TERADYNE, INC
Form 10-K
March 01, 2019
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UNITED STATES

SECURITIES AND EXCHANGE COMMISSION

WASHINGTON, D.C. 20549

FORM 10-K

ANNUAL REPORT

PURSUANT TO SECTIONS 13 OR 15(d)

OF THE SECURITIES EXCHANGE ACT OF 1934

(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

Commission file number 001-06462

TERADYNE, INC.

(Exact Name of Registrant as Specified in Its Charter)

MASSACHUSETTS	**04-2272148**
(State or Other Jurisdiction of Incorporation or Organization)	**(I.R.S. Employer Identification Number)**
600 RIVERPARK DRIVE	**01864**

NORTH READING, MASSACHUSETTS
(Address of Principal Executive Offices) **(Zip Code)**
Registrant s telephone number, including area code: (978) 370-2700

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

Title of Each Class	Name of Each Exchange on Which Registered
Common Stock, par value $0.125 per share	Nasdaq Stock Market LLC

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 Exchange 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 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) is not contained herein, and will not be contained to the best of the registrant s knowledge, in definitive proxy or information statements incorporated by reference in Part III of this Form 10-K or in 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, or a smaller reporting company. See the definitions of large accelerated filer, accelerated filer and 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 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

The aggregate market value of the voting stock held by non-affiliates of the registrant as of June 29, 2018 was approximately $6.4 billion based upon the closing price of the registrant s Common Stock on the New York Stock Exchange on that date.

The number of shares outstanding of the registrant s only class of Common Stock as of February 25, 2019 was 173,629,283 shares.

DOCUMENTS INCORPORATED BY REFERENCE

Portions of the registrant s proxy statement in connection with its 2019 annual meeting of shareholders are incorporated by reference into Part III of this Form 10-K.

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TERADYNE, INC.

FORM 10-K

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 will, would, believe, anticipate, plan, expect, estimate, project, intend, may, see, target and other words and terms of similar meaning are intended to i forward-looking statements although not all forward looking statements contain these identifying words. Forward looking statements involve risks and uncertainties, including, but not limited to, those discussed in the section entitled Risk Factors of this annual report on Form 10-K and elsewhere, and in other reports we file with the Securities and Exchange Commission. Readers are cautioned not to place undue reliance on these forward-looking statements which reflect management s analysis only as of the date hereof and are subject to risks and uncertainties that could cause actual results to differ materially from those stated or implied. Teradyne assumes no obligation to update these forward-looking statements for any reason, except as may be required by law.

PART I

Item 1: ***Business***

Teradyne, Inc. (Teradyne) was founded in 1960 and is a leading global supplier of automation equipment for test and industrial applications.

We design, develop, manufacture and sell automatic test systems used to test semiconductors, wireless products, data storage and complex electronics systems in the consumer electronics, wireless, automotive, industrial, computing, communications, and aerospace and defense industries. Our industrial automation products include collaborative robotic arms, autonomous mobile robots and advanced robotic control software used by global manufacturing and light industrial customers to improve quality, increase manufacturing and material handling efficiency and decrease manufacturing costs. Our automatic test equipment and industrial automation products and services include:

- semiconductor test (Semiconductor Test) systems;
- defense/aerospace (Defense/Aerospace) test instrumentation and systems, storage test (Storage Test) systems, and circuit-board test and inspection (Production Board Test) systems (collectively these products represent System Test);
- industrial automation (Industrial Automation) products; and
- wireless test (Wireless Test) systems.

We have a customer base which includes integrated device manufacturers (IDMs), outsourced semiconductor assembly and test providers (OSATs), original equipment manufacturers (OEMs), wafer foundries, fabless companies that design, but contract with others for the manufacture of integrated circuits (ICs), developers of wireless devices and consumer electronics, manufacturers of circuit boards, automotive suppliers, wireless product manufacturers, storage device manufacturers, aerospace and military contractors, and distributors that sell collaborative robots, autonomous mobile robots and wireless test systems.

The market for our test products is concentrated with a limited number of significant customers accounting for a substantial portion of the purchases of test equipment. One customer drives significant demand for our products both through direct sales and sales to the customer s supply partners. We expect that sales of our test products will continue to be concentrated with a limited number of significant customers for the foreseeable future.

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The sales of our products and services are dependent, to a large degree, on customers who are subject to cyclical trends in demand for their products. These cyclical periods have had, and will continue to have, a significant effect on our business because our customers often delay or accelerate purchases in reaction to changes in their businesses and to demand fluctuations in the semiconductor and electronics industries. Historically, these demand fluctuations have resulted in significant variations in our results of operations. During the first quarter of 2018, demand outlook for mobile device test capacity in 2018 declined sharply for our Semiconductor Test business. Demand in other segments of the Semiconductor Test business, including memory test, increased in 2018.

In 2015, we acquired Universal Robots A/S (Universal Robots), the leading supplier of collaborative robots which are low-cost, easy-to-deploy and simple-to-program robots that work side by side with production workers to improve quality, increase manufacturing efficiency and decrease manufacturing costs. The acquisition of Universal Robots provides a growth engine to our business. The total purchase price for Universal Robots was approximately $315 million, which included cash paid of approximately $284 million and $32 million in fair value of contingent consideration payable upon achievement of revenue and earnings targets through 2018. Contingent consideration for 2015 was $15 million and was paid in February 2016. Contingent consideration for the period from July 2015 to December 2017 was $24.6 million and was paid in March 2018. Contingent consideration for the period from July 2015 to December 2018 was $3.9 million and is expected to be paid in March 2019.

On February 26, 2018, we acquired Energid Technologies Corporation (Energid) for a total purchase price of approximately $27.6 million. Energid s technology enables and simplifies the programming of complex robotic motions used in a wide variety of end markets, ranging from heavy industry to healthcare, utilizing both traditional robots and collaborative robots.

On April 25, 2018, we acquired Mobile Industrial Robots ApS (MiR), a Danish limited liability company. MiR is the leading maker of collaborative autonomous mobile robots for industrial applications. The total purchase price was approximately $198 million, which included cash paid of approximately $145 million and $53 million in fair value of contingent consideration payable upon achievement of certain thresholds and targets for revenue and earnings before interest and taxes through 2020. At December 31, 2018, the maximum amount of contingent consideration that could be paid is $115 million. Contingent consideration for 2018 was $31.0 million and is expected to be paid in March 2019.

Universal Robots, MiR and Energid are included in our Industrial Automation segment.

Investor Information

We are a Massachusetts corporation incorporated on September 23, 1960. We are subject to the informational requirements of the Securities Exchange Act of 1934 (Exchange Act). We file periodic reports, proxy statements and other information with the Securities and Exchange Commission (SEC). The SEC maintains an internet site (http://www.sec.gov) that contains reports, proxy and information statements and other information regarding issuers that file documents electronically.

You can access financial and other information, including the charters of our Audit Committee, Compensation Committee and Nominating and Corporate Governance Committee, our Corporate Governance Guidelines and Code of Conduct, by clicking the Investors link on our web site at www.teradyne.com. We make available, free of charge, copies of our filings with the SEC, including our annual reports on Form 10-K, quarterly reports on Form 10-Q, current reports on Form 8-K and amendments to those reports filed or furnished pursuant to Section 13(a) or 15(d) of the Exchange Act through our web site as soon as reasonably practicable after filing such material electronically or otherwise furnishing it to the SEC.

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Products

Semiconductor Test

We design, manufacture, sell and support Semiconductor Test products and services on a worldwide basis. The test systems we provide are used both for wafer level and device package testing. These chips are used in automotive, industrial, communications, consumer, and computer and electronic game applications, among others. Semiconductor devices span a broad range of functionality, from very simple low-cost devices such as appliance microcontrollers, operational amplifiers or voltage regulators to complex digital signal processors and microprocessors as well as memory devices. Semiconductor Test products and services are sold to IDMs that integrate the fabrication of silicon wafers into their business, Fabless companies that outsource the manufacturing of silicon wafers, Foundries that cater to the processing and manufacturing of silicon wafers, and OSATs that provide test and assembly services for the final packaged devices to both Fabless companies and IDMs. Fabless companies perform the design of integrated circuits without manufacturing capabilities, and use Foundries for wafer manufacturing and OSATs for test and assembly. These customers obtain the overall benefit of comprehensively testing devices and reducing the total costs associated with testing by using our Semiconductor Test systems to:

- improve and control product quality;
- measure and improve product performance;
- reduce time to market; and
- increase production yields.

Our FLEX Test Platform architecture advances our core technologies to produce test equipment that is designed for high efficiency multi-site testing. Multi-site testing involves the simultaneous testing of many devices in parallel. Leading semiconductor manufacturers are using multi-site testing to significantly improve their Cost of Test economics. The FLEX Test Platform architecture addresses customer requirements through the following key capabilities:

- A high efficiency multi-site architecture that reduces tester overhead such as instrument setup, synchronization and data movement, and signal processing;
- The IG-XL software operating system which provides fast program development, including instant conversion from single to multi-site test; and
- Broad technology coverage by instruments designed to cover the range of test parameters, coupled with a universal slot test head design that allows easy test system reconfiguration to address changing test needs.

FLEX Test Platform purchases are being made by IDMs, OSATs, Foundries and Fabless customers. The FLEX Test Platform has become a widely used test solution at OSATs by providing versatile testers that can handle the widest range of devices, allowing OSATs to leverage their capital investments. The broad consumer, automotive and broadband markets have historically driven most of the device volume growth in the semiconductor industry. These markets include smart phones, cell phones, tablets, set top boxes, HDTVs, game controllers, computer graphics, and automotive controllers to name a few. These end use markets continue to be drivers for the FLEX Test Platform family of products because they require a wide range of technologies and instrument coverage. The UltraFLEX-M tester extends the FLEX Test Platform into the High Speed DRAM testing market. The FLEX Test Platform has an installed base of more than 6,400 systems.

Our J750 test system shares the IG-XL software environment with the family of FLEX Test Platform systems. The J750 is designed to address the highest volume semiconductor devices, such as microcontrollers, that are central to the functionality of almost every consumer electronics product, from small appliances to automobiles. J750 test systems combine compact packaging, high throughput and ease of production test. We

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extended the J750 platform technology to create the IP750 Image Sensor test system. The IP750 is focused on testing image sensor devices used in smart phones and other imaging products. We have continued to invest in the J750 platform with new instrument releases that bring new capabilities to existing market segments and expand the J750 platform to new devices that include high end microcontrollers and the latest generation of cameras. The J750 platform has an installed base of over 5,600 systems.

