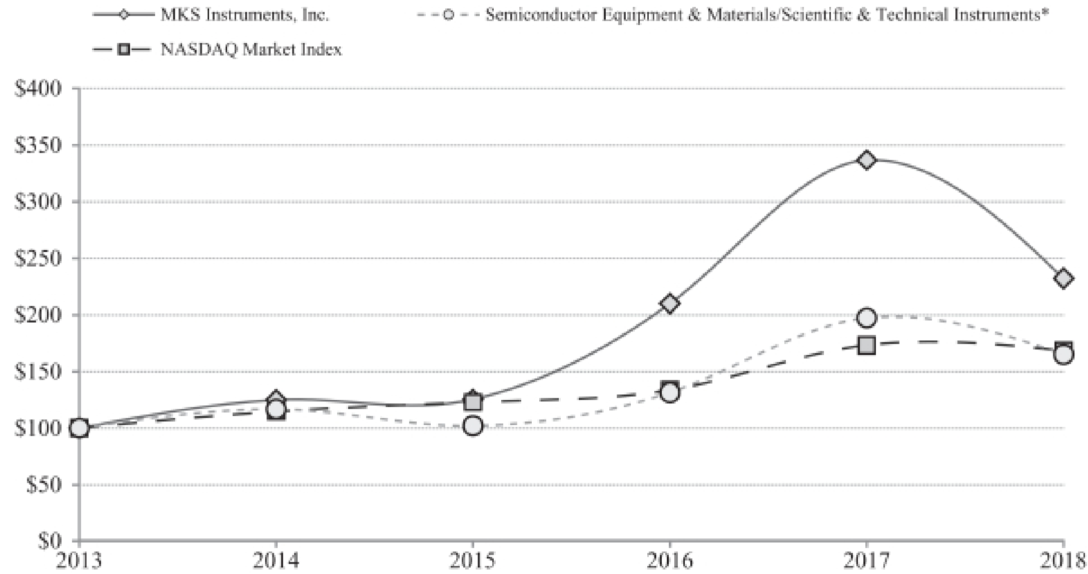
On July 25, 2011, our Board of Directors approved and on July 27, 2011, we publicly announced, a share repurchase program for the repurchase of up to an aggregate of $200 million of our outstanding common stock from time to time in open market purchases, privately negotiated transactions or through other appropriate means (the "Program"). The timing and quantity of any shares repurchased depends upon a variety of factors, including business conditions, stock market conditions and business development activities, including, but not limited to, merger and acquisition opportunities. These repurchases may be commenced, suspended or discontinued at any time without prior notice.

During 2018, the Company repurchased approximately 818,000 shares of its common stock for $75.0 million, or an average price of $91.67 per share. During 2017, the Company did not repurchase any shares of common stock. We have repurchased approximately 2,588,000 shares of common stock for approximately $127.0 million pursuant to the program since its adoption.

Comparative Stock Performance

The following graph compares the cumulative total shareholder return (assuming reinvestment of dividends) from investing $100 on December 31, 2013, and plotted at the last trading day of each of the fiscal years ended December 31, 2014, 2015, 2016, 2017 and 2018, in each of MKS' common stock; a peer group index which represents a combination of all companies comprising the Morningstar Semiconductor Equipment & Materials Industry Group Index and Morningstar Scientific & Technical Instruments Industry Group Index, published by Zacks Investment Research, Inc., with these indices weighted one-half (1/2) and one-half (1/2), respectively; and the Nasdaq Market Index. The stock price performance on the graph below is not necessarily indicative of future price performance. Our common stock is listed on the Nasdaq Global Select Market under the ticker symbol MKSI.

Performance Graph



	2013	2014	2015	2016	2017	2018
MKS Instruments, Inc.	$ 100.00	$ 124.90	$ 125.20	$ 209.90	$ 336.91	$ 232.26
Nasdaq Market Index	$ 100.00	$ 114.75	$ 122.74	$ 133.62	$ 173.22	$ 168.30
Morningstar Semiconductor Equipment & Materials/Scientific & Technical Instruments	$ 100.00	$ 116.67	$ 102.09	$ 131.35	$ 197.23	$ 165.05

* Semiconductor Equipment & Materials and Scientific & Technical Instruments indices weighted 1/2 and 1/2, respectively.

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Item 6. ***Selected Financial Data***

Selected Consolidated Financial Data

	2018	2017	2016	2015	2014
	(in thousands, except per share data)				
Statement of Operations Data(1)					
Net revenues	$ 2,075,108	$ 1,915,977	$ 1,295,342	$ 813,524	$ 780,869
Gross profit(2)	979,476	891,451	565,619	362,872	337,766
Income from operations(3)	494,059	406,634	157,267	156,612	135,142
Net income(4)	$ 392,896	$ 339,132	$ 104,809	$ 122,297	$ 115,778
Basic net income per share	$ 7.22	$ 6.26	$ 1.96	$ 2.30	$ 2.17
Diluted net income per share	$ 7.14	$ 6.16	$ 1.94	$ 2.28	$ 2.16
Cash dividends paid per common share	$ 0.78	$ 0.71	$ 0.68	$ 0.68	$ 0.66
Balance Sheet Data(1)					
Cash and cash equivalents, including restricted cash	$ 644,345	$ 333,887	$ 233,910	$ 227,574	$ 305,437
Short-term investments(5)	73,826	209,434	189,463	430,663	286,795
Working capital(5)	1,200,819	946,431	761,469	848,527	791,665
Total assets	2,614,246	2,414,018	2,212,242	1,273,347	1,224,044
Short-term debt(6)	3,986	2,972	10,993	—	—
Long-term debt, net(6)	343,842	389,993	601,229	—	—
Other liabilities(7)	133,932	145,296	131,921	21,482	38,595
Stockholders' equity	$ 1,873,187	$ 1,588,907	$ 1,241,792	$ 1,160,881	$ 1,081,822

(1) The Statement of Operations Data and the Balance Sheet Data for 2018, 2017 and 2016 include statement of operations data and assets and liabilities acquired as a result of the acquisition of Newport Corporation ("Newport") in April 2016 (the "Newport Merger").

(2) Gross profit for 2016 includes a $15.1 million charge for the amortization of the inventory step-up to fair value related to the Newport Merger.

(3) Income from operations for 2018 includes $3.6 million of restructuring charges and $3.1 million of acquisition and integration costs, which is primarily comprised of acquisition costs related to our acquisition of Electro Scientific Industries, Inc., which closed on February 1, 2019. Income from operations for 2017 includes $6.7 million of an asset impairment charge, primarily related to the write-off of goodwill and intangible assets in conjunction with the consolidation of two manufacturing plants, $5.3 million of acquisition and integration costs from the Newport Merger and $3.9 million of restructuring charges. Income from operations for 2016 includes a $15.1 million charge for the amortization of the inventory step-up to fair value, $27.3 million of acquisition and integration costs from the Newport Merger and $5.0 million of an asset impairment charge. Income from operations for 2015 includes $2.1 million of restructuring charges. Income from operations for 2014 includes $2.5 million of restructuring charges.

(4) Net income for 2018 includes an $8.3 million windfall tax benefit on the vesting of stock-based compensation and $5.0 million of accrued taxes on MKS subsidiary distributions. Net income for 2017 includes charges, net of tax, of $6.7 million of an asset impairment charge, $3.4 million of acquisition and integration costs and $3.7 million of restructuring charges. Net income for 2017 also includes a gain, net of tax of $72.0 million related to the sale of a business, a $28.7 million transition tax on accumulated foreign earnings, a $14.0 million tax accrual on a distribution to a subsidiary, a $24.5 million deferred tax adjustment, which also includes the reversal of a tax accrual on a French dividend related to the 2017 Tax Cut and Jobs Act, a $11.1 million windfall tax benefit on the vesting of stock-based compensation and an adjustment, net of tax of $5.9 million of amortization of debt issuance costs relating to the term loan credit agreement used to partially finance the Newport Merger. Net income for 2016 includes charges, net of tax, of $9.8 million of amortization of inventory step-up to fair value, $19.0 million of acquisition and

integration costs, $5.0 million of asset impairment charges and a $2.0 million withholding tax on dividends. These charges are offset by a tax benefit of $5.0 million for a legal entity restructuring. Net income for 2015 includes charges, net of tax, of $1.4 million of restructuring costs and also includes $7.7 million in tax credits for reserve releases related to the settlement of tax audits. Net income for 2014 includes charges, net of tax, of $1.5 million of restructuring costs and also includes $14.6 million in tax credits for reserve releases related to the settlement of tax audits and the expiration of the statute of limitations.

(5) Effective December 31, 2015, the Company changed the method of classification of its investments previously classified as long-term investments to short-term investments within current assets. For the year ended December 31, 2014, short-term investments have been re-classified to include investments with contractual maturities greater than one year from the date of purchase as management had the ability and intent, if necessary, to liquidate any of its cash equivalents and investments in order to meet the Company's liquidity needs in the next twelve months. Accordingly, working capital includes investments with contractual maturities greater than one year from the date of purchase.

(6) Long-term debt, net includes $343.8 million in 2018, $389.3 million in 2017 and short-term and long-term debt, net includes $6.3 million and $600.7 million, respectively, in 2016, related to the term loan credit agreement.

(7) Other liabilities include non-current deferred taxes and non-current accrued compensation.

Item 7. ***Management's Discussion and Analysis of Financial Condition and Results of Operations***

Overview

We are a global provider of instruments, subsystems and process control solutions that measure, monitor, deliver, analyze, power and control critical parameters of advanced manufacturing processes to improve process performance and productivity. Our products are derived from our core competencies in pressure measurement and control, flow measurement and control, gas and vapor delivery, gas composition analysis, residual gas analysis, leak detection, control technology, ozone generation and delivery, RF & DC power, reactive gas generation, vacuum technology, lasers, photonics, sub-micron positioning, vibration control, and optics. We also provide services relating to the maintenance and repair of our products, installation services and training.

Our primary served markets are manufacturers of capital equipment for semiconductor manufacturing, industrial technologies, life and health sciences, as well as research and defense.

Recent Events

Acquisition of Electro Scientific Industries, Inc.

On February 1, 2019, we completed our previously announced acquisition of Electro Scientific Industries, Inc., an Oregon corporation ("ESI"), pursuant to the Agreement and Plan of Merger (the "ESI Merger"). ESI is an innovator in laser-based manufacturing solutions for micro-machining applications. Micro-machining applications are used extensively in the manufacture of mobile devices, electronic components, thin film devices and semiconductor packaging. At the effective time of the ESI Merger and pursuant to the terms and conditions of the Agreement and Plan of Merger, each share of ESI's common stock issued and outstanding as of immediately prior to the effective time of the ESI Merger was converted into the right to receive $30.00 per share in cash, without interest and subject to deduction for any required withholding tax. We paid to the former ESI stockholders aggregate consideration of approximately $1 billion, excluding related transaction fees and expenses. We funded the payment of the aggregate consideration with a combination of our available cash on hand and proceeds from our term loan facility described below.

In connection with the completion of the ESI Merger, we entered into an amendment ("Amendment No. 5") to our Term Loan Credit Agreement with Barclays Bank PLC as administrative agent and collateral agent, that provided additional tranche B-5 term loan commitment in the principal amount of $650.0 million, which we used to partially fund the ESI Merger.

Also, in connection with the completion of the ESI Merger, we terminated our $50.0 million asset-based credit agreement with Deutsche Bank AG New York Branch as administrative and collateral agent, and we entered into an asset-based credit agreement with Barclays Bank PLC, as administrative agent and collateral agent, that provides senior secured revolving credit financing of up to $100.0 million, subject to a borrowing base limitation.

We currently have two reportable segments, the Vacuum & Analysis segment and the Light & Motion segment. With the acquisition of ESI, we will be adding a third segment.

The Vacuum & Analysis segment provides a broad range of instruments, components and subsystems which are derived from our core competencies in pressure measurement and control, flow measurement and control, gas and vapor delivery, gas composition analysis, residual gas analysis, leak detection, control technology, ozone generation and delivery, RF & DC power, reactive gas generation and vacuum technology. The Light & Motion segment provides a broad range of instruments, components and subsystems which are derived from our core competencies in lasers, photonics, sub-micron positioning, vibration control, and optics.

We have a diverse base of customers and our primary served markets are manufacturers of capital equipment for semiconductor manufacturing, industrial technologies, life and health sciences, as well as research and defense. Approximately 55%, 57% and 56% of our net revenues for the years 2018, 2017 and 2016, respectively, were from sales to semiconductor capital equipment manufacturers and semiconductor device manufacturers. While our acquisition of Newport Corporation ("Newport") in 2016 reduced our concentration of customers in these markets and we expect some additional reduction as a result of the ESI Merger, we anticipate that sales to such customers will continue to account for a substantial portion of our net revenues. Approximately 45%, 43% and 44% of our net revenues in the years 2018, 2017 and 2016, respectively, were from advanced manufacturing applications. These include, but are not limited to, industrial technologies, life and health sciences, and research and defense.

Net revenues from semiconductor capital equipment manufacture and semiconductor device manufacture customers increased by $48 million or 4% in 2018 compared to 2017, and increased by $373 million or 52% in 2017 compared to 2016. The increase in 2018 compared to 2017 is driven by strong sales to semiconductor customers during the first half of 2018 and is comprised of an increase in net semiconductor revenues of $26 million in the Vacuum & Analysis segment and $22 million in the Light & Motion segment. We have seen a decrease in sales to semiconductor customers during the second half of 2018 and we expect that to continue into the first half of 2019. The increase in 2017 compared to 2016 is comprised of an increase in net semiconductor revenues of $315 million in the Vacuum & Analysis segment and $58 million in the Light & Motion segment. These increases were primarily due to volume increases from our semiconductor customers. The semiconductor capital equipment industry is subject to rapid demand shifts, which are difficult to predict, and we are uncertain as to the timing or extent of future demand or any future weakness in the semiconductor capital equipment industry.

Our net revenues from customers in advanced markets, which exclude semiconductor capital equipment and semiconductor device manufacture customers, increased by $111 million or 14% in 2018 compared to 2017, and increased by $248 million or 43% in 2017 compared to 2016. The increase in 2018 compared to 2017, is attributed to an increase in net revenues from customers in our advanced markets of $83 million in the Light & Motion segment and $28 million in the Vacuum & Analysis segment. These increases are primarily due to revenue from customers in our industrial technologies market. The increase in 2017 compared to 2016 is primarily attributed to a $228 million increase in net revenues from customers in our Light & Motion segment due to the fact that 2016 only included eight months of revenue in the Light & Motion segment. In addition, net revenues from customers in our Vacuum & Analysis segment increase primarily due to revenues from the industrial technologies market of $20.1 million.

A significant portion of our net revenues are from sales to customers in international markets. For the years ended December 31, 2018, 2017 and 2016, international net revenues accounted for approximately 51%, 50% and 48% of our total net revenues, respectively. A significant portion of our international net revenues were in South Korea, Japan, Germany and Israel. We expect that international revenues will continue to account for a significant portion of total net sales for the foreseeable future, and that in particular, the proportion of our sales of Asian customers will continue to increase, due in large part to our acquisition of ESI, as approximately ninety percent of ESI's customers are located in Asia. Long-lived assets, located in the United States, were $147 million, $125 million and $123 million as of December 31, 2018, 2017 and 2016, respectively, excluding goodwill and intangibles and long-term tax-related accounts. Long-lived assets, located outside of the United States, were $77 million, $78 million, and $78 million as of December 31, 2018, 2017 and 2016, respectively, excluding goodwill and intangibles and long-term tax-related accounts.

Critical Accounting Policies and Estimates

Management's Discussion and Analysis of Financial Condition and Results of Operations discuss our consolidated financial statements, which have been prepared in accordance with accounting principles generally accepted in the United States. The preparation of these financial statements requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities and the disclosure of contingent liabilities at the date of the financial statements and the reported amounts of revenues and expenses during the reporting period. On an on-going basis, we evaluate our estimates and judgments, including those related to revenue recognition, allowance for doubtful accounts, pension plan valuations, inventory, warranty costs, stock-based compensation expense, intangible assets, goodwill and other long-lived assets, in-process research and development and income taxes. We base our estimates and judgments on historical experience and on various other factors that are believed to be reasonable under the circumstances, the results of which form the basis for making judgments about the carrying values of assets and liabilities that are not readily apparent from other sources. Actual results may differ from these estimates under different assumptions or conditions.

We believe the following critical accounting policies affect the most significant judgments, assumptions and estimates we use in preparing our consolidated financial statements:

Revenue Recognition and Allowance for Doubtful Accounts.

We adopted Accounting Standards Codification ("ASC") 606 ("ASC 606") on January 1, 2018 using the modified retrospective method for all contracts not completed as of the date of adoption. The reported results for the twelve months ended December 31, 2018 reflect the application of ASC 606 guidance while the reported results for 2017 and 2016 were prepared under the guidance of ASC 605, Revenue Recognition.

We recorded a net increase to opening retained earnings of $1.8 million as of January 1, 2018 due to the cumulative impact of adopting ASC 606, with the impact primarily related to its service business and certain custom products.

The adoption of ASC 606 represents a change in accounting principle that will more closely align revenue recognition with the delivery of our goods or services. To achieve this core principle, we apply the following five steps when recording revenue:

- Identify the contract with a customer
- Identify the performance obligations in the contract
- Determine the transaction price
- Allocate the transaction price to performance obligations in the contract
- Recognize revenue when or as the Company satisfies a performance obligation

Revenue under ASC 606 is recognized when or as obligations under the terms of a contract with our customer has been satisfied and control has transferred to the customer. The majority of our performance obligations, and associated revenue, are transferred to customers at a point in time, generally upon shipment of a product to the customer or receipt of the product by the customer and without significant judgments. Installation services are not significant and are usually completed in a short period of time (normally less than two weeks) and therefore, recorded at a point in time when the installation services are completed, rather than over time as they are not material. Extended warranty, service contracts, and repair services, which are transferred to the customer over time, are recorded as revenue as the services are performed. For repair services, we make an accrual at each quarter end based upon historical repair times within our product groups to record revenue based upon the estimated number of days completed to date, which is consistent with ratable recognition. Customized products with no alternative future use to us, and that have an enforceable right to payment for performance completed to date, are also recorded over time. We consider this to be a faithful depiction of the transfer to the customer of revenue over time as the work is performed or service is delivered, ratably over time.

Revenue is measured as the amount of consideration we expect to receive in exchange for transferring goods or providing services. Performance obligations promised in a contract are identified based on the products or services that will be transferred to the customer that are both capable of being distinct, whereby the customer can benefit from the product or service either on its own or together with other resources that are readily available from third parties or from us, and are distinct in the context of the contract, whereby the transfer of the product or service is separately identifiable from other promises in the contract. Sales, value add, and other taxes we collect concurrent with revenue-producing activities are excluded from revenue. Our normal payment terms are 30 to 60 days but vary by the type and location of our customers and the products or services offered. The time between invoicing and when payment is due is not significant. For certain products and services and customer types, we require payment before the products or services are delivered to, or performed for, the customer. None of our contracts as of December 31, 2018 contained a significant financing component.

We periodically enter into contracts with our customers in which a customer may purchase a combination of goods and or services, such as products with installation services or extended warranty obligations. These contracts include multiple promises that we evaluate to determine if the promises are separate performance obligations. Once we determine the performance obligations, we then determine the transaction price, which includes estimating the amount of variable consideration to be included in the transaction price, if any. To the extent the transaction price includes variable consideration, we estimate the amount of variable consideration that should be included in the transaction price utilizing either the expected value method or the most likely amount method depending on the method we expect to better predict the amount of consideration to which it will be entitled. There are no constraints on the variable consideration recorded. We then allocate the transaction price to each performance obligation in the contract based on a relative stand-alone selling price charged separately to customers or using an expected cost plus margin method. The corresponding revenues are recognized when or as the related performance obligations are satisfied, which are noted above. The impact of variable consideration has been immaterial.

Our standard assurance warranty period is normally 12 to 24 months and we provide for estimated warranty costs at the time of sale based upon historical experience. We sometimes sell separately-priced service contracts and extended warranty contracts related to certain of our products, especially our laser products. The separately priced contracts generally range from 12 to 60 months. We normally receive payment at the inception of the contract and recognize revenue over the term of the agreement in proportion to the costs expected to be incurred in satisfying the obligations under the contract.

We monitor and track the amount of product returns, provide for sales return allowances and reduce revenue at the time of shipment for the estimated amount of such future returns, based on historical experience. While product returns have historically been within our expectations and the provisions established, there is no assurance that we will continue to experience the same return rates that we have in the past. Any significant increase in product return rates could have a material adverse impact on our operating results for the period or periods in which such returns materialize.

While we maintain a credit approval process, significant judgments are made by management in connection with assessing our customers' ability to pay at the time of shipment. Despite this assessment, from time to time, our customers are unable to meet their payment obligations. We continuously monitor our customers' credit worthiness, and use our judgment in establishing a provision for estimated credit losses based upon our historical experience and any specific customer collection issues that we have identified. While such credit losses have historically been within our expectations and the provisions established, there is no assurance that we will continue to experience the same credit loss rates that we have in the past. A significant change in the liquidity or financial position of our customers could have a material adverse impact on the collectability of accounts receivable and our future operating results.

Inventory. We value our inventory at the lower of cost (first-in, first-out method) or market. We regularly review inventory quantities on hand and record a provision to write-down excess and obsolete inventory to its estimated net realizable value, if less than cost, based primarily on our estimated forecast of product demand. Once our inventory value is written-down and a new cost basis has been established, the inventory value is not increased due to demand increases. Demand for our products can fluctuate significantly. A significant increase in the demand for our products could result in a short-term increase in the cost of inventory purchases as a result of supply shortages or a decrease in the cost of inventory purchases as a result of volume discounts, while a significant decrease in demand could result in an increase in the charges for excess inventory quantities on hand. In addition, our industry is subject to technological change, new product development and product technological obsolescence that could result in an increase in the amount of obsolete inventory quantities on hand. Therefore, any significant unanticipated changes in demand or technological developments could have a significant impact on the value of our inventory and our reported operating results. For 2018, 2017 and 2016, our charges for excess and obsolete inventory totaled $22.3 million, $20.2 million and $16.0 million, respectively.

Warranty Costs. We provide for the estimated costs to fulfill customer warranty obligations upon the recognition of the related revenue. We provide warranty coverage for our products for periods ranging from 12 to 36 months, with the majority of our products for periods ranging from 12 to 24 months. Short-term accrued warranty obligations, which expire within one year, are included in other current liabilities and long-term accrued warranty obligations are included in other liabilities in the consolidated balance sheets. We estimate the anticipated costs of repairing our products under such warranties based on the historical costs of the repairs and any known specific product issues. The assumptions we use to estimate warranty accruals are re-evaluated periodically in light of actual experience and, when appropriate, the accruals are adjusted. Our determination of the appropriate level of warranty accrual is based upon estimates. Should product failure rates differ from our estimates, actual costs could vary significantly from our expectations. Defective products will be either repaired or replaced, generally at our option, upon meeting certain criteria.

Pension Plans. Several of our non-U.S. subsidiaries have defined benefit pension plans covering substantially all full-time employees of those subsidiaries. Some of the plans are unfunded, as permitted under the plans and applicable laws. For financial reporting purposes, the calculation of net periodic pension costs is based upon a number of actuarial assumptions, including a discount rate for plan obligations, an assumed rate of return on pension plan assets and an assumed rate of compensation increase for employees covered by the plan. All of these assumptions are based upon our judgment, considering all known trends and uncertainties. Actual results that differ from these assumptions would impact future expense recognition and the cash funding requirements of our pension plans.

Stock-Based Compensation Expense. We record compensation expense for all share-based compensation awards to employees and directors based upon the estimated fair market value of the underlying instrument. Accordingly, share-based compensation cost is measured at the grant date, based upon the fair value of the award.

We typically issue restricted stock units (“RSUs”) as stock-based compensation. We also provide employees the opportunity to purchase shares through an Employee Stock Purchase Plan (“ESPP”). For RSUs, the fair value is the stock price on the date of grant. We estimate the fair value of stock appreciation rights and shares issued under our ESPP using the Black Scholes pricing model, which is affected by our stock price as well as assumptions regarding a number of complex and subjective variables. These variables include our expected stock price volatility over the term of the awards, expected life, risk free interest rate and expected dividends. Management determined that blended volatility, a combination of historical and implied volatility, is more reflective of market conditions and a better indicator of expected volatility than historical or implied volatility alone. We are also required to estimate forfeitures at the time of grant and revise those estimates in subsequent periods if actual forfeitures differ from those estimates.

Certain RSUs involve stock to be issued upon the achievement of performance conditions (“performance shares”) under our stock incentive plans. Such performance shares become available subject to time-based vesting conditions if, and to the extent that, financial or operational performance criteria for the applicable period are achieved. Accordingly, the number of performance shares earned will vary based on the level of achievement of financial or operational performance objectives for the applicable period. Until such time that our performance can ultimately be determined, each quarter we estimate the number of performance shares to be earned based on an evaluation of the probability of achieving the performance objectives. Such estimates are revised, if necessary, in subsequent periods when the underlying factors change our evaluation of the probability of achieving the performance objectives. Accordingly, share-based compensation expense associated with performance shares may differ significantly from the amount recorded in the current period.

As part of our acquisition of Newport (the "Newport Merger"), we assumed the outstanding stock appreciation rights ("SARs") of Newport. For SARs, the converted number of shares, fair value, vesting schedule and expiration dates are all based on the original grant date information. The stock-based compensation reflects the remaining fair value for all unvested SARs as of the acquisition date, recognized over the remaining time to vest.

The assumptions used in calculating the fair value of share-based compensation awards represents management's best estimates, but these estimates involve inherent uncertainties and the application of management's judgment. As a result, if factors change and we use different assumptions, our stock-based compensation expense could be materially different in the future.

Intangible Assets, Goodwill and Other Long-Lived Assets. As a result of our acquisitions, we have identified intangible assets and generated significant goodwill. Definite-lived intangible assets are valued based on estimates of future cash flows and amortized over their estimated useful life. Goodwill and indefinite-lived intangible assets are subject to annual impairment testing as well as testing upon the occurrence of any event that indicates a potential impairment. Intangible assets and other long-lived assets are also subject to an impairment test if there is an indicator of impairment. If our expectations of future results and cash flows are significantly diminished, intangible assets and goodwill may be impaired and the resulting charge to operations may be material. When we determine that the carrying value of intangibles or other long-lived assets may not be recoverable based upon the existence of one or more indicators of impairment, we use the projected undiscounted cash flow method to determine whether an impairment exists, and then measure the impairment using discounted cash flows. To measure impairment for goodwill, we compare the fair value of our reporting units by measuring discounted cash flows to the book value of the reporting units. Goodwill would be impaired if the resulting implied fair value was less than the recorded book value of the goodwill.

The estimation of useful lives and expected cash flows require us to make significant judgments regarding future periods that are subject to some factors outside of our control. Changes in these estimates can result in significant revisions to the carrying value of these assets and may result in material charges to the results of operations.

We have elected to perform our annual goodwill impairment test as of October 31 of each year, or more often if events or circumstances indicate that there may be impairment. Goodwill is the amount by which the cost of acquired net assets exceeded the fair value of those net assets on the date of acquisition. We allocate goodwill to reporting units at the time of acquisition or when there is a change in the reporting structure and base that allocation on which reporting units will benefit from the acquired assets and liabilities. Reporting units are defined as operating segments or one level below an operating segment, referred to as a component. The estimated fair value of our reporting units was based on discounted cash flow models derived from internal earnings and internal and external market forecasts. Determining fair value requires the exercise of significant judgment, including judgments about appropriate discount rates, perpetual growth rates, projected revenues and projected profit margins. Discount rates are based on a weighted average cost of capital ("WACC"), which represents the average rate a business must pay its providers of debt and equity. The WACC used to test goodwill is derived from a group of comparable companies. Assumptions in estimating future cash flows are subject to a high degree of judgment and complexity. We make every effort to forecast these future cash flows as accurately as possible with the information available at the time the forecast is developed.

In performing our annual goodwill impairment test, we are permitted to first assess qualitative factors to determine whether it is more likely than not that the fair value of our reporting unit is less than its carrying amount, including goodwill. In performing the qualitative assessment, we consider certain events and circumstances specific to the reporting unit and to the entity as a whole, such as macroeconomic conditions, industry and market considerations, overall financial performance and cost factors when evaluating whether it is more likely than not that the fair value of the reporting unit is less than its carrying amount. We are also permitted to bypass the qualitative assessment and proceed directly to the quantitative test. If we choose to undertake the qualitative assessment and we conclude that it is more likely than not that the fair value of the reporting unit is less than its carrying amount, we would then proceed to the quantitative impairment test. In the quantitative assessment, we compare the fair value of the reporting unit to its carrying amount, which includes goodwill. If the fair value exceeds the carrying value, no impairment loss exists. If the fair value is less than the carrying amount, a goodwill impairment loss is measured and recorded.

On July 1, 2018, we reassigned goodwill to certain reporting units within the Light & Motion reportable segment resulting from a reorganization of the composition of reporting units. The goodwill was reassigned to the reporting units affected using the relative fair value approach. In conjunction with this goodwill reassignment, we performed an interim quantitative impairment test as of July 1, 2018 for all of our reporting units and concluded that the fair values of each reporting unit exceeded their respective carrying values.

As of October 31, 2018, we performed our annual impairment assessment of goodwill using the qualitative assessment and determined that it is more likely than not that the fair values of the reporting units exceed their carrying amount. We will continue to monitor and evaluate the carrying value of goodwill. If market and economic conditions or business performance deteriorate, this could increase the likelihood of us recording an impairment charge. However, we believe it is not reasonably likely that an impairment will occur at any of its reporting units over the next twelve months.

In-Process Research and Development. We value tangible and intangible assets acquired through our business acquisitions, including in-process research and development ("IPR&D"), at fair value. We determine IPR&D through established valuation techniques for various projects for the development of new products and technologies and capitalize IPR&D as an intangible asset. If the projects are completed, the intangible asset will be amortized to earnings over the expected life of the completed product. If the R&D projects are abandoned, we will write-off the related intangible asset.

The value of IPR&D is determined using the income approach, which discounts expected future cash flows from projects under development to their net present value. Each project is analyzed and estimates and judgments are made to determine the technological innovations included in the utilization of core technology, the complexity, cost, time to complete development, any alternative future use or current technological feasibility and the stage of completion.

Income Taxes.

We evaluate the realizability of our net deferred tax assets and assess the need for a valuation allowance on a quarterly basis. The future benefit to be derived from our deferred tax assets is dependent upon our ability to generate sufficient future taxable income in each jurisdiction of the right type to realize the assets. We record a valuation allowance to reduce our net deferred tax assets to the amount that is expected to be realized. To the extent we establish a valuation allowance an expense is recorded within the provision for income taxes line in the consolidated statements of operations and comprehensive income.

Accounting for income taxes requires a two-step approach to recognize and measure uncertain tax positions. The first step is to evaluate the tax position for recognition by determining if, based on the technical merits, it is more likely than not that the position will be sustained upon audit, including resolutions of related appeals or litigation processes, if any. The second step is to measure the tax benefit as the largest amount that is more than 50% likely of being realized upon ultimate settlement. We re-evaluate these uncertain tax positions on a quarterly basis. This evaluation is based on factors including, but not limited to, changes in facts or circumstances, changes in tax law, effectively settled issues under audit and new audit activity. Any change in these factors could result in the recognition of a tax benefit or an additional charge to the tax provision.

On December 22, 2017, the President of the United States signed into law the Tax Cuts and Jobs Act (the "Act"), which included significant changes to U.S. tax law. Some of the more significant changes impacting us are the reduction of the U.S. federal corporate income tax rate from 35.0% to 21.0% as of January 1, 2018, the implementation of a territorial tax system and the imposition of a transition tax on deemed repatriated cumulative earnings of foreign subsidiaries ("Transition Tax").

Income tax effects resulting from changes in tax are generally accounted for in the period in which the law is enacted and the effects are recorded as a component of provision for income taxes from continuing operations. On December 22, 2017, the Securities and Exchange Commission Staff issued Staff Accounting Bulletin No. 118 ("SAB 118") to provide guidance for reporting entities' ability to timely complete the accounting for certain income tax effects of the Act and allowed a measurement period up to one year from the enactment date of the Act. We have obtained, prepared and analyzed the information needed to complete the accounting requirements under ASC Topic 740 and, as a result, in accordance with SAB 118 we finalized and recorded the effects of the Act during the quarter ended December 31, 2018. The ultimate impact of the Act is based upon our understanding and interpretation of the regulatory guidance that has been issued regarding the Act. There remain significant provisions of the Act that impact us for which no regulatory guidance has yet been issued. Our estimated accruals for 2018 and future periods expected income tax expense may change as regulatory guidance on provisions of the Act are released.

Results of Operations

The following table sets forth, for the periods indicated, the percentage of total net revenues of certain line items included in our consolidated statements of operations and comprehensive income data:

	Years Ended December 31,		
	2018	2017	2016
Net revenues:			
Product	88.4%	88.8%	86.4%
Service	11.6	11.2	13.6
Total net revenues	100.0%	100.0%	100.0%
Cost of revenues:			
Product	46.7	47.3	48.6
Service	6.1	6.2	7.7
Total cost of revenues	52.8	53.5	56.3
Gross profit	47.2%	46.5%	43.7%
Research and development	6.5	6.9	8.5
Selling, general and administrative	14.4	15.2	17.6
Acquisition and integration costs	0.1	0.3	2.1
Restructuring	0.2	0.2	—
Environmental costs	0.1	—	—
Asset impairment	—	0.3	0.4
Fees and expenses related to repricing of term loan	—	—	0.1
Amortization of intangible assets	2.1	2.4	2.8
Income from operations	23.8%	21.2%	12.2%
Interest income	0.3	0.2	0.2
Interest expense	0.8	1.6	2.4
Gain on sale of business	—	3.9	—
Other expense, net	0.1	0.3	0.1
Income before income taxes	23.2%	23.4%	9.9%
Provision for income taxes	4.3	5.7	1.8
Net income	18.9%	17.7%	8.1%

Year Ended December 31, 2018, Compared to 2017 and 2016

Net Revenues

(Dollars in millions)	Years Ended December 31, 2018	2017	2016
Product	$ 1,835.2	$ 1,701.3	$ 1,118.5
Service	239.9	214.7	$ 176.8
Total net revenues	$ 2,075.1	$ 1,916.0	$ 1,295.3

Product revenues increased $133.9 million during 2018, compared to 2017. Product revenues for the Vacuum & Analysis segment increased by $32.7 million during 2018 compared to 2017, due to an increase in product revenues from customers in our advanced markets of $30.9 million and an increase in product revenues from our semiconductor customers of $1.8 million. Product revenues for our Light & Motion segment increased by $101.2 million during 2018, compared to 2017, due to an increase in product revenues from customers in our advanced markets of $77.2 million and an increase in product revenues from our semiconductor customers of $24.0 million. The increase in product revenues from customers in our advanced markets for both the Vacuum & Analysis segment and the Light & Motion segment were primarily due to volume increases in revenues from customers in our industrial technologies market.

Product revenues increased $582.8 million during 2017, compared to 2016. Product revenues for the Vacuum & Analysis segment increased by $316.2 million during 2017 compared to 2016, due to an increase in product revenues from our semiconductor customers of $293.9 million, primarily due to volume increases, and an increase in product revenues from customers in our advanced markets of $22.3 million. Product revenues for our Light & Motion segment increased by $266.6 million during 2017, compared to 2016, primarily due to the Newport Merger and consisted of an increase in product revenues from customers in our other advanced markets of $215.5 million and an increase in product revenues from our semiconductor customers of $51.1 million.

Service revenues consisted mainly of fees for services related to the repair of our products, maintenance, installation services and training. In 2018, we started to record the sales of spare parts in our service revenue and related cost of sales line items rather than in our product revenue and related cost of sales line items. As a result, for 2017 and 2016, we reclassified $22.1 million and $15.4 million, respectively, of product revenue for spare parts from product to service revenue. Service revenues increased $25.2 million during 2018, compared to 2017, primarily due to an increase in service revenues from the Vacuum & Analysis segment of $20.7 million, primarily from semiconductor customers. The remaining increase of $4.5 million was primarily due to an increase in service revenues from our industrial technologies market from our Light & Motion segment.

Service revenues increased $37.9 million during 2017, compared to 2016, primarily due to an increase in service revenues from the Light & Motion segment of $19.0 million, due to the fact that 2016 only included eight months of revenue from Newport as the Newport Merger occurred in April 2016. The remaining increase of $18.9 million was primarily due to an increase in service revenues from our semiconductor customers from our Vacuum & Analysis segment.

Total international net revenues, including product and service, were $1.1 billion or 50.7% of total net revenues for 2018, $960.7 million or 50.1% of total net revenues for 2017 and $619.7 million or 47.8% of total net revenues for 2016. A significant portion of the increases in 2018 and 2017 international net revenue, were in China, Germany and Japan. The increase in 2017, compared to 2016 was partially the result of the Newport Merger and consisted of increases mainly in South Korea, Japan, Israel and Germany. We expect that international revenues will continue to account for a significant percentage of total net sales for the foreseeable future, and that in particular, the proportion of our sales to Asian customers will continue to increase, due in large part to our acquisition of ESI, as approximately ninety percent of ESI's customers are located in Asia.

The following table sets forth our net revenues by reportable segment:

Net Revenues

(Dollars in millions)	Years Ended December 31, 2018	2017	2016
Vacuum & Analysis	$ 1,260.9	$ 1,207.5	$ 872.3
Light & Motion	814.2	708.5	423.0
Total net revenues	$ 2,075.1	$ 1,916.0	$ 1,295.3

Net revenues for our Vacuum & Analysis segment increased $53.4 million in 2018, compared to 2017, due to an increase in net revenues from customers in our advanced markets of $27.9 million, primarily due to increases in net revenues from customers in our industrial technologies market, and from our semiconductor customers of $25.5 million. Net revenues for our Vacuum & Analysis segment increased $335.2 million in 2017, compared to 2016, due to an increase in net revenues from our semiconductor customers of $315.0 million and an increase in net revenues from customers in our advanced markets of $20.2 million, primarily due to increases in net revenues from customers in our industrial technologies markets.

Net revenues from our Light & Motion segment increased $105.7 million in 2018, compared to 2017, due to an increase in net revenues from customers in our advanced markets of $83.3 million, primarily due to volume increases in net revenues from customers in our industrial technologies market of $58.5 million and an increase in revenues from customers in our semiconductor market of $22.4 million. Net revenues from our Light & Motion segment increased $285.5 million in 2017, compared to 2016, primarily due to the Newport Merger and consisted of an increase in net revenues from customers in our advanced markets of $228.1 million, primarily due to increases in net revenues from customers in our industrial technologies and research and defense markets and an increase in revenues from customers in our semiconductor market of $57.4 million. Net revenues from our Light & Motion segment in 2016 were $423.0 million and only represented eight months of revenue in 2016, as the Newport Merger occurred in April 2016.

The following is gross profit as a percentage of net revenues by product and service:

Gross Profit

(As a percentage of net revenues)	Years Ended December 31, 2018	2017	2016	% Points Change in 2018	% Points Change in 2017
Product	47.2%	46.7%	43.7%	0.5%	3.0%
Service	47.3%	45.0%	43.7%	2.3%	1.3%
Total gross profit percentage	47.2%	46.5%	43.7%	0.7%	2.8%

Gross profit on product revenues increased by 0.5 percentage points during 2018 compared to 2017. The increase was primarily due to an increase of 0.9 percentage points due to higher revenue volumes and 0.6 percentage points due to favorable product mix, partially offset by a decrease of 0.6 percentage points due to higher material costs and a decrease of 0.5 percentage points due to higher overhead costs.

Gross profit on product revenues increased by 3.0 percentage points during 2017 compared to 2016. The increase was primarily due to an increase of 5.5 percentage points due to higher revenue volumes, partially offset by 1.6 percentage points due to higher overhead costs, both mainly related to the Newport Merger.

Cost of service revenues consists primarily of costs for providing services for repair and training which includes salaries, related expenses and other overhead costs. Service gross profit increased by 2.3 percentage points during 2018 compared to 2017, primarily due to an increase of 5.3 percentage points due to lower overhead paid and favorable overhead absorption, partially offset by a 2.8 percentage points decrease due to higher material costs.

Service gross profit increased by 1.3 percentage points during 2017, compared to 2016, primarily due to a net increase of 1.6 percentage points due to net favorable direct labor and overhead absorption, partially offset by 0.4 percentage points due to unfavorable product mix.

The following is gross profit as a percentage of net revenues by reportable segment.

Gross Profit

(As a percentage of net revenues)	Years Ended December 31, 2018	2017	2016	% Points Change in 2018	% Points Change in 2017
Vacuum & Analysis	45.8%	45.6%	44.5%	0.2%	1.1%
Light & Motion	49.3%	48.0%	41.9%	1.3%	6.1%
Total net revenues	47.2%	46.5%	43.7%	0.7%	2.8%

Gross profit for our Vacuum & Analysis segment remained relatively flat in 2018, compared to 2017. Gross profit for our Vacuum & Analysis segment increased by 1.1 percentage points in 2017, compared to 2016, primarily due to higher revenue volumes related to revenues from customers in our semiconductor market, partially offset by unfavorable product mix.

Gross profit for our Light & Motion segment increased 1.3 percentage points in 2018, compared to 2017, primarily due to higher revenue volumes and favorable product mix, partially offset by higher material costs. Gross profit for our Light & Motion segment increased 6.1 percentage points in 2017, compared to 2016, primarily due to higher revenue volumes and lower material costs, as the prior year included $15.1 million of inventory step-up amortization charges related to the Newport Merger, and favorable product mix, partially offset by higher overhead costs.

Research and Development

(Dollars in millions)	Years Ended December 31, 2018	2017	2016
Research and development expenses	$135.7	$132.6	$110.6

Research and development expenses increased $3.1 million during 2018, compared to 2017, primarily due to an increase in compensation costs and related benefits of $2.6 million.

Research and development expenses increased $22.0 million during 2017, compared to 2016. The increase was primarily due to the fact that the Newport Merger occurred in 2016 and thus the Light & Motion segment only accounted for eight months of expense in 2016. The increase included $13.4 million of compensation costs and related benefits, $5.7 million for project materials and $1.1 million of occupancy costs.

Our research and development is primarily focused on developing and improving our instruments, components, subsystems and process control solutions to improve process performance and productivity.

We have thousands of products and our research and development efforts primarily consist of a large number of projects related to these products, none of which is individually material to us. Current projects typically have durations of 3 to 30 months depending upon whether the product is an enhancement of existing technology or a new product. Our current initiatives include projects to enhance the performance characteristics of older products, to develop new products and to integrate various technologies into subsystems. These projects support in large part, the transition in the semiconductor industry to smaller integrated circuit geometries and in the flat panel display and solar markets to larger substrate sizes, which require more advanced process control technology. Research and development expenses consist primarily of salaries and related expenses for personnel engaged in research and development, fees paid to consultants, material costs for prototypes and other expenses related to the design, development, testing and enhancement of our products.

We believe that the continued investment in research and development and ongoing development of new products are essential to the expansion of our markets, and we expect to continue to make significant investment in research and development activities. We are subject to risks if products are not developed in a timely manner, due to rapidly changing customer requirements and competitive threats from other companies and technologies. Our success primarily depends on our products being designed into new generations of equipment for the semiconductor industry and advanced technology markets. We develop products that are technologically advanced so that they are positioned to be chosen for use in each successive generation of semiconductor capital equipment. If our products are not chosen to be designed into our customers' products, our net revenues may be reduced during the lifespan of those products.

Selling, General and Administrative

	Years Ended December 31,		
(Dollars in millions)	**2018**	**2017**	**2016**
Selling, general and administrative expenses	$298.1	$290.1	$227.9

Selling, general and administrative expenses increased $8.0 million during 2018, compared to 2017. The increase was primarily due to an increase of $7.4 million of compensation costs and related benefits and $4.8 million of consulting and professional fees, primarily information technology and business development related expenses, partially offset by a decrease of $1.3 million of commissions expense, $0.9 million in travel and entertainment expenses and $0.9 million of occupancy costs.

Selling, general and administrative expenses increased $62.2 million during 2017, compared to 2016. The increase was primarily due to the fact that the Newport Merger occurred in April 2016 and thus the Light & Motion segment only accounted for eight months of expense in 2016. The increase included $37.6 million of compensation costs and related benefits, $6.4 million of commissions expense, $4.0 million of information technology related expenses, $3.3 million of consulting and professional fees and $2.5 million of depreciation expense.

Acquisition and Integration Costs

	Years Ended December 31,		
(Dollars in millions)	**2018**	**2017**	**2016**
Acquisition and integration costs	$ 3.1	$ 5.3	$27.3

We incurred $4.2 million of acquisition costs during 2018 related to the announced acquisition of ESI which closed on February 1, 2019. We recorded acquisition and integration costs related to the Newport Merger during 2017 and 2016 of $5.3 million and $27.3 million, respectively, which consisted primarily of information technology related expenses, legal and other professional fees, as well as compensation expenses related to change in control provisions in agreements for certain executives of Newport. During 2018, we reversed $1.1 million of these Newport Merger acquisition costs related to severance provisions that were not met.

Restructuring

(Dollars in millions)	Years Ended December 31, 2018	2017	2016
Restructuring	$ 3.6	$ 3.9	$ 0.6

During 2018, we recorded $3.6 million of restructuring charges, which was primarily comprised of severance costs related to a worldwide reduction in workforce during the third quarter of 2018 and transferring a portion of our shared accounting functions in the United States to a third party, as well as the consolidation of certain shared accounting functions in Asia.

During 2017, we recorded $3.9 million of restructuring charges related to the consolidation of two manufacturing plants, the restructuring of one of our international facilities and the consolidation of sales offices.

During 2016, we recorded $0.6 million of restructuring charges primarily related to the closing of one of our international facilities.

Environmental Costs

(Dollars in millions)	Years Ended December 31, 2018	2017	2016
Environmental costs	$ 1.0	$ —	$ —

We recorded environmental costs during the twelve months ended December 31, 2018, related to a U.S. Environmental Protection Agency-designated Superfund site, acquired as part of the Newport Merger.

Asset Impairment

(Dollars in millions)	Years Ended December 31, 2018	2017	2016
Asset impairment	$ —	$ 6.7	$ 5.0

During 2017, we recorded $6.7 million of impairment charges related to the consolidation of two manufacturing plants. These charges primarily related to the write-off of certain goodwill and intangible assets. During 2016, we recorded an asset impairment charge of $5.0 million on our investment in a private company.

Fees and Expenses Related to Repricing of Term Loan

(Dollars in millions)	Years Ended December 31, 2018	2017	2016
Fees and expenses related to repricing of term loan	$ 0.4	$ 0.5	$ 1.2

We recorded fees and expenses related to repricings of our Term Loan Facility (as defined below under “Liquidity and Capital Resources – Term Loan Credit Agreement.”

Amortization of Intangible Assets

(Dollars in millions)	Years Ended December 31, 2018	2017	2016
Amortization of intangible assets	$43.5	$45.7	$35.7

Amortization of intangible assets decreased by $2.2 million in 2018, due to certain intangible assets becoming fully amortized.

Amortization increased by $10.0 million during 2017, compared to 2016. The increase in 2017, compared to prior year, was primarily related to the amortization of intangible assets acquired through the Newport Merger. The increase during 2017, compared to 2016 was primarily due to the fact that the Light & Motion segment only accounted for eight months of expense in 2016.

Interest Expense, Net

	Years Ended December 31,		
(Dollars in millions)	**2018**	**2017**	**2016**
Interest expense, net	$11.2	$28.0	$28.0

Interest expense, net, decreased by $16.8 million in 2018, compared to 2017, primarily related to principal prepayments of $275.0 million since the beginning of 2017, and three repricings of our Term Loan Facility in 2017 and 2018.

Interest expense, net, remained flat and during 2017 and 2016.

Gain on Sale of Business

	Years Ended December 31,		
(Dollars in millions)	**2018**	**2017**	**2016**
Gain on sale of business	$ —	$74.9	$ —

We recorded a $74.9 million gain for 2017 on the sale of our Data Analytics Solutions business during the second quarter of 2017.

Other Expense, Net

	Years Ended December 31,		
(Dollars in millions)	**2018**	**2017**	**2016**
Other expense, net	$ 1.9	$ 5.9	$ 1.2

Other expense, net for 2018 and 2017 primarily related to changes in foreign exchange rates.

Other expense, net for 2016 includes $2.8 million of foreign exchange losses and other income, net of $1.6 million, primarily attributed to $1.3 million of net proceeds received from a Company-owned life insurance policy.

Provision for Income Taxes

	Years Ended December 31,		
(Dollars in millions)	**2018**	**2017**	**2016**
Provision for income taxes	$88.1	$108.5	$23.2

Our effective tax rate for the years 2018, 2017 and 2016 was 18.3%, 24.2% and 18.1%, respectively. The effective tax rate in 2018 and related income tax expense was impacted by the Tax Cuts and Jobs Act which was enacted into law on December 22, 2017. We account for income tax effects resulting from changes in tax laws in accordance with the authoritative guidance, which requires that these tax effects be recognized in the period in which the law is enacted and that the effects are recorded as a component of provision for income taxes from continuing operations. As a result, we recorded provisional amounts as of December 31, 2017 related to the one-time Transition Tax and the change in U.S. net deferred tax liabilities resulting from the change in the U.S. statutory rate resulting from the enactment of the Act in accordance with SAB 118. The provisional amounts recorded for the Act were finalized as of December 22, 2018 and resulted in a net decrease to our annual tax expense of approximately $0.6 million. The effective tax rate for the period ending December 31, 2018 was lower than the U.S. statutory rate due to foreign earnings taxed at lower rates, windfall benefits of stock compensation and the new deduction for foreign derived intangible income from the Act, offset by state income taxes.

The effective tax rate in 2017 was lower than the U.S. statutory tax rate due to foreign earnings taxed at lower rates, windfall benefits of stock compensation and the domestic production deduction offset by deferred taxes recorded as a result of a change in the indefinite reinvestment assertion with respect to certain foreign subsidiaries.

At December 31, 2018, the total amount of gross unrecognized tax benefits, which excludes interest and penalties, was approximately $32.7 million. At December 31, 2017, the total amount of gross unrecognized tax benefits, which excludes interest and penalties, was approximately $27.3 million. The net increase from December 31, 2017 was primarily attributable to the addition of reserves for the federal Transition Tax from the Act along with certain non-U.S. items offset by decreases from settlement of an audit by the U.S. Internal Revenue Service (“IRS”) and the expiration of certain statutes of limitations. At December 31, 2018, excluding interest and penalties, there were approximately $25.1 million of net unrecognized tax benefits that, if recognized, would impact our annual effective tax rate. We accrue interest and, if applicable, penalties for any uncertain tax positions. Interest and penalties are classified as a component of income tax expense. At December 2018, 2017 and 2016, we had accrued interest on unrecognized tax benefits of approximately $0.6 million, $0.3 million and $0.5 million, respectively.

Over the next 12 months it is reasonably possible that we may recognize approximately $2.1 million of previously net unrecognized tax benefits, excluding interest and penalties, related to federal, state and foreign tax positions as a result of the expiration of statutes of limitations. The U.S. statute of limitations remains open for tax years 2015 through present. The statute of limitations for our tax filings in other jurisdictions varies between fiscal years 2013 through the present. We also have certain federal credit carry-forwards and state tax loss and credit carry-forwards that are open to examination for tax years 2000 through the present.

We are subject to examination by U.S. federal, state and foreign tax authorities. The IRS commenced an examination of our U.S. federal income tax filings for tax years 2015 and 2016 during the quarter ended September 30, 2017. This audit was effectively settled during the quarter ended March 31, 2018. During the quarter ended March 31, 2018 we received notification from the IRS of its intent to audit our U.S. subsidiary, Newport, for tax year 2015. This audit commenced during the quarter ended June 30, 2018 and there have been no proposed adjustments through December 31, 2018.

On a quarterly basis, we evaluate both positive and negative evidence that affects the realizability of net deferred tax assets and assess the need for a valuation allowance. The future benefit to be derived from our deferred tax assets is dependent upon our ability to generate sufficient future taxable income in each jurisdiction of the right type to realize the assets.

In 2018 we recorded a net benefit to income tax expense of $1.6 million, excluding interest and penalties, due to reserve releases related to the expiration of certain statutes of limitations for previously open tax years and the effective settlement of an IRS audit. In 2017 we recorded a net benefit to income tax expense of $3.1 million, excluding interest and penalties, due to reserve releases related to the expiration of statutes of limitations for previously open tax years. For 2016 we recorded a net benefit to income tax expense of $2.6 million, excluding interest and penalties, due to reserve releases related to the expiration of the statutes of limitations for previously open tax years.

The United Kingdom is negotiating its withdrawal from the European Union (“EU”). It is possible that the United Kingdom may leave the EU without having negotiated terms of its withdrawal (no deal Brexit). If there is a no deal Brexit, tax treaties between the United Kingdom and member states of the EU will displace certain EU directives now in effect including the Parent / Subsidiary Directive. The Parent Subsidiary Directive currently eliminates withholding taxes on the payment of dividends between associated companies of different EU member states. The United Kingdom tax treaties with EU member states generally permit withholding taxes to be applied at reduced rates. If there is a no deal Brexit, our tax expense may increase due to the imposition of withholding taxes on dividends paid from our EU subsidiaries to our United Kingdom subsidiaries.

Our future effective tax rate depends on various factors, including further interpretations and guidance from U.S. federal and state governments on the impact of the enactment of the Act, the adoption of the proposed regulations issued by the U.S. IRS on the one-time transition tax and the global intangible low-taxed income provision, as well as the geographic composition of our pre-tax income, and changes in income tax reserves for unrecognized tax benefits. We monitor these factors and timely adjust our estimates of the effective tax rate accordingly. We expect that the geographic mix of pre-tax income will continue to have a favorable impact on our effective tax rate, however the geographic mix of pre-tax income can change based on multiple factors resulting in changes to the effective tax rate in future periods. While we believe we have adequately provided for all tax positions, amounts asserted by taxing authorities could materially differ from our accrued positions as a result of uncertain and complex application of tax law and regulations. Additionally, the recognition and measurement of certain tax benefits include estimates and judgment by management. Accordingly, we could record additional provisions or benefits for U.S. federal, state, and foreign tax matters in future periods as new information becomes available.

Liquidity and Capital Resources

Cash, cash equivalents and short-term marketable investments totaled $718.2 million at December 31, 2018, an increase of $174.9 million compared to $543.3 million at December 31, 2017. This increase and the primary driver in our current and anticipated future cash flows is and will continue to be cash generated from operations, consisting primarily of our net income, excluding non-cash changes and changes in operating assets and liabilities. In periods when our sales are growing, higher sales to customers will result in increased trade receivables, and inventories will generally increase as we build products for future sales. This may result in lower cash generated from operations. Conversely, in periods when our sales are declining, our trade accounts receivable and inventory balances will generally decrease, resulting in increased cash from operations.

Net cash provided by operating activities was $413.8 million for 2018 and resulted from net income of $392.9 million, which included non-cash net charges of $118.9 million, offset by an increase in working capital of $98.0 million. The increase in working capital consisted primarily of an increase in inventories of $73.8 million, a decrease in income taxes of $11.4 million, a decrease in accrued compensation of $8.7 million and a decrease in other current and non-current liabilities of $4.0 million.

Net cash provided by operating activities was $355.2 million for 2017 and resulted from net income of $339.1 million, which included non-cash net charges of $66.5 million, offset by an increase in working capital of $50.4 million. The increase in working capital consisted of an increase in inventories of $72.4 million, an increase in trade accounts receivable of $44.1 million and an increase in current and non-current assets of $8.6 million, all as a result of a significant increase in our business in 2017. These increases were offset by an increase in accrued compensation of $32.5 million mainly related to variable compensation, other current and non-current liabilities of $18.0 million, income taxes of $12.8 million and accounts payable of $11.4 million.

