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

Form 10-K

(Mark One)

ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934
For the fiscal year ended December 31, 2018

or

TRANSITION REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934
For the transition period from to

000-31311
(Commission file number)

PDF SOLUTIONS, INC.

(Exact name of registrant as specified in its charter)

Delaware
(State or other jurisdiction of
Incorporation or organization)

25-1701361
(I.R.S. Employer
Identification No.)

2858 De La Cruz Blvd.
Santa Clara, California
(Address of Registrant's principal executive offices)

95050
(Zip Code)

(408) 280-7900

(Registrant's telephone number, including area code)

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

<u>Title of Class</u>	<u>Name of Each Exchange on Which Registered</u>
Common Stock, \$0.00015 par value	The NASDAQ Stock Market LLC

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

None

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

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

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

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

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

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

- | | |
|--|---|
| <input type="checkbox"/> Large accelerated filer | <input checked="" type="checkbox"/> Accelerated filer |
| <input type="checkbox"/> Non-accelerated filer | <input type="checkbox"/> Smaller reporting company |
| <input type="checkbox"/> Emerging growth company | |
| <input type="checkbox"/> If an emerging growth company, indicated 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 Act). Yes No

The aggregate market value of the voting stock held by non-affiliates of the Registrant was approximately \$291.1 million as of the last business day of the Registrant's most recently completed second fiscal quarter, based upon the closing sale price on the NASDAQ Global Market reported for such date. Shares of Common Stock held by each officer and director and by each person who owns 10% or more of the outstanding Common Stock have been excluded in that such persons may be deemed to be affiliates. This determination of affiliate status is not necessarily a conclusive determination for other purposes.

There were 32,595,723 shares of the Registrant's Common Stock outstanding as of March 1, 2019.

DOCUMENTS INCORPORATED BY REFERENCE

Part III incorporates certain information by reference from the definitive Proxy Statement to be filed within 120 days from December 31, 2018.

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SPECIAL NOTE REGARDING FORWARD LOOKING STATEMENTS

This Annual Report on Form 10-K, particularly in Item 1 “Business” and Item 7 “Management’s Discussion and Analysis of Financial Condition and Results of Operations,” includes forward-looking statements within the meaning of Section 27A of the Securities Act of 1933, as amended (the “Securities Act”) and Section 21E of the Securities Exchange Act of 1934, as amended (the “Exchange Act”). These statements include, but are not limited to, statements concerning: expectations about the effectiveness of our business and technology strategies; expectations regarding global economic trends; expectations regarding recent and future acquisitions; current semiconductor industry trends; expectations of the success and market acceptance of our intellectual property and our solutions; and our ability to obtain additional financing if needed. Our actual results could differ materially from those projected in the forward-looking statements as a result of a number of factors, risks and uncertainties discussed in this Form 10-K, especially those contained in Item 1A of this Form 10-K. The words “may,” “anticipate,” “plan,” “continue,” “could,” “projected,” “expect,” “believe,” “intend,” and “assume,” the negative of these terms and similar expressions are used to identify forward-looking statements. All forward-looking statements and information included herein is given as of the filing date of this Form 10-K with the Securities and Exchange Commission (“SEC”) and based on information available to us at the time of this report and future events or circumstances could differ significantly from these forward-looking statements. Unless required by law, we undertake no obligation to update publicly any such forward-looking statements.

The following information should be read in conjunction with the Consolidated Financial Statements and notes thereto included in this Annual Report on Form 10-K. All references to fiscal year apply to our fiscal year that ends on December 31. All references to “we”, “us”, “our”, “PDF”, “PDF Solutions” or “the Company” refer to PDF Solutions, Inc.

PART I

Item 1. Business

Business Overview

PDF Solutions offers products and services designed to empower engineers and data scientists across the semiconductor ecosystem to improve the yield, quality, and profitability of their products. Our solutions combine proprietary software, physical intellectual property (or IP) for integrated circuit (or IC) designs, electrical measurement hardware tools, proven methodologies, and professional services. We primarily monetize our solutions through time-based license fees and contract revenue for professional services. In some cases, especially on our historical yield ramp engagements, we also receive a value-based royalty that we call a Gainshare performance incentive. Our products and services have been sold to integrated device manufacturers (or IDMs), fabless semiconductor companies, foundries, out-sourced semiconductor assembly and test (or OSATs), and system houses.

The key benefits of our products and services are improved product yields and product quality with faster time-to-market, which collectively increases profitability for our customers. For example, our foundry customers generate and analyze key manufacturing data using our solutions to shorten the time necessary for technology development and to provide their fabless customers with a higher yielding process with improved electrical performance, which are both critical metrics for market success. Also, for example, our integrated device manufacturers (or IDMs) and fabless customers use our solutions to generate unique, differentiated data that can be analyzed with our machine learning (ML) and artificial intelligence (AI) algorithms to predict downstream manufacturing issues, resulting in shorter time for initial designs to meet performance requirements with fewer iterations and faster time-to-market. For further example, our foundry and OSAT customers use the AI and ML applications of our software to optimize for process control, assembly, and/or test.

Our long-term business strategy is to be the solutions provider of choice for the semiconductor and electronic supply chain to enable our customers to optimize processes, designs, and fabrication for high yield, low cost, time-to-market, and high performance. To achieve this, we intend to:

- *Expand Our Market Opportunity By Offering Complete Solutions.* We intend to increase the breadth and depth of the use of our solutions by focusing on complete offerings instead of only point products at both new and existing customers. For example, with deployments of our 1st and 2nd generation DFI systems and with DFI on-chip instruments embedded in over 100 customer chips from 28nm down to 7nm, we believe there is a ready market for our analysis software, which is co-optimized with the measurement instruments for comprehensiveness and efficiency to identify blockers that impact product yield and quality weeks or months earlier than with any other hardware- or software-based methodology. We believe the foresight provided by this application will be of significant interest to companies across the semiconductor industry and will provide a solid footprint that can be expanded in subsequent years with the license of additional analysis applications, such as yield, fault detection and classification (or FDC), and test.
- *Expand in China.* China represents a significant opportunity for the semiconductor industry over the next few decades. Success in China will depend on the successful engagement with customers in three key categories: fabless semiconductor vendors, pure-play foundries, and memory vendors. PDF has customers in all three categories that are well-known and highly respected by other prospective customers in China. We intend to leverage our success with these customers to further penetrate the China market. We also intend to leverage our foresight capabilities, led by the combination of our DFI solutions and Exensio platform, to provide compelling capabilities for the emerging China semiconductor ecosystem as they ramp to the most advanced process nodes.
- *Align Our Business to the Evolving Semiconductor Marketplace.* As fewer companies continue down the path of Moore's Law, the vast majority of other companies are embracing a "More than Moore" (or MtM) approach, seeking to achieve higher performance and smaller form-factors but without the design and manufacturing costs of the most advanced process nodes. Due to our extensive knowledge about every process node currently in mass production at the majority of the world's leading foundries, we are in position to be the provider of choice for semiconductor companies embracing an MtM approach to bring their new products to market. Combined with the differentiated data generated by our solutions, our products and services are designed to accelerate how quickly customers can achieve fast yield ramps for products based on manufacturing techniques such as system-in-package (or SiP) and multi-chip-packages (or MCPs) that are popular with MtM design approaches.

Brief History

PDF Solutions was incorporated in Pennsylvania in November 1992, and we reincorporated in California in November 1995. In July 2000, we reincorporated in Delaware, and in July 2001, we completed an initial public offering. Our shares of common stock are currently traded on the NASDAQ Global Market as PDFS. From 2000 through 2009, we expanded our technology footprint and our operations in various countries through acquisitions. From 2009 to 2018, we primarily focused on the pervasive application of our technology to leading edge logic manufacturing and achieving yield targets with our clients that maximized Gainshare revenues. In 2013, we leveraged our extensive experience in yield simulation software and Characterization Vehicle test chip development and started research and development on an e-beam solution for non-contact, inline electrical characterization and process control for wafer inspection. The first generation e-beam tool was completed in 2015, and the second generation was commercially deployed in 2018. In a parallel effort, starting in 2014, we re-architected our point-solution software tools into a new generation, highly-integrated data analytics platform, which resulted in accelerated growth in software through 2018. Headquartered in Santa Clara, California, we also operate worldwide in Canada, China, France, Germany, Italy, Japan, Korea, and Taiwan.

Industry Background

Rapid technological innovation with increasingly shorter product life cycles has fueled the economic growth of the semiconductor industry since the days of the PC revolution. IC companies have historically ramped production slowly, produced at high volume once a product gained market acceptance, and slowly reduced production volume when price and demand started to decrease near the end of the product's life cycle. Today there are many different business models across the semiconductor industry: products that follow the traditional life cycle just described, products targeted towards fast-moving market segments like IoT, utilizing mature process nodes and requiring a fast ramp to volume with a relatively short life cycle, and products focused on long term market segments like automotive and industrial where product life cycles can last a decade or longer. There is a lot of variation across these business models depending on the level of design complexity and the maturity of the process node used for product implementation. Processors, memory and FPGAs continue to leverage the most advanced process nodes and experience significant challenges to achieve competitive initial yields and optimized performance. Some products and market segments, however, are content to utilize older process nodes. Regardless of the process node used for implementation or how long the product will be sold in the market, success for every semiconductor company is predicated on fast product yield ramp and the ability to optimize manufacturing and test metrics, such as yield reclamation, product quality, and test efficiency, throughout a product's life cycle. Thus, technologies or capabilities that can accelerate yield ramp, improve product quality, and optimize production efficiencies are highly sought after because they typically lead to cost reduction and revenue generation concurrently, causing a leveraged effect on profitability.

Technology and Intellectual Property Protection

Through yield, performance, and reliability improvement services over more than 20 years, we have accumulated a vast library of physical IP in the form of test structures. As part of our DFI and CV solutions, our engineers create designs of experiments (or DOEs) and layouts for targeted fail modes. We have also developed electrical measurement hardware tools and proprietary extraction, design, and analysis software. In addition, our technology embodies many production-proven and patented algorithms. Further, our IP includes proven methodologies that our implementation teams use as guidelines to drive our customers' use of our technology. We continually enhance our core technologies through the codification of knowledge that we gain in the use of our products and delivery of services.

Our future success and competitive position rely to some extent upon our ability to protect these proprietary technologies and IP, to generate revenue from the licensed sale and support of our software and hardware to customers, and to prevent competitors from using our systems, methods, and technologies in their products or solutions. To accomplish this, we rely primarily on a combination of contractual provisions, confidentiality procedures, trade secrets, and patent, copyright, mask work, and trademark laws. We license our products and technologies pursuant to non-exclusive license agreements that impose restrictions on customers' use. In addition, we seek to avoid disclosure of our trade secrets, including requiring employees, customers, and others with access to our proprietary information to execute confidentiality agreements with us, and restricting access to our source code. We also seek to protect our software, documentation, and other written materials under trade secret and copyright laws. We seek to protect our IP under patent laws and as of December 31, 2018, we held 140 U.S. patents. Our issued patents have expiration dates from 2019 through 2037. We intend to prepare additional patent applications when we feel it is beneficial. We also employ protection of our trademarks, with registration of marks, including Characterization Vehicle, CV, eProbe, Exensio, pdfFasTest, PDF Solutions, the PDF Solutions logo. We have common law rights to additional trademarks, including ALPS, Design-for-Inspection, DFI, DirectProbe, and DirectScan.

Products and Services

Through organic development and targeted acquisitions over more than 20 years, we have accumulated an array of highly-integrated and co-designed proprietary software, physical IP for IC designs, electrical measurement tools, and proven methodologies. Subsets of this array are selected to address each customer's specific technical and business requirements. For example, a fabless customer designing a new product may use our proprietary on-wafer instruments and cell libraries to design physical IP to enhance their design for manufacturability or inspection. By way of another example, a fabless company in volume manufacturing may use our data analytic software tools, which are also available to their foundry partners, to monitor how their designs are performing at their foundry partners. The following gives more information about our products and services, including when combined into solutions.

Solutions

Data Analytics Solutions. Our Exensio[®]-based solutions are designed to link the critical data streams from the entire manufacturing process – from bare wafer to packaged part or system – to improve yield and yield recovery, provide both better operational and process control of tools and testers, and maintain comprehensive traceability from starting wafer through to final packaged part or system. When used in conjunction with our Characterization Vehicle solutions, our data analytics solutions enable customers to correlate the unique, differentiated CV_i data with other manufacturing data, to improve yield and yield recovery while simultaneously reducing the overhead of manufacturing and test operations. The services we provide with this solution include data analysis, integration and configuration for MES or facility-wide deployment, tool connections, development of filter plans, data collection, management, and training.

Design-for-Inspection[™] (or DFI[™]) Solutions. Our DFI solutions are designed to enable our customers to achieve non-contact, inline electrical characterization and process control. DFI provides customers an ability to insert on-chip instruments with calibrated electrical responses directly in the product wafer without any die area penalty. In addition, DFI is designed to be high-throughput, enabling inline use. The electrical measurements augment and enhance existing inline defect inspection and metrology methods. The services we provide with this solution include design of the on-chip instruments tuned to our customers' product and/or process specifics, design synthesis support for DFI instrument insertion, on-site tool support services, data analysis, and training

- *Foundry Solution.* We provide our foundry customers a complete DFI system for inline characterization and process control. This DFI infrastructure includes not only on-wafer IP, or on-chip instruments, but also the eProbe[®] measurement tool and the Exensio[®] Characterization software for DFI data processing and analysis. All aspects of the foundry solution are optimized for high data contrast, fast data handling, and comprehensive data analysis to provide foresight into downstream issues that could impact product yield, quality, or performance.

- *Fabless IP.* We work closely with our fabless customers to tune the DFI on-chip instruments to reflect the key aspects of their product designs. We also provide proprietary software that is designed to efficiently distribute DFI filler cells across the die, for maximum issue coverage with fast readout. DFI is designed to enable every fabless company designing products at 28 nanometers and below to achieve better manufacturing results.

Characterization Vehicle Solutions. We offer solutions that are designed to accelerate the efficiency of yield learning by shortening the learning cycle, learning more per cycle, and reducing the number of silicon wafers required in manufacturing processes. The services we provide with this solution include designing test structures and DOEs that are tuned to our customers' product and/or process specifics, tester support, data analysis, and training. Our targeted offerings include:

- *Process R&D.* Our process R&D solutions are designed to help customers increase the robustness of their manufacturing processes by characterizing and reducing the variability of unit processes and device performance with respect to layout characteristics within anticipated process design rules.
- *Process Integration and Yield Ramp.* Our process integration and yield ramp solutions are designed to enable our customers to more quickly ramp the yield of new products early in the manufacturing process by characterizing the process-design interactions within each key process module, simulating product yield loss by process module, and prioritizing quantitative yield improvement by design block in real products.
- *Design-Specific Characterization Vehicle Infrastructure.* Leveraging our learnings from Characterization Vehicle test structures to accelerate foundry process development, we are now applying that technology to specific designs via CV™ Core. By implementing Characterization Vehicle test structures as physical IP embedded within a semiconductor customer's design, we can collect differentiated data related to the performance and reliability of each chip. Using that data in our Exensio platform, we can deliver product-specific insights that enable them to prioritize engineering efforts and deliver improved and more predictable IC reliability and performance.

Products

Our solutions incorporate our various proprietary software and hardware products and other technologies, depending on the customers' needs. The Exensio platform and modules are also offered on a standalone licensed basis. Our software and hardware products and other technologies include the following:

Exensio Platform. Our Exensio platform addresses the big data manufacturing challenge of today's advanced process nodes and highly integrated products, by linking across YMS, FDC, test floor, and other enterprise data types. These data types include inline and end-of-line metrology, yield, parametric, performance, manufacturing consumables, tool-level sensor data, test floor data, logistical data, as well as custom data types. By providing a common environment for all these different data types from many different points in the manufacturing and test process, our Exensio platform enables customers to rapidly perform root cause diagnosis of yield, performance, and quality issues that impact manufacturing and test operations. This same platform also enables predictive and proactive optimization decisions for process control, process adjustments, PM scheduling, tool corrective actions, wafer dispatching, and wafer level and final test. Collectively, our Exensio platform enables real-time rapid diagnosis and understanding of key manufacturing and test metrics during both inline and end-of-line wafer processing, helping customers reduce product variability and cost simultaneously. The platform currently consists of five main modules in the field today. These modules can be used separately, or combined to provide seamless integration of these traditionally disparate data flows and applications. Certain Exensio functionality is available as either an on-premise installation or through our software-as-a-service (or SaaS) offering. The five main modules of the Exensio platform are as follows:

- *Exensio Yield* collects yield data and stores it in an embedded, analysis-ready database. This database provides a common environment and a consistent view of all product yield data, enabling product engineers to identify and analyze production yield, performance, reliability and other issues. The Exensio Yield module is designed to handle very large data sets, commonplace in the semiconductor industry, and, in combination with our proprietary analytics tools, aids engineers in diagnosing complex issues that negatively impact productivity, yield, and time-to-market for the products they develop. To support the multi-dimensional product requirements of our customers, the powerful, interactive visualization and analysis capabilities in Exensio Yield are highly flexible and user-configurable.

- *Exensio Control* provides FDC capabilities for monitoring, alarming and control of manufacturing tool sets. These capabilities include proprietary data collection and analysis of tool sensor trace data and summary indicators to rapidly identify sources of process variations and manufacturing excursions. When used together with the above Exensio Yield module, the accretive data mining and correlation capabilities enable identification of tool level sources of yield loss and process variation that impact end of line product yield, performance and reliability.
- *Exensio Test* provides comprehensive data collection and analysis capabilities for data generated during manufacturing test operations. These capabilities include the overall optimization of test operations management, including improving test productivity, supporting test floor operations, and implementing adaptive test. This module also provides predictive insights based on proprietary analytics during test, assembly and packaging — maximizing the efficiency of test operations, productivity improvements and yield reclamation.
- *Exensio Characterization* encapsulates test structure analysis functionality of both electrical and inline inspection data from our proprietary Characterization Vehicle test chips and DFI on-chip instruments.
- *Exensio ALPS* provides device manufacturers with the capability to link all device data, including fabrication and characterization data, from every step of the product life cycle. This includes data from manufacturing, test and assembly, final test, and field use. This proprietary data linkage also enables device manufacturers to maintain full traceability of their finished products back to the source wafer without the need for Electronic Chip IDs, or ECIDs. This capability is becoming an essential requirement for safety-critical market segments such as automotive and mil-aero.