Our Magnum platform addresses the requirements of mass production test of memory devices such as flash memory and DRAM. Flash and DRAM memory are widely used core building blocks in modern electronic products finding wide application in consumer, industrial, and computing equipment. Magnum V, the newest member of the family, is a next generation memory test solution designed for parallel memory test in the flash, DRAM and multi-chip package markets. In 2019, we plan to introduce a high-speed DRAM test version of our Magnum platform giving us full product coverage of the memory test market. The Magnum platform has an installed base of over 2,600 systems.

Our ETS platform is used by semiconductor manufacturers and assembly and test subcontractors, primarily in the analog/mixed signal markets that cover more cost sensitive applications. Our proprietary SmartPin technology enables high efficiency multi-site testing, on an individual test system, permitting greater test throughput. Semiconductors tested by ETS platform systems are incorporated into a wide range of products in historically high-growth markets, including mobile devices, video/multimedia products, automotive electronics, computer peripherals, and notebook and desktop computers. The newest products from the platform include the ETS-88, a high performance multi-site production test system designed to test a wide variety of high volume commodity and precision devices, and the ETS-800, a high performance multi-site production test system to test high complexity power devices in automotive, industrial and consumer applications. The ETS platform has an installed base of over 4,900 systems.

System Test

Our System Test segment is comprised of three business units: Defense/Aerospace, Storage Test and Production Board Test.

Defense/Aerospace

We are a leading provider of high performance test systems, subsystems, instruments and service for the defense and aerospace markets. Our test products are used to ensure the readiness of military and commercial aerospace electronics systems. New programs, such as tactical aircraft and missile systems, as well as upgrade programs, continue to fuel the demand for high performance test systems in this market. Our test products are well-suited to the demands of defense/aerospace electronics manufacturers and repair depots worldwide. Our leadership in this market is underscored by our success with major Department of Defense programs across all U.S. military service branches and many allied defense services worldwide.

Storage Test

The Storage Test business unit addresses the high throughput, automated manufacturing test requirements of hard disk drive (HDD) and solid state disk (SSD) manufacturers and semiconductor manufacturers. Our products address the client and enterprise storage markets. The client market is driven by the needs of desktop, laptop, and external HDD and SSD storage products. The enterprise market is driven by the needs of data centers and cloud storage. During 2017, we developed a system level test product for the semiconductor production market, which shipped in 2017 and 2018. The business unit s products lead in addressing customer requirements related to factory density, throughput and thermal performance.

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Production Board Test

Our test systems are used by electronics manufacturers worldwide to perform In-Circuit-Test (ICT) and device programming of printed circuit board assemblies. Fast, accurate and cost-effective test capabilities are hallmark features of our Test Station and Spectrum ICT product families. We offer the Test Station in off-line and automated in-line configurations. The automated in-line configurations address the growing requirements for automating production lines for high volume applications, such as automotive electronics.

Industrial Automation

Our Industrial Automation segment is comprised of three business units: Universal Robots, Mobile Industrial Robots and Energid.

Universal Robots

Universal Robots, which we acquired in June 2015, is the leading supplier of collaborative robots, which are low-cost, easy-to-deploy and simple-to-program robots that work side by side with production workers to improve quality, increase manufacturing efficiency and decrease manufacturing costs. Collaborative robots are designed to mimic the motion of a human arm and can be fitted with task specific grippers or fixtures to support a wide range of applications. Universal Robots offers three collaborative robot models, the UR3, UR5, and UR10, each with different weight carrying capacity and arm reach. All models are easily integrated into existing production environments. Universal Robots products are differentiated by their:

- easy programming using a graphical interface which allows users to program the collaborative robot in a few hours;
- flexibility and ease of use in allowing customers to change the task the collaborative robot is performing as their production demands dictate;
- safe operations as collaborative robots can assist workers in side by side production environments requiring no special safety enclosures or shielding to protect workers; and
- short payback period, on average less than 12 months.

In 2018, Universal Robots introduced its e-series collaborative robots which include technology advances that enable faster development of applications, greater precision and improved safety.

Cumulatively, Universal Robots has sold over 30,000 collaborative robots in diverse production environments and applications.

Mobile Industrial Robots

MiR, which was acquired in April 2018, is the leading supplier of collaborative autonomous mobile robots, which are low-cost, easy-to-deploy and simple-to-program mobile robots that increase manufacturing and warehouse efficiency and decrease costs. Collaborative autonomous mobile robots are designed to move material from point to point via autonomous navigation rather than the need for traditional mobile robot guidance infrastructure such as painted or magnetic strips, and are designed to navigate safely around obstacles and people. MiR offers three collaborative autonomous mobile robot models, the MiR100, MiR200, MiR500, each with different payload carrying capacity. All models are easily integrated into existing production environments. MiR s products are differentiated by their:

- easy programming using a graphical interface which allows users to program the collaborative robot in a few hours;

ease of use, speed of deployment and flexibility in allowing customers to change the task as their demands dictate;

- reliable autonomous navigation over large manufacturing and warehouse areas; and
- short payback period, on average less than 12 months.

Cumulatively, MiR has sold over 1,800 collaborative autonomous mobile robots in diverse production and warehouse environments and applications.

Energid

Energid, which was acquired in February 2018, is a leading supplier of real-time advanced robot motion control software, which automation suppliers use to coordinate the control of multiple automation axes for performing tasks. Motion control software performs the complex mathematics and functions needed to enable robot motion for tasks such as grasping and moving an object. Energid offers developer and run time licenses of its Actin software. Actin is integrated by customers into the customers robot and automation solutions. Actin products are differentiated by their:

- highly flexible, adaptive, robot motion control; and
- task optimized robotic path planning.

Cumulatively, Energid has sold over 500 Actin developer and run time licenses deployed in diverse automation applications.

Wireless Test

Our acquisition of LitePoint in 2011 and ZTEC Instruments Inc. (ZTEC) in 2013 expanded our product offerings in the wireless test market. Under the LitePoint brand name, these products provide test solutions utilized in the development and manufacturing of wireless devices. The world s leading makers of smart phones, tablets, notebooks, laptops, peripherals, and Internet-of-Things (IoT) devices rely on LitePoint technology to ensure their products get into consumer hands with high quality and high efficiency.

LitePoint hardware and software wireless test solutions are used in test insertions that span design verification to high volume manufacturing and are deployed across the entire production eco-system from the wireless chipset suppliers to the consumer brands. Wireless devices are often tested at multiple points along the manufacturing process that include insertions at component, system-in-package (SiP), module, PCB, SMT and finished product stages.

Design verification is an important step in the development process for evaluating product performance prior to starting production. As end market unit volumes have increased, the quantity of units and the amount of data that must be analyzed for a successful product launch continues to grow. LitePoint products provide easy to use, domain specific tools for rapid analysis of product performance. This helps to speed time to market.

In high volume manufacturing, before products are packaged and shipped, wireless test enables the calibration of each individual product s wireless performance to improve range, data throughput and battery life. Testing also verifies product specifications for product quality control. As markets become increasingly competitive, product performance and quality provide brand differentiation.

Wireless standards can be thought of in two categories, connectivity and cellular. Connectivity covers many standards such as Wi-Fi, Bluetooth, and GPS. LitePoint s IQxel products cover emerging Wi-Fi standards such as 802.11ax and 802.11ad as well as the existing standards 802.11a/b/g/n and 11ac, and includes a variety of other standards such as Bluetooth Classic, Bluetooth 5.0 and Bluetooth low energy, Zigbee, Z-Wave, NFC, LoRa, GPS, GLONASS and others.

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The IQxel product family s high-performance wireless and multi-device testing economics is aligned with the needs of networking equipment, Internet gateways, IoT products and embedded modules used in smartphones, tablets, and PCs. Another connectivity product, the IQnfc, addresses the growing use of NFC technology for payments with mobile devices.

Cellular standards include 2G, 3G, 4G and emerging 5G mobile phone technologies. LitePoint s IQxstream is a multi-device production test optimized solution for high-speed testing of GSM, EDGE, CDMA2000, TD-SCDMA, WCDMA, HSPA+, LTE-FDD, TD_LTE, and LTE-A, and 5G technologies. It is used for calibration and verification of smartphones, tablets, small cell wireless gateways and embedded cellular modules. The IQcell, is a multi-device cellular signaling test solution which enables user experience testing of LTE cellular devices via over-the-air connections. The IQgig family provides test solution at the intermediary and millimeter wave frequencies for 5G and 802.11ad.

An important component in all wireless systems is the analog RF front end. The performance of these components is continually pushed higher as device makers add more bands, channels, antennas and higher data rates. We offer the LitePoint zSeries of modular wireless test instruments for design verification test and production testing of these wireless components. The lab-in-a-box zSeries solution provides simple and fast design verification of RF power amplifier and smart device RF front end modules. It is capable of rapid analysis of the latest digital pre-distortion and envelope tracking technologies for both LTE and Wi-Fi standards. A ruggedized version of the product is designed for high volume testing of these same devices.

To complement the test systems, LitePoint offers turnkey test software for over 350 of the most popular wireless chipsets. These optimized solutions provide rapid development of high volume manufacturing solutions with a minimum of engineering effort by customers.

Sales and Distribution

In 2018, no single customer accounted for more than 10% of our consolidated revenues. In 2017 and 2016, revenues from Taiwan Semiconductor Manufacturing Company Ltd. accounted for 13% and 12%, respectively, of our consolidated revenues. In 2016, revenues from JA Mitsui Leasing, Ltd. accounted for 12% of our consolidated revenues. Taiwan Semiconductor Manufacturing Company Ltd. and JA Mitsui Leasing, Ltd. are customers of our Semiconductor Test segment. In each of the years, 2018, 2017, and 2016, our five largest customers in aggregate accounted for 27%, 32% and 36% of our consolidated revenues, respectively.