Net cash provided by operating activities was $180.1 million for 2016 and resulted from net income of $104.8 million, which included non-cash net charges of $97.6 million, offset by an increase in working capital of

$22.3 million. The increase in working capital consisted of an increase in trade accounts receivable of $58.1 million, an increase in inventories of $13.8 and an increase in current and non-current assets of $12.2 million. These increases were offset by an increase in income taxes of $30.9 million, accounts payable of $16.2 million, an increase in accrued compensation of $11.0 million and an increase in other current and non-current liabilities of $3.7 million.

Net cash provided by investing activities was $72.8 million for 2018, due to net sales and maturities of short-term investments of $135.7 million, offset by the purchases of production-related equipment of $62.9 million. Net cash provided by investing activities was $22.6 million for 2017 and resulted primarily from proceeds received of $72.5 million from the sale of our Data Analytics Solutions business, partially offset by purchases of production-related equipment of $31.3 million and net purchases of short-term investments of $18.7 million. Net cash used in investing activities was $727.0 million for 2016 and resulted primarily from $939.6 million of cash, primarily used for the Newport Merger and $19.1 million used for the purchase of production-related equipment, partially offset by net proceeds from sales and maturities of investments of $231.5 million. The purchase of production-related equipment could increase to support future sales growth.

Net cash used in financing activities was $178.0 million for 2018 and primarily resulted from the repurchase of common stock of $75.0 million, partial repayment of our Term Loan Facility of $50.0 million, dividend payments made to common stockholders of $42.4 million and net payments related to tax payments for employee stock awards of $11.1 million. Net cash used in financing activities was $279.7 million and resulted primarily from partial repayment of the Term Loan Facility of $228.1 million, dividend payments made to common stockholders of $38.2 million and net payments related to tax payments for employee stock awards of $12.2 million. Net cash provided by financing activities was $560.1 million for 2016 and resulted from net proceeds of $598.5 million, primarily related to the Term Loan Facility used to finance the Newport Merger, offset by dividend payments made to common stockholders of $36.4 million and net payments related to tax payments made for employee stock awards of $1.9 million.

On July 25, 2011, our Board of Directors approved a share repurchase program for the repurchase of up to an aggregate of $200 million of our common stock from time to time in open market purchases, privately negotiated transactions or through other appropriate means. The timing and quantity of any shares repurchased depends upon a variety of factors, including business conditions, stock market conditions and business development activities, including, but not limited to, merger and acquisition opportunities. These repurchases may be commenced, suspended or discontinued at any time without prior notice. During 2018, we repurchased approximately 818,000 shares of our common stock for $75.0 million, or an average price of $91.67 per share. During 2017, we did not repurchase any shares of our common stock. During 2016, we repurchased approximately 45,000 shares of our common stock for $1.5 million at an average price of $34.50 per share.

Holders of our common stock are entitled to receive dividends when and if they are declared by our Board of Directors. For the year ended December 31, 2018, we paid cash dividends of $42.4 million in the aggregate, or $0.78 per share. For the year ended December 31, 2017, we paid cash dividends of $38.2 million in the aggregate, or $0.71 per share. For the year ended December 31, 2016, we paid cash dividends of $36.4 million in the aggregate, or $0.68 per share. Future dividend declarations, if any, as well as the record and payment dates for such dividends, are subject to the final determination of our Board of Directors. In addition, under the terms of our Term Loan Facility and our senior secured asset-based revolving credit facility, we may be restricted from paying dividends under certain circumstances.

On February 11, 2019, the Company's Board of Directors declared a quarterly cash dividend of $0.20 per share to be paid on March 8, 2019 to shareholders of record as of February 25, 2019.

Acquisition of Electro Scientific Industries, Inc.

On February 1, 2019, we completed our previously announced acquisition of ESI pursuant to the ESI Merger. At the effective time of the ESI Merger and pursuant to the terms and conditions of the Agreement and

Plan of Merger, each share of ESI's common stock issued and outstanding as of immediately prior to the effective time of the ESI Merger was converted into the right to receive $30.00 per share in cash, without interest and subject to deduction for any required withholding tax. We paid to the former ESI stockholders aggregate consideration of approximately $1 billion, excluding related transaction fees and expenses. We funded the payment of the aggregate consideration with a combination of our available cash on hand and proceeds from our term loan facility described below.

Sale of Data Analytics Solutions Business

In April 2017, we completed the sale of our Data Analytics Solutions business for total proceeds of $72.5 million, net of cash sold, and we recorded a pre-tax gain of $74.9 million. This business, which had net revenues in 2016 of $12.7 million and was included in the Vacuum & Analysis segment, was no longer a part of our long-term strategic objectives.

Term Loan Credit Agreement

In connection with the completion of the Newport Merger, we entered into a term loan credit agreement (the "Credit Agreement") with Barclays Bank PLC, as administrative agent and collateral agent, and the lenders from time to time party thereto (the "Lenders"), that provided senior secured financing in the original principal amount of $780.0 million, subject to increase at our option and subject to the receipt of lender commitments in accordance with the Credit Agreement (the "Term Loan Facility"). Borrowings under the Term Loan Facility bear interest per annum at one of the following rates selected by the Company: (a) a base rate determined by reference to the highest of (1) the federal funds effective rate plus 0.50%, (2) the "prime rate" quoted in *The Wall Street Journal*, (3) a LIBOR rate determined by reference to the costs of funds for U.S. dollar deposits for an interest period of one month adjusted for certain additional costs, plus 1.00%, and (4) a floor of 1.75%, plus, in each case, an applicable margin; or (b) a LIBOR rate determined by reference to the costs of funds for U.S. dollar deposits for the interest period relevant to such borrowing adjusted for certain additional costs, subject to a LIBOR rate floor of 0.75%, plus an applicable margin. We have elected the interest rate as described in clause (b). The Credit Agreement provides that all loans will be determined by reference to the Base Rate if the LIBOR rate cannot be ascertained, if regulators impose material restrictions on the authority of a lender to make LIBOR rate loans, and for other reasons. The Term Loan Facility was issued with original issue discount of 1.00% of the principal amount thereof.

In June 2016, we entered into Amendment No. 1 (the "Repricing Amendment 1") to the Credit Agreement by and among the Company, the Lenders and Barclays Bank PLC, as administrative agent and collateral agent for the Lenders. The Repricing Amendment 1 decreased the applicable margin for borrowings under our Term Loan Facility to 2.50% for base rate borrowings and 3.50% for LIBOR borrowings and extended the period during which a prepayment premium may be required for a "Repricing Transaction" (as defined in the Credit Agreement) until six months after the effective date of the Repricing Amendment 1. In connection with the execution of the Repricing Amendment 1, we paid a prepayment premium of 1.00%, or $7.3 million, as well as certain fees and expenses of the administrative agent and the Lenders, in accordance with the terms of the Credit Agreement. Immediately prior to the effectiveness of the Repricing Amendment 1, we prepaid $50.0 million of principal under the Credit Agreement. In September 2016, we prepaid an additional $60.0 million under the Credit Agreement.

In September 2016, we entered into an interest rate swap agreement, which has a maturity date of September 30, 2020, to fix the rate on $335.0 million of the then-outstanding balance under the Credit Agreement. The rate is fixed at 1.198% per annum plus the applicable credit spread, which was 1.75% at December 31, 2018. The notional amount of the interest rate swap agreement was $290.0 million and had a fair value of $6.1 million at December 31, 2018.

In December 2016, we entered into Amendment No. 2 (the "Repricing Amendment 2") to the Credit Agreement by and among the Company, the Lenders and Barclays Bank PLC, as administrative agent and collateral agent for the Lenders. The Repricing Amendment 2 decreased the applicable margin for our term loan under the Credit Agreement to 2.75% for LIBOR borrowings and 1.75% for base rate borrowings and reset the period during which a prepayment premium may be required for a Repricing Transaction until six months after the effective date of the Repricing Amendment 2. In November 2016, prior to the effectiveness of the Repricing Amendment 2, we prepaid an additional $40.0 million of principal under the Credit Agreement. In March 2017, we prepaid an additional $50.0 million of principal under the Credit Agreement.

In July 2017, we entered into Amendment No. 3 (the “Repricing Amendment 3”) to our Credit Agreement by and among the Company, the Lenders and Barclays Bank PLC, as administrative agent and collateral agent for the Lenders. The Repricing Amendment 3 decreased the applicable margin for our term loan under the Credit Agreement to 2.25% for LIBOR rate loans when the Total Leverage Ratio (as defined in the Credit Agreement) is at or above 1.25:1 and decreased to 2.00% when the Total Leverage Ratio was below 1.25:1, both with a LIBOR floor of 0.75%. The margin for base rate borrowings decreased to 1.25% when our Total Leverage Ratio was at or above 1.25:1 and will decrease to 1.00% when the Total Leverage Ratio is below 1.25:1. The period in which a prepayment premium may be required for a Repricing Transaction was reset to six months after the effective date of the Repricing Amendment 3.

In April 2018, we entered into Amendment No. 4 (the “Repricing Amendment 4”) to the Credit Agreement by and among the Company, the Lenders and Barclays Bank PLC, as administrative agent and collateral agent for the Lenders. The Repricing Amendment 4 decreased the applicable margin for our term loan under the Credit Agreement to 1.75% for LIBOR rate loans, with a LIBOR rate floor of 0.75%. The margin for base rate borrowings decreased to 0.75% with a base rate floor of 1.75%. The period during which a prepayment premium may be required for a Repricing Transaction was reset to six months after the effective date of the Repricing Amendment 4.

In July 2017, August 2017, November 2017 and March 2018 we voluntarily prepaid $50.0 million, $75.0 million, $50.0 million and $50.0 million, respectively, of principal under the Credit Agreement. As of December 31, 2018, after total principal prepayments of $425.0 million and regularly scheduled principal payments of $6.5 million, the total outstanding principal balance was $348.5 million. The interest rate as of December 31, 2018 was 4.1%.

We incurred $28.7 million of deferred finance fees, original issue discount and repricing fees related to the term loans under the Term Loan Facility, which are included in long-term debt in the accompanying consolidated balance sheets and are being amortized to interest expense over the estimated life of the term loans using the effective interest method. A portion of these fees have been accelerated in connection with the various debt prepayments during 2016, 2017 and 2018. As of December 31, 2018, the remaining balance of the deferred finance fees, original issue discount and repricing fees related to the Term Loan Facility was $4.7 million.

Under the Credit Agreement, we are required to prepay outstanding term loans, subject to certain exceptions, with portions of our annual excess cash flow as well as with the net cash proceeds of certain asset sales, certain casualty and condemnation events and the incurrence or issuance of certain debt. As a result of our Total Leverage Ratio, we were not required to make a prepayment of excess cash flow for fiscal year end 2018. We are also required to make scheduled quarterly payments each equal to 0.25% of the principal amount of the term loan, less the amount of certain voluntary and mandatory repayments after such date, with the balance due on the seventh anniversary of the closing date. As a result of making total prepayments of $425.0 million through December 31, 2018, we are no longer required to make any scheduled quarterly principal payments on the Term Loan Facility we had in place as of December 31, 2018 until maturity of the loan.

All obligations under the Term Loan Facility are guaranteed by certain of our domestic subsidiaries, and are secured by substantially all of our assets and the assets of such subsidiaries, subject to certain exceptions and exclusions.

The Credit Agreement contains customary representations and warranties, affirmative and negative covenants and provisions relating to events of default. If an event of default occurs, the Lenders under the Term Loan Facility will be entitled to take various actions, including the acceleration of amounts due under the Term Loan Facility and all actions generally permitted to be taken by a secured creditor. At December 31, 2018, we were in compliance with all covenants under the Credit Agreement.

Incremental Term Loan Facility

On February 1, 2019, in connection with the completion of the ESI Merger, we entered into Amendment No. 5 to the Credit Agreement. Amendment No. 5 provides an additional tranche B-5 term loan commitment in the principal amount of $650.0 million (the "Incremental Term Loan Facility"), all of which was drawn down in connection with the closing of the ESI Merger. The Incremental Term Loan Facility matures on February 1, 2026 and bears interest at a rate per annum equal to, at our option, any of the following, plus, in each case, an applicable margin: (a) a base rate determined by reference to the highest of (1) the federal funds effective rate plus 0.50%, (2) the prime rate quoted in *The Wall Street Journal*, (3) a LIBOR rate determined by reference to the costs of funds for U.S. dollar deposits for an interest period of one month adjusted for certain additional costs, plus 1.00% and (4) a floor of 1.00%; and (b) a LIBOR rate determined by reference to the costs of funds for U.S. dollar deposits for the interest period relevant to such borrowing adjusted for certain additional costs, with a floor of 0.00%. The Incremental Term Loan Facility was issued with original issue discount of 1.00% of the principal amount thereof and the applicable margin for borrowings under the Incremental Term Loan Facility is 1.25% with respect to base rate borrowings and 2.25% with respect to LIBOR borrowings. As a consequence of the pricing of the Incremental Term Loan Facility, the applicable margin for the existing Term Loan Facility currently outstanding under the Credit Agreement (in the approximate outstanding principal amount of $348.0 million) was increased to 1.00% (from 0.75%) with respect to base rate borrowings and 2.00% (from 1.75%) with respect to LIBOR borrowings.

We are required to make scheduled quarterly payments each equal to 0.25% of the original principal amount of the tranche B-5 term loans, with the balance due on the seventh anniversary of the closing date of Amendment No. 5. If on or prior to the date that is six months after the closing date of Amendment No. 5 we prepay any tranche B-5 term loan in connection with a repricing transaction, we must pay a prepayment premium of 1.00% of the aggregate principal amount of the loans so prepaid.

Except as described above, the terms, covenants and events of default applicable to the Incremental Term Loan Facility are materially consistent with the terms, covenants and events of default applicable to tranche B-4 term loans currently outstanding under the Credit Agreement. The Incremental Term Loan Facility is guaranteed and secured on the same basis as the tranche B-4 term loans currently outstanding under the Credit Agreement. Pursuant to Amendment No. 5, we also effectuated certain amendments to the Credit Agreement which make certain of the negative covenants and other provisions less restrictive and, therefore, provide us with additional flexibility.

Senior Secured Asset-Based Revolving Credit Facility

In connection with the completion of the Newport Merger, we entered into an asset-based credit agreement with Deutsche Bank AG New York Branch, as administrative agent and collateral agent, the other borrowers from time to time party thereto, and the lenders and letters of credit issuers from time to time party thereto, that provided senior secured financing of up to $50.0 million, which we never borrowed against. On February 1, 2019, in connection with the completion of the ESI Merger, we terminated the $50.0 million asset-based credit agreement with Deutsche Bank AG New York Branch and entered into an asset-based credit agreement with Barclays Bank PLC, as administrative agent and collateral agent, the other borrowers from time to time party thereto, and the lenders and letters of credit issuers from time to time party thereto (the "ABL Credit Agreement"), that provides senior secured revolving credit financing of up to $100.0 million, subject to a borrowing base limitation (the "ABL Facility"). The borrowing base for the ABL Facility at any time equals the sum of: (a) 85% of certain eligible accounts; plus (b) subject to certain notice and field examination and appraisal requirements, the lesser of (i) the lesser of (A) 65% of the lower of cost or market value of certain eligible inventory and (B) 85% of the net orderly liquidation value of certain eligible inventory and (ii) 30% of the borrowing base; minus (c) reserves established by the administrative agent; provided that until the administrative agent's receipt of a field examination of accounts receivable (and certain eligible inventory if eligible inventory is included in the borrowing base) the borrowing base shall be equal to the greater of $50.0 million and the borrowing base otherwise in effect. If such field exam has not occurred by the 90th day after the closing date (subject to certain extensions), the borrowing base shall be reduced to zero on such 90th day until such field exam occurs. The ABL Facility includes borrowing capacity in the form of letters of credit up to $25.0 million.

Borrowings under the ABL Facility bear interest at a rate per annum equal to, at our option, any of the following, plus, in each case, an applicable margin: (a) a base rate determined by reference to the highest of (1) the federal funds effective rate plus 0.50%, (2) the "prime rate" quoted in *The Wall Street Journal*, (3) a LIBOR rate determined by reference to the costs of funds for U.S. dollar deposits for an interest period of one month adjusted for certain additional costs, plus 1.00% and (4) a floor of 0.00%; and (b) a LIBOR rate determined by reference to the costs of funds for U.S. dollar deposits for the interest period relevant to such borrowing adjusted for certain additional costs, with a floor of 0.00%. The initial applicable margin for borrowings under the ABL Facility is 0.50% with respect to base rate borrowings and 1.50% with respect to LIBOR borrowings. Commencing with the completion of the first fiscal quarter ending after the closing of the ABL Facility, the applicable margin for borrowings thereunder is subject to upward or downward adjustment each fiscal quarter, based on the average historical excess availability during the preceding quarter.

In addition to paying interest on any outstanding principal under the ABL Facility, we are required to pay a commitment fee in respect of the unutilized commitments thereunder equal to 0.25% per annum. We must also pay customary letter of credit fees and agency fees.

Mandatory Prepayments. If at any time the aggregate amount of outstanding loans, protective advances, unreimbursed letter of credit drawings and undrawn letters of credit under the ABL Facility exceeds the lesser of (a) the commitment amount and (b) the borrowing base, we are required to repay outstanding loans and/or cash collateralize letters of credit, with no reduction of the commitment amount. During any period that the amount available under the ABL Facility is less than the greater of (i) $8.5 million and (ii) 10.0% of the lesser of (1) the commitment amount and (2) the borrowing base for three consecutive business days, until the time when excess availability has been at least the greater of (i) $8.5 million and (ii) 10.0% of the lesser of (1) the commitment amount and (2) the borrowing base, in each case, for 30 consecutive calendar days (a "Cash Dominion Period"), or during the continuance of an event of default, we are required to repay outstanding loans and/or cash collateralize letters of credit with the cash that it is required to deposit daily in a collection account maintained with the administrative agent under the ABL Facility. During a Cash Dominion Period, we may make borrowings under the ABL Facility subject to the satisfaction of customary funding conditions.

Voluntary Prepayments. We may voluntarily reduce the unutilized portion of the commitment amount and repay outstanding loans from time to time. Prepayments of the loans may be made without premium or penalty other than customary "breakage" costs with respect to LIBOR loans.

Amortization and Final Maturity. There is no scheduled amortization under our ABL Facility. The principal amount outstanding under the ABL Facility is due and payable in full on the fifth anniversary of the closing date; provided, that if any balance of the Term Loan Facility remains outstanding under the Credit Agreement on the date that is 180 days prior to April 29, 2023, then the ABL Facility will become due and payable in full on the date that is 91 days prior to April 29, 2023.

Guarantees and Security. All obligations under the ABL Facility are unconditionally guaranteed by certain of our existing domestic subsidiaries and are required to be guaranteed by certain of our future domestic subsidiaries. All obligations under the ABL Facility, and the guarantees of those obligations, are secured, subject to certain exceptions, by substantially all of our assets and the assets of our subsidiaries that have guaranteed the ABL Facility (referred to herein as the subsidiary guarantors), including, in each case subject to customary exceptions and exclusions:

- a first-priority security interest in personal property consisting of, among other things, accounts receivable, inventory, deposit accounts, securities accounts, commodities accounts, cash and cash equivalents, instruments, chattel paper, and certain assets related to the foregoing and, in each case, proceeds thereof (such property, the "Current Asset Collateral");
- a second-priority pledge of all of the capital stock directly held by us and any subsidiary guarantors (which pledge, in the case of the capital stock of each (a) domestic subsidiary that is directly owned by us or by any subsidiary guarantor and that holds no material assets other than equity interests in one or more controlled foreign corporations or (b) foreign subsidiary, is limited to 65% of the stock of such subsidiary); and
- a second-priority security interest in substantially all other tangible and intangible assets, including substantially all of our owned equipment and intellectual property.

Certain Covenants and Events of Default. The ABL Credit Agreement contains a number of negative covenants that, among other things and subject to certain exceptions, restrict the ability of us and each of our subsidiaries to:

- incur additional indebtedness;
- incur liens;
- pay dividends on our capital stock or redeem, repurchase or retire our capital stock or our other indebtedness;
- make investments, loans and acquisitions;
- create restrictions on the payment of dividends or other amounts to us from our restricted subsidiaries;
- engage in transactions with its affiliates;
- sell assets, including capital stock of its subsidiaries;
- materially alter the business it conducts;
- consolidate or merge; and
- engage in sale-leaseback transactions.

From the time when we have excess availability less than the greater of (a) 10.0% of the lesser of (1) the commitment amount and (2) the borrowing base and (b) $8.5 million, until the time when we have excess availability equal to or greater than the greater of (a) 10.0% of the lesser of (1) the commitment amount and (2) the borrowing base and (b) $8.5 million for 30 consecutive days, or during the continuance of an event of default, the ABL Credit Agreement requires us to maintain a Fixed Charge Coverage Ratio (as defined in the ABL Credit Agreement) tested on the last day of each fiscal quarter of at least 1.0 to 1.0.

The ABL Credit Agreement also contains customary representations and warranties, affirmative covenants and provisions relating to events of default. If an event of default occurs, the lenders under the ABL Facility will be entitled to take various actions, including the acceleration of amounts due under the ABL Facility and all actions permitted to be taken by a secured creditor.

Lines of Credit and Short-Term Borrowing Arrangements

One of our Japanese subsidiaries has lines of credit and short-term borrowing arrangements with two financial institutions which arrangements generally expire and are renewed at three-month intervals. The lines of credit provide for aggregate borrowings as of December 31, 2018, of up to an equivalent of $20.9 million U.S. dollars. One of the borrowing arrangements has an interest rate based on the Tokyo Interbank Offer Rate at the time of borrowing and the other has an interest rate based on the Japanese Short-Term Prime Lending Rate. There were no borrowings outstanding under these arrangements at December 31, 2018 and 2017.

We assumed various revolving lines of credit and a financing facility with the completion of the Newport Merger. These revolving lines of credit and financing facility have no expiration date and provide for aggregate borrowings as of December 31, 2018 of up to an equivalent of $11.3 million U.S. dollars. These lines of credit have a base interest rate of 1.25% plus a Japanese Yen overnight LIBOR rate. Total borrowings outstanding under these arrangements were $3.4 million and $3.0 million at December 31, 2018 and 2017.

One of our Austrian subsidiaries has various outstanding loans from the Austrian government to fund research and development. These loans are unsecured and do not require principal repayment as long as certain conditions are met. Interest on these loans is payable semi-annually. The interest rates associated with these loans range from 0.75% – 2.00%.

We have provided financial guarantees for certain unsecured borrowings and have standby letters of credit, some of which do not have fixed expiration dates. At December 31, 2018, our maximum exposure as a result of these financial guarantees and standby letters of credit was approximately $5.4 million.

Our total cash and cash equivalents, including restricted cash and short-term marketable investments at December 31, 2018 consisted of $464.7 million held in the United States and $253.5 million held by our foreign subsidiaries. We believe that our current cash and investments position and available borrowing capacity, together with the cash anticipated to be generated from our operations, will be sufficient to satisfy our estimated working capital, planned capital expenditure requirements, and any future cash dividends declared by our Board of Directors or share repurchases through at least the next 12 months and the foreseeable future.

Contractual Obligations

In connection with the ESI Merger, which closed in February 2019, in addition to the entry into the amendment to our Term Loan Facility described above, we assumed certain contractual lease obligations and purchase obligations. None of those items are included in the table below.

Future contractual obligations as of December 31, 2018 are as follows:

	Payment Due By Period					
Contractual Obligations (In thousands)	Total	Less than 1 Year	1-3 years	3-5 years	After 5 years	Other(1)
Operating lease obligations	$ 66,296	$ 20,106	$ 27,467	$ 9,984	$ 8,739	$ —
Purchase obligations(2)	295,194	254,069	26,474	11,008	3,643	—
Pension obligations	31,548	1,046	2,462	2,441	25,599	—
Debt	352,536	3,986	86	348,464	—	—
Other long-term liabilities reflected on the Balance Sheet under U.S. GAAP(3)	102,383	881	20,033	449	56,096	24,924
Total	$ 847,957	$ 280,088	$ 76,522	$ 372,346	$ 94,077	$ 24,924

(1) This balance relates to our reserve for uncertain tax positions.

(2) As of December 31, 2018, we have entered into purchase commitments for certain inventory components and other equipment and services used in our normal operations. The majority of these purchase

commitments covered by these arrangements are for periods less than a year and aggregate to approximately $254.1 million.

(3) The majority of this balance relates to deferred tax liabilities.

Derivatives

We enter into derivative instruments for risk management purposes only, including derivatives designated as hedging instruments and those utilized as economic hedges. We operate internationally, and in the normal course of business, are exposed to fluctuations in interest rates and foreign exchange rates. These fluctuations can increase the costs of financing, investing and operating the business. We have used derivative instruments, such as forward exchange contracts and an interest rate hedge to manage certain foreign currency and interest rate exposures.

By nature, all financial instruments involve market and credit risks. We enter into derivative instruments with major investment grade financial institutions and no collateral is required. We have policies to monitor the credit risk of these counterparties. While there can be no assurance, we do not anticipate any material non-performance by any of these counterparties.

We hedge a portion of our forecasted foreign currency denominated intercompany sales of inventory, over a maximum period of eighteen months, using forward foreign exchange contracts accounted for as cash-flow hedges related to Japanese, South Korean, British, Euro and Taiwanese currencies. To the extent these derivatives are effective in offsetting the variability of the hedged cash flows, and otherwise meet the hedge accounting criteria, changes in the derivatives' fair value are not included in current earnings but are included in accumulated other comprehensive income in stockholders' equity. These changes in fair value will subsequently be reclassified into earnings, as applicable, when the forecasted transaction occurs. To the extent that a previously designated hedging transaction is no longer an effective hedge, any ineffectiveness measured in the hedging relationship is recorded currently in earnings in the period it occurs. The cash flows resulting from forward exchange contracts are classified in the consolidated statements of cash flows as part of cash flows from operating activities. We do not enter into derivative instruments for trading or speculative purposes.

We also enter into forward exchange contracts to hedge certain balance sheet amounts. To the extent the hedge accounting criteria is not met, the related foreign currency forward contracts are considered as economic hedges and changes in the fair value of these contracts are recorded immediately in earnings in the period in which they occur. These include hedges that are used to reduce exchange rate risks arising from the change in fair value of certain foreign currency-denominated assets and liabilities (i.e., payables, receivables) and other economic hedges where the hedge accounting criteria were not met.

We had forward exchange contracts with notional amounts totaling $159.4 million outstanding at December 31, 2018 of which $59.1 million were outstanding to exchange South Korean Won to U.S. dollars and $43.8 million were outstanding to exchange Japanese Yen to U.S. dollars. We had forward exchange contracts with notional amounts totaling $208.9 million outstanding at December 31, 2017 of which $79.7 million were outstanding to exchange South Korean Won to U.S. dollars and $70.2 million were outstanding to exchange Japanese Yen to U.S. dollars.

As of December 31, 2018, the unrealized loss that will be reclassified from accumulated other comprehensive income to earnings over the next twelve months is immaterial. Gains and losses on forward exchange contracts that qualify for hedge accounting are classified in cost of products in 2018, 2017 and 2016 and totaled a loss of $3.4 million, a loss of $2.7 million and a loss of $1.4 million, respectively. There were no ineffective portions of the derivatives recorded in 2018, 2017 and 2016.

We hedge certain intercompany accounts receivable and intercompany loans with forward exchange contracts. Typically, as these derivatives hedge existing amounts that are denominated in foreign currencies, the derivatives do not qualify for hedge accounting. Realized and unrealized gains and losses on forward exchange contracts that do not qualify for hedge accounting are recognized currently in earnings. The net foreign exchange losses on these derivatives were immaterial in each of 2018, 2017 and 2016. Foreign currency gains or losses are classified in other expense, net. The cash flows resulting from forward exchange contracts are classified in our consolidated statements of cash flows as part of cash flows from operating activities. We do not hold or issue derivative financial instruments for trading purposes.

We have also entered into an interest rate swap agreement related to our Credit Agreement. See details above under “Term Loan Credit Agreement.”

Off-Balance Sheet Arrangements

We do not have any financial partnerships with unconsolidated entities, such as entities often referred to as structured finance, special purpose entities or variable interest entities which are often established for the purpose of facilitating off-balance sheet arrangements or other contractually narrow or limited purposes. Accordingly, we are not exposed to any financing, liquidity, market or credit risk that could arise if we had such relationships.

Recently Issued Accounting Pronouncements

In October 2018, the Financial Accounting Standards Board (“FASB”) issued Accounting Standards Update (“ASU”) 2018-16, “Derivatives and Hedging (Topic 815).” This standard permits the use of the Overnight Index Swap Rate (“OIS”) based on the Secured Overnight Financing Rate as a U.S. benchmark interest rate for hedge accounting purposes under Topic 815 in addition to the interest rates on direct treasury obligations of the U.S. government, the London Interbank Offered Rate (“LIBOR”) swap rate, the OIS rate based on the Federal Funds Effective Rate and the Securities industry and Financial Markets Association Municipal Swap Rate. This standard is effective for annual periods beginning after December 15, 2018, including interim periods within those fiscal years. We are currently evaluating the requirements of this standard and have not yet determined its impact on our consolidated financial statements.

In August 2018, the FASB issued ASU 2018-15, “Intangibles-Goodwill and Other-Internal-Use Software (Subtopic 350-40): Customer’s Accounting for Implementation Costs Incurred in a Cloud Computing Arrangement That is a Service Contract.” This standard aligns the requirements for capitalizing implementation costs incurred in a hosting arrangement that is a service contract with the requirements for capitalizing implementation costs incurred to develop or obtain internal-use software (and hosting arrangements that include an internal-use software license). The accounting for the service element of a hosting arrangement that is a service contract is not affected by the amendments of this update. This standard is effective for annual periods beginning after December 15, 2019, including interim periods within those fiscal years. We are currently evaluating the requirements of this standard and have not yet determined its impact on our consolidated financial statements.

In March 2018, the FASB issued ASU 2018-05, “Income Taxes (Topic 740).” This standard is an amendment that adopts the language of SAB 118 and aims to address certain circumstances that may arise for registrants in accounting for the income tax effects of the Act and to address any uncertainty or diversity of views in practice regarding the application of Topic 740 in situations where a registrant does not have the necessary information available, prepared, or analyzed (including computations) in reasonable detail to complete the accounting under Topic 740 for certain income tax effects of the Act for the reporting period in which the Act was enacted. The provisions of this ASU were applied to our December 31, 2017 financial statements. We recorded provisional amounts with respect to the Act at December 31, 2017 and for the nine months ended September 30, 2018. During the quarter ended December 31, 2018, we completed our analysis and finalized the provisional amounts that were previously recorded. The ultimate impact of this Act is based upon our understanding and interpretation of the regulatory guidance that has been issued regarding the Act.

In August 2017, the FASB issued ASU 2017-12, “Derivatives and Hedging (Topic 815).” This standard better aligns an entity’s risk management activities and financial reporting for hedging relationships through changes to both the designation and measurement guidance for qualifying hedging relationships and the presentation of hedge results. The provisions of this ASU are effective for annual periods beginning after December 15, 2018, including interim periods within those fiscal years. We do not expect adoption of this ASU to have a material impact on our consolidated financial statements.

In February 2016, the FASB issued ASU 2016-02, “Leases (Topic 842).” This standard requires the recognition of lease assets and liabilities for all leases, with certain exceptions, on the balance sheet. In transition, lessees and lessors have the option to either apply the standard retrospectively through a cumulative-effect adjustment to the opening balance of retained earnings in the period of adoption or they can apply the new standard to comparative periods presented. This ASU is effective for annual periods beginning after December 15, 2018, including interim periods within those fiscal years. The FASB issued additional updates to the new standard in Topic 842 (Update 2018-01 in January 2018 – Land Easement Practical Expedient for Transition to Topic 842, (Update 2018-10 – Codification Improvements to Topic 842 and Update 2018-11 in July 2018 – Targeted Improvements). We have reviewed the requirements of the new standard and have formulated a plan for implementation. We have communicated our approach to our Audit Committee and have provided regular updates as appropriate. We have accumulated details on the population of leases and entered these details into a selected software database, which will be a repository and accounting solution for reporting and disclosure requirements required by the standard. We estimate that the balance sheet gross up (recording the right-of-use asset and lease liability) will be approximately $60 to $65 million at adoption on January 1, 2019. We will continue to assess and disclose the impact that this ASU will have on our consolidated financial statements, disclosures and related controls, when known.

Item 7A. *Quantitative and Qualitative Disclosures about Market Risk*

Market Risk and Sensitivity Analysis

Our primary exposures to market risks include fluctuations in interest rates on our Term Loan Facility and investment portfolio, as well as fluctuations in foreign currency exchange rates.

Foreign Exchange Rate Risk

We mainly enter into forward exchange contracts to reduce currency exposure arising from intercompany sales of inventory. We also enter into forward exchange contracts to reduce foreign exchange risks arising from the change in fair value of certain foreign currency denominated assets and liabilities.

We had forward exchange contracts with notional amounts totaling $159.4 million outstanding and a net fair value liability totaling $1.3 million at December 31, 2018. We had forward exchange contracts with notional amounts totaling $208.9 million outstanding and a net fair value asset of $6.0 million at December 31, 2017. The potential fair value loss for a hypothetical 10% adverse change in the currency exchange rate on our forward exchange contracts at December 31, 2018 and 2017 would be immaterial.

Interest Rate Risk

We hold our cash, cash equivalents and short-term investments for working capital purposes. Some of the securities we invest in are subject to market risk. This means that a change in prevailing interest rates may cause the principal amount of such investments to fluctuate. To minimize this risk, we maintain our portfolio of cash, cash equivalents and short-term investments in a variety of securities including money market funds and government debt securities. Due to the short-term nature of these instruments, we believe that we do not have any material exposure to changes in the fair value of our investment portfolio as a result of changes in interest rates. Declines in interest rates, however, would reduce future interest income. The effect of a hypothetical 10% increase or decrease in overall interest rates would not have had a material impact on our operating results or the total fair value of the portfolio.

We are exposed to market risks related to fluctuations in interest rates related to our Term Loan Facility. As of December 31, 2018, we owed $348.5 million with $290.0 million at a fixed interest rate of 1.198%, plus the applicable credit spread which was 1.75% at December 31, 2018, and $58.5 million at a variable interest rate of 1.75% plus LIBOR. We performed a sensitivity analysis on the outstanding portion of our debt obligations as of December 31, 2018. The effect of a hypothetical 10% increase or decrease in overall interest rates would not have had a material impact on our operating results or the total fair value of the portfolio.

From time to time, we have outstanding lines of credit and short-term borrowings with variable interest rates, primarily denominated in Japanese Yen. As of December 31, 2018, $3.4 million was outstanding under these arrangements. These lines of credit have a base interest rate of 1.25% plus a Japanese Yen overnight LIBOR rate. A 10% change in interest rates would not have had a material impact on our operating results.

Item 8. ***Financial Statements and Supplementary Data***

Report of Independent Registered Public Accounting Firm

To the Board of Directors and Stockholders of MKS Instruments, Inc.

Opinions on the Financial Statements and Internal Control over Financial Reporting

We have audited the accompanying consolidated balance sheets of MKS Instruments, Inc. and its subsidiaries (the "Company") as of December 31, 2018 and 2017, and the related consolidated statements of operations and comprehensive income, stockholders' equity and cash flows for each of the three years in the period ended December 31, 2018, including the related notes and schedule of valuation and qualifying accounts for each of the three years in the period ended December 31, 2018 appearing under Item 15(a)(2) (collectively referred to as the "consolidated financial statements"). We also have audited the Company's internal control over financial reporting as of December 31, 2018, based on criteria established in *Internal Control – Integrated Framework* (2013) issued by the Committee of Sponsoring Organizations of the Treadway Commission (COSO).

In our opinion, the consolidated financial statements referred to above present fairly, in all material respects, the financial position of the Company as of December 31, 2018 and 2017, and the results of its operations and its cash flows for each of the three years in the period ended December 31, 2018 in conformity with accounting principles generally accepted in the United States of America. Also in our opinion, the Company maintained, in all material respects, effective internal control over financial reporting as of December 31, 2018, based on criteria established in *Internal Control – Integrated Framework* (2013) issued by the COSO.

Change in Accounting Principle

As discussed in Note 3 to the consolidated financial statements, the Company changed the manner in which it accounts for revenue from contracts with customers in 2018.

Basis for Opinions

The Company's management is responsible for these consolidated financial statements, for maintaining effective internal control over financial reporting, and for its assessment of the effectiveness of internal control over financial reporting, included in Management's Annual Report on Internal Control over Financial Reporting appearing under Item 9A. Our responsibility is to express opinions on the Company's consolidated financial statements and on the Company's internal control over financial reporting based on our audits. We are a public accounting firm registered with the Public Company Accounting Oversight Board (United States) (PCAOB) and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audits in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audits to obtain reasonable assurance about whether the consolidated financial statements are free of material misstatement, whether due to error or fraud, and whether effective internal control over financial reporting was maintained in all material respects.

Our audits of the consolidated financial statements included performing procedures to assess the risks of material misstatement of the consolidated financial statements, whether due to error or fraud, and performing procedures that respond to those risks. Such procedures included examining, on a test basis, evidence regarding the amounts and disclosures in the consolidated financial statements. Our audits also included evaluating the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of the consolidated financial statements. Our audit of internal control over financial reporting included obtaining an understanding of internal control over financial reporting, assessing the risk that a material weakness exists, and testing and evaluating the design and operating effectiveness of internal control based on the assessed risk. Our audits also included performing such other procedures as we considered necessary in the circumstances. We believe that our audits provide a reasonable basis for our opinions.

Definition and Limitations of Internal Control over Financial Reporting

A company's internal control over financial reporting is a process designed to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles. A company's internal control over financial reporting includes those policies and procedures that (i) pertain to the maintenance of records that, in reasonable detail, accurately and fairly reflect the transactions and dispositions of the assets of the company; (ii) provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that receipts and expenditures of the company are being made only in accordance with authorizations of management and directors of the company; and (iii) provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use, or disposition of the company's assets that could have a material effect on the financial statements.

Because of its inherent limitations, internal control over financial reporting may not prevent or detect misstatements. Also, projections of any evaluation of effectiveness to future periods are subject to the risk that controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

/s/ PricewaterhouseCoopers LLP
Boston, Massachusetts
February 26, 2019

We have served as the Company's auditor since 1981.

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MKS Instruments, Inc.

Consolidated Balance Sheets

	December 31, 2018	December 31, 2017
	(in thousands, except share data)	
ASSETS		
Current assets:		
Cash and cash equivalents	$ 644,345	$ 333,887
Short-term investments	73,826	209,434
Trade accounts receivable, net of allowance for doubtful accounts of $5,243 and $4,135 at December 31, 2018 and 2017, respectively	295,454	300,308
Inventories	384,689	339,081
Other current assets	65,790	53,543
Total current assets	1,464,104	1,236,253
Property, plant and equipment, net	194,367	171,782
Goodwill	586,996	591,047
Intangible assets, net	319,807	366,398
Long-term investments	10,290	10,655
Other assets	38,682	37,883
Total assets	$ 2,614,246	$ 2,414,018
LIABILITIES AND STOCKHOLDERS' EQUITY		
Current liabilities:		
Short-term debt	$ 3,986	$ 2,972
Accounts payable	83,825	82,518
Accrued compensation	82,350	96,147
Income taxes payable	16,358	21,398
Deferred revenue and customer advances	14,246	26,194
Other current liabilities	62,520	60,593
Total current liabilities	263,285	289,822
Long-term debt, net	343,842	389,993
Non-current deferred taxes	48,223	61,571
Non-current accrued compensation	55,598	51,700
Other liabilities	30,111	32,025
Total liabilities	741,059	825,111
Commitments and contingencies (Note 21)		
Stockholders' equity:		
Preferred stock, $0.01 par value, 2,000,000 shares authorized; none issued and outstanding	—	—
Common stock, no par value, 200,000,000 shares authorized; 54,039,554 and 54,355,535 shares issued and outstanding at December 31, 2018 and 2017, respectively	113	113
Additional paid-in capital	793,932	789,644
Retained earnings	1,084,797	795,698
Accumulated other comprehensive (loss) gain	(5,655)	3,452
Total stockholders' equity	1,873,187	1,588,907
Total liabilities and stockholders' equity	$ 2,614,246	$ 2,414,018

The accompanying notes are an integral part of the consolidated financial statements.

MKS Instruments, Inc.

Consolidated Statements of Operations and Comprehensive Income

	Years Ended December 31, 2018	2017	2016
	(in thousands, except per share data)		
Net Revenues:			
Products	$1,835,202	$1,701,301	$1,118,579
Services	239,906	214,676	176,763
Total net revenues	2,075,108	1,915,977	1,295,342
Cost of revenues:			
Cost of products	969,288	906,369	630,208
Cost of service	126,344	118,157	99,515
Total cost of revenues (exclusive of amortization shown separately below)	1,095,632	1,024,526	729,723
Gross profit	979,476	891,451	565,619
Research and development	135,720	132,555	110,579
Selling, general and administrative	298,118	290,056	227,932
Acquisition and integration costs	3,113	5,332	27,279
Restructuring	3,567	3,920	642
Environmental costs	1,000	—	—
Asset impairment	—	6,719	5,000
Fees and expenses related to repricing of term loan	378	492	1,239
Amortization of intangible assets	43,521	45,743	35,681
Income from operations	494,059	406,634	157,267
Interest income	5,775	3,021	2,560
Interest expense	16,942	30,990	30,611
Gain on sale of business	—	74,856	—
Other expense, net	1,942	5,896	1,239
Income before income taxes	480,950	447,625	127,977
Provision for income taxes	88,054	108,493	23,168
Net income	$ 392,896	$ 339,132	$ 104,809
Other comprehensive income:			
Changes in value of financial instruments designated as cash flow hedges, net of tax expense (benefit)(1)	$ 4,942	$ (4,568)	$ 3,380
Foreign currency translation adjustments, net of tax of $0 for 2018, 2017 and 2016	(14,161)	37,172	(22,713)
Unrecognized pension gain (loss), net of tax benefit(2)	149	323	(266)
Unrealized (loss) gain on investments, net of tax (benefit) expense(3)	(37)	1,072	223
Total comprehensive income	$ 383,789	$ 373,131	$ 85,433
Net income per share:			
Basic	$ 7.22	$ 6.26	$ 1.96
Diluted	$ 7.14	$ 6.16	$ 1.94
Cash dividends paid per common share	$ 0.78	$ 0.71	$ 0.68
Weighted average common shares outstanding:			
Basic	54,406	54,137	53,472
Diluted	54,992	55,074	54,051

(1) Tax expense (benefit) was $1,347, $(1,468), and $2,535 for the years ended December 31, 2018, 2017 and 2016, respectively.

(2) Tax expense (benefit) was $86, $(88) and $(199) for the years ended December 31, 2018, 2017 and 2016, respectively.

(3) Tax expense (benefit) was $2, $(769), and $167 for the years ended December 31, 2018, 2017 and 2016, respectively.

The accompanying notes are an integral part of the consolidated financial statements.

MKS Instruments, Inc.

Consolidated Statements of Stockholders' Equity

(in thousands, except share data)	Common Stock Shares	Common Stock Amount	Additional Paid-In Capital	Retained Earnings	Accumulated Other Comprehensive Income/(Loss)	Total Stockholders' Equity
Balance at December 31, 2015	53,199,720	$ 113	$744,725	$ 427,214	$ (11,171)	$1,160,881
Net issuance under stock-based plans	517,939		6,902			6,902
Stock-based compensation			25,228			25,228
Tax effect from stock-based plans			1,254			1,254
Stock repurchase	(44,798)		(627)	(918)		(1,545)
Cash dividend				(36,361)		(36,361)
Comprehensive income (net of tax):						
Net income				104,809		104,809
Other comprehensive loss					(19,376)	(19,376)
Balance at December 31, 2016	53,672,861	$ 113	$777,482	$ 494,744	$ (30,547)	$1,241,792
Net issuance under stock-based plans	682,674		(12,216)			(12,216)
Stock-based compensation			24,378			24,378
Cash dividend				(38,178)		(38,178)
Comprehensive income (net of tax):						
Net income				339,132		339,132
Other comprehensive loss					33,999	33,999
Balance at December 31, 2017	54,355,535	$ 113	$789,644	$ 795,698	$ 3,452	$1,588,907
Net issuance under stock-based plans	502,150		(11,104)			(11,104)
Stock-based compensation			27,262			27,262
Stock repurchase	(818,131)		(11,870)	(63,130)		(75,000)
Cash dividend				(42,405)		(42,405)
Accounting Standards Codification Topic 606 adjustment				1,738		1,738
Comprehensive income (net of tax):						
Net income				392,896		392,896
Other comprehensive loss					(9,107)	(9,107)
Balance at December 31, 2018	54,039,554	$ 113	$793,932	$1,084,797	$ (5,655)	$1,873,187

The accompanying notes are an integral part of the consolidated financial statements.

MKS Instruments, Inc.

Consolidated Statements of Cash Flows
(in thousands)

	Years Ended December 31, 2018	2017	2016
Cash flows from operating activities:			
Net income	$ 392,896	$ 339,132	$ 104,809
Adjustments to reconcile net income to net cash provided by operating activities:			
Depreciation and amortization	79,853	82,556	65,926
Amortization of inventory step-up adjustment to fair value	—	—	15,090
Amortization of debt issuance cost and original issue discount	4,718	10,699	9,265
Stock-based compensation	27,262	24,378	25,228
Provision for excess and obsolete inventory	22,324	20,213	16,039
Provision for doubtful accounts	1,435	825	1,109
Deferred income taxes	(19,388)	(4,831)	(38,822)
Excess tax benefits from stock-based compensation	—	—	(1,468)
Asset impairment	—	6,719	5,000
Gain on sale of business	—	(74,856)	—
Other	2,649	824	256
Changes in operating assets and liabilities:			
Trade accounts receivable	(546)	(44,077)	(58,111)
Inventories	(73,779)	(72,471)	(13,798)
Income taxes	(11,430)	12,805	30,914
Other current and non-current assets	(1,639)	(8,631)	(12,165)
Accrued compensation	(8,649)	32,502	10,965
Other current and non-current liabilities	(3,948)	18,030	3,681
Accounts payable	2,023	11,405	16,180
Net cash provided by operating activities	413,781	355,222	180,098
Cash flows from investing activities:			
Acquisition of business, net of cash acquired	—	—	(939,591)
Net proceeds from sale of business	—	72,509	—
Purchases of investments	(253,598)	(229,557)	(268,458)
Maturities of investments	181,749	157,342	160,917
Sales of investments	207,542	53,564	338,996
Purchases of property, plant and equipment	(62,941)	(31,287)	(19,123)
Other	—	66	273
Net cash provided by (used in) investing activities	72,752	22,637	(726,986)
Cash flows from financing activities:			
Proceeds from short-term borrowings	67,629	28,360	18,964
Payments of short-term borrowings	(67,163)	(29,711)	(11,742)
Proceeds from long-term borrowings	40	191	744,653
Payments of long-term borrowings	(50,003)	(228,141)	(153,395)
Repurchases of common stock	(75,000)	—	(1,545)
Net proceeds related to employee stock awards	(11,104)	(12,216)	(1,922)
Dividend payments	(42,405)	(38,178)	(36,361)
Excess tax benefit from stock-based compensation	—	—	1,468
Net cash (used in) provided by financing activities	(178,006)	(279,695)	560,120
Effect of exchange rate changes on cash and cash equivalents	1,931	1,813	(6,896)
Increase in cash and cash equivalents	310,458	99,977	6,336
Cash and cash equivalents, including restricted cash, at beginning of year	333,887	233,910	227,574
Cash and cash equivalents, including restricted cash, at end of year	$ 644,345	$ 333,887	$ 233,910
Supplemental disclosure of cash flow information:			
Cash paid during the period for:			
Interest	$ 14,593	$ 20,467	$ 20,839
Income taxes	$ 91,765	$ 104,691	$ 44,967

The accompanying notes are an integral part of the consolidated financial statements.

MKS INSTRUMENTS, INC.

NOTES TO CONSOLIDATED FINANCIAL STATEMENTS
(in thousands, except share and per share data)

1) Business Description

MKS Instruments, Inc. ("MKS" or the "Company") was founded in 1961 and is a global provider of instruments, subsystems and process control solutions that measure, monitor, deliver, analyze, power and control critical parameters of advanced manufacturing processes to improve process performance and productivity. The Company's products are derived from its core competencies in pressure measurement and control, flow measurement and control, gas and vapor delivery, gas composition analysis, residual gas analysis, leak detection, control technology, ozone generation and delivery, power, reactive gas generation, vacuum technology, lasers, photonics, sub-micron positioning, vibration control, and optics. The primary served markets are manufacturers of capital equipment for semiconductor manufacturing, industrial technologies, life and health sciences, as well as research and defense. The Company groups its products into six product groups based upon the similarity of the product function, type of product and manufacturing processes. These six groups are: Analytical and Controls Solutions Products; Power, Plasma and Reactive Gas Solutions Products; Vacuum Solutions Products; Photonics Products; Optics Products; and Laser Products.

The Company has two reportable segments: Vacuum & Analysis and Light & Motion.

2) Basis of Presentation

The consolidated financial statements include the accounts of MKS Instruments, Inc. and its wholly owned subsidiaries. All intercompany accounts and transactions have been eliminated in consolidation.

The consolidated financial statements have been prepared in accordance with accounting principles generally accepted in the United States of America ("U.S. GAAP"). The preparation of these financial statements requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities and the disclosure of contingent liabilities at the date of the financial statements and the reported amounts of revenues and expenses during the reporting period. On an on-going basis, management evaluates its estimates and judgments, including those related to revenue recognition and allowance for doubtful accounts, inventory valuation, warranty costs, stock-based compensation, intangible assets, goodwill, other long-lived assets, in process research and development and other acquisition expenses and income taxes. Management bases its estimates and judgments on historical experience and on various other factors that are believed to be reasonable under the circumstances, the results of which form the basis for making judgments about the carrying values of assets and liabilities that are not readily apparent from other sources. Actual results may differ from these estimates under different assumptions or conditions.

MKS INSTRUMENTS, INC.

NOTES TO CONSOLIDATED FINANCIAL STATEMENTS — (continued)
(in thousands, except share and per share data)

Reclassification of certain line items in prior period financial statements

The Company has historically recorded the revenue and related cost of revenue for the sale of its spare parts within Products in its Statements of Operations for the Vacuum & Analysis segment. The Company has now determined that these items are better presented within revenue and related cost of revenue within Services for the Vacuum & Analysis segment in its Statements of Operations to align with the current manner in which the Company operates it service business, and has elected to reclassify these amounts in previously issued financial statements as shown below. This change in presentation has no impact on total revenue or total cost of revenue.

	Twelve Months Ended December 31, 2017		
	As previously reported	Adjustment	As revised
Net revenues:			
Products	$1,723,433	$ (22,132)	$1,701,301
Services	192,544	22,132	214,676
Total net revenues	1,915,977	—	1,915,977
Cost of revenues:			
Cost of products	901,546	4,823	906,369
Cost of services	122,980	(4,823)	118,157
Total cost of revenues	$1,024,526	$ —	$1,024,526

	Twelve Months Ended December 31, 2016		
	As previously reported	Adjustment	As revised
Net revenues:			
Products	$1,134,013	$ (15,434)	$1,118,579
Services	161,329	15,434	176,763
Total net revenues	1,295,342	—	1,295,342
Cost of revenues:			
Cost of products	627,850	2,358	630,208
Cost of services	101,873	(2,358)	99,515
Total cost of revenues	$ 729,723	$ —	$ 729,723

3) Summary of Significant Accounting Policies

Revenue from Contracts with Customers

The Company adopted Accounting Standards Codification ASC 606 (“ASC 606”) on January 1, 2018 using the modified retrospective method for all contracts not completed as of the date of adoption. The reported results for the twelve months ended December 31, 2018 reflect the application of ASC 606 guidance while the reported results for 2017 were prepared under the guidance of Accounting Standards Codification 605, Revenue Recognition.

The Company has recorded a net increase to opening retained earnings of $1,809 as of January 1, 2018 due to the cumulative impact of adopting ASC 606, with the impact primarily related to its service business and certain custom products. The impact to revenue for the year ended December 31, 2018 as a result of applying ASC 606 was immaterial.

MKS INSTRUMENTS, INC.

NOTES TO CONSOLIDATED FINANCIAL STATEMENTS — (continued)
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The adoption of ASC 606 represents a change in accounting principle that will more closely align revenue recognition with the delivery of the Company's goods or services and will provide financial statement readers with enhanced disclosures. To achieve this core principle, the Company applies the following steps:

- Identify the contract with a customer
- Identify the performance obligations in the contract
- Determine the transaction price
- Allocate the transaction price to performance obligations in the contract
- Recognize revenue when or as the Company satisfies a performance obligation

Revenue under ASC 606 is recognized when or as obligations under the terms of a contract with the Company's customer has been satisfied and control has transferred to the customer. The majority of the Company's performance obligations, and associated revenue, are transferred to customers at a point in time, generally upon shipment of a product to the customer or receipt of the product by the customer and without significant judgments. Installation services are not significant and are usually completed in a short period of time (normally less than two weeks) and therefore, recorded at a point in time when the installation services are completed, rather than over time as they are not material. Extended warranty, service contracts, and repair services, which are transferred to the customer over time, are recorded as revenue as the services are performed. For repair services, the Company makes an accrual at quarter end based upon historical repair times within its product groups to record revenue based upon the estimated number of days completed to date, which is consistent with ratable recognition. Customized products with no alternative future use to the Company, and that have an enforceable right to payment for performance completed to date, are also recorded over time. The Company considers this to be a faithful depiction of the transfer to the customer of revenue over time as the work is performed or service is delivered, ratably over time.

Revenue is measured as the amount of consideration the Company expects to receive in exchange for transferring goods or providing services. Performance obligations promised in a contract are identified based on the products or services that will be transferred to the customer that are both capable of being distinct, whereby the customer can benefit from the product or service either on its own or together with other resources that are readily available from third parties or from the Company, and are distinct in the context of the contract, whereby the transfer of the product or service is separately identifiable from other promises in the contract. Sales, value add, and other taxes the Company collects concurrent with revenue-producing activities are excluded from revenue. The Company's normal payment terms are 30 to 60 days but vary by the type and location of its customers and the products or services offered. The time between invoicing and when payment is due is not significant. For certain products and services and customer types, the Company requires payment before the products or services are delivered to, or performed for, the customer. None of the Company's contracts as of December 31, 2018 contained a significant financing component. Contract assets as of January 1 and December 31, 2018 were $3,065 and $3,624, respectively, and included in other current assets.

Contracts with Multiple Performance Obligations

The Company periodically enters into contracts with its customers in which a customer may purchase a combination of goods and or services, such as products with installation services or extended warranty obligations. These contracts include multiple promises that the Company evaluates to determine if the promises are separate performance obligations. Once the Company determines the performance obligations, the Company then determines the transaction price, which includes estimating the amount of variable consideration to be included in the transaction price, if any. To the extent the transaction price includes variable consideration, the Company estimates the amount of variable consideration that should be included in the transaction price utilizing either the expected value method or the most likely amount method depending on the method the Company expects to better predict the amount of consideration to which it will be entitled. There are no constraints on the variable consideration recorded. The Company then allocates the transaction price to each performance obligation in the contract based on a relative stand-alone selling price charged separately to customers or using an expected cost plus margin method. The corresponding revenues are recognized when or as the related performance obligations are satisfied, which are noted above. The impact of variable consideration was immaterial during 2018.