Design-for-Inspection (or DFI) System. Our DFI IP design engineers develop designs-of-experiments (or DOEs) to determine how IC design building blocks interact with the manufacturing process. These on-chip instruments are inserted into test and product wafers and measured on custom e-beam measurement hardware. The DFI system leverages our production-proven design and analysis infrastructure, and includes:

- *DFI On-Chip Instruments.* Our on-chip characterization instruments are developed with the same proprietary design software as our CV test chips and are tuned to capture key features of our customers' product layouts using our proprietary FIRE™ layout analysis software. These DFI instruments are based on our Characterization Vehicle technology and are designed to be placed in test chips, scribe lines, or in product die, without any area penalty, and to exhibit specific electrical responses.
- *eProbe® Non-Contact E-Beam Tool.* Our eProbe e-beam tools are designed to measure the electrical response of the DFI instruments. This new measure, which we call an Electrical Response Index (or ERI), allows for more precise inline characterization of design-process interactions. The second generation tool includes orders of magnitude advances in throughput and accuracy that now enable DFI on-chip instruments to be used for inline control for leading-edge semiconductor process nodes.
- *Exensio® Characterization Software.* Exensio Characterization software, also a part of our Exensio platform, is designed to analyze the billions of measurements collected from DFI on-chip instruments using the eProbe tool.

Characterization Vehicle Infrastructure. Our engineers develop a DOE to determine how IC design building blocks interact with the manufacturing process. Our software utilizes the DOE, in combination with our proprietary library of building blocks that highlight potential yield and performance issues, to generate CV test chip layouts. Our CV infrastructure includes:

- *CV Test Chips.* Our family of proprietary test chip products is run through the manufacturing process with intentional process modifications to explore the effects of potential process improvements given natural manufacturing variations. Our custom-designed CV test chips are optimized for our test hardware and analysis software and include DOEs tuned to each customer's process. Our full-reticle short-flow CV test chips provide a fast learning cycle for specific process modules and are fully integrated with third-party failure analysis and inspection tools for a complete diagnosis to understand root causes. Our Scribe CV products are inserted directly on customers' product wafers and collect data about critical layers. Our DirectProbe™ CV test chips enable ultra-fast yield learning for new product designs by allowing our clients to measure components of actual product layout.

- *Exensio Characterization software.* Exensio Characterization software, also a part of our Exensio platform, collects data from our CV test chips, enabling models of the performance effects of process variations on these design building blocks to be generated for use with our FIRE™ software.
- *pdFasTest® Electrical Tester.* Our proprietary hardware system enables fast defect and parametric characterization of manufacturing processes. This automated system provides parallel functional testing, thus minimizing the time required to perform millions of electrical measurements to test our CV test chips.

FIRE Software. Our FIRE software analyzes an IC design to perform design attribute extraction and feature-based yield modeling to compute both systematic and random yield loss due to optical proximity effects, etch micro-lading, dishing in CM, and other basic process issues. FIRE Software is driven by a combination of industry-standard layout data and proprietary yield models created from our CV test chips described above.

Template Technology. Our Template technology includes Templatyzer software and IP for identifying and developing a set of layout patterns that are tailored to a given manufacturing process and target product application, and checks the proposed designs against this set of patterns for optimal manufacturability.

Customers

Our existing customers include foundries, IDMs, fabless semiconductor design companies, OSATs, as well as some equipment manufacturers, including those that embed and distribute our Exensio ALPS products in their equipment. Our semiconductor customers' targeted product segments vary significantly, including microprocessors, memory, graphics, image sensor solutions, and communications. We believe that the adoption of our solutions by such companies for usage in a wide range of products validates the application of our solutions to the broader semiconductor market.

GLOBALFOUNDRIES Inc., which, together with its subsidiaries, we collectively call GlobalFoundries, represented 37% of our revenues for 2018 and 40% of our revenues for 2017. GlobalFoundries and Samsung represented 41% and 11%, respectively, of our revenues for 2016. No other customer accounted for 10% or more of our revenues in 2018, 2017, and 2016.

Although a substantial portion of our total revenues are concentrated in a small number of customers, the total revenues for each of these customers in any period is the result of our Design-to-silicon-yield solutions and Gainshare performance incentives revenues being recognized in the period under multiple, separate contracts, with no interdependent performance obligations. In general, our customer contracts are non-cancellable. These contracts were all entered into in the ordinary course of our business and contain general terms and conditions that are standard across most of our yield improvement solutions customers, including providing services typically targeted to one manufacturing process node, for example, the 28 or 14 nanometer node. Fluctuations in future results may occur if any of these customers default on contractual commitments or renegotiate pre-existing contractual commitments, including due to adverse changes in their own business. For example, during the third quarter of 2018, a major customer publicly announced that it was indefinitely suspending the development and production of its 7nm technology node. This customer's decision negatively impacted our Design-to-silicon-yield solutions revenues in the fourth quarter of 2018. We cannot assess the ultimate resolution of this non-cancellable contract at the current time, pending further discussion with the customer. We expect that Gainshare performance incentives revenues related to this contract will not be recognized in the long-term as Gainshare performance incentives revenues are based on future production of the customer. See the discussion in "Risk Factors" under Item 1A for more information about risks associated with customer concentration and contractual provisions.

International revenues accounted for approximately 60% of our total revenues for 2018 compared to 61% for 2017 and 64% for 2016. We base these calculations on the geographic location of where the work is performed. Revenues from customers by geographic area based on the location of the customers' work sites for our last three fiscal years can be found in Note 11, "Customer and Geographic Information" to the consolidated financial statements. Additional discussion regarding the risks associated with international operations can be found under Item 1A, "Risk Factors".

See our "Notes to Consolidated Financial Statements", included under Part II, Item 8. "Financial Statements and Supplementary Data" for additional geographic information.

Sales and Marketing

Our sales strategy is to pursue targeted accounts through a combination of our direct sales force, our solution service teams, and strategic alliances. After we are engaged by a customer and early in the solution services, our engineers seek to establish relationships in the organization and gain an understanding of our customers' business issues. Our direct sales and solution service teams combine their efforts to deepen our customer relationships by expanding our penetration across the customer's products, processes and technologies. This close working relationship with the customer has the added benefit of helping us identify new product areas and technologies in which we should next focus our research and development efforts. From time-to-time, we use sales representatives/agents in various locations to augment direct sales in certain territories. For example, in 2018, we engaged Abrolex in China, Recynergy in Taiwan, Tessolve in India and Southeast Asia. We expect to continue to establish strategic alliances with process licensors, vendors in the electronic design automation software, capital equipment for IC production, and test silicon IP and mask-making software segments to create and take advantage of sales channel and co-marketing opportunities. Additionally, we expect to form relationships with key value chain participants, including foundries and OSATs, to provide services and value across the manufacturing supply chain.

Research and Development

Our research and development focuses on developing and introducing new proprietary technologies, including our DFI solution as well as other software products and enhancements to our existing solutions, such as field applications for DFI. We use a rapid-prototyping paradigm in the context of the customer engagement to achieve these goals. We have made, and expect to continue to make, substantial investments in research and development. The complexity of our technologies requires expertise in physical IC design and layout, transistor design and semiconductor physics, semiconductor process integration, numerical algorithms, e-beam technology, hardware, statistics and software development. We believe that our team of engineers will continue to advance our market and technological leadership. We conduct in-house training for our engineers in the technical areas. Our training also extends to focusing on ways to enhance client service skills. Although it fluctuates, we can have up to one quarter of our research and development engineers operating in the field, partnered with solution services engineers in a deliberate strategy to provide direct feedback between technology development and customer needs. We also utilize a variety of skilled independent contractors for specialized development.

Competition

The semiconductor industry is highly competitive and driven by rapidly changing design and process technologies, evolving standards, short product life cycles, and decreasing prices. We expect market competition to continue to develop and increase as the market for data and analytics continues to evolve. We believe the solution to address the needs of IC companies requires a comprehensive and unified platform comprised of a big data management infrastructure, AI/ML-based analytics engines, and products that generate and collect differentiated data that enrich the analytics process. Currently, we are a leading provider of comprehensive commercial hardware, software and IP solutions for optimizing and improving design, manufacturing and test operations processes through the application of differentiated data and advanced analytics. We face indirect competition from internal groups at IC companies that use disparate and ad hoc tools not optimized to accelerate process-design integration or test operations. Some providers of semiconductor manufacturing software, inspection equipment, electronic design automation, or design IP may seek to broaden their product offerings and compete with us. In each of the market segments we compete in, we face competition from established and potential competitors, some of which may have greater financial, research, engineering, manufacturing and marketing resources than we have.

We face competition for some of the point applications of our products, including some of those used by the internal groups at IC companies. Specifically there are several suppliers of (i) yield management and/or prediction systems, such as KLA-Tencor, Siemens AG ("Siemens"), Rudolph Technologies, Inc. ("Rudolph"), Synopsys, Inc., and Qualtera, (ii) semiconductor manufacturing software, such as Applied Materials, Inc., BISTel Inc., Invantest, Inc., Optimal+, Rudolph, and Siemens and, (iii) inline inspection, metrology and electrical test equipment providers, such as Applied Materials and Keysight Technologies, Inc. Further, we may compete with the products or offerings of the same or additional companies if we expand our offerings, or they expand their offerings, through acquisition or development.

We believe that our solutions compare favorably with respect to competition because we have demonstrated results and reputation, strong core technology, ability to create innovative technology, and ability to implement solutions for new technology and product generations.

Employees

As of December 31, 2018, we had 365 employees worldwide, including 219 on client service teams, 83 in research and development, 26 in sales and marketing, and 37 in general and administrative functions. Of these employees, 155 are located in the United States and Canada, 174 in Asia, and 36 in Europe.

None of our employees are represented by a labor union. Our employees in France and Italy are subject to collective bargaining agreements in those countries. We believe our relationship with our employees is good. Competition is intense in the recruiting of personnel in our industry. We believe that our future success will depend, in part, on our continued ability to hire and retain qualified management, marketing and technical employees.

Executive Officers

The following table and notes set forth information about our current executive officers as of February 28, 2019.

Name	Age	Position
John K. Kibarian, Ph.D.	54	President, Chief Executive Officer, and Director
Christine A. Russell	69	Executive Vice President, Finance and Chief Financial Officer
Kimon Michaels, Ph.D.	52	Executive Vice President, Products and Solutions

John K. Kibarian, Ph.D., one of our founders, has served as President since November 1991 and has served as our Chief Executive Officer since July 2000. Dr. Kibarian has served as a director since December 1992. Dr. Kibarian received a B.S. in Electrical Engineering, an M.S. E.C.E. and a Ph.D. E.C.E. from Carnegie Mellon University.

Christine A. Russell, joined in July 2018 as Vice President, Finance, and was appointed Chief Financial Officer effective August 10, 2018. Ms. Russell was designated an Executive VP in February 2019. Prior to joining the Company, Ms. Russell served as Chief Financial Officer, UniPixel, Inc. (Nasdaq:UNXL), a touch sensor company, from May 2015 to August 2017. Prior to UniPixel, she was Chief Financial Officer of Vendavo, Inc. from May 2014 to March 2015, a SaaS based pricing and margin optimization software company. She also served as Chief Financial Officer of Evans Analytical Group from May 2009 to September 2013, a global provider of analytical testing for technology companies including major semiconductor, chemicals and pharmaceuticals firms. Prior to EAG, she served in the roles of both Chief Financial Officer and EVP Business Development at Virage Logic (Nasdaq:VIRL), a semiconductor intellectual property company. Prior positions include Chief Financial Officer for OuterBay Technologies, a database archiving software company and Chief Financial Officer of Ceva, Inc. (Nasdaq: CEVA), a DSP IP company. She currently serves as Audit Committee Chair and Director for both QuickLogic Corporation and eGain Corporation. Ms. Russell holds a B.A. and M.B.A. from the University of Santa Clara.

Kimon Michaels, Ph.D., one of our founders, has served as Vice President, Products and Solutions since July 2010 and was designated an Executive VP in February 2019. Dr. Michaels served as Vice President, Design for Manufacturability from June 2007 through June 2010. Prior to that, Dr. Michaels served as Vice President, Field Operations for Manufacturing Process Solutions from January 2006 through May 2007, and has been a Director since November 1995. From March 1993 through December 2005, he served in various vice presidential capacities. He also served as Chief Financial Officer from November 1995 to July 1998. Dr. Michaels received a B.S. in Electrical Engineering, an M.S. E.C.E. and a Ph.D. E.C.E. from Carnegie Mellon University

Available Information

We file or furnish various reports, such as registration statements, periodic and current reports, proxy statements and other materials with the SEC. Our Internet website address is www.pdf.com. You may obtain, free of charge on our website, copies of 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, as soon as reasonably practicable after we electronically file such material with, or furnish it to, the SEC. The Company's website address provided is not intended to function as a hyperlink, and the information on the Company's website is not, and should not be considered, part of this Annual Report on Form 10-K and is not incorporated by reference herein.

The SEC maintains a Web site (<http://www.sec.gov>) that contains reports, proxy and information statements and other information regarding issuers, such as us, that file electronically with the SEC.

Item 1A. Risk Factors

We generate most of our revenues from a limited number of customers, and a large percentage of our revenues from a single customer, so decreased business with, or the loss of, any one of these customers, or pricing pressure, or customer consolidation could significantly reduce our revenue or margins, negatively impact results of operations, and require us to accept lower margin business on future nodes.

Historically, we have had a small number of large customers for our core solutions and that contribute significant Gainshare performance incentives revenue. In the year ended December 31, 2018, one customer, GlobalFoundries, accounted for 37% of our revenues. We could lose a customer due to its decision not to engage us on future process nodes, its decision to reduce the scope of our services or technology used, which is permitted in certain of our contracts if the customer company's business materially adversely changes, its decision not to develop its own future process node, or as a result of industry factors, including but not limited to consolidation. During the third quarter of 2018, a major customer announced that it was suspending indefinitely the development and production of its 7nm technology node. This customer's decision negatively impacted our Design-to-silicon-yield solutions revenues in the fourth quarter of 2018. Gainshare performance incentives revenues will be negatively affected in the long-term as Gainshare performance incentives revenues are based on future production of the customer. Consolidation among our customers could also lead to increased customer bargaining power, or reduced customer spending on software and services. Further, new business may be delayed if a key customer uses its leverage to push for terms that are worse for us and we nonetheless continue to negotiate for better terms, in which case Solutions revenue in any particular quarter or year may fail to meet expectations. Also, the loss of any of these customers or the failure to secure new contracts with these customers could further increase our reliance on our remaining customers. Further, if any of our key customers default, declare bankruptcy or otherwise delay or fail to pay amounts owed, or we otherwise have a dispute with any of these customers, our results of operations would be negatively affected in the short term and possibly the long term. These customers may seek to renegotiate pre-existing contractual commitments due to adverse changes in their own businesses, which would harm our operating results. These events could cause significant fluctuations in results of operations because our expenses are fixed in the short term and it takes us a long time to replace customers or reassign resources

If we are unable to complete development and qualification of our e-beam measurement tool for inline wafer inspection on schedule or at all, or successfully commercialize our Design-for-Inspection (DFI) solution, our future market opportunity and revenues will suffer and our costs may not be recouped.

Certain use cases of our DFI solution remain to be proven, and the inline version still needs to be qualified by the first commercial customer. To date, we have invested significantly in the design and development of our DFI eProbe tool and related intellectual property. If existing foundry customers fail to renew or expand the number or use of the systems they are using, or new foundry customers fail to adopt our DFI solution, our results will suffer. For example, in 2018 an early adopter of our DFI solution at 7nm elected to exercise an early exit under the contract in connection with its decision to suspend indefinitely further development and production at 7nm, which negatively impacted the long-term revenue we expected under this contract and possibility for renewal or expansion. Also, if the results of our DFI solution are not as we expect, we may not be able to successfully commercialize these technologies on schedule, or at all, and we may miss the market opportunity and not recoup our investment. Further, our DFI tool may cause unexpected damage to wafers or delay processing wafers, which we could be liable for, or which may make customers unwilling to use it. If we are not able to create significant interest and show reliable and useful results, our investment may not be recouped and our future results may suffer.

Decreases in wafer volumes at our customers' manufacturing sites or the volume of ICs that some of our customers are able to sell to their customers would cause our Gainshare performance incentives revenue to suffer.

Our Gainshare performance incentives revenue is largely determined by wafer volumes at manufacturing sites covered by our contracts and, in some cases, the volume of an IC product that our customer is able to sell to its customers. Both of these factors are outside of our control. Further, some of our manufacturing customers' business is largely dependent on customers that use our manufacturing customer as a second or third source. If those customers consolidate and/or otherwise move the orders to manufacturing facilities not covered by our contracts, or suspend their manufacturing at covered facilities for any reason, including consolidation, our Gainshare revenue will decrease. Reduced demand for semiconductor products decreases the volume of wafers and, in some cases, products our customers are able to sell, which would also directly decrease our Gainshare revenue. For example, 28nm volumes were lower in 2018 than expected. Also, our customers may unilaterally decide to implement changes to their manufacturing processes during the period that is covered by Gainshare, which could negatively affect yield results and our revenue. Since we currently work on a small number of large projects at specified manufacturing sites and, in some cases, on specific IC products, our results of operations are adversely affected by negative changes at those sites or in those products. For example, if wafer orders from sites covered by our contracts are not secured by our customers, if an end product does not achieve commercial viability, if a process line or, in some cases, a specific product, does not achieve significant increases in yield or sustain significant volume manufacturing during the time we receive Gainshare, revenues associated with such volumes or products would be negatively impacted. This could significantly reduce our revenue and results of operations below expectations. In addition, if we work with two directly competitive manufacturing facilities or products, volume in one may offset volume, and thus any of our related Gainshare, in the other facility or product.

If semiconductor designers and manufacturers and their suppliers do not continue to adopt, or they significantly delay adoption of, our products and solutions, our revenues will suffer.

If semiconductor designers and manufacturers and their suppliers do not continue to adopt our products and solutions, both as currently comprised and as we may offer them in the future, our revenues will decline. We may not be successful if we do not continue to enter into long-term agreements with existing customers and new customers that cover a larger number of IC products, processes, or manufacturing and test/assembly facilities. If we do not continue to develop customer relationships with companies that are integrated device manufacturers (or IDMs), fabless semiconductor companies, foundries, and out-sourced assembly and test companies (or OSATs), as well as system houses, the market acceptance of our solutions will suffer. Factors that may limit adoption of our products and solutions by semiconductor companies include:

- our existing and potential customers' delay in their adoption or suspension of the current or next process technology including derivatives of older nodes;
- our inability to keep pace with the rapidly evolving technologies and equipment used in the semiconductor design and manufacturing processes;
- our inability to convince foundry customer to adopt or expand adoption of DFI solution or fabless customers to include our on-chip measurement devices in tape outs;
- our customers' failure to achieve satisfactory results using our solutions;
- the lack of proven results with new technologies and solutions that we may develop; and
- our inability to develop, market, or sell effective solutions that are outside of our traditional logic focus of manufacturing process solutions, for example, 3-D memory processes or our DFI IP and hardware technology.

The semiconductor market is volatile and unpredictable and is exacerbated by economic uncertainty, which limits our ability to forecast our business and could negatively impact our results of operations.