OSAT customers, such as Taiwan Semiconductor Manufacturing Company Ltd., often purchase our test systems based upon recommendations from OEMs, IDMs and Fabless companies. In all cases when an OSAT customer purchases a test system from us, we consider the OSAT as the customer since credit risk, title and risk of loss, among other things, are between Teradyne and the OSAT. We estimate consolidated revenues driven by a single OEM customer, combining direct sales to that customer with sales to the customer s OSATs (which include Taiwan Semiconductor Manufacturing Company Ltd. and its leasing company, JA Mitsui Leasing, Ltd.), accounted for approximately 13%, 22%, and 26% of our consolidated revenues in 2018, 2017, and 2016, respectively. The loss of, or significant decrease in demand from, this OEM customer, or any of our five largest direct customers, could have a material adverse effect on our business, results of operations and financial condition.

We have sales and service offices located throughout North America, Asia and Europe. We sell in these areas predominantly through a direct sales force, except for Industrial Automation products which are sold through distributors. Our manufacturing activities are primarily conducted through subcontractors and outsourced contract manufacturers with significant operations in China and Malaysia.

Sales to customers outside the United States were 87%, 88%, and 87%, respectively, of our consolidated revenues in 2018, 2017 and 2016. Sales are attributed to geographic areas based on the location of the customer site.

See also Item 1A: Risk Factors and Note R: Operating Segment, Geographic and Significant Customer Information in Notes to Consolidated Financial Statements.

Competition

We face significant competition throughout the world in each of our reportable segments. Competitors in the Semiconductor Test segment include, among others, Advantest Corporation and Cohu, Inc.

Competitors in the System Test segment include, among others, Keysight Technologies, Inc., Advantest Corporation, Test Research, Inc. and SPEA S.p.A.

Competitors in our Industrial Automation segment include manufacturers of traditional industrial robots such as KUKA Robotics Corporation, ABB, FANUC and Yaskawa Electric Corporation, companies with emerging collaborative robot offerings such as Techman, Doosan, and AUBO Robotics, and manufacturers of autonomous mobile robots such as Omron, Fetch, and OTTO Motors.

Competitors in our Wireless Test segment include, among others, Rohde & Schwarz GmbH & Co. KG, Anritsu Company, Keysight Technologies, Inc. and National Instruments Corporation.

Some of our competitors have substantially greater financial and other resources to pursue engineering, manufacturing, marketing and distribution of their products. We also face competition from emerging Asian companies and from internal suppliers at several of our customers. Some of our competitors have introduced or announced new products with certain performance characteristics which may be considered equal or superior to those we currently offer. We expect our competitors to continue to improve the performance of their current products and to introduce new products or new technologies that provide improved cost of ownership and performance characteristics. See also Item 1A: Risk Factors.

Backlog

At December 31, 2018 and 2017, our backlog of unfilled orders in our four reportable segments was as follows:

	2018	2017 (1)
	(in millions)	
Semiconductor Test	$ 367.5	$ 464.2
System Test	149.5	111.9
Wireless Test	32.0	35.5
Industrial Automation	19.7	14.8
	$ 568.7	$ 626.4

(1) December 31, 2017 backlog has not been adjusted for the new revenue standard adopted January 1, 2018. If the Wireless Test backlog was calculated based on the new revenue standard, the backlog balance would have been $21.3 million. Backlog for each of the other reportable segments was not materially affected by the adoption of the new revenue standard.

Of the backlog at December 31, 2018, approximately 98% of the Semiconductor Test backlog, 89% of the System Test backlog, and 35% of the Industrial Automation backlog is expected to be delivered in 2019.

Customers may delay delivery of products or cancel orders suddenly and without advanced notice, subject to possible cancellation penalties. Due to possible customer changes in delivery schedules and cancellation of orders, our backlog at any particular date is not necessarily indicative of the actual sales for any succeeding period. Delays in delivery schedules or cancellations of backlog during any particular period could have a material adverse effect on our business, financial condition or results of operations.

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Raw Materials

Our products contain electronic and mechanical components that are provided by a wide range of suppliers. Some of these components are standard products, while others are manufactured to our specifications. We can experience occasional delays in obtaining timely delivery of certain items. While the majority of our components are available from multiple suppliers, certain items are obtained from sole sources. We may experience a temporary adverse impact if any of our sole source suppliers delay or cease to deliver products.

Intellectual Property and Licenses

The development of our products, both hardware and software, is based in significant part on proprietary information, our brands and technology. We protect our rights in proprietary information, brands and technology through various methods, such as:

- patents;
- copyrights;
- trademarks;
- trade secrets;
- standards of business conduct and related business practices; and
- technology license agreements, software license agreements, non-disclosure agreements, employment agreements, and other agreements.

However, these protections might not be effective in all circumstances. Competitors might independently develop similar technology or exploit our proprietary information and our brands in countries where we lack enforceable intellectual property rights or where enforcement of such rights through the legal system provides an insufficient deterrent. Also, intellectual property protections can lapse or be invalidated through appropriate legal processes. We do not believe that any single piece of intellectual property or proprietary rights is essential to our business.

Employees

As of December 31, 2018, we employed approximately 4,900 people. Since the inception of our business, we have experienced no work stoppages or other labor disturbances.

Environmental Affairs

We are subject to various federal, state, and local government laws and regulations relating to the protection of employee health and safety and the environment. We accrue for all known environmental liabilities when it becomes probable that we will incur cleanup costs and those costs can reasonably be estimated. Estimated environmental costs are not expected to materially affect the financial position or results of our operations in future periods. However, estimates of future costs are subject to change due to protracted cleanup periods and changing environmental remediation laws and regulations.

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OUR EXECUTIVE OFFICERS

Pursuant to General Instruction G(3) of Form 10-K, the following table is included in Part I of this Annual Report on Form 10-K in lieu of being included in the Proxy Statement for the Annual Meeting of Shareholders. The table sets forth the names of all of our executive officers and certain other information relating to their positions held with Teradyne and other business experience. Our executive officers do not have a specific term of office but rather serve at the discretion of the Board of Directors.

Executive Officer	Age	Position	Business Experience For The Past 5 Years
Mark E. Jagiela	58	Chief Executive Officer and President	Chief Executive Officer since February 2014; President of Teradyne since January 2013; President of Semiconductor Test from 2003 to February 2016; Vice President of Teradyne from 2001 to 2013.
Gregory R. Beecher	61	Vice President, Chief Financial Officer and Treasurer	Vice President and Chief Financial Officer of Teradyne since 2001; Treasurer of Teradyne from 2003 to 2005 and since 2006.
Charles J. Gray	57	Vice President, General Counsel and Secretary	Vice President, General Counsel and Secretary of Teradyne since April 2009.
Bradford B. Robbins	60	President of Wireless Test	President of Wireless Test since August 2014; Chief Operating Officer of LitePoint Corporation from 2012 to 2014; Vice President of Teradyne since 2001.
Gregory S. Smith	55	President of Semiconductor Test	President of Semiconductor Test since February 2016; Vice President, SOC Business Group and Marketing Manager for Semiconductor Test Group from January 2014 to February 2016; Business Unit Manager, Complex SOC Business Unit from 2009 to January 2014.
Walter G. Vahey	54	Executive Vice President, Business Development	Executive Vice President, Business Development since December 2017; President of System Test from July 2012 to December 2017; Vice President of Teradyne since 2008; General Manager of Storage Test from 2008 to December 2017; General Manager of Production Board Test from April 2013 to December 2017.

Item 1A: ***Risk Factors***
Risks Associated with Our Business

The risks described below are not the only risks that we face. Additional risks and uncertainties not currently known to us or that we currently deem to be immaterial also may materially adversely affect our business, financial condition and/or operating results.

Our business is impacted by global and industry-specific economic cycles, which are difficult to predict, and actions we have taken or may take to offset these cycles may not be sufficient.

Capital equipment providers in the electronics and semiconductor industries, such as Teradyne, have, in the past, been negatively impacted by both sudden slowdowns in the global economies and recurring cyclicality

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within those industries. These cycles have resulted in periods of over-supply; a trend we believe will continue to occur for newer generations of electronic products. Our business and results of operations depend, in significant part, upon capital expenditures of manufacturers of semiconductors and other electronics, which in turn depend upon the current and anticipated market demand for those products. Disruption or deterioration in economic conditions may reduce customer purchases of our products, thereby reducing our revenues and earnings. In addition, such adverse changes in economic conditions, and resulting slowdowns in the market for our products, may, among other things, result in increased price competition for our products, increased risk of excess and obsolete inventories, increased risk in the collectability of our accounts receivable from our customers, potential reserves for doubtful accounts and write-offs of accounts receivable, increased risk of restructuring charges, and higher operating costs as a percentage of revenues, which, in each case and together, adversely affect our operating results. We are unable to predict the likely duration, frequency and severity of disruptions in financial markets, credit availability, and adverse economic conditions throughout the world, and we cannot ensure that the level of revenues or new orders for a fiscal quarter will be sustained in subsequent quarters. We have taken actions to address the effects of general economic variability and recurring industry cyclicality, including implementing cost control and reduction measures. We cannot predict whether these measures will be sufficient to offset global or market-specific disruptions that might affect our test businesses and we may need to take additional or different measures in the future.

We are subject to intense competition.

We face significant competition throughout the world in each of our reportable segments. Some of our competitors have substantial financial and other resources to pursue engineering, manufacturing, marketing and distribution of their products. We also face competition from emerging Asian equipment companies and internal development at several of our customers. Some of our competitors have introduced or announced new products with certain performance characteristics that may be considered equal or superior to those we currently offer. We expect our competitors to continue to improve the performance of their current products and to introduce new products or new technologies that provide improved cost of ownership and performance characteristics. New product introductions by competitors could cause a decline in revenues or loss of market acceptance of our products.

The market for our products is concentrated, and our business depends, in part, on obtaining orders from a few significant customers.

The market for our products is concentrated with a limited number of significant customers accounting for a substantial portion of the purchases of test equipment. In each of the years 2018, 2017, and 2016, our five largest customers in aggregate accounted for 27%, 32%, and 36% of consolidated revenues, respectively. We estimate consolidated revenues driven by a single OEM customer, combining direct sales to that customer with sales to the customer s OSATs (which include Taiwan Semiconductor Manufacturing Company Ltd. and its leasing company, JA Mitsui Leasing, Ltd.), accounted for approximately 13%, 22%, and 26% of our consolidated revenues in 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. In addition, our ability to increase sales will depend, in part, on our ability to obtain orders from current or new significant customers. The opportunities to obtain orders from these customers may be limited, which may impair our ability to grow revenues. We expect that sales of our products will continue to be concentrated with a limited number of significant customers for the foreseeable future. The loss of a significant customer or any reduction in orders by these customers, including reductions due to market or competitive conditions, such as we experienced in our Wireless Test segment, would likely have a material adverse effect on our business, financial condition or results of operations.