(in thousands, except share and per share data)

Deferred Revenues

The Company's standard assurance warranty period is normally 12 to 24 months. The Company sells separately-priced service contracts and extended warranty contracts related to certain of its products, especially its laser products. The separately priced contracts generally range from 12 to 60 months. The Company normally receives payment at the inception of the contract and recognizes revenue over the term of the agreement in proportion to the costs expected to be incurred in satisfying the obligations under the contract. The Company has elected to use the practical expedient related to disclosing the remaining performance obligations as of December 31, 2018, as the majority have a duration of less than one year.

A rollforward of the Company's deferred revenue and customer advances is as follows:

	Year Ended December 31, 2018
Beginning balance, January 1(1)	$ 27,800
Amount of deferred revenue and customer advances recognized in income(3)	(83,497)
Additions to deferred revenue and customer advances	73,171
Ending balance, December 31(2)	$ 17,474

(1) Beginning deferred revenue and customer advances as of January 1, 2018 included $12,842 of current deferred revenue, $3,126 of long-term deferred revenue and $13,352 of current customer advances, net of a $1,520 adjustment related to the adoption of ASC 606.

(2) Ending deferred revenue and customer advances as of December 31, 2018 included $8,134 of current deferred revenue, $3,228 of long-term deferred revenue and $6,112 of current customer advances.

(3) The deferred revenue and customers advances recognized in income that relates to fiscal year 2018 was $61,012.

Costs to Obtain and Fulfill a Contract

Under ASC 606, the Company expenses sales commissions when incurred because the amortization period would have been one year or less. These costs are recorded within selling, general and administration expenses. The Company has elected to recognize the costs for freight and shipping when control over products has transferred to the customer as an expense in cost of sales.

The Company monitors and tracks the amount of product returns and reduces revenue at the time of shipment for the estimated amount of future returns, based on historical experience. The Company makes estimates evaluating its allowance for doubtful accounts. The Company continuously monitors collections and payments from its customers and maintains a provision for estimated credit losses based upon its historical experience and any specific customer collection issues that it has identified.

(in thousands, except share and per share data)

Disaggregation of Revenue

The following table summarizes revenue from contracts with customers:

	Year Ended December 31, 2018		
	Vacuum & Analysis	Light & Motion	Total
Net revenues:			
Products	$ 1,080,343	$ 754,859	$ 1,835,202
Services	180,519	59,387	239,906
Total net revenues	$ 1,260,862	$ 814,246	$ 2,075,108

	Year Ended December 31, 2017		
	Vacuum & Analysis	Light & Motion	Total
Net revenues:			
Products	$ 1,047,639	$ 653,662	$ 1,701,301
Services	159,818	54,858	214,676
Total net revenues	$ 1,207,457	$ 708,520	$ 1,915,977

	Year Ended December 31, 2016		
	Vacuum & Analysis	Light & Motion	Total
Net revenues:			
Products	$731,364	$387,215	$ 1,118,579
Services	140,927	35,836	176,763
Total net revenues	$872,291	$423,051	$ 1,295,342

Product revenue, excluding revenue from certain custom products, is recorded at a point in time, while the majority of service revenue and revenue from certain custom products is recorded over time.

Refer to Note 19 for revenue by reportable segment, geography and groupings of similar products.

Accounts Receivable Allowances

Accounts receivable allowances include sales returns and bad debt allowances. The Company monitors and tracks the amount of product returns and reduces revenue at the time of shipment for the estimated amount of such future returns, based on historical experience. The Company makes estimates evaluating its allowance for doubtful accounts. The Company continuously monitors collections and payments from its customers and maintains a provision for estimated credit losses based upon its historical experience and any specific customer collection issues that it has identified.

Research and Development

Research and development costs are expensed as incurred and consist mainly of compensation-related expenses and project materials. The Company's research and development efforts include numerous projects, which generally have a duration of 3 to 30 months. Acquired in-process research and development ("IPR&D") expenses, which are capitalized at fair value as an intangible asset until the related project is completed, are then amortized over the estimated useful life of the product. The Company monitors projects and, if they are abandoned, the Company immediately writes them off.

Advertising Costs

Advertising costs are expensed as incurred and were immaterial in 2018, 2017 and 2016.

Stock-Based Compensation

The accounting for share-based compensation expense requires the measurement and recognition of compensation expense for all share-based payment awards made to employees and directors based on estimated fair values. For restricted stock units ("RSUs"), the fair value is the fair value on the date of grant that normally vests over a three year period. The Company also provides employees the opportunity to purchase shares through an employee stock purchase plan. For shares issued under its employee stock purchase plan, the Company has estimated the fair value on the date of grant using the Black Scholes pricing model, which is affected by the Company's stock price as well as assumptions regarding a number of complex and subjective variables. These variables include the Company's expected stock price volatility over the term of the awards, expected life, risk-free interest rate and expected dividends. The Company is also required to estimate forfeitures at the time of grant and revise those estimates in subsequent periods if actual forfeitures differ from those estimates.

Management determined that blended volatility, a combination of historical and implied volatility, is more reflective of market conditions and a better indicator of expected volatility than historical or implied volatility alone. The assumptions used in calculating the fair value of share-based payment awards represent management's best estimates, but these estimates involve inherent uncertainties and the application of management judgment. As a result, if factors change and the Company uses different assumptions, its stock-based compensation expense could be materially different in the future.

Accumulated Other Comprehensive Income

For foreign subsidiaries where the functional currency is the local currency, assets and liabilities are translated into U.S. dollars at the current exchange rate on the balance sheet date. Revenue and expenses are translated at average rates of exchange prevailing during the year. Translation adjustments resulting from this process are recorded to Accumulated Other Comprehensive Income ("OCI"). Unrealized gains and losses on securities classified as available-for-sale and unrecognized pension gains and losses are included in OCI in consolidated stockholders' equity. For derivative instruments designated as cash-flow hedges, the effective portion of the derivative's gain (loss) is initially reported as a component of OCI and is subsequently recognized in earnings when the hedged exposure is recognized in earnings.

Net Income Per Share

Basic net income per share is based on the weighted average number of common shares outstanding, and diluted net income per share is based on the weighted average number of common shares outstanding and all potential dilutive common equivalent shares outstanding. The dilutive effect of options is determined under the treasury stock method using the average market price for the period. Common equivalent shares are included in the per share calculations when the effect of their inclusion would be dilutive.

Cash and Cash Equivalents and Investments

All highly liquid investments with a maturity date of three months or less at the date of purchase are considered to be cash equivalents. The appropriate classification of investments in securities is determined at the time of purchase. Debt securities that the Company does not have the intent and ability to hold to maturity are classified as “available-for-sale” and are carried at fair value.

The Company classifies investments with maturity dates greater than twelve months in short-term investments rather than long-term investments. This method classifies these securities as current based on the nature of the securities and the availability for use in current operations. The Company believes this method is preferable because it is more reflective of the Company’s assessment of its overall liquidity position.

The Company reviews its investment portfolio on a quarterly basis to identify and evaluate individual investments that have indications of possible impairment. The factors considered in determining whether a loss is other-than-temporary include: the length of time and extent to which fair market value has been below the cost basis, the financial condition and near-term prospects of the issuer, credit quality, and the Company’s ability to hold the investment for a period of time sufficient to allow for any anticipated recovery in fair value.

Concentrations of Credit Risk

The Company’s significant concentrations of credit risk consist principally of cash and cash equivalents, investments, forward exchange contracts and trade accounts receivable. The Company maintains cash and cash equivalents with financial institutions including some banks with which it had borrowings. The Company maintains investments primarily in U.S. Treasury and government agency securities and corporate debt securities. The Company enters into forward currency contracts with high credit-quality financial institutions in order to minimize credit risk exposure. The Company’s largest customers are primarily concentrated in the semiconductor industry, and a limited number of these customers account for a significant portion of the Company’s revenues. The Company regularly monitors the creditworthiness of its customers and believes it has adequately provided for potential credit loss exposures. Credit is extended for all customers based primarily on financial condition, and collateral is not required.

The Company had one customer, Applied Materials, Inc., comprising 12%, 13% and 14% of net revenues for 2018, 2017 and 2016, respectively, and another customer, Lam Research Corporation, comprising 11%, 12% and 11% of net revenues for 2018, 2017 and 2016, respectively. During the years 2018, 2017 and 2016, approximately 55%, 57% and 56% of the Company’s net revenues, respectively, were from sales to semiconductor capital equipment manufacturers and semiconductor device manufacturers. There were no customers that represented 10% or more of the Company’s accounts receivable balance as of December 31, 2018. One customer, Applied Materials, Inc., represented 10% or more of the Company’s accounts receivable balance as of December 31, 2017.

Inventories

Inventories are stated at the lower of cost or market, cost being determined using a standard costing system which approximates cost based on a first-in, first-out method. The Company regularly reviews inventory quantities on hand and records a provision to write-down excess and obsolete inventory to its estimated net realizable value, if less than cost, based primarily on its estimated forecast of product demand.

Property, Plant and Equipment

Property, plant and equipment are stated at cost. Expenditures for major renewals and betterments that extend the useful lives of property, plant and equipment are capitalized. Expenditures for maintenance and repairs are charged to expense as incurred. When assets are sold or otherwise disposed of, the cost and related accumulated depreciation are eliminated from the accounts and any resulting gain or loss is recognized in earnings.

Depreciation is provided on the straight-line method over the estimated useful lives of ten to fifty years for buildings and three to sixteen years for machinery and equipment, furniture and fixtures and office equipment, which includes enterprise resource planning software. Leasehold improvements are amortized over the shorter of the lease term or the estimated useful life of the leased asset.

Intangible Assets

Intangible assets resulting from the acquisitions of businesses are estimated by management based on the fair value of assets acquired. These include acquired customer lists, technology, patents, trade names, covenants not to compete and IPR&D. Intangible assets are amortized from one to eighteen years on a straight-line basis which represents the estimated periods of benefit and the expected pattern of consumption.

Goodwill

Goodwill is the amount by which the cost of acquired net assets exceeded the fair value of those net assets on the date of acquisition. The Company allocates goodwill to reporting units at the time of acquisition or when there is a change in the reporting structure and bases that allocation on which reporting units will benefit from the acquired assets and liabilities. Reporting units are defined as operating segments or one level below an operating segment, referred to as a component. The Company assesses goodwill for impairment on an annual basis as of October 31 or more frequently when events and circumstances occur indicating that the recorded goodwill may be impaired.

The estimated fair value of the Company's reporting units are based on discounted cash flow models derived from internal earnings and internal and external market forecasts. Determining fair value requires the exercise of significant judgment, including judgments about appropriate discount rates, perpetual growth rates, projected revenues and projected profit margins. Discount rates are based on a weighted average cost of capital ("WACC"), which represents the average rate a business must pay its providers of debt and equity. The WACC used to test goodwill is derived from a group of comparable companies. Assumptions in estimating future cash flows are subject to a high degree of judgment and complexity. The Company makes every effort to forecast these future cash flows as accurately as possible with the information available at the time the forecast is developed.

In performing the Company's annual goodwill impairment test, the Company is permitted to first assess qualitative factors to determine whether it is more likely than not that the fair value of our reporting unit is less than its carrying amount, including goodwill. In performing the qualitative assessment, the Company considers certain events and circumstances specific to the reporting unit and to the entity as a whole, such as macroeconomic conditions, industry and market considerations, overall financial performance and cost factors when evaluating whether it is more likely than not that the fair value of the reporting unit is less than its carrying amount. The Company is also permitted to bypass the qualitative assessment and proceed directly to the quantitative test. If the Company chooses to undertake the qualitative assessment and concludes that it is more likely than not that the fair value of the reporting unit is less than its carrying amount, the Company would then proceed to the quantitative impairment test. In the quantitative assessment, the Company compares the fair value of the reporting unit to its carrying amount, which includes goodwill. If the fair value exceeds the carrying value, no impairment loss exists. If the fair value is less than the carrying amount, a goodwill impairment loss is measured and recorded.

Effective July 1, 2018, the Company reassigned goodwill to certain reporting units within the Light & Motion reportable segment resulting from a reorganization of the composition of reporting units. The goodwill was reassigned to the reporting units affected using the relative fair value approach. In conjunction with this goodwill reassignment, the Company performed an interim quantitative impairment test as of July 1, 2018 for all of its reporting units and concluded that the fair values of each reporting unit exceeded their respective carrying values.

As of October 31, 2018, the Company performed its annual impairment assessment of goodwill using the qualitative assessment and determined that it is more likely than not that the fair values of the reporting units exceed their carrying amount.

Impairment of Long-Lived Assets

The Company evaluates the recoverability of its long-lived assets whenever events and changes in circumstances indicate that the carrying amount of an asset may not be fully recoverable. This periodic review may result in an adjustment of estimated depreciable lives or asset impairment. When indicators of impairment are present, the carrying values of the asset are evaluated in relation to their operating performance and future undiscounted cash flows of the underlying business. If the future undiscounted cash flows are less than their carrying value, impairment exists. The impairment is measured as the difference between the carrying value and the fair value of the underlying asset. Fair values are based on estimates of market prices and assumptions concerning the amount and timing of estimated future cash flows and assumed discount rates, reflecting varying degrees of perceived risk. In 2017, the Company recorded an impairment charge of $6,719 related to certain long-lived assets as a result of consolidating two manufacturing plants.

Foreign Exchange

The functional currency of the majority of the Company’s foreign subsidiaries is the applicable local currency. For those subsidiaries, assets and liabilities are translated to U.S. dollars at year-end exchange rates. Income and expense accounts are translated at the average exchange rates prevailing during the year. The resulting translation adjustments are included in accumulated other comprehensive income (loss) in consolidated stockholders’ equity. Foreign exchange transaction gains and losses are classified in other income/expense in the statement of operations.

Net foreign exchange losses resulting from re-measurement were $2,497 and $6,132 for the years ended December 31, 2018 and 2017, respectively, and are included in other expense (income). Net foreign exchange losses resulting from re-measurement were $2,823 for the year ended December 31, 2016. In 2016, we reclassified the impact of foreign exchange losses (gains), from selling, general and administrative expenses to other expense (income), net. These amounts do not reflect the corresponding gain (loss) from foreign exchange contracts. See Note 7 “Derivatives” regarding foreign exchange contracts.

Income Taxes

The Company records income taxes using the asset and liability method. Deferred income tax assets and liabilities are recognized for the future tax consequences attributable to differences between the financial statement carrying amounts of existing assets and liabilities and their respective income tax bases, and also for operating loss and tax credit carry-forwards. On a quarterly basis, the Company evaluates both the positive and negative evidence that affects the realizability of net deferred tax assets and assesses the need for a valuation allowance. The future benefit to be derived from its deferred tax assets is dependent upon its ability to generate sufficient future taxable income in each jurisdiction of the right type to realize the assets. The Company records a valuation allowance to reduce its net deferred tax assets to the amount that is expected to be realized. To the extent the Company establishes a valuation allowance an expense will be recorded as a component of the provision for income taxes on the statement of operations.

During 2016, the Company increased its valuation allowance by $6,400 primarily related to the addition of historical valuation allowances for Newport Corporation (“Newport”) and its subsidiaries which were included as a result of the acquisition in April 2016. As a result, the valuation allowance was $12,527 at December 31, 2016. During 2017, the Company increased its valuation allowance by $1,102, primarily related to certain state tax credits. As a result, the valuation allowance was $13,629 at December 31, 2017. During 2018, the Company increased its valuation allowance by $4,307 which is attributable to certain tax credit and net operating loss carry forward amounts. As a result, the valuation allowance was $17,936 at December 31, 2018.

Accounting for income taxes requires a two-step approach to recognize and measure uncertain tax positions. The first step is to evaluate the tax position for recognition by determining if, based on the technical merits, it is more likely than not that the position will be sustained upon audit, including resolutions of related appeals or litigation processes, if any. The second step is to measure the tax benefit as the largest amount that is more than 50% likely of being realized upon ultimate settlement. The Company re-evaluates these uncertain tax positions on a quarterly basis. This evaluation is based on factors including, but not limited to, changes in facts or circumstances, changes in tax law, effectively settled issues under audit and new audit activity. Any change in these factors could result in the recognition of a tax benefit or an additional charge to the tax provision.

On December 22, 2017, the President of the United States signed into law the Tax Cuts and Jobs Act (the “Act”), which included significant changes to U.S. tax law. Some of the more significant changes impacting the Company are the reduction of the U.S. federal corporate income tax rate from 35.0% to 21.0% as of January 1, 2018, the implementation of a territorial tax system and the imposition of a transition tax on deemed repatriated cumulative earnings of foreign subsidiaries (“Transition Tax”).

Income tax effects resulting from changes in tax are generally accounted for by the Company in the period in which the law is enacted and the effects are recorded as a component of provision for income taxes from continuing operations. On December 22, 2017, the Securities and Exchange Commission Staff issued Staff Accounting Bulletin No. 118 (“SAB 118”) to provide guidance for reporting entities’ ability to timely complete the accounting for certain income tax effects of the Act and allowed a measurement period up to one year from the enactment date of the “Act”. The Company has obtained, prepared and analyzed the information needed to complete the accounting requirements under Accounting Standards Codification (“ASC”) Topic 740 and as a result, in accordance with SAB 118, the Company has finalized and recorded the effects of the Act during the quarter ended December 31, 2018. The ultimate impact of the Act on the Company is based upon the Company’s understanding and interpretation of the regulatory guidance that has been issued regarding the Act.

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4) Recently Issued Accounting Pronouncements

In October 2018, the Financial Accounting Standards Board ("FASB") issued Accounting Standards Update ("ASU") 2018-16, "Derivatives and Hedging (Topic 815)." This standard permits the use of the Overnight Index Swap Rate ("OIS") based on the Secured Overnight Financing Rate as a U.S. benchmark interest rate for hedge accounting purposes under Topic 815 in addition to the interest rates on direct treasury obligations of the U.S. government, the London Interbank Offered Rate ("LIBOR") swap rate, the OIS rate based on the Federal Funds Effective Rate and the Securities industry and Financial Markets Association Municipal Swap Rate. This standard is effective for annual periods beginning after December 15, 2018, including interim periods within those fiscal years. The Company is currently evaluating the requirements of this standard and has not yet determined the impact on its consolidated financial statements.

In August 2018, the FASB issued ASU 2018-15, "Intangibles-Goodwill and Other-Internal-Use Software (Subtopic 350-40): Customer's Accounting for Implementation Costs Incurred in a Cloud Computing Arrangement That is a Service Contract." This standard aligns the requirements for capitalizing implementation costs incurred in a hosting arrangement that is a service contract with the requirements for capitalizing implementation costs incurred to develop or obtain internal-use software (and hosting arrangements that include an internal-use software license). The accounting for the service element of a hosting arrangement that is a service contract is not affected by the amendments of this update. This standard is effective for annual periods beginning after December 15, 2019, including interim periods within those fiscal years. The Company is currently evaluating the requirements of this standard and has not yet determined the impact on its consolidated financial statements.

In March 2018, the Financial Accounting Standards Board ("FASB") issued Accounting Standards Update ("ASU") 2018-05, "Income Taxes (Topic 740)." This standard is an amendment that adopts the language of Securities and Exchange Commission Staff Accounting Bulletin No. 118 ("SAB 118") and aims to address certain circumstances that may arise for registrants in accounting for the income tax effects of the Tax Cuts and Jobs Act (the "Act") and to address any uncertainty or diversity of views in practice regarding the application of Topic 740 in situations where a registrant does not have the necessary information available, prepared, or analyzed (including computations) in reasonable detail to complete the accounting under Topic 740 for certain income tax effects of the Act for the reporting period in which the Act was enacted. The provisions of this ASU were applied to the Company's December 31, 2017 financial statements. The Company recorded provisional amounts with respect to the Act under SAB 118 at December 31, 2017 and for the nine months ended September 30, 2018. During the quarter ended December 31, 2018, the Company completed its analysis and finalized the provisional amounts that were previously recorded. The ultimate impact of the Act is based upon the Company's understanding and interpretation of the regulatory guidance that has been issued regarding the Act.

In August 2017, the FASB issued ASU 2017-12, "Derivatives and Hedging (Topic 815)." This standard better aligns an entity's risk management activities and financial reporting for hedging relationships through changes to both the designation and measurement guidance for qualifying hedging relationships and the presentation of hedge results. The provisions of this ASU are effective for annual periods beginning after December 15, 2018, including interim periods within those fiscal years. The Company does not expect adoption of this ASU to have a material impact on the Company's consolidated financial statements.

In May 2017, the FASB issued ASU 2017-09, "Compensation-Stock Compensation (Topic 718)-Scope of Modification Accounting." This standard provides guidance about which changes to the terms or conditions of a share-based payment award require an entity to apply modification accounting in Topic 718. The provisions of this ASU are effective for annual periods beginning after December 15, 2017, including interim periods within those fiscal years. The Company adopted this ASU during the first quarter of 2018 and the adoption of this ASU did not have a material impact on the Company's consolidated financial statements.

In March 2017, the FASB issued ASU 2017-07, "Compensation-Retirement Benefits (Topic 715) – Improving the Presentation of Net Periodic Pension Cost and Net Periodic Postretirement Benefit Cost." This standard requires that an employer disaggregate the service cost component from the other components of net benefit cost. This standard also provides explicit guidance on how to present the service cost component and the other components of the net benefit cost in the income statement and allows only the service cost component of net benefit cost to be eligible for capitalization. The provisions of this ASU are effective for annual periods beginning after December 31, 2017, including interim periods within those fiscal years. The Company adopted this ASU during the first quarter of 2018 and the adoption of this ASU did not have a material impact on the Company's consolidated financial statements.

In November 2016, the FASB issued ASU 2016-18, "Statement of Cash Flows (Topic 230) – Restricted Cash," an amendment to ASU 2016-15. This standard requires that a statement of cash flows explain the change during the period in the total of cash, cash equivalents and amounts generally described as restricted cash and restricted cash equivalents. Therefore, amounts generally described as restricted cash and restricted cash equivalents should be included with cash and cash equivalents when reconciling the beginning-of-period and end-of-period total amounts shown on the statement of cash flows. The provisions of this ASU are effective for annual periods beginning after December 15, 2017, including interim periods within those fiscal years and should be applied at the time of adoption of ASU 2016-15. The Company adopted this ASU during the first quarter of 2018 and the adoption of this ASU did not have a material impact on the Company's consolidated financial statements.

In October 2016, the FASB issued ASU 2016-16, "Income Taxes (Topic 740) – Intra-Entity Transfer of Assets Other Than Inventory." This standard requires that an entity recognize the income tax consequences of an intra-entity transfer of an asset other than inventory when the transfer occurs as opposed to when the assets have been sold to an outside party. The provisions of this ASU are effective for annual periods beginning after December 15, 2017, including interim periods within those fiscal years. The Company adopted this ASU during the first quarter of 2018 and the adoption of this ASU did not have a material impact on the Company's consolidated financial statements.

In August 2016, the FASB issued ASU 2016-15, "Statement of Cash Flows (Topic 230) – Classification of Certain Cash Receipts and Cash Payments." This standard addresses eight specific cash flow issues with the objective of addressing the diversity in practice in how certain cash receipts and cash payments are presented and classified in the statement of cash flows under Topic 230. The provisions of this ASU are effective for annual periods beginning after December 15, 2017, including interim periods within those fiscal years. The Company adopted this ASU during the first quarter of 2018 and the adoption of this ASU did not have a material impact on the Company's consolidated financial statements.

In February 2016, the FASB issued ASU 2016-02, "Leases (Topic 842)." This standard requires the recognition of lease assets and liabilities for all leases, with certain exceptions, on the balance sheet. In transition, lessees and lessors have the option to either apply the standard retrospectively through a cumulative-effect adjustment to the opening balance of retained earnings in the period of adoption or they can apply the new standard to comparative periods presented. This ASU is effective for annual periods beginning after December 15, 2018, including interim periods within those fiscal years. The FASB issued additional updates to the new standard in Topic 842 (Update 2018-01 in January 2018 – Land Easement Practical Expedient for

Transition to Topic 842, Update 2018-10 – Codification Improvements to Topic 842 and Update 2018-11 in July 2018 – Targeted Improvements). The Company has reviewed the requirements of this standard and has formulated a plan for implementation. The management team has communicated its approach to the Audit Committee and have provided regular updates as appropriate. The Company has accumulated details on the population of leases and entered these details into a selected software database, which will be a repository and accounting solution for reporting and disclosure requirements required by the standard. The Company estimates that the balance sheet gross up (recording the right-of-use asset and lease liability) will be approximately $60,000 to $65,000 at adoption on January 1, 2019. The Company will continue to assess and disclose the impact that this ASU will have on its consolidated financial statements, disclosures and related controls, when known.

In January 2016, the FASB issued ASU 2016-01, "Financial Instruments-Overall (Subtopic 825-10)-Recognition and Measurement of Financial Assets and Financial Liabilities." This ASU provides guidance for the recognition, measurement, presentation, and disclosure of financial instruments. The new standard revises accounting related to equity investments and the presentation of certain fair value changes for financial assets and liabilities measured at fair value. Among other things, it amends the presentation and disclosure requirements of equity securities that do not result in consolidation and are not accounted for under the equity method. Changes in the fair value of these equity securities will be recognized directly in net income. This standard is effective for annual periods beginning after December 15, 2017, including interim periods within those fiscal years. The Company adopted this ASU during the first quarter of 2018 and the adoption of this ASU did not have a material impact on the Company's consolidated financial statements.

In May 2014, the FASB issued ASU 2014-09, "Revenue from Contracts with Customers (Topic 606)" ("ASC 606"). This ASU provides for a single comprehensive model to use in accounting for revenue arising from contracts with customers and has replaced most existing revenue recognition guidance in GAAP. This ASU is effective for fiscal years and interim periods within those years beginning after December 15, 2017. The two permitted transition methods under the new standard are the full retrospective method, in which case the standard would be applied to each prior reporting period presented, or the modified retrospective method, in which case the cumulative effect of applying the standard would be recognized at the date of initial application. The Company used the modified retrospective method upon adoption in the first quarter of 2018. The FASB issued additional updates to the new revenue standard in Topic 606 relating to reporting revenue on a gross versus net basis (Update 2016-08 in March 2016), identifying performance obligations and licensing arrangements (Update 2016-10 in April 2016), narrow-scope improvements and practical expedients (Update 2016-12 in May 2016), technical corrections and improvements (Update 2016-20 in December 2016), and SEC Updates (Update 2017-13 in September 2017 and Update 2017-14 in November 2017). The adoption of this ASU did not have a material impact on the Company's consolidated financial statements as described further in Note 3.

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5) Investments

Investments classified as short-term consist of the following:

	Years Ended December 31, 2018	2017
Available-for-sale investments:		
Time deposits and certificates of deposit	$ 102	$ 9,757
Bankers' acceptance drafts	989	5,330
Asset-backed securities	9,113	36,990
Commercial paper	19,359	13,750
Corporate obligations	9,352	77,821
Municipal bonds	—	1,970
U.S. treasury obligations	13,298	28,078
U.S. agency obligations	21,613	35,738
	$ 73,826	$209,434

Investments classified as long-term consist of the following:

	Years Ended December 31, 2018	2017
Available-for-sale investments:		
Group insurance contracts	$ 5,890	$ 6,255
Cost method investments:		
Minority interest in a private company	4,400	4,400
	$ 10,290	$ 10,655

The following table shows the gross unrealized gains and (losses) aggregated by investment category for available-for-sale investments:

As of December 31, 2018:	Cost	Gross Unrealized Gains	Gross Unrealized (Losses)	Estimated Fair Value
Short-term investments:				
Available-for-sale investments:				
Time deposits and certificates of deposit	$ 102	$ —	$ —	$ 102
Bankers' acceptance drafts	989	—	—	989
Asset-backed securities	9,121	1	(9)	9,113
Commercial paper	19,504	—	(145)	19,359
Corporate obligations	9,367	—	(15)	9,352
U.S. treasury obligations	13,294	4	—	13,298
U.S. agency obligations	21,617	2	(6)	21,613
	$73,994	$ 7	$ (175)	$73,826

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NOTES TO CONSOLIDATED FINANCIAL STATEMENTS — (continued)
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As of December 31, 2018:	Cost	Gross Unrealized Gains	Gross Unrealized (Losses)	Estimated Fair Value
Long-term investments:				
Available-for-sale investments:				
Group insurance contracts	$5,546	$ 344	$ —	$ 5,890

As of December 31, 2017:	Cost	Gross Unrealized Gains	Gross Unrealized (Losses)	Estimated Fair Value
Short-term investments:				
Available-for-sale investments:				
Time deposits and certificates of deposit	$ 9,756	$ 1	$ —	$ 9,757
Bankers' acceptance drafts	5,330	—	—	5,330
Asset-backed securities	37,017	15	(42)	36,990
Commercial paper	13,810	—	(60)	13,750
Corporate obligations	77,788	58	(25)	77,821
Municipal bonds	1,970	—	—	1,970
U.S. treasury obligations	28,054	24	—	28,078
U.S. agency obligations	35,728	10	—	35,738
	$209,453	$ 108	$ (127)	$209,434

As of December 31, 2017:	Cost	Gross Unrealized Gains	Gross Unrealized (Losses)	Estimated Fair Value
Long-term investments:				
Available-for-sale investments:				
Group insurance contracts	$6,006	$ 249	$ —	$ 6,255

The tables above, which show the gross unrealized gains and (losses) aggregated by investment category for available-for-sale investments as of December 31, 2018 and 2017, reflect the inclusion within short-term investments of investments with contractual maturities greater than one year from the date of purchase. Management has the ability, if necessary, to liquidate any of its investments in order to meet the Company's liquidity needs in the next 12 months. Accordingly, those investments with contractual maturities greater than one year from the date of purchase are classified as short-term on the accompanying balance sheets.

Interest income is accrued as earned. Dividend income is recognized as income on the date the stock trades "ex-dividend." The cost of marketable securities sold is determined by the specific identification method and realized gains or losses are reflected in income and were not material in 2018, 2017 and 2016.

6) Fair Value Measurements

In accordance with the provisions of fair value accounting, a fair value measurement assumes that the transaction to sell an asset or transfer a liability occurs in the principal market for the asset or liability or, in the absence of a principal market, the most advantageous market for the asset or liability and defines fair value based upon an exit price model.

The fair value measurement guidance establishes a fair value hierarchy which requires an entity to maximize the use of observable inputs and minimize the use of unobservable inputs when measuring fair value. The guidance describes three levels of inputs that may be used to measure fair value:

Level 1 Quoted prices in active markets for identical assets or liabilities as of the reporting date. Active markets are those in which transactions for the asset or liability occur in sufficient frequency and volume to provide pricing information on an ongoing basis.

Level 2 Observable inputs other than Level 1 prices, such as quoted prices for similar assets or liabilities; quoted prices in markets that are not active; or other inputs that are observable or can be corroborated by observable market data for substantially the full term of the assets or liabilities. Level 2 assets and liabilities include debt securities with quoted prices that are traded less frequently than exchange-traded instruments or securities or derivative contracts that are valued using a pricing model with inputs that are observable in the market or can be derived principally from or corroborated by observable market data.

Level 3 Unobservable inputs that are supported by little or no market activity and that are significant to the fair value of the assets or liabilities. Level 3 assets and liabilities include financial instruments whose value is determined using pricing models, discounted cash flow methodologies, or similar techniques, as well as instruments for which the determination of fair value requires significant management judgment or estimation.

In certain cases, the inputs used to measure fair value may fall into different levels of the fair value hierarchy. In such cases, the Company categorizes such assets and liabilities based on the lowest level input that is significant to the fair value measurement in its entirety. The Company's assessment of the significance of a particular input to the fair value measurement in its entirety requires judgment and considers factors specific to the asset.

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NOTES TO CONSOLIDATED FINANCIAL STATEMENTS — (continued)
(in thousands, except share and per share data)

Assets and liabilities of the Company measured at fair value on a recurring basis as of December 31, 2018, are summarized as follows:

		Fair Value Measurements at Reporting Date Using		
Description	December 31, 2018	Quoted Prices in Active Markets for Identical Assets (Level 1)	Significant Other Observable Inputs (Level 2)	Significant Unobservable Inputs (Level 3)
Assets:				
Cash equivalents:				
Money market funds	$ 180,340	$ 180,340	$ —	$ —
Time deposits and certificates of deposit	850	—	850	—
Commercial paper	2,687	—	2,687	—
U.S. agency obligations	3,418	—	3,418	—
Restricted cash – money market funds	110	110	—	—
Available-for-sale securities:				
Time deposits and certificates of deposit	102	—	102	—
Bankers' acceptance drafts	989	—	989	—
Asset-backed securities	9,113	—	9,113	—
Commercial paper	19,359	—	19,359	—
Corporate obligations	9,352	—	9,352	—
U.S. treasury obligations	13,298	—	13,298	—
U.S. agency obligations	21,613	—	21,613	—
Group insurance contracts	5,890	—	5,890	—
Derivatives – currency forward contracts	2,485	—	2,485	—
Funds in investments and other assets:				
Israeli pension assets	14,408	—	14,408	—
Derivatives – interest rate hedge – non-current	6,083	—	6,083	—
Total assets	$ 290,097	$ 180,450	$109,647	$ —
Liabilities:				
Derivatives – currency forward contracts	$ 1,168	$ —	$ 1,168	$ —
Reported as follows:				
Assets:				
Cash and cash equivalents, including restricted cash(1)	$ 187,405	$ 180,450	$ 6,955	$ —
Short-term investments	73,826	—	73,826	—
Other current assets	2,485	—	2,485	—
Total current assets	$ 263,716	$ 180,450	$ 83,266	$
Long-term investments(2)	$ 5,890	$ —	$ 5,890	$ —
Other assets	20,491	—	20,491	—
Total long-term assets	$ 26,381	$ —	$ 26,381	$ —
Liabilities:				
Other current liabilities	$ 1,168	$ —	$ 1,168	$ —

(1) The cash and cash equivalent amounts presented in the table above does not include cash of $456,940 as of December 31, 2018.
(2) The long-term investments presented in the table above do not include our minority interest investment in a private company, which is accounted for under the cost method.

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NOTES TO CONSOLIDATED FINANCIAL STATEMENTS — (continued)
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Assets and liabilities of the Company measured at fair value on a recurring basis as of December 31, 2017, are summarized as follows:

		Fair Value Measurements at Reporting Date Using		
Description	December 31, 2017	Quoted Prices in Active Markets for Identical Assets (Level 1)	Significant Other Observable Inputs (Level 2)	Significant Unobservable Inputs (Level 3)
Assets:				
Cash equivalents:				
Money market funds	$ 4,987	$ 4,987	$ —	$ —
Time deposits and certificates of deposit	2,100	—	2,100	—
Commercial paper	30,475	—	30,475	—
Restricted cash – money market funds	119	119	—	—
Available-for-sale securities:				
Time deposits and certificates of deposit	9,757	—	9,757	—
Bankers' acceptance drafts	5,330	—	5,330	—
Asset-backed securities	36,990	—	36,990	—
Commercial paper	13,750	—	13,750	—
Corporate obligations	77,821	—	77,821	—
Municipal bonds	1,970	—	1,970	—
U.S. treasury obligations	28,078	—	28,078	—
U.S. agency obligations	35,738	—	35,738	—
Group insurance contracts	6,255	—	6,255	—
Derivatives – currency forward contracts	168	—	168	—
Funds in investments and other assets:				—
Israeli pension assets	15,048	—	15,048	—
Derivatives – interest rate hedge – non-current	6,179	—	6,179	—
Total assets	$ 274,765	$ 5,106	$269,659	$ —
Liabilities:				
Derivatives – currency forward contracts	$ 6,198	$ —	$ 6,198	$ —
Reported as follows:				
Assets:				
Cash and cash equivalents, including restricted cash(1)	$ 37,681	$ 5,106	$ 32,575	$ —
Short-term investments	209,434	—	209,434	—
Other current assets	168	—	168	—
Total current assets	$ 247,283	$ 5,106	$242,177	$ —
Long-term investments(2)	$ 6,255	$ —	$ 6,255	$ —
Other assets	21,227	—	21,227	—
Total long-term assets	$ 27,482	$ —	$ 27,482	$ —
Liabilities:				
Other current liabilities	$ 6,198	$ —	$ 6,198	$ —

(1) The cash and cash equivalent amounts presented in the table above do not include cash of $292,808 and non-negotiable time deposits of $3,398 as of December 31, 2017.

(2) The long-term investments presented in the table above do not include our minority interest investment in a private company, which is accounted for under the cost method.

Money Market Funds

Money market funds are cash and cash equivalents and are classified within Level 1 of the fair value hierarchy.

Available-For-Sale Investments

As of December 31, 2018, available-for-sale investments consisted of time deposits and drafts denominated in the Euro currency, certificates of deposit, bankers' acceptance drafts, asset-backed securities (which include auto loans, credit card receivables and equipment trust receivables), commercial paper, corporate obligations, municipal bonds, U.S. treasury, U.S. agency obligations and group insurance contracts.

The Company measures its debt and equity investments at fair value. The Company's available-for-sale investments are classified within Level 1 and Level 2 of the fair value hierarchy.

Israeli Pension Assets

Israeli pension assets represent investments in mutual funds, government securities and other time deposits. These investments are set aside for the retirement benefit of the employees at the Company's Israeli subsidiaries. These funds are classified within Level 2 of the fair value hierarchy.

Derivatives

As a result of the Company's global operating activities, the Company is exposed to market risks from changes in foreign currency exchange rates and variable interest rates, which may adversely affect its operating results and financial position. When deemed appropriate, the Company minimizes its risks from foreign currency exchange rate and interest rate fluctuations through the use of derivative financial instruments. The principal market in which the Company executes its foreign currency contracts and interest rate swaps is the institutional market in an over-the-counter environment with a relatively high level of price transparency. The market participants usually are large commercial banks. The forward foreign currency exchange contracts and interest rate hedge are valued using broker quotations, or market transactions and are classified within Level 2 of the fair value hierarchy.

7) Derivatives

The Company enters into derivative instruments for risk management purposes only, including derivatives designated as hedging instruments and those utilized as economic hedges. The Company operates internationally and, in the normal course of business, is exposed to fluctuations in interest rates and foreign exchange rates. These fluctuations can increase the costs of financing, investing and operating the business. The Company has used derivative instruments, such as forward contracts, to manage certain foreign currency exposure, and interest rate swaps to manage interest rate exposure.

(in thousands, except share and per share data)

By nature, all financial instruments involve market and credit risks. The Company enters into derivative instruments with major investment grade financial institutions, for which no collateral is required. The Company has policies to monitor the credit risk of these counterparties. While there can be no assurance, the Company does not anticipate any material non-performance by any of these counterparties.

Interest Rate Swap Agreement

On September 30, 2016, the Company entered into an interest rate swap agreement to fix the rate on approximately 50% of its then outstanding term loan balance, as described further in Note 13. This hedge fixes the interest rate paid on the hedged debt at 1.198% per annum plus the credit spread, which was 1.75% as of December 31, 2018, through September 30, 2020. The interest rate swap will be recorded at fair value on the balance sheet and changes in the fair value will be recognized in OCI. To the extent that this arrangement is no longer an effective hedge, any ineffectiveness measured in the hedging relationship is recorded currently in earnings in the period it occurs. The notional amount of this transaction was $290,000 and had a fair value of $6,083 at December 31, 2018. The notional amount of this transaction was $305,000 and had a fair value of $6,179 at December 31, 2017.

Foreign Exchange Contracts

The Company hedges a portion of its forecasted foreign currency-denominated intercompany sales of inventory, over a maximum period of eighteen months, using forward foreign exchange contracts accounted for as cash-flow hedges related to Japanese, South Korean, British, Euro and Taiwanese currencies. To the extent these derivatives are effective in off-setting the variability of the hedged cash flows, and otherwise meet the hedge accounting criteria, changes in the derivatives' fair value are not included in current earnings but are included in OCI in stockholders' equity. These changes in fair value will subsequently be reclassified into earnings, as applicable, when the forecasted transaction occurs. To the extent that a previously designated hedging transaction is no longer an effective hedge, any ineffectiveness measured in the hedging relationship will be recorded currently in earnings in the period in which it occurs. The cash flows resulting from forward exchange contracts are classified in the consolidated statements of cash flows as part of cash flows from operating activities. The Company does not enter into derivative instruments for trading or speculative purposes.

As of December 31, 2018 and 2017, the Company had outstanding forward foreign exchange contracts with gross notional values of $159,394 and $208,922, respectively. The following tables provide a summary of the primary net hedging positions and corresponding fair values held as of December 31, 2018 and 2017:

	December 31, 2018	
Currency Hedged (Buy/Sell)	Gross Notional Value	Fair Value(1)
U.S. Dollar/Japanese Yen	$ 43,770	$ (478)
U.S. Dollar/South Korean Won	59,149	570
U.S. Dollar/Euro	23,515	688
U.S. Dollar/U.K. Pound Sterling	11,827	323
U.S. Dollar/Taiwan Dollar	21,133	214
Total	$159,394	$ 1,317

(in thousands, except share and per share data)

Currency Hedged (Buy/Sell)	December 31, 2017 Gross Notional Value	December 31, 2017 Fair Value(1)
U.S. Dollar/Japanese Yen	$ 70,175	$ (233)
U.S. Dollar/South Korean Won	79,672	(3,799)
U.S. Dollar/Euro	26,140	(1,047)
U.S. Dollar/U.K. Pound Sterling	12,104	(337)
U.S. Dollar/Taiwan Dollar	20,831	(614)
Total	$208,922	$ (6,030)

(1) Represents the receivable (payable) amount included in the consolidated balance sheet.

The following table provides a summary of the fair value amounts of the Company's derivative instruments:

Derivatives Designated as Hedging Instruments	Years Ended December 31, 2018	2017
Derivative assets:		
Forward exchange contracts(1)	$ 2,485	$ 168
Foreign currency interest rate hedge(2)	6,083	6,179
Derivative liabilities:		
Forward exchange contracts(1)	(1,168)	(6,198)
Total net derivative asset designated as hedging instruments	$ 7,400	$ 149

(1) The derivative asset of $2,485 and derivative liability of $1,168 related to the forward foreign exchange contracts are classified in other current assets and other current liabilities in the consolidated balance sheet as of December 31, 2018. The derivative asset of $168 and derivative liability of $6,198 related to the forward foreign exchange contracts are classified in other current assets and other current liabilities in the consolidated balance sheet as of December 31, 2017. These forward foreign exchange contracts are subject to a master netting agreement with one financial institution. However, the Company has elected to record these contracts on a gross basis in the balance sheet.
(2) The foreign currency interest rate hedge asset of $6,083 and $6,179 is classified in other assets in the consolidated balance sheet as of December 31, 2018 and 2017, respectively.

The net amount of existing gains as of December 31, 2018 that is expected to be reclassified from OCI into earnings within the next 12 months is immaterial.

The following table provides a summary of the gains (losses) on derivatives designated as cash flow hedging instruments:

Derivatives Designated as Cash Flow Hedging Instruments	Years Ended December 31, 2018	2017	2016
Forward exchange contracts:			
Net gain (loss) recognized in OCI(1)	$ 6,289	$(6,036)	$ 5,914
Net loss reclassified from OCI into income(2)	$(3,367)	$(2,685)	$(1,414)

(1) Net change in the fair value of the effective portion classified in OCI.
(2) Effective portion classified as cost of products.

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(in thousands, except share and per share data)

The following table provides a summary of losses on derivatives not designated as cash flow hedging instruments:

Derivatives Not Designated as Hedging Instruments	Years Ended December 31, 2018	2017	2016
Forward exchange contracts:			
Net gain (loss) recognized in income (1)	$ 105	$(3,416)	$ (31)

(1) The Company enters into forward foreign exchange contracts to hedge against changes in the balance sheet for certain subsidiaries to mitigate the risk associated with certain foreign currency transactions in the ordinary course of business. These derivatives are not designated as cash flow hedging instruments and gains or losses from these derivatives are recorded immediately in other expense, net in 2018 and 2017.

8) Inventories

Inventories consist of the following:

	Years Ended December 31, 2018	2017
Raw material	$ 235,593	$ 191,351
Work-in-process	61,908	54,050
Finished goods	87,188	93,680
	$ 384,689	$ 339,081

Inventory-related excess and obsolete charges of $22,324, $20,213 and $16,039 were recorded in cost of products in the years ended December 31, 2018, 2017 and 2016, respectively.

9) Property, Plant and Equipment

Property, plant and equipment consist of the following:

	Years Ended December 31, 2018	2017
Land	$ 11,448	$ 11,650
Buildings	104,023	103,563
Machinery and equipment	330,821	317,073
Furniture and fixtures, office equipment and software	149,145	145,945
Leasehold improvements	66,569	65,293
Construction in progress	44,823	13,619
	706,829	657,143
Less: accumulated depreciation	512,462	485,361
	$ 194,367	$ 171,782

Depreciation of property, plant and equipment totaled $36,332, $36,813 and $30,245 for the years ended 2018, 2017 and 2016, respectively.

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NOTES TO CONSOLIDATED FINANCIAL STATEMENTS — (continued)
(in thousands, except share and per share data)

10) Acquisitions and Dispositions

Electro Scientific Industries, Inc.

See Note 22 for information on the acquisition of Electro Scientific Industries, Inc.

Newport Corporation

On April 29, 2016, the Company completed its acquisition of Newport pursuant to an Agreement and Plan of Merger, dated as of February 22, 2016 (the "Merger Agreement"), by and among the Company, PSI Equipment, Inc., a wholly owned subsidiary of the Company ("Merger Sub"), and Newport (the "Newport Merger"). At the effective time of the Newport Merger and pursuant to the terms and conditions of the Merger Agreement, each share of Newport's common stock that was issued and outstanding immediately prior to the effective time of the Newport Merger was converted into the right to receive $23.00 in cash, without interest and subject to deduction for any required withholding tax.

Newport's innovative solutions leverage its expertise in advanced technologies, including lasers, photonics and precision motion equipment, and optical components and sub-systems, to enhance the capabilities and productivity of its customers' manufacturing, engineering and research applications. Newport is a global supplier of advanced-technology products and systems to customers in the scientific research and defense/security, microelectronics, life and health sciences and industrial manufacturing markets.

The purchase price of Newport consisted of the following:

Cash paid for outstanding shares(1)	$ 905,254
Settlement of share-based compensation awards(2)	8,824
Cash paid for Newport debt(3)	93,200
Total purchase price	$1,007,278
Less: cash and cash equivalents acquired	(61,463)
Total purchase price, net of cash and cash equivalents acquired	$ 945,815

(1) Represents cash paid of $23.00 per share for approximately 39,359,000 shares of Newport common stock, without interest and subject to a deduction for any required withholding tax.
(2) Represents the vested but unissued portion of Newport share-based compensation awards as of the acquisition date of April 29, 2016.
(3) Represents the cash paid for the outstanding balance of Newport's senior secured revolving credit agreement.

The Company funded the payment of the aggregate consideration with a combination of the Company's available cash on hand and the proceeds from the Company's senior secured term loan facility, as described in Note 13.

Under the acquisition method of accounting, the total estimated acquisition consideration is allocated to the acquired tangible and intangible assets and assumed liabilities of Newport based on their fair values as of the acquisition date. Any excess of the acquisition consideration over the fair value of assets acquired and liabilities assumed is allocated to goodwill. Goodwill and intangible assets will not be amortizable for tax purposes.

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NOTES TO CONSOLIDATED FINANCIAL STATEMENTS — (continued)
(in thousands, except share and per share data)

The following table summarizes the allocation of the purchase price to the fair values assigned to assets acquired and liabilities assumed at the date of the Newport Merger:

Current assets (including cash)	$ 186,137
Inventory	142,714
Intangible assets	404,506
Goodwill	396,027
Property, plant and equipment	119,932
Long-term assets	22,725
Total assets acquired	1,272,041
Current liabilities	95,156
Intangible liability	4,302
Other long-term liabilities	165,305
Total liabilities assumed	264,763
Fair value of assets acquired and liabilities assumed	1,007,278
Less: cash and cash equivalents acquired	(61,463)
Total purchase price, net of cash and cash equivalents acquired	$ 945,815

The fair value write-up of acquired finished goods inventory was $15,090, the amount of which will be amortized over the expected period during which the acquired inventory is sold. Accordingly, the Company recorded $15,090 of incremental costs of sales charges associated with the fair value write-up of inventory acquired in the Newport Merger for the year ended December 31, 2016.

The fair value write-up of acquired property, plant and equipment of $36,242 will be amortized over the useful life of the assets. Property, plant and equipment is valued at its value-in-use, unless there was a known plan to dispose of the asset.

The acquired intangible assets are being amortized on a straight-line basis, which approximates the economic use of the asset.

The following table reflects the allocation of the acquired intangible assets and liabilities and related estimate of useful lives:

Order backlog	$ 12,100	1 year
Customer relationships	247,793	6-18 years
Trademarks and trade names	55,900	Indefinite
Developed technology	75,386	4-8 years
In-process research and development	6,899	Undefined(1)
Leasehold interest (favorable)	6,428	4-5 years
Total intangible assets	$404,506	
Leasehold interest (unfavorable)	$ 4,302	

(1) The useful lives of in-process research and development will be defined in the future upon further evaluation of the status of these programs.

(in thousands, except share and per share data)

The fair value of the acquired intangibles was determined using the income approach. In performing these valuations, the key underlying probability-adjusted assumptions of the discounted cash flows were projected revenues, gross margin expectations and operating cost estimates. The valuations were based on the information that was available as of the acquisition date and the expectations and assumptions that have been deemed reasonable by the Company's management. There are inherent uncertainties and management judgment required in these determinations. This acquisition resulted in a purchase price that exceeded the estimated fair value of tangible and intangible assets, the excess amount of which was allocated to goodwill.

The Company believes the amount of goodwill relative to identifiable intangible assets relates to several factors including: (1) potential buyer-specific synergies related to market opportunities for a combined product offering; and (2) potential to leverage the Company's sales force to attract new customers and revenue and cross sell to existing customers.

The results of this acquisition were included in the Company's consolidated operations beginning on April 29, 2016. Newport constitutes the Company's Light & Motion reportable segment (Note 19).

Certain executives from Newport had severance provisions in their respective Newport employment agreements. The agreements included terms that were accounted for as dual-trigger arrangements. Through the Company's acquisition accounting, the expense relating to these benefits was recognized in the combined entity's financial statements, however, the benefit itself will not be distributed until the final provision is met by each eligible executive. The Company recorded costs of $6,635 and $3,334 as compensation expense and stock-based compensation expense, respectively, during 2016 in connection with these severance provisions. The shares underlying the restricted stock units and stock appreciation rights that are eligible for accelerated vesting if the executive exercises his rights are not issued as of each reporting period-end and are excluded from the computation of basic earnings per share and included in the computation of diluted earnings per share for each reporting period.

Pro Forma Results

The following unaudited pro forma financial information presents the combined results of operations of the Company as if the Newport Merger had occurred on January 1, 2015. The unaudited pro forma financial information is not necessarily indicative of what the Company's condensed consolidated results of operations actually would have been had the acquisition occurred at the beginning of each year. In addition, the unaudited pro forma financial information does not attempt to project the future results of operations of the combined company.

	2016
Total net revenues	$ 1,475,637
Net income	111,076
Net income per share:	
Basic	$ 2.08
Diluted	$ 2.06

The unaudited pro forma financial information above gives effect primarily to the following:

(1) Incremental amortization and depreciation expense related to the estimated fair value of identifiable intangible assets and property, plant and equipment from the purchase price allocation.

(2) Revenue adjustments as a result of the reduction in deferred revenue related to its estimated fair value.
(3) Incremental interest expense related to the Company's term loan credit agreement.
(4) The exclusion of acquisition costs and inventory step-up amortization from the year ended December 31, 2016.
(5) The estimated tax impact of the above adjustments.

Cost Method Investment in a Private Company

In April 2016, the Company invested $9,300 for a minority interest in a private company, which operates in the field of semiconductor process equipment instrumentation. The Company accounted for this investment using the cost method of accounting. During the fourth quarter of 2016, the Company recognized an impairment loss on this investment of $5,000 based upon financial information of this private company. In July 2017, the Company invested an additional $100 in this private company.

Sale of Data Analytics Solutions

In April 2017, the Company completed the sale of its Data Analytics Solutions business for total proceeds of $72,509, net of cash sold and recorded a gain of $74,856. This business, which had revenues in 2016 of $12,700 and was included in the Vacuum & Analysis segment, was no longer a part of the Company's long-term strategic objectives.

The business did not qualify as a discontinued operation as this sale did not represent a strategic shift in the Company's business, nor did the sale have a major effect on the Company's operations. Therefore, the results of operations for all periods are included in the Company's income from operations. The assets and liabilities of this business have not been reclassified or segregated in the consolidated balance sheet or consolidated statements of cash flows as the amounts were immaterial.

11) Goodwill and Intangible Assets

Goodwill

The Company's methodology for allocating the purchase price relating to purchase acquisitions is determined through established and generally accepted valuation techniques. Goodwill is measured as the excess of the cost of the acquisition over the sum of the amounts assigned to tangible and identifiable intangible assets acquired less liabilities assumed. The Company assigns assets acquired (including goodwill) and liabilities assumed to one or more reporting units as of the date of acquisition. Typically acquisitions relate to a single reporting unit and thus do not require the allocation of goodwill to multiple reporting units. If the products obtained in an acquisition are assigned to multiple reporting units, the goodwill is distributed to the respective reporting units as part of the purchase price allocation process.

Goodwill and purchased intangible assets with indefinite useful lives are not amortized, but are reviewed for impairment annually during the fourth quarter of each fiscal year and whenever events or changes in circumstances indicate that the carrying value of an asset may not be recoverable. The process of evaluating the potential impairment of goodwill and intangible assets requires significant judgment. The Company regularly monitors current business conditions and other factors including, but not limited to, adverse industry or economic trends, restructuring actions and lower projections of profitability that may impact future operating results.

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NOTES TO CONSOLIDATED FINANCIAL STATEMENTS — (continued)
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Effective July 1, 2018, the Company reassigned goodwill to certain reporting units within the Light & Motion reportable segment resulting from a reorganization of the composition of reporting units. The goodwill was reassigned to the reporting units affected using the relative fair value approach. In conjunction with this goodwill reassignment, the Company performed an interim quantitative impairment test as of July 1, 2018 for all of its reporting units and concluded that the fair values of each reporting unit exceeded their respective carrying values.

The changes in the carrying amount of goodwill and accumulated impairment losses were as follows:

	2018			2017		
	Gross Carrying Amount	Accumulated Impairment Loss	Net	Gross Carrying Amount	Accumulated Impairment Loss	Net
Beginning balance at January	$735,323	$ (144,276)	$591,047	$727,999	$ (139,414)	$588,585
Sale of business(1)	—	—	—	(3,115)	—	(3,115)
Impairment loss(2)	—	—	—	—	(4,862)	(4,862)
Foreign currency translation	(4,051)	—	(4,051)	10,439	—	10,439
Ending balance at December 31	$731,272	$ (144,276)	$586,996	$735,323	$ (144,276)	$591,047

(1) In 2017, the Company sold its Data Analytics business and, as a result, charged the related goodwill of $3,115 to the gain on sale of business.

(2) In 2017, the Company recorded an impairment loss of $4,862 related to the write-off of goodwill as a result of the discontinuation of a product line and consolidation of two manufacturing plants.

Intangible Assets

The Company is required to test certain long-lived assets when indicators of impairment are present. For the purposes of the impairment test, long-lived assets are grouped with other assets and liabilities at the lowest level for which identifiable cash flows are largely independent of the cash flows of other assets and liabilities. During 2017, the Company recorded impairment charges of $1,511 related to the write off of intangible assets as a result of the discontinuation of a product line and consolidation of two manufacturing plants.