The semiconductor industry historically has been volatile with up cycles and down cycles, due to sudden changes in customers' manufacturing capacity requirements and spending, which depend in part on capacity utilization, demand for customers' IC products by consumers, inventory levels relative to demand, and access to affordable capital. As a result of the various factors that affect this volatility, the timing and length of any cycles can be difficult to predict. Economic uncertainty exacerbates negative trends in consumer spending and can cause some of our customers to delay or refrain altogether from entering into new engagements, licensing new or additional software products, or renewing maintenance and support for existing licensed software. Difficulties in obtaining capital and deteriorating market conditions may also lead to the inability of some customers to obtain affordable financing for other purchases, which could tie up funds otherwise budgeted for purchases of our solutions and technologies. For example, the timing of the build-out of the semiconductor market in China depends significantly on governmental funding on both local and national levels and a delay in this funding could negatively affect our revenues. Any of these events could negatively affect our revenues and make it challenging for us to forecast our operating results, make business decisions, and identify the risks that may affect our business, financial condition and results of operations. Customers with liquidity issues may also lead to additional bad debt expense.

Our solution implementations or system installation/configurations may take longer than budgeted, which could slow our revenue recognition and may also result in a loss contract, which would negatively affect our operating results.

Our solution implementations require a team of engineers to collaborate with our customers to address complex issues by using our software and other technologies, and the installation and configuration of our software into our customers' fabrication and test/assembly facilities requires experienced engineers working with our customers on active foundry and test/assembly equipment. We must estimate the amount of resources needed to complete both of these types of services in order to estimate when the engineers will be able to commence the next engagement. In addition, our accounting for contracts with such services, which generate fixed fees, sometimes requires adjustments to profit (loss) based on revised estimates during the performance of the contract. These adjustments may have a material effect on our results of operations in the period in which they are made. The estimates giving rise to these risks, which are inherent in fixed-price contracts, include the forecasting of costs and schedules, and contract revenues related to contract performance.

Our sales cycle is lengthy and customers may delay entering into contracts or decide not to adopt our products or solutions after we have performed services or provided evaluation licenses, which could result in delays in recognizing revenue and negatively impact our results of operations in a quarter or result in lower revenue than we expected if a contract is not consummated at all.

On-going negotiations and evaluation projects for new products, with new customers or in new markets may not result in significant revenues for us if we are unable to close new engagements on terms favorable to us, in a timely manner, or at all. Unexpected delays in our sales cycle could cause our revenues to fall short of expectations. Further, the timing and length of negotiations required to enter into agreements with our customers and the ultimate enforcement of complex negotiated contractual provisions as we intended is difficult to predict. If we do not successfully negotiate certain key complex contractual provisions, there are disputes regarding such provisions or they are not enforced as we intended, the future available market for our solutions could decrease and our revenues and results of operations would suffer. Further, our customers sometimes delay starting negotiations until they begin developing a new process, need to insert a new product, or experience specific yield issues. This means that on occasion we have, and may continue to provide technology and services under preliminary documentation before executing the final contract. In these cases, we would not recognize revenue and would defer associated costs until execution of the final contract, which, if significant, could negatively impact our results of operations in the periods before we execute the final contract. Further, if we were to incur significant effort and then fail to enter into a final contract, we would have to write-off such deferred costs in the period in which the negotiations ended, which would decrease our gross margin and could result in significant operating losses.

If we fail to protect our intellectual property rights, customers or potential competitors may be able to use our technologies to develop their own solutions which could weaken our competitive position, reduce our revenue, or increase our costs.

Our success depends largely on the proprietary nature of our technologies. Our contractual, patent, copyright, trademark, and trade secret protection may not be effective against any particular threat or in any particular location. Our pending patent applications may not result in issued patents, and even if issued, they may not be sufficiently broad to protect our proprietary technologies. Some foreign countries do not currently provide effective legal protection for intellectual property and our ability to prevent the unauthorized use of our products in those countries is therefore limited. Our trade secrets may also be stolen, otherwise become known, or be independently developed by competitors. Litigation may be necessary from time to time to enforce our IP rights or to determine the validity and scope of the proprietary rights of others. As a result of any such litigation, we could lose our proprietary rights and incur substantial unexpected operating costs. Litigation could also divert our resources, including our managerial and engineering resources. If we are unable to exclude others from using our proprietary technologies and methods without compensation to us, through litigation or otherwise, it could impede our ability to grow our business and our revenues may suffer.

We pursue new product and technology initiatives, including our DFI solution and Exensio platform, from time to time, and if we fail to successfully carry out these initiatives, our business, financial condition, or results of operations could be adversely impacted.

As part of the evolution of our business, we have made substantial investments to develop new products, including our DFI solution and Exensio platform, and enhancements to existing products through our research and development efforts. If we are unable to anticipate technological changes in our industry by introducing new or enhanced products in a timely and cost-effective manner, or if we fail to introduce products that meet market demand, we may lose our competitive position, our products may become obsolete, and our business, financial condition or results of operations could be adversely affected.

We may have to invest more resources in research and development than anticipated, which could increase our operating expenses and negatively affect our operating results.

We devote substantial resources to research and development. New competitors, technological advances in the semiconductor industry or by competitors, our entry into new markets, or other competitive factors may require us to invest significantly greater resources than we anticipate. If we are required to invest significantly greater resources than anticipated without a corresponding increase in revenue, our operating results could decline. Additionally, our periodic research and development expenses may be independent of our level of revenue, which could negatively impact our financial results. Finally, there can be no guarantee that our research and development investments will result in products that create additional revenue.

We face operational and financial risks associated with international operations that could negatively impact our revenue.

We derive over half of our revenue from sales outside of the United States, and we expect our international business to continue to grow, in particular in China. We have in the past expanded and reorganized, at different times, our non-U.S. operations and may in the future continue such expansion or reorganization by establishing or restructuring international subsidiaries, offices, or contractor relationships in locations, if and when, deemed appropriate by our management. Thus, the success of our business is subject to risks inherent in doing business internationally, including in particular:

- our growth in China is dependent upon continued investments in the semiconductor industry by both private and public entities within China. Should circumstances change such that the level of investments are substantially reduced, our future growth potential may be limited;
- some of our key engineers and other personnel are foreign nationals and they may not be permitted access to certain technical information under U.S. export laws or by certain of our customers and may have difficulty gaining access to the United States and other countries in which our customers or our offices may be located and it may be difficult for us to recruit and retain qualified technical and managerial employees in foreign offices;
- ineffective or inadequate protection or enforcement of our intellectual property in foreign jurisdictions;
- greater difficulty in collecting account receivables resulting in longer collection periods or bad debt;
- language and other cultural differences may inhibit our sales and marketing efforts and create internal communication problems among our U.S. and foreign teams, increasing the difficulty of managing multiple, remote locations performing various development, quality assurance, and yield ramp analysis projects;
- compliance with, inconsistencies among, and unexpected changes in, a wide variety of foreign laws and regulatory environments with which we are not familiar, including, among other issues, with respect to employees, personal data, tax, protection of our IP, and a wide variety of operational regulations and trade and export controls under domestic, foreign, and international law;
- currency risk due to the fact that certain of our payables and for our international offices are denominated in the foreign currency, including the Euro, Yen, and RMB, while virtually all of our revenues is denominated in U.S. dollars, or in the event a larger portion of our revenues becomes denominated in foreign currencies, we would be subject to a potentially significant exchange rate risk;
- inadequate local infrastructure that could result in business disruptions;
- additional taxes, interest, and potential penalties, and uncertainty around changes in tax laws of various countries;
- quarantine, private travel limitation, or business disruption in regions affecting our operations, stemming from actual, imminent or perceived outbreak of human pandemic or contagious disease; or
- economic or political instability, including but not limited to armed conflict, terrorism, interference with information or communication of networks or systems, and the resulting disruption to economic activity and business operations.

Further, our employees and contractors include professionals located in various international locations, including Shanghai, China, who provide primarily CV test chip-related services, and Ramallah, Palestine, who provide software-related development, quality assurance, maintenance, and other technical support services for certain of our software products. Political changes, including policies regarding export control, that affect these or other international operations could disrupt or limit the work our employees and contractors are able to perform, and thus negatively affect the range of services we are able to provide our customers or our cost for such services.

In addition, our global operations are subject to numerous U.S. and foreign laws and regulations, including those related to anti-corruption, tax, corporate governance, imports and exports, financial and other disclosures, privacy and labor relations. These laws and regulations are complex and may have differing or conflicting legal standards, making compliance difficult and costly. In addition, there is uncertainty regarding how proposed, contemplated or future changes to these complex laws and regulations could affect our business. We may incur substantial expense in complying with the new obligations to be imposed by these laws and regulations, and we may be required to make significant changes in our business operations, all of which may adversely affect our revenues and our business overall. If we violate these laws and regulations we could be subject to fines, penalties or criminal sanctions, and may be prohibited from conducting business in one or more countries. Although we have implemented policies and procedures to help ensure compliance with these laws and regulations, there can be no assurance that our employees, contractors, agents or partners will not violate such laws and regulations. Any violation individually or in the aggregate could have a material adverse effect on our operations and financial condition.

Inadvertent disclosure of our customers' confidential information or our failure to comply with our client's security rules, including for hosted solutions or on-site access could result in costly litigation, cause us to lose existing and potential customers, or negatively impact on-going business with existing customers.

Our customers consider their product yield information and other confidential information, which we must collect in the course of our engagement with the customer or through our software tools, to be extremely competitively sensitive. Many of our clients have strict security rules for on-site access to, or hosting, to their confidential information. If we inadvertently disclosed or were required to disclose this information, or if we fail to adequately comply with customers' security protocols for accessing or hosting confidential information, we would likely lose existing and potential customers, could be subject to costly litigation, or our on-going business could be negatively impacted. In addition, to avoid potential disclosure of confidential information to competitors, some of our customers may, in the future, ask us not to work with key products or processes, which could limit our revenue opportunities.

Our ability to sell our products may depend on the quality of our support and services offerings, including delivering of software as a service (SaaS), and our failure to offer high-quality support and services could negatively affect our sales and results of operations.

Once our software products are integrated within our customers' hardware and software systems, our customers may depend on our support organization to resolve any issues relating to our products. Further, in connection with delivering our software as a service, which requires us to maintain adequate server hardware and internet infrastructure, including system redundancies, we will need to meet contractual uptime obligations. A high level of system and support is critical for the successful marketing and sale of our products. If we do not effectively provide subscription access to our SaaS customers, assist our customers in deploying our products, succeed in helping our customers quickly resolve post-deployment issues, and provide effective ongoing support and data security, our ability to sell our software products to existing customers may be negatively affected, our results of operations could be negatively impacted if we must provide credits for system downtime, and our reputation with potential customers could be harmed. If our software customers have a poor perception of our support and services offerings, they may choose not to purchase via SaaS, renew software support and maintenance or term-based licenses when the current period expires. In addition, due to our international operations, our system and support organization faces challenges associated with delivering support, hours that support is available, training, and documentation where the user's native language may not be English. If we fail to maintain high-quality support and services, our customers may choose our competitors' products instead of ours in the future, which would negatively affect our revenues and results of operations.

Defects in our proprietary technologies, hardware and software tools, and failure to effectively remedy any such defects could decrease our revenue and our competitive market share.

If the software, hardware, or proprietary technologies we provide to a customer contain defects that negatively impact customers' ability to use our solutions or software, increase our customers' cost of goods sold and time-to-market or damage our customers' property, these defects could significantly decrease the market acceptance of our solutions or results in warranty or other claims. We must adequately train our new personnel, especially our client service and technical support personnel, to effectively and accurately, respond to and support our customers. If we fail to do this, it could lead to dissatisfaction among our customers, which could slow our growth. Further, the cost of support resources required to remedy any defects in our technologies, hardware, or software tools could exceed our expectations. Any actual or perceived defects with our software, hardware, or proprietary technologies may also hinder our ability to attract or retain industry partners or customers, leading to a decrease in our revenue. These defects are frequently found during the period following introduction of new software, hardware, or proprietary technologies or enhancements to existing software, hardware, or proprietary technologies. Our software, hardware, and proprietary technologies may contain errors not discovered until after customer implementation of the silicon design and manufacturing process recommended by us. If our software, hardware, or proprietary technologies contain errors or defects, it could require us to expend significant resources to remedy these problems or defend/indemnify claims, which could reduce margins and result in the diversion of technical and other resources from our other customer implementations and development efforts.

If we do not effectively manage, support, and safeguard our worldwide information systems, and integrate recent and planned growth, our business strategy may fail.

We are heavily reliant on our technology and infrastructure to provide our products and services to our customers. We have experienced in the past, and may experience in the future, interruptions in our information systems on which our global operations depend. Further, we may face attempts by others to gain unauthorized access through the Internet to our information technology systems whether hosted by us or service providers, to intentionally hack, interfere with, or cause physical or digital damage to or failure of such systems (such as significant viruses or worms), which attempts we or they may be unable to prevent. Our security measures may also be breached due to employee errors, malfeasance, or otherwise. Third parties may also attempt to influence employees, users, suppliers or customers to disclose sensitive information in order to gain access to our, our customers' or business partners' data. Additionally, third parties with whom we work, such as vendors or developers, may violate applicable laws or our policies and such violations can place personal information of our customers at risk.

We or our service providers could be unaware of an incident or its magnitude and effects until after it is too late to prevent it and the damage it may cause. The theft, unauthorized use, or a cybersecurity attack that results in the publication of our trade secrets and other confidential business information as a result of such an incident could negatively affect our competitive position, the value of our investment in product or research and development, and third parties might assert against us or our customers claims related to resulting losses of confidential or proprietary information or end-user data and/or system reliability. In any such event, our business could be subject to significant disruption, which could impact our revenues or cause customers to cease doing business with us, and we could suffer monetary and other losses, including reputational harm, which costs we may not be able to recover from our service providers. Our operations are dependent upon our ability to protect our technology infrastructure against damage from business continuity events that could have a significant disruptive effect on our operations.

In addition, we collect, use, store or disclose (collectively, "process") an increasingly large amount of personal information, including from employees and customers, in connection with the operation of our business. The personal information we process is subject to an increasing number of federal, state, local and foreign laws regarding privacy and data security, as well as contractual commitments. Any failure or perceived failure by us to comply with such obligations may result in governmental enforcement actions, fines, litigation, or public statements against us by consumer advocacy groups or others and could cause our customers to lose trust in us, which could have an adverse effect on our reputation and business. Additionally, changes to applicable privacy or data security laws could impact how we process personal information, and therefore limit the effectiveness of our solutions or our ability to develop new solutions. For example, the European Union General Data Protection Regulation, which becomes fully effective on May 25, 2018, imposes more stringent data protection requirements, and provides for greater penalties for noncompliance of up to the greater of €20 million or four percent of worldwide annual revenues.

Additionally, we must frequently expand our internal information system to meet increasing demand in storage, computing and communication, which may result in increased costs. Our internal information system is expensive to expand and must be highly secure due to the sensitive nature of our customers' information that we transmit. Building and managing the support necessary for our growth places significant demands on our management and resources. These demands may divert these resources from the continued growth of our business and implementation of our business strategy.

If we are not able to retain, attract, motivate, and strategically locate talented employees, including some key executives, our business may suffer.

Our success and competitiveness depend on our ability to retain, attract, motivate, and strategically locate in our offices around the globe, talented employees, including some of our key executives. Achieving this objective may be difficult due to many factors, including fluctuations in global economic and industry conditions, changes in our management or leadership, the hiring practices at our competitors or customers, cost reduction activities, and the effectiveness of our compensation programs, including equity-based programs. Further, we have had, and expect to continue to have, difficulty in obtaining visas permitting entry for some of our employees that are foreign nationals into the United States, and delays in obtaining visas permitting entry into other key countries, for several of our key personnel, which disrupts our ability to strategically locate our personnel. In recent years, the United States has increased the level of Security in granting H-1(b), L-1 and other business visas. The Trump administration has indicated that immigration reform is a priority. If we lose the services of certain of our key executives or a significant number of our engineers, it could disrupt our ability to implement our business strategy. If we do not successfully attract, retain, and motivate key employees, including key executives, we may be unable to realize our business objectives and our operating results may suffer.

Our stock price has been volatile in the past, and our earnings per share and other operating results may vary quarter to quarter, which could result in not meeting investors' expectations and cause our stock price to drop.

Our stock price has fluctuated widely during the last few years, from a low closing price of \$7.73 per share in October 2018 to a high closing price of \$24.16 per share in December 2016. A factor in the volatility may be that our historical quarterly operating results have fluctuated. Our future quarterly operating results will likely fluctuate from time to time and may not meet the expectations of securities analysts and investors in some future period, which could cause our stock price to decrease again. A significant reduction in our stock price negatively impacts our ability to raise equity capital in the public markets and increases the cost to us, as measured by dilution to our existing shareholders, of equity financing. In addition, the reduced stock price also increases the cost to us, in terms of dilution, of using our equity for employee compensation or for acquisitions of other businesses. A greatly reduced stock price could also have other negative results, including the potential loss of confidence by employees, the loss of institutional investor interest, a hostile take-over bid, and fewer business development opportunities. Also, significant volatility in the stock price could be followed by a securities class action lawsuit, which could result in substantial costs and a diversion of our management's attention and resources.

Competition in the market for yield improvement solutions and increased integration between IC design and manufacturing may intensify in the future, which could impede our ability to grow or execute our strategy.

Competition in our market may intensify in the future, which could slow our ability to grow or execute our strategy and could lead to increased pricing pressure, negatively impacting our revenues. Our current and potential customers may choose to develop their own solutions internally, particularly if we are slow in deploying our solutions or improving them to meet market needs. These and other competitors may be able to operate with a lower cost structure than our engineering organization, which would give any such competitor's products a competitive advantage over our solutions. We currently face indirect competition from the internal groups at IC companies and some direct competition from providers of (i) yield management and/or prediction systems, such as KLA-Tencor, Siemens AG ("Siemens"), Rudolph Technologies, Inc. ("Rudolph"), Synopsys, Inc., and Qualtera, (ii) semiconductor manufacturing software, such as Applied Materials, Inc., BISTel Inc., Invantest, Inc., Optimal+, Rudolph, and Siemens and, (iii) inline inspection, metrology and electrical test equipment providers, such as Applied Materials and Keysight Technologies, Inc. Further, we may compete with the products or offerings of these named companies or additional companies if we expand our offerings through acquisition or development. There may be other providers of commercial solutions for systematic IC yield and performance enhancement of which we are not aware. Further, some providers of yield management software or inspection equipment may seek to broaden their product offerings and compete with us. In addition, we believe that the demand for solutions that address the need for better integration between the silicon design and manufacturing processes may encourage direct competitors to enter into our market. For example, large integrated organizations, such as IDMs, electronic design automation software providers, IC design service companies or semiconductor equipment vendors, may expand their product offerings or decide to spin-off a business unit to compete with us. Other potential competitors include fabrication facilities that may decide to offer solutions competitive with ours as part of their value proposition to their customers. If these potential competitors change the pricing environment or are able to attract industry partners or customers faster than we can, we may not be able to grow and execute our strategy as quickly or at all.