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Our operating results are likely to fluctuate significantly.

Our operating results are affected by a wide variety of factors that could materially adversely affect revenues or profitability. The following factors could impact future operations:

- a worldwide economic slowdown or disruption in the global financial markets;
- competitive pressures on selling prices;
- our ability to introduce, and the market acceptance of, new products;
- changes in product revenues mix resulting from changes in customer demand;
- the level of orders received which can be shipped in a quarter because of the tendency of customers to wait until late in a quarter to commit to purchase due to capital expenditure approvals and constraints occurring at the end of a quarter, or the hope of obtaining more favorable pricing from a competitor seeking the business;
- engineering and development investments relating to new product introductions, and the expansion of manufacturing, outsourcing and engineering operations in Asia;
- provisions for excess and obsolete inventory relating to the lack of demand for and the discontinuance of products;
- impairment charges for certain long-lived and intangible assets, and goodwill;
- an increase in the leasing of our products to customers;
- our ability to expand our global distribution channel for our collaborative robots;
- parallel or multi-site testing could lead to a decrease in the ultimate size of the market for our products; and
- the ability of our suppliers and subcontractors to meet product quality or delivery requirements needed to satisfy customer orders for our products, especially if consolidated revenues increase.

As a result of the foregoing and other factors, we have experienced and may continue to experience material fluctuations in future operating results on a quarterly or annual basis which could materially and adversely affect our business, financial condition, operating results or stock price.

We are subject to risks of operating internationally.

A significant portion of our total revenues is derived from customers outside the United States. Our international sales and operations are subject to significant risks and difficulties, including:

- unexpected changes in legal and regulatory requirements affecting international markets;
- changes in tariffs and exchange rates;
- social, political and economic instability, acts of terrorism and international conflicts;
- difficulties in protecting intellectual property;
- difficulties in accounts receivable collection;
- cultural differences in the conduct of business;
- difficulties in staffing and managing international operations;
- compliance with customs regulations; and
- compliance with international tax laws and regulations.

In addition, an increasing portion of our products and the products we purchase from our suppliers are sourced or manufactured in foreign locations, including China and Malaysia, and a large portion of the devices our products test are fabricated and tested by foundries and subcontractors in Taiwan, China, Singapore and other parts of Asia. As a result, we are subject to a number of economic and other risks, particularly during times of political or financial instability in these regions. Disruption of manufacturing or supply sources in these international locations could materially adversely impact our ability to fill customer orders and potentially result in lost business.

The implementation of tariffs and export controls on our products may have a material impact on our business.

Our business operations and supply chain are global and may be disrupted by the implementation of tariffs and export controls on our products.

On July 6, 2018 and August 23, 2018, the United States Trade Representative imposed a 25% tariff on two lists of products, including certain Teradyne products that are made in China and imported into the United States. We have submitted requests for exclusion of our products from the tariff, but there is no assurance that our requests will be approved. We have implemented operational changes that will mitigate the impact of the 25% tariff on the import of our impacted products into the United States. As a result, we do not expect that the tariff will have a material adverse effect on our business, financial condition or results of operations.

On September 24, 2018, the United States Trade Representative imposed a 10% tariff on many additional products made in China and imported into the United States. The tariff rate may increase to 25% in 2019. At this time, we do not expect that this tariff will significantly impact any Teradyne products and thus the tariff should not have a material adverse effect on our business, financial condition or results of operations.

On June 29, 2018, the United States Department of Commerce announced that it has commenced a review of new export controls focusing on emerging and foundational technologies. While there is uncertainty as to the technologies that will be covered, the new export controls could cover technologies used in one or more Teradyne products and, therefore, could impact the sale of certain Teradyne products and have a material adverse effect on our business, financial condition or results of operations.

The United States Department of Commerce from time to time has taken action to restrict the access of U.S.-origin technologies to Chinese companies by adding them to the Entity List under U.S. Export Administration Regulations. The addition to the Entity List of Chinese companies who are customers or potential customers could impact the sale and/or support of certain Teradyne products to those customers or potential customers and, therefore, have a material adverse effect on our business, financial condition or results of operations.

In addition to the actions taken by the United States, China has implemented retaliatory tariffs on products made in the United States and imported into China, including certain Teradyne products. We plan to assess and implement, if appropriate, operational changes that would mitigate the impact of the retaliatory tariffs. However, notwithstanding our efforts, the retaliatory tariffs or other trade restrictions implemented by China could disrupt our business operations, sales and supply chain and, therefore, have a material adverse effect on our business, financial condition or results of operations.

If we fail to develop new technologies to adapt to our customers needs and if our customers fail to accept our new products, our revenues will be adversely affected.

We believe that our technological position depends primarily on the technical competence and creative ability of our engineers. In a rapidly evolving market, such as ours, the development or acquisition of new technologies, commercialization of those technologies into products and market acceptance and customer

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demand for those products are critical to our success. Successful product development or acquisition, introduction and acceptance depend upon a number of factors, including:

- new product selection;
- ability to meet customer requirements;
- development of competitive products by competitors;
- timely and efficient completion of product design;
- timely and efficient implementation of manufacturing and manufacturing processes;
- timely remediation of product performance issues, if any, identified during testing;
- assembly processes and product performance at customer locations;
- differentiation of our products from our competitors products;
- management of customer expectations concerning product capabilities and product life cycles;
- transition of customers to new product platforms;
- ability to attract and retain technical talent; and
- innovation that does not infringe on the intellectual property rights of third parties.

We may be subject to product recalls and warranty and product liability claims.

We invest significant resources in the design, manufacture and testing of our products. However, we may discover design or manufacturing defects in our products after they have been shipped and, as a result, we may incur development and remediation costs and be required to settle warranty and product liability claims. In addition, if any of our products contain defects or have reliability, quality or safety issues, we may need to conduct a product recall which could result in significant repair or replacement costs and substantial delays in product shipments and may damage our reputation which could make it more difficult to sell our products. Any of these results could have a material adverse effect on our business, results of operations or financial condition.

If our suppliers do not meet product or delivery requirements, we could have reduced revenues and earnings.

Certain components, including semiconductor chips, may be in short supply from time to time because of high industry demand or the inability of some vendors to consistently meet our quality or delivery requirements. If any of our suppliers were to cancel contracts or commitments or fail to meet the quality or delivery requirements needed to satisfy customer orders for our products, we could lose time-sensitive customer orders, have significantly decreased revenues and earnings and be subject to contractual penalties, which would have a material adverse effect on our business, results of operations and financial condition. In addition, we rely on contract manufacturers for certain subsystems used in our products, and our ability to meet customer orders for those products depends upon the timeliness and quality of the work performed by these subcontractors, over whom we do not exercise any control.

To a certain extent, we are dependent upon the ability of our suppliers and contractors to help meet increased product or delivery requirements. It may be difficult for certain suppliers to meet delivery requirements in a period of rapid growth, therefore impacting our ability to meet our customers demands.

We rely on the financial strength of our suppliers. There can be no assurance that the loss of suppliers either as a result of financial viability, bankruptcy or otherwise will not have a material adverse effect on our business, results of operations or financial condition.

Our operations may be adversely impacted if our outsourced contract manufacturers or service providers fail to perform.

We depend on Flex Ltd. (Flex) to manufacture and test our FLEX and J750 family of products from its facility in China and on other contract manufacturers to manufacture other products. If for any reason these contract manufacturers cannot provide us with these products in a timely fashion, or at all, we may not be able to sell these products to our customers until we enter a similar arrangement with an alternative contract manufacturer. If we experience a problem with our supply of products from Flex or our other contract manufacturers, it may take us significant time to either manufacture the product or find an alternate contract manufacturer, which could result in substantial expense and disruption to our business.

We have also outsourced certain general and administrative functions to reputable service providers, many of which are in foreign countries, sometimes impacting communication with them because of language and time differences. Their presence in foreign countries also increases the risk they could be exposed to political risk. Additionally, there may be difficulties encountered in coordinating the outsourced operations with existing functions and operations. If we fail in successfully coordinating and managing the outsourced service providers, it may cause an adverse effect on our operations which could have a material adverse effect on our business, results of operations or financial condition.

We may not fully realize the benefits of our acquisitions or strategic alliances.

In June 2015, we acquired Universal Robots, and, in 2018, we acquired Energid and MiR. We may not be able to realize the benefit of acquiring or successfully growing these businesses. We may continue to acquire additional businesses, form strategic alliances or create joint ventures with third parties that we believe will complement or augment our existing businesses. We may not be able to realize the expected synergies and cost savings from the integration with our existing operations of other businesses or technologies that we may acquire. In addition, the integration process for our acquisitions may be complex, costly and time consuming and include unanticipated issues, expenses and liabilities. We may have difficulty in developing, manufacturing and marketing the products of a newly acquired company in a manner that enhances the performance of our combined businesses or product lines and allows us to realize value from expected synergies. Following an acquisition, we may not achieve the revenue or net income levels that justify the acquisition. Acquisitions may also result in one-time charges (such as acquisition-related expenses, write-offs or restructuring charges) or in the future, impairment of goodwill or acquired intangible assets that adversely affect our operating results. Additionally, we may fund acquisitions of new businesses, strategic alliances or joint ventures by utilizing our cash, incurring debt, issuing shares of our common stock, or by other means.

We may incur significant liabilities if we fail to comply with environmental regulations.

We are subject to both domestic and international environmental regulations and statutory strict liability relating to the use, storage, discharge, site cleanup and disposal of hazardous chemicals used in our manufacturing processes. If we fail to comply with present and future regulations, or are required to perform site remediation, we could be subject to future liabilities or cost, including penalties or the suspension of production. Present and future regulations may also:

- restrict our ability to expand facilities;
- restrict our ability to ship certain products;
- require us to modify our operations logistics;
- require us to acquire costly equipment; or
- require us to incur other significant costs and expenses.

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Pursuant to present regulations and agreements, we are conducting groundwater and subsurface assessment and monitoring and are implementing remediation and corrective action plans for facilities located in Massachusetts and New Hampshire which are no longer conducting manufacturing operations. As of December 31, 2018, we have not incurred material costs as a result of the monitoring and remediation steps taken at the Massachusetts and New Hampshire sites.