Components of the Company’s acquired intangible assets are comprised of the following:

As of December 31, 2018	Gross	Impairment Charges(1)	Accumulated Amortization	Foreign Currency Translation	Net
Completed technology	$172,431	$ (105)	$ (137,283)	$ (73)	$ 34,970
Customer relationships	282,744	(1,406)	(63,788)	(269)	217,281
Patents, trademarks, trade names and other	110,523	—	(42,954)	(13)	67,556
	$565,698	$ (1,511)	$ (244,025)	$ (355)	$319,807

As of December 31, 2017	Gross	Impairment Charges(1)	Accumulated Amortization	Foreign Currency Translation	Net
Completed technology	$172,431	$ (105)	$ (115,371)	$ 333	$ 57,288
Customer relationships	282,744	(1,406)	(45,518)	1,571	237,391
Patents, trademarks, trade names and other	110,523	—	(38,730)	(74)	71,719
	$565,698	$ (1,511)	$ (199,619)	$ 1,830	$366,398

(in thousands, except share and per share data)

(1) In 2017, the Company recorded impairment charges of $1,511 related to the write-off of intangible assets as a result of the discontinuation of a product line and consolidation of two manufacturing plants.

Aggregate amortization expense related to acquired intangible assets for the years 2018, 2017 and 2016 was $43,521, $45,743 and $35,681, respectively. The amortization expense in 2018, 2017 and 2016 is net of $885, $811 and $569, respectively, of amortization income from unfavorable lease commitments. Aggregate net amortization expense related to acquired intangible assets and unfavorable lease commitments for future years is:

Year	Amount
2019	$ 40,073
2020	$ 28,076
2021	$ 20,206
2022	$ 17,584
2023	$ 17,220
Thereafter	$138,693

12) Product Warranties

The Company provides for the estimated costs to fulfill customer warranty obligations upon the recognition of the related revenue. While the Company engages in extensive product quality programs and processes, including actively monitoring and evaluating the quality of its component suppliers, the Company's warranty obligation is affected by shipment volume, product failure rates, utilization levels, material usage and supplier warranties on parts delivered to the Company. Should actual product failure rates, utilization levels, material usage, or supplier warranties on parts differ from the Company's estimates, revisions to the estimated warranty liability would be required.

Product warranty activities were as follows:

	Years Ended December 31,	
	2018	2017
Beginning balance	$ 10,104	$ 8,261
Provision for product warranties	15,987	15,884
Direct and other charges to warranty liability	(15,692)	(14,041)
Ending balance(1)	$ 10,399	$ 10,104

(1) Short-term product warranty of $9,986 and long-term product warranty of $413, each as of December 31, 2018, are included within other current liabilities and other liabilities, respectively, within the accompanying consolidated balance sheet. Short-term product warranty of $9,719 and long-term product warranty of $385 as of December 31, 2017, are included within other current liabilities and other liabilities, respectively, within the accompanying consolidated balance sheet.

13) Debt

Term Loan Credit Agreement

In connection with the completion of the Newport Merger, the Company entered into a term loan credit agreement (the "Credit Agreement") with Barclays Bank PLC, as administrative agent and collateral agent, and the lenders from time to time party thereto (the "Lenders"), that provided senior secured financing in the original principal amount of $780,000, subject to increase at the Company's option and subject to receipt of lender commitments in accordance with the Credit Agreement (the "Term Loan Facility"). Borrowings under the Term Loan Facility bear interest per annum at one of the following rates selected by the Company: (a) a base rate determined by reference to the highest of (1) the federal funds effective rate plus 0.50%, (2) the "prime rate" quoted in *The Wall Street Journal*, (3) a LIBOR rate determined by reference to the costs of funds for U.S. dollar deposits for an interest period of one month adjusted for certain additional costs, plus 1.00%, and (4) a floor of 1.75%, plus, in each case, an applicable margin; or (b) a LIBOR rate determined by reference to the costs of funds for U.S. dollar deposits for the interest period relevant to such borrowing adjusted for certain additional costs, subject to a LIBOR rate floor of 0.75%, plus an applicable margin. The Company has elected the interest rate as described in clause (b). The Credit Agreement provides that all loans will be determined by reference to the Base Rate if the LIBOR rate cannot be ascertained, if regulators impose material restrictions on the authority of a lender to make LIBOR rate loans, or for other reasons. The Term Loan Facility was issued with original issue discount of 1.00% of the principal amount thereof.

On June 9, 2016, the Company entered into Amendment No. 1 (the "Repricing Amendment 1") to the Credit Agreement by and among the Company, the Lenders and Barclays Bank PLC, as administrative agent and collateral agent for the Lenders. The Repricing Amendment 1 decreased the applicable margin for borrowings under the Company's Term Loan Facility to 2.50% for base rate borrowings and 3.50% for LIBOR borrowings and extended the period during which a prepayment premium may be required for a "Repricing Transaction" (as defined in the Credit Agreement) until six months after the effective date of the Repricing Amendment 1. In connection with the execution of the Repricing Amendment 1, the Company paid a prepayment premium of 1.00%, or $7,300, as well as certain fees and expenses of the administrative agent and the Lenders, in accordance with the terms of the Credit Agreement. Immediately prior to the effectiveness of the Repricing Amendment 1, the Company prepaid $50,000 of principal under the Credit Agreement. In September 2016, the Company prepaid an additional $60,000 under the Credit Agreement.

On September 30, 2016, the Company entered into an interest rate swap agreement, which has a maturity date of September 30, 2020, to fix the rate on $335,000 of the then-outstanding balance of the Credit Agreement. The rate is fixed at 1.198% per annum plus the applicable credit spread, which was 1.75% at December 31, 2018. The notional amount of this transaction was $290,000 and had a fair value of $6,083 at December 31, 2018.

On December 14, 2016, the Company entered into Amendment No. 2 (the "Repricing Amendment 2") to the Credit Agreement by and among the Company, the Lenders and Barclays Bank PLC, as administrative agent and collateral agent for the Lenders. The Repricing Amendment 2 decreased the applicable margin for the Company's term loan under the Credit Agreement to 2.75% for LIBOR borrowings and 1.75% for base rate borrowings and reset the period during which a prepayment premium may be required for a Repricing Transaction until six months after the effective date of the Repricing Amendment 2. In November 2016, prior to the effectiveness of the Repricing Amendment 2, the Company prepaid an additional $40,000 of principal under the Credit Agreement. In March 2017, the Company prepaid an additional $50,000 of principal under the Credit Agreement.

On July 6, 2017, the Company entered into Amendment No. 3 (the "Repricing Amendment 3") to the Credit Agreement by and among the Company, the Lenders and Barclays Bank PLC, as administrative agent and collateral agent for the Lenders. The Repricing Amendment 3 decreased the applicable margin for the Company's term loan under the Credit Agreement to 2.25% for LIBOR rate loans when the Total Leverage Ratio (as defined in the Credit Agreement) was at or above 1.25:1 and decreased to 2.00% when the Total Leverage

Ratio was below 1.25:1, both with a LIBOR floor of 0.75%. The margin for base rate borrowings decreased to 1.25% when the Total Leverage Ratio is at or above 1.25:1 and to 1.00% when the Total Leverage Ratio is below 1.25:1. The period during which a prepayment premium may be required for a Repricing Transaction was reset to six months after the effective date of the Repricing Amendment 3.

On April 11, 2018, the Company entered into Amendment No. 4 (the "Repricing Amendment 4") to the Credit Agreement by and among the Company, the Lenders and Barclays Bank PLC, as administrative agent and collateral agent for the Lenders. The Repricing Amendment 4 decreased the applicable margin for the Company's LIBOR rate term loan under the Credit Agreement to 1.75%, with a LIBOR rate floor of 0.75%. The margin for base rate borrowings decreased to 0.75% with a base rate floor of 1.75%. The period during which a prepayment premium may be required for a Repricing Transaction was reset to six months after the effective date of the Repricing Amendment 4.

In July 2017, August 2017, November 2017 and March 2018, the Company voluntarily prepaid $50,000, $75,000, $50,000 and $50,000, respectively, of principal under the Credit Agreement. As of December 31, 2018, after total prepayments of $425,000 and regularly scheduled principal payments of $6,536, the total outstanding principal balance was $348,464. The interest rate as of December 31, 2018 was 4.1%.

The Company incurred $28,747 of deferred finance fees, original issue discount and repricing fees related to the term loans under the Term Loan Facility, which are included in long-term debt in the accompanying consolidated balance sheets and are being amortized to interest expense over the estimated life of the term loans using the effective interest method. A portion of these fees has been accelerated in connection with the various debt prepayments during 2016, 2017 and 2018. As of December 31, 2018, the remaining balance of the deferred finance fees, original issue discount and repricing fee related to the Term Loan Facility was $4,708.

Under the Credit Agreement, the Company is required to prepay outstanding term loans, subject to certain exceptions, with portions of its annual excess cash flow as well as with the net cash proceeds of certain asset sales, certain casualty and condemnation events and the incurrence or issuance of certain debt. As a result of our Total Leverage Ratio, we were not required to make a prepayment of excess cash flow for the fiscal year end 2018. The Company is also required to make scheduled quarterly payments each equal to 0.25% of the principal amount of the term loans outstanding, less the amount of certain voluntary and mandatory repayments after such date, with the balance due on the seventh anniversary of the closing date. As a result of making total prepayments of $425,000 through December 31, 2018 on the Term Loan Facility we had in place as of December 31, 2018. The Company is no longer required to make any scheduled principal payments on the Term Loan Facility we had in place as of December 31, 2018 until maturity date of the loan.

All obligations under the Term Loan Facility are guaranteed by certain of the Company's domestic subsidiaries, and are collateralized by substantially all of the Company's assets and the assets of such subsidiaries, subject to certain exceptions and exclusions.

The Credit Agreement contains customary representations and warranties, affirmative and negative covenants and provisions relating to events of default. If an event of default occurs, the Lenders under the Term Loan Facility will be entitled to take various actions, including the acceleration of amounts due under the Term Loan Facility and all actions generally permitted to be taken by a secured creditor. At December 31, 2018, the Company was in compliance with all covenants under the Credit Agreement.

Senior Secured Asset-Based Revolving Credit Facility

In connection with the completion of the Newport Merger, the Company also entered into an asset-based credit agreement with Deutsche Bank AG New York Branch, as administrative agent and collateral agent, the other borrowers from time to time party thereto, and the lenders and letters of credit issuers from time to time party thereto (the "ABL Facility"), that provides senior secured financing of up to $50,000, subject to a borrowing base limitation. The borrowing base for the ABL Facility at any time equals the sum of: (a) 85% of certain eligible accounts; plus (b) subject to certain notice and field examination and appraisal requirements, the lesser of (i) the lesser of (A) 65% of the lower of cost or market value of certain eligible inventory and (B) 85% of the net orderly liquidation value of certain eligible inventory and (ii) 30% of the borrowing base; minus (c) reserves established by the administrative agent; provided that until the administrative agent's receipt of a field examination of accounts receivable the borrowing base shall be equal to 70% of the book value of certain eligible accounts. The ABL Facility includes borrowing capacity in the form of letters of credit up to $15,000. The Company has not drawn against the ABL Facility as of December 31, 2018.

Borrowings under the ABL Facility bear interest per annum at one of the following rates selected by the Company: (a) a base rate determined by reference to the highest of (1) the federal funds effective rate plus 0.50%, (2) the "prime rate" quoted in *The Wall Street Journal*, and (3) a LIBOR rate determined by reference to the costs of funds for U.S. dollar deposits for an interest period of one month adjusted for certain additional costs, plus 1.00%, plus, in each case, an initial applicable margin of 0.75%; and (b) a LIBOR rate determined by reference to the costs of funds for U.S. dollar deposits for the interest period relevant to such borrowing adjusted for certain additional costs, plus an initial applicable margin of 1.75%. Commencing with the completion of the first fiscal quarter ending after the closing of the ABL Facility, the applicable margin for borrowings thereunder is subject to upward or downward adjustment each fiscal quarter, based on the average historical excess availability during the preceding quarter.

The Company incurred $1,201 of costs in connection with the ABL Facility, which were capitalized and included in other assets in the accompanying consolidated balance sheets and are being amortized to interest expense using the straight-line method over the contractual term of five years of the ABL Facility.

In addition to paying interest on outstanding principal under the ABL Facility, the Company is required to pay a commitment fee in respect of the unutilized commitments thereunder. The initial commitment fee is 0.375% per annum. The total commitment fees recognized in interest expense during 2018 was immaterial. Commencing with the completion of the first fiscal quarter ending after the closing of the ABL Facility, the commitment fee is subject to downward adjustment based on the amount of average unutilized commitments for the three month period immediately preceding such adjustment date. The Company must also pay customary letter of credit fees and agency fees.

Lines of Credit and Short-Term Borrowing Arrangements

One of the Company's Japanese subsidiaries has lines of credit and short-term borrowing arrangements with two financial institutions, which arrangements generally expire and are renewed at three month intervals. The lines of credit provided for aggregate borrowings as of December 31, 2018 of up to an equivalent of $20,856 U.S. dollars. One of the borrowing arrangements has an interest rate based on the Tokyo Interbank Offer Rate at the time of borrowing and the other has an interest rate based on the Japanese Short-Term Prime Lending Rate. There were no borrowings outstanding under these arrangements at December 31, 2018 and 2017.

The Company assumed various revolving lines of credit and a financing facility with the completion of the Newport Merger. These revolving lines of credit and financing facility have no expiration date and provided for aggregate borrowings as of December 31, 2018 of up to an equivalent of $11,335 U.S. dollars. These lines of credit have a base interest rate of 1.25% plus a Japanese Yen overnight LIBOR rate. Total borrowings outstanding under these arrangements were $3,389 and $2,965 at December 31, 2018 and 2017.

(in thousands, except share and per share data)

One of the Company's Austrian subsidiaries has various outstanding loans from the Austrian government to fund research and development. These loans are unsecured and do not require principal repayment as long as certain conditions are met. Interest on these loans is payable semi-annually. The interest rates associated with these loans range from 0.75%—2.00%.

	December 31, 2018	December 31, 2017
Short-term debt:		
Japanese lines of credit	$ 2,724	$ 2,750
Japanese receivables financing facility	665	215
Other debt	597	7
	$ 3,986	$ 2,972

	December 31, 2018	December 31, 2017
Long-term debt:		
Austrian loans due through March 2020 and other debt	$ 86	$ 714
Term Loan Facility, net(1)	343,756	389,279
	$ 343,842	$ 389,993

(1) Net of deferred financing fees, original issuance discount and re-pricing fee in the aggregate of $4,708 and $9,185 as of December 31, 2018 and 2017, respectively.

The Company recognized interest expense of $16,942, $30,990 and $30,611 for the twelve months ended December 31, 2018, 2017 and 2016, respectively.

Contractual maturities of the Company's debt obligations as of December 31, 2018 are as follows:

Year	Amount
2019	$ 3,986
2020	$ 72
2021	$ 14
2022	$ —
2023	$ 348,464

14) Income Taxes

The Act, which was enacted on December 22, 2017, reduced the U.S. federal corporate tax rate from 35% to 21% effective January 1, 2018, required companies to pay a one-time transition tax on earnings of certain foreign subsidiaries that were previously tax deferred and created new taxes on certain foreign sourced earnings. The Company applied SAB 118 when accounting for the enactment effects of the Act. As of December 22, 2018 the company has completed, and recorded, the impacts of the Act based on its understanding and interpretation of the regulatory guidance that has been issued.

(in thousands, except share and per share data)

For the year ended December 31, 2018, the Company recognized a tax benefit of $625 related to an adjustment of the provisional estimates that had been previously recorded for the Act and included these adjustments as a component of income tax expense from continuing operations.

The global intangible low-taxed income ("GILTI") provision from the Act subjects a U.S. shareholder to current tax on GILTI earned by certain foreign subsidiaries. Under FASB Staff Q&A, Topic 740 No. 5, the Company has elected to recognize the resulting tax on GILTI as a period expense in the period the tax is incurred. Based upon the proposed GILTI regulations, the Company has estimated that the impact of the GILTI tax, net of foreign tax credits, will increase its effective tax rate for the year ended December 31, 2018 by approximately 0.4%.

A reconciliation of the Company's effective tax rate to the U.S. federal statutory rate is as follows:

	Years Ended December 31,		
	2018	2017	2016
U.S. Federal income tax statutory rate	21.0%	35.0%	35.0%
Federal tax credits	(0.7)	(0.7)	(1.8)
State income taxes, net of federal benefit	1.3	1.0	0.8
Effect of foreign operations taxed at various rates	(1.3)	(12.1)	(12.7)
Qualified production activity tax benefit	—	(1.4)	(2.9)
Foreign derived intangible income	(2.1)	—	—
Global intangible low taxed income, net of foreign tax credits	0.4	—	—
Transition tax, net of foreign tax credits	(0.1)	6.4	—
Revaluation of U.S. deferred income taxes	(0.3)	(5.0)	—
Revaluation of prepaid taxes	1.6	—	—
Stock based compensation	(1.3)	(2.5)	—
Deferred tax asset valuation allowance	—	(0.1)	2.1
Release of income tax reserves (including interest)	(0.4)	(0.4)	(2.4)
Taxes on foreign dividends, net of foreign tax credits	(1.0)	3.3	(2.2)
Acquisition and integration related costs	—	—	1.5
Other	1.2	0.7	0.7
	18.3%	24.2%	18.1%

MKS INSTRUMENTS, INC.

NOTES TO CONSOLIDATED FINANCIAL STATEMENTS — (continued)
(in thousands, except share and per share data)

The components of income from operations before income taxes and the related provision for income taxes consist of the following:

	Years Ended December 31,		
	2018	2017	2016
Income from operations before income taxes:			
United States	$287,309	$224,979	$ 42,491
Foreign	193,641	222,646	85,486
	$480,950	$447,625	$127,977
Current taxes:			
United States	$ 41,428	$ 77,023	$ 17,693
State	8,094	6,149	2,359
Foreign	57,920	30,152	41,938
	107,442	113,324	61,990
Deferred taxes:			
United States	(2,533)	(16,250)	(23,604)
State and Foreign	(16,855)	11,419	(15,218)
	(19,388)	(4,831)	(38,822)
Provision for income taxes	$ 88,054	$108,493	$ 23,168

The significant components of the deferred tax assets and deferred tax liabilities are as follows:

	Years Ended December 31,	
	2018	2017
Deferred tax assets:		
Carry-forward losses and credits	$ 23,675	$ 25,834
Inventory and warranty reserves	17,945	17,734
Accrued expenses and other reserves	10,260	15,393
Stock-based compensation	5,351	5,092
Executive supplemental retirement benefits	5,972	4,984
Other	2,396	597
Total deferred tax assets	$ 65,599	$ 69,634
Deferred tax liabilities:		
Acquired intangible assets	$(74,120)	$ (83,092)
Depreciation and amortization	(8,332)	(10,150)
Loan costs	(1,108)	(2,157)
Foreign withholding taxes	(3,176)	(16,206)
Unrealized gain	(1,952)	(469)
Total deferred tax liabilities	(88,688)	(112,074)
Valuation allowance	(17,936)	(13,629)
Net deferred tax (liabilities) assets	$(41,025)	$ (56,069)

Due to the reduction in U.S. federal statutory tax rate resulting from the enactment of the Act, the Company recorded a provisional adjustment reducing its net deferred tax liabilities by $22,345 as of December 31, 2017.

MKS INSTRUMENTS, INC.

NOTES TO CONSOLIDATED FINANCIAL STATEMENTS — (continued)
(in thousands, except share and per share data)

This provisional adjustment was finalized during the year ended December 31, 2018 and an additional tax provision of $2,614 was recorded.

As of December 31, 2018, the Company has federal, state and foreign gross research and other tax credit carry-forwards of $29,858. Included in the total carry-forward are $15,081 of credits that can be carried forward indefinitely and the remaining credits expire at various dates through 2035. The Company also had, state and foreign gross net operating loss and capital loss carry-forwards of $43,715. Included in the total carry-forward are $36,057 of losses that can be carried forward indefinitely while the remaining losses expire at various dates through 2035.

Although the Company believes that its tax positions are consistent with applicable U.S. federal, state and international laws, it maintains certain tax reserves as of December 31, 2018 in the event its tax positions were to be challenged by the applicable tax authority and additional tax assessed upon audit.

A reconciliation of the beginning and ending amount of gross unrecognized tax benefits is as follows:

	Years Ended December 31,		
	2018	2017	2016
Balance at beginning of year	$27,345	$25,465	$ 4,332
Increases/(decreases) for prior years	934	640	(195)
Increases for the current year	6,091	4,340	23,940
Reductions related to expiration of statutes of limitations and audit settlements	(1,686)	(3,100)	(2,612)
Balance at end of year	$32,684	$27,345	$25,465

As of December 31, 2018, the total amount of gross unrecognized tax benefits, which excludes interest and penalties, was $32,684. As of December 31, 2017, the total amount of gross unrecognized tax benefits, which excludes interest and penalties, was $27,345. The net increase from December 31, 2017 was primarily attributable to the addition of reserves for the federal transition tax from the Act along with certain non-U.S. items offset by decreases from settlement of an audit by the U.S. Internal Revenue Service (“IRS”) and the expiration of certain statutes of limitations.

The Company accrues interest and, if applicable, penalties for any uncertain tax positions. Interest and penalties are classified as a component of income tax expense. As of December 31, 2018, 2017 and 2016, the Company had accrued interest on unrecognized tax benefits of approximately $568, $327 and $491, respectively.

Over the next 12 months it is reasonably possible that the Company may recognize approximately $2,150 of previously net unrecognized tax benefits, excluding interest and penalties, related to various U.S. federal, state and foreign tax positions primarily due to the expiration of certain statutes of limitations.

The Company and its subsidiaries are subject to examination by U.S. federal, state and foreign tax authorities. The IRS commenced an examination of our U.S. federal income tax filings for tax years 2015 and 2016 during the quarter ended September 30, 2017. This audit was effectively settled during the quarter ended March 31, 2018 and the impact was not material. During the quarter ended March 31, 2018 the Company received notification from the United States Internal Revenue Service of its intent to audit the Company’s U.S. subsidiary, Newport Corporation, for tax year 2015. This audit commenced during the quarter ended June 30, 2018 and there have been no proposed adjustments through December 31, 2018. The U.S. statute of limitations remains open for tax years 2015 through present. The statute of limitations for the Company's tax filings in other jurisdictions varies between fiscal years 2013 through present. The Company has certain federal credit carry-forwards and state tax loss and credit carry-forwards that are open to examination for tax years 2000 through the present.

On a quarterly basis, the Company evaluates both positive and negative evidence that affects the realizability of net deferred tax assets and assesses the need for a valuation allowance. The future benefit to be derived from its deferred tax assets is dependent upon its ability to generate sufficient future taxable income to realize the assets.

During 2018, the Company increased its valuation allowance by $4,307, primarily attributable to certain tax credit and net operating loss carryforward amounts. During 2017, the Company increased its valuation allowance by $1,102, primarily related to certain state tax credits. During 2016, the Company increased its valuation allowance by $6,400, primarily related to the addition of historical valuation allowances for Newport and its subsidiaries which were included as a result of the acquisition in April 2016.

The Act provided for a mandatory one-time transition tax on deemed repatriation of the post-1986 undistributed cumulative earnings and profits of the Company's foreign subsidiaries. As of the year ended December 31, 2017 the Company estimated that it had approximately $560,000 of undistributed foreign earnings subject to the Transition Tax and recognized approximately $27,610 of income tax expense, net of foreign tax credits, in its consolidated statement of operations for the Year ended December 31, 2017. In accordance with SAB 118 the Company finalized the provisional amounts it previously recorded for the Transition Tax during the year ended December 31, 2018. As a result of finalizing the Transition Tax amount the Company recorded an additional tax benefit, net of foreign tax credits, of $4,624 in its consolidated statement of operations for the year ended December 31, 2018. The reduction in Transition Tax was based upon a final amount of undistributed foreign earnings of approximately $521,000.

No provision has been made for the deferred taxes related to certain outside basis differences in the Company's non-US subsidiaries. The Company continues to assert indefinite reinvestment in these outside basis differences generated through December 31, 2018. Determination of the amount of unrecognized deferred tax liability on outside basis differences is not practicable because the amount of such liability, if any, is dependent upon circumstances existing and tax planning choices available when a transaction using outside basis occurs.

The Company's Israeli subsidiaries have elected to be treated under a preferential Israeli tax regime under which their taxable income is taxed at reduced rates. These reduced rates range anywhere between 7.5% and 16%. One of the Company's Israeli subsidiaries effectively settled an examination for tax years 2012 and 2013 during the quarter ended June 30, 2017.

15) Stockholders' Equity

Stock Repurchase Program

On July 25, 2011, the Company's Board of Directors approved a share repurchase program for the repurchase of up to an aggregate of $200,000 of its outstanding common stock from time to time in open market purchases, privately negotiated transactions or through other appropriate means. The timing and quantity of any shares repurchased will depend upon a variety of factors, including business conditions, stock market conditions and business development activities, including, but not limited to, merger and acquisition opportunities. These repurchases may be commenced, suspended or discontinued at any time without prior notice.

During 2018, the Company repurchased approximately 818,000 shares of its common stock for $75,000 at an average price of $91.67 per share. During 2017, there were no repurchases of common stock. During 2016, the Company repurchased 44,798 shares of its common stock for $1,545 at an average price of $34.50 per share.

The Company has repurchased approximately 2,588,000 shares of common stock for approximately $127,000 pursuant to the program since its adoption.

Cash Dividends

Holders of the Company's common stock are entitled to receive dividends when and if they are declared by the Company's Board of Directors. The Company's Board of Directors declared a cash dividend of $0.18 per share during the first quarter of 2018 and $0.20 per share during the second, third and fourth quarters of 2018, which totaled $42,405. The Company's Board of Directors declared a cash dividend of $0.175 per share during the first, second, and third quarters of 2017, and $0.18 per share during the fourth quarter of 2017, which totaled $38,178.

Future dividend declarations, if any, as well as the record and payment dates for such dividends, are subject to the final determination of the Company's Board of Directors.

On February 11, 2019, the Company's Board of Directors declared a quarterly cash dividend of $0.20 per share to be paid on March 8, 2019 to Stockholders of record as of February 25, 2019.

16) Stock-Based Compensation

Employee Stock Purchase Plans

The 2014 ESPP Plan was adopted by the Board of Directors on February 10, 2014 and approved by the Company's stockholders on May 5, 2014. The 2014 ESPP Plan authorizes the issuance of up to an aggregate of 2,500,000 shares of common stock to participating employees. Offerings under the 2014 ESPP Plan commence on June 1 and December 1 and terminate, respectively, on November 30 and May 31. Historically, under the 2014 ESPP Plan, eligible employees could purchase shares of common stock through payroll deductions of up to 10% of their compensation or up to an annual maximum amount of $21,250. The price at which an employee's purchase option was exercised for each offering period was the lower of (1) 85% of the closing price of the common stock on the Nasdaq Global Select Market on the day that each offering commences, or (2) 85% of the closing price on the day that the offering terminated. On January 31, 2017, the Compensation Committee of the Board of Directors approved an increase in the exercise price to the lower of (1) 90% of the closing price of the common stock on the Nasdaq Global Select Market on the day that each offering commences, or (2) 90% of the closing price on the day that each offering terminates. The increase in the exercise price became effective for the Offering commencing on June 1, 2017. As a result of this change, the annual maximum payroll deduction was increased from $21,250 to $22,500. During 2018, 2017, and 2016, the Company issued 105,672, 105,506, and 139,079 shares, respectively, of common stock to employees who participated in the 2014 ESPP Plan at exercise prices of $84.11 and $70.61 per share in 2018, $46.37 and $74.12 per share in 2017, and $31.40 and $35.16 per share in 2016. As of December 31, 2018, there were 1,926,731 shares reserved for future issuance under the 2014 ESPP Plan.

Equity Incentive Plans

The Company has granted RSUs to employees and directors under the 2014 Stock Incentive Plan (the "2014 Plan"). The 2014 Plan is administered by the Compensation Committee of the Company's Board of Directors.

The 2014 Plan is intended to attract and retain employees and directors, and to provide an incentive for these individuals to assist the Company to achieve long-range performance goals and to enable these individuals to participate in the long-term growth of the Company.

The 2014 Plan was adopted by the Board of Directors on February 10, 2014 and was approved by the Company's stockholders on May 5, 2014. Up to 18,000,000 shares of common stock (subject to adjustment in the event of stock splits and other similar events) may be issued pursuant to awards granted under the 2014 Plan. The Company may grant options, RSUs, restricted stock, stock appreciation rights ("SARs") and other stock-based awards to employees, officers, directors, consultants and advisors under the 2014 Plan. Any full-value awards granted under the 2014 Plan will be counted against the shares reserved for issuance under the 2014 Plan as 2.4 shares for each share of common stock subject to such award and any award granted under the 2014 Plan that is not a full-value award (including, without limitation, any option or SAR) will be counted against the shares reserved for issuance under the plan as one share for each one share of common stock subject to such award. "Full-value award" means any RSU, or other stock-based award with a per share price or per unit purchase price lower than 100% of fair market value on the date of grant. To the extent a share that was subject to an award that counted as one share is returned to the 2014 Plan, each applicable share reserve will be credited with one share. To the extent that a share that was subject to an award that counts as 2.4 shares is returned to the 2014 Plan, each applicable share reserve will be credited with 2.4 shares. As of December 31, 2018, there were 14,079,849 shares reserved for future issuance under the 2014 Plan.

The Company's 2004 Stock Incentive Plan (the "2004 Plan") expired in March 2014 and no further awards may be granted under the 2004 Plan, although there are still outstanding RSUs which may vest under the 2004 Plan. The 2004 Plan, the 1995 Plan, the 1997 Director Stock Plan and the 2014 Plan are referred to herein as the "Plans."

RSUs granted to employees in 2018, 2017 and 2016 generally vest 33% per year on the anniversary of the date of grant. RSUs granted to certain employees who are at least 60 years old and have a minimum of 10 Years of Service (as defined in the applicable RSU agreement) are expensed immediately. RSUs granted to directors generally vest at the earliest of (1) one day prior to the next annual meeting, (2) 13 months from date of grant, or (3) the effective date of a change in control of the Company. Certain RSUs are subject to performance conditions ("performance shares") under the Company's 2004 Plan and 2014 Plan. Such performance shares are available, subject to time-based vesting conditions, if, and to the extent that, financial or operational performance criteria for the applicable period are achieved. Accordingly, the number of performance shares earned will vary based on the level of achievement of financial or operational performance objectives for the applicable period.

In connection with the completion of the Newport Merger, the Company assumed:

- all RSUs granted under any Newport equity plan that were outstanding immediately prior to the effective time of the Newport Merger, and as to which shares of Newport common stock were not fully distributed in connection with the closing of the Newport Merger, and
- all stock appreciation rights granted under any Newport equity plan, whether vested or unvested, that were outstanding immediately prior to the effective time of the Newport Merger.

As of the effective time of the Newport Merger, based on a formula provided in the Merger Agreement, (a) the Newport RSUs were converted automatically into RSUs with respect to 360,674 shares of the Company's common stock (the "Assumed RSUs"), and (b) the Newport stock appreciation rights were converted automatically into SARs with respect to 899,851 shares of the Company's common stock (the "Assumed SARs").

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NOTES TO CONSOLIDATED FINANCIAL STATEMENTS — (continued)
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Included in the total number of Assumed RSUs were 36,599 RSUs for outside directors that were part of the Newport Deferred Compensation Plan (the "DC Plan"), from which 19,137 underlying shares were released in May 2016, 5,515 shares were released in May 2017 and 5,561 shares were released in May 2018. As of December 31, 2018, 6,694 Company RSUs remained outstanding under the DC Plan, and an additional 66 shares of the Company's common stock were added to the DC Plan due to reinvested dividends. As of December 31, 2017, 12,134 Company RSUs remained outstanding under the DC Plan, and an additional 122 shares of the Company's common stock were added to the DC Plan due to reinvested dividends. As of December 31, 2016, 17,462 Company RSUs remained outstanding under the DC Plan, and an additional 187 shares of the Company's common stock were added to the DC Plan due to reinvested dividends. These Assumed RSUs will not become issued shares until their respective release dates.

The shares of the Company's common stock that are subject to the Assumed SARs and the Assumed RSUs are issuable pursuant to the Company's 2014 Plan.

The 1,260,525 shares of the Company's common stock that are issuable pursuant to the Assumed RSUs and the Assumed SARs under the 2014 Plan were registered under the Securities Act of 1933, as amended ("Securities Act"), on a registration statement on Form S-8. These shares are in addition to the 18,000,000 shares of the Company's common stock reserved for issuance under the 2014 Plan and previously registered under the Securities Act on a registration statement on Form S-8.

The following table presents the activity for RSUs under the Plans:

	Year Ended December 31, 2018	
	Non-vested RSUs	Weighted Average Grant Date Fair Value
Non-vested RSUs — beginning of period	943,379	$ 47.57
Accrued dividend shares	66	$ 94.11
Granted	266,411	$ 111.64
Vested	(490,453)	$ 44.70
Forfeited or expired	(72,009)	$ 66.22
Non-vested RSUs — end of period	647,394	$ 74.04

The following table presents the activity for SARs under the Plans:

	Year Ended December 31, 2018	
	Non-vested SARs	Weighted Average Base Value
SARs — beginning of period	282,907	$ 28.62
Exercised	(103,419)	$ 28.78
Forfeited or expired	(1,950)	$ 29.00
SARs Outstanding — end of period	177,538	$ 28.52

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NOTES TO CONSOLIDATED FINANCIAL STATEMENTS — (continued)
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At December 31, 2018, the Company's outstanding and exercisable SARs, the weighted-average base value, the weighted average remaining contractual life and the aggregate intrinsic value thereof, were as follows:

	Number of Shares	Weighted Average Base Value	Weighted Average Remaining Contractual Life (years)	Aggregate Intrinsic Value
SARs outstanding and exercisable	177,538	$ 28.52	2.4	$ 6,408

The Company settles employee RSU vesting and SARs exercises with newly issued shares of the Company's common stock.

Stock-Based Compensation Expense

The Company recognized the full impact of its share-based payment plans in the consolidated statements of operations and comprehensive income for the years 2018, 2017 and 2016. As of December 31, 2018, 2017, and 2016, the Company capitalized $471 of such cost on its consolidated balance sheet. The following table reflects the effect of recording stock-based compensation for the years 2018, 2017 and 2016:

	Years Ended December 31,		
	2018	2017	2016
Stock-based compensation expense by type of award:			
RSUs	$24,883	$ 22,428	$23,302
SARs	98	529	700
Employee stock purchase plan	2,281	1,421	1,226
Total stock-based compensation	$27,262	24,378	25,228
Windfall tax effect on stock-based compensation	(8,277)	(11,071)	—
Net effect on net income	$18,985	$ 13,307	$25,228
Effect on net earnings per share:			
Basic	$ 0.35	$ 0.25	$ 0.47
Diluted	$ 0.35	$ 0.24	$ 0.47

The pre-tax effect within the consolidated statements of operations and comprehensive income of recording stock-based compensation for the years 2018, 2017 and 2016 was as follows:

	Years Ended December 31,		
	2018	2017	2016
Cost of revenues	$ 3,516	$ 3,894	$ 2,997
Research and development expense	2,750	2,816	2,529
Selling, general and administrative expense	20,996	17,668	19,702
Total pre-tax stock-based compensation expense	$27,262	$24,378	$25,228

Valuation Assumptions

The Company determines the fair value of RSUs based on the closing market price of the Company's common stock on the date of the award, and estimates the fair value of employee stock purchase plan rights using the Black-Scholes valuation model. Such values are recognized as expense on a straight-line basis for time-based awards and using the accelerated graded vesting method for performance-based awards, both over the requisite service periods, net of estimated forfeitures except for retirement eligible employees in which the Company expenses the fair value of the grant in the period the grant is issued. The estimation of stock-based awards that will ultimately vest requires significant judgment. The Company considers many factors when estimating expected forfeitures, including types of awards and historical experience. Actual results, and future changes in estimates, may differ substantially from the Company's current estimates.

(in thousands, except share and per share data)

The weighted average fair value per share of employee stock purchase plan rights granted in 2018, 2017 and 2016 was $21.74, $13.14, and $8.52, respectively. The fair value of the employees' purchase plan rights was estimated using the Black-Scholes option-pricing model with the following weighted average assumptions:

	Years Ended December 31,		
	2018	2017	2016
Employee stock purchase plan rights:			
Expected life (years)	0.5	0.5	0.5
Risk-free interest rate	1.8%	0.8%	0.5%
Expected volatility	38.6%	26.5%	25.4%
Expected annual dividends per share	$ 0.76	$ 0.69	$ 0.68

Expected volatilities for 2018, 2017 and 2016 are based on a combination of implied and historical volatilities of the Company's common stock; the expected life represents the weighted average period of time that options granted are expected to be outstanding giving consideration to vesting schedules and the Company's historical exercise patterns; and the risk-free interest rate is based on the U.S. Treasury yield curve in effect at the time of grant for periods corresponding with the expected life of the option.

The total intrinsic value of SARs exercised and the total fair value of RSUs vested during 2018, 2017 and 2016 was approximately $61,626, $60,302 and $18,844, respectively. As of December 31, 2018, the unrecognized compensation cost related to RSUs and SARs was approximately $19,039 and will be recognized over and estimated weighted average amortization period of 0.91 years.

17) Employee Benefit Plans

The Company has a 401(k) profit-sharing plan for U.S. employees meeting certain requirements in which eligible employees may contribute between 1% and 50% of their annual compensation to this plan, and, with respect to employees who are age 50 and older, certain specified additional amounts, limited by an annual maximum amount determined by the Internal Revenue Service. The Company, at its discretion, makes certain matching contributions to these plans based on participating employees' contributions to the plans and their total compensation. The Company's contributions were $6,093, $5,651 and $6,524 for 2018, 2017 and 2016, respectively.

The Company maintains a bonus plan which provides cash awards to key employees, at the discretion of the compensation committee of the Board of Directors, based upon operating results and employee performance. In addition, the Company's foreign locations also have various bonus plans based upon local operating results and employee performance. The total bonus expense was $38,254, $46,783 and $28,097 for 2018, 2017 and 2016, respectively.

The Company provides supplemental retirement benefits for one of its current executive officers and a number of former retired executives. The total cost of these benefits was $4,609, $3,478 and $1,805 for 2018, 2017 and 2016, respectively. The accumulated benefit obligation was $20,644 and $15,929 at December 31, 2018 and 2017, respectively, which was included in other long-term liabilities.

(in thousands, except share and per share data)

The Company also has a deferred compensation plan for certain Light & Motion segment executives.

Defined Benefit Pension Plans

As a result of the Newport Merger, the Company assumed all assets and liabilities of Newport's defined benefit pension plans, which cover substantially all of its full-time employees in France, Germany, Israel and Japan. In addition, there are certain pension assets and liabilities relating to former employees in the United Kingdom. The German plan is unfunded, as permitted under the plan and applicable laws.

For financial reporting purposes, the calculation of net periodic pension costs was based upon a number of actuarial assumptions including a discount rate for plan obligations, an assumed rate of return on pension plan assets and an assumed rate of compensation increase for employees covered by the plan. All of these assumptions were based upon management's judgment, considering all known trends and uncertainties. Actual results that differ from these assumptions would impact future expense recognition and the cash funding requirements of the Company's pension plans.

The net periodic benefit costs for the plans included the following components:

	Year Ended December 31,	
	2018	2017
Service cost	$ 657	$ 708
Interest cost on projected benefit obligations	433	458
Expected return on plan assets	(115)	(116)
Amortization of actuarial net loss	127	400
	$ 1,102	$ 1,450

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NOTES TO CONSOLIDATED FINANCIAL STATEMENTS — (continued)
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The changes in projected benefit obligations and plan assets, as well as the ending balance sheet amounts for the Company's defined benefit plans, were as follows:

	Year Ended December 31,	
	2018	2017
Change in projected benefit obligations:		
Projected benefit obligations, beginning of year	$ 25,736	$ 23,450
Service cost	657	708
Interest cost	433	458
Actuarial gain	(98)	(312)
Benefits paid	(895)	(1,271)
Currency translation adjustments	(948)	2,703
Projected benefit obligations, end of year	$ 24,885	$ 25,736
Change in plan assets:		
Fair value of plan assets, beginning of year	$ 8,152	$ 7,672
Company contributions	324	324
(Loss) gain on plan assets	(56)	177
Benefits paid	(369)	(722)
Currency translation adjustments	(229)	701
Fair value of plan assets, end of year	7,822	8,152
Net underfunded status	$ (17,063)	$ (17,584)

Changes in plan assets and benefit obligations recognized in other comprehensive income included the following components:

	Year Ended December 31,	
	2018	2017
Amounts recognized in accumulated comprehensive income:		
Accumulated net actuarial gain	$ 235	$ 235
Income tax (expense) benefit	(86)	88
Accumulated other comprehensive gain	$ 149	$ 323

As of December 31, 2018, the estimated benefit payments for the Company's defined benefit plans for the next 10 years were as follows:

	Estimated benefit payments
2019	$ 1,046
2020	$ 1,252
2021	$ 1,210
2022	$ 1,312
2023	$ 1,129
2024-2028	$ 7,313
	$ 13,262

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The Company expects to contribute $1,660 to the plans during 2019.

The weighted-average rates used to determine the net periodic benefit costs were as follows:

	December 31, 2018
Discount rate	1.9%
Rate of increase in salary levels	2.1%
Expected long-term rate of return on assets	1.9%

In determining the expected long-term rate of return on plan assets, the Company considers the relative weighting of plan assets, the historical performance of total plan assets and individual asset classes, and economic and other indicators of future performance.

Plan assets were held in the following categories as a percentage of total plan assets:

	Year Ended December 31, 2018	
	Amount	Percentage
Cash	$ 193	2.00%
Debt securities	4,855	62
Equity securities	1,342	17
Other	1,432	19
	$ 7,822	100%

In general, the Company's asset management objectives include maintaining an adequate level of diversification to reduce interest rate and market risk while providing adequate liquidity to meet immediate and future benefit payment requirements. In Japan, assets are primarily invested in pooled funds of insurance companies. The expected long-term rate of return on these assets is approximately 1.5%, which is based on the general yield environment for high quality instruments in Japan. The United Kingdom pension plan invests in a combination of equity and bond funds. The allocation mix is designed to minimize risk while providing a rate of return that will provide asset growth which will be sufficient to cover expected liabilities. The expected long-term rate of return on these assets is approximately 2.7%, which is a combination of long dated government and corporate bond yields for the bond funds, and long dated government and corporate bond yields with an allowance for out-performance for equity funds. In France, assets are invested in group insurance contracts and the expected long-term rate of return on these assets is approximately 1.6%, which is based on the expected return on the underlying assets.

The Company's Israeli plans account for the deferred vested benefits using the shut-down method of accounting, which resulted in assets of $14,409 and vested benefit obligations of $17,552, as of December 31, 2018 and assets of $15,048 and vested benefit obligations of $17,932, as of December 31, 2017. Under the shut-down method, the liability is calculated as if it were payable as of the balance sheet date, on an undiscounted basis.

Other Pension-Related Assets

As of December 31, 2018 and 2017, the Company had assets with an aggregate market value of $5,890 and $6,255, respectively, which it has set aside in connection with its German pension plans. These assets are invested in group insurance contracts through the insurance companies administering these plans, in accordance

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NOTES TO CONSOLIDATED FINANCIAL STATEMENTS — (continued)
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with applicable pension laws. The Germany contracts have a guaranteed minimum rate of return ranging from 2.25% to 4.25%, depending on the contract. Because the assets were not separate legal assets of the pension plan, they were not included in the Company's plan assets shown above. However, the Company has designated such assets to pay pension benefits. Such assets are included in other assets in the accompanying consolidated balance sheet.

18) Net Income Per Share

The following is a reconciliation of basic to diluted net income per share:

	Years Ended December 31,		
	2018	2017	2016
Numerator:			
Net income	$ 392,896	$ 339,132	$ 104,809
Denominator:			
Shares used in net income per common share — basic	$54,406,000	54,137,000	53,472,000
Effect of dilutive securities	586,000	937,000	579,000
Shares used in net income per common share — diluted	54,992,000	55,074,000	54,051,000
Net income per common share:			
Basic	$ 7.22	$ 6.26	$ 1.96
Diluted	$ 7.14	$ 6.16	$ 1.94

Basic earnings per share ("EPS") is computed by dividing income available to common stockholders by the weighted-average number of common shares outstanding during the period. The computation of diluted EPS is similar to the computation of basic EPS except that the denominator is increased to include the number of additional common shares that would have been outstanding (using the treasury stock method) if securities containing potentially dilutive common shares (RSUs and SARs) had been converted to such common shares, and if such assumed conversion is dilutive.

In 2018, 2017 and 2016, the potential dilutive effect of 79,500, 404 and 508 weighted average shares, respectively, of RSUs, were excluded from the computation of diluted weighted-average shares outstanding, as the shares would have had an anti-dilutive effect on EPS, and would thus need to be excluded from the computation of diluted weighted-average shares.

19) Business Segment, Geographic Area, Product and Significant Customer Information

The Company is a global provider of instruments, subsystems and process control solutions that measure, monitor, deliver, analyze, power and control critical parameters of advanced manufacturing processes to improve process performance and productivity for its customers. The Company's products are derived from its core competencies in pressure measurement and control, flow measurement and control, gas and vapor delivery, gas composition analysis, residual gas analysis, leak detection, control technology, ozone generation and delivery, RF & DC power, reactive gas generation, vacuum technology, lasers, photonics, sub-micron positioning, vibration control, and optics. The Company also provides services related to the maintenance and repair of its products, installation services and training. The Company's primary served markets are manufacturers of capital equipment for semiconductor manufacturing, industrial technologies, life and health sciences, as well as research and defense.

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NOTES TO CONSOLIDATED FINANCIAL STATEMENTS — (continued)
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The Company's Chief Operating Decision Maker ("CODM") utilizes financial information to make decisions about allocating resources and assessing performance for the entire Company, which is used in the decision making process to assess performance. Based upon the information provided to the CODM, the Company has determined it has two reportable segments. The Company's two reportable segments are: Vacuum & Analysis and Light & Motion.

The Vacuum & Analysis segment provides a broad range of instruments, components and subsystems which are derived from the Company's core competencies in pressure measurement and control, flow measurement and control, gas and vapor delivery, gas composition analysis, residual gas analysis, leak detection, control technology, ozone generation and delivery, RF & DC power, reactive gas generation and vacuum technology.

The Light & Motion segment provides a broad range of instruments, components and subsystems which are derived from the Company's core competencies in lasers, photonics, sub-micron positioning, vibration control, and optics.

The Company derives its segment results directly from the manner in which results are reported in its management reporting system. The accounting policies that the Company uses to derive reportable segment results are substantially the same as those used for external reporting purposes. The Company does not disclose external or intersegment revenues separately by reportable segment as this information is not presented to the CODM for decision making purposes.

The following are net revenues by reportable segment:

	Years Ended December 31,		
	2018	2017	2016
Vacuum & Analysis	$ 1,260,862	$ 1,207,457	$ 872,291
Light & Motion	814,246	708,520	423,051
	$ 2,075,108	$ 1,915,977	$ 1,295,342

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NOTES TO CONSOLIDATED FINANCIAL STATEMENTS — (continued)
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The following is a reconciliation of segment gross profit to consolidated net income:

	Years Ended December 31, 2018	2017	2016
Gross profit by reportable segment:			
Vacuum & Analysis	$577,552	$551,078	$388,220
Light & Motion	401,924	340,373	177,399
Total gross profit by reportable segment	979,476	891,451	565,619
Operating expenses:			
Research and development	135,720	132,555	110,579
Selling, general and administrative	298,118	290,056	227,932
Acquisition and integration costs	3,113	5,332	27,279
Restructuring	3,567	3,920	642
Environmental costs	1,000	—	—
Asset impairment	—	6,719	5,000
Fees and expenses related to repricing of term loan	378	492	1,239
Amortization of intangible assets	43,521	45,743	35,681
Income from operations	494,059	406,634	157,267
Interest income	5,775	3,021	2,560
Interest expense	16,942	30,990	30,611
Gain on sale of business	—	74,856	—
Other expense, net	1,942	5,896	1,239
Income before income taxes	480,950	447,625	127,977
Provision for income taxes	88,054	108,493	23,168
Net income	$392,896	$339,132	$104,809

The following is capital expenditures by reportable segment for the years ended December 31, 2018, 2017 and 2016:

	Vacuum & Analysis	Light & Motion	Total
December 31, 2018:			
Capital expenditures	$ 40,144	$ 22,797	$62,941
December 31, 2017:			
Capital expenditures	$ 17,111	$ 14,176	$31,287
December 31, 2016:			
Capital expenditures	$ 11,732	$ 7,391	$19,123

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NOTES TO CONSOLIDATED FINANCIAL STATEMENTS — (continued)
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The following is depreciation and amortization of intangible assets by reportable segment for the years ended December 31, 2018, 2017 and 2016:

	Vacuum & Analysis	Light & Motion	Total
December 31, 2018:			
Depreciation and amortization	$ 20,808	$ 59,045	$79,853
December 31, 2017:			
Depreciation and amortization	$ 20,297	$ 62,259	$82,556
December 31, 2016:			
Depreciation and amortization	$ 20,820	$ 45,106	$65,926

Total income tax expense is not presented by reportable segment because the necessary information is not available or used by the CODM.

The following are segment assets by reportable segment:

	Vacuum & Analysis	Light & Motion	Corporate, Eliminations and Other	Total
December 31, 2018:				
Segment assets:				
Accounts receivable	$ 171,604	$ 140,658	$ (16,808)	$295,454
Inventory	222,965	161,658	66	384,689
Total segment assets	$ 394,569	$ 302,316	$ (16,742)	$680,143

	Vacuum & Analysis	Light & Motion	Corporate, Eliminations and Other	Total
December 31, 2017:				
Segment assets:				
Accounts receivable	$ 201,318	$ 119,934	$ (20,944)	$300,308
Inventory	197,831	141,250	—	339,081
Total segment assets	$ 399,149	$ 261,184	$ (20,944)	$639,389

A reconciliation of segment assets to consolidated total assets is as follows:

	Years Ended December 31,	
	2018	2017
Total segment assets	$ 680,143	$ 639,389
Cash and cash equivalents, restricted cash and investments	728,461	553,976
Other current assets	65,790	53,543
Property, plant and equipment, net	194,367	171,782
Goodwill and intangible assets, net	906,803	957,445
Other assets	38,682	37,883
Consolidated total assets	$ 2,614,246	$ 2,414,018

(in thousands, except share and per share data)

Information about the Company's operations in different geographic regions is presented in the tables below. Net revenues to unaffiliated customers are based on the location in which the sale originated. Transfers between geographic areas are at negotiated transfer prices and have been eliminated from consolidated net revenues.

	Years Ended December 31,		
Net revenues:	**2018**	**2017**	**2016**
United States	$ 1,022,660	$ 955,284	$ 675,601
South Korea	203,567	212,763	112,432
Japan	193,264	167,318	96,954
Europe	244,009	209,912	156,365
Asia (excluding South Korea and Japan)	411,608	370,700	253,990
	$ 2,075,108	$ 1,915,977	$ 1,295,342

	Years Ended December 31,	
Long-lived assets:(1)	**2018**	**2017**
United States	$ 146,687	$ 124,689
Europe	26,794	28,820
Asia	50,572	49,645
	$ 224,053	$ 203,154

(1) Long-lived assets include property, plant and equipment, net and certain other assets, and exclude goodwill and intangibles and long-term tax-related accounts.

Goodwill associated with each of our reportable segments is as follows:

	Years Ended December 31,	
	2018	**2017**
Reportable segment:		
Vacuum & Analysis	$ 197,126	$ 197,617
Light & Motion	389,870	393,430
Total goodwill	$ 586,996	$ 591,047

(in thousands, except share and per share data)

Worldwide Product Information

Because the reportable segment information above does not reflect worldwide sales of the Company's products, the Company groups its products into six groups of similar products based upon the similarity of product function. Worldwide net revenue for each group of products is as follows:

	Years Ended December 31,		
	2018	2017	2016
Analytical and Control Solutions Products	$ 116,183	$ 131,376	$ 115,758
Power, Plasma and Reactive Gas Solutions Products	610,111	564,343	367,665
Vacuum Solutions Products	534,568	511,738	388,868
Laser Products	274,815	225,168	124,432
Optics Products	227,577	203,775	124,218
Photonics Products	311,854	279,577	174,401
	$ 2,075,108	$ 1,915,977	$ 1,295,342

Sales of Analytical and Control Solutions Products; Power, Plasma and Reactive Gas Solutions Products; and Vacuum Solutions Products are included in the Company's Vacuum & Analysis segment. Sales of Laser Products; Optics Products; and Photonics Products are included in the Light & Motion segment.

Major Customers

The Company had two customers with net revenues greater than 10% of total net revenues in the periods shown as follows:

	Years Ended December 31,		
	2018	2017	2016
Applied Materials, Inc.	11.7%	12.7%	13.6%
Lam Research Corporation	10.8%	11.7%	11.2%

Net revenues for each of our reportable segments include revenues from each of the two customers, which represent net revenues greater than 10% of total net revenues.

20) Restructurings

During 2018, the Company recorded restructuring charges of $3,567, primarily related to severance costs related to a worldwide reduction in workforce including severance costs related to transferring a portion of our shared accounting functions in the United States to a third party, as well as the consolidation of certain shared accounting functions in Asia.

During 2017, the Company recorded restructuring charges of $3,920. The restructuring charges were primarily severance and facility costs related to the consolidation of two manufacturing plants, a restructuring of one of our international facilities and the consolidation of sales offices.

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NOTES TO CONSOLIDATED FINANCIAL STATEMENTS — (continued)
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The activity related to the Company's restructuring accrual is shown below:

	2018	2017
Balance at January 1	$ 3,244	$ 540
Charged to expense	3,567	3,920
Payments and adjustment	(4,179)	(1,216)
Balance at December 31	$ 2,632	$ 3,244

21) Commitments and Contingencies

Newport Litigation

In March 2016, two putative class actions lawsuit captioned Dixon Chung v. Newport Corp., et al., Case No. A-16-733154-C and Hubert C. Pincon v. Newport Corp., et al., Case No. A-16-734039-B were filed in the District Court, Clark County, Nevada on behalf of a putative class of stockholders of Newport for claims related to the Merger Agreement between the Company, Newport, and Merger Sub. The lawsuits named as defendants the Company, Newport, Merger Sub, and certain then current and former members of Newport's board of directors. Both complaints alleged that Newport directors breached their fiduciary duties to Newport's stockholders by agreeing to sell Newport through an inadequate and unfair process, which led to inadequate and unfair consideration, by agreeing to unfair deal protection devices and by omitting material information from the proxy statement. The complaints also alleged that the Company, Newport, and Merger Sub aided and abetted the directors' alleged breaches of their fiduciary duties. The complaints sought injunctive relief, including to enjoin or rescind the Merger Agreement, and an award of attorneys' and other fees and costs, among other relief. On April 14, 2016, the Court consolidated the actions.

On October 19, 2016, plaintiffs in the consolidated action filed an amended complaint captioned In re Newport Corporation Shareholder Litigation, Case No. A-16-733154-B, in the District Court, Clark County, Nevada, on behalf of a putative class of Newport's stockholders for claims related to the Merger Agreement. The amended complaint contained substantially similar allegations related to Newport's former board of directors' alleged breaches of their fiduciary duties to Newport's stockholders. The amended complaint sought monetary damages, including pre- and post-judgment interest. On June 22, 2017, the Court granted Defendants' motion to dismiss and dismissed the amended complaint against all defendants but granted plaintiffs leave to amend.