Measurement of our Gainshare performance incentives and other variable consideration requires data collection and customers' use of estimates in some cases, and is subject to customer agreement and later offset if actual data differ from customers' estimates, which can result in uncertainty and cause quarterly results to fluctuate.

We can only recognize revenue based on Gainshare performance incentives once we have reached agreement with our customers on their level of yield performance improvements and quarterly agreements are sometimes based on estimates of volume results each quarter. Measuring the amount of yield improvement is inherently complicated and dependent on our customers' internal processes, thus, there may be uncertainty as to some components of measurement. Also, some variable considerations can be highly susceptible to delays in the customer measurement of key factors such as reporting volumes results and level of yield. Therefore, we may have to estimate revenue related to contingent variable fees or usage-based or sales-based royalties prior to the receipt of performance reports, such as Gainshare acknowledgements, or other related information from customers. These estimates are subject judgment to evaluate whether it is probable that a significant revenue reversal will not occur in future periods, which could result in our recognition of less revenue than expected in any particular period and later offset when actual results become available.

Changes in the structure of our customer contracts, including the mix between fixed and variable revenue and the inclusion of acceptance criteria can adversely affect the amount and timing of our total revenues.

Our long-term success is largely dependent upon our ability to structure our future customer contracts in line with market condition. In addition, if we are unsuccessful in selling our software on a time-basis or the mix shifts toward more Gainshare, we may increase the variability or timing of recognition of our revenue, and therefore increase the risk that our total future revenues will be lower than expected and fluctuate significantly from period to period. Further, if we agree to contractual acceptance criteria in contracts and fail to meet them, the total revenues we receive under a contract could be delayed or decline.

We have experienced losses in the past and we may incur losses again in the future.

We have experienced losses in the past and we may incur losses again in the future if we are not able to adequately control our costs or if total revenues fail to meet expectations. In addition, virtually all of our quarterly operating expenses are fixed, so any shortfall in anticipated quarterly revenue could significantly reduce our operating results below expectations. Our accumulated deficit was \$30.5 million as of December 31, 2018. We expect to continue to incur significant expenses in connection with:

- funding for research and development;
- expansion of our solution implementation teams;
- restructuring costs related to our cost control and management efforts;
- expansion of our sales and marketing efforts; and
- additional non-cash charges relating to amortization and stock-based compensation.

Our technologies could infringe the intellectual property rights of others, causing costly litigation and the loss of significant rights.

Significant litigation regarding intellectual property rights exists in the semiconductor industry. It is possible that a third party may claim that our technologies infringe their intellectual property rights or misappropriate their trade secrets. Any claim, even if without merit, could be time consuming to defend, result in costly litigation, or require us to enter into royalty or licensing agreements, which may not be available to us on acceptable terms, or at all. A successful claim of infringement against us in connection with the use of our technologies could adversely affect our business.

Changes in effective tax rates could positively affect our earnings, thereby raising investors' expectations, while the final tax rates that are determined could be significantly higher, thereby lowering our earnings and causing us to miss investors' expectations, which could cause our stock price to drop, and we may not be able to use tax credits before their expiration if we fail to have sufficient future income.

We conduct our business globally and, as a result, are subject to taxation in the United States and foreign countries. Our future tax rates could be affected by numerous factors, including recent changes in tax laws or the interpretation of such tax laws and changes in accounting policies. Our filings are subject to reviews or audit by the Internal Revenue Service and state, local and foreign taxing authorities. We cannot be sure that any final determination in an audit would not be materially different than the treatment reflected in our historical income tax provisions and accruals. If additional taxes are assessed as a result of an audit, there could be a significant negative effect on our income tax provision and our operating results in the period or periods for which that determination is made. Any changes in our geographical earnings mix in various tax jurisdictions, including those resulting from transfer pricing adjustments, could materially increase our effective tax rate. Furthermore, we maintain deferred tax assets related to federal, foreign and certain state tax credits. Our ability to use these credits prior to their expiration is dependent upon having sufficient future income.

Uncertainties in the interpretation and application of the 2017 Tax Cuts and Jobs Act could materially affect our tax obligations and effective tax rate.

The 2017 Tax Cuts and Jobs Act (the Tax Act) was enacted on December 22, 2017, and significantly changes how the U.S. imposes income tax on multinational corporations. The U.S. Department of Treasury has broad authority to issue regulations and interpretative guidance that may significantly impact how we will apply the law and affect our results of operations in the period issued. The Tax Act requires complex computations not previously provided in U.S. tax law. As such, the application of accounting guidance for such items is currently uncertain. Further, compliance with the Tax Act and the accounting for such provisions require accumulation of information not previously required or regularly produced. As a result, we have provided a provisional estimate on the effect of the Tax Act in our financial statements. Accounting for certain of these provisions requires the exercise of significant judgment. As additional regulatory guidance is issued by the applicable taxing authorities, accounting treatment is clarified, we perform additional analysis on the application of the law, and we refine estimates in calculating the impact, our final analysis, which will be recorded in the period completed, may be different from our current provisional amounts, which could materially affect our tax obligations and effective tax rate.

Our business could be negatively affected as a result of actions of activist shareholders, and such activism could impact the trading value of our securities.

In recent years, shareholder activists have become involved in numerous public companies, including PDF Solutions. Shareholder activists frequently propose to involve themselves in the governance, strategic direction and operations of the Company. Such proposals may disrupt our business, increase our expenses, and divert the attention of our Board of Directors and our management and employees, and any perceived uncertainties as to our future direction resulting from such a situation could result in the loss of potential business opportunities, interfere with our ability to execute our strategic plan be exploited by our competitors, cause concern to our current or potential customers, and make it more difficult to attract and retain qualified personnel and business partners, all of which could adversely affect our business. A proxy contest for the election of directors at our annual meeting could also require us to incur significant legal fees and proxy solicitation expenses. In addition, actions of activist shareholders may cause significant fluctuations in our stock price based on temporary or speculative market perceptions or other factors that do not necessarily reflect the underlying fundamentals and prospects of our business.

Our success depends upon our ability to effectively plan and manage our resources and restructure our business through rapidly fluctuating economic and market conditions, and such actions may have an adverse effect on our financial and operating results.

Our ability to successfully offer our products and services in a rapidly evolving market requires an effective planning, forecasting, and management process to enable us to effectively scale and adjust our business and business models in response to fluctuating market opportunities and conditions.

From time to time, we have increased investment in our business by, for example, increasing headcount, acquiring companies, and increasing our investment in R&D, sales and marketing, and other parts of our business. Conversely, in 2018, we initiated a restructuring plan to reduce expenses and align its operations with evolving business needs. Some of our expenses related to such efforts are fixed costs that cannot be rapidly or easily adjusted in response to fluctuations in our business or numbers of employees. Rapid changes in the size, alignment or organization of our workforce, including sales account coverage, could adversely affect our ability to develop and deliver products and services as planned or impair our ability to realize our current or future business and financial objectives. Our ability to achieve the anticipated cost savings and other benefits from our restructuring initiatives within the expected time frame is subject to many estimates and assumptions, which are subject to significant economic, competitive and other uncertainties, some of which are beyond our control. If these estimates and assumptions are incorrect, if we are unsuccessful at implementing changes, or if other unforeseen events occur, our business and results of operations could be adversely affected.

Global economic conditions could materially adversely impact demand for our products and services.

Our operations and performance depend significantly on worldwide economic conditions. Uncertainty about global economic conditions could result in customers postponing purchases of our products and services in response to tighter credit, unemployment, negative financial news and/or declines in income or asset values and other macroeconomic factors, which could have a material negative effect on demand for our products and services and, accordingly, on our business, results of operations or financial condition. For example, any economic and political uncertainty caused by the United States tariffs imposed on goods from China, among other potential countries, and any corresponding tariffs from China or such other countries in response, may negatively impact demand and/or increase the cost for our products.

Item 1B. Unresolved Staff Comments

None.

Item 2. Properties

Our principal executive offices are located in Santa Clara, California, where we lease approximately 20,800 square feet of office space expiring in August 2028.

Additionally, as of December 31, 2018, our facilities include the following:

- In Milpitas, California, we lease approximately 17,800 square feet of office and laboratory facilities expiring in January 2023.
- In La Jolla, California, Pittsburgh, Pennsylvania and Richardson, Texas, we lease an aggregate of approximately 12,700 square feet of office space under various leases that expire at different times through October 2022.
- In Shanghai, China, we lease approximately 18,400 square feet of office space expiring in November 2023.
- In France, Germany, Italy, Japan, Korea, and Taiwan, we lease an aggregate of approximately 17,600 square feet of office space under various leases that expire at different times through April 2024.

We believe our existing and planned facilities are adequate to meet our current needs and are being utilized consistently with our past practice. We consistently look for opportunities to minimize costs related to office space through improved efficiencies and intend to make changes to leased facilities in the future as appropriate to reflect changes in worldwide operations and headcount.

Item 3. Legal Proceedings

From time to time, we are subject to various claims and legal proceedings that arise in the ordinary course of business. We accrue for losses related to litigation when a potential loss is probable and the loss can be reasonably estimated in accordance with FASB requirements. As of December 31, 2018, we were not party to any material legal proceedings, thus no loss was probable and no amount was accrued.

Item 4. Mine Safety Disclosures

None.

PART II

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

Our common stock trades on the NASDAQ Global Market under the symbol "PDFS." As of March 1, 2019, we had approximately 32 stockholders of record. The number of stockholders of record does not include individuals whose stock is in nominee or "street name" accounts through brokers.

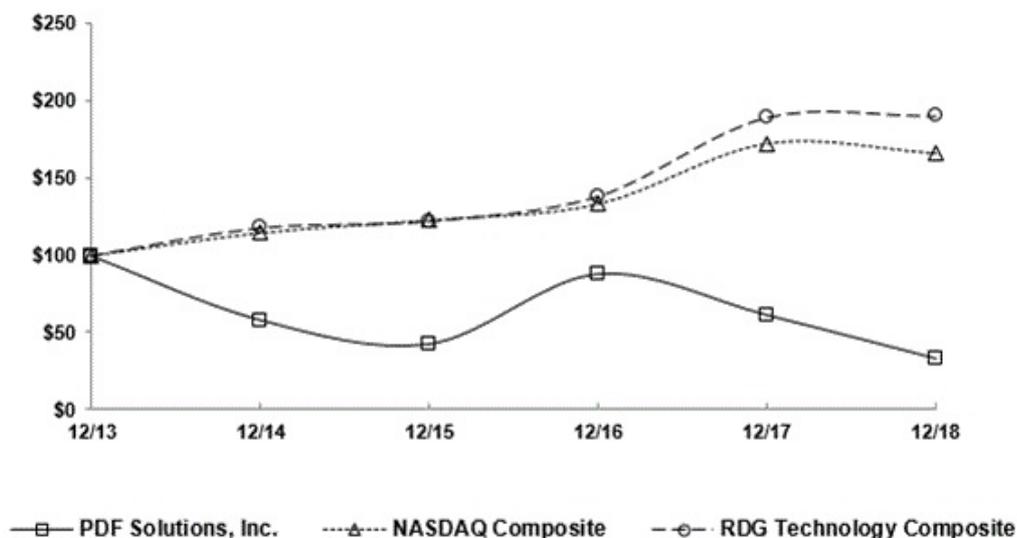
Dividend Policy

No cash dividends were declared or paid in 2018, 2017 or 2016. We currently intend to retain all available funds to finance future internal growth and product development and stock repurchases and therefore do not anticipate paying any cash dividends on our common stock for the foreseeable future.

Stock Performance Graph

The following graph and tables compare the cumulative total stockholder return data for our stock since December 31, 2013 to the cumulative return over such period of (i) The NASDAQ Composite Index and (ii) the RDG Technology Composite Index. The graph assumes that \$100 was invested on December 31, 2013. The graph and tables further assume that such amount was initially invested in the Common Stock of the Company at a per share price of \$25.62 (closing price on December 31, 2013) and that of any dividends were reinvested. This performance graph and the corresponding tables are not “soliciting material,” are not deemed filed with the SEC and are not to be incorporated by reference in any filing by us under the Securities Act or the Exchange Act whether made before or after the date hereof and irrespective of any general incorporation language in any such filing. The stock price performance on the following graph and tables is not necessarily indicative of future stock price performance.

COMPARISON OF 5 YEAR CUMULATIVE TOTAL RETURN*
Among PDF Solutions, Inc., the NASDAQ Composite Index
and the RDG Technology Composite Index



*\$100 invested on 12/31/13 in stock or index, including reinvestment of dividends.
Fiscal year ending December 31.

	12/13	12/14	12/15	12/16	12/17	12/18
PDF Solutions, Inc.	100.00	58.00	42.31	88.02	61.28	32.90
NASDAQ Composite Index	100.00	114.62	122.81	133.19	172.11	165.84
RDG Technology	100.00	117.81	122.23	138.28	189.14	190.13

Purchases of Equity Securities by the Issuer and Affiliated Purchasers

On October 25, 2016, the Board of Directors adopted a program that was effective immediately to repurchase up to \$25.0 million of the Company's common stock both on the open market and in privately negotiated transactions over the next two years. On May 29, 2018, the Board of Directors terminated that 2016 stock repurchase program, and adopted a new program to repurchase up to \$25.0 million of the Company's common stock both on the open market and in privately negotiated transactions, from time to time, over the next two years. During the year ended December 31, 2018, the Company repurchased 437,000 shares for \$5.2 million under the 2016 program and no shares were repurchased under the 2018 program. As of December 31, 2018, 1,279,000 shares had been repurchased at an average price of \$14.59 per share under the 2016 program, for a total purchase of \$18.7 million. Under the 2018 program, as of December 31, 2018, \$25.0 million of the Company's common stock remained available for future repurchases.

There were no purchases made by or on behalf of the Company or any "affiliated purchaser" (as the term is defined in Rule 10b-18(a)(3) under the Exchange Act) of our common stock during the fourth quarter ended December 31, 2018.

Item 6. Selected Financial Data.

The following selected consolidated financial information has been derived from the audited consolidated financial statements. The information set forth below is not necessarily indicative of results of future operations and should be read in conjunction with Item 7. "Management's Discussion and Analysis of Financial Condition and Results of Operations" and the consolidated financial statements and notes to those statements included therein and in Part IV of this Form 10-K.

	Year Ended December 31,				
	2018	2017	2016	2015	2014
	(In thousands, except per share amounts)				
Consolidated Statements of Operations Data:					
Revenues:					
Design-to-silicon-yield solutions	\$ 60,081	\$ 74,436	\$ 77,162	\$ 63,839	\$ 52,769
Gainshare performance incentives	25,713	27,435	30,299	34,138	47,394
Total revenues	85,794	101,871	107,461	97,977	100,163
Cost of Design-to-silicon-yield solutions:					
Direct costs of Design-to-silicon-yield solutions	42,228	47,050	44,074	38,847	37,822
Amortization of acquired technology	575	471	374	176	—
Impairment of deferred costs	—	—	—	—	1,892
Total cost of Design-to-silicon-yield solutions	42,803	47,521	44,448	39,023	39,714
Gross profit	42,991	54,350	63,013	58,954	60,449
Operating expenses:					
Research and development	27,998	30,078	27,559	19,096	14,064
Selling, general and administrative	23,934	23,684	22,056	20,421	18,457
Amortization of other acquired intangible assets	435	398	432	196	31
Restructuring charges	576	—	—	—	57
Total operating expenses	52,943	54,160	50,047	39,713	32,609
Income (loss) from operations	(9,952)	190	12,966	19,241	27,840
Interest and other income (expense), net	493	(264)	(10)	181	119
Income (loss) before taxes	(9,459)	(74)	12,956	19,422	27,959
Income tax provision (benefit)	(1,743)	1,263	3,853	7,015	9,497
Net income (loss)	\$ (7,716)	\$ (1,337)	\$ 9,103	\$ 12,407	\$ 18,462
Net income (loss) per share:					
Basic	\$ (0.24)	\$ (0.04)	\$ 0.29	\$ 0.39	\$ 0.60
Diluted	\$ (0.24)	\$ (0.04)	\$ 0.28	\$ 0.39	\$ 0.58
Weighted average common shares:					
Basic	32,169	32,038	31,373	31,424	30,743
Diluted	32,169	32,038	32,431	32,164	31,939

	December 31,				
	2018	2017	2016	2015	2014
(In thousands)					
Consolidated Balance Sheets Data:					
Cash and cash equivalents	\$ 96,089	\$ 101,267	\$ 116,787	\$ 126,158	\$ 115,464
Working capital	137,693	144,263	151,757	148,795	147,032
Total assets	225,905	224,176	222,329	191,769	177,438
Long-term obligations	6,582	6,171	5,004	3,006	3,227
Total stockholders' equity	199,795	198,368	198,803	174,307	161,823

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

Overview

We provide hardware, software and IP products to integrated circuit (or IC) vendors and their supply chain that are used to create, generate and collect differentiated data about their manufacturing process. This data can then be managed and analyzed by our software tools to optimize and improve the design, manufacturing and test operations processes used by these IC vendors to improve the yield, quality, and profitability of the products they develop. We package our solutions in various ways to meet our customers' specific business and budgetary needs, each of which provides us with various revenue streams. We receive a mix of license and service fees for use of our hardware and software and related installation, integration, training, and maintenance and support services, and, in some cases, a variable, performance-based fee.

Industry Trend

The logic foundry market at the leading edge nodes, such as 10nm and 7nm, is undergoing significant change. The leading foundry has increased market share as other foundries either suspended 7nm development or forecasted a later start of mass production. This trend will likely negatively impact our future Integrated Yield Ramp business on these nodes. For many foundries, utilization rates for 28nm fabs remain suppressed. We expect most logic foundries to invest in derivatives of older process nodes, such as 28nm and 20nm, to extract additional value as many of their customers will not move to advanced nodes due to either technological barriers or restrictive economics. Leading foundries that are continuing to invest in leading edge nodes are expected to continue to invest in new technologies such as memory, and packaging, multi-patterned and EUV lithography, as well as new innovations in process control and variability management. We expect China's investment in semiconductors to continue for at least the next few years. In order for these trends to provide opportunities for us to increase our business in process control and electrical characterization, Chinese semiconductor manufacturers will need to increase their production volumes on advanced technology nodes.

Generally, the demand for consumer electronics and communications devices continues to drive technological innovation in the semiconductor industry as the need for products with greater performance, lower power consumption, reduced costs and smaller size continues to grow with each new product generation. In addition, advances in computing systems and mobile devices have fueled demand for higher capacity memory chips. To meet these demands, IC manufacturers and designers are constantly challenged to improve the overall performance of their ICs by designing and manufacturing ICs with more embedded applications to create greater functionality while lowering power and cost per transistor. As this trend continues, companies will continually be challenged to improve process capabilities to optimally produce ICs with minimal random and systematic yield loss, which is driven by the lack of compatibility between the design and its respective manufacturing process. We believe that these difficulties will create a greater need for products and services that address yield loss across the IC product life cycle.