On January 27, 2003, the European Union adopted the following directives: (i) the directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (the RoHS Directive); and (ii) the directive on Waste Electrical and Electronic Equipment (the WEEE Directive). The WEEE Directive became effective August 13, 2005 and the RoHS Directive became effective on July 6, 2006. Both the RoHS Directive and the WEEE Directive alter the form and manner in which electronic equipment is imported, sold and handled in the European Union. Other jurisdictions, such as China, have followed the European Union s lead in enacting legislation with respect to hazardous substances and waste removal. Ensuring compliance with the RoHS Directive, the WEEE Directive and similar legislation in other jurisdictions, and integrating compliance activities with our suppliers and customers could result in additional costs and disruption to operations and logistics and thus, could have a negative impact on our business, operations or financial condition.

We currently are, and in the future may be, subject to litigation or regulatory proceedings that could have an adverse effect on our business.

From time to time, we may be subject to litigation or other administrative, regulatory or governmental proceedings, including tax audits and resulting claims that could require significant management time and resources and cause us to incur expenses and, in the event of an adverse decision, pay damages or incur costs in an amount that could have a material adverse effect on our financial position or results of operations.

Third parties may claim we are infringing their intellectual property and we could suffer significant litigation costs, licensing expenses or be prevented from selling our products.

We have been sued for patent infringement in the past and receive notifications from time to time that we may be in violation of patents held by others. An assertion of patent infringement against us, if successful, could have a material adverse effect on our ability to sell our products or it could force us to seek a license to the intellectual property rights of others or alter such products so that they no longer infringe the intellectual property rights of others. A license could be very expensive to obtain or may not be available at all. Similarly, changing our products or processes to avoid infringing the rights of others may be costly or impractical. Additionally, patent litigation could require a significant use of management resources and involve a lengthy and expensive defense, even if we eventually prevail. If we do not prevail, we might be forced to pay significant damages, obtain licenses, modify our products, or stop making our products; each of which could have a material adverse effect on our financial condition, operating results or cash flows.

If we are unable to protect our intellectual property (IP), we may lose a valuable asset or may incur costly litigation to protect our rights.

We protect the technology that is incorporated in our products in several ways, including through patent, copyright, trademark and trade secret protection and by contractual agreement. However, even with these protections, our IP may still be challenged, invalidated or subject to other infringement actions. While we believe that our IP has value in the aggregate, no single element of our IP is in itself essential. If a significant portion of our IP is invalidated or ineffective, our business could be materially adversely affected.

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We may incur higher tax rates than we expect and may have exposure to additional international tax liabilities and costs.

We are subject to paying income taxes in the United States and various other countries where we operate. Our effective tax rate is dependent on where our earnings are generated and the tax regulations and the interpretation and judgment of administrative tax or revenue entities in the United States and other countries. We have pursued a global tax strategy which could be adversely affected by the mix of earnings and tax rates in the countries where we operate, changes to tax laws, tax regulations or an adverse tax ruling by administrative entities. We are also subject to tax audits in the countries where we operate. Any material change in our tax liability resulting from changes in tax laws, tax regulations, administrative ruling or from an audit from an administrative tax or revenue entity could negatively affect our financial results.

As a multinational corporation, we are subject to income taxes as well as non-income based taxes, in both the United States and various foreign jurisdictions. In certain foreign jurisdictions, we qualify for tax incentives and tax holidays based on our ability to meet, on a continuing basis, various tests relating to our employment levels, research and development expenditures and other qualification requirements in a particular foreign jurisdiction. While we intend to operate in such a manner to maintain and maximize our tax incentives, no assurance can be given that we have so qualified or that we will so qualify for any particular year or jurisdiction. If we fail to qualify and to remain qualified for certain foreign tax incentives and tax holidays, we may be subject to further taxation or an increase in our effective tax rate which would adversely impact our financial results. In December 2015, we entered into an agreement with the Singapore Economic Development Board which extended our Singapore tax holiday under substantially similar terms to the agreement which expired on December 31, 2015. The new tax holiday is scheduled to expire on December 31, 2020. The tax savings attributable to the Singapore tax holiday for the years ended December 31, 2018, 2017 and 2016 were $11.9 million or $0.06 per diluted share, $24.8 million or $0.12 per diluted share and $17.0 million or $0.08 per diluted share, respectively. These tax savings may not be achievable in subsequent years due to changes in Singapore s tax laws or the expiration of the tax holiday.

In addition, we may incur additional costs, including headcount expenses, in order to maintain or obtain a foreign tax incentive in a particular foreign jurisdiction.

We have significant guarantees, indemnification and customer confidentiality obligations.

From time to time, we make guarantees to customers regarding the delivery, price and performance of our products and guarantee certain indebtedness, performance obligations or lease commitments of our subsidiary and affiliate companies. We also have agreed to provide indemnification to our officers, directors, employees and agents, to the extent permitted by law, arising from certain events or occurrences while the officer, director, employee or agent, is or was serving at our request in such capacity. Additionally, we have confidentiality obligations to certain customers and if breached would require the payment of significant penalties. If we become liable under any of these obligations, it could materially and adversely affect our business, financial condition or operating results. For additional information see Note K: Commitments and Contingencies Guarantees and Indemnification Obligations in Notes to Consolidated Financial Statements.

We may discontinue or reduce our quarterly cash dividend or share repurchase program.

In January 2014, our Board of Directors initiated a quarterly cash dividend of $0.06 per share. In January 2017, our Board of Directors increased our quarterly cash dividend to $0.07 per share and in January 2018, our Board of Directors increased our quarterly cash dividend to $0.09 per share. In January 2018, our Board of Directors approved a new $1.5 billion share repurchase authorization. In 2018 and 2017, we repurchased $823 million and $200 million of common stock, respectively. We intend to repurchase $500 million in 2019. Holders of our common stock are only entitled to receive dividends when and if they are declared by our Board of Directors. Future cash dividends and share repurchases are subject to the discretion of our Board of Directors and will depend, among other things, upon our earnings, capital requirements and financial condition. While we have declared a quarterly cash dividend on our common stock and authorized a share repurchase program, we are not required to do either and may reduce or eliminate our cash dividend or share repurchase program in the future. The reduction or elimination of our cash dividend or our share repurchase program could adversely affect the market price of our common stock.

We have incurred indebtedness and may incur additional indebtedness.

On December 12, 2016, we completed a private offering of $460.0 million aggregate principal amount of 1.25% convertible senior unsecured notes (the Notes) due December 15, 2023 and received net proceeds, after issuance costs, of approximately $450.8 million, $33.0 million of which was used to pay the net cost, after being partially offset by proceeds from the sale of the warrants, of the convertible note hedge transactions and $50.1 million of which was used to repurchase 2 million shares of our common stock. Holders of the Notes may require us to repurchase the Notes upon the occurrence of certain fundamental changes involving us or the holders may elect to convert into shares of our common stock.

On April 27, 2015, we entered into a five-year, senior secured revolving credit facility of up to $350.0 million. Subject to customary conditions, we may seek to obtain from existing or new lenders incremental commitments under the credit facility in an aggregate principal amount not to exceed $150.0 million. We have not borrowed any funds under this credit facility. We could borrow funds under this credit facility at any time for general corporate purposes and working capital.

The issuance of the Notes and any additional indebtedness, among other things, could:

- make it difficult to make payments on this indebtedness and our other obligations;
- make it difficult to obtain any necessary future financing for working capital, capital expenditures, debt service requirements or other purposes;
- require the dedication of a substantial portion of any cash flow from operations to service for indebtedness, thereby reducing the amount of cash flow available for other purposes, including capital expenditures; and
- limit our flexibility in planning for, or reacting to, changes in our business and the industries in which we compete.

Our convertible note hedge and warrant transactions could impact the value of our stock.

Concurrent with the offering of the Notes, we entered into convertible note hedge transactions (the Note Hedge Transactions) with the initial purchasers or their affiliates (the Option Counterparties). The Note Hedge Transactions cover, subject to customary anti-dilution adjustments, the number of shares of our common stock that underlie the Notes, with a strike price equal to the conversion price of the Notes of $31.70. The Note Hedge Transactions cover, subject to customary anti-dilution adjustments, approximately 14.5 million shares of our common stock.

Separately and concurrent with the pricing of the Notes, we entered into warrant transactions with the Option Counterparties (the Warrant Transactions) in which we sold net-share-settled (or, at our election subject to certain conditions, cash-settled) warrants to the Option Counterparties. The Warrant Transactions cover, subject to customary anti-dilution adjustments, approximately 14.5 million shares of our common stock. The strike price of the warrants is $39.78 per share. The Warrant Transactions could have a dilutive effect to our common stock to the extent that the market price per share of our common stock, as measured under the terms of the Warrant Transactions, exceeds the applicable strike price of the warrants.

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The Note Hedge Transactions are expected to reduce the potential dilution to our common stock upon any conversion of the Notes. However, the Warrant Transactions could separately have a dilutive effect to the extent that the market value per share of our common stock exceeds the applicable strike price of the warrants. The net cost of the Note Hedge Transactions, after being partially offset by the proceeds from the sale of the warrants, was approximately $33.0 million.

In connection with establishing their initial hedge of these convertible note hedge and warrant transactions, the Option Counterparties have entered into various derivative transactions with respect to our common stock and/or purchase shares of our common stock or other securities, including the Notes, concurrent with, or shortly after, the pricing of the Notes. In addition, the Option Counterparties may modify their hedge positions by entering into or unwinding various derivative transactions with respect to our common stock or by selling our common stock or other securities, including the Notes, in secondary market transactions (and may do so during any observation period related to the conversion of the Notes). These activities could adversely impact the value of our common stock and the Notes.

We may not be able to pay our debt and other obligations.

If our cash flow is inadequate to meet our obligations, we could face substantial liquidity problems. If we are unable to generate sufficient cash flow or otherwise obtain funds necessary to make required payments on the Notes or certain of our other obligations, we would be in default under the terms thereof, which would permit the holders of those obligations to accelerate their maturity and also could cause defaults under future indebtedness we may incur. Any such default could have a material adverse effect on our business, prospects, financial position and operating results. In addition, we cannot be certain that we would be able to repay amounts due on the Notes if those obligations were to be accelerated following the occurrence of any other event of default as defined in the instruments creating those obligations, or if the holders of the Notes require us to repurchase the Notes upon the occurrence of a fundamental change involving us. Moreover, we cannot be certain that we will have sufficient funds or will be able to arrange for financing to pay the principal amount due on the Notes at maturity.