On July 27, 2017, plaintiffs filed a second amended complaint containing substantially similar allegations but naming only Newport's former directors as defendants. On August 8, 2017, the Court dismissed the Company and Newport from the action. The second amended complaint seeks monetary damages, including pre- and post-judgment interest. The Court granted a motion for class certification on September 27, 2018, appointing Mr. Pincon and Locals 302 and 612 of the International Union of Operating Engineers—Employers Construction Industry Retirement Trust as class representatives. On June 11, 2018, plaintiff Dixon Chung was voluntarily dismissed from the litigation. Discovery is ongoing in this action.

ESI Litigation

On November 29, 2018, a complaint captioned Brian Morris et. al. v. Electro Scientific Industries, Inc. et al. was filed in the U.S. District Court for the District of Oregon by alleged former stockholders of ESI in connection with the acquisition of ESI by the Company. The complaint named the Company's subsidiary, ESI, and the former members of ESI's board of directors as defendants. Five additional complaints were subsequently filed, two in the U.S. District Court for the District of Oregon and three in the Multnomah County Circuit Court in the State of Oregon. The cases filed in the U.S. District Court were dated December 6, 2018 and December 12, 2018 and captioned Melvyn Klein et. al. v. Electro Scientific Industries, Inc. et al. and Donald Mager et. al. v. Electro Scientific Industries, Inc. et al., respectively. The complaints filed in Multnomah County Circuit Court were dated December 5, 2018, December 5, 2018 and December 13, 2018 and captioned Michael Kent et. al v. Electro Scientific Industries, Inc. et al., Christopher Stanley et. al v. Electro Scientific Industries, Inc. et al. and Eduardo Colmenares et. al. v. Electro Scientific Industries, Inc., MKS Instruments, Inc., et al., respectively (collectively with Brian Morris et. al. v. Electro Scientific Industries, Inc. et. al., the “Lawsuits”). On February 16, 2019, the parties came to an agreement on a settlement in principle that would resolve the Lawsuits, which is subject to the execution of a settlement agreement and dismissal of the Lawsuits with prejudice.

(in thousands, except share and per share data)

These lawsuits are purported class actions brought on behalf of former ESI stockholders, asserting various claims against the former members of the ESI board of directors, ESI, MKS, and MKS’ merger subsidiary, including breach of fiduciary duty and aiding and abetting the breach of fiduciary duty. The lawsuits allege that the consideration paid to the ESI shareholders did not appropriately value ESI, and that ESI’s merger related disclosures failed to disclose certain material information regarding the merger. These complaints purport to seek unspecified damages.

The Company believes that the claims in these complaints are without merit and intends to vigorously defend this litigation. ESI provided supplemental merger related disclosures to eliminate the burden and expense of litigation and to avoid any possible disruption to the merger that could result from further litigation.

The Company is subject to various legal proceedings and claims, which have arisen in the ordinary course of business. In the opinion of management, the ultimate disposition of these matters will not have a material adverse effect on our results of operations, financial condition or cash flows.

The Company leases certain of its facilities and machinery and equipment under operating leases expiring in various years through 2026. Generally, the facility leases require the Company to pay maintenance, insurance and real estate taxes. Rental expense under operating leases totaled $20,912, $19,693 and $16,253 for 2018, 2017 and 2016, respectively.

Minimum lease payments under operating leases are as follows:

Year Ending December 31,	Operating Leases
2019	$ 20,106
2020	$ 17,142
2021	$ 10,325
2022	$ 5,573
2023	$ 4,410
Thereafter	$ 8,739
Total minimum lease payments	$ 66,295

As of December 31, 2018, the Company has entered into purchase commitments for certain inventory components and other equipment and services used in its normal operations. The majority of these purchase commitments covered by these arrangements are for periods of less than one year and aggregate to approximately $254,069.

To the extent permitted by Massachusetts law, the Company’s Restated Articles of Organization, as amended, require the Company to indemnify any of its current or former officers or directors or any person who has served or is serving in any capacity with respect to any of the Company’s employee benefit plans. The

Company believes that the estimated exposure for these indemnification obligations is currently not material. Accordingly, the Company has no material liabilities recorded for these requirements as of December 31, 2018.

The Company also enters into agreements in the ordinary course of business which include indemnification provisions. Pursuant to these agreements, the Company indemnifies, holds harmless and agrees to reimburse the indemnified party, generally its customers, for losses suffered or incurred by the indemnified party in connection with certain patent or other intellectual property infringement claims, and, in some instances, other claims, by any third party with respect to the Company's products. The term of these indemnification obligations is generally perpetual after execution of the agreement. The maximum potential amount of future payments the Company could be required to make under these indemnification agreements is, in some instances, not contractually limited. The Company has never incurred costs to defend lawsuits or settle claims related to these indemnification obligations. As a result, the Company believes the estimated fair value of these obligations is minimal. Accordingly, the Company has no liabilities recorded for these obligations as of December 31, 2018.

As part of past acquisitions and divestitures of businesses or assets, the Company has provided a variety of indemnifications to the sellers and purchasers for certain events or occurrences that took place prior to the date of the acquisition or divestiture. Typically, certain of the indemnifications expire after a defined period of time following the transaction, but certain indemnifications may survive indefinitely. The maximum potential amount of future payments the Company could be required to make for such obligations is undeterminable at this time. Other than obligations recorded as liabilities at the time of the acquisitions, historically the Company has not made significant payments for these indemnifications. Accordingly, no material liabilities have been recorded for these obligations.

In conjunction with certain asset sales, the Company may provide routine indemnifications whose terms range in duration and often are not explicitly defined. Where appropriate, an obligation for such indemnification is recorded as a liability. Because the amounts of liability under these types of indemnifications are not explicitly stated, the overall maximum amount of the obligation under such indemnifications cannot be reasonably estimated. Other than obligations recorded as liabilities at the time of the asset sale, historically the Company has not made significant payments for these indemnifications.

22) Subsequent Event

Acquisition of Electro Scientific Industries, Inc (amounts not in thousands, except per share data).

On February 1, 2019, the Company completed its previously announced acquisition of Electro Scientific Industries, Inc., an Oregon corporation ("ESI"), pursuant to the Agreement and Plan of Merger (the "ESI Merger"). ESI is an innovator in laser-based manufacturing solutions for micro-machining applications. Micro-machining applications are used extensively in the manufacture of mobile devices, electronic components, thin film devices and semiconductor packaging. At the effective time of the ESI Merger and pursuant to the terms and conditions of the Agreement and Plan of Merger, each share of ESI's common stock issued and outstanding as of immediately prior to the effective time of the ESI Merger, was converted into the right to receive $30.00 per share in cash, without interest and subject to deduction for any required withholding tax. The Company paid to the former ESI stockholders aggregate consideration of approximately $1 billion, excluding related transaction fees and expenses. The Company funded the payment of the aggregate consideration with a combination of its available cash on hand and the proceeds from the term loan facility described below.

The Company was not able to include certain required disclosures in its annual report on Form 10-K for the year ended December 31, 2018 because the information necessary to complete the preliminary purchase price allocation related to the acquisition was not yet available.

MKS INSTRUMENTS, INC.

NOTES TO CONSOLIDATED FINANCIAL STATEMENTS — (continued)
(in thousands, except share and per share data)

In connection with the completion of the ESI Merger, the Company entered into an amendment ("Amendment No. 5") to the Term Loan Credit agreement with Barclays Bank PLC as administrative agent and collateral agent, that provided additional tranche B-5 term loan commitment in the principal amount of $650.0 million which was used to partially fund the ESI Merger.

Also, in connection with the completion of the ESI Merger, the Company terminated its $50.0 million asset-based credit agreement with Deutsche Bank AG New York Branch as administrative and collateral agent, and the Company entered into an asset-based credit agreement with Barclays Bank PLC, as administrative agent and collateral agent, that provides senior secured revolving credit financing of up to $100.0 million, subject to a borrowing base limitation.

MKS Instruments, Inc.
Supplemental Financial Data

	Quarter Ended March 31	Quarter Ended June 30	Quarter Ended Sept. 30	Quarter Ended Dec. 31
	(Table in thousands, except per share data) (Unaudited)			
2018				
Statement of Operations Data				
Net revenues	$ 554,275	$ 573,140	$ 487,152	$ 460,541
Gross profit	262,855	274,877	231,860	209,884
Income from operations	131,639	151,291	117,045	94,084
Net income	$ 105,121	$ 122,862	$ 93,277	$ 71,636
Net income per share:				
Basic	$ 1.93	$ 2.25	$ 1.71	$ 1.33
Diluted	$ 1.90	$ 2.22	$ 1.70	$ 1.32
Cash dividends paid per common share	$ 0.18	$ 0.20	$ 0.20	$ 0.20
2017				
Statement of Operations Data				
Net revenues	$ 437,153	$ 480,757	$ 486,267	$ 511,800
Gross profit	205,547	219,583	227,995	238,326
Income from operations	83,580	92,883	110,155	120,016
Net income	$ 65,060	$ 120,440	$ 75,994	$ 77,638
Net income per share:				
Basic	$ 1.21	$ 2.22	$ 1.40	$ 1.43
Diluted	$ 1.18	$ 2.19	$ 1.38	$ 1.41
Cash dividends paid per common share	$ 0.175	$ 0.175	$ 0.175	$ 0.18

Item 9. ***Changes in and Disagreements with Accountants on Accounting and Financial Disclosure***

None.

Item 9A. ***Controls and Procedures***

Evaluation of Disclosure Controls and Procedures

Our management, with the participation of our Chief Executive Officer and Chief Financial Officer, evaluated the effectiveness of our disclosure controls and procedures as of December 31, 2018. The term “disclosure controls and procedures,” as defined in Rules 13a-15(e) and 15d-15(e) under the Securities Exchange Act of 1934, as amended (the “Exchange Act”), means controls and other procedures of an issuer that are designed to ensure that information required to be disclosed by the issuer in the reports that it files or submits under the Exchange Act is recorded, processed, summarized and reported, within the time periods specified in the SEC’s rules and forms. Disclosure controls and procedures include, without limitation, controls and procedures designed to ensure that information required to be disclosed by an issuer in the reports that it files or submits under the Exchange Act is accumulated and communicated to the issuer’s management, including its principal executive and principal financial officers, or persons performing similar functions as appropriate to allow timely decisions regarding required disclosure. Management recognizes that any controls and procedures, no matter how well designed and operated, can provide only reasonable assurance of achieving their objectives and management necessarily applies its judgment in evaluating the cost-benefit relationship of possible controls and procedures. Based on the evaluation of our disclosure controls and procedures as of December 31, 2018, our Chief Executive Officer and Chief Financial Officer concluded that, as of such date, our disclosure controls and procedures were effective at the reasonable assurance level to ensure that information required to be disclosed by us in reports that we file or submit under the Exchange Act is recorded, processed, summarized and reported within the time periods specified in Securities and Exchange Commission rules and forms and is accumulated and communicated to our management, including our Chief Executive Officer and Chief Financial Officer as appropriate to allow timely decisions regarding required disclosure.

Management’s Report on Internal Control over Financial Reporting

Our management is responsible for establishing and maintaining adequate internal control over financial reporting. Internal control over financial reporting is defined in Rules 13a-15(f) and 15d-15(f) promulgated under the Exchange Act as a process designed by, or under the supervision of our Chief Executive Officer and Chief Financial Officer or persons performing similar functions and effected by our Board of Directors, management and other personnel, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles and includes those policies and procedures that:

- Pertain to the maintenance of records that in reasonable detail accurately and fairly reflect the transactions and dispositions of the assets of the Company;
- Provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that our receipts and expenditures of the Company are being made only in accordance with authorization of our management and directors of the Company; and
- Provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use or disposition of our assets that could have a material effect on the financial statements.

Because of its inherent limitations, internal control over financial reporting may not prevent or detect misstatements. Projections of any evaluation of effectiveness to future periods are subject to the risk that controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

Under the supervision and with the participation of our management including our Chief Executive Officer and Chief Financial Officer, we conducted an assessment of the effectiveness of our internal control over financial reporting as of December 31, 2018. In making this assessment, we used the criteria set forth in the *Internal Control-Integrated Framework* (2013) issued by the Committee of Sponsoring Organizations of the Treadway Commission. Based on our assessment, our management concluded that, as of December 31, 2018, our internal control over financial reporting was effective.

Our internal controls over financial reporting as of December 31, 2018 have been audited by PricewaterhouseCoopers LLP, an independent registered public accounting firm, as stated in their attestation report which appears in Item 8 of this Annual Report on Form 10-K.

Changes in Internal Control over Financial Reporting

There was no change in our internal control over financial reporting (as defined in Rules 13a-15(f) and 15d-15(f) under the Exchange Act) during our fourth fiscal quarter that has materially affected, or is reasonably likely to materially affect, our internal control over financial reporting.

Item 9B. ***Other Information***

None.

PART III

Item 10. *Directors, Executive Officers and Corporate Governance*

The information required by this item will be set forth under the captions "Proposal One — Election of Directors," "Directors," "Corporate Governance," "Executive Officers," "Corporate Governance — Code of Ethics" and "Corporate Governance — Board of Directors Meetings and Committees of the Board of Directors — Audit Committee" in our definitive proxy statement for the 2019 Annual Meeting of Stockholders to be filed with the Securities and Exchange Commission no later than 120 days after the end of our fiscal year, and is incorporated herein by reference.

We are also required under Item 405 of Regulation S-K to provide information concerning delinquent filers of reports under Section 16 of the Securities and Exchange Act of 1934, as amended. This information will be set forth under the caption "Section 16(a) Beneficial Ownership Reporting Compliance" in our definitive proxy statement for the 2019 Annual Meeting of Stockholders to be filed with the Securities and Exchange Commission no later than 120 days after the end of our fiscal year, and is incorporated herein by reference.

Item 11. *Executive Compensation*

The information required by this item will be set forth under the captions "Executive Officers," "Executive Compensation — Compensation Discussion and Analysis," "Corporate Governance — Compensation Committee Interlocks and Insider Participation," "Compensation Committee Report" and "Director Compensation" in our definitive proxy statement for the 2019 Annual Meeting of Stockholders to be filed with the Securities and Exchange Commission no later than 120 days after the end of our fiscal year, and is incorporated herein by reference.

Item 12. *Security Ownership of Certain Beneficial Owners and Management and Related Stockholder Matters*

The information required by Item 403 of Regulation S-K will be set forth under the caption "Security Ownership of Certain Beneficial Owners and Management" in our definitive proxy statement for the 2018 Annual Meeting of Stockholders to be filed with the Securities and Exchange Commission no later than 120 days after the end of our fiscal year, and is incorporated herein by reference.

The information required by Item 201(d) of Regulation S-K will be set forth under the caption "Equity Compensation Plan Information" in our definitive proxy statement for the 2019 Annual Meeting of Stockholders to be filed with the Securities and Exchange Commission no later than 120 days after the end of our fiscal year, and is incorporated herein by reference.

Item 13. *Certain Relationships and Related Transactions and Director Independence*

The information required by this item will be set forth under the captions "Corporate Governance — Board Independence" and "Corporate Governance — Transactions with Related Persons" in our definitive proxy statement for the 2019 Annual Meeting of Stockholders to be filed with the Securities and Exchange Commission no later than 120 days after the end of our fiscal year, and is incorporated herein by reference.

Item 14. *Principal Accountant Fees and Services*

The information required by this item will be set forth under the caption "Audit and Financial Accounting Oversight — Principal Accountant Fees and Services" in our definitive proxy statement for the 2019 Annual Meeting of Stockholders to be filed with the Securities and Exchange Commission no later than 120 days after the end of our fiscal year, and is incorporated herein by reference.

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PART IV

Item 15. ***Exhibits and Financial Statement Schedules***

(a) The following documents are filed as a part of this Report:

1. *Financial Statements*. The following Consolidated Financial Statements are included under Item 8 of this Annual Report on Form 10-K.

INDEX TO CONSOLIDATED FINANCIAL STATEMENTS

Financial Statements:

2. *Financial Statement Schedules.* The following consolidated financial statement schedule is included in this Annual Report on Form 10-K:

Schedule II — Valuation and Qualifying Accounts

Schedules other than those listed above have been omitted since they are either not required or information is otherwise included.

3. *Exhibits.* The following exhibits are filed as part of this Annual Report on Form 10-K.

Exhibit No.	Title
+2.1(1)	Agreement and Plan of Merger, by and among the Registrant, PSI Equipment, Inc. and Newport Corporation, dated February 22, 2016
+2.2(17)	Agreement and Plan of Merger, by and among the Registrant, Merger Sub and Electro Scientific Industries, Inc., dated October 29, 2018
+3.1(2)	Restated Articles of Organization of the Registrant
+3.2(3)	Articles of Amendment to Restated Articles of Organization, as filed with the Secretary of State of Massachusetts on May 18, 2001
+3.3(4)	Articles of Amendment to Restated Articles of Organization, as filed with the Secretary of State of Massachusetts on May 16, 2002
+3.4(5)	Amended and Restated By-Laws of the Registrant
+4.1(6)	Specimen certificate representing the Common Stock
+10.1(7)	Term Loan Credit Agreement, dated April 29, 2016, by and among the Registrant, Barclays Bank PLC, as administrative agent and collateral agent, and the lenders from time to time party thereto
+10.2(8)	Amendment No. 1 to Term Loan Credit Agreement, dated as of June 9, 2016, by and among the Registrant, the other loan parties party thereto, Barclays Bank PLC, as administrative agent and collateral agent, and each participating lender party thereto

Exhibit No.	Title
+10.3(9)	Amendment No. 2 to Term Loan Credit Agreement, dated as of December 14, 2016, by and among the Registrant, the other loan parties party thereto, Barclays Bank PLC, as administrative agent and collateral agent, and each participating lender party thereto
+10.4(10)	Amendment No. 3 to Term Loan Credit Agreement, dated as of July 6, 2017, by and among the Registrant, the other loan parties party thereto, Barclays Bank PLC, as administrative agent and collateral agent, and each participating lender party thereto
+10.5(18)	Amendment No. 4 to Term Loan Credit Agreement, dated as of April 11, 2018, by and among the Registrant, the other loan parties party thereto, Barclays Bank PLC, as administrative agent and collateral agent, and each participating lender party thereto
+10.6(19)	Amendment No. 5 to Term Loan Credit Agreement and Amendment to Term Loan Guaranty and Term Loan Security Agreement, dated as of February 1, 2019, by and among the Registrant, the other loan parties party thereto, Barclays Bank PLC, as administrative agent and collateral agent, and each participating lender party thereto
+10.7(7)	ABL Credit Agreement, dated April 29, 2016, by and among the Registrant, Deutsche Bank AG New York Branch, as administrative agent and collateral agent, the other borrowers from time to time party thereto, and the lenders and letters of credit issuers from time to time party thereto
+10.8(19)	ABL Credit Agreement, dated as of February 1, 2019, by and among the Registrant, Barclays Bank PLC, as administrative agent and collateral agent, the other borrowers from time to time party thereto, and the lenders and letters of credit issuers from time to time party thereto
+10.9(5)*	2014 Stock Incentive Plan
+10.10(5)*	2014 Employee Stock Purchase Plan
+10.11(5)*	Form of Restricted Stock Unit Agreement for Non-Employee Directors under the 2014 Stock Incentive Plan
10.12*	Form of Restricted Stock Unit Agreement for Employees under the 2014 Stock Incentive Plan
+10.13(11)*	MKS Instruments, Inc. Management and Key Employee Bonus Plan
+10.14(11)*	MKS Instruments, Inc. Light & Motion Division Management and Key Employee Bonus Plan
+10.15(12)*	Employment Agreement, dated as of July 1, 2005, between John Bertucci and the Registrant
+10.16(13)*	Employment Agreement, dated October 22, 2013, between Gerald Colella and the Registrant
+10.17(11)*	Amendment, dated March 27, 2018, to Employment Agreement, dated as of October 22, 2013, between Gerald Colella and the Registrant
+10.18(14)*	Amendment No. 2, dated October 29, 2018, to Employment Agreement, dated as of October 22, 2013, between Gerald Colella and the Registrant
+10.19(15)*	Newport Corporation's 2006 Performance-Based Stock Incentive Plan
+10.20(15)*	Form of Stock Appreciation Right Award Agreement under Newport Corporation's 2006 Performance-Based Stock Incentive Plan
+10.21(15)*	Newport Corporation's 2011 Stock Incentive Plan
+10.22(15)*	Newport Corporation's Amended and Restated 2011 Stock Incentive Plan
+10.23(15)*	Form of Restricted Stock Unit Award Agreement (with performance-based vesting) used under Newport Corporation's 2011 Stock Incentive Plan and Amended and Restated 2011 Stock Incentive Plan
+10.24(15)*	Form of Stock Appreciation Right Award Agreement used under Newport Corporation's 2011 Stock Incentive Plan and the Amended and Restated 2011 Stock Incentive Plan
+10.25(15)*	Form of Indemnification Agreement between Newport Corporation and Robert Phillippy

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Exhibit No.	Title
+10.26(15)*	Form of the Registrant's RSU Assumption Agreement for U.S. Employees Relating to Newport Corporation's Amended and Restated 2011 Stock Incentive Plan and 2011 Stock Incentive Plan
+10.27(15)*	Form of the Registrant's RSU Assumption Agreement for Employees Outside of the United States Relating to Newport Corporation's Amended and Restated 2011 Stock Incentive Plan and 2011 Stock Incentive Plan
+10.28(15)*	Form of the Registrant's SAR Assumption Agreement for U.S. Employees Relating to Newport Corporation's Amended and Restated 2011 Stock Incentive Plan, 2011 Stock Incentive Plan and 2006 Performance-Based Stock Incentive Plan
+10.29(15)*	Form of the Registrant's SAR Assumption Agreement for Employees Outside of the United States Relating to Newport Corporation's Amended and Restated 2011 Stock Incentive Plan, 2011 Stock Incentive Plan and 2006 Performance-Based Stock Incentive Plan
+10.30(16)*	Employment Agreement, dated August 1, 2016, between Seth Bagshaw and the Registrant
+10.31(16)*	Employment Agreement, dated August 1, 2016, between John Abrams and the Registrant
+10.32(20)*	Employment Agreement, dated May 9, 2018, between John Lee and the Registrant
+10.33(16)*	Employment Agreement, dated August 1, 2016, between Dennis Werth and Newport Corporation
+10.34(16)*	Form of Indemnification Agreement between Newport Corporation and Dennis Werth
+10.35(14)*	Amendment No. 1, dated October 29, 2018, to Employment Agreement, dated as of August 1, 2016, by and between the Registrant and Seth Bagshaw
+10.36(14)*	Amendment No. 1, dated October 29, 2018, to Employment Agreement, dated as of May 9, 2018, by and between the Registrant and John Lee
+10.37(20)*	Transition and Retirement Agreement, dated as of May 9, 2018, by and between the Registrant and John Abrams
+10.38(21)*	Letter Agreement, dated as of June 5, 2018, by and between the Registrant and Dennis Werth
10.39*	Electro Scientific Industries, Inc.'s 2004 Stock Incentive Plan
10.40*	Form of Restricted Stock Units Award Agreement (with time-based vesting) used under Electro Scientific Industries, Inc.'s 2004 Stock Incentive Plan for 2016-2017
10.41*	Form of Restricted Stock Units Award Agreement (with time-based vesting) used under Electro Scientific Industries, Inc.'s 2004 Stock Incentive Plan for 2018
10.42*	Form of Restricted Stock Units Award Agreement (with performance-based vesting) used under Electro Scientific Industries, Inc.'s 2004 Stock Incentive Plan for 2016-2017
10.43*	Form of Restricted Stock Units Award Agreement (with performance-based vesting) used under Electro Scientific Industries, Inc.'s 2004 Stock Incentive Plan for 2018
10.44*	Form of the Registrant's RSU Assumption Agreement (with time-based vesting) for U.S. Employees Relating to Electro Scientific Industries, Inc.'s 2004 Stock Incentive Plan
10.45*	Form of the Registrant's RSU Assumption Agreement (with time-based vesting) for Employees Outside of the United States Relating to Electro Scientific Industries, Inc.'s 2004 Stock Incentive Plan
10.46*	Form of the Registrant's RSU Assumption Agreement (with performance-based vesting) for U.S. Employees Relating to Electro Scientific Industries, Inc.'s 2004 Stock Incentive Plan
10.47*	Form of the Registrant's RSU Assumption Agreement (with performance-based vesting) for Employees Outside of the United States Relating to Electro Scientific Industries, Inc.'s 2004 Stock Incentive Plan

Exhibit No.	Title
21.1	Subsidiaries of the Registrant
23.1	Consent of PricewaterhouseCoopers LLP
31.1	Certification of Principal Executive Officer pursuant to Rule 13a-14(a)/Rule 15d-14(a) of the Securities Exchange Act of 1934
31.2	Certification of Principal Financial Officer pursuant to Rule 13a-14(a)/Rule 15d-14(a) of the Securities Exchange Act of 1934
32.1	Certification of Chief Executive Officer and Chief Financial Officer pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002
101.INS	XBRL Instance Document
101.SCH	XBRL Taxonomy Extension Schema Document
101.CAL	XBRL Taxonomy Calculation Linkbase
101.LAB	XBRL Taxonomy Labels Linkbase Document
101.PRE	XBRL Taxonomy Presentation Linkbase Document
101.DEF	XBRL Taxonomy Extension Definition Linkbase Document

+ Previously filed
* Management contract or compensatory plan arrangement

The following materials from MKS Instruments, Inc.'s Annual Report on Form 10-K for the year ended December 31, 2018, are formatted in XBRL (Extensible Business Reporting Language): (i) the Consolidated Balance Sheets, (ii) the Consolidated Statements of Operations and Comprehensive Income, (iii) the Consolidated Statements of Stockholders' Equity, (iv) the Consolidated Statements of Cash Flows, and (v) Notes to the Consolidated Financial Statements.

(1) Incorporated by reference to the Current Report on Form 8-K filed with the Securities and Exchange Commission on February 23, 2016.

(2) Incorporated by reference to the Registration Statement on Form S-4 (File No. 333-49738), filed with the Securities and Exchange Commission on November 13, 2000.

(3) Incorporated by reference to the Registrant's Quarterly Report on Form 10-Q for the quarter ended June 30, 2001 (File No. 000-23621), filed with the Securities and Exchange Commission on August 14, 2001.

(4) Incorporated by reference to the Registrant's Quarterly Report on Form 10-Q for the quarter ended June 30, 2002 (File No. 000-23621), filed with the Securities and Exchange Commission on August 13, 2002.

(5) Incorporated by reference to the Registrant's Current Report on Form 8-K (File No. 000-23621), filed with the Securities and Exchange Commission on May 6, 2014.

(6) Incorporated by reference to the Registration Statement on Form S-1 filed with the Securities and Exchange Commission on January 28, 1999.

(7) Incorporated by reference to the Registrant's Current Report on Form 8-K filed with the Securities and Exchange Commission on April 29, 2016.

(8) Incorporated by reference to the Registrant's Current Report on Form 8-K filed with the Securities and Exchange Commission on June 9, 2016.

(9) Incorporated by reference to the Registrant's Current Report on Form 8-K filed with the Securities and Exchange Commission on December 14, 2016.

(10) Incorporated by reference to the Registrant's Current Report on Form 8-K filed with the Securities and Exchange Commission on July 6, 2017.

(11) Incorporated by reference to the Registrant's Quarterly Report on Form 10-Q for the quarter ended March 31, 2018.

(12) Incorporated by reference to the Registrant's Current Report on Form 8-K filed with the Securities and Exchange Commission on July 5, 2005.

(13) Incorporated by reference to the Registrant's Current Report on Form 8-K filed with the Securities and Exchange Commission on October 24, 2013.

(14) Incorporated by reference to the Registrant's Current Report on Form 8-K filed with the Securities and Exchange Commission on November 1, 2018.

(15) Incorporated by reference to the Registrant's Quarterly Report on Form 10-Q for the quarter ended March 31, 2016.

(16) Incorporated by reference to the Registrant's Quarterly Report on Form 10-Q for the quarter ended June 30, 2016.

(17) Incorporated by reference to the Registrant's Current Report on Form 8-K filed with the Securities and Exchange Commission on October 30, 2018.

(18) Incorporated by reference to the Registrant's Current Report on Form 8-K filed with the Securities and Exchange Commission on April 12, 2018.

(19) Incorporated by reference to the Registrant's Current Report on Form 8-K filed with the Securities and Exchange Commission on February 1, 2019.

(20) Incorporated by reference to the Registrant's Current Report on Form 8-K filed with the Securities and Exchange Commission on May 11, 2018.

(21) Incorporated by reference to the Registrant's Quarterly Report on Form 10-Q for the quarter ended June 30, 2018.

(b) Exhibits

MKS hereby files as exhibits to our Annual Report on Form 10-K those exhibits listed in Item 15(a) above.

(c) Financial Statement Schedules

Item 16. ***Form 10-K Summary***

Not applicable.

MKS INSTRUMENTS, INC.
SCHEDULE II—VALUATION AND QUALIFYING ACCOUNTS

Description	Balance at Beginning of Year	Additions: Acquisition Beginning Balance	Additions: Charged to Costs and Expenses	Additions: Charged to Other Accounts	Deductions & Write-offs	Balance at End of Year
	(in thousands)					
Allowance for doubtful accounts:						
Years ended December 31,						
2018	$ 4,135	$ —	$ 1,435	$ —	$ (327)	$ 5,243
2017	$ 3,909	$ —	$ 825	$ —	$ (599)	$ 4,135
2016	$ 1,760	$ 1,292	$ 1,109	$ (66)	$ (186)	$ 3,909

Description	Balance at Beginning of Year	Additions: Acquisition Beginning Balance	Additions: Charged to Costs and Expenses	Additions: Charged to Other Accounts	Deductions & Write-offs	Balance at End of Year
	(in thousands)					
Allowance for sales returns:						
Years ended December 31,						
2018	$ 1,295	$ —	$ 124	$ —	$ (386)	$ 1,033
2017	$ 1,138	$ —	$ (142)	$ —	$ 299	$ 1,295
2016	$ 601	$ 423	$ 2,262	$ —	$ (2,148)	$ 1,138

Description	Balance at Beginning of Year	Additions: Acquisition Beginning Balance	Additions: Charged to Costs and Expenses	Additions: Charged to Other Accounts	Deductions	Balance at End of Year
	(in thousands)					
Valuation allowance on deferred tax asset:						
Years ended December 31,						
2018	$ 13,629	$ —	$ 4,825	$ —	$ (518)	$ 17,936
2017	$ 12,527	$ —	$ 1,603	$ —	$ (501)	$ 13,629
2016	$ 6,127	$ 3,769	$ 2,719	$ —	$ (88)	$ 12,527

SIGNATURES

Pursuant to the requirements of Section 13 or 15(d) of the Securities Exchange Act of 1934, the registrant has duly caused this annual report on Form 10-K for the fiscal year ended December 31, 2018, to be signed on its behalf by the undersigned, thereunto duly authorized on the 26th day of February 2019.

MKS INSTRUMENTS, INC.

By: /s/ Gerald G. Colella
Gerald G. Colella
Chief Executive Officer and Director
(Principal Executive Officer)

Pursuant to the requirements of the Securities Exchange Act of 1934, this report has been signed below by the following persons on behalf of the registrant and in the capacities and on the date indicated.

SIGNATURES	TITLE	DATE
/s/ John R. Bertucci John R. Bertucci	Chairman of the Board of Directors	February 26, 2019
/s/ Gerald G. Colella Gerald G. Colella	Chief Executive Officer and Director (Principal Executive Officer)	February 26, 2019
/s/ Seth H. Bagshaw Seth H. Bagshaw	Senior Vice President, Chief Financial Officer and Treasurer (Principal Financial and Accounting Officer)	February 26, 2019
/s/ Rajeev Batra Rajeev Batra	Director	February 26, 2019
/s/ Gregory R. Beecher Gregory R. Beecher	Director	February 26, 2019
/s/ Richard S. Chute Richard S. Chute	Director	February 26, 2019
/s/ Peter R. Hanley Peter R. Hanley	Director	February 26, 2019
/s/ Rick D. Hess Rick D. Hess	Director	February 26, 2019
/s/ Jacqueline F. Moloney Jacqueline F. Moloney	Director	February 26, 2019
/s/ Elizabeth A. Mora Elizabeth A. Mora	Director	February 26, 2019

Exhibit 10.12

MKS INSTRUMENTS, INC.

Restricted Stock Unit Agreement
Granted Under the 2014 Stock Incentive Plan

AGREEMENT made **«Grant Date»** (the “Grant Date”), between MKS Instruments, Inc., a Massachusetts corporation (the “Company”), and **«Participant Name»** (the “Participant”).

For valuable consideration, receipt of which is acknowledged, the parties hereto agree as follows:

1. General. The Company hereby grants to the Participant restricted stock units (“RSUs”) with respect to the number of shares set forth in Exhibit A hereto (the “Shares”) of common stock, no par value, of the Company (“Common Stock”), subject to the terms and conditions set forth in this Agreement and in the Company’s 2014 Stock Incentive Plan (the “Plan”). The RSUs represent a promise by the Company to deliver Shares upon vesting.

(a) Definitions.

(i) “Code” means the U.S. Internal Revenue Code of 1986, as amended.

(ii) “Determination Date” (if applicable) is defined in Exhibit A hereto.

(iii) “Disability” means disability as defined in Section 216(i)(1) of the U.S. Social Security Act.

(iv) “Employ” or “employment” with the Company includes employment with a parent or subsidiary of the Company as defined in Code Section 424(e) or (f), during the time in which such entity is a parent or subsidiary of the Company.

(v) “Forfeiture” means any forfeiture of RSUs pursuant to Section 2.

(vi) [“Retirement”[1] means a voluntary termination of employment by the Participant after he or she is at least age sixty-five (65) and has at least ten (10) Years of Service with the Company (“Normal Retirement”) or after he or she is at least age sixty (60) and has at least fifteen (15) Years of Service with the Company (“Early Retirement”). A Participant’s termination shall not be deemed to be on account of Retirement unless he or she provides the Company with notice of the Retirement at least sixty (60) days in advance of his or her proposed termination date and assists in the orderly transition of duties as requested by the Company. The Company may waive such advance notice requirement in its sole discretion.]

(vii) “Vesting Date” is defined on Exhibit A hereto.

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1 Only officers and certain other employees designated by the Compensation Committee are entitled to acceleration of vesting upon Retirement. Also, for certain of these officers and employees, Retirement means a voluntary termination of employment by the Participant after he or she is at least age sixty (60) and has at least ten (10) Years of Service with the Company.

(viii) ["Years of Service"[2] means the total number of years of employment since Participant's original date of employment with the Company; provided, however, that if the Participant left or was terminated from employment with the Company and was then rehired, any previous employment period shall be included in the Years of Service only if (A) the Participant's absence from employment with the Company did not exceed five (5) years and (B) the total number of days employed by the Company exceeds the total number of days that the Participant was absent from employment.]

(b) Vesting Period. Subject to the terms and conditions of this Agreement (including the Forfeiture provisions described in Section 2 below), the RSUs shall vest according to the terms set forth in Exhibit A. As soon as practicable after each applicable Vesting Date, but no later than thirty (30) days following the Vesting Date, the Company shall instruct its transfer agent to deposit the Shares subject to the RSUs into the Participant's existing equity account at Fidelity Stock Plan Services, LLC, or such other broker with which the Company has established a relationship ("Broker"), subject to payment in accordance with Section 6 of all applicable [withholding][3] taxes. Notwithstanding the above, the Shares may be distributed following the date contemplated in this Section 1(b) solely to the extent permitted or required under Code Section 409A and regulations thereunder ("Section 409A").

2. Forfeiture.

(a) Cessation of Employment. In the event that the Participant ceases to be employed by the Company for any reason or no reason (except for death, Disability or Retirement[4]), with or without cause, prior to a Vesting Date, all of the Participant's unvested RSUs shall automatically be forfeited as of such cessation. For purposes hereof, employment shall not be considered as having ceased during any bona fide leave of absence if such leave of absence has been approved in writing by the Company. However, in the event of any leave of absence, the Company may, in its sole discretion, suspend vesting of the RSUs, subject to applicable law and the provisions of Section 409A. The vesting of the RSUs shall not be affected by any change in the type of employment the Participant has with the Company so long as the Participant continuously maintains employment. In the event that the Participant ceases to be employed by the Company by reason of death, Disability or Retirement[5] prior to a Vesting Date, then all of the Participant's unforfeited RSUs shall become immediately and fully vested (subject to any performance criteria in Exhibit A) and shall no longer be subject to the Forfeiture provisions under this Agreement and the Shares subject to such RSUs shall be delivered to the Participant as soon as practicable (but no later than thirty (30) days) following the Participant's termination date, provided, however, that, if such death, Disability or Retirement[6] occurs prior to the Determination Date, if any, then the number of RSUs to be so vested shall be determined, and become vested, on the Determination Date, and the Shares subject to such vested portion of the RSUs shall be delivered to the Participant as soon as practicable (but no later than thirty (30) days) following such Determination Date, provided further that if such Retirement[7] is deemed an Early Retirement and occurs prior to the Determination Date, if any, then the number of RSUs to be so vested shall be determined by prorating the total amount earned by the portion of the performance period during which the Participant was employed.

2 See Footnote 2 above.
3 Delete for employees located outside of the United States.
4 See Footnote 2 above.
5 See Footnote 2 above.
6 See Footnote 2 above.
7 See Footnote 2 above.

(b) [Change in Control[8]. Notwithstanding the foregoing, if, prior to any Vesting Date, and within two years after the effectiveness of a Change in Control (as defined below), the Participant is (i) terminated by the Company without Cause (as defined below) or (ii) terminates his employment for Good Reason (as defined below), then, all (or, in the case of a performance-based RSU that is still subject to performance criteria per Exhibit A, the Target Number of RSUs (as defined on Exhibit A, if applicable) of the Participant's unforfeited RSUs shall become immediately and fully vested and shall no longer be subject to the Forfeiture provisions under this Agreement. For purposes of this section "Change in Control" means the first to occur of any of the following events: (I) any "person" (as that term is used in Section 13 and 14(d)(2) of the Securities Exchange Act of 1934 ("Exchange Act")) becomes the beneficial owner (as that term is used in Section 13(d) of the Exchange Act), directly or indirectly, of fifty percent (50%) or more of the Company's capital stock entitled to vote in the election of directors; (II) the shareholders of the Company approve any consolidation or merger of the Company, other than a consolidation or merger of the Company in which the holders of the common stock of the Company immediately prior to the consolidation or merger hold more than fifty percent (50%) of the common stock of the surviving corporation immediately after the consolidation or merger; or (III) the shareholders of the Company approve the sale or transfer of all or substantially all of the assets of the Company to parties that are not within a "controlled group of corporations" (as defined in Code Section 1563) in which the Company is a member. For purposes of this Agreement, "Cause" shall mean conviction for the commission of a felony, willful failure by the Participant to perform his responsibilities to the Company, or willful misconduct by the Participant. For purposes of this section, "Good Reason" shall mean termination of the Participant's employment by the Participant within 90 days following (I) a material diminution in the Participant's positions, duties and responsibilities from those described in the Participant's Employment Agreement, (II) a material reduction in the Participant's base salary (other than a reduction which is part of a general salary reduction program affecting senior executives of the Company), (III) a material reduction in the aggregate value of the pension and welfare benefits provided to the Participant from those in effect prior to the Change in Control (other than a reduction which is proportionate to the reductions applicable to other senior executives pursuant to a cost-saving plan that includes all senior executives), (IV) a material breach of any provision of the Participant's Employment Agreement by the Company or (V) the Company's requiring the Participant to be based at a location that creates for the Participant a one way commute in excess of 60 miles from his primary residence, except for required travel on the Company's business to an extent substantially consistent with the business travel obligations of the Participant under the Participant's Employment Agreement. Notwithstanding the foregoing, a termination shall not be treated as a termination for Good Reason (I) if the Participant shall have consented in writing to the occurrence of the event giving rise to the claim of termination for Good Reason or (II) unless the Participant shall have delivered a written notice to the Company within thirty (30) days of his having actual knowledge of the occurrence of one of such events stating that he intends to terminate his employment for Good Reason and specifying the factual basis for such termination, and such event, if capable of being cured, shall not have been cured within thirty (30) days of the receipt of such notice.][2]

8 Only certain of the Company's officers and other employees designated by the Compensation Committee of the Board of Directors will be entitled to acceleration of vesting upon a Change in Control.

(c) Clawback. In the event that (i) the Participant is, at any time during the period beginning on the Grant Date and ending on the Vesting Date (or, if later, on the Determination Date) an "executive officer" of the Company (as defined in Rule 3b-7 under the Exchange Act) and (ii) the RSUs are (or were at any time) subject to performance criteria per Exhibit A, then the RSUs (and any Shares issued under the RSUs) shall be subject to potential cancellation, recoupment, rescission, payback or other action in accordance with the terms of any applicable Company clawback policy (the "Clawback Policy") or any applicable law, as may be in effect from time to time. The Participant hereby acknowledges and consents to the Company's application, implementation and enforcement of (i) any applicable Clawback Policy as may be in effect from time to time and (ii) any provision of applicable law relating to cancellation, recoupment, rescission or payment of compensation, and agrees that the Company may take such actions as may be necessary to effectuate the Clawback Policy without further consideration or action.

3. Restrictions on Transfer. The Participant shall not sell, assign, transfer, pledge, hypothecate or otherwise dispose of, by operation of law or otherwise (collectively "transfer") any RSUs, or any interest therein; provided that the Participant may transfer the RSUs to the extent necessary to fulfill a domestic relations order (as defined in Section 414(p)(1)(B) of the Code).

4. Provisions of the Plan. This Agreement is subject to the provisions of the Plan, a copy of which is furnished to the Participant with this Agreement.

5. Section 409A. To the extent the Participant is or becomes subject to U.S. Federal income taxation, the RSUs and payments made pursuant to this Agreement are intended to comply with or qualify for an exemption from the requirements of Section 409A and this Agreement shall be construed consistently therewith. Neither the Company nor the Participant shall have any right to accelerate or defer payment under this Agreement except to the extent specifically permitted or required by Section 409A. Terms defined in the Agreement shall have the meanings given such terms under Section 409A if and to the extent required to comply with Section 409A, including that references to "termination of employment" shall be considered to be references to a "separation from service" as defined under Section 409A. Notwithstanding any other provision of this Agreement, the Company reserves the right, to the extent it deems necessary or advisable, in its sole discretion, to unilaterally amend the Plan and/or this Agreement to ensure that all awards hereunder qualify for exemption from or otherwise comply with Section 409A; provided, however, that the Company makes no undertaking to preclude Section 409A from applying to this Award or to guarantee compliance therewith. Any payments described in this Section 5 that are due within the "short term deferral period" as defined in Section 409A shall not be treated as deferred compensation unless applicable law requires otherwise. If and to the extent any portion of any payment, compensation or other benefit provided to the Participant in connection with his or her employment termination is determined to constitute "nonqualified deferred compensation" within the meaning of Section 409A and the Participant is a specified employee as defined in Section 409A(2)(B)(i) of the Code, as determined by the Company in accordance with its procedures, by which determination the Participant hereby agrees that he or she is bound, such portion of the payment, compensation or other benefit shall not be paid before the day that is six months plus one

day after the date of separation from service (as determined under Section 409A (the "New Payment Date")), except as Section 409A may then permit. The aggregate of any payments that otherwise would have been paid to the Participant during the period between the date of separation from service and the New Payment Date shall be paid to the Participant in a lump sum on the New Payment Date, and any remaining payments will be paid on their original schedule. Notwithstanding the foregoing, the Company, its affiliates, directors, officers and agents shall have no liability to a Participant, or any other party, if the RSU that is intended to be exempt from, or compliant with, Section 409A is not so exempt or compliant, or for any action taken by the Company's Board of Directors, a committee thereof or its delegates.

6. Withholding Taxes[9,10].

(a) The Company's obligation to deliver Shares to the Participant upon the vesting of RSUs shall be subject to the satisfaction of all income tax (including federal, state and local taxes), social insurance, payroll tax, payment on account or other tax related withholding requirements ("Withholding Taxes"). In order to satisfy all Withholding Taxes of the Participant's RSUs, the Participant agrees to the following:

(b) The Participant hereby elects to satisfy all Withholding Taxes obligation that may arise through the retention by the Company of Shares. Accordingly, the Participant hereby instructs the Company, with no further action by the Participant, to deduct and retain from the number of Shares to which the Participant is entitled from the RSUs then vested or scheduled to vest such number of Shares as is equal to the value of the Withholding Taxes. The fair market value of such surrendered Shares will be based on the closing price of the Company's Common Stock on the respective vesting date, provided, however, that if such date is not a trading day, the Company shall use the closing price on the first trading day following such date. The Participant agrees that in the event the Company withholds RSUs with a value in excess of the maximum amount of social insurance that can be imposed in any particular year, the Company will refund the excess amount in cash to the Participant.

9 This section is applicable to employees who are located in the United States. For employees located outside of the United States, Section 6 shall read as follows:

6. Taxes.

(a) The Company's obligation to deliver Shares to the Participant upon the vesting of the RSUs shall be subject to the satisfaction of all income tax, social insurance, payroll tax or other tax related requirements.

(b) The Participant has reviewed with the Participant's own tax advisors the tax consequences of this equity award and the transactions contemplated by this Agreement. The Participant is relying solely on such advisors and not on any statements or representations of the Company or any of its agents. The Participant understands that the Participant (and not the Company) shall be responsible for the Participant's own tax liability that may arise as a result of this equity award or the transactions contemplated by this Agreement.

10 For employees located in certain countries outside of the United States, specific local law tax and securities law provisions will also be inserted.

(c) Participant has reviewed with the Participant's own tax advisors the federal, state, local and foreign tax consequences of this equity award and the transactions contemplated by this Agreement. The Participant is relying solely on such advisors and not on any statements or representations of the Company or any of its agents. The Participant understands that the Participant (and not the Company) shall be responsible for the Participant's own tax liability that may arise as a result of this equity award or the transactions contemplated by this Agreement.

(d) The Participant represents to the Company that, as of the date hereof, he/she is not aware of any material nonpublic information about the Company or the Common Stock. The Participant and the Company have structured this Agreement to constitute a "binding contract" relating to the retention by the Company of Common Stock pursuant to this Section 6, consistent with the affirmative defense to liability under Section 10(b) of the Securities Exchange Act of 1934 under Rule 10b5-1(c) promulgated under such Act.

7. Nature of the Grant. In signing this Agreement, the Participant acknowledges that:

(a) The Plan is established voluntarily by the Company, it is discretionary in nature and may be modified, amended, suspended or terminated by the Company at any time, except to the extent otherwise provided in the Plan and this Agreement.

(b) The grant of RSUs is voluntary and occasional and does not create any contractual or other right to receive future awards of RSUs, or benefits in lieu of RSUs even if RSUs have been awarded repeatedly in the past.

(c) All decisions with respect to future grants of RSUs, if any, will be at the sole discretion of the Company.

(d) The Participant's participation in the Plan is voluntary.

(e) RSUs are not part of normal or expected compensation or salary for any purpose, including, but not limited to, calculation of any wage payment, severance, redundancy, or other end of service payments, bonuses, long-service awards, pension or retirement benefits or similar payments and in no event should be considered as compensation for, or relating in any way to, past services for the Company or the Participant's employer or arising under any employment agreement.

(f) No voting or dividend or distribution rights apply with respect to the RSUs.

(g) The future value of the underlying Shares is unknown and cannot be predicted with certainty.

(h) If the Participant receives Shares upon vesting, the value of such Shares acquired on vesting of RSUs may increase or decrease in value.

(i) In consideration of the grant of RSUs, no claim or entitlement to compensation or damages arises from termination of the RSUs or diminution in value of the RSUs or Shares received upon vesting of RSUs resulting from termination of the Participant's employment by the Company or the Participant's employer (for any reason whatsoever and whether or not in breach of local labor laws) and the Participant irrevocably releases the Company and his or her employer from any such claim that may arise; if, notwithstanding the foregoing, any such claim is found by a court of competent jurisdiction to have arisen, then, by signing this Agreement, the Participant shall be deemed irrevocably to have waived his or her entitlement to pursue such claim.

(j) If the Participant ceases to be an employee (whether or not in breach of local labor laws), the Participant's right to receive RSUs and vest under the Plan, if any, will terminate effective as of the date that the Participant is no longer actively employed by the Company and will not be extended by any notice period mandated under local law (*e.g.*, active employment would not include a period of "garden leave" or similar period pursuant to local law); the Committee shall have the exclusive discretion to determine when the Participant is no longer actively employed for purposes of the Plan.

8. <u>Data Privacy Notice and Consent</u>. The Participant hereby explicitly and unambiguously consents to the collection, use and transfer, in electronic or other form, of his or her personal data as described in this paragraph, by and among, as applicable, the Participant's employer and the Company and its subsidiaries and affiliates for, among other purposes, implementing, administering and managing the Participant's participation in the Plan. The Participant understands that the Company and its subsidiaries hold certain personal information about the Participant, including the Participant's name, home address and telephone number, date of birth, social security number or identification number, salary, nationality, job title, any Shares or directorships held in the Company, details of all options or any other entitlement to Shares awarded, canceled, exercised, vested, unvested or outstanding in the Participant's favor, for the purpose of managing and administering the Plan ("Data"). The Participant further understands that the Company and/or its subsidiaries will transfer Data amongst themselves as necessary for employment purposes, including implementation, administration and management of the Participant's participation in the Plan, and that the Company and/or any of its subsidiaries may each further transfer Data to Broker or such other stock plan service provider or other third parties assisting the Company with processing of Data. The Participant understands that these recipients may be located in the United States, and that the recipient's country may have different data privacy laws and protections than in the Participant's country. The Participant authorizes them to receive, possess, use, retain and transfer the Data, in electronic or other form, for the purposes described in this section, including any requisite transfer to Broker or such other stock plan service provider or other third party as may be required for the administration of the Plan and/or the subsequent holding of Shares of stock on the Participant's behalf. The Participant understands that he or she may, at any time, request access to the Data, request any necessary amendments to it or refuse or withdraw the consents herein, in any case without cost, by contacting in writing his or her local human resources representative. The Participant understands, however, that withdrawal of consent may affect the Participant's ability to participate in or realize benefits from the Plan. For more information on the consequences of refusal to consent or withdrawal of consent, the Participant understands that he or she may contact his or her local human resources representative.

9. Miscellaneous.

(a) No Rights to Employment. The Participant acknowledges and agrees that the vesting of the RSUs pursuant to Section 1 and Exhibit A hereof is earned only in accordance with the terms of such sections. The Participant further acknowledges and agrees that the transactions contemplated hereunder and the vesting schedule set forth herein do not constitute an express or implied promise of continued engagement as an employee for the vesting period, for any other period, or at all.

(b) Severability. The invalidity or unenforceability of any provision of this Agreement shall not affect the validity or enforceability of any other provision of this Agreement, and each other provision of this Agreement shall be severable and enforceable to the extent permitted by law.

(c) Waiver. Any provision for the benefit of the Company contained in this Agreement may be waived, either generally or in any particular instance, by the Board of Directors of the Company or its delegate.

(d) Binding Effect. This Agreement shall be binding upon and inure to the benefit of the Company and the Participant and their respective heirs, executors, administrators, legal representatives, successors and assigns, subject to the restrictions on transfer set forth in Section 3 of this Agreement.

(e) Notice. All notices required or permitted hereunder shall be in writing and deemed effectively given upon personal delivery or five days after deposit in the United States Post Office, by registered or certified mail, postage prepaid, addressed to the other party hereto at the address shown beneath his or its respective signature to this Agreement, or at such other address or addresses as either party shall designate to the other in accordance with this Section 9(e).

(f) Pronouns. Whenever the context may require, any pronouns used in this Agreement shall include the corresponding masculine, feminine or neuter forms, and the singular form of nouns and pronouns shall include the plural, and vice versa.

(g) Language. If the Participant has received this Agreement or any other document related to the Plan translated into a language other than English and if the translated version is different than the English version, the English version will control.

(h) Electronic Delivery. The Company may, in its sole discretion, decide to deliver any documents related to participation in the Plan, RSUs granted under the Plan or future RSUs that may be granted under the Plan by electronic means or to request the Participant's consent to participate in the Plan by electronic means. The Participant hereby consents to receive such documents by electronic delivery and, if requested, to agree to participate in the Plan through an on-line or electronic system established and maintained by the Company or another third party designated by the Company.

(i) Entire Agreement. This Agreement and the Plan constitute the entire agreement between the parties, and supersedes all prior agreements and understandings, relating to the subject matter of this Agreement.

(j) Amendment. Except as provided in Section 5, this Agreement may be amended or modified only by a written instrument executed by both the Company and the Participant.

(k) Governing Law. This Agreement shall be construed, interpreted and enforced in accordance with the internal laws of the Commonwealth of Massachusetts without regard to any applicable conflicts of laws.

(l) The Participant's Acknowledgments. The Participant acknowledges that he or she: (i) has read this Agreement; (ii) has been represented in the preparation, negotiation, and execution of this Agreement by legal counsel of the Participant's own choice or has voluntarily declined to seek such counsel; (iii) understands the terms and consequences of this Agreement; and (iv) is fully aware of the legal and binding effect of this Agreement.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the day and year first above written.

MKS INSTRUMENTS, INC.

By: ______________________________
Name:
Title:
2 Tech Drive
Andover, MA 01810

«Electronic Signature»

Participant's Signature

ELECTRO SCIENTIFIC INDUSTRIES, INC.
2004 STOCK INCENTIVE PLAN
(As amended January 25, 2005, April 20, 2005, October 25, 2007, May 12, 2011, December 21, 2012, August 21, 2014, August 18, 2015 and August 18, 2016)

1. **Purpose.** The purpose of this 2004 Stock Incentive Plan (the "Plan") is to enable Electro Scientific Industries, Inc. (the "Company") to attract and retain the services of (i) selected employees, officers and directors of the Company or any parent or subsidiary of the Company and (ii) selected non-employee agents, consultants, advisors and independent contractors of the Company or any parent, subsidiary of the Company. For purposes of this Plan, a person is considered to be employed by or in the service of the Company if the person is employed by or in the service of any entity (the "Employer") that is either the Company or a parent or subsidiary of the Company.

2. **Shares Subject to the Plan.** Subject to adjustment as provided below and in Section 12, the shares to be offered under the Plan shall consist of Common Stock of the Company ("Common Stock"), and the total number of shares of Common Stock that may be issued under the Plan shall be 4,750,000 shares plus any shares that at the time the Plan is approved by shareholders are available for grant under the Company's 1989 Stock Option Plan, 1996 Stock Incentive Plan and 2000 Stock Option Incentive Plan, which plans were previously approved by shareholders of the Company, and the Company's 2000 Stock Option Plan, which plan was not previously approved by the Company's shareholders (collectively, the "Prior Plans"), or that may subsequently become available for grant under any of the Prior Plans through the expiration, termination, forfeiture or cancellation of grants. If an option, stock appreciation right or Performance-Based Award granted under the Plan expires, terminates or is canceled, the unissued shares subject to that option, stock appreciation right or Performance-Based Award shall again be available under the Plan. If shares awarded as a bonus pursuant to Section 9 or sold pursuant to Section 10 under the Plan are forfeited to or repurchased by the Company, the number of shares forfeited or repurchased shall again be available under the Plan. Shares used to satisfy tax obligations related to an award, other than for a stock option or stock appreciation right, will not become available for future grant under the Plan.

3. **Effective Date and Duration of Plan.**

3.1 ***Effective Date.*** The Plan shall become effective as of July 15, 2004. No awards shall be made under the Plan until the Plan is approved by shareholders of the Company in accordance with rules of The Nasdaq Stock Market.