The interest in Industry 4.0 is another trend that will drive increased innovation in semiconductor and electronics manufacturing. The ability to add cost-effective sensors to monitor every step of a manufacturing process and the continual reduction in the cost per terabyte of data storage is moving companies that manufacture products directly or through a supply chain to collect as much manufacturing and test data as possible in order to analyze it and optimize every aspect of manufacturing and test operations to lower costs and improve product quality and profitability. Many software companies, both large and small, are developing advanced analytics solutions that employ both artificial intelligence and machine learning algorithms to identify and optimize these inefficiencies in the manufacturing supply chain. We believe that this trend will continue for the next few years, and the challenges involved in finding new insights will create opportunities for companies that have a combination of advanced analytics capabilities, domain-specific IP, and professional services.

Financial Highlights

The following were our financial highlights for the year ended December 31, 2018:

- Total revenues were \$85.8 million, which was a decrease of \$16.1 million, or 16%, compared to the year ended December 31, 2017. Design-to-silicon-yield solutions revenue was \$60.1 million, which was a decrease of \$14.4 million, or 19%, compared to the year ended December 31, 2017. The decrease in Design-to-silicon-yield solutions revenue was primarily related to lower hours incurred across multiple contracts and customers. Additionally, a major customer suspended the development and production of its 7nm technology node, which impacted the Company's Design-to-silicon-yield solutions revenue in the fourth quarter of 2018. These decreases were partially offset by increases in revenue from Exensio big data and DFI solutions driven by strong business activity in the year. Gainshare performance incentives revenue was \$25.7 million, a decrease of \$1.7 million, or 6%, compared to the year ended December 31, 2017. The decrease in Gainshare performance incentives revenue was primarily due to lower incentives revenue from the 28nm technology nodes, partially offset by higher incentives revenue from the 14nm technology nodes from two of our major customers. Gross margin was 50%, compared to 53% for the year ended December 31, 2017.
- Net loss was \$7.7 million, compared to \$1.3 million for the year ended December 31, 2017. The increase in net loss was attributable to 16% lower revenue for the year ended December 31, 2018, partially offset by a \$5.9 million decrease in cost of sales and operating expenses that was primarily related to decrease in personnel-related cost driven by lower headcount and a decrease in stock-based compensation expense, and a \$3.0 million decrease in income tax provision due primarily to the impact of the recently enacted U.S. Tax Cuts and Jobs Act, which provide for, among other things, a decrease in the maximum federal tax rate from 35% to 21% and higher pre-tax operating loss, partially offset by lower excess tax benefits related to employee stock compensation.
- Net loss per basic and diluted share was \$0.24, which was an increase in net loss of \$0.20 per basic and diluted share compared to net loss per basic and diluted share of \$0.04 for the year ended December 31, 2017.
- Cash, cash equivalents and investments decreased \$5.2 million to \$96.1 million at December 31, 2018, from \$101.3 million at December 31, 2017, primarily due to cash used in investing activities related to property and equipment purchased for the development of our DFI solution, new office headquarters and expansion of our research and development laboratory and clean room, and cash used in financing activities primarily due to repurchases of our common stock, partially offset by cash generated from operating activities during the year.

Critical Accounting Estimates

The preparation of financial statements and related disclosures in conformity with accounting principles generally accepted in the United States requires us to make judgments, assumptions, and estimates that affect the amounts reported in the Consolidated Financial Statements and accompanying notes. Note 1 of Notes to Consolidated Financial Statements describes the significant accounting policies and methods used in the preparation of the Consolidated Financial Statements. We consider the accounting policies described below to be our critical accounting policies. These critical accounting policies are impacted significantly by judgments, assumptions, and estimates used in the preparation of the Consolidated Financial Statements and actual results could differ materially from the amounts reported based on these policies.

Revenue Recognition

We derive revenues from two sources: Design-to-silicon-yield Solutions and Gainshare performance incentives.

Design-to-silicon-yield solutions — We recognize revenue for each element of Design-to-silicon-yield solutions as follows:

We generate a significant portion of our Design-to-silicon-yield solutions revenue from fixed-price solution implementation service contracts delivered over a specific period of time. Revenue under project-based contracts for solution implementation services is recognized as services are performed using a percentage of completion method based on costs or labor-hours inputs, whichever is the most appropriate measure of the progress towards completion of the contract. Due to the nature of the work performed in these arrangements, the estimation of costs or hours at completion is complex, subject to many variables and requires significant judgment. Key factors reviewed by us to estimate costs to complete each contract are future labor and product costs and expected productivity efficiencies. If circumstances arise that change the original estimates of revenues, costs, or the extent of progress toward completion, revisions to the estimates are made. These revisions may result in increases or decreases in estimated revenues or costs. Losses on fixed-price solution implementation contracts are recognized in the period when they become probable. Revisions in profit estimates are reflected in the period in which the conditions that require the revisions become known and can be estimated (cumulative catch-up method).

On occasion, we include our products as a component of our fixed-price service contracts. In such instances, we determine whether the services performed and products included are distinct. In most cases, the arrangement is a single performance obligation and therefore, follows the pattern of transfer as the service is provided. We apply a measure of progress (typically hours-to-hours or cost-to-cost) to any fixed consideration. As a result, revenue is generally recognized over the period the services are performed using the percentage-of-completion method. This results in revenue recognition that corresponds with the value to the client of the services transferred to date relative to the remaining services promised.

We also license our DFI system as a separate component of fixed-price service contracts. We allocate revenue to all deliverables based on their standalone selling prices, or SSP. In such instances, we apply judgment to estimate the range of SSPs for each performance obligation.

We license some of our software products separately from solution implementations, primarily our Exensio software platform and related products. The majority of these products are delivered as on-premise software licenses, while others can be delivered entirely or partially through hosted Software-as-a-Service (or SaaS). Revenue from perpetual (one-time charge) license software is recognized at the time of the inception of the arrangement when control transfers to the client, if the software license is distinct from the services offered by us. Revenue from post-contract support subscription is recognized over the contract term on a straight-line basis, because we are providing (i) a service of standing ready to provide support, when-and-if needed, and (ii) unspecified software upgrades on a when-and-if available basis over the contract term. Revenue from time-based license software is allocated to each performance obligation and is recognized either at a point in time or over time. The license component is recognized at the time of the delivery of the software license, with the post-contract support subscription component being recognized ratably over for the committed term of the contract. Revenue from SaaS arrangements that allow for the use of a hosted software product or service over a contractually determined period of time without taking possession of software are accounted for as subscriptions and are recognized as revenue ratably, on a straight-line basis, over the subscription period beginning on the date the service is first made available to customers.

Gainshare performance incentives — Our contracts to provide yield improvement services have historically included two components: (1) a fixed fee for performance by the Company of services delivered over a specific period of time; and (2) a Gainshare performance incentive component where the customer pays a variable fee, usually after the fixed fee period has ended, related to the usage of the Company's intellectual property. Revenue derived from Gainshare performance incentives is contingent upon our customers reaching certain defined production yield levels. Gainshare performance incentive periods are usually subsequent to the delivery of all contractual services and performance obligations. We record Gainshare revenue as a usage-based royalty in accordance with customers' usage of the intellectual property and in the same period in which the usage occurs.

Income Taxes

We are required to assess the whether it is more-likely-than that our deferred tax assets will be recovered from future taxable income. If we believe that they are not likely to be realizable before the expiration dates applicable to such assets, then to the extent we believe that recovery is not likely, we must establish a valuation allowance. Changes in the net deferred tax assets, less offsetting valuation allowance, in a period are recorded through the income tax provision and could have a material impact on the consolidated statements of operations. The valuation allowance was approximately \$9.8 million and \$9.1 million as of December 31, 2018, and December 31, 2017, respectively, which was related to California R&D tax credits and California net operating losses related to an acquisition that we currently do not believe to be “more-likely-than-not” to be ultimately realized. If we conclude at a future financial reporting period that there has been a change in our ability to realize our California R&D credit and net operating loss carry forward deferred tax assets, and it is at such time “more-likely-than-not” that we will realize the tax credits before applicable expiration dates, our tax provision will decrease in the period in which we make such determination.

Our income tax calculations are based on application of the respective U.S. federal, state or foreign tax law. Our tax filings, however, are subject to audit by the respective tax authorities. Accordingly, we recognize tax liabilities based upon our estimate of whether, and the extent to which, additional taxes will be due when such estimates are more-likely-than-not to be sustained. An uncertain income tax position will not be recognized if it has less than a 50% likelihood of being sustained. To the extent the final tax liabilities are different than the amounts originally accrued, the increases or decreases are recorded as income tax expense or benefit in the consolidated statements of operations and comprehensive income (loss). At December 31, 2018, no deferred taxes have been provided on undistributed earnings from the Company’s international subsidiaries. The Company intends to reinvest the earnings of its non-U.S. subsidiaries in those operations indefinitely. As such, the Company has not provided for any foreign withholding taxes on the earnings of foreign subsidiaries as of December 31, 2018. The earnings of the Company’s foreign subsidiaries are taxable in the U.S. in the year earned under the Global Intangible Low-Taxed Income (“GILTI”) rules implemented under 2017 Tax Cuts and Jobs Act (“TCJA”).

Software Development Costs

Internally developed software includes software developed to meet our internal needs to provide solution implementation services to our end-customers. These capitalized costs consist of internal compensation related costs and external direct costs incurred during the application development stage and are amortized over their useful lives, which is generally six years. The costs to develop software that is marketed externally have not been capitalized as we believe our current software development process is essentially completed concurrent with the establishment of technological feasibility. As such, all related software development costs are expensed as incurred and included in research and development expense in our consolidated statements of operations and comprehensive income (loss).

Stock-Based Compensation

Stock-based compensation is estimated at the grant date based on the award’s fair value and is recognized on a straight-line basis over the vesting period, which for us is generally four years. As stock-based compensation expense recognized is based on awards ultimately expected to vest, it has been reduced for estimated forfeitures. Forfeitures are estimated at the time of grant and revised, if necessary, in subsequent periods if actual forfeitures differ from those estimates.

We have elected to use the Black-Scholes-Merton option-pricing model for our stock option grants, which incorporates various assumptions including volatility, expected life and interest rates. The expected volatility is based on the historical volatility of our common stock over the most recent period commensurate with the estimated expected life of stock options. The expected life of an award is based on historical experience and on the terms and conditions of the stock awards granted to employees. The interest rate assumption is based upon observed Treasury yield curve rates appropriate for the expected life of stock options.

Goodwill and Intangible Assets

We record goodwill when the purchase consideration of an acquisition exceeds the fair value of the net tangible and identified intangible assets as of the date of acquisition. We perform an annual impairment assessment of goodwill during the fourth quarter of each calendar year or more frequently, if required to determine if any events or circumstances exist, such as an adverse change in business climate or a decline in the overall industry demand, that would indicate that it would more likely than not reduce the fair value of a reporting unit below its carrying amount, including goodwill. If events or circumstances do not indicate that the fair value of a reporting unit is below its carrying amount, then goodwill is not considered to be impaired and no further testing is required. If further testing is required, we perform a two-step process. The first step involves comparing the fair value of its reporting unit to its carrying value, including goodwill. If the carrying value of the reporting unit exceeds its fair value, the second step of the test is performed by comparing the carrying value of the goodwill in the reporting unit to its implied fair value. An impairment charge is recognized for the excess of the carrying value of goodwill over its implied fair value. For the purpose of impairment testing, we have determined that we have one reporting unit. There was no impairment of goodwill for the year ended December 31, 2018.

Our long-lived assets, excluding goodwill, consist of property and equipment and intangible assets. We periodically review our long-lived assets for impairment. For assets to be held and used, we initiate our review whenever events or changes in circumstances indicate that the carrying amount of a long-lived asset group may not be recoverable. Recoverability of an asset group is measured by comparison of its carrying amount to the expected future undiscounted cash flows that the asset group is expected to generate. If it is determined that an asset group is not recoverable, an impairment loss is recorded in the amount by which the carrying amount of the asset group exceeds its fair value. There was no impairment of long-lived assets for the year ended December 31, 2018.

Recent Accounting Pronouncements and Accounting Changes

See our Note 1, “Description of Business and Summary of Significant Accounting Policies” of “Notes to Consolidated Financial Statements” included under Part II, Item 8 of this Form 10-K for a description of recent accounting pronouncements and accounting changes, including the expected dates of adoption and estimated effects, if any, on our consolidated financial statements.

Results of Operations

Discussion of Financial Data for the years ended December 31, 2018, 2017 and 2016

Revenues

	Years Ended December 31,			\$ Change	% Change	\$ Change	% Change
	2018	2017	2016	2017 to 2018		2016 to 2017	
(Dollars in thousands)							
Design-to-silicon-yield solutions	\$ 60,081	\$ 74,436	\$ 77,162	\$ (14,355)	(19)%	\$ (2,726)	(4)%
Gainshare performance incentives	25,713	27,435	30,299	(1,722)	(6)%	(2,864)	(9)%
Total	<u>\$ 85,794</u>	<u>\$ 101,871</u>	<u>\$ 107,461</u>	<u>\$ (16,077)</u>	<u>(16)%</u>	<u>\$ (5,590)</u>	<u>(5)%</u>
Design-to-silicon-yield solutions as a percentage of total revenues	70%	73%	72%				
Gainshare performance incentives as a percentage of total revenues	30%	27%	28%				

Design-to-silicon-yield solutions revenue is derived from services (including solution implementations, software support and maintenance, consulting, and training) and software and hardware licenses provided during our customer yield improvement engagements as well as during solution product sales. Design-to-silicon-yield solutions revenue decreased \$14.4 million and \$2.7 million for the years ended December 31, 2018 and 2017, respectively, compared to the prior year periods, due primarily to the decrease in revenue from our yield ramp solutions resulting from lower hours worked across multiple contracts and customers. Additionally, a major customer suspended the development and production of its 7nm technology node, which impacted the Company’s Design-to-silicon-yield solutions revenue in the fourth quarter of 2018. These decreases were partially offset by increases in revenue from Exensio big data and DFI solutions that were driven by strong business activity. Our Design-to-silicon-yield solutions revenue may fluctuate in the future and is dependent on a number of factors, including the semiconductor industry’s continued acceptance of our solutions, the timing of purchases by existing and new customers, cancellations by existing customers, and our ability to attract new customers and penetrate new markets, and further penetration of our current customer base. Fluctuations in future results may also occur if any of our significant customers renegotiate pre-existing contractual commitments, including due to adverse changes in their own business.

Gainshare performance incentives revenue represent royalties and performance incentives earned contingent upon our customers reaching certain defined operational levels. Revenue derived from Gainshare performance incentives decreased \$1.7 million and \$2.9 million for the years ended December 31, 2018 and 2017, respectively, compared to the prior year periods due primarily to lower Gainshare performance incentives revenue from the 28nm technology nodes, partially offset by higher incentives revenue from the 14nm technology nodes. Our Gainshare performance incentives revenue may continue to fluctuate from period to period. Gainshare performance incentives revenue is dependent on many factors that are outside our control, including among others, continued production of ICs by our customers at facilities at which we generate Gainshare, sustained yield improvements by our customers, and our ability to enter into new solutions contracts containing Gainshare performance incentives.

Cost of Design-to-silicon-yield solutions

	<u>Years Ended December 31,</u>			<u>\$ Change</u>	<u>% Change</u>	<u>\$ Change</u>	<u>% Change</u>
	<u>2018</u>	<u>2017</u>	<u>2016</u>	<u>2017 to 2018</u>		<u>2016 to 2017</u>	
(Dollars in thousands)							
Direct costs of Design-to-silicon-yield solutions	\$ 42,228	\$ 47,050	\$ 44,074	\$ (4,822)	(10)%	\$ 2,976	7%
Amortization of acquired technology	575	471	374	104	22%	97	26%
Total	\$ 42,803	\$ 47,521	\$ 44,448	\$ (4,718)	(10)%	\$ 3,073	7%
<i>As a percentage of total revenues</i>	<i>50%</i>	<i>47%</i>	<i>41%</i>				

Cost of Design-to-silicon-yield solutions consists of costs incurred to provide and support our services, costs recognized in connection with licensing our software, and amortization of acquired technology. Direct costs of Design-to-silicon-yield solutions consist of services costs and software licenses costs. Services costs consist of material, employee compensation and related benefits, overhead costs, travel and allocated facilities-related costs.

Software license costs consist of costs associated with licensing third-party software used by the Company in providing services to our customers in solution engagements, or sold in conjunction with our software products. Direct costs of Design-to-silicon-yield solutions decreased for the year ended December 31, 2018, compared to the year ended December 31, 2017, primarily due to a \$3.8 million decrease in personnel-related cost driven by lower headcount and stock-based compensation expense, a \$0.5 million decrease in software licenses costs and a \$0.2 million decrease in equipment expense. Direct costs of Design-to-silicon-yield solutions increased for the year ended December 31, 2017, compared to the year ended December 31, 2016, primarily due to a \$1.5 million increase in personnel-related cost driven by worldwide merit increases and an increase in headcount in Asia, a \$1.0 million increase in depreciation expense primarily due to depreciation of test equipment and a \$0.4 million increase in equipment expenses.

Amortization of acquired technology increased for the years ended December 31, 2018 and 2017 primarily due to the amortization of acquired technology from acquisition of certain assets from Realtime Performance Europe B.V. (dba "Kinesys Software") in July 2017.

Research and Development

	<u>Years Ended December 31,</u>			<u>\$ Change</u>	<u>% Change</u>	<u>\$ Change</u>	<u>% Change</u>
	<u>2018</u>	<u>2017</u>	<u>2016</u>	<u>2017 to 2018</u>		<u>2016 to 2017</u>	
(Dollars in thousands)							
Research and Development	\$ 27,998	\$ 30,078	\$ 27,559	\$ (2,080)	(7)%	\$ 2,519	9%
<i>As a percentage of total revenues</i>	<i>33%</i>	<i>30%</i>	<i>26%</i>				

Research and development expenses consist primarily of personnel-related costs to support product development activities, including compensation and benefits, outside development services, travel, facilities cost allocations, and stock-based compensation charges. Research and development expenses decreased for the year ended December 31, 2018, compared to the year ended December 31, 2017, primarily due to a \$1.3 million decrease in subcontractor expenses that is primarily related to our DFI and Exensio development projects, and a \$1.6 million decrease in personnel-related expense driven by lower headcount and stock-based compensation expense, partially offset by a \$0.3 million increase depreciation expense for laboratory equipment, a \$0.2 million write-down in carrying value of certain equipment, and a \$0.2 million increase in facilities expense. Research and development expenses increased for the year ended December 31, 2017, compared to the year ended December 31, 2016, primarily due to a \$1.4 million increase in subcontractor expenses that is primarily related to our DFI and Exensio development projects, a \$0.7 million increase in personnel-related cost primarily due to worldwide merit increases, and a \$0.4 million increase in depreciation expense that is related to our DFI equipment. We anticipate our expenses in research and development will fluctuate in absolute dollars from period to period as a result of the size and the timing of product development projects and revenue generating activity requirements.