Restrictive covenants in the agreement governing our senior secured revolving credit facility may restrict our ability to pursue business strategies.

The agreement governing our senior secured revolving credit facility limits our ability, among other things, to: incur additional secured indebtedness; sell, transfer, license or dispose of assets; consolidate or merge; enter into transactions with our affiliates; and incur liens. In addition, our senior secured revolving credit facility contains financial and other restrictive covenants that limit our ability to engage in activities that may be in our long term best interest, such as, subject to permitted exceptions, making capital expenditures in excess of certain thresholds, making investments, loans and other advances, and prepaying any additional indebtedness while our indebtedness under our senior secured revolving credit facility is outstanding. Our failure to comply with financial and other restrictive covenants could result in an event of default, which if not cured or waived, could result in the lenders requiring immediate payment of all outstanding borrowings or foreclosing on collateral pledged to them to secure the indebtedness.

Our business may suffer if we are unable to attract and retain key employees.

Competition for employees with skills we require is intense in the high technology industry. Our success will depend on our ability to attract and retain key technical employees. The loss of one or more key or other employees, a decrease in our ability to attract additional qualified employees, or the delay in hiring key personnel could each have a material adverse effect on our business, results of operations or financial condition.

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Our operations, and the operations of our customers and suppliers, are subject to risks of natural catastrophic events, widespread health epidemics, acts of war, terrorist attacks and the threat of domestic and international terrorist attacks, any one of which could result in cancellation of orders, delays in deliveries or other business activities, or loss of customers and could negatively affect our business and results of operations.

Our business is international in nature, with our sales, service and administrative personnel and our customers and suppliers located in numerous countries throughout the world. Our operations, and those of our customers and suppliers, are subject to disruption for a variety of reasons, including work stoppages, acts of war, terrorism, health epidemics, fires, earthquakes, hurricanes, volcanic eruptions, energy shortages, telecommunication failures, tsunamis, flooding or other natural disasters. Such disruption could materially increase our costs and expenses as well as cause delays in, among other things, shipments of products to our customers, our ability to perform services requested by our customers, or the installation and acceptance of our products at customer sites. Any of these conditions could have a material adverse effect on our business, financial condition or results of operations.

A breach of our operational or security systems could negatively affect our business and results of operations.

We rely on various information technology networks and systems, some of which are managed by third parties, to process, transmit and store electronic information, including confidential data, and to carry out and support a variety of business activities, including manufacturing, research and development, supply chain management, sales and accounting. A failure in or a breach of our operational or security systems or infrastructure, or those of our suppliers and other service providers, including as a result of cyber attacks, could disrupt our business, result in the disclosure or misuse of proprietary or confidential information, damage our reputation, cause losses and increase our costs.

We may face risks associated with shareholder activism.

Publicly traded companies have increasingly become subject to campaigns by shareholders advocating corporate actions such as financial restructuring, increased borrowing, special dividends, stock repurchases or divestitures. We may become subject in the future to such shareholder activity and demands. Such activities could interfere with our ability to execute our business plans, be costly and time-consuming, disrupt our operations, divert the attention of management or result in our initiating borrowing or increasing our share repurchase plan or dividend, any of which could have an adverse effect on our business or stock price.

Provisions of our charter and by-laws and Massachusetts law may make a takeover of Teradyne more difficult.

There are provisions in our basic corporate documents and under Massachusetts law that could discourage, delay or prevent a change in control, even if a change in control may be regarded as beneficial to some or all of our stockholders.

Item 1B: ***Unresolved Staff Comments***

None.

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Item 2: ***Properties***

The following table provides information as to our principal facilities:

Location	Operating Segment	Major Activity (1)	Approximate Square Feet of Floor Space
Properties owned:			
North Reading, Massachusetts	Semiconductor Test & System Test	1-2-3-4-5	422,000
Agoura Hills, California	Semiconductor Test	3-4	120,000
Kumamoto, Japan	Semiconductor Test	2-3-4-5	60,300
			602,300
Properties leased:			
Odense, Denmark	Industrial Automation	2-3-4-5	247,000
Cebu, Philippines	Semiconductor Test	1-2-5	209,000
San Jose, California	Semiconductor Test & Wireless Test	2-3-4-5	185,700
Shanghai, China	Semiconductor Test, System Test, Wireless Test & Industrial Automation	3-4-5	103,000
Buffalo Grove, Illinois	Semiconductor Test	2-3-4-5	95,000
Sunnyvale, California	Wireless Test & Semiconductor Test	2-3-4-5	71,300
Heredia, Costa Rica	Semiconductor Test	1-5	63,000
Hsinchu, Taiwan	Semiconductor Test & System Test	4	43,000
Seoul, Korea	Semiconductor Test & Industrial Automation	4	34,000
Singapore, Singapore	Semiconductor Test & Industrial Automation	1-3-4	32,700
			1,083,700

(1) Major activities have been separated into the following categories: 1. Corporate Administration, 2. Manufacturing, 3. Engineering, 4. Sales and Marketing, 5. Storage and Distribution.

Item 3: ***Legal Proceedings***

We are subject to legal proceedings, claims and investigations that arise in the ordinary course of business such as, but not limited to, patent, employment, commercial and environmental matters. We believe that we have meritorious defenses against all pending claims and intend to vigorously contest them. While it is not possible to predict or determine the outcomes of any pending claims or to provide possible ranges of losses that may arise, we believe the potential losses associated with all of these actions are unlikely to have a material adverse effect on our results of operations, financial condition or cash flows.

Item 4: ***Mine Safety Disclosure***

Not Applicable.

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PART II

Item 5: ***Market for Registrant s Common Equity, Related Shareholder Matters and Issuer Purchases of Equity Securities***

Our common stock is traded on the Nasdaq Global Select Market under the trading symbol TER . Before November 27, 2018, our common stock traded on the New York Stock Exchange.

See Item 7: Management s Discussion and Analysis of Financial Condition and Results of Operations, for information on the frequency and amounts of our quarterly cash dividends, equity compensation plans and performance graph.

The following table includes information with respect to repurchases we made of our common stock during the three months ended December 31, 2018 (in thousands except per share price):

Period	(a) Total Number of Shares (or Units) Purchased	(b) Average Price Paid per Share (or Unit)	(c) Total Number of Shares (or Units) Purchased as Part of Publicly Announced Plans or Programs	(d) Maximum Number (or Approximate Dollar Value) of Shares (or Units) that may Yet Be Purchased Under the Plans or Programs
October 1, 2018 October 28, 2018	3,115	$ 33.87	3,113	$ 832,309
October 29, 2018 November 25, 2018	2,386	$ 34.54	2,383	$ 750,000
November 26, 2018 December 31, 2018	2,300	$ 31.95	2,300	$ 676,522
	7,801(1)	$ 33.51(1)	7,796	

(1) Includes approximately five thousand shares at an average price of $36.24 withheld from employees for the payment of taxes.
We satisfy U.S. federal and state minimum withholding tax obligations due upon the vesting and the conversion of restricted stock units into shares of our common stock, by automatically withholding from the shares being issued, a number of shares with an aggregate fair market value on the date of such vesting and conversion that would satisfy the minimum withholding amount due.

Item 6: ***Selected Financial Data***

	Years Ended December 31,				
	2018	2017	2016	2015	2014
	(dollars in thousands, except per share amounts)				
Consolidated Statement of Operations Data (1)(2)(3)(4)(5):					
Revenues	$ 2,100,802	$ 2,136,606	$ 1,753,250	$ 1,639,578	$ 1,647,824
Net income (loss)	$ 451,779	$ 257,692	$ (43,421)	$ 206,477	$ 81,272
Net income (loss) per common share-basic	$ 2.41	$ 1.30	$ (0.21)	$ 0.98	$ 0.40
Net income (loss) per common share-diluted	$ 2.35	$ 1.28	$ (0.21)	$ 0.97	$ 0.37

Cash dividend declared per common share	$ 0.36	$ 0.28	$ 0.24	$ 0.24	$ 0.18
Consolidated Balance Sheet Data:					
Total assets	$ 2,706,606	$ 3,109,545	$ 2,762,493	$ 2,548,674	$ 2,538,520
Long-term debt obligations	$ 379,981	$ 365,987	$ 352,669	$	$

(1) The year ended December 31, 2018 includes $49.5 million of tax benefit related to the finalization of the U.S. transition tax liability, $3.3 million of pension actuarial gains, and the results of operations of Mobile Industrial Robots and Energid from April 25, 2018 and February 26, 2018, respectively.

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(2) The year ended December 31, 2017 includes $186.0 million of provisional tax expense related to the Tax Reform Act and $6.6 million of pension actuarial gains.
(3) The year ended December 31, 2016 includes a $254.9 million goodwill impairment charge and an $83.3 million acquired intangible assets impairment charge related to the Wireless Test segment, and $3.2 million of pension actuarial gains.
(4) The year ended December 31, 2015 includes $17.7 million of pension actuarial losses, a $5.4 million gain from the sale of an equity investment and the results of operations of Universal Robots from June 12, 2015.
(5) The year ended December 31, 2014 includes a $98.9 million goodwill impairment charge related to the Wireless Test segment and $46.6 million of pension actuarial losses.

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

Overview

We are a leading global supplier of automation equipment for test and industrial applications. We design, develop, manufacture and sell automatic test systems used to test semiconductors, wireless products, data storage and complex electronics systems in the consumer electronics, wireless, automotive, industrial, computing, communications, and aerospace and defense industries. Our industrial automation products include collaborative robotic arms, autonomous mobile robots and advanced robotic control software used by global manufacturing and light industrial customers to improve quality, increase manufacturing and material handling efficiency and decrease manufacturing costs. Our automatic test equipment and industrial automation products and services include:

- semiconductor test (Semiconductor Test) systems;
- defense/aerospace (Defense/Aerospace) test instrumentation and systems, storage test (Storage Test) systems, and circuit-board test and inspection (Production Board Test) systems (collectively these products represent System Test);
- industrial automation (Industrial Automation) products; and
- wireless test (Wireless Test) systems.