3.2 ***Duration*.** The Plan shall continue in effect until all shares available for issuance under the Plan have been issued and all restrictions on the shares have lapsed. The Board of Directors may suspend or terminate the Plan at any time except with respect to Awards then outstanding under the Plan. Termination shall not affect any Awards or any right of the Company to repurchase shares or the forfeitability of shares issued under the Plan.

4. **Administration.**

4.1 ***Board of Directors*.** The Plan shall be administered by the Board of Directors of the Company, which shall determine and designate the individuals to whom awards shall be made, the amount of the awards and the other terms and conditions of the awards. Subject to the provisions of the Plan, including without limitation the provisions of Section 19 which limit the ability of the Board of Directors to accelerate awards except in the case of death, disability, or a Transaction as provided in Section 12.2, the Board of Directors may adopt and amend rules and regulations relating to administration of the Plan, advance the lapse of any waiting period, accelerate any exercise date, waive or modify any restriction applicable to shares (except those restrictions imposed by law) and make all other determinations in the judgment of the Board of Directors necessary or desirable for the administration of the Plan. The interpretation and construction of the provisions of the Plan and related agreements by the Board of Directors shall be final and conclusive. The Board of Directors may correct any defect or supply any omission or reconcile any inconsistency in the Plan or in any related agreement in the manner and to the extent it deems expedient to carry the Plan into effect, and the Board of Directors shall be the sole and final judge of such expediency.

4.2 ***Committee.*** The Board of Directors may delegate to any committee of the Board of Directors (the “Committee”) any or all authority for administration of the Plan. If authority is delegated to the Committee, all references to the Board of Directors in the Plan shall mean and relate to the Committee, except (i) as otherwise provided by the Board of Directors and (ii) that only the Board of Directors may amend or terminate the Plan as provided in Sections 3 and 13.

5. **Types of Awards; Eligibility; Limitations.**

5.1 ***Types of Awards, Eligibility.*** The Board of Directors may, from time to time, take the following actions, separately or in combination, under the Plan (“Awards”): (i) grant Incentive Stock Options, as defined in Section 422 of the Internal Revenue Code of 1986, as amended (the “Code”), as provided in Sections 6.1, 6.2 and 8; (ii) grant options other than Incentive Stock Options (“Non-Statutory Stock Options”) as provided in Sections 6.1, 6.3 and 8; (iii) grant stock appreciation rights as provided in Sections 7 and 8; (iv) award stock bonuses (including bonuses in the form of restricted stock units) as provided in Section 9; (v) sell shares subject to restrictions as provided in Sections 10; (vi) award Performance-Based Awards as provided in Section 11. Awards may be made to employees, including employees who are officers or directors, and to non-employee directors; provided, however, that only employees of the Company or any parent or subsidiary of the Company (as defined in subsections 424(e) and 424(f) of the Code) are eligible to receive Incentive Stock Options under the Plan. The Board of Directors shall select the individuals to whom awards shall be made and shall specify the action taken with respect to each individual to whom an award is made.

5.2 ***Per Employee Share Limitations.*** No employee may be granted options and/or stock appreciation rights for more than an aggregate of 500,000 shares of Common Stock in any calendar year or restricted stock or restricted stock units (including, for the avoidance of doubt, performance-based restricted stock units) for more than an aggregate of 650,000 shares of Common Stock in any calendar year; provided, however, that to the extent the annual limitation is not fully used in any year for an employee, any shares not used may be added to the number of shares for which options and/or stock appreciation rights or restricted stock and/or restricted stock units, as applicable, may be granted to that employee in any future year.

5.3 ***Maximum Number of Shares Issuable Upon Exercise of ISOs.*** The maximum aggregate number of shares of Common Stock that may be issued under the Plan upon exercise of Incentive Stock Options will not exceed 9,568,684 shares.

5.4 ***Reservation of Additional Shares.*** Except as provided in Section 12, additional shares of Common Stock may not be reserved for issuance under the Plan without the approval of the Company’s shareholders.

6. **Stock Options.**

6.1 ***General Rules Relating to Options.***

6.1-1 **Terms of Grant.** The Board of Directors may grant options under the Plan. With respect to each option grant, the Board of Directors shall determine the number of shares subject to the option, the exercise price, the period of the option, the time or times at which the option may be exercised and whether the option is an Incentive Stock Option or a Non-Statutory Stock Option.

6.1-2 **Nontransferability.** Each Incentive Stock Option and, unless otherwise determined by the Board of Directors, each other option granted under the Plan by its terms (i) shall be nonassignable and nontransferable by the optionee, either voluntarily or by operation of law, except by will or by the laws of descent and distribution of the state or country of the optionee’s domicile at the time of death, and (ii) during the optionee’s lifetime, shall be exercisable only by the optionee. No stock option may be transferred by an optionee in exchange for cash or property.

6.1-3 **Purchase of Shares.** Unless the Board of Directors determines otherwise, on or before the date specified for completion of the purchase of shares pursuant to an option exercise, the optionee must pay the Company the full purchase price of those shares in cash or by check or, with the consent of the Board of Directors, in whole or in part, in

Common Stock of the Company valued at fair market value, restricted stock or other contingent awards denominated in either stock or cash, promissory notes and other forms of consideration. Unless otherwise determined by the Board of Directors, any Common Stock provided in payment of the purchase price must have been previously acquired and held by the optionee for at least six months. The fair market value of Common Stock provided in payment of the purchase price shall be the closing price of the Common Stock last reported before the time payment in Common Stock is made or, if earlier, committed to be made, if the Common Stock is publicly traded, or another value of the Common Stock as specified by the Board of Directors. No shares shall be issued until full payment for the shares has been made, including all amounts owed for tax withholding. With the consent of the Board of Directors, an optionee may request the Company to apply automatically the shares to be received upon the exercise of a portion of a stock option (even though stock certificates have not yet been issued) to satisfy the purchase price for additional portions of the option.

6.2 ***Incentive Stock Options.*** Incentive Stock Options shall be subject to the following additional terms and conditions:

6.2-1 **Limitation on Amount of Grants.** If the aggregate fair market value of stock (determined as of the date the option is granted) for which Incentive Stock Options granted under this Plan (and any other stock incentive plan of the Company or its parent or subsidiary corporations, as defined in subsections 424(e) and 424(f) of the Code) are exercisable for the first time by an employee during any calendar year exceeds $100,000, the portion of the option or options not exceeding $100,000, to the extent of whole shares, will be treated as an Incentive Stock Option and the remaining portion of the option or options will be treated as a Non-Statutory Stock Option. The preceding sentence will be applied by taking options into account in the order in which they were granted. If, under the $100,000 limitation, a portion of an option is treated as an Incentive Stock Option and the remaining portion of the option is treated as a Non-Statutory Stock Option, unless the optionee designates otherwise at the time of exercise, the optionee's exercise of all or a portion of the option will be treated as the exercise of the Incentive Stock Option portion of the option to the full extent permitted under the $100,000 limitation. If an optionee exercises an option that is treated as in part an Incentive Stock Option and in part a Non-Statutory Stock Option, the Company will designate the portion of the stock acquired pursuant to the exercise of the Incentive Stock Option portion as Incentive Stock Option stock by issuing a separate certificate for that portion of the stock and identifying the certificate as Incentive Stock Option stock in its stock records.

6.2-2 **Limitations on Grants to 10 percent Shareholders.** An Incentive Stock Option may be granted under the Plan to an employee possessing more than 10 percent of the total combined voting power of all classes of stock of the Company or any parent or subsidiary (as defined in subsections 424(e) and 424(f) of the Code) only if the option price is at least 110 percent of the fair market value, as described in Section 6.2-4, of the Common Stock subject to the option on the date it is granted and the option by its terms is not exercisable after the expiration of five years from the date it is granted.

6.2-3 **Duration of Options.** Subject to Sections 6.2-2, 8.1 and 8.2, Incentive Stock Options granted under the Plan shall continue in effect for the period fixed by the Board of Directors, except that by its terms no Incentive Stock Option shall be exercisable after the expiration of 10 years from the date it is granted.

6.2-4 **Option Price.** The option price per share shall be determined by the Board of Directors at the time of grant. The option price shall not be less than 100 percent of the fair market value of the Common Stock covered by the Incentive Stock Option at the date the option is granted. The fair market value shall be the closing price of the Common Stock last reported on the date the option is granted, if the stock is publicly traded, or another value of the Common Stock as specified by the Board of Directors.

6.2-5 **Limitation on Time of Grant.** No Incentive Stock Option shall be granted on or after the tenth anniversary of the last action by the Board of Directors adopting the Plan or approving an increase in the number of shares available for issuance under the Plan, which action was subsequently approved within 12 months by the shareholders.

6.2-6 **Early Dispositions.** If within two years after an Incentive Stock Option is granted or within 12 months after an Incentive Stock Option is exercised, the optionee sells or otherwise disposes of Common Stock acquired on exercise of the Option, the optionee shall within 30 days of the sale or disposition notify the Company in writing of (i) the date of the sale or disposition, (ii) the amount realized on the sale or disposition and (iii) the nature of the disposition (e.g., sale, gift, etc.).

6.3 ***Non-Statutory Stock Options.*** Non-Statutory Stock Options shall be subject to the following terms and conditions, in addition to those set forth in Sections 6.1 and 8.

6.3-1 **Option Price.** The option price for Non-Statutory Stock Options shall be determined by the Board of Directors at the time of grant. The option price shall not be less than 100 percent of the fair market value of the Common Stock covered by the Non-Statutory Stock Option at the date the option is granted. The fair market value shall be the closing price of the Common Stock last reported on the date the option is granted, if the stock is publicly traded, or another value of the Common Stock as specified by the Board of Directors.

6.3-2 **Duration of Options.** Non-Statutory Stock Options granted under the Plan shall continue in effect for the period fixed by the Board of Directors, except that no Non-Statutory Option shall be exercisable after the expiration of 10 years from the date it is granted.

7. **Stock Appreciation Rights.**

7.1 ***Grant.*** Stock appreciation rights may be granted under the Plan by the Board of Directors, subject to such rules, terms, and conditions as the Board of Directors prescribes. The Board of Directors may provide that stock appreciation rights may be granted in substitution for stock options granted under the Plan. With respect to each grant, the Board shall determine the number of shares subject to the stock appreciation right, the exercise price of the stock appreciation right, the period of the stock appreciation right, and the time or times at which the stock appreciation right may be exercised. The exercise price of a stock appreciation right shall not be less than 100 percent of the fair market value of the Common Stock covered by the stock appreciation right on the date the stock appreciation right is granted. The fair market value shall be the closing price of the Common Stock last reported on the date the stock appreciation right is granted, if the stock is publicly traded, or another value of the Common Stock as specified by the Board of Directors. Stock appreciation rights shall continue in effect for the period fixed by the Board of Directors., not to exceed ten years.

7.2 ***Stock Appreciation Rights Granted in Connection with Options.*** If a stock appreciation right is granted in connection with an option, the stock appreciation right shall be exercisable only to the extent and on the same conditions that the related option could be exercised. Upon exercise of a stock appreciation right, any option or portion thereof to which the stock appreciation right relates terminates. If a stock appreciation right is granted in connection with an option, upon exercise of the option, the stock appreciation right or portion thereof to which the grant relates terminates.

7.3 ***Exercise.*** Each stock appreciation right shall entitle the holder, upon exercise, to receive from the Company in exchange therefor an amount equal in value to the excess of the fair market value on the date of exercise of one share of Common Stock of the Company over the exercise price as determined by the Board of Directors (or, in the case of a stock appreciation right granted in connection with an option, the option price per share under the option to which the stock appreciation right relates), multiplied by the number of shares covered by the stock appreciation right, or portion thereof, that is surrendered. Payment by the Company upon exercise of a stock appreciation right may be made in Common Stock valued at fair market value, in cash, or partly in Common Stock and partly in cash, all as determined by the Board of Directors. For this purpose, the fair market value of the Common Stock shall be the closing price of the Common Stock last reported before the time of exercise, or such other value of the Common Stock as specified by the Board of Directors.

7.4 ***Fractional Shares.*** No fractional shares shall be issued upon exercise of a stock appreciation right. In lieu thereof, cash may be paid in an amount equal to the value of the fraction or, if the Board of Directors shall determine, the number of shares may be rounded downward to the next whole share.

7.5 ***Nontransferability.*** Each stock appreciation right granted in connection with an Incentive Stock Option and, unless otherwise determined by the Board of Directors, each other stock appreciation right granted under the Plan, by its terms shall be nonassignable and nontransferable by the holder, either voluntarily or by operation of law, except by will or by the laws of descent and distribution of the state or country of the holder's domicile at the time of death, and each stock appreciation right by its terms shall be exercisable during the holder's lifetime only by the holder. No stock appreciation right may be transferred by the holder in exchange for cash or property.

8. **Exercise of Options and Stock Appreciation Rights.**

8.1 ***Exercise.*** Except as provided in Section 8.2 or as determined by the Board of Directors, no option or stock appreciation right granted under the Plan may be exercised unless at the time of exercise the holder is employed by or in the service of the Company and shall have been so employed or provided such service continuously since the date the option or stock appreciation right was granted. Except as provided in Sections 8.2, 12 and 17, options and stock appreciation rights granted under the Plan may be exercised from time to time over the period stated in each option or stock appreciation right in amounts and at times prescribed by the Board of Directors, provided that options and stock appreciation rights may not be exercised for fractional shares. Except as provided in Section 12 or in the provisions of an award agreement addressing treatment of an award in a Transaction (as defined in Section 12.2), no stock option or stock appreciation right granted under the Plan shall be exercisable until at least twelve months after the date it was granted, except that awards may be made under the Plan for stock options and stock appreciation rights that are exercisable in less than twelve months after the date of grant provided that the aggregate number of shares of Common Stock subject to such awards do not to exceed five percent of the total shares reserved for issuance under the Plan. Unless otherwise determined by the Board of Directors, if a holder does not exercise an option or stock appreciation right in any one year for the full number of shares to which the holder is entitled in that year, the holder's rights shall be cumulative and the holder may acquire those shares in any subsequent year during the term of the option or stock appreciation right.

8.2 ***Termination of Employment or Service*.**

8.2-1 **General Rule.** Unless otherwise determined by the Board of Directors, if a holder's employment or service with the Company terminates for any reason other than because of total disability or death as provided in Sections 8.2-2 and 8.2-3, his or her option or stock appreciation right may be exercised at any time before the expiration date of the option or stock appreciation right or the expiration of 3 months after the date of termination, whichever is the shorter period, but only if and to the extent the holder was entitled to exercise the option or stock appreciation right at the date of termination. Notwithstanding the foregoing, unless otherwise determined by the Board of Directors, if a holder's employment or service with the Company terminates for any reason other than because of total disability or death as provided in Sections 8.2-2 and 8.2-3, and such holder dies before the expiration date of the option or stock appreciation right and the expiration of 3 months after the date of termination, his or her option or stock appreciation right may be exercised at any time before the expiration date of the option or stock appreciation right or before the date 12 months after the date of termination, whichever is the shorter period, but only if and to the extent the holder was entitled to exercise the option or stock appreciation right at the date of termination and only by the person or persons to whom the holder's rights under the option or stock appreciation right shall pass by the holder's will or by the laws of descent and distribution of the state or country of domicile at the time of death.

8.2-2 **Termination Because of Total Disability.** Unless otherwise determined by the Board of Directors, if a holder's employment or service with the Company terminates because of total disability, his or her option or stock appreciation right may be exercised at any time before the expiration date of the option or stock appreciation right or before the date 12 months after the date of termination, whichever is the shorter period, but only if and to the extent the holder was entitled to exercise the option or stock appreciation right at the date of termination. The term "total disability" means a medically determinable mental or physical impairment that is expected to result in death or has lasted or is expected to last for a continuous period of 12 months or more and that, in the opinion of the Company and two independent physicians, causes the holder to be unable to perform his or her duties as an employee, director or officer of the Employer and unable to be engaged in any substantial gainful activity. Total disability shall be deemed to have occurred on the first day after the two independent physicians have furnished their written opinion of total disability to the Company and the Company has reached an opinion of total disability.

8.2-3 **Termination Because of Death.** Unless otherwise determined by the Board of Directors, if a holder dies while employed by or providing service to the Company, his or her option or stock appreciation right may be exercised at any time before the expiration date of the option or stock appreciation right or before the date 12 months after the date of death, whichever is the shorter period, but only if and to the extent the holder was entitled to exercise the option or stock appreciation right at the date of death and only by the person or persons to whom the holder’s rights under the option or stock appreciation right shall pass by the holder’s will or by the laws of descent and distribution of the state or country of domicile at the time of death.

8.2-4 **Amendment of Exercise Period Applicable to Termination.** The Board of Directors may at any time extend the 3-month and 12-month exercise periods any length of time not longer than the original expiration date of the option or stock appreciation right.

8.2-5 **Failure to Exercise Option or Stock Appreciation Right.** To the extent that the option or stock appreciation right of any deceased holder or any holder whose employment or service terminates is not exercised within the applicable period, all further rights to purchase shares pursuant to the option or stock appreciation right shall cease and terminate.

8.2-6 **Leave of Absence.** Absence on leave approved by the Employer or on account of illness or disability shall not be deemed a termination or interruption of employment or service. Unless otherwise determined by the Board of Directors, vesting of options and stock appreciation rights shall continue during a medical, family or military leave of absence or other leave approved by the Employer, whether paid or unpaid, and vesting of options and stock appreciation rights shall be suspended during any other unpaid leave of absence.

8.3 ***Notice of Exercise or Surrender.*** Unless the Board of Directors determines otherwise, shares may be acquired pursuant to an option or stock appreciation right granted under the Plan only upon the Company’s receipt of written notice from the holder of the holder’s binding commitment to purchase shares, specifying the number of shares the holder desires to acquire under the option or stock appreciation right and the date on which the holder agrees to complete the transaction, and, if required to comply with the Securities Act of 1933, containing a representation that it is the holder’s intention to acquire the shares for investment and not with a view to distribution. Unless the Board of Directors determines otherwise, cash may be paid upon surrender of a stock appreciation right granted under the Plan only upon the Company’s receipt of written notice from the holder of the holder’s binding commitment to surrender the stock appreciation right, specifying the number of shares subject to the stock appreciation right being surrendered and the date on which the holder agrees to complete the surrender.

8.4 ***Tax Withholding.*** Each holder who has exercised an option or stock appreciation right shall, immediately upon notification of the amount due, if any, pay to the Company in cash or by check amounts necessary to satisfy any applicable federal, state and local tax withholding requirements. If additional withholding is or becomes required (as a result of exercise of an option or stock appreciation right or as a result of disposition of shares acquired pursuant to exercise of an option or stock appreciation right) beyond any amount deposited before delivery of the certificates, the holder shall pay such amount, in cash or by check, to the Company on demand. If the holder fails to pay the amount demanded, the Company or the Employer may withhold that amount from other amounts payable to the holder, including salary, subject to applicable law. With the consent of the Board of Directors, a holder may satisfy this obligation, in whole or in part, by instructing the Company to withhold from the shares to be issued upon exercise or by delivering to the Company other shares of Common Stock; provided, however, that the number of shares so withheld or delivered in connection with an option exercise shall not exceed the minimum amount necessary to satisfy the required withholding obligation.

8.5 ***Reduction of Reserved Shares.*** Upon the exercise of an option or stock appreciation right, the number of shares reserved for issuance under the Plan shall be reduced by the number of shares issued upon exercise of the option or stock appreciation right and the number of shares subject to the award that are not issued shall be available for issuance under the Plan. Cash payments of stock appreciation rights shall not reduce the number of shares of Common Stock reserved for issuance under the Plan.

9. **Stock Bonuses.** The Board of Directors may award shares under the Plan as stock bonuses, including restricted stock units that provide for delivery of Common Stock at a later date. Shares awarded as a bonus shall be subject to the terms, conditions and restrictions determined by the Board of Directors. The restrictions may include restrictions concerning transferability and forfeiture of the shares awarded, together with any other restrictions determined by the Board of Directors. The Board of Directors may require the recipient to sign an agreement as a condition of the award, but may not require the recipient to pay any monetary consideration other than amounts necessary to satisfy tax withholding requirements. The agreement may contain any terms, conditions, restrictions, representations and warranties required by the Board of Directors. The certificates representing the shares awarded shall bear any legends required by the Board of Directors. The Company may require any recipient of a stock bonus to pay to the Company in cash or by check upon demand amounts necessary to satisfy any applicable federal, state or local tax withholding requirements. If the recipient fails to pay the amount demanded, the Company or the Employer may withhold that amount from other amounts payable to the recipient, including salary, subject to applicable law. With the consent of the Board of Directors, a recipient may satisfy this obligation, in whole or in part, by instructing the Company to withhold from any shares to be issued or by delivering to the Company other shares of Common Stock; provided, however, that the number of shares so withheld or delivered shall not exceed the minimum amount necessary to satisfy the required withholding obligation. Upon the issuance of a stock bonus, the number of shares reserved for issuance under the Plan shall be reduced by the sum of the number of shares issued plus the number of shares withheld to satisfy tax obligations as provided in the immediately preceding sentence.

10. **Restricted Stock.**

10.1 ***Restricted Stock.*** The Board of Directors may issue shares under the Plan for any consideration (including promissory notes and services) determined by the Board of Directors. Shares issued under the Plan shall be subject to the terms, conditions and restrictions determined by the Board of Directors; provided, however, that, except as provided in Section 12 or in the provisions of an award agreement addressing treatment of an award in a Transaction (as defined in Section 12.2), any award made under this Section 10 the vesting for which is time-based will provide for a restriction period of at least three years, with the restriction to lapse no more quickly than with respect to one-third of the shares annually over the three-year restriction period. Subject to the provisions of the Plan, the restrictions may include restrictions concerning transferability, repurchase by the Company and forfeiture of the shares issued, together with any other restrictions determined by the Board of Directors. All Common Stock issued pursuant to this Section 10.1 shall be subject to a Restricted Stock Agreement, which shall be executed by the Company and the prospective recipient of the shares before the delivery of certificates representing the shares. The Agreement may contain any terms, conditions, restrictions, representations and warranties required by the Board of Directors.

10.2 ***Other Provisions***. The certificates representing shares of restricted stock shall bear any legends required by the Board of Directors. The Company may require any participant receiving restricted stock to pay to the Company in cash or by check upon demand amounts necessary to satisfy any applicable federal, state or local tax withholding requirements. If the participant fails to pay the amount demanded, the Company or the Employer may withhold that amount from other amounts payable to the participant, including salary, subject to applicable law. With the consent of the Board of Directors, a participant may satisfy this obligation, in whole or in part, by instructing the Company to withhold from any shares to be issued or by delivering to the Company other shares of Common Stock; provided, however, that the number of shares so withheld or delivered shall not exceed the minimum amount necessary to satisfy the required withholding obligation. Upon the issuance of restricted stock, the number of shares reserved for issuance under the Plan shall be reduced by the sum of the number of shares issued and the number of shares withheld to satisfy tax obligations as provided in the immediately preceding sentence.

11. **Performance-Based Awards.** The Board of Directors may grant awards intended to qualify as qualified performance-based compensation under Section 162(m) of the Code and the regulations thereunder (“Performance-Based Awards”). Performance-Based Awards shall be denominated at the time of grant either in Common Stock (“Stock Performance Awards”) or in dollar amounts (“Dollar Performance Awards”). Payment under a Stock Performance Award or a Dollar Performance Award shall be made, at the discretion of the Board of Directors, in Common Stock (“Performance Shares”), or in cash or in any combination thereof. Performance-Based Awards shall be subject to the following terms and conditions:

11.1 ***Award Period***. The Board of Directors shall determine the period of time for which a Performance-Based Award is made (the “Award Period”).

11.2 ***Performance Goals and Payment.*** The Board of Directors shall establish in writing objectives ("Performance Goals") that must be met by the Company or any subsidiary, division or other unit of the Company ("Business Unit") during the Award Period as a condition to payment being made under the Performance-Based Award. The Performance Goals for each award shall be one or more targeted levels of performance with respect to one or more of the following objective measures with respect to the Company or any Business Unit: earnings, earnings per share, stock price increase, total shareholder return (stock price increase plus dividends), return on equity, return on assets, return on capital, economic value added, sales, revenues, operating income, inventories, inventory turns, cash flows, or any of the foregoing before the effect of acquisitions, divestitures, accounting changes, restructuring and special charges, extraordinary items and all items of gain, loss or expense determined to be extraordinary or unusual in nature or infrequent in occurrence (determined according to criteria established by the Board of Directors). The Board of Directors shall also establish the number of Performance Shares or the amount of cash payment to be made under a Performance-Based Award if the Performance Goals are met or exceeded, including the fixing of a maximum payment (subject to Section 11.4). The Board of Directors may establish other restrictions to payment under a Performance-Based Award, such as a continued employment requirement, in addition to satisfaction of the Performance Goals. Some or all of the Performance Shares may be issued at the time of the award as restricted shares subject to forfeiture in whole or in part if Performance Goals or, if applicable, other restrictions are not satisfied.

11.3 ***Computation of Payment.*** During or after an Award Period, the performance of the Company or Business Unit, as applicable, during the period shall be measured against the Performance Goals. If the Performance Goals are not met, no payment shall be made under a Performance-Based Award. If the Performance Goals are met or exceeded, the Board of Directors shall certify that fact in writing and certify the number of Performance Shares earned or the amount of cash payment to be made under the terms of the Performance-Based Award.

11.4 ***Maximum Awards.*** No participant may receive in any fiscal year Stock Performance Awards under which the aggregate amount payable under the Awards exceeds the equivalent of 650,000 shares of Common Stock or Dollar Performance Awards under which the aggregate amount payable under the Awards exceeds $4,000,000.

11.5 ***Tax Withholding.*** Each participant who has received Performance Shares shall, upon notification of the amount due, pay to the Company in cash or by check amounts necessary to satisfy any applicable federal, state and local tax withholding requirements. If the participant fails to pay the amount demanded, the Company or the Employer may withhold that amount from other amounts payable to the participant, including salary, subject to applicable law. With the consent of the Board of Directors, a participant may satisfy this obligation, in whole or in part, by instructing the Company to withhold from any shares to be issued or by delivering to the Company other shares of Common Stock; provided, however, that the number of shares so delivered or withheld shall not exceed the minimum amount necessary to satisfy the required withholding obligation.

11.6 ***Effect on Shares Available.*** The payment of a Performance-Based Award in cash shall not reduce the number of shares of Common Stock reserved for issuance under the Plan. The number of shares of Common Stock reserved for issuance under the Plan shall be reduced by the sum of the number of shares issued upon payment of an award and any shares withheld to satisfy tax obligations as provided in the last sentence of Section 11.5 in the case of Performance-Based Awards that are in the form of performance-based restricted stock units.

12. **Changes in Capital Structure.**

12.1 ***Stock Splits, Stock Dividends, Changes in Capitalization.*** If the outstanding Common Stock of the Company is hereafter increased or decreased or changed into or exchanged for a different number or kind of shares or other securities of the Company by reason of any stock split, combination of shares, dividend payable in shares, recapitalization or reclassification, appropriate adjustment shall be made by the Board of Directors in the number and kind of shares available for grants under the Plan and in all other share amounts set forth in the Plan. In addition, the Board of Directors shall make appropriate adjustment in the number and kind of shares subject to any Awards theretofor granted, and the exercise and settlement prices of those Awards, if any, so that the holder's proportionate interest before and after the occurrence of the event is maintained without changing the aggregate exercise or settlement price, if any. If any other change to the capital or corporate structure of the Company affecting Common Stock occurs, such as an extraordinary non-recurring dividend in cash or property, in order to prevent or limit diminution or enlargement of benefits or potential benefits intended to be made available under the Plan, the Board of Directors, in its sole discretion, may adjust the number or kind of shares subject to and/or the exercise price of outstanding Awards and make appropriate adjustments to any related share limits in the Plan with respect to Awards; provided that no such adjustments shall be made with respect to stock options or stock appreciation rights in the case of dividends of cash or property that are not extraordinary and non-recurring. Notwithstanding the foregoing, the Board of Directors shall have no obligation to effect any adjustment that would or might result in the issuance of fractional shares, and any fractional shares resulting from any adjustment may be disregarded or provided for in any manner determined by the Board of Directors. Any such adjustments made by the Board of Directors shall be conclusive.

12.2 ***Mergers, Reorganizations, Etc.*** In the event of a merger, consolidation, plan of exchange, acquisition of property or stock, split-up, split-off, spin-off, reorganization or liquidation to which the Company is a party or any sale, lease, exchange or other transfer (in one transaction or a series of related transactions) of all, or substantially all, of the assets of the Company (each, a "Transaction"), the Board of Directors shall, in its sole discretion and to the extent possible under the structure of the Transaction, select one or more of the following alternatives for treating outstanding Awards under the Plan, with the Board of Directors having the discretion to apply different alternatives to various outstanding Awards:

12.2-1 Outstanding Awards shall remain in effect in accordance with their terms.

12.2-2 Outstanding Awards shall be converted into (a) Awards with respect to stock in one or more of the corporations, including the Company, that are the surviving or acquiring corporations in the Transaction, or (b) in a Transaction in which the consideration received is cash, if determined in the sole discretion of the Board of Directors, a cash obligation of the acquiring entity, with such conversion to occur by assumption of the Plan, assumption of Awards, or substitution of Awards. The amount, type of securities subject thereto and exercise or settlement price of the converted Awards shall be determined by the Board of Directors of the Company, taking into account the relative values of the companies involved in the Transaction and the exchange rate, if any, used in determining shares of the surviving corporation(s) to be held by holders of shares of the Company following the Transaction. Unless otherwise determined by the Board of Directors, the converted Awards shall be vested or released from restrictions on transfer and repurchase and forfeiture rights only to the extent that the vesting requirements or restrictions relating to Awards granted hereunder have been satisfied.

12.2-3 The Board of Directors shall provide a period of 30 days or less before the completion of the Transaction during which outstanding Awards may be exercised to the extent then exercisable, and upon the expiration of that period, all outstanding Awards (including Awards that are not options or stock appreciation rights) shall immediately terminate.

12.2-4 Outstanding Awards shall be cancelled immediately prior to the completion of the Transaction in exchange for a payment with respect to each vested or exercisable share subject to such cancelled Award in (i) cash, (ii) stock in one or more corporations that are the surviving or acquiring corporations in the Transaction, or (iii) other property which, in any such case, shall have a fair market value equal to the fair market value of the consideration to be paid per share of Common Stock in the Transaction over the exercise or settlement price per share under the Award, if any (the "Spread"). In the event such determination is made by the Board of Directors, the Spread (reduced by applicable withholding taxes, if any) shall be paid to the holders in respect of their cancelled Awards as soon as practicable following the closing of the Transaction. This provision shall not apply to Incentive Stock Options awarded prior to October 25, 2007.

The Board of Directors may, in its sole discretion, accelerate in full or in part the vesting or exercisability of Awards under the Plan and the full or partial release from restrictions on transfer and repurchase or forfeiture rights of Award under the Plan, on such terms and conditions as the Board of Directors may specify prior to the completion of the Transaction.

12.3 ***Dissolution of the Company.*** In the event of the dissolution of the Company, options and stock appreciation rights shall be treated in accordance with Section 12.2-3.

12.4 ***Rights Issued by Another Corporation.*** The Board of Directors may also grant options, stock appreciation rights, stock bonuses and Performance-Based Awards and issue restricted stock under the Plan with terms, conditions and provisions that vary from those specified in the Plan, provided that any such awards are granted in substitution for, or in connection with the assumption of, existing options, stock appreciation rights, stock bonuses, Performance-Based Awards or restricted stock granted, awarded or issued by another corporation and assumed or otherwise agreed to be provided for by the Company pursuant to or by reason of an acquisition of another entity, business or an interest in another entity whether by merger, stock purchase, asset purchase or other form of transaction.

13. **Amendment of the Plan.** The Board of Directors may at any time modify or amend the Plan in any respect. Except as provided in Section 12, however, no change in an award already granted shall be made without the written consent of the holder of the award if the change would adversely affect the holder.

14. **Approvals**. The Company's obligations under the Plan are subject to the approval of state and federal authorities or agencies with jurisdiction in the matter. The Company will use its best efforts to take steps required by state or federal law or applicable regulations, including rules and regulations of the Securities and Exchange Commission and any stock exchange on which the Company's shares may then be listed, in connection with the grants under the Plan. The foregoing notwithstanding, the Company shall not be obligated to issue or deliver Common Stock under the Plan if such issuance or delivery would violate state or federal securities laws.

15. **Employment and Service Rights.** Nothing in the Plan or any award pursuant to the Plan shall (i) confer upon any employee any right to be continued in the employment of an Employer or interfere in any way with the Employer's right to terminate the employee's employment at will at any time, for any reason, with or without cause, or to decrease the employee's compensation or benefits, or (ii) confer upon any person engaged by an Employer any right to be retained or employed by the Employer or to the continuation, extension, renewal or modification of any compensation, contract or arrangement with or by the Employer.

16. **Rights as a Shareholder**. The recipient of any award under the Plan shall have no rights as a shareholder with respect to any shares of Common Stock until the date the recipient becomes the holder of record of those shares. Except as otherwise expressly provided in the Plan, no adjustment shall be made for dividends or other rights for which the record date occurs before the date the recipient becomes the holder of record.

17. **Suspension or Termination of Awards; Claw-Back.** Notwithstanding any provision of the Plan to the contrary, if at any time (including after a notice of exercise has been delivered with respect to an Award that is an option or stock appreciation right), the Board of Directors, including any Committee authorized pursuant to Section 4.2 (the Board of Directors or such Committee, the "Committee" for purposes of this Section), reasonably believes that a participant, other than a non-employee director, has committed an act of misconduct as described in this section, the Committee may suspend the participant's right to exercise any stock option or stock appreciation right or the vesting of restricted stock or restricted stock unit awards pending a determination of whether an act of misconduct has been committed. If the Committee determines a participant, other than a non-employee director, has committed an act of embezzlement, fraud, dishonesty, nonpayment of any obligation owed to the Company or its subsidiaries, breach of fiduciary duty or deliberate disregard of Company rules resulting in loss, damage or injury to the Company, or if a participant makes an unauthorized disclosure of any Company trade secret or confidential information, engages in any conduct constituting unfair competition, induces any customer to breach a contract with the Company or induces any principal for whom the Company or its subsidiaries acts as agent to terminate such agency relationship, neither the participant nor his or her estate shall be entitled to exercise any stock option or stock appreciation right whatsoever and the participant's restricted stock or restricted stock unit agreement shall be terminated and cancelled. In addition, for any participant who is designated an "executive officer" by the Board of Directors, if the Committee determines that the participant engaged in an act of embezzlement, fraud or breach of fiduciary duty during the participant's employment that contributed to an obligation to restate the Company's financial statements ("Contributing Misconduct"), the participant

shall be required to repay to the Company, in cash and upon demand, the Option Proceeds and/or Restricted Stock Proceeds, as applicable, resulting from the sale or other disposition (including to the Company) of shares issued or issuable upon exercise of a stock option or stock appreciation right or upon vesting of restricted stock or a restricted stock unit, as applicable, if the sale or disposition was effected during the 12-month period following the first public issuance or filing with the Securities and Exchange Commission of the financial statements required to be restated. The term "Option Proceeds" means, with respect to any sale or other disposition (including to the Company) of shares issued or issuable upon exercise of an option or stock appreciation right, an amount determined appropriate by the Committee to reflect the effect of the restatement on the Company's stock price, up to the amount equal to the number of shares sold or disposed of multiplied by the difference between the market value per share at the time of such sale or disposition and the exercise price. The term "Restricted Stock Proceeds" means, with respect to any sale or other disposition (including to the Company) of restricted stock or a restricted stock unit, an amount determined appropriate by the Committee to reflect the effect of the restatement on the Company's stock price, up to the amount equal to the market value per share at the time of such sale or other disposition multiplied by the number of shares or units sold or disposed of. The return of Option Proceeds and/or Restricted Stock Proceeds is in addition to and separate from any other relief available to the Company due to the executive officer's Contributing Misconduct. Any determination by the Committee with respect to the foregoing shall be final, conclusive and binding on all parties. For any participant who is an "executive officer," the determination of the Committee shall be subject to the approval of the Board of Directors.

18. Repricing of Stock Options or SARs. Except as provided in Section 12, any amendment to the Plan or any award agreement that results in the repricing of an option or stock appreciation right issued under the Plan shall not be effective without prior approval of the shareholders of the Company. For this purpose, repricing includes a reduction in the exercise price of a stock option or a stock appreciation right or the cancellation of a stock option or a stock appreciation right in exchange for cash, stock options or stock appreciation rights with an exercise price less than the exercise price of the cancelled stock option or stock appreciation right, other awards under the Plan or any other consideration provided by the Company.

19. No Discretionary Acceleration of Vesting. Notwithstanding any provision of the Plan to the contrary, except as set forth in the proviso below, the Board of Directors shall not exercise discretion to accelerate vesting of any Award granted under the Plan; provided, however, that, notwithstanding any provision of the Plan to the contrary, the Board of Directors shall have the authority, in its discretion, to provide for accelerated vesting, exercisability and distribution of any Awards held by a participant under the Plan in the event of the participant's death or disability or upon or following consummation of a Transaction as provided in Section 12.2.

Exhibit 10.40

**RESTRICTED STOCK UNITS
AWARD AGREEMENT**

This Award Agreement (the "Agreement") is entered into as of __________ by and between Electro Scientific Industries, Inc., an Oregon corporation (the "Company"), and __________ ("Recipient"), for the grant of restricted stock units with respect to the Company's Common Stock ("Common Stock"). By accepting this award Recipient agrees to be bound by the terms and conditions of this Agreement.

On __________, the Compensation Committee of the Company's Board of Directors (the "Committee") made a restricted stock units award to Recipient pursuant to the Company's 2004 Stock Incentive Plan (the "Plan") and Recipient desires to accept the award subject to the terms and conditions of this Agreement.

IN CONSIDERATION of the mutual covenants and agreements set forth in this Agreement, the parties agree to the following.

1. Grant and Terms of Restricted Stock Units. The Company grants to Recipient __________ restricted stock units, subject to the adjustments, restrictions, terms and conditions set forth in this Agreement.

(a) *Rights under Restricted Stock Units.* A restricted stock unit (an "RSU") represents the unsecured right to require the Company to deliver to Recipient one share of Common Stock for each RSU, subject to Section 1(c). The number of shares of Common Stock deliverable with respect to each RSU is subject to adjustment as determined by the Board of Directors of the Company as to the number and kind of shares of stock deliverable upon any merger, reorganization, consolidation, recapitalization, stock dividend, spin-off or other change in the corporate structure affecting the Common Stock generally.

(b) *Vesting and Delivery Dates.* The RSUs issued under this Agreement shall initially be 100% unvested and subject to forfeiture. Subject to this Section 1(b) and Section 1(c), the RSUs shall vest 25% annually on each of the first four anniversaries of the date of grant. The RSUs shall become vested on the vesting date only if Recipient continues to be an employee of the Company through such vesting date. The delivery date for a RSU shall be the date on which such RSU vests.

(c) *Payment before Vesting Date*.

(1) *Payment on Death or Total Disability*. If Recipient ceases to be an employee of the Company by reason of Recipient's death or physical disability, outstanding but unvested RSUs shall become immediately vested in an amount determined by multiplying the total number of RSUs subject to this Agreement by a percentage calculated by dividing the number of whole months elapsed from the date of this Agreement to the date of termination of employment by 48 (the "Pro Rata Percentage"). The delivery date shall also accelerate. The term "total disability" means a medically determinable mental or physical impairment that is expected to result in death or has lasted or is expected to last for a continuous period

of 12 months or more and that, in the opinion of the Company and two independent physicians approved by the Company, causes Recipient to be unable to perform his or her duties as an employee, director, officer or consultant of the Company and unable to engage in any substantial gainful activity. Total disability shall be deemed to have occurred after both of the following have occurred:

(A) The two independent physicians have furnished their written opinion of total disability to the Company; and

(B) The Company has reached an opinion of total disability.

(2) *Acceleration on Normal Retirement.* After Recipient attains age 65, outstanding but unvested RSUs shall become vested each calendar year in an amount determined by multiplying the total number of RSUs subject to this Agreement by the Pro Rata Percentage as of the earlier of December 31 of the year or the date of Recipient’s termination of employment. The delivery date shall also be accelerated.

(3) *Double Trigger Acceleration on Change in Control.*

(i) All of the RSUs shall immediately vest if a Change in Control (as defined below) occurs and at any time after the Change in Control and on or before the first anniversary of the Change in Control, (i) the Recipient’s employment is terminated by the Company (or its successor) without Cause (as defined below), or (ii) the Recipient’s employment is terminated by the Recipient for Good Reason (as defined below); provided, however, that the RSUs may also immediately vest in connection with a sale of the Company as provided in Section 1(c)(4) below.

(ii) For purposes of this Agreement, a “Change in Control” of the Company shall mean the occurrence of any of the following events:

(A) At any time during a period of two consecutive years, individuals who at the beginning of such period constituted the Board of Directors of the Company (“Incumbent Directors”) shall cease for any reason to constitute at least a majority thereof; provided, however, that the term “Incumbent Director” shall also include each new director elected during such two-year period whose nomination or election was approved by two-thirds of the Incumbent Directors then in office;

(B) Any “person” or “group” (within the meaning of Sections 13(d) and 14(d)(2) of the Exchange Act) shall, as a result of a tender or exchange offer, open market purchases or privately negotiated purchases from anyone other than the Company, have become the beneficial owner (within the meaning of Rule 13d-3 under the Exchange Act), directly or indirectly, of more than fifty percent (50%) of the then outstanding Common Stock of the Company;

(C) A consolidation, merger or plan of exchange involving the Company ("Merger") as a result of which the holders of outstanding securities of the Company ordinarily having the right to vote for the election of directors ("Voting Securities") immediately prior to the Merger do not continue to hold at least 50% of the combined voting power of the outstanding Voting Securities of the surviving corporation or a parent corporation of the surviving corporation immediately after the Merger, disregarding any Voting Securities issued to or retained by such holders in respect of securities of any other party to the Merger; or

(D) A sale, lease, exchange, or other transfer (in one transaction or a series of related transactions) of all or substantially all of the assets of the Company.

(iii) For purposes of this Agreement, "Cause" shall mean (a) the willful and continued failure to perform substantially the Recipient's reasonably assigned duties with the Company (or its successor) (other than any such failure resulting from incapacity due to physical or mental illness) after a demand for substantial performance is delivered to the Recipient by the Company (or its successor) which specifically identifies the manner in which the Company (or its successor) believes that the Recipient has not substantially performed the Recipient's duties, (b) the willful engagement in illegal conduct which is materially and demonstrably injurious to the Company (or its successor), or (c) the commission of an act by Recipient, or the failure of Recipient to act, which constitutes gross negligence or gross misconduct. No act, or failure to act, shall be considered "willful" if the Recipient reasonably believed that the action or omission was in, or not opposed to, the best interests of the Company (or its successor).

(iv) For purposes of this Agreement, "Good Reason" shall mean Recipient's voluntary termination, within 30 days following the expiration of any Company cure period (discussed below) following the occurrence of one or more of the following, without Recipient's consent:

(A) the assignment of a different title, job or responsibilities that results in a substantial reduction in the duties of the Recipient after the Change in Control when compared to the Recipient's duties with respect to the Company's operations prior to the Change in Control; provided that any change made solely as the result of the Company becoming a subsidiary or business unit of a larger company in a Change in Control shall not constitute Good Reason unless Recipient's new duties are substantially reduced from his or her prior duties;

(B) a reduction in Recipient's target bonus or base salary;

(C) the Company's requiring Recipient to be based more than 50 miles from the principal office at in which Recipient is based immediately prior to the Change in Control, except for reasonably required travel on the Company's business; or

(D) the failure by any successor to the Company to expressly assume this Agreement or any obligation under this Agreement.

Recipient may not resign for Good Reason without first providing the Company with written notice within 90 days of the initial existence of the condition that Recipient believes constitutes Good Reason specifically identifying the acts or omissions constituting the grounds for Good Reason and a reasonable cure period of not less than 30 days following the date of such notice.

For purposes of the "Good Reason" definition, the term "Company" will be interpreted to include any subsidiary, parent, affiliate or successor thereto, if applicable.

(4) *Sale of the Company*. If there shall occur a merger, consolidation or plan of exchange involving the Company pursuant to which the outstanding shares of Common Stock of the Company are converted into cash or other stock, securities or property, or a sale, lease, exchange or other transfer (in one transaction or a series of related transactions) of all, or substantially all, the assets of the Company, then, as determined by the Committee or the Board of Directors, either:

(i) the unvested RSUs shall be converted into restricted stock units for stock of the surviving or acquiring corporation in the applicable transaction, with the amount and type of shares subject thereto to be conclusively determined by the Committee, taking into account the relative values of the companies involved in the applicable transaction and the exchange rate, if any, used in determining shares of the surviving corporation to be held by the former holders of the Company's Common Stock following the applicable transaction, and disregarding fractional shares, with the dates for vesting of RSUs and delivery of shares of Common Stock unchanged;

(ii) the unvested RSUs shall be converted into a cash payment obligation of the surviving or acquiring corporation in an amount equal to the proceeds a holder of the underlying shares would have received in proceeds from such transaction with respect to those shares; or

(iii) all of the unvested RSUs shall immediately vest and all underlying shares shall be delivered simultaneously with the closing of the applicable transaction such that the Recipient will participate as a shareholder in receiving proceeds from such transaction with respect to those shares.

(d) *Forfeiture of RSUs on Other Terminations of Employment.* If Recipient ceases to be an employee of the Company for any reason that does not result in acceleration or payment pursuant to Section 1(c), Recipient shall immediately forfeit all outstanding but unvested RSUs granted pursuant to this Agreement and Recipient shall have no right to receive the related Common Stock.

(e) *Restrictions on Transfer and Delivery on Death.* Recipient may not sell, transfer, assign, pledge or otherwise encumber or dispose of the RSUs. Recipient may designate beneficiaries to receive shares of stock with respect to RSUs if Recipient dies before the delivery date by so indicating on Exhibit A, which is incorporated into and made a part of this agreement. If Recipient fails to designate beneficiaries on Exhibit A, the shares will be delivered to Recipient's estate.

(f) *Reinvestment of Dividend Equivalents.* On each date on which the Company pays a dividend on a share of Common Stock with respect to an RSU, the number of RSUs subject to this Agreement shall be increased by a number equal to the number of whole or fractional shares of Common Stock with a value equal to the value of the dividends that would have been paid on the stock deliverable pursuant to the RSUs (if such shares were outstanding), divided by the closing stock price on the dividend payment date. If the vesting date for any RSUs subject to this Agreement occurs within seven business days of the payment date for a dividend, the Company, at its option, may elect to pay to Recipient cash, net of withholding, equal to the cash dividend payable on the RSUs which so vest in lieu of increasing the number of RSUs subject to this Agreement.

(g) *Delivery on Delivery Date.* As soon as practicable following the delivery date, the Company shall deliver to Recipient a certificate for the number of shares of Common Stock represented by all RSUs having a delivery date on the same date, rounded down to the whole share. No fractional shares of Common Stock shall be issued. The Company shall pay to Recipient in cash an amount equal to the value of any fractional shares that would otherwise have been issued, valued as of the delivery date. If shares or cash are to be delivered on a particular date, the shares or cash shall be deemed delivered on that date for purposes of compliance with the terms of this Agreement if the cash or shares are actually delivered within 45 days after the specified date as determined in the Company's discretion with the Recipient having no right to determine the delivery date. Recipient shall not have any right to determine or direct the date of actual delivery.

(h) *Recipient's Rights as Shareholder.* Recipient shall have no rights as a shareholder with respect to the RSUs or the shares underlying them until the Company delivers the shares to Recipient on the delivery date.

(i) *Tax Withholding*. Recipient acknowledges that, not later than the actual delivery date, the value of delivered shares of Common Stock will be treated as ordinary compensation income for federal and state income and FICA tax purposes, and that the Company will be required to withhold taxes on this income amount. The Company will notify Recipient of the required withholding amount. Concurrently with or prior to the delivery of the certificate referred to in Section 1(g), Recipient shall pay to the Company the required withholding amount in cash or, at the election of Recipient (which election must be made on or before the vesting date), by surrendering to the Company for cancellation shares of the Company's Common Stock to be delivered with respect to the RSUs or other shares of the Company's Common Stock valued at the closing market price for the Company's Common Stock on the vesting date. If Recipient pays the withholding amount in shares of Common Stock, the Company shall pay to Recipient in cash the amount of any resulting over payment.

(j) *Section 409A.* The award made pursuant to this Agreement shall be interpreted in accordance with Section 409A and Treasury regulations and other interpretive guidance issued thereunder, including without limitation any such regulations or other guidance issued after the grant of the award. For example, notwithstanding anything to the contrary in this Agreement, (i) a termination of employment shall be determined with respect to standards for “separation from service” within the meaning of applicable regulations; (ii) the provisions described in Sections 1(c)(4)(ii) and 1(c)(4)(iii) shall apply only if such events qualify as a “termination or liquidation of the plan” within the meaning of Treas. Reg. § 1.409A 3(j)(4)(ix); and the provision described in Section 1(c)(4)(i) shall apply only if such events qualify as a “change of control event” within the meaning of Treas. Reg. § 1.409A-3(i)(5)(i).

(1) Notwithstanding any provision of the award to the contrary, the Company may adopt such amendments to the award or adopt other policies and procedures (including amendments, policies and procedures with retroactive effect), or take any other actions, that the Company determines are necessary or appropriate to (1) exempt the award from the application of Section 409A or preserve the intended tax treatment of the benefits provided with respect to the award, or (2) comply with the requirements of Section 409A.

(2) If an amount is determined to be subject to applicable provisions of Section 409A of the Code, payment in connection with termination of employment for a reason other than death may not start or be made to Recipient if the Company determines Recipient is a “key employee” as defined in Section 416(i) of the Code, without regard to Section 416(i)(5) of the Code, before the date which is six months after the date of termination, notwithstanding any other provisions for time of payment in this Agreement, if such delay in payment is necessary to comply with Section 409A of the Code. The Company may determine that Recipient is a key employee in the event of doubt or to avoid impractical efforts or expense to make an exact determination of key employees. Recipient shall have no claim, rights or remedy if the determination is not correct.

2. Miscellaneous.

(a) *Entire Agreement; Amendment.* This Agreement and the Plan (including without limitation Section 17 thereof) constitutes the entire agreement of the parties with regard to the subjects hereof and may be amended only by written agreement between the Company and Recipient.

(b) *Notices.* Any notice required or permitted under this Agreement shall be in writing and shall be deemed sufficient when delivered personally to the party to whom it is addressed or when deposited into the United States mail as registered or certified mail, return receipt requested, postage prepaid, addressed to Electro Scientific Industries, Inc., Attention: Corporate Secretary, at its principal executive offices or to Recipient at the address of Recipient in the Company’s records, or at such other address as such party may designate by ten (10) days’ advance written notice to the other party.

(c) *Rights and Benefits.* The rights and benefits of this Agreement shall inure to the benefit of and be enforceable by the Company's successors and assigns and, subject to the restrictions on transfer of this Agreement, be binding upon Recipient's heirs, executors, administrators, successors and assigns.

(d) *Further Action.* The parties agree to execute such further instruments and to take such further action as may reasonably be necessary to carry out the intent of this Agreement.

(e) *Applicable Law; Attorneys' Fees.* The terms and conditions of this Agreement shall be governed by the laws of the State of Oregon. In the event either party institutes litigation hereunder, the prevailing party shall be entitled to reasonable attorneys' fees to be set by the trial court and, upon any appeal, the appellate court.

ELECTRO SCIENTIFIC INDUSTRIES, INC.

By: ______________________________
Authorized Officer

EXHIBIT A

DESIGNATION OF BENEFICIARY

Name ______________________________ **Social Security Number ____-___-_____**

I designate the following person(s) to receive any restricted stock units outstanding upon my death under the Restricted Stock Units Award Agreement with Electro Scientific Industries, Inc.:

A. Primary Beneficiary(ies)

Name_________________________
Birth Date _____________________
Address___________________________
Social Security Number ____-___-_____
Relationship _________________________
City__________ State____ Zip ________

Name_________________________
Birth Date _____________________
Address___________________________
Social Security Number ____-___-_____
Relationship _________________________
City__________ State____ Zip ________

Name_________________________
Birth Date _____________________
Address___________________________
Social Security Number ____-___-_____
Relationship _________________________
City__________ State____ Zip ________

If more than one primary beneficiary is named, the units will be divided equally among those primary beneficiaries who survive the undersigned.

B. Secondary Beneficiary(ies)

In the event no Primary Beneficiary is living at the time of my death, I designate the following the person(s) as my beneficiary(ies):

Name_________________________
Birth Date _____________________
Address___________________________
Social Security Number ____-___-_____
Relationship _________________________
City__________ State____ Zip ________

Name_________________________
Birth Date _____________________
Address___________________________
Social Security Number ____-___-_____
Relationship _________________________
City__________ State____ Zip ________

Name_________________________
Birth Date _____________________
Address___________________________
Social Security Number ____-___-_____
Relationship _________________________
City__________ State____ Zip ________

If more than one Secondary Beneficiary is named, the units will be divided equally among those Secondary beneficiaries who survive the undersigned.

This designation revokes and replaces all prior designations of beneficiaries under the Restricted Stock Units Award Agreement.

____ Date signed: ___________________, 20___
Signature

Exhibit 10.41

RESTRICTED STOCK UNITS
AWARD AGREEMENT

This Award Agreement (the "Agreement") is entered into as of __________ by and between Electro Scientific Industries, Inc., an Oregon corporation (the "Company"), and __________ ("Recipient"), for the grant of restricted stock units with respect to the Company's Common Stock ("Common Stock"). By accepting this award Recipient agrees to be bound by the terms and conditions of this Agreement.

The Compensation Committee of the Company's Board of Directors (the "Committee") made a restricted stock units award to Recipient pursuant to the Company's 2004 Stock Incentive Plan (the "Plan") and Recipient desires to accept the award subject to the terms and conditions of this Agreement.

IN CONSIDERATION of the mutual covenants and agreements set forth in this Agreement, the parties agree to the following.

1. **Grant and Terms of Restricted Stock Units**. The Company grants to Recipient __________ restricted stock units, subject to the adjustments, restrictions, terms and conditions set forth in this Agreement.

(a) *Rights under Restricted Stock Units.* A restricted stock unit (an "RSU") represents the unsecured right to require the Company to deliver to Recipient one share of Common Stock for each RSU, subject to Section 1(c). The number of shares of Common Stock deliverable with respect to each RSU is subject to adjustment as determined by the Board of Directors of the Company as to the number and kind of shares of stock deliverable upon any merger, reorganization, consolidation, recapitalization, stock dividend, spin-off or other change in the corporate structure affecting the Common Stock generally.

(b) *Vesting and Delivery Dates.* The RSUs issued under this Agreement shall initially be 100% unvested and subject to forfeiture. Subject to this Section 1(b) and Section 1(c), the RSUs shall vest according to the below vesting schedule. The RSUs shall become vested on the vesting date only if Recipient continues to be an employee of the Company through such vesting date. The delivery date for a RSU shall be the date on which such RSU vests.

Vest Date	# of Shares
{vest date 1}	{# of Shares 1}
{vest date 2} (if needed)	{# of Shares 2}
{vest date 3} (if needed)	{# of Shares 3}
(and so on if needed.)	

(c) *Payment before Vesting Date*.