Selling, General and Administrative

	Years Ended December 31,			<u>\$ Change</u>	<u>% Change</u>	<u>\$ Change</u>	<u>% Change</u>
	<u>2018</u>	<u>2017</u>	<u>2016</u>				
(Dollars in thousands)							
Selling, general and administrative	\$ 23,934	\$ 23,684	\$ 22,056	\$ 250	1%	\$ 1,628	7%
<i>As a percentage of total revenues</i>	28%	23%	21%				

Selling, general and administrative expenses consist primarily of compensation and benefits for sales, marketing and general and administrative personnel, legal and accounting services, marketing communications, travel and facilities cost allocations, and stock-based compensation charges. Selling, general and administrative expenses increased slightly for the year ended December 31, 2018, compared to the year ended December 31, 2017, primarily due to a \$0.2 million increase in facilities expense, a \$0.2 million increase in legal expense, a \$0.1 million increase in consulting and professional fees, and \$0.1 million increase in office relocation expense, partially offset by a \$0.2 million decrease in personnel-related cost related to lower stock-based compensation expense and a \$0.2 million decrease in bad debt expense. Selling, general and administrative expenses increased for the year ended December 31, 2017, compared to the year ended December 31, 2016, primarily due to a \$0.4 million increase in personnel-related cost that is primarily due to worldwide merit increases and hiring of executives, a \$0.4 million increase in accounting cost related to accounting policy and tax law changes, a \$0.4 million increase in facilities expense, a \$0.3 million increase in legal expense related to an acquisition, and a \$0.3 million increase in bad debt expense due to higher level of accounts receivable, offset by a \$0.1 million decrease in depreciation expense. We anticipate our selling, general and administrative expenses will fluctuate in absolute dollars from period to period as a result of cost control initiatives and to support increased selling efforts in the future.

Amortization of Other Acquired Intangible Assets

	Years Ended December 31,			<u>\$ Change</u>	<u>% Change</u>	<u>\$ Change</u>	<u>% Change</u>
	<u>2018</u>	<u>2017</u>	<u>2016</u>				
(Dollars in thousands)							
Amortization of other acquired intangible assets	\$ 435	\$ 398	\$ 432	\$ 37	9%	\$ (34)	(8)%

Amortization of other acquired intangible assets consists of the amortization of intangibles acquired as a result of a business combination. The increase in amortization of acquired intangible assets for the years ended December 31, 2018 and 2017 was primarily due to the amortization of acquired intangible assets from 2017 acquisition.

Restructuring charges

	Years Ended December 31,			<u>\$ Change</u>	<u>% Change</u>	<u>\$ Change</u>	<u>% Change</u>
	<u>2018</u>	<u>2017</u>	<u>2016</u>				
(Dollars in thousands)							
Restructuring charges	\$ 576	\$ —	\$ —	\$ 576	100%	\$ —	—%

Restructuring charges for the year ended December 31, 2018, were primarily related to employee separation charges incurred as part of the Company's restructuring plan announced on September 27, 2018, to reduce expenses and align its operations with evolving business needs.

See Note 8, Restructuring Charges, in Notes to Consolidated Financial Statements in Item 8 of Part II of this Report for more information regarding this restructuring plan.

Interest and Other Income (Expense), Net

	Years Ended December 31,			\$ Change	% Change	\$ Change	% Change
	2018	2017	2016	2017 to 2018		2016 to 2017	
(Dollars in thousands)							
Interest and other income (expense), net	\$ 493	\$ (264)	\$ (10)	\$ 757	(287)%	\$ (254)	2,540%

Interest and other income (expense), net, primarily consists of interest income and foreign currency transaction exchange gain (loss). Interest and other income, net, increased for the year ended December 31, 2018, compared to the year ended December 31, 2017, primarily due to net favorable fluctuations in foreign exchange rates and an increase in interest income due to higher interest rates. Interest and other expense, net, increased for the year ended December 31, 2017, compared to the year ended December 31, 2016, primarily due to net unfavorable fluctuations in foreign exchange rates, partially offset by increase in interest income due to higher interest rates. We anticipate interest and other income (expense) will fluctuate in future periods as a result of our projected use of cash and fluctuations of foreign exchange rates.

Income Tax Provision (Benefit)

	Years Ended December 31,			\$ Change	% Change	\$ Change	% Change
	2018	2017	2016	2017 to 2018		2016 to 2017	
(Dollars in thousands)							
Income tax provision (benefit)	\$ (1,743)	\$ 1,263	\$ 3,853	\$ (3,006)	(238)%	\$ (2,590)	(67)%

Our effective tax rate for 2018 was 18.4%, which was different from the statutory federal tax rate primarily due to our pre-tax loss, the impact of US tax reform enacted in December 2017, impacts from employee stock compensation, and tax credits. The change in income tax benefit to \$1.7 million for the year ended December 31, 2018 from income tax provision of \$1.3 million from the year ended December 31, 2017, was primarily due to a higher pre-tax operating loss and impact of recently enacted U.S. tax reform, partially offset by lower excess tax benefits related to employee stock compensation.

Our effective tax rate for 2017 was significantly different from the statutory federal tax rate for the year ended December 31, 2017 primarily due to our pre-tax loss and the impact of US tax reform enacted in December 2017. The change in income tax provision to \$1.3 million for the year ended December 31, 2017 from \$3.9 million for the year ended December 31, 2016 was primarily due to the lower taxable income and tax reform impact. As a result of the legislation enacted, we recognized a tax expense of \$3.2 million for the year ended December 31, 2017 and corresponding \$3.2 million decrease in net deferred tax assets as of December 31, 2017.

Any significant change in our future effective tax rates could adversely impact our consolidated financial position, results of operations and cash flows. Our future tax rates may be adversely affected by a number of factors including increase in expenses not deductible for tax purposes, tax legislations in the U.S. and in foreign countries where we are subject to tax jurisdictions, the geographic composition of our pre-tax income, the amount of our pre-tax income as business activities fluctuate, our ability to use tax attributes such as research and development tax credits and net operation losses, the tax effects of employee stock activity, audit examinations with adverse outcomes, changes in general accepted accounting principles and the effectiveness of our tax planning strategies.

Liquidity and Capital Resources

As of December 31, 2018, our working capital, defined as total current assets less total current liabilities, was \$137.7 million, compared to \$144.3 million as of December 31, 2017. Cash and cash equivalents were \$96.1 million as of December 31, 2018, compared to \$101.3 million as of December 31, 2017. As of December 31, 2018 and 2017, cash and cash equivalents held by our foreign subsidiaries were \$4.1 million and \$3.1 million, respectively. We believe that our existing cash resources and anticipated funds from operations will satisfy our cash requirements to fund our operating activities, capital expenditures, restructuring and other obligations for the next twelve months.

	Year Ended December 31,			\$ Change	\$ Change
	2018	2017	2016	2017 to 2018	2016 to 2017
(In thousands)					
Consolidated Statements of Cash Flows Data					
Net cash flows provided by (used in):					
Operating activities	\$ 13,338	\$ 10,545	\$ 2,000	\$ 2,793	\$ 8,545
Investing activities	(13,116)	(14,096)	(11,282)	980	(2,814)
Financing activities	(5,202)	(12,224)	30	7,022	(12,254)
Effect of exchange rate changes on cash and cash equivalents	(198)	255	(119)	(453)	374
Net decrease in cash and cash equivalents	<u>\$ (5,178)</u>	<u>\$ (15,520)</u>	<u>\$ (9,371)</u>	<u>\$ 10,342</u>	<u>\$ (6,149)</u>

Net Cash Flows Provided by Operating Activities

Cash flow from operating activities during 2018 mostly consisted of net loss, adjusted for certain non-cash items which primarily consisted of depreciation and amortization, share-based compensation expense and deferred tax assets. Cash generated from operating activities increased by \$2.8 million for the year ended December 31, 2018, compared to the year ended December 31, 2017, driven primarily by \$13.8 million increase in net change from operating assets and liabilities, which was partially offset by a \$6.4 million increase in net loss and increase in non-cash adjustments to net loss by \$4.6 million primarily due to increase in deferred tax assets of \$3.7 million. The major contributors to the net change in operating assets and liabilities for the year ended December 31, 2018 were as follows:

- Accounts receivable decreased by \$6.8 million due primarily to lower billings and higher collections. Days of sales outstanding, or DSO, increased primarily due to slower payments by certain customers in Asia. We have not incurred any significant write-offs of accounts receivable for fiscal years 2018, 2017 and 2016.
- Other non-current assets decreased by \$3.6 million primarily due to billings to customers for unbilled receivables that had reached billing milestones and overall decrease in revenue.
- Prepaid expenses and other current assets increased by \$2.1 million primarily due to contract assets resulting from the effect of adopting Accounting Standard Update (ASU) No. 2014-09, Revenue from Contracts with Customers (Topic 606).
- Deferred revenues increased by \$2.5 million primarily due to timing of billing and revenue recognition.

Cash flow from operating activities during 2017 mostly consisted of net loss, adjusted for certain non-cash items, which primarily consisted of depreciation and amortization and share-based compensation expense. Cash generated from operating activities increased by \$8.5 million for the year ended December 31, 2017, compared to the year ended December 31, 2016, primarily due to a \$17.4 million increase in net change from operating assets and liabilities and a \$1.5 million increase in non-cash adjustments to net loss primarily due to a \$1.3 million increase in depreciation and amortization, partially offset by a \$10.4 million increase in net loss. The major contributors to the net change in operating assets and liabilities for the year ended December 31, 2017 were as follows:

- Accounts receivable increased by \$9.6 million primarily due to delayed payments from a few customers despite a decrease in revenues. The increase in accounts receivable and DSO was primarily driven by the geographic shift in total revenues to Asia, where slower payments are common due to governmental currency controls and regulations in certain countries. Other non-current assets decreased by \$2.1 million primarily due to the decrease in long-term unbilled portion of the solution contracts.
- Other non-current assets decreased by \$2.1 million primarily due to the decrease in long-term unbilled portion of the solution contracts.

Net Cash Flows Used in Investing Activities

Cash used in investing activities decreased by \$1.0 million from for the year ended December 31, 2018 compared to year ended December 31, 2017. Cash used in investing activities increased by \$2.8 million from for the year ended December 31, 2017 compared to year ended December 31, 2016. For the year ended December 31, 2018, cash flows used in investing activities consisted of \$13.1 million payments for capital expenditures which included purchases of test equipment, furniture and fixture and leasehold improvements for the new office headquarters and expansion of research and development laboratory and clean room. For the year ended December 31, 2017, cash flows used in investing activities primarily consisted of \$10.2 million payments for capital expenditures, primarily test equipment and \$3.8 million cash paid for acquisition of business.

For the year ended December 31, 2016, cash used in investing activities is consisted of \$11.3 million payments for capital expenditures, primarily related to development of our DFI solution.

Net Cash Flows Used in Financing Activities

Net cash used in financing activities decreased by \$7.0 million for the year ended December 31, 2018, compared to year ended December 31, 2017. Net cash used in financing activities increased by \$12.3 million for the year ended December 31, 2017, compared to year ended December 31, 2016. For the year ended December 31, 2018, net cash used in financing activities primarily consisted of \$5.2 million cash used to repurchase shares of our common stock and \$2.1 million cash payments for taxes related to net share settlement of equity awards, partially offset by \$2.4 million of proceeds from our Employee Stock Purchase Plan and exercise of stock options. For the year ended December 31, 2017, net cash used in financing activities primarily consisted of \$13.4 million cash used to repurchase shares of our common stock and \$3.5 million cash payments for taxes related to net share settlements of equity awards, partially offset by \$4.7 million proceeds from our Employee Stock Purchase Plan and exercise of stock options.

For the year ended December 31, 2016, net cash provided by financing activities primarily consisted of \$3.0 million proceeds from the exercise of stock options and \$1.6 million proceeds from our Employee Stock Purchase Plan, partially offset by \$4.5 million cash used to repurchase shares of our common stock and cash payments for taxes related to net share settlements of equity awards.

Off-Balance Sheet Arrangements

We do not have any off-balance sheet arrangements, investments in special purpose entities or undisclosed borrowings or debt.

Contractual Obligations

The following table summarizes our known contractual obligations (in thousands) as of December 31, 2018:

Contractual Obligations	Payments Due by Period						Total
	2019	2020	2021	2022	2023	2023 and thereafter	
Operating lease obligations(1)	\$ 1,677	\$ 1,811	\$ 1,653	\$ 1,484	\$ 1,127	\$ 3,673	\$ 11,425
Purchase obligations(2)	7,788	532	396	8	5	—	8,729
Total(3)	<u>\$ 9,465</u>	<u>\$ 2,343</u>	<u>\$ 2,049</u>	<u>\$ 1,492</u>	<u>\$ 1,132</u>	<u>\$ 3,673</u>	<u>\$ 20,154</u>

(1) In April 2018, we entered into a new approximately 20,800 square foot lease, located in Santa Clara, California. The term of the new lease is ten years commencing on September 1, 2018. The total lease obligation over the new lease term is approximately \$7.3 million, less a lease abatement allowance of approximately \$0.4 million. The terms of the new lease include a tenant improvement allowance of \$1.5 million. Future minimum lease payments under the lease are included in the above table.

(2) Purchase obligations consist of agreements to purchase goods and services entered in the ordinary course of business.

(3) The contractual obligation table above excludes liabilities for uncertain tax positions of \$3.0 million, which are not practicable to assign to any particular years, due to the inherent uncertainty of the tax positions. See Note 9 of “Notes to Consolidated Financial Statements” for further discussion.

Item 7A. Quantitative and Qualitative Disclosures About Market Risk

The following discusses our exposure to market risk related to changes in interest rates and foreign currency exchange rates. We do not currently own any equity investments, nor do we expect to own any in the foreseeable future. This discussion contains forward-looking statements that are subject to risks and uncertainties. Actual results could vary materially as a result of a number of factors.

Interest Rate Risk. As of December 31, 2018, we had cash and cash equivalents of \$96.1 million. Cash and cash equivalents consisted of cash and highly liquid money market instruments. We would not expect our operating results or cash flows to be affected to any significant degree by the effect of a sudden change in market interest on our portfolio. A hypothetical increase in market interest rates of 100 basis points from the market rates in effect at December 31, 2018, would cause the fair value of these investments to decrease by an immaterial amount which would not have significantly impacted our financial position or results of operations.

Foreign Currency and Exchange Risk. Certain of our payables for our international offices are denominated in the local currency, including the Euro, Yen and RMB. Therefore, a portion of our operating expenditures is subject to foreign currency risks. We enter into foreign currency forward contracts to reduce the exposure to foreign currency exchange rate fluctuations on certain foreign currency denominated monetary assets and liabilities. We do not use foreign currency forward contracts for speculative or trading purposes. We record these forward contracts at fair value. The counterparty to these foreign currency forward contracts is a large global financial institution that we believe is creditworthy, and therefore, we believe the credit risk of counterparty non-performance is not significant. The change in fair value of these contracts is recorded into earnings as a component of other income (expense), net and offsets the change in fair value of foreign currency denominated monetary assets and liabilities, which is also recorded in other income (expense), net. As of December 31, 2018, the notional amount of this outstanding forward contract was \$8.2 million. A foreign currency exchange rate movement of plus-or-minus 10% will result in the change in fair value of this contract of plus-or-minus \$0.8 million.

Item 8. Financial Statements and Supplementary Data

REPORT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

**To the Board of Directors and Stockholders
PDF Solutions, Inc.**

Opinion on the Financial Statements

We have audited the accompanying consolidated balance sheet of PDF Solutions, Inc. (a Delaware corporation) and its subsidiaries (the “Company”) as of December 31, 2018, and the related consolidated statements of operations and comprehensive income (loss), stockholders’ equity, and cash flows for the year ended December 31, 2018, and the related notes (collectively referred to as the “consolidated financial statements”). In our opinion, the consolidated financial statements present fairly, in all material respects, the financial position of the Company as of December 31, 2018, and the results of its operations and its cash flows for the year then ended, in conformity with accounting principles generally accepted in the United States of America.

We also have audited, in accordance with the standards of the Public Company Accounting Oversight Board (United States) (“PCAOB”), the Company’s internal control over financial reporting as of December 31, 2018, based on criteria established in *Internal Control—Integrated Framework (2013)* issued by the Committee of Sponsoring Organizations of the Treadway Commission (COSO), and our report dated March 7, 2019, expressed an unqualified opinion.

Change in Accounting Principle

As discussed in Note 1 to the consolidated financial statements, the Company adopted Accounting Standard Codification Topic 606, *Revenue from Contracts with Customers*, effective January 1, 2018.

Basis for Opinion

These consolidated financial statements are the responsibility of the Company’s management. Our responsibility is to express an opinion on the Company’s consolidated financial statements based on our audit. We are a public accounting firm registered with the PCAOB and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audit in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the consolidated financial statements are free of material misstatement, whether due to error or fraud. Our audit included performing procedures to assess the risks of material misstatement of the consolidated financial statements, whether due to error or fraud, and performing procedures that respond to those risks. Such procedures included examining, on a test basis, evidence regarding the amounts and disclosures in the consolidated financial statements. Our audit also included evaluating the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of the consolidated financial statements. We believe that our audit provides a reasonable basis for our opinion.

We have served as the Company’s auditor since 2018.

/s/ BPM LLP
San Jose, CA
March 7, 2019

REPORT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

**To the Board of Directors and Stockholders
PDF Solutions, Inc.**

Opinion on Internal Control over Financial Reporting

We have audited the internal control over financial reporting of PDF Solutions, Inc. (a Delaware corporation) and its subsidiaries (the “Company”) as of December 31, 2018, based on criteria established in *Internal Control—Integrated Framework* issued by the Committee of Sponsoring Organizations of the Treadway Commission (2013 framework) (the “COSO criteria”). In our opinion, the Company maintained, in all material respects, effective internal control over financial reporting as of December 31, 2018, based on the COSO criteria.

We also have audited, in accordance with the standards of the Public Company Accounting Oversight Board (United States) (“PCAOB”), the consolidated balance sheet as of December 31, 2018 and the related consolidated statements of operations and comprehensive income (loss), stockholders’ equity, and cash flows for the year then ended, and the related notes (collectively referred to as the “consolidated financial statements”) of the Company, and our report dated March 7, 2019 expressed an unqualified opinion on those consolidated financial statements.