We have a customer base which includes integrated device manufacturers (IDMs), outsourced semiconductor assembly and test providers (OSATs), original equipment manufacturers (OEMs), wafer foundries, fabless companies that design, but contract with others for the manufacture of integrated circuits (ICs), developers of wireless devices and consumer electronics, manufacturers of circuit boards, automotive suppliers, wireless product manufacturers, storage device manufacturers, aerospace and military contractors, and distributors that sell collaborative robots, autonomous mobile robots and wireless test systems.

The market for our test products is concentrated with a limited number of significant customers accounting for a substantial portion of the purchases of test equipment. One customer drives significant demand for our products both through direct sales and sales to the customer s supply partners. We expect that sales of our test products will continue to be concentrated with a limited number of significant customers for the foreseeable future.

The sales of our products and services are dependent, to a large degree, on customers who are subject to cyclical trends in the demand for their products. These cyclical periods have had, and will continue to have, a significant effect on our business because our customers often delay or accelerate purchases in reaction to changes in their businesses and to demand fluctuations in the semiconductor and electronics industries. Historically, these demand fluctuations have resulted in significant variations in our results of operations. During the first quarter of 2018, demand outlook for mobile device test capacity in 2018 declined sharply for our Semiconductor Test business. Demand in other segments of the Semiconductor Test business, including memory test, increased in 2018.

In 2015, we acquired Universal Robots A/S (Universal Robots), the leading supplier of collaborative robots which are low-cost, easy-to-deploy and simple-to-program robots that work side by side with production workers to improve quality, increase manufacturing efficiency and decrease manufacturing costs. The acquisition of Universal Robots provides a growth engine to our business. The total purchase price for Universal Robots was approximately $315 million, which included cash paid of approximately $284 million and $32 million in fair value of contingent consideration payable upon achievement of revenue and earnings targets through 2018. Contingent consideration for 2015 was $15 million and was paid in February 2016. Contingent consideration for the period from July 2015 to December 2017 was $24.6 million and was paid March 2018. Contingent consideration for the period from July 2015 to December 2018 was $3.9 million and it is expected to be paid in March 2019.

On February 26, 2018, we acquired Energid Technologies Corporation (Energid) for a total purchase price of approximately $27.6 million. Energid s technology enables and simplifies the programming of complex robotic motions used in a wide variety of end markets, ranging from heavy industry to healthcare, utilizing both traditional robots and collaborative robots.

On April 25, 2018, we acquired Mobile Industrial Robots ApS (MiR), a Danish limited liability company. MiR is the leading maker of collaborative autonomous mobile robots for industrial applications. The total purchase price was approximately $198 million, which included cash paid of approximately $145 million and $53 million in fair value of contingent consideration payable upon achievement of certain thresholds and targets for revenue and earnings before interest and taxes through 2020. At December 31, 2018, the maximum amount of contingent consideration that could be paid is $115 million. Contingent consideration for 2018 was $31.0 million and is expected to be paid in March 2019.

Universal Robots, MiR and Energid are included in our Industrial Automation segment.

We believe our recent acquisitions have enhanced our opportunities for growth. We intend to continue to invest in our business, grow market share in our markets and expand further our addressable markets while tightly managing our costs.

Critical Accounting Policies and Estimates

We have identified the policies discussed below as critical to understanding our business and our results of operations and financial condition. The impact and any associated risks related to these policies on our business operations is discussed throughout Management s Discussion and Analysis of Financial Condition and Results of Operations where such policies affect our reported and expected financial results.

Revenue from Contracts with Customers

We adopted Accounting Standards Codification (ASC) 606, *Revenue from Contracts with Customers* on January 1, 2018 using the modified retrospective method for all contracts not completed as of the date of adoption. The reported results for 2018 reflect the application of ASC 606 while the reported results for 2017 were prepared under the guidance of ASC 605, *Revenue Recognition,* which is also referred to herein as Legacy GAAP or the previous guidance. We recorded a net increase to retained earnings of $12.7 million as of January 1, 2018 due to the cumulative impact of adopting ASC 606. The adoption of ASC 606 represents a change in accounting principle that will more closely align revenue recognition with the delivery of Teradyne s hardware and services and will provide financial statement readers with enhanced disclosures. In accordance with ASC 606, revenue is recognized when or as a customer obtains control of promised goods or services. The amount of revenue recognized reflects the consideration to which Teradyne expects to be entitled to receive in exchange for fulfillment of the performance obligation. Teradyne s primary source of revenue will continue to be from the sale of systems, instruments, robots, and the delivery of services.

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In accordance with ASC 606, we recognize revenues, when or as control is transferred to a customer. Our determination of revenue is dependent upon a five step process outlined below.

Step 1: Identify the contract with the customer

We account for a contract with a customer when there is written approval, the contract is committed, the rights of the parties, including payment terms, are identified, the contract has commercial substance and consideration is probable of collection.

Step 2: Identify the performance obligations in the contract

We periodically enter into contracts with customers in which a customer may purchase a combination of goods and services, such as products with extended warranty obligations. We determine performance obligations by assessing whether the products or services are distinct from the other elements of the contract. In order to be distinct, the product or service must perform either on its own or with readily available resources and must be separate within the context of the contract.

Step 3: Determine the transaction price

We consider the amount stated on the face of the purchase order to be the transaction price. We do not have variable consideration which could impact the stated purchase price agreed to by us and the customer.

Step 4: Allocate the transaction price to the performance obligations in the contract

Transaction price is allocated to each individual performance obligation based on the standalone selling price of that performance obligation. We use standalone transactions when available to value each performance obligation. If standalone transactions are not available, we will estimate the standalone selling price through market assessments or cost plus a reasonable margin analysis. Any discounts from standalone selling price are spread proportionally to each performance obligation.

Step 5: Recognize revenue when (or as) the entity satisfies a performance obligation

In order to determine the appropriate timing for revenue recognition, we first determine if the transaction meets any of three criteria for over time recognition. If the transaction meets the criteria for over time recognition, we recognize revenue as the good or service is delivered. We use input variables such as hours or months utilized or costs incurred to determine the amount of revenue to recognize in a given period. Input variables are used as they best align consumption with benefit to the customer. For transactions that do not meet the criteria for over time recognition, we will recognize revenue at a point in time based on an assessment of the five criteria for transfer of control. We have concluded that revenue should be recognized when shipped or delivered based on contractual terms. Typically acceptance of our products and services is a formality as we deliver similar systems, instruments and robots to standard specifications. In cases where acceptance is not deemed a formality, we will defer revenue recognition until customer acceptance.

Translation of Non-U.S. Currencies

The functional currency for all non-U.S. subsidiaries is the U.S. dollar, except for the Industrial Automation segment for which the local currency is its functional currency. All foreign currency denominated monetary assets and liabilities are remeasured on a monthly basis into the functional currency using exchange rates in effect at the end of the period. All foreign currency denominated non-monetary assets and liabilities are remeasured into the functional currency using historical exchange rates. Net foreign exchange gains and losses resulting from remeasurement are included in other (income) expense, net. For Industrial Automation, assets and liabilities are translated into U.S. dollars using exchange rates in effect at the end of the period. Revenues and expense amounts are translated using an average of exchange rates in effect during the period. Translation adjustments are recorded within accumulated other comprehensive income (loss).

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Retirement and Postretirement Plans

We recognize net actuarial gains and losses and the change in the fair value of the plan assets in our operating results in the year in which they occur or upon any interim remeasurement of the plans. We calculate the expected return on plan assets using the fair value of the plan assets. Actuarial gains and losses are generally measured annually as of December 31 and, accordingly, recorded during the fourth quarter of each year or upon any interim remeasurement of the plans.

In March 2017, the Financial Accounting Standards Board (FASB) issued ASU 2017-07, *Compensation Retirement Benefits (Topic 715): Improving the Presentation of Net Periodic Pension Cost and Net Periodic Postretirement Benefit Cost.* We retrospectively adopted the new accounting guidance on presentation of net periodic pension costs and net periodic postretirement benefit costs in the first quarter of 2018. This guidance requires the service cost component of net benefit costs to be reported in the same line item in the consolidated statement of operations as other employee compensation costs. The non-service components of net benefit costs such as interest cost, expected return on assets, amortization of prior service cost, and actuarial gains or losses, are required to be reported separately outside of income or loss from operations. Following the adoption of this guidance, we continue to record the service cost component in the same line item as other employee compensation costs and the non-service components of net benefit costs such as interest cost, expected return on assets, amortization of prior service cost, and actuarial gains or losses are reported within other (income) expense, net. In 2017 and 2016, the retrospective adoption of this standard decreased income from operations by $5.0 million and $3.0 million, respectively, due to the reclass of net actuarial pension gains and increased non-operating (income) expense by the same amount with no impact to net income (loss).

Inventories

Inventories are stated at the lower of cost (first-in, first-out basis) or net realizable value. On a quarterly basis, we use consistent methodologies to evaluate all inventories for net realizable value. We record a provision for both excess and obsolete inventory when such write-downs or write-offs are identified through the quarterly review process. The inventory valuation is based upon assumptions about future demand, product mix, and possible alternative uses.

Equity Incentive and Stock Purchase Plans

Stock-based compensation expense is based on the grant-date fair value estimated in accordance with the provisions of ASC 718, *Compensation Stock Compensation.* Upon adoption of ASU 2016-09, *Compensation-Stock Compensation (Topic 718): Improvements to Employee Share-Based Payment Accounting,* in the first quarter of 2017, we made an accounting policy election to continue accounting for forfeitures by applying an estimated forfeiture rate and recognizing compensation costs only for those stock-based compensation awards expected to vest. In accordance with ASU 2016-09, starting in the first quarter of 2017, excess tax benefits or tax deficiencies are recognized as a discrete tax benefit or discrete tax expense to the current income tax provision in our consolidated statements of operations and are reported as cash flows from operating activities. On January 1, 2017, a cumulative effect adjustment of $39.1 million for any prior year excess tax benefits or tax deficiencies not previously recorded was recorded as an increase to retained earnings and deferred tax assets. All cash payments made to taxing authorities on the employees behalf for withheld shares are presented as financing activities on the statement of cash flows. In 2018 and 2017, we recognized a discrete tax benefit of $7.6 million and $6.3 million, respectively, related to net excess tax benefit.