(1) *Payment on Death or Total Disability*. If Recipient ceases to be an employee of the Company by reason of Recipient's death or physical disability, outstanding but unvested RSUs shall become immediately vested in an amount determined by multiplying the total number of RSUs subject to this Agreement by a percentage calculated by dividing the number of whole months elapsed from the date of this Agreement to the date of termination of service by the total number of whole months in the vesting period (the "Pro Rata Percentage"); provided, however, that the number of RSUs so vested shall be reduced by the number of any RSUs that previously vested pursuant to Section 1(b). The delivery date shall also accelerate. The term "total disability" means a medically determinable mental or physical impairment that is expected to result in death or has lasted or is expected to last for a continuous period of 12 months or more and that, in the opinion of the Company and two independent physicians approved by the Company, causes Recipient to be unable to perform his or her duties as an employee, director, officer or consultant of the Company and unable to engage in any substantial gainful activity. Total disability shall be deemed to have occurred after both of the following have occurred:

(A) The two independent physicians have furnished their written opinion of total disability to the Company; and

(B) The Company has reached an opinion of total disability.

(2) *Acceleration on Normal Retirement.* After Recipient attains age 65, outstanding but unvested RSUs shall become vested each calendar year in an amount determined by multiplying the total number of RSUs subject to this Agreement by the Pro Rata Percentage as of the earlier of December 31 of the year or the date of Recipient's termination of employment. The delivery date shall also be accelerated.

(3) *Double Trigger Acceleration on Change in Control.*

(i) All of the RSUs shall immediately vest if a Change in Control (as defined below) occurs and at any time after the Change in Control and on or before the first anniversary of the Change in Control, (i) the Recipient's employment is terminated by the Company (or its successor) without Cause (as defined below), or (ii) the Recipient's employment is terminated by the Recipient for Good Reason (as defined below); provided, however, that the RSUs may also immediately vest in connection with a sale of the Company as provided in Section 1(c)(4) below.

(ii) For purposes of this Agreement, a "Change in Control" of the Company shall mean the occurrence of any of the following events:

(A) At any time during a period of two consecutive years, individuals who at the beginning of such period constituted the Board of Directors of the Company ("Incumbent Directors") shall cease for any reason to constitute at least a majority thereof; provided, however, that the term "Incumbent Director" shall also include each new director elected during such two-year period whose nomination or election was approved by two-thirds of the Incumbent Directors then in office;

(B) Any “person” or “group” (within the meaning of Sections 13(d) and 14(d)(2) of the Exchange Act) shall, as a result of a tender or exchange offer, open market purchases or privately negotiated purchases from anyone other than the Company, have become the beneficial owner (within the meaning of Rule 13d-3 under the Exchange Act), directly or indirectly, of more than fifty percent (50%) of the then outstanding Common Stock of the Company;

(C) A consolidation, merger or plan of exchange involving the Company (“Merger”) as a result of which the holders of outstanding securities of the Company ordinarily having the right to vote for the election of directors (“Voting Securities”) immediately prior to the Merger do not continue to hold at least 50% of the combined voting power of the outstanding Voting Securities of the surviving corporation or a parent corporation of the surviving corporation immediately after the Merger, disregarding any Voting Securities issued to or retained by such holders in respect of securities of any other party to the Merger; or

(D) A sale, lease, exchange, or other transfer (in one transaction or a series of related transactions) of all or substantially all of the assets of the Company.

(iii) For purposes of this Agreement, “Cause” shall mean (a) the willful and continued failure to perform substantially the Recipient’s reasonably assigned duties with the Company (or its successor) (other than any such failure resulting from incapacity due to physical or mental illness) after a demand for substantial performance is delivered to the Recipient by the Company (or its successor) which specifically identifies the manner in which the Company (or its successor) believes that the Recipient has not substantially performed the Recipient’s duties, (b) the willful engagement in illegal conduct which is materially and demonstrably injurious to the Company (or its successor), or (c) the commission of an act by Recipient, or the failure of Recipient to act, which constitutes gross negligence or gross misconduct. No act, or failure to act, shall be considered “willful” if the Recipient reasonably believed that the action or omission was in, or not opposed to, the best interests of the Company (or its successor).

(iv) For purposes of this Agreement, “Good Reason” shall mean Recipient’s voluntary termination, within 30 days following the expiration of any Company cure period (discussed below) following the occurrence of one or more of the following, without Recipient’s consent:

(A) the assignment of a different title, job or responsibilities that results in a substantial reduction in the duties of the Recipient after the Change in Control when compared to the Recipient's duties with respect to the Company's operations prior to the Change in Control; provided that any change made solely as the result of the Company becoming a subsidiary or business unit of a larger company in a Change in Control shall not constitute Good Reason unless Recipient's new duties are substantially reduced from his or her prior duties;

(B) a reduction in Recipient's target bonus or base salary as in effect immediately prior to the Change in Control;

(C) a material reduction in total benefits available to the Recipient under cash incentive, stock incentive and other employee benefit plans after the Change in Control compared to the total package of such benefits as in effect prior to the Change in Control;

(D) the Recipient is required to be based more than 50 miles from where the Recipient's office is located immediately prior to the Change in Control except for required travel on company business to an extent substantially consistent with the business travel obligations which the Recipient undertook on behalf of the Company prior to the Change in Control; or

(E) the failure by any successor to the Company to expressly assume this Agreement or any obligation under this Agreement.

Recipient may not resign for Good Reason without first providing the Company with written notice within 90 days of the initial existence of the condition that Recipient believes constitutes Good Reason specifically identifying the acts or omissions constituting the grounds for Good Reason and a reasonable cure period of not less than 30 days following the date of such notice.

For purposes of the "Good Reason" definition, the term "Company" will be interpreted to include any subsidiary, parent, affiliate or successor thereto, if applicable.

(4) *Sale of the Company*. If there shall occur a merger, consolidation or plan of exchange involving the Company pursuant to which the outstanding shares of Common Stock of the Company are converted into cash or other stock, securities or property, or a sale, lease, exchange or other transfer (in one transaction or a series of related transactions) of all, or substantially all, the assets of the Company, then, as determined by the Committee or the Board of Directors, either:

(i) the unvested RSUs shall be converted into restricted stock units for stock of the surviving or acquiring corporation in the applicable transaction, with the amount and type of shares subject thereto to be conclusively determined by the Committee, taking into account the relative values of the companies involved in the applicable transaction and the exchange rate, if any, used in determining shares of the surviving corporation to be held by the former holders of the Company's Common Stock following the applicable transaction, and disregarding fractional shares, with the dates for vesting of RSUs and delivery of shares of Common Stock unchanged;

(ii) the unvested RSUs shall be converted into a cash payment obligation of the surviving or acquiring corporation in an amount equal to the proceeds a holder of the underlying shares would have received in proceeds from such transaction with respect to those shares; or

(iii) all of the unvested RSUs shall immediately vest and all underlying shares shall be delivered simultaneously with the closing of the applicable transaction such that the Recipient will participate as a shareholder in receiving proceeds from such transaction with respect to those shares.

(d) *Forfeiture of RSUs on Other Terminations of Employment.* If Recipient ceases to be an employee of the Company for any reason that does not result in acceleration or payment pursuant to Section 1(c), Recipient shall immediately forfeit all outstanding but unvested RSUs granted pursuant to this Agreement and Recipient shall have no right to receive the related Common Stock.

(e) *Restrictions on Transfer and Delivery on Death.* Recipient may not sell, transfer, assign, pledge or otherwise encumber or dispose of the RSUs. If Recipient dies before the delivery date, the shares will be released with the Company's brokerage, or Recipient's brokerage if separately designated. Recipient should maintain proper beneficiary designations with the brokerage and/or ensure Recipient's estate is aware of the share's location for proper delivery.

(f) *Reinvestment of Dividend Equivalents.* On each date on which the Company pays a dividend on a share of Common Stock with respect to an RSU, the number of RSUs subject to this Agreement shall be increased by a number equal to the number of whole or fractional shares of Common Stock with a value equal to the value of the dividends that would have been paid on the stock deliverable pursuant to the RSUs (if such shares were outstanding), divided by the closing stock price on the dividend payment date. If the vesting date for any RSUs subject to this Agreement occurs within seven business days of the payment date for a dividend, the Company, at its option, may elect to pay to Recipient cash, net of withholding, equal to the cash dividend payable on the RSUs which so vest in lieu of increasing the number of RSUs subject to this Agreement.

(g) *Delivery on Delivery Date.* As soon as practicable following the delivery date, the Company shall deliver to Recipient a certificate for the number of shares of Common Stock represented by all RSUs having a delivery date on the same date, rounded down to the whole share. No fractional shares of Common Stock shall be issued. The Company shall pay to Recipient in cash an amount equal to the value of any fractional shares that would otherwise have been issued, valued as of the delivery date. If shares or cash are to be delivered on a particular date, the shares or cash shall be deemed delivered on that date for purposes of compliance with the terms of this Agreement if the cash or shares are actually delivered within 45 days after the specified date as determined in the Company's discretion with the Recipient having no right to determine the delivery date. Recipient shall not have any right to determine or direct the date of actual delivery.

(h) *Recipient's Rights as Shareholder.* Recipient shall have no rights as a shareholder with respect to the RSUs or the shares underlying them until the Company delivers the shares to Recipient on the delivery date.

(i) *Tax Withholding*. Recipient acknowledges that, not later than the actual delivery date, the value of delivered shares of Common Stock will be treated as ordinary compensation income for federal and state income and FICA tax purposes, and that the Company will be required to withhold taxes on this income amount. The Company will notify Recipient of the required withholding amount. Concurrently with or prior to the delivery of the certificate referred to in Section 1(g), Recipient shall pay to the Company the required withholding amount in cash or, at the election of Recipient (which election must be made on or before the vesting date), by surrendering to the Company for cancellation shares of the Company's Common Stock to be delivered with respect to the RSUs or other shares of the Company's Common Stock valued at the closing market price for the Company's Common Stock on the vesting date. If Recipient pays the withholding amount in shares of Common Stock, the Company shall pay to Recipient in cash the amount of any resulting over payment.

(j) *Section 409A.* The award made pursuant to this Agreement shall be interpreted in accordance with Section 409A and Treasury regulations and other interpretive guidance issued thereunder, including without limitation any such regulations or other guidance issued after the grant of the award. For example, notwithstanding anything to the contrary in this Agreement, (i) a termination of employment shall be determined with respect to standards for "separation from service" within the meaning of applicable regulations; (ii) the provisions described in Sections 1(c)(4)(ii) and 1(c)(4)(iii) shall apply only if such events qualify as a "termination or liquidation of the plan" within the meaning of Treas. Reg. § 1.409A 3(j)(4)(ix); and (iii) the provision described in Section 1 (c)(4)(i) shall apply only if such events qualify as a "change of control event" within the meaning of Treas. Reg. § 1.409A-3(i)(5)(i).

(1) Notwithstanding any provision of the award to the contrary, the Company may adopt such amendments to the award or adopt other policies and procedures (including amendments, policies and procedures with retroactive effect), or take any other actions, that the Company determines are necessary or appropriate to (1) exempt the award from the application of Section 409A or preserve the intended tax treatment of the benefits provided with respect to the award, or (2) comply with the requirements of Section 409A.

(2) If an amount is determined to be subject to applicable provisions of Section 409A of the Code, payment in connection with termination of employment for a reason other than death may not start or be made to Recipient if the Company determines Recipient is a "key employee" as defined in Section 416(i) of the Code, without regard to Section 416(i)(5) of the Code, before the date which is six months after the date of termination, notwithstanding any other provisions for time of payment in this Agreement, if such delay in payment is necessary to comply with Section 409A of the Code. The Company may determine that Recipient is a key employee in the event of doubt or to avoid impractical efforts or expense to make an exact determination of key employees. Recipient shall have no claim, rights or remedy if the determination is not correct.

2. Miscellaneous.

(a) *Entire Agreement; Amendment.* This Agreement and the Plan (including without limitation Section 17 thereof) constitutes the entire agreement of the parties with regard to the subjects hereof and may be amended only by written agreement between the Company and Recipient.

(b) *Notices.* Any notice required or permitted under this Agreement shall be in writing and shall be deemed sufficient when delivered personally to the party to whom it is addressed or when deposited into the United States mail as registered or certified mail, return receipt requested, postage prepaid, addressed to Electro Scientific Industries, Inc., Attention: Corporate Secretary, at its principal executive offices or to Recipient at the address of Recipient in the Company's records, or at such other address as such party may designate by ten (10) days' advance written notice to the other party.

(c) *Rights and Benefits.* The rights and benefits of this Agreement shall inure to the benefit of and be enforceable by the Company's successors and assigns and, subject to the restrictions on transfer of this Agreement, be binding upon Recipient's heirs, executors, administrators, successors and assigns.

(d) *Further Action.* The parties agree to execute such further instruments and to take such further action as may reasonably be necessary to carry out the intent of this Agreement.

(e) *Applicable Law; Attorneys' Fees.* The terms and conditions of this Agreement shall be governed by the laws of the State of Oregon. In the event either party institutes litigation hereunder, the prevailing party shall be entitled to reasonable attorneys' fees to be set by the trial court and, upon any appeal, the appellate court.

Exhibit 10.42

PERFORMANCE-BASED
RESTRICTED STOCK UNITS AWARD AGREEMENT

This Award Agreement (the "Agreement") is entered into as of _________________ by and between Electro Scientific Industries, Inc., an Oregon corporation (the "Company"), and ____________________ ("Recipient"), for the grant of restricted stock units with respect to the Company's Common Stock ("Common Stock"). By accepting this award Recipient agrees to be bound by the terms and conditions of this Agreement.

On _____________________, the Compensation Committee of the Company's Board of Directors approved a restricted stock units award to Recipient pursuant to the Company's 2004 Stock Incentive Plan (the "Plan") to be granted effective on December 5, 2017. The award is intended to qualify as performance-based compensation under Section 162(m) of the Internal Revenue Code of 1986, as amended (the "Code"). Recipient desires to accept the award subject to the terms and conditions of this Agreement.

IN CONSIDERATION of the mutual covenants and agreements set forth in this Agreement, the parties agree to the following:

1. **Grant and Terms of Restricted Stock Units**. The Company grants to Recipient under the Plan ___________ restricted stock units, subject to the adjustments, restrictions, terms and conditions set forth in this Agreement.

(a) *Rights under Restricted Stock Units*. A restricted stock unit (an "RSU") represents the unsecured right to require the Company to deliver to Recipient one share of Common Stock for each RSU. The number of shares of Common Stock deliverable with respect to each RSU is subject to adjustment as determined by the Board of Directors of the Company as to the number and kind of shares of stock deliverable upon any merger, reorganization, consolidation, recapitalization, stock dividend, spin-off or other change in the corporate structure affecting the Common Stock generally.

(b) *Vesting*. The RSUs issued under this Agreement shall initially be 100% unvested and subject to forfeiture as set forth below.

(i) Except as set forth in Section 1(d), if Recipient ceases to be employed by the Company for any reason or for no reason prior to _________________, the unvested RSUs shall be forfeited to the Company.

(ii) To the extent that the number of RSUs first specified above are reduced in accordance with Section 1(b)(iii) and except as provided in Section 1(d), the reduction shall be forfeited to the Company. The extent to which any Performance Goal is achieved, if at all, shall be determined by a date that is no later than December 31 of the calendar year in which the Performance Period to which the Performance Goal relates ends. Nothing contained in this Agreement shall confer upon Recipient any right to be employed by the Company or to continue to provide services to the Company or to interfere in any way with the right of the Company to terminate Recipient's services at any time for any reason, with or without cause.

(iii) The RSUs shall be earned based on three “Performance Goals” based on the relative performance of the Company’s Common Stock against the Russell 2000 Index, as follows:

(A) __________ of the RSUs will be earned based on the Relative Performance Percentage for the period beginning December 5, 2017 and ending December 4, 2018 (the “First Performance Period”), as follows: (i) 100% of the RSUs will be earned if the Relative Performance Percentage for the First Performance Period is equal to 100%; (ii) for every percentage point that the Relative Performance Percentage is less than 100% for the First Performance Period, three percent fewer of the RSUs available to be earned with respect to the First Performance Period will be earned, so that no RSUs will be earned with respect to that period if the Relative Performance Percentage is less than or equal to 66.7%; and (iii) for every percentage point that the Relative Performance Percentage for the First Performance Period is greater than 100%, two percent more of the RSUs available to be earned for such period will be earned, so that 150% of the target RSUs for such period will be earned if the Relative Performance Percentage is 125% for such period, provided that no more than 150% of the RSUs available to be earned in the First Performance Period may be earned based on this Performance Goal.

(B) _________ of the RSUs will be earned based on the Relative Performance Percentage for the period beginning December 5, 2017 and ending December 4, 2019 (the “Second Performance Period”), as follows: (i) 100% of the RSUs will be earned if the Relative Performance Percentage for the Second Performance Period is equal to 100%; (ii) for every percentage point that the Relative Performance Percentage is less than 100% for the Second Performance Period, three percent fewer of the RSUs available to be earned with respect to the Second Performance Period will be earned, so that no RSUs will be earned with respect to that period if the Relative Performance Percentage is less than or equal to 66.7%; and (iii) for every percentage point that the Relative Performance Percentage for the Second Performance Period is greater than 100%, two percent more of the RSUs available to be earned for such period will be earned, so that 200% of the target RSUs for such period will be earned if the Relative Performance Percentage is 150% for such period, provided that no more than 200% of the RSUs available to be earned in the Second Performance Period may be earned based on this Performance Goal.

(C) __________ of the RSUs will be earned based on the Relative Performance Percentage for the period beginning December 5, 2017 and ending December 4, 2020 (the “Third Performance Period”), as follows: (i) 100% of the RSUs will be earned if the Relative Performance Percentage for the Third Performance Period is equal to 100%; (ii) for every percentage point that the Relative Performance Percentage is less than 100% for the Third Performance Period, three percent fewer of the RSUs available to be earned with respect to the Third Performance Period will be earned, so that no RSUs will be earned with respect to that period if the Relative Performance Percentage is less than or equal to 66.7%; and (iii) for every percentage point that the Relative Performance Percentage for the Third Performance Period is greater than 100%, two percent more of the RSUs available to be earned for such period will be earned, so that 200% of the target RSUs for such period will be earned if the Relative Performance Percentage is 150% for such period, provided that no more than 200% of the RSUs available to be earned at target performance in the Third Performance Period may be earned based on this Performance Goal, with such number reduced by the aggregate number of RSUs earned with respect to the First Performance Period and the Second Performance Period (but with such reduction not to reduce the number of RSUs earned in the Third Performance Period below zero).

(D) Notwithstanding anything in this Agreement to the contrary, the total number of RSUs that are earned under this Agreement shall not exceed the lesser of (i) a number of shares with an aggregate value, based on the closing price of the Company's Common Stock in the last trading date preceding the vesting date, that is five times the result of (A) __________ by (B) __________, rounded down to the nearest whole share, and (ii) 200% of the number of RSUs set forth in the first sentence of Section 1.

(E) Performance of the Company's Common Stock relative to the Russell 2000 Index for a given Performance Period will be measured as follows:

(i) To determine relative performance, the baseline metrics are the 20 trading day average closing price of the Company's Common Stock and the Russell 2000 Index, as reported in The Wall Street Journal, or such other reliable source as is determined by the Compensation Committee or the Board of Directors, in its sole discretion, with the last of the 20 trading days falling on __________. This 20 day average establishes both the Company baseline stock price (the "Company Baseline Stock Price") and the Russell 2000 Index baseline (the "Russell 2000 Baseline") against which future Company stock and Russell 2000 Index performance will be compared.

(ii) Next, the Company will measure the 20 trading day average closing price of the Company and the Russell 2000 Index, as reported in The Wall Street Journal, or such other reliable source as is determined by the Compensation Committee or the Board of Directors, in its sole discretion, with the last trading day of such 20-trading day period ending on the last trading day of the applicable Performance Period (establishing both the "Company Closing Price" and the "Russell 2000 Index Closing Price" for such Performance Period).

(iii) The Company will then measure Company performance for a given Performance Period by dividing the Company Closing Price by the Company Baseline Stock Price, with the quotient expressed as a percentage of the Company Baseline Stock Price (the "Company Percentage Performance"). The Company will then measure Russell 2000 Index Performance over the same period by dividing the Russell 2000 Index Closing Price by the Russell 2000 Index Baseline with the quotient expressed as a percentage of the Russell 2000 Index Baseline (the "Russell 2000 Index Percentage Performance").

(iv) The Company will then subtract the Russell 2000 Index Percentage Performance from the Company Percentage Performance, then add 100 to the result, with the final result constituting the relative Company Common Stock performance as a percentage (the "Relative Performance Percentage").

(F) "Performance Period" means any of the First Performance Period, the Second Performance Period or the Third Performance Period.

(G) The number of RSUs determined pursuant to clauses (A), (B) and (C) of this Section 1(b)(iii) (subject to the limitations in clause (D)) shall vest on the last day of the Third Performance Period, subject to Section 1(b)(i). Except as provided in Section 1(d), any RSUs that are not vested at the end of the Third Performance Period shall be forfeited.

(c) *Delivery Date*. Except as set forth in Section 1(d)(iv), the delivery date for shares of Common Stock with respect to RSUs earned subject to this Agreement shall be as soon as practicable after the Third Performance Period ends, but in no event later than December 31 of the calendar year in which such fiscal year ends.

(d) Proration upon Termination for Certain Reasons Prior to End of Performance Period; Treatment on Change in Control.

(i) *Proration on Death or Total Disability*. If Recipient ceases to be an employee of the Company prior to the end of the Performance Period by reason of Recipient's death or total disability, the RSUs that have not otherwise vested or been forfeited pursuant to Section 1(b)(iii)(G) shall not be forfeited under Section 1(b)(i) and the following shall apply:

(1) With respect to any Performance Period that is completed prior to Recipient's termination of employment, the number of RSUs earned with respect to such Performance Period(s) shall not be reduced.

(2) With respect to the any Performance Period during which Recipient's employment terminates, the number of RSUs Recipient would otherwise be entitled to receive pursuant to Section 1(b)(iii) with respect to that Performance Period if Recipient were employed through the end of that Performance Period (the "Base Payout") shall be reduced to a number determined by multiplying the Base Payout by a percentage calculated by dividing the number of months elapsed from the beginning of such Performance Period to the date of termination of employment (rounded down to the whole month) by the number of months in such Performance Period. RSUs for the Performance Period in which employment terminates that exceed the reduced number shall be forfeited to the Company.

(3) The shares of Common Stock with respect to RSUs determined under (1) and (2) shall be delivered as soon as practicable on or after the end of the Third Performance Period in which employment terminates, but in no event later than December 31 of the calendar year in which the Third Performance Period ends.

(4) The term “total disability” means a medically determinable mental or physical impairment that is expected to result in death or has lasted or is expected to last for a continuous period of 12 months or more and that, in the opinion of the Company and two independent physicians approved by the Company, causes Recipient to be unable to perform his or her duties as an employee, director, officer or consultant of the Company and unable to engage in any substantial gainful activity. Total disability shall be deemed to have occurred after both of the following have occurred:

(A) The two independent physicians have furnished their written opinion of total disability to the Company; and

(B) The Company has reached an opinion of total disability.

(ii) *Double Trigger Acceleration on Change in Control*.

(1) The number of unvested RSUs Recipient would otherwise be entitled to receive pursuant to Section 1(b)(iii) if Recipient were employed through the end of the Third Performance Period shall immediately vest (provided, however, that if vesting occurs pursuant to this Section 1(d)(ii) during or prior to the end of a Performance Period that has not yet ended it will be conclusively presumed that the RSUs would have been at the 100% vesting level for each such unfinished Performance Period, subject to any action taken by the Compensation Committee or the Board of Directors pursuant to clause (1) or (2) of Section 1(d)(iii), including the final paragraph of Section 1(d)(iii)) if a Change in Control (as defined below) occurs and either:

(A) at any time after the Change in Control and on or before the first anniversary of the Change in Control, (i) the Recipient’s employment is terminated by the Company (or its successor) without Cause (as defined below), or (ii) the Recipient’s employment is terminated by the Recipient for Good Reason (as defined below); or

(B) at any time after the Change in Control (i) the Company or the surviving or acquiring entity terminates this Agreement and all similar agreements, including because the achievement of any of the Performance Goals becomes reasonably unable to be determined;

Notwithstanding the foregoing, the RSUs may also immediately vest in connection with a sale of the Company as provided in Section 1(d)(iii) below.

(2) For purposes of this Agreement, a “Change in Control” of the Company shall mean the occurrence of any of the following events:

(A) At any time during a period of two consecutive years, individuals who at the beginning of such period constituted the Board of Directors of the Company (“Incumbent Directors”) shall cease for any reason to constitute at least a majority thereof; provided, however, that the term “Incumbent Director” shall also include each new director elected during such two-year period whose nomination or election was approved by two-thirds of the Incumbent Directors then in office;

(B) Any "person" or "group" (within the meaning of Sections 13(d) and 14(d)(2) of the Exchange Act) shall, as a result of a tender or exchange offer, open market purchases or privately negotiated purchases from anyone other than the Company, have become the beneficial owner (within the meaning of Rule 13d-3 under the Exchange Act), directly or indirectly, of more than fifty percent (50%) of the then outstanding Common Stock of the Company;

(C) A consolidation, merger or plan of exchange involving the Company ("Merger") as a result of which the holders of outstanding securities of the Company ordinarily having the right to vote for the election of directors ("Voting Securities") immediately prior to the Merger do not continue to hold at least fifty percent (50%) of the combined voting power of the outstanding Voting Securities of the surviving corporation or a parent corporation of the surviving corporation immediately after the Merger, disregarding any Voting Securities issued to or retained by such holders in respect of securities of any other party to the Merger; or

(D) A sale, lease, exchange, or other transfer (in one transaction or a series of related transactions) of all or substantially all of the assets of the Company.

(3) For purposes of this Agreement, "Cause" shall mean (a) the willful and continued failure to perform substantially the Recipient's reasonably assigned duties with the Company (or its successor) (other than any such failure resulting from incapacity due to physical or mental illness) after a demand for substantial performance is delivered to the Recipient by the Company (or its successor) which specifically identifies the manner in which the Company (or its successor) believes that the Recipient has not substantially performed the Recipient's duties, (b) the willful engagement in illegal conduct which is materially and demonstrably injurious to the Company (or its successor), or (c) the commission of an act by Recipient, or the failure of Recipient to act, which constitutes gross negligence or gross misconduct. No act, or failure to act, shall be considered "willful" if the Recipient reasonably believed that the action or omission was in, or not opposed to, the best interests of the Company (or its successor).

(4) For purposes of this Agreement, "Good Reason" shall mean:

(A) the assignment of a different title, job or responsibilities that results in a decrease in the level of responsibility of the Recipient after the Change in Control when compared to the Recipient's level of responsibility for the Company's operations prior to the Change in Control; provided that Good Reason shall not exist if the Recipient continues to have the same or a greater general level of responsibility for Company operations after the Change in Control as the Recipient had prior to the Change in Control even if the Company operations are a subsidiary or division of the surviving company,

(B) a reduction in the Recipient's base pay as in effect immediately prior to the Change in Control,

(C) a material reduction in total benefits available to the Recipient under cash incentive, stock incentive and other employee benefit plans after the Change in Control compared to the total package of such benefits as in effect prior to the Change in Control, or

(D) the Recipient is required to be based more than 50 miles from where the Recipient's office is located immediately prior to the Change in Control except for required travel on company business to an extent substantially consistent with the business travel obligations which the Recipient undertook on behalf of the Company prior to the Change in Control.

(iii) *Sale of the Company*. If there shall occur a merger, consolidation or plan of exchange involving the Company pursuant to which the outstanding shares of Common Stock of the Company are converted into cash or other stock, securities or property, or a sale, lease, exchange or other transfer (in one transaction or a series of related transactions) of all, or substantially all, the assets of the Company, then, as determined by the Committee or the Board of Directors, either:

(1) the unvested RSUs shall be converted into restricted stock units for stock of the surviving or acquiring corporation in the applicable transaction, with the amount and type of shares subject thereto to be conclusively determined by the Committee, taking into account the relative values of the companies involved in the applicable transaction and the exchange rate, if any, used in determining shares of the surviving corporation to be held by the former holders of the Company's Common Stock following the applicable transaction, and disregarding fractional shares, with the dates for vesting of RSUs, payment and other terms of this Agreement unchanged;

(2) the unvested RSUs shall be converted into a cash payment obligation of the surviving or acquiring corporation in an amount equal to the proceeds a holder of the underlying shares would have received in proceeds from such transaction with respect to those shares, with the dates for vesting of RSUs, payment and other terms of this Agreement unchanged; or

(3) all of the unvested RSUs shall immediately vest based on the number of RSUs earned for completed Performance Periods and assuming 100% earning level for any uncompleted Performance Periods and all underlying shares shall be delivered simultaneously with the closing of the applicable transaction such that the Recipient will participate as a shareholder in receiving proceeds from such transaction with respect to those shares.

In the case of (1) and (2) if any Performance Period has not been completed as of the date of the transaction, the Company Closing Price for such Performance Period shall be deemed to be the price per share received by the Company's stockholders in the transaction. Relative performance for such uncompleted Performance Period shall then be measured against the Russell 2000 Index performance from the Russell 2000 Index Baseline through the 20 trading day average closing price of the Russell 2000 Index in the period ending on the date of the closing of the transaction. The Company's stock performance relative to the Russell 2000 Index shall then be determined consistently with the methodology specified herein for completed Performance Periods. The number of RSUs subject to this Agreement so determined shall then continue to vest based upon Recipient's continuing service to the Company, the acquirer, or their parents or subsidiaries through May 16, 2019, subject to accelerated vesting as set forth in Section 1(d)(ii).

(iv) *Delivery Date*. For purposes of Section 1(d)(ii) or (iii), the delivery date for shares of Common Stock with respect to RSUs shall be as soon as practicable on or after the vesting described in such sections.

(e) *Forfeiture of RSUs on Other Terminations of Employment*. If Recipient ceases to be an employee of the Company for any reason that does not result in acceleration or payment pursuant to Section 1(d), Recipient shall immediately forfeit all outstanding but unvested RSUs granted pursuant to this Agreement and Recipient shall have no right to receive the related Common Stock.

(f) *Restrictions on Transfer and Delivery on Death*. Recipient may not sell, transfer, assign, pledge or otherwise encumber or dispose of the RSUs. Recipient may designate beneficiaries to receive stock if Recipient dies before the delivery date by so indicating on Exhibit A, which is incorporated into and made a part of this Agreement. If Recipient fails to designate beneficiaries on Exhibit A, the shares will be delivered to Recipient's estate.

(g) *Reinvestment of Dividend Equivalents*. On each date on which the Company pays a dividend on a share of Common Stock with respect to an RSU, the number of RSUs subject to this Agreement shall be increased by a number equal to the number of whole or fractional shares of Common Stock with a value equal to the value of the dividends that would have been paid on the stock deliverable pursuant to the RSUs (if such shares were outstanding), divided by the closing stock price on the dividend payment date. If the vesting date for any RSUs subject to this Agreement occurs within seven business days of the payment date for a dividend, the Company, at its option, may elect to pay to Recipient cash, net of withholding, equal to the cash dividend payable on the RSUs which so vest in lieu of increasing the number of RSUs subject to this Agreement.

(h) *Delivery on Delivery Date*. On the delivery date the Company shall deliver to Recipient a certificate for the number of shares of Common Stock represented by all RSUs having a delivery date on the same date, rounded down to the whole share. No fractional shares of Common Stock shall be issued. The Company shall pay to Recipient in cash an amount equal to the value of any fractional shares that would otherwise have been issued, valued as of the delivery date. If shares or cash are to be delivered on a particular date, the shares or cash shall be deemed delivered on that date for purposes of compliance with the terms of this Agreement if the cash or shares are actually delivered within 45 days after the specified date as determined in the Company's discretion with the Recipient having no right to determine the delivery date. Recipient shall not have any right to determine or direct the date of actual delivery; provided however, that delivery required to be made in no event later than December 31 of the calendar year in which the Performance Period ends must be made on or before such date.

(i) *Recipient's Rights as Shareholder*. Recipient shall have no rights as a shareholder with respect to the RSUs or the shares underlying them until the Company delivers the shares to Recipient on the delivery date.

(j) *Tax Withholding*. Recipient acknowledges that, not later than the actual delivery date, the value of delivered shares of Common Stock will be treated as ordinary compensation income for federal and state income and FICA tax purposes, and that the Company will be required to withhold taxes on this income amount. The Company will notify Recipient of the required withholding amount. In connection with the delivery of the certificate referred to in Section 1(h), Recipient shall pay to the Company the required withholding amount in cash or, at the election of Recipient (which election must be made on or before the vesting date), by surrendering to the Company for cancellation shares of the Company's Common Stock to be delivered with respect to the RSUs or other shares of the Company's Common Stock valued at the closing market price for the Company's Common Stock on the vesting date. If Recipient pays the withholding amount in shares of Common Stock, the Company shall pay to Recipient in cash the amount of any resulting over payment.

(k) *Section 409A*. The award made pursuant to this Agreement is intended to comply with and shall be interpreted in accordance with the requirements of Section 409A and Treasury regulations and other interpretive guidance issued thereunder, including without limitation any such regulations or other guidance issued after the grant of the award. Without limiting the generality of the foregoing, notwithstanding anything to the contrary in this Agreement:

(i) Any payment of Non-Qualified Deferred Compensation made pursuant to a voluntary or involuntary termination of employment shall be withheld and not paid until Recipient incurs both (i) such a termination of employment and (ii) a "separation from service" with the Company within the meaning of Treas. Reg. Section 1.409A-1(h).

(ii) The provisions described in Sections 1(d)(ii)(1)(B) and 1(d)(iii)(3) shall apply only if such events qualify as a "termination or liquidation of the plan" within the meaning of Treas. Reg. § 1.409A-3(j)(4)(ix);

(iii) The provisions described in Section 1(d)(ii) shall apply only if the "Change in Control" as defined in 1(d)(ii)(2) qualifies as a "change of control event" within the meaning of Treas. Reg. § 1.409A-3(i)(5)(i)

(iv) If an amount is determined to be subject to applicable provisions of Section 409A of the Code, payment in connection with termination of employment for a reason other than death may not start or be made to Recipient if the Company determines Recipient is a "key employee" as defined in Section 416(i) of the Code, without regard to Section 416(i)(5) of the Code, before the date which is six months after the date of termination, notwithstanding any other provisions for time of payment in this Agreement, if such delay in payment is necessary to comply with Section 409A of the Code. The Company may determine that Recipient is a key employee in the event of doubt or to avoid impractical efforts or expense to make an exact determination of key employees. Recipient shall have no claim, rights or remedy if the determination is not correct.

(v) The Company may adopt such amendments to the award or adopt other policies and procedures (including amendments, policies and procedures with retroactive effect), or take any other actions, that the Company determines are necessary or appropriate to (1) exempt the award from the application of Section 409A or preserve the intended tax treatment of the benefits provided with respect to the award, or (2) comply with the requirements of Section 409A.

2. **Miscellaneous**.

(a) *Entire Agreement; Amendment*. This Agreement and the Plan (including without limitation Section 17 thereof) constitute the entire agreement of the parties with regard to the subjects hereof and may be amended only by written agreement between the Company and the Recipient.

(b) *Notices*. Any notice required or permitted under this Agreement shall be in writing and shall be deemed sufficient when delivered personally to the party to whom it is addressed or when deposited into the United States mail as registered or certified mail, return receipt requested, postage prepaid, addressed to Electro Scientific Industries, Inc., Attention: Corporate Secretary, at its principal executive offices or to the Recipient at the address of Recipient in the Company's records, or at such other address as such party may designate by ten (10) days' advance written notice to the other party.

(c) *Rights and Benefits*. The rights and benefits of this Agreement shall inure to the benefit of and be enforceable by the Company's successors and assigns and, subject to the restrictions on transfer of this Agreement, be binding upon the Recipient's heirs, executors, administrators, successors and assigns.

(d) *Further Action*. The parties agree to execute such further instruments and to take such further action as may reasonably be necessary to carry out the intent of this Agreement.

(e) *Applicable Law; Attorneys' Fees*. The terms and conditions of this Agreement shall be governed by the laws of the State of Oregon. In the event either party institutes litigation hereunder, the prevailing party shall be entitled to reasonable attorneys' fees to be set by the trial court and, upon any appeal, the appellate court.

ELECTRO SCIENTIFIC INDUSTRIES, INC.

By: ______________________________
Authorized Officer

EXHIBIT A

DESIGNATION OF BENEFICIARY

Name ______________________________ **Social Security Number ____-___-_____**

I designate the following person(s) to receive any restricted stock units outstanding upon my death under the Performance-Based Restricted Stock Units Award Agreement with Electro Scientific Industries, Inc.:

Primary Beneficiary(ies)

Name_________________________ Social Security Number ____-___-_____
Birth Date _____________________ Relationship _________________________
Address___________________________ City__________ State____ Zip ________

Name_________________________ Social Security Number ____-___-_____
Birth Date _____________________ Relationship _________________________
Address___________________________ City__________ State____ Zip ________

Name_________________________ Social Security Number ____-___-_____
Birth Date _____________________ Relationship _________________________
Address___________________________ City__________ State____ Zip ________

If more than one primary beneficiary is named, the units will be divided equally among those primary beneficiaries who survive the undersigned.

Secondary Beneficiary(ies)

In the event no Primary Beneficiary is living at the time of my death, I designate the following the person(s) as my beneficiary(ies):

Name_________________________ Social Security Number ____-___-_____
Birth Date _____________________ Relationship _________________________
Address___________________________ City__________ State____ Zip ________

Name_________________________ Social Security Number ____-___-_____
Birth Date _____________________ Relationship _________________________
Address___________________________ City__________ State____ Zip ________

Name_________________________ Social Security Number ____-___-_____
Birth Date _____________________ Relationship _________________________
Address___________________________ City__________ State____ Zip ________

If more than one Secondary Beneficiary is named, the units will be divided equally among those Secondary beneficiaries who survive the undersigned.

This designation revokes and replaces all prior designations of beneficiaries under the Performance-Based Restricted Stock Units Award Agreement.

____ Date signed: ____________________, 20___
Signature

PERFORMANCE-BASED
RESTRICTED STOCK UNITS AWARD AGREEMENT

This Award Agreement (the “Agreement”) is entered into as of _________________ by and between Electro Scientific Industries, Inc., an Oregon corporation (the “Company”), and ____________________ (“Recipient”), for the grant of restricted stock units with respect to the Company’s Common Stock (“Common Stock”). By accepting this award Recipient agrees to be bound by the terms and conditions of this Agreement.

The Compensation Committee of the Company’s Board of Directors made a restricted stock units award to Recipient pursuant to the Company’s 2004 Stock Incentive Plan (the “Plan”). Recipient desires to accept the award subject to the terms and conditions of this Agreement.

IN CONSIDERATION of the mutual covenants and agreements set forth in this Agreement, the parties agree to the following:

1. **Grant and Terms of Restricted Stock Units**. The Company grants to Recipient under the Plan ___________ restricted stock units, subject to the adjustments, restrictions, terms and conditions set forth in this Agreement.

(a) *Rights under Restricted Stock Units*. A restricted stock unit (an “RSU”) represents the unsecured right to require the Company to deliver to Recipient one share of Common Stock for each RSU. The number of shares of Common Stock deliverable with respect to each RSU is subject to adjustment as determined by the Board of Directors of the Company as to the number and kind of shares of stock deliverable upon any merger, reorganization, consolidation, recapitalization, stock dividend, spin-off or other change in the corporate structure affecting the Common Stock generally.

(b) *Vesting*. The RSUs issued under this Agreement shall initially be 100% unvested and subject to forfeiture as set forth below.

(i) Except as set forth in Section 1(d), if Recipient ceases to be employed by the Company for any reason or for no reason prior to _________________, the unvested RSUs shall be forfeited to the Company.

(ii) To the extent that the number of RSUs first specified above are reduced in accordance with Section 1(b)(iii) and except as provided in Section 1(d), the reduction shall be forfeited to the Company. The extent to which any Performance Goal is achieved, if at all, shall be determined by a date that is no later than December 31 of the calendar year in which the Performance Period to which the Performance Goal relates ends. Nothing contained in this Agreement shall confer upon Recipient any right to be employed by the Company or to continue to provide services to the Company or to interfere in any way with the right of the Company to terminate Recipient’s services at any time for any reason, with or without cause.

(iii) The RSUs shall be earned based on three “Performance Goals” based on the relative performance of the Company’s Common Stock against the Russell 2000 Index, as follows:

(A) One third of the granted RSUs will be earned based on the Relative Performance Percentage for the period beginning on the date of grant and ending on the first anniversary of the date of grant (the “First Performance Period”), as follows: (i) 100% of the RSUs will be earned if the Relative Performance Percentage for the First Performance Period is equal to 100%; (ii) for every percentage point that the Relative Performance Percentage is less than 100% for the First Performance Period, three percent fewer of the RSUs available to be earned with respect to the First Performance Period will be earned, so that no RSUs will be earned with respect to that period if the Relative Performance Percentage is less than or equal to 66.7%; and (iii) for every percentage point that the Relative Performance Percentage for the First Performance Period is greater than 100%, two percent more of the RSUs available to be earned for such period will be earned, so that 150% of the target RSUs for such period will be earned if the Relative Performance Percentage is 125% for such period, provided that no more than 150% of the RSUs available to be earned in the First Performance Period may be earned based on this Performance Goal.

(B) One third of the granted RSUs will be earned based on the Relative Performance Percentage for the period beginning on the date of grant and ending on the second anniversary of the date of grant (the “Second Performance Period”), as follows: (i) 100% of the RSUs will be earned if the Relative Performance Percentage for the Second Performance Period is equal to 100%; (ii) for every percentage point that the Relative Performance Percentage is less than 100% for the Second Performance Period, three percent fewer of the RSUs available to be earned with respect to the Second Performance Period will be earned, so that no RSUs will be earned with respect to that period if the Relative Performance Percentage is less than or equal to 66.7%; and (iii) for every percentage point that the Relative Performance Percentage for the Second Performance Period is greater than 100%, two percent more of the RSUs available to be earned for such period will be earned, so that 200% of the target RSUs for such period will be earned if the Relative Performance Percentage is 150% for such period, provided that no more than 200% of the RSUs available to be earned in the Second Performance Period may be earned based on this Performance Goal.

(C) The full number of granted RSUs will be earned based on the Relative Performance Percentage for the period beginning on the date of grant and ending on the third anniversary of the date of grant (the “Third Performance Period”), as follows: (i) 100% of the RSUs will be earned if the Relative Performance Percentage for the Third Performance Period is equal to 100%; (ii) for every percentage point that the Relative Performance Percentage is less than 100% for the Third Performance Period, three percent fewer of the RSUs available to be earned with respect to the Third Performance Period will be earned, so that no RSUs will be earned with respect to that period if the Relative Performance Percentage is less than or equal to

66.7%; and (iii) for every percentage point that the Relative Performance Percentage for the Third Performance Period is greater than 100%, two percent more of the RSUs available to be earned for such period will be earned, so that 200% of the target RSUs for such period will be earned if the Relative Performance Percentage is 150% for such period, provided that no more than 200% of the RSUs available to be earned at target performance in the Third Performance Period may be earned based on this Performance Goal, with such number reduced by the aggregate number of RSUs earned with respect to the First Performance Period and the Second Performance Period (but with such reduction not to reduce the number of RSUs earned in the Third Performance Period below zero).

(D) Notwithstanding anything in this Agreement to the contrary, the total number of RSUs that are earned under this Agreement shall not exceed the lesser of (i) a number of shares with an aggregate value, based on the closing price of the Company's Common Stock on the last trading date preceding the vesting date, that is five times the result of (A) __________by (B) __________, rounded down to the nearest whole share, and (ii) 200% of the number of RSUs set forth in the first sentence of Section 1.

(E) Performance of the Company's Common Stock relative to the Russell 2000 Index for a given Performance Period will be measured as follows:

(i) To determine relative performance, the baseline metrics are the 30 trading day average closing price of the Company's Common Stock and the Russell 2000 Index, as reported in The Wall Street Journal, or such other reliable source as is determined by the Compensation Committee or the Board of Directors, in its sole discretion, with the last of the 30 trading days falling on the first market open date directly preceding the date of grant. This 30 day average establishes both the Company baseline stock price (the "Company Baseline Stock Price") and the Russell 2000 Index baseline (the "Russell 2000 Baseline") against which future Company stock and Russell 2000 Index performance will be compared.

(ii) Next, the Company will measure the 30 trading day average closing price of the Company and the Russell 2000 Index, as reported in The Wall Street Journal, or such other reliable source as is determined by the Compensation Committee or the Board of Directors, in its sole discretion, with the last trading day of such 30 trading day period ending on the last trading day of the applicable Performance Period (establishing both the "Company Closing Price" and the "Russell 2000 Index Closing Price" for such Performance Period).

(iii) The Company will then measure Company performance for a given Performance Period by dividing the Company Closing Price by the Company Baseline Stock Price, with the quotient expressed as a percentage of the Company Baseline Stock Price (the "Company Percentage Performance"). The Company will then measure Russell 2000 Index Performance over the same period by dividing the Russell 2000 Index Closing Price by the Russell 2000 Index Baseline with the quotient expressed as a percentage of the Russell 2000 Index Baseline (the "Russell 2000 Index Percentage Performance").

(iv) The Company will then subtract the Russell 2000 Index Percentage Performance from the Company Percentage Performance, then add 100 to the result, with the final result constituting the relative Company Common Stock performance as a percentage (the “Relative Performance Percentage”).

(F) “Performance Period” means any of the First Performance Period, the Second Performance Period or the Third Performance Period.

(G) The number of RSUs determined pursuant to clauses (A), (B) and (C) of this Section 1(b)(iii) (subject to the limitations in clause (D)) shall vest on the last day of the Third Performance Period, subject to Section 1(b)(i). Except as provided in Section 1(d), any RSUs that are not vested at the end of the Third Performance Period shall be forfeited.

(c) *Delivery Date*. Except as set forth in Section 1(d)(iv), the delivery date for shares of Common Stock with respect to RSUs earned subject to this Agreement shall be as soon as practicable after the Third Performance Period ends, but in no event later than December 31 of the calendar year in which such fiscal year ends.

(d) Proration upon Termination for Certain Reasons Prior to End of Performance Period; Treatment on Change in Control.

(i) *Proration on Death or Total Disability*. If Recipient ceases to be an employee of the Company prior to the end of the Performance Period by reason of Recipient’s death or total disability, the RSUs that have not otherwise vested or been forfeited pursuant to Section 1(b)(iii)(G) shall not be forfeited under Section 1(b)(i) and the following shall apply:

(1) With respect to any Performance Period that is completed prior to Recipient’s termination of employment, the number of RSUs earned with respect to such Performance Period(s) shall not be reduced.

(2) With respect to the any Performance Period during which Recipient’s employment terminates, the number of RSUs Recipient would otherwise be entitled to receive pursuant to Section 1(b)(iii) with respect to that Performance Period if Recipient were employed through the end of that Performance Period (the “Base Payout”) shall be reduced to a number determined by multiplying the Base Payout by a percentage calculated by dividing the number of months elapsed from the beginning of such Performance Period to the date of termination of employment (rounded down to the whole month) by the number of months in such Performance Period. RSUs for the Performance Period in which employment terminates that exceed the reduced number shall be forfeited to the Company.

(3) The shares of Common Stock with respect to RSUs determined under (1) and (2) shall be delivered as soon as practicable on or after the end of the Third Performance Period in which employment terminates, but in no event later than December 31 of the calendar year in which the Third Performance Period ends.

(4) The term "total disability" means a medically determinable mental or physical impairment that is expected to result in death or has lasted or is expected to last for a continuous period of 12 months or more and that, in the opinion of the Company and two independent physicians approved by the Company, causes Recipient to be unable to perform his or her duties as an employee, director, officer or consultant of the Company and unable to engage in any substantial gainful activity. Total disability shall be deemed to have occurred after both of the following have occurred:

(A) The two independent physicians have furnished their written opinion of total disability to the Company; and

(B) The Company has reached an opinion of total disability.

(ii) *Double Trigger Acceleration on Change in Control*.

(1) The number of unvested RSUs Recipient would otherwise be entitled to receive pursuant to Section 1(b)(iii) if Recipient were employed through the end of the Third Performance Period shall immediately vest (provided, however, that if vesting occurs pursuant to this Section 1(d)(ii) during or prior to the end of a Performance Period that has not yet ended it will be conclusively presumed that the RSUs would have been at the 100% vesting level for each such unfinished Performance Period, subject to any action taken by the Compensation Committee or the Board of Directors pursuant to clause (1) or (2) of Section 1(d)(iii), including the final paragraph of Section 1(d)(iii)) if a Change in Control (as defined below) occurs and either:

(A) at any time after the Change in Control and on or before the first anniversary of the Change in Control, (i) the Recipient's employment is terminated by the Company (or its successor) without Cause (as defined below), or (ii) the Recipient's employment is terminated by the Recipient for Good Reason (as defined below); or

(B) at any time after the Change in Control (i) the Company or the surviving or acquiring entity terminates this Agreement and all similar agreements, including because the achievement of any of the Performance Goals becomes reasonably unable to be determined;

Notwithstanding the foregoing, the RSUs may also immediately vest in connection with a sale of the Company as provided in Section 1(d)(iii) below.

(2) For purposes of this Agreement, a “Change in Control” of the Company shall mean the occurrence of any of the following events:

(A) At any time during a period of two consecutive years, individuals who at the beginning of such period constituted the Board of Directors of the Company (“Incumbent Directors”) shall cease for any reason to constitute at least a majority thereof; provided, however, that the term “Incumbent Director” shall also include each new director elected during such two-year period whose nomination or election was approved by two-thirds of the Incumbent Directors then in office;

(B) Any “person” or “group” (within the meaning of Sections 13(d) and 14(d)(2) of the Exchange Act) shall, as a result of a tender or exchange offer, open market purchases or privately negotiated purchases from anyone other than the Company, have become the beneficial owner (within the meaning of Rule 13d-3 under the Exchange Act), directly or indirectly, of more than fifty percent (50%) of the then outstanding Common Stock of the Company;

(C) A consolidation, merger or plan of exchange involving the Company (“Merger”) as a result of which the holders of outstanding securities of the Company ordinarily having the right to vote for the election of directors (“Voting Securities”) immediately prior to the Merger do not continue to hold at least fifty percent (50%) of the combined voting power of the outstanding Voting Securities of the surviving corporation or a parent corporation of the surviving corporation immediately after the Merger, disregarding any Voting Securities issued to or retained by such holders in respect of securities of any other party to the Merger; or

(D) A sale, lease, exchange, or other transfer (in one transaction or a series of related transactions) of all or substantially all of the assets of the Company.

(3) For purposes of this Agreement, “Cause” shall mean (a) the willful and continued failure to perform substantially the Recipient’s reasonably assigned duties with the Company (or its successor) (other than any such failure resulting from incapacity due to physical or mental illness) after a demand for substantial performance is delivered to the Recipient by the Company (or its successor) which specifically identifies the manner in which the Company (or its successor) believes that the Recipient has not substantially performed the Recipient’s duties, (b) the willful engagement in illegal conduct which is materially and demonstrably injurious to the Company (or its successor), or (c) the commission of an act by Recipient, or the failure of Recipient to act, which constitutes gross negligence or gross misconduct. No act, or failure to act, shall be considered “willful” if the Recipient reasonably believed that the action or omission was in, or not opposed to, the best interests of the Company (or its successor).

(4) For purposes of this Agreement, “Good Reason” shall mean:

(A) the assignment of a different title, job or responsibilities that results in a decrease in the level of responsibility of the Recipient after the Change in Control when compared to the Recipient’s level of responsibility for the Company’s operations prior to the Change in Control; provided that Good Reason shall not exist if the Recipient continues to have the same or a greater general level of responsibility for Company operations after the Change in Control as the Recipient had prior to the Change in Control even if the Company operations are a subsidiary or division of the surviving company;

(B) a reduction in the Recipient’s base pay as in effect immediately prior to the Change in Control;

(C) a material reduction in total benefits available to the Recipient under cash incentive, stock incentive and other employee benefit plans after the Change in Control compared to the total package of such benefits as in effect prior to the Change in Control; or

(D) the Recipient is required to be based more than 50 miles from where the Recipient’s office is located immediately prior to the Change in Control except for required travel on company business to an extent substantially consistent with the business travel obligations which the Recipient undertook on behalf of the Company prior to the Change in Control; or

(E) the failure by any successor to the Company to expressly assume this Agreement or any obligation under this Agreement.

Recipient may not resign for Good Reason without first providing the Company with written notice within 90 days of the initial existence of the condition that Recipient believes constitutes Good Reason specifically identifying the acts or omissions constituting the grounds for Good Reason and a reasonable cure period of not less than 30 days following the date of such notice.

For purposes of the “Good Reason” definition, the term “Company” will be interpreted to include any subsidiary, parent, affiliate or successor thereto, if applicable.

(iii) *Sale of the Company*. If there shall occur a merger, consolidation or plan of exchange involving the Company pursuant to which the outstanding shares of Common Stock of the Company are converted into cash or other stock, securities or property, or a sale, lease, exchange or other transfer (in one transaction or a series of related transactions) of all, or substantially all, the assets of the Company, then, as determined by the Committee or the Board of Directors, either:

(1) the unvested RSUs shall be converted into restricted stock units for stock of the surviving or acquiring corporation in the applicable transaction, with the amount and type of shares subject thereto to be conclusively determined by the Committee, taking into account the relative values of the companies involved in the

applicable transaction and the exchange rate, if any, used in determining shares of the surviving corporation to be held by the former holders of the Company's Common Stock following the applicable transaction, and disregarding fractional shares, with the dates for vesting of RSUs, payment and other terms of this Agreement unchanged;

(2) the unvested RSUs shall be converted into a cash payment obligation of the surviving or acquiring corporation in an amount equal to the proceeds a holder of the underlying shares would have received in proceeds from such transaction with respect to those shares, with the dates for vesting of RSUs, payment and other terms of this Agreement unchanged; or

(3) all of the unvested RSUs shall immediately vest based on the number of RSUs earned for completed Performance Periods and assuming 100% earning level for any uncompleted Performance Periods and all underlying shares shall be delivered simultaneously with the closing of the applicable transaction such that the Recipient will participate as a shareholder in receiving proceeds from such transaction with respect to those shares.

In the case of (1) and (2) if any Performance Period has not been completed as of the date of the transaction, the Company Closing Price for such Performance Period shall be deemed to be the price per share received by the Company's stockholders in the transaction. Relative performance for such uncompleted Performance Period shall then be measured against the Russell 2000 Index performance from the Russell 2000 Index Baseline through the 30 trading day average closing price of the Russell 2000 Index in the period ending on the date of the closing of the transaction. The Company's stock performance relative to the Russell 2000 Index shall then be determined consistently with the methodology specified herein for completed Performance Periods. The number of RSUs subject to this Agreement so determined shall then continue to vest based upon Recipient's continuing service to the Company, the acquirer, or their parents or subsidiaries through May 9, 2021, subject to accelerated vesting as set forth in Section 1(d)(ii).

(iv) *Delivery Date*. For purposes of Section 1(d)(ii) or (iii), the delivery date for shares of Common Stock with respect to RSUs shall be as soon as practicable on or after the vesting described in such sections.

(e) *Forfeiture of RSUs on Other Terminations of Employment*. If Recipient ceases to be an employee of the Company for any reason that does not result in acceleration or payment pursuant to Section 1(d), Recipient shall immediately forfeit all outstanding but unvested RSUs granted pursuant to this Agreement and Recipient shall have no right to receive the related Common Stock.

(f) *Restrictions on Transfer and Delivery on Death*. Recipient may not sell, transfer, assign, pledge or otherwise encumber or dispose of the RSUs. If Recipient dies before the delivery date, the shares will be released with the Company's brokerage, or Recipient's brokerage if separately designated. Recipient should maintain proper beneficiary designations with the brokerage and/or ensure Recipient's estate is aware of the share's location for proper delivery.