Basis for Opinion

The Company’s management is responsible for maintaining effective internal control over financial reporting, and for its assessment of the effectiveness of internal control over financial reporting, included in the accompanying Management’s Report on Assessment of Internal Controls Over Financial Reporting. Our responsibility is to express an opinion on the Company’s internal control over financial reporting based on our audit. We are a public accounting firm registered with the PCAOB and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audit in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether effective internal control over financial reporting was maintained in all material respects. Our audit of internal control over financial reporting included obtaining an understanding of internal control over financial reporting, assessing the risk that a material weakness exists, and testing and evaluating the design and operating effectiveness of internal control based on the assessed risk. Our audit also included performing such other procedures as we considered necessary in the circumstances. We believe that our audit provides a reasonable basis for our opinion.

Definition and Limitations of Internal Control over Financial Reporting

A company’s internal control over financial reporting is a process designed to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles. A company’s internal control over financial reporting includes those policies and procedures that (1) pertain to the maintenance of records that, in reasonable detail, accurately and fairly reflect the transactions and dispositions of the assets of the company; (2) provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that receipts and expenditures of the company are being made only in accordance with authorizations of management and directors of the company; and (3) provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use, or disposition of the company’s assets that could have a material effect on the financial statements.

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

/s/ BPM LLP
San Jose, California
March 7, 2019

REPORT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

To the Board of Directors and Stockholders of PDF Solutions, Inc.

Opinion on the Financial Statements

We have audited the consolidated balance sheet of PDF Solutions, Inc. and its subsidiaries (the “Company”) as of December 31, 2017, and the related consolidated statements of operations and comprehensive income (loss), stockholders’ equity and cash flows for each of the two years in the period ended December 31, 2017, including the related notes (collectively referred to as the “consolidated financial statements”). In our opinion, the consolidated financial statements present fairly, in all material respects, the financial position of the Company as December 31, 2017, and the results of its operations and its cash flows for each of the two years in the period ended December 31, 2017 in conformity with accounting principles generally accepted in the United States of America.

Basis for Opinion

These consolidated financial statements are the responsibility of the Company's management. Our responsibility is to express an opinion on the Company's consolidated financial statements based on our audits. We are a public accounting firm registered with the Public Company Accounting Oversight Board (United States) (PCAOB) and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audits of these consolidated financial statements in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the consolidated financial statements are free of material misstatement, whether due to error or fraud.

Our audits included performing procedures to assess the risks of material misstatement of the consolidated financial statements, whether due to error or fraud, and performing procedures that respond to those risks. Such procedures included examining, on a test basis, evidence regarding the amounts and disclosures in the consolidated financial statements. Our audits also included evaluating the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of the consolidated financial statements. We believe that our audits provide a reasonable basis for our opinion.

/s/ PricewaterhouseCoopers LLP

San Jose, California

March 16, 2018

We served as the Company's auditor from 2009 to 2018

PDF SOLUTIONS, INC.
CONSOLIDATED BALANCE SHEETS
(in thousands, except par values)

	December 31,	
	2018	2017
ASSETS		
Current assets:		
Cash and cash equivalents	\$ 96,089	\$ 101,267
Accounts receivable, net of allowances of \$332 and \$374, respectively	51,570	57,564
Prepaid expenses and other current assets	9,562	5,069
Total current assets	<u>157,221</u>	<u>163,900</u>
Property and equipment, net	35,681	25,386
Goodwill	1,923	1,923
Intangible assets, net	5,064	6,074
Deferred tax assets	19,044	16,348
Other non-current assets	6,972	10,545
Total assets	<u>\$ 225,905</u>	<u>\$ 224,176</u>
LIABILITIES AND STOCKHOLDERS' EQUITY		
Current liabilities:		
Accounts payable	\$ 2,454	\$ 2,536
Accrued compensation and related benefits	4,727	6,493
Accrued and other current liabilities	3,235	2,627
Deferred revenues - current portion	8,477	7,981
Billings in excess of recognized revenues	635	—
Total current liabilities	<u>19,528</u>	<u>19,637</u>
Long-term income taxes payable	3,751	3,902
Other non-current liabilities	2,831	2,269
Total liabilities	<u>26,110</u>	<u>25,808</u>
Commitments and contingencies (Note 5)		
Stockholders' equity:		
Preferred stock, \$0.00015 par value, 5,000 shares authorized, no shares issued and outstanding	—	—
Common stock, \$0.00015 par value, 70,000 shares authorized; shares issued 40,677 and 39,799, respectively; shares outstanding 32,382 and 32,112, respectively	5	5
Additional paid-in capital	310,660	297,950
Treasury stock, at cost, 8,295 and 7,688 shares, respectively	(79,142)	(71,793)
Accumulated deficit	(30,452)	(27,089)
Accumulated other comprehensive loss	(1,276)	(705)
Total stockholders' equity	<u>199,795</u>	<u>198,368</u>
Total liabilities and stockholders' equity	<u>\$ 225,905</u>	<u>\$ 224,176</u>

See accompanying notes to consolidated financial statements.

PDF SOLUTIONS, INC.
CONSOLIDATED STATEMENTS OF OPERATIONS AND COMPREHENSIVE INCOME (LOSS)
(in thousands, except per share amounts)

	Year Ended December 31,		
	2018	2017	2016
Revenues:			
Design-to-silicon-yield solutions	\$ 60,081	\$ 74,436	\$ 77,162
Gainshare performance incentives	25,713	27,435	30,299
Total revenues	<u>85,794</u>	<u>101,871</u>	<u>107,461</u>
Costs of Design-to-silicon-yield solutions:			
Direct costs of Design-to-silicon-yield solutions	42,228	47,050	44,074
Amortization of acquired technology	575	471	374
Total cost of Design-to-silicon-yield solutions	<u>42,803</u>	<u>47,521</u>	<u>44,448</u>
Gross profit	<u>42,991</u>	<u>54,350</u>	<u>63,013</u>
Operating expenses:			
Research and development	27,998	30,078	27,559
Selling, general and administrative	23,934	23,684	22,056
Amortization of other acquired intangible assets	435	398	432
Restructuring charges	576	—	—
Total operating expenses	<u>52,943</u>	<u>54,160</u>	<u>50,047</u>
Income (loss) from operations	(9,952)	190	12,966
Interest and other income (expense), net	493	(264)	(10)
Income (loss) before income taxes	(9,459)	(74)	12,956
Income tax provision (benefit)	(1,743)	1,263	3,853
Net income (loss)	<u>\$ (7,716)</u>	<u>\$ (1,337)</u>	<u>\$ 9,103</u>
Net income (loss) per share:			
Basic	<u>\$ (0.24)</u>	<u>\$ (0.04)</u>	<u>\$ 0.29</u>
Diluted	<u>\$ (0.24)</u>	<u>\$ (0.04)</u>	<u>\$ 0.28</u>
Weighted average common shares:			
Basic	<u>32,169</u>	<u>32,038</u>	<u>31,373</u>
Diluted	<u>32,169</u>	<u>32,038</u>	<u>32,431</u>
Net income (loss)	\$ (7,716)	\$ (1,337)	\$ 9,103
Other comprehensive income (loss):			
Foreign currency translation adjustments, net of tax	(571)	1,286	(448)
Comprehensive income (loss)	<u>\$ (8,287)</u>	<u>\$ (51)</u>	<u>\$ 8,655</u>

See accompanying notes to consolidated financial statements.

PDF SOLUTIONS, INC.
CONSOLIDATED STATEMENTS OF STOCKHOLDERS' EQUITY
(in thousands)

	Common Stock		Additional Paid-In Capital	Treasury Stock		Accumulated Deficit	Accumulated Other Comprehensive (Loss)	Total
	Shares	Amount		Shares	Amount			
Balances, January 1, 2016	31,111	\$ 5	\$ 266,008	6,365	\$ (50,383)	\$ (39,780)	\$ (1,543)	\$ 174,307
Issuance of common stock in connection with employee stock purchase plan	173	-	1,557	-	-	-	-	1,557
Issuance of common stock in connection with exercise of options	393	-	2,972	-	-	-	-	2,972
Vesting of restricted stock units	336	-	-	-	-	-	-	-
Purchases of treasury stock in connection with tax withholdings on restricted stock grants	-	-	-	136	(2,317)	-	-	(2,317)
Repurchases of common stock	(149)	-	-	149	(2,182)	-	-	(2,182)
Stock-based compensation expense	-	-	10,886	-	-	-	-	10,886
Tax benefit from employee stock plans	-	-	-	-	-	-	-	-
Comprehensive income	-	-	-	-	-	9,103	(448)	8,655
Cumulative-effect adjustment from adoption of ASU 2016-09	-	-	-	-	-	4,925	-	4,925
Balances, December 31, 2016	31,864	\$ 5	\$ 281,423	6,650	\$ (54,882)	\$ (25,752)	\$ (1,991)	\$ 198,803
Issuance of common stock in connection with employee stock purchase plan	200	-	1,864	-	-	-	-	1,864
Issuance of common stock in connection with exercise of options	440	-	2,823	-	-	-	-	2,823
Vesting of restricted stock units	450	-	-	-	-	-	-	-
Purchases of treasury stock in connection with tax withholdings on restricted stock grants	-	-	-	196	(3,493)	-	-	(3,493)
Repurchases of common stock	(842)	-	-	842	(13,418)	-	-	(13,418)
Stock-based compensation expense	-	-	11,840	-	-	-	-	11,840
Tax benefit from employee stock plans	-	-	-	-	-	-	-	-
Comprehensive income	-	-	-	-	-	(1,337)	1,286	(51)
Balances, December 31, 2017	32,112	\$ 5	\$ 297,950	7,688	\$ (71,793)	\$ (27,089)	\$ (705)	\$ 198,368
Cumulative-effect adjustment from adoption of ASU 2014-09	-	-	-	-	-	4,353	-	4,353
Issuance of common stock in connection with employee stock purchase plan	201	-	1,831	-	-	-	-	1,831
Issuance of common stock in connection with exercise of options	81	-	560	-	-	-	-	560
Vesting of restricted stock units	425	-	-	-	-	-	-	-
Purchases of treasury stock in connection with tax withholdings on restricted stock grants	-	-	-	170	(2,101)	-	-	(2,101)
Repurchases of common stock	(437)	-	-	437	(5,248)	-	-	(5,248)
Stock-based compensation expense	-	-	10,319	-	-	-	-	10,319
Comprehensive loss	-	-	-	-	-	(7,716)	(571)	(8,287)
Balances, December 31, 2018	32,382	\$ 5	\$ 310,660	8,295	\$ (79,142)	\$ (30,452)	\$ (1,276)	\$ 199,795

See accompanying notes to consolidated financial statements.

PDF SOLUTIONS, INC.
CONSOLIDATED STATEMENTS OF CASH FLOWS
(in thousands)

	Year Ended December 31,		
	2018	2017	2016
Cash flows from operating activities:			
Net income (loss)	\$ (7,716)	\$ (1,337)	\$ 9,103
Adjustments to reconcile net income (loss) to net cash provided by operating activities:			
Depreciation and amortization	4,967	4,789	3,584
Stock-based compensation expense	10,295	11,810	11,002
Amortization of acquired intangible assets	1,010	869	805
Deferred taxes	(4,171)	(504)	216
Provision for (reversal of) allowance for doubtful accounts	(42)	174	(99)
Unrealized loss (gain) on foreign currency forward contract	67	(27)	(47)
Loss on disposal and write-down in value of property and equipment	230	6	107
Adjustment to contingent consideration related to acquisition	114	—	—
Changes in operating assets and liabilities:			
Accounts receivable	6,828	(9,581)	(14,620)
Prepaid expenses and other current assets	(2,115)	373	(1,688)
Other non-current assets	3,560	2,103	(10,988)
Accounts payable	(1,406)	1,963	85
Accrued compensation and related benefits	(1,609)	249	1,178
Accrued and other liabilities	240	72	(231)
Deferred revenues	2,451	(326)	4,772
Billings in excess of recognized revenues	635	(88)	(1,179)
Net cash provided by operating activities	<u>13,338</u>	<u>10,545</u>	<u>2,000</u>
Cash flows from investing activities:			
Purchases of property and equipment	(13,116)	(10,255)	(11,282)
Payments of business acquisitions, net of cash acquired	—	(3,841)	—
Net cash used in investing activities	<u>(13,116)</u>	<u>(14,096)</u>	<u>(11,282)</u>
Cash flows from financing activities:			
Payment of contingent consideration related to acquisition	(244)	—	—
Proceeds from exercise of stock options	560	2,822	2,972
Repurchases of common stock	(5,248)	(13,418)	(2,182)
Proceeds from employee stock purchase plan	1,831	1,865	1,557
Payments for taxes related to net share settlement of equity awards	(2,101)	(3,493)	(2,317)
Net cash provided by (used in) financing activities	<u>(5,202)</u>	<u>(12,224)</u>	<u>30</u>
Effect of exchange rate changes on cash and cash equivalents	(198)	255	(119)
Net decrease in cash and cash equivalents	(5,178)	(15,520)	(9,371)
Cash and cash equivalents, beginning of year	101,267	116,787	126,158
Cash and cash equivalents, end of year	<u>\$ 96,089</u>	<u>\$ 101,267</u>	<u>\$ 116,787</u>
Supplemental disclosure of cash flow information:			
Cash paid during the period for:			
Taxes	<u>\$ 2,582</u>	<u>\$ 2,244</u>	<u>\$ 3,635</u>
Property and equipment received and accrued in accounts payable and accrued and other liabilities	<u>\$ 2,101</u>	<u>\$ 1,235</u>	<u>\$ 666</u>
Tenant allowance paid by landlord for leasehold improvements	<u>\$ 1,536</u>	<u>\$ —</u>	<u>\$ —</u>

See accompanying notes to consolidated financial statements.

PDF SOLUTIONS, INC.
NOTES TO CONSOLIDATED FINANCIAL STATEMENTS

1. DESCRIPTION OF BUSINESS AND SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES***Description of Business***

PDF Solutions, Inc. (the “Company” or “PDF”), provides differentiated data and analytics solutions to the semiconductor and electronics industries. The Company offers an end-to-end analytics platform that empowers engineers and data scientists across the semiconductor ecosystem to rapidly improve the yield, quality, and profitability of their products.

Basis of Presentation

The consolidated financial statements include the accounts of the Company and its wholly-owned subsidiaries after the elimination of all significant intercompany balances and transactions.

Use of Estimates

The preparation of financial statements in conformity with generally accepted accounting principles in the United States (“U.S. GAAP”) requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities, the disclosure of contingent assets and liabilities at the date of the financial statements and the reported amounts of revenues and expenses during the reporting period. Significant estimates in these financial statements include revenue recognition, stock-based compensation expense and accounting for income taxes. Actual results could differ from those estimates.

Concentration of Credit Risk

Financial instruments that potentially expose the Company to concentrations of credit risk consist primarily of cash and cash equivalents and accounts receivable. The Company maintains its cash and cash equivalents with what it considers high credit quality financial institutions.

The Company primarily sells its technologies and services to companies in Asia, Europe and North America within the semiconductor industry. As of December 31, 2018, two customers accounted for 56% of the Company’s gross accounts receivable and one customer accounted for 37% of the Company’s revenues for 2018. As of December 31, 2017, two customers accounted for 56% of the Company’s gross accounts receivable and one customer accounted for 40% of the Company’s revenues for 2017. See Note 11 for further details. The Company does not require collateral or other security to support accounts receivable. To reduce credit risk, management performs ongoing credit evaluations of its customers’ financial condition. The Company maintains allowances for potential credit losses. The allowance for doubtful accounts, which was based on management’s best estimates, could be adjusted in the near term from current estimates depending on actual experience. Such adjustments could be material to the consolidated financial statements.

Cash, Cash Equivalents and Short-term Investments

The Company considers all highly liquid investments with an original maturity of 90 days or less to be cash equivalents. Investments with original maturities greater than three months and less than one year are classified as short-term investments.

Property and Equipment

Property and equipment are stated at cost and are depreciated using the straight-line method over the estimated useful lives (in years) of the related asset as follows:

Computer equipment	3
Software	3
Furniture, fixtures, equipment and test equipment	3 - 10
Leasehold improvements	Shorter of estimated useful life or term of lease

Long-lived Assets

The Company's long-lived assets, excluding goodwill, consist of property and equipment and intangible assets. The Company periodically reviews its long-lived assets for impairment. For assets to be held and used, the Company initiates its review whenever events or changes in circumstances indicate that the carrying amount of a long-lived asset group may not be recoverable. Recoverability of an asset group is measured by comparison of its carrying amount to the expected future undiscounted cash flows that the asset group is expected to generate. If it is determined that an asset group is not recoverable, an impairment loss is recorded in the amount by which the carrying amount of the asset group exceeds its fair value.

Goodwill

The Company records goodwill when the purchase consideration of an acquisition exceeds the fair value of the net tangible and identified intangible assets as of the date of acquisition. The Company performs an annual impairment assessment of its goodwill during the fourth quarter of each calendar year or more frequently if required to determine if any events or circumstances exist, such as an adverse change in business climate or a decline in the overall industry demand, that would indicate that it would more likely than not reduce the fair value of a reporting unit below its carrying amount, including goodwill. If events or circumstances do not indicate that the fair value of a reporting unit is below its carrying amount, goodwill is not considered to be impaired and no further testing is required. If further testing is required, the Company performs a two-step process. The first step involves comparing the fair value of its reporting unit to its carrying value, including goodwill. If the carrying value of the reporting unit exceeds its fair value, the second step of the test is performed by comparing the carrying value of the goodwill in the reporting unit to its implied fair value. An impairment charge is recognized for the excess of the carrying value of goodwill over its implied fair value. For the purpose of impairment testing, the Company has determined that it has one reporting unit. There has been no impairment of goodwill for any periods presented.

Accounts Receivable

Accounts receivable include amounts that are unbilled at the end of the period that are expected to be billed and collected within 12-month period. Unbilled accounts receivable is determined on an individual contract basis. Unbilled accounts receivable, included in accounts receivable, totaled \$22.2 million as of December 31, 2018 and 2017. Unbilled accounts receivable that are not expected to be billed and collected during the succeeding 12-month period are recorded in other non-current assets and totaled \$5.3 million and \$8.6 million as of December 31, 2018 and 2017, respectively. The Company performs ongoing credit evaluations of its customers' financial condition. An allowance for doubtful accounts is maintained for probable credit losses based upon the Company's assessment of the expected collectability of the accounts receivable. The allowance for doubtful accounts is reviewed on a quarterly basis to assess the adequacy of the allowance.

Allowance for doubtful accounts are summarized below (in thousands):

	Balance at Beginning of Period	Charged to Costs and Expenses	Deductions/ Write-offs of Accounts	Balance at End of Period
Allowance for doubtful accounts				
2018	\$ 374	\$ —	\$ 42	\$ 332
2017	\$ 200	\$ 174	\$ —	\$ 374
2016	\$ 299	\$ —	\$ 99	\$ 200

Software Development Costs

Internally developed software includes software developed to meet our internal needs to provide solution implementation services to our end-customers. These capitalized costs consist of internal compensation related costs and external direct costs incurred during the application development stage and are amortized over their useful lives, generally six years. The costs to develop software that is marketed externally have not been capitalized as we believe our current software development process is essentially completed concurrent with the establishment of technological feasibility. As such, all related software development costs are expensed as incurred and included in research and development expense in our consolidated statements of operations and comprehensive income (loss).