Income Taxes

Deferred tax assets and liabilities are determined based on differences between financial reporting and tax basis of assets and liabilities and are measured using the enacted tax rates and laws that will be in effect when the differences are expected to reverse. The measurement of deferred tax assets is reduced by a valuation allowance

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if it is more likely than not that some or all of the deferred tax assets will not be realized. We performed the required assessment of positive and negative evidence regarding the realization of the net deferred tax assets in accordance with ASC 740, *Accounting for Income Taxes.* This assessment included the evaluation of scheduled reversals of deferred tax liabilities, estimates of projected future taxable income and tax-planning strategies. Although realization is not assured, based on our assessment, we concluded that it is more likely than not that such assets, net of the existing valuation allowance, will be realized.

Investments

We account for our investments in debt and equity securities in accordance with the provisions of ASC 320-10, *Investments Debt and Equity Securities.* On a quarterly basis, we review our investments to identify and evaluate those that have an indication of a potential other-than-temporary impairment. Factors considered in determining whether a loss is other-than-temporary include:

- The length of time and the extent to which the market value has been less than cost;
- The financial condition and near-term prospects of the issuer; and
- The intent and ability to retain the investment in the issuer for a period of time sufficient to allow for any anticipated recovery in market value.

Financial Assets and Financial Liabilities

In January 2016, the FASB issued ASU 2016-01, *Financial Instruments Overall (Subtopic 825-10): Recognition and Measurement of Financial Assets and Financial Liabilities.* We adopted the new accounting guidance in the first quarter of 2018 using the modified retrospective approach. This guidance requires that changes in fair value of equity marketable securities be accounted for directly in earnings. Previously, the changes in fair value of equity marketable securities were recorded in accumulated other comprehensive income on the balance sheet. We continue to record realized gains in interest income and realized losses in interest expense. The adoption of this new accounting guidance increased the January 1, 2018 retained earnings balance by $3.1 million and decreased the accumulated other comprehensive income balance by the same amount.

Goodwill, Intangible and Long-Lived Assets

We assess goodwill for impairment at least annually in the fourth quarter, as of December 31, on a reporting unit basis, or more frequently, when events and circumstances occur indicating that the recorded goodwill may be impaired. If the book value of a reporting unit exceeds its fair value, the implied fair value of goodwill is compared with the carrying amount of goodwill. If the carrying amount of goodwill exceeds the implied fair value, an impairment charge is recorded in an amount equal to that excess.

In the second quarter of 2016, the Wireless Test reporting unit (which is our Wireless Test operating and reportable segment) reduced headcount by 11% as a result of a sharp decline in projected demand attributable to an estimated smaller future wireless test market. The decrease in projected demand was due to lower forecasted buying from our largest Wireless Test segment customer (who had previously contributed between 51% and 73% of annual Wireless Test sales since the LitePoint acquisition in 2011) as a result of the customer s numerous operational efficiencies; slower smartphone growth rates; and a slowdown of new wireless technology adoption. We considered the headcount reduction and sharp decline in projected demand to be a triggering event for an interim goodwill impairment test. Following the interim goodwill impairment test, we recorded a goodwill impairment charge of $254.9 million, with approximately $8.0 million of goodwill remaining.

No goodwill impairment was identified in the fourth quarter of 2018, 2017, and 2016, as part of the annual goodwill impairment test.

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We assess the impairment of intangible and long-lived assets whenever events or changes in circumstances indicate that the carrying value may not be recoverable. Factors we consider important in the determination of an impairment include significant underperformance relative to historical or projected future operating results, significant changes in the manner that we use the acquired asset and significant negative industry or economic trends.

As a result of the interim goodwill impairment test in the second quarter of 2016 described above, we performed an impairment test of the Wireless Test segment s intangible and long-lived assets based on the comparison of the estimated undiscounted cash flows to the recorded value of the assets and recorded an $83.3 million acquired intangible assets impairment charge, with approximately $2.2 million of intangible assets remaining at December 31, 2018. There were no events or circumstances indicating that the carrying value of acquired intangible and long-lived assets may not be recoverable in 2018 and 2017; as such no impairment test was performed. When we determine that the carrying value of intangible and long-lived assets may not be recoverable based upon the existence of one or more of the above indicators of impairment, we measure any impairment based on a projected discounted cash flow method using a discount rate commensurate with the associated risks.

Results of Operations

The following table sets forth the percentage of total net revenues included in our consolidated statements of operations:

	Years Ended December 31,		
	2018	**2017**	**2016**
Percentage of revenues:			
Revenues:			
Products	82.3%	83.5%	82.9%
Services	17.7	16.5	17.1
Total revenues	100.0	100.0	100.0
Cost of revenues:			
Cost of products	34.6	35.6	37.6
Cost of services	7.3	7.2	7.7
Total cost of revenues (exclusive of acquired intangible assets amortization shown separately below)	41.9	42.8	45.3
Gross profit	58.1	57.2	54.7
Operating expenses:			
Selling and administrative	18.6	16.3	18.1
Engineering and development	14.4	14.4	16.7
Acquired intangible assets amortization	1.9	1.4	3.0
Restructuring and other	0.7	0.4	1.3
Goodwill impairment			14.5
Acquired intangible assets impairment			4.8
Total operating expenses	35.5	32.6	58.3
Income (loss) from operations	22.6	24.6	(3.6)
Non-operating (income) expenses:			
Interest income	(1.3)	(0.8)	(0.5)
Interest expense	1.5	1.0	0.2
Other (income) expense, net	0.1	(0.1)	(0.1)
Income (loss) before income taxes	22.3	24.5	(3.1)
Income tax provision (benefit)	0.8	12.5	(0.7)
Net income (loss)	21.5%	12.1%	(2.5)%

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Revenues

Revenues for our reportable segments were as follows:

	2018	2017	2016	2017-2018 Dollar Change	2016-2017 Dollar Change
			(in millions)		
Semiconductor Test	$ 1,492.4	$ 1,662.5	$ 1,368.2	$ (170.1)	$ 294.3
Industrial Automation	261.5	170.1	99.0	91.4	71.1
System Test	216.1	192.1	189.8	24.0	2.3
Wireless Test	132.0	111.9	96.2	20.1	15.7
Corporate and Other	(1.2)			(1.2)	
	$ 2,100.8	$ 2,136.6	$ 1,753.3	$ (35.8)	$ 383.3

The decrease in Semiconductor Test revenues of $170.1 million, or 10%, from 2017 to 2018 was driven primarily by a decrease in sales in the mobility and microcontroller test segments, partially offset by increased sales in memory and analog test segments and an increase in service revenues. The increase in Semiconductor Test revenues of $294.3 million, or 22%, from 2016 to 2017 was driven primarily by increased sales in the microcontroller, power management, flash memory, and automotive safety test segments and an increase in service revenues.

The increase in Industrial Automation revenues of $91.4 million, or 54%, from 2017 to 2018 was due to higher demand for collaborative robotic arms and the acquisition of MiR, completed in April 2018. MiR added revenues of $24.1 million in 2018. The increase in Industrial Automation revenues of $71.1 million, or 72%, from 2016 to 2017 was due to higher demand for collaborative robotic arms.

The increase in System Test revenues of $24.0 million, or 12%, from 2017 to 2018 was primarily due to higher system sales in Production Board Test and higher sales of 3.5 hard disk drive and system level testers in Storage Test. The increase in System Test revenues of $2.3 million, or 1%, from 2016 to 2017 was primarily due to higher service revenue in Defense/Aerospace test instrumentation and systems.

The increase in Wireless Test revenues of $20.1 million, or 18%, from 2017 to 2018 was primarily due to higher demand for next generation wireless products. The increase in Wireless Test revenues of $15.7 million, or 16%, from 2016 to 2017 was primarily due to higher demand for connectivity test systems and higher service revenue.

Our reportable segments accounted for the following percentages of consolidated revenues:

	2018	2017	2016
Semiconductor Test	71%	78%	78%
Industrial Automation	12	8	6
System Test	10	9	11
Wireless Test	6	5	5
	100%	100%	100%

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Revenues by country as a percentage of total revenues were as follows (1):

	2018	2017	2016
Taiwan	25%	32%	37%
China	17	12	10
United States	13	12	13
Europe	11	8	7
Korea	8	10	8
Japan	8	8	8
Malaysia	6	6	6
Singapore	5	5	4
Philippines	4	5	3
Thailand	3	1	3
Rest of the World		1	1
	100%	100%	100%

(1) Revenues attributable to a country are based on the location of the customer site.
The breakout of product and service revenues was as follows:

	2018	2017	2016	2017-2018 Dollar Change	2016-2017 Dollar Change
			(in millions)		
Product revenues	$ 1,729.6	$ 1,784.7	$ 1,453.2	$ (55.1)	$ 331.5
Service revenues	371.2	351.9	300.0	19.3	51.9
	$ 2,100.8	$ 2,136.6	$ 1,753.3	$ (35.8)	$ 383.3

Our product revenues decreased $55.1 million, or 3%, in 2018 from 2017 primarily due to lower sales in Semiconductor Test mobility test segment, partially offset by higher sales in Industrial Automation, System Test and Wireless Test. Service revenues increased $19.3 million, or 5%.

Our product revenues increased $331.5 million, or 23%, in 2017 from 2016 primarily due to higher sales across all Semiconductor Test products and higher sales in Industrial Automation. Service revenues, which are derived from the servicing of our installed base of products and include equipment maintenance contracts, repairs, extended warranties, parts sales, and applications support increased $51.9 million, or 17%.

In 2018, no single customer accounted for more than 10% of our consolidated revenues. In 2017 and 2016, revenues from one customer accounted for 13% and 12%, respectively, of our consolidated revenues. In 2016, a different customer accounted for 12% of our consolidated revenues. In each of the years, 2018, 2017, and 2016, our five largest customers in aggregate accounted for 27%, 32%, and 36%, respectively, of our consolidated revenues. We estimate consolidated revenues driven by a single OEM customer, combining direct sales to that customer with sales to the customer s OSATs, accounted for approximately 13%, 22%, and 26% of our consolidated revenues in 2018, 2017, and 2016, respectively.

Gross Profit

	2018	2017	2016	2017-2018 Dollar / Point Change	2016-2017 Dollar / Point Change
			(dollars in millions)		
Gross profit	$ 1,220.4	$ 1,221.5	$ 958.6	$ (1.1)	$ 262.9
Percent of total revenues	58.1%	57.2%	54.7%		