(g) *Reinvestment of Dividend Equivalents*. On each date on which the Company pays a dividend on a share of Common Stock with respect to an RSU, the number of RSUs subject to this Agreement shall be increased by a number equal to the number of whole or fractional shares of Common Stock with a value equal to the value of the dividends that would have been paid on the stock deliverable pursuant to the RSUs (if such shares were outstanding), divided by the closing stock price on the dividend payment date. If the vesting date for any RSUs subject to this Agreement occurs within seven business days of the payment date for a dividend, the Company, at its option, may elect to pay to Recipient cash, net of withholding, equal to the cash dividend payable on the RSUs which so vest in lieu of increasing the number of RSUs subject to this Agreement.

(h) *Delivery on Delivery Date*. On the delivery date the Company shall deliver to Recipient a certificate for the number of shares of Common Stock represented by all RSUs having a delivery date on the same date, rounded down to the whole share. No fractional shares of Common Stock shall be issued. The Company shall pay to Recipient in cash an amount equal to the value of any fractional shares that would otherwise have been issued, valued as of the delivery date. If shares or cash are to be delivered on a particular date, the shares or cash shall be deemed delivered on that date for purposes of compliance with the terms of this Agreement if the cash or shares are actually delivered within 45 days after the specified date as determined in the Company's discretion with the Recipient having no right to determine the delivery date. Recipient shall not have any right to determine or direct the date of actual delivery; provided however, that delivery required to be made in no event later than December 31 of the calendar year in which the Performance Period ends must be made on or before such date.

(i) *Recipient's Rights as Shareholder*. Recipient shall have no rights as a shareholder with respect to the RSUs or the shares underlying them until the Company delivers the shares to Recipient on the delivery date.

(j) *Tax Withholding*. Recipient acknowledges that, not later than the actual delivery date, the value of delivered shares of Common Stock will be treated as ordinary compensation income for federal and state income and FICA tax purposes, and that the Company will be required to withhold taxes on this income amount. The Company will notify Recipient of the required withholding amount. In connection with the delivery of the certificate referred to in Section 1(h), Recipient shall pay to the Company the required withholding amount in cash or, at the election of Recipient (which election must be made on or before the vesting date), by surrendering to the Company for cancellation shares of the Company's Common Stock to be delivered with respect to the RSUs or other shares of the Company's Common Stock valued at the closing market price for the Company's Common Stock on the vesting date. If Recipient pays the withholding amount in shares of Common Stock, the Company shall pay to Recipient in cash the amount of any resulting over payment.

(k) *Section 409A*. The award made pursuant to this Agreement is intended to comply with and shall be interpreted in accordance with the requirements of Section 409A and Treasury regulations and other interpretive guidance issued thereunder, including without limitation any such regulations or other guidance issued after the grant of the award. Without limiting the generality of the foregoing, notwithstanding anything to the contrary in this Agreement:

(i) Any payment of Non-Qualified Deferred Compensation made pursuant to a voluntary or involuntary termination of employment shall be withheld and not paid until Recipient incurs both (i) such a termination of employment and (ii) a “separation from service” with the Company within the meaning of Treas. Reg. Section 1.409A-1(h).

(ii) The provisions described in Sections 1(d)(ii)(1)(B) and 1(d)(iii)(3) shall apply only if such events qualify as a “termination or liquidation of the plan” within the meaning of Treas. Reg. § 1.409A-3(j)(4)(ix);

(iii) The provision described in Section 1(d)(iii)(1) shall apply only if such events qualify as a “change of control event” within the meaning of Treas. Reg. § 1.409A- 3(i)(5)(i).

(iv) If an amount is determined to be subject to applicable provisions of Section 409A of the Code, payment in connection with termination of employment for a reason other than death may not start or be made to Recipient if the Company determines Recipient is a “key employee” as defined in Section 416(i) of the Code, without regard to Section 416(i)(5) of the Code, before the date which is six months after the date of termination, notwithstanding any other provisions for time of payment in this Agreement, if such delay in payment is necessary to comply with Section 409A of the Code. The Company may determine that Recipient is a key employee in the event of doubt or to avoid impractical efforts or expense to make an exact determination of key employees. Recipient shall have no claim, rights or remedy if the determination is not correct.

(v) The Company may adopt such amendments to the award or adopt other policies and procedures (including amendments, policies and procedures with retroactive effect), or take any other actions, that the Company determines are necessary or appropriate to (1) exempt the award from the application of Section 409A or preserve the intended tax treatment of the benefits provided with respect to the award, or (2) comply with the requirements of Section 409A.

2. **Miscellaneous**.

(a) *Entire Agreement; Amendment*. This Agreement and the Plan (including without limitation Section 17 thereof) constitute the entire agreement of the parties with regard to the subjects hereof and may be amended only by written agreement between the Company and the Recipient.

(b) *Notices*. Any notice required or permitted under this Agreement shall be in writing and shall be deemed sufficient when delivered personally to the party to whom it is addressed or when deposited into the United States mail as registered or certified mail, return receipt requested, postage prepaid, addressed to Electro Scientific Industries, Inc., Attention: Corporate Secretary, at its principal executive offices or to the Recipient at the address of Recipient in the Company's records, or at such other address as such party may designate by ten (10) days' advance written notice to the other party.

(c) *Rights and Benefits*. The rights and benefits of this Agreement shall inure to the benefit of and be enforceable by the Company's successors and assigns and, subject to the restrictions on transfer of this Agreement, be binding upon the Recipient's heirs, executors, administrators, successors and assigns.

(d) *Further Action*. The parties agree to execute such further instruments and to take such further action as may reasonably be necessary to carry out the intent of this Agreement.

(e) *Applicable Law; Attorneys' Fees*. The terms and conditions of this Agreement shall be governed by the laws of the State of Oregon. In the event either party institutes litigation hereunder, the prevailing party shall be entitled to reasonable attorneys' fees to be set by the trial court and, upon any appeal, the appellate court.

Exhibit 10.44

MKS INSTRUMENTS, INC.
RSU ASSUMPTION AGREEMENT
FOR U.S. EMPLOYEES

Holder: [____________________]

RESTRICTED STOCK UNIT ASSUMPTION AGREEMENT effective as of February __, 2019 (the "***RSU Assumption Agreement***").

WHEREAS, MKS Instruments, Inc., a Massachusetts corporation ("***MKS***"), has acquired Electro Scientific Industries, Inc., an Oregon corporation ("***ESI***"), through the merger of a wholly owned MKS subsidiary into ESI (the "***Merger***"), pursuant to the Agreement and Plan of Merger by and among MKS, ESI and such subsidiary dated as of October 29, 2018, as may have been amended from time to time (the "***Merger Agreement***").

WHEREAS, before the consummation of the Merger, you held one or more outstanding awards of restricted stock units ("***RSUs***") with respect to shares of the common stock of ESI, no par value per share ("***ESI Common Stock***"), that you received either under the Electro Scientific Industries, Inc. 2004 Stock Incentive Plan, as such plan has been amended from time to time, most recently on August 18, 2016 (the "***ESI Plan***"), or outside of the ESI Plan as a material inducement to commence employment with ESI, each of which is evidenced by a Restricted Stock Units Award Agreement, as each such agreement may have been amended from time to time (an "***RSU Agreement***").

WHEREAS, the provisions of the Merger Agreement required MKS to assume, at the effective time of the Merger (the "***Effective Time***"), each RSU award that was outstanding as of immediately prior to the Effective Time. Under the assumption, MKS has converted the number of shares of ESI Common Stock covered by each such RSU award into shares of MKS common stock, no par value per share ("***MKS Common Stock***"), using an exchange ratio (the "***Equity Award Exchange Ratio***") determined based on the Merger consideration and pre-closing trading prices for the MKS Common Stock pursuant to a method specified in the Merger Agreement. MKS has provided you the actual Equity Award Exchange Ratio in the employee communication to you regarding the conversion.

WHEREAS, the purpose of this RSU Assumption Agreement is to evidence MKS's assumption of your outstanding RSU award identified on Annex A hereto at the Effective Time and to reflect certain adjustments to such RSU award that were necessary or advisable in connection with their assumption by MKS.

NOW, THEREFORE, MKS and you agree as follows:

1. MKS has assumed, as of the Effective Time, all the duties and obligations of ESI under the RSU award identified on Annex A hereto (the "***ESI RSUs***" and, as assumed, the "***Assumed ESI RSUs***") and will issue from the MKS Instruments, Inc. 2014 Stock Incentive Plan, as it may be amended or replaced from time to time (the "***MKS Incentive Plan***"), any shares that become distributable with respect to the Assumed ESI RSUs. In connection with such assumption, the number of shares of MKS Common Stock under the Assumed ESI RSU award covered by this RSU Assumption Agreement reflects the Equity Award Exchange Ratio, resulting in Assumed ESI RSUs for the number of shares of MKS Common Stock indicated on Annex A hereto. If you also held other ESI equity compensation awards at the Effective Time, including other RSUs that were granted subject to vesting based solely on the satisfaction of service conditions, those other awards are covered under one or more separate assumption agreements.

2. By clicking acceptance of this RSU Assumption Agreement, you hereby acknowledge receipt of this RSU Assumption Agreement and understand that all rights and liabilities with respect to your Assumed ESI RSU award are as set forth in the applicable RSU Agreement, the ESI Plan (to the extent incorporated into the RSU Agreement) and this RSU Assumption Agreement.

3. The intent of the foregoing adjustments to your ESI RSUs is to preserve their value as determined in connection with the Merger, and you agree that this assumption satisfies Section 12.2-2 of the ESI Plan, if applicable, and the relevant provision of the applicable RSU Agreement.

4. The following provisions will govern the Assumed ESI RSU award:

(a) Unless the context otherwise requires, all references in the applicable RSU Agreement and the ESI Plan (to the extent incorporated into such RSU Agreement) are adjusted as follows: (i) all references to the "Company" mean ESI (after the merger with a subsidiary of MKS) and any successor entity into which ESI is subsequently merged subject to subsection (d) below, and, for purposes of "Reorganization Event" under the MKS Incentive Plan, MKS, (ii) all references to "Stock," "Common Stock" or "Shares" mean shares of MKS Common Stock, (iii) all references to the "Board" mean the Board of Directors of MKS or the Compensation Committee of such Board and (iv) any interpretation of corporate law for purposes of the Assumed ESI RSU award will be under Massachusetts law rather than Oregon law.

(b) All other provisions governing the vesting and termination of the Assumed ESI RSU award, including any post-Effective Time rights to acceleration you may have under the applicable RSU Agreement or otherwise, remain the same as set forth in the applicable RSU Agreement (or other applicable agreement), and those provisions (and any related provisions of the ESI Plan incorporated by reference into such RSU Agreement) will accordingly govern and control your rights under this RSU Assumption Agreement to receive MKS Common Stock under the Assumed ESI RSUs covered by this RSU Assumption Agreement.

(c) No accelerated vesting of the shares to be received under the ESI RSU awards has occurred solely by reason of the Merger or MKS's assumption of those RSUs. Accordingly, the Assumed ESI RSU award represented by this RSU Assumption Agreement will continue to vest in accordance with the same installment vesting schedule in effect for the shares covered by the applicable ESI RSUs (as set forth in the applicable RSU Agreement) immediately prior to the Effective Time except that the number of shares of MKS Common Stock subject to each installment of such vesting schedule has been adjusted to reflect the Equity Award Exchange Ratio. This statement is not intended to override any post-Effective Time rights to acceleration you may have under the RSU Agreement or any other agreement with ESI. For the avoidance of doubt and notwithstanding anything to the contrary in the applicable RSU Agreement, any pro-rata acceleration provisions in any Assumed ESI RSU award (such as in connection with death or disability, as applicable) shall take into account the Equity Award Exchange Ratio and any shares that vested before the Effective Time.

(d) For purposes of applying any and all provisions of the applicable RSU Agreement and the ESI Plan relating to your status as an employee of ESI or its parent or subsidiaries for purposes of determining your continuous employment, you will be deemed to be continuously employed for as long as you continue to render services as an employee to MKS or any present or future parent company or majority-owned subsidiary of MKS. Accordingly, the provisions of the applicable RSU Agreement governing the termination of the Assumed ESI RSUs in connection with your ceasing to be an employee will, after the Effective Time, be applied on the basis of your cessation of employee status with MKS and its parent and majority-owned subsidiaries.

(e) Shares of MKS Common Stock delivered to you upon settlement of your Assumed ESI RSU shall not be rounded down to the nearest whole share. Rather, fractional shares of MKS Common Stock, if any, shall be delivered to you.

(f) Tax Withholding. MKS's obligation to deliver Shares to you upon the vesting of the RSUs shall be subject to the satisfaction of all income tax (including federal, state and local taxes), social insurance, payroll tax, payment on account or other tax-related withholding requirements ("***Tax Withholding***"). In order to satisfy all Tax Withholding related to your RSUs, you agree to the following:

(i) MKS shall determine the amount of any taxes that MKS or any affiliated company may be obligated to withhold with respect to the grant, vesting, or other event with respect to the RSUs. MKS expects to withhold a sufficient number of shares of MKS Common Stock in connection with such event to satisfy the amount of any such Tax Withholding that arises. The amount of taxable compensation that you will recognize in connection with any such event and the fair market value of such withheld Shares will be based on the closing price of MKS Common Stock on the respective vesting date, provided, however, that if such date is not a trading day, MKS will use the closing price on the first trading day following such date. MKS may take such action without notice to you and will then remit to you the balance of any proceeds from withholding such shares in excess of the amount reasonably determined to be necessary to satisfy such Tax Withholding obligations. You will have no discretion as to the satisfaction of Tax Withholding obligations in such manner. If, however, MKS for any reason does not satisfy the Tax Withholding obligations with respect to the vesting of the RSUs as provided above in this Section 4(f)(i) or otherwise pays taxes on your behalf (that are your responsibility), MKS or its affiliate shall be entitled to require a cash payment by or on behalf of you and/or to deduct from other compensation payable to you the amount of any such Tax Withholding obligations or MKS-paid taxes that are your responsibility.

(ii) You acknowledge and agree that you have had an opportunity to review with your own tax advisors the federal, state, local and non-U.S. tax consequences of the Assumed ESI RSU award and the transactions contemplated by this RSU Assumption Agreement. You are relying solely on such advisors and not on any statements or representations of MKS, ESI, or any of their affiliates or agents. You understand that you (and not MKS, ESI or their affiliates) shall be responsible for your own tax liability that may arise as a result of the Assumed ESI RSU award or the transactions contemplated by this RSU Assumption Agreement.

5. Except to the extent specifically modified by this RSU Assumption Agreement, all of the terms and conditions of the applicable RSU Agreement as in effect immediately prior to the Effective Time continue in full force and effect and are not in any way amended, revised or otherwise affected by this RSU Assumption Agreement.

IN WITNESS WHEREOF, MKS Instruments, Inc. has caused this RSU Assumption Agreement to be delivered on its behalf by its duly-authorized officer or agent.

MKS INSTRUMENTS, INC.

By: [Insert electronic signature]
Gerald G. Colella, CEO

Date: __________, 2019

Annex A

Name of RSU Holder [__________________________]

Original Grant Date	**Number of shares of ESI Common Stock subject to RSUs at the Effective Time**	**Number of shares of MKS Common Stock under RSUs After Conversion**

(The number of shares of MKS Common Stock following the conversion has been calculated by multiplying the number of shares of ESI Common Stock represented by the RSUs at the Effective Time by the Equity Award Exchange Ratio and rounding to the nearest whole share.)

Exhibit 10.45

MKS INSTRUMENTS, INC.
RSU ASSUMPTION AGREEMENT
FOR EMPLOYEES OUTSIDE OF THE UNITED STATES

Holder: [__________________]

RESTRICTED STOCK UNIT ASSUMPTION AGREEMENT effective as of February __, 2019 (the "***RSU Assumption Agreement***").

WHEREAS, MKS Instruments, Inc., a Massachusetts corporation ("***MKS***"), has acquired Electro Scientific Industries, Inc., an Oregon corporation ("***ESI***"), through the merger of a wholly owned MKS subsidiary into ESI (the "***Merger***"), pursuant to the Agreement and Plan of Merger by and among MKS, ESI and such subsidiary dated as of October 29, 2018, as may have been amended from time to time (the "***Merger Agreement***").

WHEREAS, before the consummation of the Merger, you held one or more outstanding awards of restricted stock units ("***RSUs***") with respect to shares of the common stock of ESI, no par value per share ("***ESI Common Stock***"), that you received either under the Electro Scientific Industries, Inc. 2004 Stock Incentive Plan, as such plan has been amended from time to time, most recently on August 18, 2016 (the "***ESI Plan***"), or outside of the ESI Plan as a material inducement to commence employment with ESI, each of which is evidenced by a Restricted Stock Units Award Agreement, as each such agreement may have been amended from time to time (an "***RSU Agreement***").

WHEREAS, the provisions of the Merger Agreement required MKS to assume, at the effective time of the Merger (the "***Effective Time***"), each RSU award that was outstanding as of immediately prior to the Effective Time. Under the assumption, MKS has converted the number of shares of ESI Common Stock covered by each such RSU award into shares of MKS common stock, no par value per share ("***MKS Common Stock***"), using an exchange ratio (the "***Equity Award Exchange Ratio***") determined based on the Merger consideration and pre-closing trading prices for the MKS Common Stock pursuant to a method specified in the Merger Agreement. MKS has provided you the actual Equity Award Exchange Ratio in the employee communication to you regarding the conversion.

WHEREAS, the purpose of this RSU Assumption Agreement is to evidence MKS's assumption of your outstanding RSU award identified on Annex A hereto at the Effective Time and to reflect certain adjustments to such RSU award that were necessary or advisable in connection with their assumption by MKS.

NOW, THEREFORE, MKS and you agree as follows:

1. MKS has assumed, as of the Effective Time, all the duties and obligations of ESI under the RSU award identified on Annex A hereto (the "***ESI RSUs***" and, as assumed, the "***Assumed ESI RSUs***") and will issue from the MKS Instruments, Inc. 2014 Stock Incentive Plan as it may be amended or replaced from time to time (the "***MKS Incentive Plan***"), any shares that become distributable with respect to the Assumed ESI RSUs. In connection with such assumption, the number of shares of MKS Common Stock under the Assumed ESI RSU award covered by this RSU Assumption Agreement reflects the Equity Award Exchange Ratio, resulting in Assumed ESI RSUs for the number of shares of MKS Common Stock indicated on Annex A hereto. If you also held other ESI equity compensation awards at the Effective Time, including other RSUs that were granted subject to vesting based solely on the satisfaction of service conditions, those other awards are covered under one or more separate assumption agreements.

2. By clicking acceptance of this RSU Assumption Agreement, you hereby acknowledge receipt of this RSU Assumption Agreement and understand that all rights and liabilities with respect to your Assumed ESI RSU award are as set forth in the applicable RSU Agreement, the ESI Plan (to the extent incorporated into the RSU Agreement) and this RSU Assumption Agreement.

3. The intent of the foregoing adjustments to your ESI RSUs is to preserve their value as determined in connection with the Merger, and you agree that this assumption satisfies Section 12.2-2 of the ESI Plan, if applicable, and the relevant provision of the applicable RSU Agreement.

4. The following provisions will govern the Assumed ESI RSU award:

(a) Unless the context otherwise requires, all references in the applicable RSU Agreement and the ESI Plan (to the extent incorporated into such RSU Agreement) are adjusted as follows: (i) all references to the “Company” mean ESI (after the merger with a subsidiary of MKS) and any successor entity into which ESI is subsequently merged subject to subsection (d) below, and, for purposes of “Reorganization Event” under the MKS Incentive Plan, MKS, (ii) all references to “Stock,” “Common Stock” or “Shares” mean shares of MKS Common Stock, (iii) all references to the “Board” mean the Board of Directors of MKS or the Compensation Committee of such Board and (iv) any interpretation of corporate law for purposes of the Assumed ESI RSU award will be under Massachusetts law rather than Oregon law.

(b) All other provisions governing the vesting and termination of the Assumed ESI RSU award, including any post-Effective Time rights to acceleration you may have under the applicable RSU Agreement or otherwise, remain the same as set forth in the applicable RSU Agreement (or other applicable agreement), and those provisions (and any related provisions of the ESI Plan incorporated by reference into such RSU Agreement) will accordingly govern and control your rights under this RSU Assumption Agreement to receive MKS Common Stock under the Assumed ESI RSUs covered by this RSU Assumption Agreement.

(c) No accelerated vesting of the shares to be received under the ESI RSU awards has occurred solely by reason of the Merger or MKS’s assumption of those RSUs. Accordingly, the Assumed ESI RSU award represented by this RSU Assumption Agreement will continue to vest in accordance with the same installment vesting schedule in effect for the shares covered by the applicable ESI RSUs (as set forth in the applicable RSU Agreement) immediately prior to the Effective Time except that the number of shares of MKS Common Stock subject to each installment of such vesting schedule has been adjusted to reflect the Equity Award Exchange Ratio. This statement is not intended to override any post-Effective Time rights to acceleration you may have under the RSU Agreement or any other agreement with ESI. For the avoidance of doubt and notwithstanding anything to the contrary in the applicable RSU Agreement, any pro-rata acceleration provisions in any Assumed ESI RSU award (such as in connection with death or disability, as applicable) shall take into account the Equity Award Exchange Ratio and any shares that vested before the Effective Time.

(d) For purposes of applying any and all provisions of the applicable RSU Agreement and the ESI Plan relating to your status as an employee of, ESI or its parent or subsidiaries for purposes of determining your continuous employment, you will be deemed to be continuously employed for as long as you continue to render services as an employee to MKS or any present or future parent company or majority-owned subsidiary of MKS. Accordingly, the provisions of the applicable RSU Agreement governing the termination of the Assumed ESI RSUs in connection with your ceasing to be an employee will, after the Effective Time, be applied on the basis of your cessation of employee status with MKS and its parent and majority-owned subsidiaries.

(e) Shares of MKS Common Stock delivered to you upon settlement of your Assumed ESI RSU shall not be rounded down to the nearest whole share. Rather, fractional shares of MKS Common Stock, if any, shall be delivered to you.

(f) Taxes.

(i) MKS’s obligation to deliver Shares to you upon the vesting of the RSUs shall be subject to your satisfaction of all income tax, social insurance, payroll tax, payment on account, or other tax related requirements (“***Tax Obligations***”).

(ii) You have reviewed with your own tax advisors the Tax Obligations applicable to you with respect to this Assumed ESI RSU award and the transactions contemplated by this RSU Assumption Agreement. You are relying solely on such advisors and not on any statements or representations of MKS, ESI, or any of their affiliates or agents. You understand that you (and not MKS, ESI or their affiliates) shall be responsible for complying with your own Tax Obligations that may arise as a result of this Assumed ESI RSU award or the transactions contemplated by this RSU Assumption Agreement.

(iii) MKS or its affiliates may be required to withhold amounts to satisfy Tax Obligations on your behalf. To the extent that MKS or any of its affiliates pays on your behalf any Tax Obligations for which you are responsible, MKS shall be entitled to require a cash payment by or on behalf of you and/or to deduct from other compensation payable to you the amount of any such Tax Obligations paid by MKS or its affiliates.

(g) Additional Provisions. The Assumed ESI RSU award shall also be subject to provisions set forth on Exhibit A attached hereto, as applicable.

5. Except to the extent specifically modified by this RSU Assumption Agreement, all of the terms and conditions of the applicable RSU Agreement as in effect immediately prior to the Effective Time continue in full force and effect and are not in any way amended, revised or otherwise affected by this RSU Assumption Agreement.

IN WITNESS WHEREOF, MKS Instruments, Inc. has caused this RSU Assumption Agreement to be delivered on its behalf by its duly-authorized officer or agent.

MKS INSTRUMENTS, INC.

By: [Insert electronic signature]
Gerald G. Colella, CEO

Date: ___________, 2019

Annex A

Name of RSU Holder [______________________________]

Original Grant Date	Number of shares of ESI Common Stock subject to RSUs at the Effective Time	Number of shares of MKS Common Stock under RSUs After Conversion

(The number of shares of MKS Common Stock following the conversion has been calculated by multiplying the number of shares of ESI Common Stock represented by the RSUs at the Effective Time by the Equity Award Exchange Ratio and rounding to the nearest whole share.)

Exhibit A

1. Nature of the Grant. In signing this RSU Assumption Agreement, you acknowledge that:

(a) The MKS Incentive Plan, under which the Assumed ESI RSU award is granted, has been established voluntarily by MKS, is discretionary in nature and may be modified, amended, suspended or terminated by MKS at any time, except to the extent otherwise provided in the MKS Incentive Plan and this RSU Assumption Agreement.

(b) The grant of the Assumed ESI RSU award does not create any contractual or other right to receive future awards of RSUs, or benefits in lieu of RSUs, even if RSUs have been awarded repeatedly in the past.

(c) All decisions with respect to future grants of RSUs, if any, will be at the sole discretion of MKS.

(d) Your participation in the MKS Incentive Plan is voluntary.

(e) RSUs are not part of normal or expected compensation or salary for any purpose, including, but not limited to, calculation of any wage payment, severance, redundancy, or other end of service payments, bonuses, long-service awards, pension or retirement benefits or similar payments and in no event should be considered as compensation for, or relating in any way to, past services for MKS or your employer or arising under any employment agreement.

(f) The future value of the underlying shares of MKS Common Stock is unknown and cannot be predicted with certainty.

(g) If you receive shares of MKS Common Stock upon vesting, the value of such shares of MKS Common Stock acquired on vesting may increase or decrease in value.

2. Data Privacy Notice and Consent. You hereby explicitly and unambiguously consent to the collection, use and transfer, in electronic or other form, of your personal data as described in this paragraph, by and among, as applicable, your employer and MKS and its subsidiaries and affiliates for, among other purposes, implementing, administering and managing your participation in the MKS Incentive Plan. You understand that MKS and its subsidiaries hold certain personal information about you, including your name, home address and telephone number, date of birth, social security number or identification number, salary, nationality, job title, any shares of MKS Common Stock or directorships held in MKS, details of all options or any other entitlement to shares of MKS Common Stock awarded, canceled, exercised, vested, unvested or outstanding in your favor, for the purpose of managing and administering the MKS Incentive Plan ("Data"). You further understand that MKS and/or its subsidiaries will transfer Data amongst themselves as necessary for employment purposes, including implementation, administration and management of your participation in the MKS Incentive Plan, and that MKS and/or any of its subsidiaries may each further transfer Data to a broker or such other stock plan service provider or other third parties assisting MKS with processing of Data. You understand that these recipients may be located in the United States, and that the recipient's country may have different data privacy laws and protections than in your country. You authorize them to receive, possess, use, retain and transfer the Data, in electronic or other form, for the purposes described in this section, including any requisite transfer to a broker or such other stock plan service provider or other third party as may be required for the administration of the MKS Incentive Plan and/or the subsequent holding of shares of MKS Common Stock on your behalf. You understand that you may, at any time, request access to the Data, request any necessary amendments to it or refuse or withdraw the consents herein, in any case without cost, by contacting in writing your local human resources representative. You understand, however, that withdrawal of consent may affect your ability to participate in or realize benefits from the MKS Incentive Plan. For more information on the consequences of refusal to consent or withdrawal of consent, you understand that you may contact your local human resources representative.

3. Additional Notices to Hong Kong Participants.

Warning: The contents of this RSU Assumption Agreement and the related MKS Incentive Plan have not been reviewed by any regulatory authority in Hong Kong. You are advised to exercise caution in relation to the offer. If you are in doubt about any of the contents of this RSU Assumption Agreement or the related MKS Incentive Plan, you should obtain independent professional advice.

The Assumed ESI RSU award and the related shares of MKS Common Stock are not being offered to the public in Hong Kong or with the view to or in connection with any further sale in Hong Kong. The securities in relation to the MKS Incentive Plan will only be offered to eligible employees. You shall not resell the securities in relation to the MKS Incentive Plan to the public in Hong Kong.

Exhibit 10.46

MKS INSTRUMENTS, INC.
PRSU ASSUMPTION AGREEMENT
FOR U.S. EMPLOYEES

Holder: [___________________]

PERFORMANCE-BASED RESTRICTED STOCK UNIT ASSUMPTION AGREEMENT effective as of February __, 2019 (the "***PRSU Assumption Agreement***").

WHEREAS, MKS Instruments, Inc., a Massachusetts corporation ("***MKS***"), has acquired Electro Scientific Industries, Inc., an Oregon corporation ("***ESI***"), through the merger of a wholly owned MKS subsidiary into ESI (the "***Merger***"), pursuant to the Agreement and Plan of Merger by and among MKS, ESI and such subsidiary dated as of October 29, 2018, as may have been amended from time to time (the "***Merger Agreement***").

WHEREAS, before the consummation of the Merger, you held one or more outstanding awards of restricted stock units that were granted subject to vesting based on both the achievement of performance goals and the satisfaction of services conditions ("***PRSUs***") with respect to shares of the common stock of ESI, no par value per share ("***ESI Common Stock***"), that you received under the Electro Scientific Industries, Inc. 2004 Stock Incentive Plan, as such plan has been amended from time to time, most recently on August 18, 2016 (the "***ESI Plan***"), each of which is evidenced by a Performance-Based Restricted Stock Units Award Agreement, as each such agreement may have been amended from time to time (a "***PRSU Agreement***").

WHEREAS, the provisions of the Merger Agreement required MKS to assume, at the effective time of the Merger (the "***Effective Time***"), each PRSU award that was outstanding as of immediately prior to the Effective Time. Under the assumption, MKS has converted the number of shares of ESI Common Stock covered by each such PRSU award, as determined in accordance with the PRSU award, into shares of MKS common stock, no par value per share ("***MKS Common Stock***"), using an exchange ratio (the "***Equity Award Exchange Ratio***") determined based on the Merger consideration and pre-closing trading prices for the MKS Common Stock pursuant to a method specified in the Merger Agreement. MKS has provided you the actual Equity Award Exchange Ratio in the employee communication to you regarding the conversion.

WHEREAS, the purpose of this PRSU Assumption Agreement is to evidence MKS's assumption of your outstanding PRSU award identified on Annex A hereto at the Effective Time and to reflect certain adjustments to such PRSU award that were necessary or advisable in connection with their assumption by MKS.

NOW, THEREFORE, MKS and you agree as follows:

1. MKS has assumed, as of the Effective Time, all the duties and obligations of ESI under the PRSU award identified on Annex A hereto (the "***ESI PRSUs***" and, as assumed, the "***Assumed ESI PRSUs***") and will issue from the MKS Instruments, Inc. 2014 Stock Incentive Plan, as it may be amended or replaced from time to time (the "***MKS Incentive Plan***"), any shares that become distributable with respect to the Assumed ESI PRSUs. In connection with such assumption, the number of shares of MKS Common Stock under the Assumed ESI PRSU award that were earned or deemed to be earned, in accordance with the terms of the applicable ESI PRSU award and subject to any limitations set forth therein, covered by this PRSU Assumption Agreement reflects the Equity Award Exchange Ratio, resulting in Assumed ESI PRSUs for the number of shares of MKS Common Stock indicated on Annex A hereto. If you also held other ESI equity compensation awards at the Effective Time, including other PRSUs, those other awards are covered under one or more separate assumption agreements.

2. By clicking acceptance of this PRSU Assumption Agreement, you hereby acknowledge receipt of this PRSU Assumption Agreement and understand that all rights and liabilities with respect to your Assumed ESI PRSU award are as set forth in the applicable PRSU Agreement, the ESI Plan (to the extent incorporated into the PRSU Agreement) and this PRSU Assumption Agreement.

3. The intent of the foregoing adjustments to your ESI PRSUs is to preserve their value as determined in connection with the Merger, and you agree that this assumption satisfies Section 12.2-2 of the ESI Plan, if applicable, and the relevant provision of the applicable PRSU Agreement.

4. The following provisions will govern the Assumed ESI PRSU award:

(a) Unless the context otherwise requires, all references in the applicable PRSU Agreement and the ESI Plan (to the extent incorporated into such PRSU Agreement) are adjusted as follows: (i) all references to the "Company" mean ESI (after the merger with a subsidiary of MKS) and any successor entity into which ESI is subsequently merged subject to subsection (c) below, and, for purposes of "Reorganization Event" under the MKS Incentive Plan, MKS, (ii) all references to "Stock," "Common Stock" or "Shares" mean shares of MKS Common Stock, (iii) all references to the "Board" mean the Board of Directors of MKS or the Compensation Committee of such Board and (iv) any interpretation of corporate law for purposes of the Assumed ESI PRSU award will be under Massachusetts law rather than Oregon law.

(b) All other provisions governing the vesting and termination of the Assumed ESI PRSU award, including any post-Effective Time rights to acceleration you may have under the applicable PRSU Agreement or otherwise, remain the same as set forth in the applicable PRSU Agreement (or other applicable agreement), and those provisions (and any related provisions of the ESI Plan incorporated by reference into such PRSU Agreement) will accordingly govern and control your rights under this PRSU Assumption Agreement to receive MKS Common Stock under the Assumed ESI PRSUs covered by this PRSU Assumption Agreement. For the avoidance of doubt, in accordance with the terms of the applicable PRSU Agreement, performance under the applicable PRSU Agreement was measured at the Effective Time and, following the Merger, the Assumed ESI PRSUs ceased to be subject to the enumerated performance factors and now vest solely based on your continued provision of service to MKS or any subsidiary of MKS through the period specified in the applicable PRSU Agreement.

(c) For purposes of applying any and all provisions of the applicable PRSU Agreement and the ESI Plan relating to your status as an employee of ESI or its parent or subsidiaries for purposes of determining your continuous employment, you will be deemed to be continuously employed for as long as you continue to render services as an employee to MKS or any present or future parent company or majority-owned subsidiary of MKS. Accordingly, the provisions of the applicable PRSU Agreement governing the termination of the Assumed ESI PRSUs in connection with your ceasing to be an employee will, after the Effective Time, be applied on the basis of your cessation of employee status with MKS and its parent and majority-owned subsidiaries.

(d) Shares of MKS Common Stock delivered to you upon settlement of your Assumed ESI PRSUs shall not be rounded down to the nearest whole share. Rather, fractional shares of MKS Common Stock, if any, shall be delivered to you.

(e) Tax Withholding. MKS's obligation to deliver Shares to you upon the vesting of the PRSUs shall be subject to the satisfaction of all income tax (including federal, state and local taxes), social insurance, payroll tax, payment on account or other tax-related withholding requirements ("***Tax Withholding***"). In order to satisfy all Tax Withholding related to your PRSUs, you agree to the following:

(i) MKS shall determine the amount of any taxes that MKS or any affiliated company may be obligated to withhold with respect to the grant, vesting, or other event with respect to the PRSUs. MKS expects to withhold a sufficient number of shares of MKS Common Stock in connection with such event to satisfy the amount of any such Tax Withholding that arises. The amount of taxable compensation that you will recognize in connection with any such event and the fair market value of such withheld Shares will be based on the closing price of MKS Common Stock on the respective vesting date, provided, however, that if such date is not a trading day, MKS will use the closing price on the first trading day following such date. MKS may take such action without notice to you and will then remit to you the balance of any proceeds from withholding such shares in excess of the amount reasonably determined to be necessary to satisfy such Tax Withholding obligations. You will have no discretion as to the satisfaction of Tax Withholding obligations in such manner. If, however, MKS for any reason does not satisfy the Tax Withholding obligations with respect to the vesting of the PRSUs as provided above in this Section 4(e)(i) or otherwise pays taxes on your behalf (that are your responsibility), MKS or its affiliate shall be entitled to require a cash payment by or on behalf of you and/or to deduct from other compensation payable to you the amount of any such Tax Withholding obligations or MKS-paid taxes that are your responsibility.

(ii) You acknowledge and agree that you have had an opportunity to review with your own tax advisors the federal, state, local and non-U.S. tax consequences of the Assumed ESI PRSU award and the transactions contemplated by this PRSU Assumption Agreement. You are relying solely on such advisors and not on any statements or representations of MKS, ESI, or any of their affiliates or agents. You understand that you (and not MKS, ESI or their affiliates) shall be responsible for your own tax liability that may arise as a result of the Assumed ESI PRSU award or the transactions contemplated by this PRSU Assumption Agreement.

5. Except to the extent specifically modified by this PRSU Assumption Agreement, all of the terms and conditions of the applicable PRSU Agreement as in effect immediately prior to the Effective Time continue in full force and effect and are not in any way amended, revised or otherwise affected by this PRSU Assumption Agreement.

IN WITNESS WHEREOF, MKS Instruments, Inc. has caused this PRSU Assumption Agreement to be delivered on its behalf by its duly-authorized officer or agent.

MKS INSTRUMENTS, INC.

By: [Insert electronic signature]
Gerald G. Colella, CEO

Date: ___________, 2019

Annex A

Name of PRSU Holder [______________________________]

Original Grant Date	Number of Shares of ESI Common Stock Earned and Deemed Earned, After Application of Cap	Number of Shares of MKS Common Stock under PRSUs After Conversion, All Treated as Subject to Time-Based Vesting

(The number of shares of MKS Common Stock following the conversion has been calculated by multiplying the number of shares of ESI Common Stock earned for any completed performance periods or deemed earned for any incomplete performance periods at the time of the Merger, in accordance with and subject to limitations contained in, the ESI PRSU award (including the cap on the number of shares of ESI Common Stock that may be earned under the ESI PRSU award) by the Equity Award Exchange Ratio and rounding to the nearest whole share. Any shares of ESI Common Stock subject to PRSUs that were not deemed earned by satisfaction of the relevant performance goal or that exceed the maximum cap for shares that may vest under the PRSUs have been forfeited as of the Effective Time.)

MKS INSTRUMENTS, INC.
PRSU ASSUMPTION AGREEMENT
FOR EMPLOYEES OUTSIDE OF THE UNITED STATES

Holder: [_______________]

PERFORMANCE-BASED RESTRICTED STOCK UNIT ASSUMPTION AGREEMENT effective as of February __, 2019 (the "***PRSU Assumption Agreement***").

WHEREAS, MKS Instruments, Inc., a Massachusetts corporation ("***MKS***"), has acquired Electro Scientific Industries, Inc., an Oregon corporation ("***ESI***"), through the merger of a wholly owned MKS subsidiary into ESI (the "***Merger***"), pursuant to the Agreement and Plan of Merger by and among MKS, ESI and such subsidiary dated as of October 29, 2018, as may have been amended from time to time (the "***Merger Agreement***").

WHEREAS, before the consummation of the Merger, you held one or more outstanding awards of restricted stock units that were granted subject to vesting based on both the achievement of performance goals and the satisfaction of services conditions ("***PRSUs***") with respect to shares of the common stock of ESI, no par value per share ("***ESI Common Stock***"), that you received under the Electro Scientific Industries, Inc. 2004 Stock Incentive Plan, as such plan has been amended from time to time, most recently on August 18, 2016 (the "***ESI Plan***"), each of which is evidenced by a Performance-Based Restricted Stock Units Award Agreement, as each such agreement may have been amended from time to time (a "***PRSU Agreement***").

WHEREAS, the provisions of the Merger Agreement required MKS to assume, at the effective time of the Merger (the "***Effective Time***"), each PRSU award that was outstanding as of immediately prior to the Effective Time. Under the assumption, MKS has converted the number of shares of ESI Common Stock covered by each such PRSU award, as determined in accordance with the PRSU award, into shares of MKS common stock, no par value per share ("***MKS Common Stock***") using an exchange ratio (the "***Equity Award Exchange Ratio***") determined based on the Merger consideration and pre-closing trading prices for the MKS Common Stock pursuant to a method specified in the Merger Agreement. MKS has provided you the actual Equity Award Exchange Ratio in the employee communication to you regarding the conversion.

WHEREAS, the purpose of this PRSU Assumption Agreement is to evidence MKS's assumption of your outstanding PRSU award identified on Annex A hereto at the Effective Time and to reflect certain adjustments to such PRSU award that were necessary or advisable in connection with their assumption by MKS.

NOW, THEREFORE, MKS and you agree as follows:

1. MKS has assumed, as of the Effective Time, all the duties and obligations of ESI under the PRSU award identified on Annex A hereto (the "***ESI PRSUs***" and, as assumed, the "***Assumed ESI PRSUs***") and will issue from the MKS Instruments, Inc. 2014 Stock Incentive Plan as it may be amended or replaced from time to time (the "***MKS Incentive Plan***"), any shares that become distributable with respect to the Assumed ESI PRSUs. In connection with such assumption, the number of shares of MKS Common Stock under the Assumed ESI PRSU award that were earned or deemed to be earned, in accordance with the terms of the applicable ESI PRSU award and subject to any limitations set forth therein, covered by this PRSU Assumption Agreement reflects the Equity Award Exchange Ratio, resulting in Assumed ESI PRSUs for the number of shares of MKS Common Stock indicated on Annex A hereto. If you also held other ESI equity compensation awards at the Effective Time, including other PRSUs, those other awards are covered under one or more separate assumption agreements.

2. By clicking acceptance of this PRSU Assumption Agreement, you hereby acknowledge receipt of this PRSU Assumption Agreement and understand that all rights and liabilities with respect to your Assumed ESI PRSU award are as set forth in the applicable PRSU Agreement, the ESI Plan (to the extent incorporated into the PRSU Agreement) and this PRSU Assumption Agreement.

3. The intent of the foregoing adjustments to your ESI PRSUs is to preserve their value as determined in connection with the Merger, and you agree that this assumption satisfies Section 12.2-2 of the ESI Plan, if applicable, and the relevant provision of the applicable PRSU Agreement.

4. The following provisions will govern the Assumed ESI PRSU award:

(a) Unless the context otherwise requires, all references in the applicable PRSU Agreement and the ESI Plan (to the extent incorporated into such PRSU Agreement) are adjusted as follows: (i) all references to the "Company" mean ESI (after the merger with a subsidiary of MKS) and any successor entity into which ESI is subsequently merged subject to subsection (c) below, and, for purposes of "Reorganization Event" under the MKS Incentive Plan, MKS, (ii) all references to "Stock," "Common Stock" or "Shares" mean shares of MKS Common Stock, (iii) all references to the "Board" mean the Board of Directors of MKS or the Compensation Committee of such Board and (iv) any interpretation of corporate law for purposes of the Assumed ESI PRSU award will be under Massachusetts law rather than Oregon law.

(b) All other provisions governing the vesting and termination of the Assumed ESI PRSU award, including any post-Effective Time rights to acceleration you may have under the applicable PRSU Agreement or otherwise, remain the same as set forth in the applicable PRSU Agreement (or other applicable agreement), and those provisions (and any related provisions of the ESI Plan incorporated by reference into such PRSU Agreement) will accordingly govern and control your rights under this PRSU Assumption Agreement to receive MKS Common Stock under the Assumed ESI PRSUs covered by this PRSU Assumption Agreement. For the avoidance of doubt, in accordance with the terms of the applicable PRSU Agreement, performance under the applicable PRSU Agreement was measured at the Effective Time and, following the Merger, the Assumed ESI PRSUs ceased to be subject to the enumerated performance factors and now vest solely based on your continued provision of service to MKS or any subsidiary of MKS through the period specified in the applicable PRSU Agreement.

(c) For purposes of applying any and all provisions of the applicable PRSU Agreement and the ESI Plan relating to your status as an employee of ESI or its parent or subsidiaries for purposes of determining your continuous employment, you will be deemed to be continuously employed for as long as you continue to render services as an employee to MKS or any present or future parent company or majority-owned subsidiary of MKS. Accordingly, the provisions of the applicable PRSU Agreement governing the termination of the Assumed ESI PRSUs in connection with your ceasing to be an employee will, after the Effective Time, be applied on the basis of your cessation of employee status with MKS and its parent and majority-owned subsidiaries.

(d) Shares of MKS Common Stock delivered to you upon settlement of your Assumed ESI PRSUs shall not be rounded down to the nearest whole share. Rather, fractional shares of MKS Common Stock, if any, shall be delivered to you.

(e) Taxes.

(i) MKS's obligation to deliver Shares to you upon the vesting of the PRSUs shall be subject to your satisfaction of all income tax, social insurance, payroll tax, payment on account, or other tax related requirements ("***Tax Obligations***").

(ii) You have reviewed with your own tax advisors the Tax Obligations applicable to you with respect to this Assumed ESI PRSU award and the transactions contemplated by this PRSU Assumption Agreement. You are relying solely on such advisors and not on any statements or representations of MKS, ESI, or any of their affiliates or agents. You understand that you (and not MKS, ESI or their affiliates) shall be responsible for complying with your own Tax Obligations that may arise as a result of the Assumed ESI PRSU award or the transactions contemplated by this PRSU Assumption Agreement.

(iii) MKS or its affiliates may be required to withhold amounts to satisfy Tax Obligations on your behalf. To the extent that MKS or any of its affiliates pays on your behalf any Tax Obligations for which you are responsible, MKS shall be entitled to require a cash payment by or on behalf of you and/or to deduct from other compensation payable to you the amount of any such Tax Obligations paid by MKS or its affiliates.

(f) Additional Provisions. The Assumed ESI PRSU award shall also be subject to provisions set forth on Exhibit A attached hereto, as applicable.

5. Except to the extent specifically modified by this PRSU Assumption Agreement, all of the terms and conditions of the applicable PRSU Agreement as in effect immediately prior to the Effective Time continue in full force and effect and are not in any way amended, revised or otherwise affected by this PRSU Assumption Agreement.

IN WITNESS WHEREOF, MKS Instruments, Inc. has caused this PRSU Assumption Agreement to be delivered on its behalf by its duly-authorized officer or agent.

MKS INSTRUMENTS, INC.

By: [Insert electronic signature]
Gerald G. Colella, CEO

Date: __________, 2019

Annex A

Name of PRSU Holder [______________________________]

Original Grant Date	Number of Shares of ESI Common Stock Earned and Deemed Earned, After Application of Cap	Number of Shares of MKS Common Stock under PRSUs After Conversion, All Treated as Subject to Time-Based Vesting

(The number of shares of MKS Common Stock following the conversion has been calculated by multiplying the number of shares of ESI Common Stock earned for any completed performance periods or deemed earned for any incomplete performance periods at the time of the Merger, in accordance with and subject to limitations contained in, the ESI PRSU award (including the cap on the number of shares of ESI Common Stock that may be earned under the ESI PRSU award) by the Equity Award Exchange Ratio and rounding to the nearest whole share. Any shares of ESI Common Stock subject to PRSUs that were not deemed earned by satisfaction of the relevant performance goal or that exceed the maximum cap for shares that may vest under the PRSUs have been forfeited as of the Effective Time.)

Exhibit A

1. Nature of the Grant. In signing this PRSU Assumption Agreement, you acknowledge that:

(a) The MKS Incentive Plan, under which the Assumed ESI PRSUs are granted, has been established voluntarily by MKS, is discretionary in nature and may be modified, amended, suspended or terminated by MKS at any time, except to the extent otherwise provided in the MKS Incentive Plan and this PRSU Assumption Agreement.

(b) The grant of the Assumed ESI PRSUs does not create any contractual or other right to receive future awards of PRSUs, or benefits in lieu of PRSUs, even if PRSUs have been awarded repeatedly in the past.

(c) All decisions with respect to future grants of PRSUs, if any, will be at the sole discretion of MKS.

(d) Your participation in the MKS Incentive Plan is voluntary.

(e) PRSUs are not part of normal or expected compensation or salary for any purpose, including, but not limited to, calculation of any wage payment, severance, redundancy, or other end of service payments, bonuses, long-service awards, pension or retirement benefits or similar payments and in no event should be considered as compensation for, or relating in any way to, past services for MKS or your employer or arising under any employment agreement.

(f) The future value of the underlying shares of MKS Common Stock is unknown and cannot be predicted with certainty.

(g) If you receive shares of MKS Common Stock upon vesting, the value of such shares of MKS Common Stock acquired on vesting may increase or decrease in value.

2. Data Privacy Notice and Consent. You hereby explicitly and unambiguously consent to the collection, use and transfer, in electronic or other form, of your personal data as described in this paragraph, by and among, as applicable, your employer and MKS and its subsidiaries and affiliates for, among other purposes, implementing, administering and managing your participation in the MKS Incentive Plan. You understand that MKS and its subsidiaries hold certain personal information about you, including your name, home address and telephone number, date of birth, social security number or identification number, salary, nationality, job title, any shares of MKS Common Stock or directorships held in MKS, details of all options or any other entitlement to shares of MKS Common Stock awarded, canceled, exercised, vested, unvested or outstanding in your favor, for the purpose of managing and administering the MKS Incentive Plan (“Data”). You further understand that MKS and/or its subsidiaries will transfer Data amongst themselves as necessary for employment purposes, including implementation, administration and management of your participation in the MKS Incentive Plan, and that MKS and/or any of its subsidiaries may each further transfer Data to a broker or such other stock plan service provider or other third parties assisting MKS with processing of Data. You understand that these recipients may be located in the United States, and that the recipient’s country may have different data privacy laws and protections than in your country. You authorize them to receive, possess, use, retain and transfer the Data, in electronic or other form, for the purposes described in this section, including any requisite transfer to a broker or such other stock plan service provider or other third party as may be required for the administration of the MKS Incentive Plan and/or the subsequent holding of shares of MKS Common Stock on your behalf. You understand that you may, at any time, request access to the Data, request any necessary amendments to it or refuse or withdraw the consents herein, in any case without cost, by contacting in writing your local human resources representative. You understand, however, that withdrawal of consent may affect your ability to participate in or realize benefits from the MKS Incentive Plan. For more information on the consequences of refusal to consent or withdrawal of consent, you understand that you may contact your local human resources representative.

3. Additional Notices to Hong Kong Participants.

Warning: The contents of this PRSU Assumption Agreement and the related MKS Incentive Plan have not been reviewed by any regulatory authority in Hong Kong. You are advised to exercise caution in relation to the offer. If you are in doubt about any of the contents of this PRSU Assumption Agreement or the related MKS Incentive Plan, you should obtain independent professional advice.

The Assumed ESI PRSUs and the related shares of MKS Common Stock are not being offered to the public in Hong Kong or with the view to or in connection with any further sale in Hong Kong. The securities in relation to the MKS Incentive Plan will only be offered to eligible employees. You shall not resell the securities in relation to the MKS Incentive Plan to the public in Hong Kong.

SUBSIDIARIES OF THE REGISTRANT

SUBSIDIARY	JURISDICTION OF INCORPORATION
Beijing Newport Spectra-Physics Technologies Co., Ltd.	China
EAS Equipment, Inc.	Delaware
High Q Laser GmbH	Austria
Micro-Controle Spectra-Physics S.A.S.	France
MKS Denmark ApS	Denmark
MKS German Holding GmbH	Germany
MKS Instruments (China) Company Limited	China
MKS Instruments (Hong Kong) Limited	Hong Kong
MKS Instruments (Shanghai) Limited	China
MKS Instruments (Singapore) Pte. Ltd.	Singapore
MKS Instruments Deutschland GmbH	Germany
MKS Instruments Holdings Ltd	United Kingdom
MKS Instruments Israel Ltd.	Israel
MKS Instruments Italy S.r.l.	Italy
MKS Instruments UK Limited	United Kingdom
MKS International Holdings Limited	United Kingdom
MKS Japan, Inc.	Japan
MKS Korea Ltd.	Korea
MKS Taiwan Technology Limited	Taiwan
Newport Corporation	Nevada
Newport European Distribution Company	California
Newport Instruments Canada Corporation	Canada
Newport Laser Holding GmbH	Austria
Newport Ophir Holdings Ltd.	Israel
Newport Opto-Electronics Technologies (Korea), LLC	Korea
Newport Opto-Electronics Technologies (Singapore) Pte. Ltd.	Singapore
Newport Opto-Electronics Technologies (Wuxi) Company Limited	China
Newport Spectra-Physics B.V.	Netherlands
Newport Spectra-Physics GmbH	Germany
Newport Spectra-Physics Limited	United Kingdom
Ophir Japan Ltd.	Japan
Ophir Optics Europe GmbH	Switzerland
Ophir Optics S.R.L.	Romania
Ophir Optronics GmbH	Germany
Ophir Optronics Ltd.	Israel
Ophir Optronics Solutions Ltd.	Israel
Ophir Spiricon Europe GmbH	Germany
Ophir-Spiricon, LLC	Utah
Spectra-Physics, K.K.	Japan
V-Gen Ltd.	Israel

EXHIBIT 23.1

CONSENT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

We hereby consent to the incorporation by reference in the Registration Statements on Form S-3 (Nos.333-34450 and 333-109753) and S-8 (Nos.333-78069, 333-78071, 333-78073, 333-31224, 333-54486, 333-54488, 333-54490, 333-90498, 333-90500, 333-90502, 333-116385, 333-116387, 333-116389, 333-127221, 333-161211, 333-195750, 333-211026, and 333-229483) of MKS Instruments, Inc. of our report dated February 26, 2019 relating to the financial statements, financial statement schedule, and the effectiveness of internal control over financial reporting, which appears in this Form 10-K.

/s/ PricewaterhouseCoopers LLP
Boston, Massachusetts
February 26, 2019

EXHIBIT 31.1

CERTIFICATION OF PRINCIPAL EXECUTIVE OFFICER
PURSUANT TO RULE 13a-14(a)/RULE 15d-14(a) OF THE
SECURITIES EXCHANGE ACT OF 1934, AS AMENDED

I, Gerald G. Colella, certify that:

1. I have reviewed this annual report on Form 10-K of MKS Instruments, Inc.;

2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;

3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;

4. The registrant's other certifying officer and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:

   a) Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this annual report is being prepared;

   b) Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;

   c) Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and

   d) Disclosed in this report any changes in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and

5. The registrant's other certifying officer and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):

   a) All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and

   b) Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Dated: February 26, 2019

/s/ Gerald G. Colella
Gerald G. Colella
Chief Executive Officer
(Principal Executive Officer)

EXHIBIT 31.2

CERTIFICATION OF PRINCIPAL FINANCIAL OFFICER
PURSUANT TO RULE 13a-14(a)/RULE 15d-14(a) OF THE
SECURITIES EXCHANGE ACT OF 1934, AS AMENDED

I, Seth H. Bagshaw, certify that:

1. I have reviewed this annual report on Form 10-K of MKS Instruments, Inc.;

2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;

3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;

4. The registrant's other certifying officer and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:

   a) Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this annual report is being prepared;

   b) Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;

   c) Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and

   d) Disclosed in this report any changes in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and

5. The registrant's other certifying officer and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):

   a) All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and

   b) Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Dated: February 26, 2019

/s/ Seth H. Bagshaw
Seth H. Bagshaw
Senior Vice President, Chief Financial Officer and Treasurer
(Principal Financial Officer)

EXHIBIT 32.1

CERTIFICATION OF CHIEF EXECUTIVE OFFICER AND CHIEF FINANCIAL OFFICER

PURSUANT TO 18 U.S.C. SECTION 1350,

AS ADOPTED PURSUANT TO

SECTION 906 OF THE SARBANES-OXLEY ACT OF 2002

In connection with the Annual Report on Form 10-K of MKS Instruments, Inc. (the “Company”) for the period ended December 31, 2018 as filed with the Securities and Exchange Commission on the date hereof (the “Report”), the undersigned, Gerald G. Colella, Chief Executive Officer of the Company, and Seth H. Bagshaw, Senior Vice President, Chief Financial Officer and Treasurer of the Company, each hereby certifies, pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002, that, based on his knowledge:

(1) The Report fully complies with the requirements of Section 13(a) or 15(d) of the Securities Exchange Act of 1934; and

(2) The information contained in the Report fairly presents, in all material respects, the financial condition and results of operations of the Company.

Dated: February 26, 2019

/s/ Gerald G. Colella
Gerald G. Colella
Chief Executive Officer

Dated: February 26, 2019

/s/ Seth H. Bagshaw
Seth H. Bagshaw
Senior Vice President, Chief Financial Officer and Treasurer