Research and Development

Research and development expenses consist primarily of personnel-related costs to support product development activities, including compensation and benefits, outside development services, travel, facilities cost allocations, and stock-based compensation charges. Research and development expenses are charged to operations as incurred.

Stock-Based Compensation

Stock-based compensation is estimated at the grant date based on the award's fair value and is recognized on a straight-line basis over the vesting periods, generally four years. The Company has elected to use the Black-Scholes-Merton option-pricing model, which incorporates various assumptions including volatility, expected life and interest rates. The expected volatility is based on the historical volatility of the Company's common stock over the most recent period commensurate with the estimated expected life of the Company's stock options. The expected life of an award is based on historical experience and on the terms and conditions of the stock awards granted to employees. The interest rate assumption is based upon observed Treasury yield curve rates appropriate for the expected life of the Company's stock options. As stock-based compensation expense recognized is based on awards ultimately expected to vest, it has been reduced for estimated forfeitures. Forfeitures are estimated at the time of grant and revised, if necessary, in subsequent periods if actual forfeitures differ from those estimates.

Income Taxes

The Company's provision for income tax comprises its current tax liability and change in deferred tax assets and liabilities. Deferred tax assets and liabilities are recognized for the expected tax consequences of temporary differences between the tax bases of assets and liabilities. The measurement of current and deferred tax assets and liabilities is based on provisions of enacted tax laws; the effect of future changes in tax laws or rates are not anticipated. Valuation allowances are provided to reduce deferred tax assets to an amount that in management's judgment is more likely than not to be recoverable against future taxable income. No U.S. taxes are provided on earnings of non-U.S. subsidiaries, to the extent such earnings are deemed to be permanently invested. The Company's income tax calculations are based on application of the respective U.S. federal, state or foreign tax laws. The Company's tax filings, however, are subject to audit by the respective tax authorities. Accordingly, the Company recognizes tax liabilities based upon its estimate of whether, and the extent to which, additional taxes will be due when such estimates are more-likely-than-not to be sustained. An uncertain income tax position will not be recognized if it has less than a 50% likelihood of being sustained. To the extent the final tax liabilities are different from the amounts originally accrued, the increases or decreases are recorded as income tax expense or benefit in the consolidated statements of operations and comprehensive income (loss).

Net Income (Loss) Per Share

Basic net income (loss) per share is computed by dividing net income by weighted average number of common shares outstanding for the period (excluding outstanding stock options and shares subject to repurchase). Diluted net income (loss) per share is computed using the weighted-average number of common shares outstanding for the period plus the potential effect of dilutive securities which are convertible into common shares (using the treasury stock method), except in cases in which the effect would be anti-dilutive. Dilutive potential common shares consist of incremental common shares issuable upon exercise of stock options, upon vesting of restricted stock units, contingently issuable shares for all periods and assumed issuance of shares under employee stock purchase plan. No dilutive potential common shares are included in the computation of any diluted per share amount when a loss from continuing operations was reported by the Company.

Foreign Currency Translation

The functional currency of the Company's foreign subsidiaries is the local currency for the respective subsidiary. The assets and liabilities are translated at the period-end exchange rate, and statements of operations are translated at the average exchange rate during the year. Gains and losses resulting from foreign currency translations are included as a component of other comprehensive income (loss). Gains and losses resulting from foreign currency transactions are included in the consolidated statements of operations and comprehensive income (loss).

Derivative Financial Instruments

The Company operates internationally and is exposed to potentially adverse movements in foreign currency exchange rates. The Company enters into foreign currency forward contracts to reduce the exposure to foreign currency exchange rate fluctuations on certain foreign currency denominated monetary assets and liabilities. The Company does not use foreign currency contracts for speculative or trading purposes. The Company records these forward contracts at fair value. The counterparty to these foreign currency forward contracts is a large global financial institution that the Company believes is creditworthy, and therefore, we believe the credit risk of counterparty non-performance is not significant. These foreign currency forward contracts are not designated for hedge accounting treatment. Therefore, the change in fair value of these derivatives is recorded into earnings as a component of interest and other income (expense), net and offsets the change in fair value of the foreign currency denominated monetary assets and liabilities, which are also recorded in interest and other income (expense), net. The duration of these forward contracts is usually between two to three months.

Litigation

From time to time, the Company is subject to various claims and legal proceedings that arise in the ordinary course of business. The Company accrues for losses related to litigation when a potential loss is probable and the loss can be reasonably estimated in accordance with Financial Accounting Standard Board ("FASB") requirements. As of December 31, 2018, the Company is not a party to any material legal proceedings, thus no loss was probable and no amount was accrued.

Recently Adopted Accounting Pronouncements

In May 2014, the FASB issued Accounting Standards Update ("ASU") No. 2014-09, Revenue from Contracts with Customers (Topic 606), which supersedes the revenue recognition requirements in Revenue Recognition (Topic 605). Subsequently, the FASB has issued several amendments to the standard, including clarification on accounting for licenses of intellectual property and identifying performance obligations. Under Topic 606, the new revenue recognition standard provides a five-step analysis of transactions to determine when and how revenue is recognized. The core principle is that a company should recognize revenue to reflect the transfer of promised goods or services to customers in an amount that reflects the consideration to which the entity expects to be entitled in exchange for those goods or services. The Company adopted this new standard on the first day of the first fiscal quarter of fiscal 2018. The Company chose to adopt the standard using the modified retrospective transition method. See Revenue Recognition, in Note 2 for further information, including further discussion on the impact of adoption and changes in accounting policies relating to revenue recognition.

In August 2016, the FASB issued ASU No. 2016-15, Statement of Cash Flows (Topic 230): Classification of Certain Cash Receipts and Cash Payments. The purpose of this standard is to clarify the treatment of several cash flow categories. This update is effective for annual periods beginning after December 15, 2017, and interim periods within those fiscal years. The Company adopted this standard on January 1, 2018, and it did not have a material impact on its financial statements and footnote disclosures.

In November 2016, the FASB issued ASU No. 2016-18, Statement of Cash Flows (Topic 230): Restricted Cash, that will require that the amounts generally described as restricted cash and restricted cash equivalents would be included with cash and cash equivalents when reconciling the beginning-of-period and end-of-period amounts shown on the statement of cash flows. The new guidance also requires certain disclosures to supplement the statement of cash flows. This update is effective for annual periods beginning after December 15, 2017, and interim periods within those fiscal years. The Company adopted this standard on January 1, 2018, and it did not have a material impact on its financial statements and footnote disclosures.

In January 2017, the FASB issued ASU No. 2017-01, Business Combinations: Clarifying the Definition of a Business, which narrows the existing definition of a business and provides a framework for evaluating whether a transaction should be accounted for as an acquisition (or disposal) of assets or a business. The guidance is effective for fiscal years beginning after December 15, 2017. The Company adopted this standard on January 1, 2018, and it did not have a material impact on its financial statements and footnote disclosures.

In May 2017, the FASB issued ASU No. 2017-09, Compensation-Stock Compensation (Topic 718) Scope of Modification Accounting. This standard clarifies which changes to the terms or conditions of a share-based payment award require an entity to apply modification accounting in Topic 718. The standard is effective for interim and annual reporting periods beginning after December 15, 2017. The Company adopted this standard on January 1, 2018, and it did not have a material impact on its financial statements and footnote disclosures.

In March 2018, the FASB issued ASU No. 2018-05, Income Taxes (Topic 740): Amendments to SEC Paragraphs Pursuant to SEC Staff Accounting Bulletin No. 118. The staff of the SEC recognized the complexity of reflecting the impacts of the Tax Cuts and Job Act (“TCJA”), and on December 22, 2017, issued guidance in Staff Accounting Bulletin 118 (SAB 118), which clarifies accounting for income taxes under Accounting Standards Codification (ASC) 740 if information is not yet available or complete and provides for up to a one-year period in which to complete the required analysis and accounting (the measurement period). The Company accounted for the tax effects of the TCJA under the guidance of SAB 118, on a provisional basis as of December 31, 2017 and through the first three quarters of 2018. The accounting for TCJA was completed as of December 31, 2018. Refer to Note 9, Income Taxes, for further discussion regarding the impact of this standard to the Company's consolidated financial statements.

Recent Accounting Standards or Updates Not Yet Effective

In February 2016, the FASB issued ASU No. 2016-02, Leases (Topic 842). The update requires that most leases, including operating leases, be recorded on the balance sheet as an asset and a liability, initially measured at the present value of the lease payments. Subsequently, the lease asset will be amortized generally on a straight-line basis over the lease term, and the lease liability will bear interest expense and be reduced for lease payments. The amendments in this update are effective for public companies' financial statements issued for fiscal years beginning after December 15, 2018, including interim periods within those fiscal years. In July 2018, the FASB issued ASU No. 2018-11 - Leases (Topic 842): Targeted Improvements (ASU No. 2018-11). Prior to ASU No. 2018-11, a modified retrospective transition was required for financing or operating leases existing at or entered into after the beginning of the earliest comparative period presented in the financial statements. ASU No. 2018-11 allows entities an additional transition method to the existing requirements whereby an entity could adopt the provisions of ASU No. 2016-02 by recognizing a cumulative-effect adjustment to the opening balance of retained earnings in the period of adoption without adjustment to the financial statements for periods prior to adoption. In December 2018, the FASB issued ASU No. 2018-20, Leases (Topic 842): Narrow-Scope Improvements for Lessors, which clarified how lessors should apply certain aspects of the new lease standard. The Company intends to adopt this guidance in the first quarter of fiscal 2019 using the new transition method provided by ASU No. 2018-11. The adoption of this standard will result in the recognition of right-of-use assets and lease liabilities from its long-term operating lease obligations, and is expected to have a material impact on the Company's consolidated balance sheet.

In January 2017, the FASB issued ASU No. 2017-04, Intangibles - Goodwill and Other (Topic 350). This standard eliminates step 2 from the annual goodwill impairment test. This update is effective for annual periods beginning after December 15, 2019, and interim periods within those fiscal years, with early adoption permitted, and is to be applied on a prospective basis. The Company does not anticipate that the adoption of this standard will have a significant impact on its consolidated financial statements or the related disclosures.

In February 2018, the FASB issued ASU No. 2018-02, Income Statement – Reporting Comprehensive Income (Topic 220): Reclassification of Certain Tax Effect from Accumulated Other Comprehensive Income. This update allows a reclassification from accumulated other comprehensive income to retained earnings for stranded tax effects resulting from the TCJA enacted in December 2017. This update will be effective for the Company for fiscal years beginning after December 15, 2018 and interim periods within those fiscal years. Early adoption is permitted. The Company does not anticipate that the adoption of this standard will have a significant impact on its consolidated financial statements or the related disclosures.

In August 2018, the FASB issued ASU No. 2018-15, Intangibles - Goodwill and Other - Internal-Use Software (Subtopic 350-40): Customer's Accounting for Implementation Costs Incurred in a Cloud Computing Arrangement That Is a Service Contract. The new guidance clarifies the accounting for implementation costs incurred to develop or obtain internal-use software in cloud computing arrangements. Further, the standard also requires entities to expense the capitalized implementation costs of a hosting arrangement over the term of the hosting arrangement. This standard is effective for the Company beginning in the first quarter of 2020. Early adoption is permitted. ASU No. 2018-15 should be applied either retrospectively or prospectively to all implementation costs incurred after the date of adoption. The Company has not yet determined the impact of this standard on its consolidated financial statements.

2. REVENUE RECOGNITION

On January 1, 2018, the Company adopted Topic 606, using the modified retrospective transition method applied to those contracts which were not completed as of January 1, 2018. Under this method, the Company evaluated contracts that were in effect at the beginning of fiscal 2018 as if those contracts had been accounted for under Topic 606 from the beginning of their terms. Upon adoption, the Company recognized the cumulative effect of adopting this guidance as an adjustment to accumulated deficit on the date of initial application. The comparative information in prior periods has not been restated and continues to be reported under the accounting standards in effect for those periods.

The Company also considered the impact of subtopic ASC 340-40. Prior to the adoption of Topic 606, the Company expensed commission costs and related fringe benefits as incurred. Under ASC 340-40, the Company is required to capitalize and amortize the incremental costs of obtaining or fulfilling a contract over the period of the expected benefit. Incremental costs of obtaining and fulfilling a contract are recognized as an asset if the costs are expected to be recovered.

The most significant impacts of the adoption of Topic 606 are as follows:

- At the adoption date, the Company recorded a net decrease of \$4.4 million to accumulated deficit related to the acceleration of revenue required by the adoption of Topic 606 using the modified retrospective method and the capitalization of incremental sales commission costs, net of related deferred tax impact. Under the modified retrospective method, a portion of revenue for uncompleted contracts, which would have been recognized in future periods under Topic 605, was accelerated and recognized as an adjustment to accumulated deficit as of the date of adoption. As a result, the beginning balance of accounts receivable on January 1, 2018 increased by \$0.8 million, contract assets were established at \$1.9 million and deferred revenue decreased by \$2.5 million. The Company capitalized \$0.5 million of incremental sales commission costs at the adoption date directly related to obtaining customer contracts and will amortize these costs over the lives of the contracts for which such commissions are paid.
- For fiscal 2018, revenue generated under Topic 606 is expected to be slightly higher than revenue would have been under Topic 605. This is the result of a combination of factors, including the reduction of deferred revenue that under Topic 605 would continue to be recognized as revenue in 2018 and beyond, as well as changes in the timing of revenue recognition as discussed below. The actual effect on revenue recognized for the year ended December 31, 2018 was approximately \$1.2 million.

The adoption of Topic 606 impacted the Company's accounting for certain commercial software multi-element arrangements that combine software-related deliverables, which may include software contracts with varying terms and service elements. Topic 605 required establishing vendor specific objective evidence of fair value ("VSOE"), for undelivered elements to recognize revenue separately for each of the different elements. Topic 606 requires the Company to allocate consideration to each separate different performance obligation through the use of stand-alone selling prices ("SSPs") and to recognize the revenue as if those performance obligations had been sold on a standalone basis, either at a point-in-time or over time. The most significant impact of this change relates to the Company's accounting for software license revenue. For the Company's Exensio software that is licensed under a time-based license model, the Company will recognize a portion of revenue on these types of contracts at the time of delivery rather than ratably over the term of the license. For perpetual software license contracts, the Company will allocate consideration to the different performance obligations based on their SSPs rather than using the VSOE for undelivered elements as required under Topic 605.

Under the Company's previous accounting practices, revenue was recognized from Gainshare performance incentive agreements in the period of receipt of related Gainshare acknowledgement reports, which was generally one quarter in arrears from the period in which the underlying sales (usage) occurred. Under Topic 606, the Company is required to record Gainshare revenue in the same period in which the usage occurs. Because the Company generally does not receive the acknowledgment reports during a given quarter within the time frame necessary to adequately review the reports and include the actual amounts in its quarterly results for such quarter, the Company accrues the related revenue based on estimates of the customer's underlying sales achievement. As a result of accruing revenue for the quarter based on such estimates, adjustments will be required in the following quarter to true-up revenue to the actual amounts reported.

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Under Topic 605, the Company recognized revenue for professional services, including revenue from fixed price solution implementation service contracts, either on a percentage-of-completion method or time-and-materials method. Under Topic 606, revenue related to these professional services will remain substantially unchanged.

The following table summarizes the effects of adopting Topic 606 on the Company's consolidated balance sheet as of December 31, 2018:

(In thousands)	As reported under Topic 606	Adjustments	Balances under Topic 605
Accounts receivable, net of allowance	\$ 51,570	\$ (979)	\$ 50,591
Prepaid expenses and other current assets	9,562	(2,980)	6,582
Deferred tax assets	19,044	443	19,487
Other non-current assets	6,972	(34)	6,938
Deferred revenues – current portion	8,477	1,918	10,395
Long-term income taxes payable	3,751	(1,032)	2,719
Other non-current liabilities	2,831	787	3,618
Accumulated deficit	(30,452)	(5,223)	(35,675)

The Company's net cash provided by operating activities for the year ended December 31, 2018 did not change due to the adoption of Topic 606. The following table summarizes the effects of adopting Topic 606 on the financial statement line items of the Company's consolidated statement of cash flows for the year December 31, 2018:

(In thousands)	As reported under Topic 606	Adjustments	Balances under Topic 605
Net loss	\$ (7,716)	\$ (870)	\$ (8,586)
Adjustments to reconcile loss to net cash provided by operating activities:			
Deferred taxes	(4,171)	(127)	(4,298)
Changes in operating assets and liabilities:			
Accounts receivable	6,828	187	7,015
Prepaid expenses and other current assets	(2,115)	588	(1,527)
Other non-current assets	3,560	34	3,594
Deferred revenue	2,451	188	2,639

The Company derives revenue from two sources: Design-to-silicon-yield solutions and Gainshare performance incentives.

Revenue is recognized when control of products or services is transferred to customers, in an amount that reflects the consideration the Company expects to be entitled to in exchange for those promised products or services.

The Company determines revenue recognition through the following five steps:

- Identification of the performance obligations in the contract
- Determination of the transaction price
- Allocation of the transaction price to the performance obligations in the contract
- Recognition of revenue when, or as, performance obligations are satisfied

The Company accounts for a contract when it has approval and commitment from both parties, the rights of the parties are identified, payment terms are identified, the contract has commercial substance and collectability of consideration is probable.

The Company enters into contracts that can include various combinations of licenses, products and services, some of which are distinct and are accounted for as separate performance obligations. For contracts with multiple performance obligations, the Company allocates the transaction price of the contract to each performance obligation, generally on a relative basis using its standalone selling price. The Company does not adjust transaction price for the effects of a significant financing component when the period between the transfers of the promised good or service to the customer and payment for that good or service by the customer is expected to be one year or less. The Company assessed each of its revenue generating arrangements in order to determine whether a significant financing component exists, and determined its contracts do not include a significant financing component for the year ended December 31, 2018.

Nature of Products and Services

Design-to-silicon-yield Solutions —The Company recognizes revenue for each element of Design-to-silicon-yield solutions as follows:

The Company generates a significant portion of its Design-to-silicon-yield solutions revenue from fixed-price solution implementation service contracts delivered over a specific period of time. Revenue under project-based contracts for solution implementation services is recognized as services are performed using a percentage-of-completion method based on costs or labor-hours inputs. Due to the nature of the work performed in these arrangements, the estimation of costs or hours at completion is complex, subject to many variables and requires significant judgment. Key factors reviewed by the Company to estimate costs to complete each contract are future labor and product costs and expected productivity efficiencies. If circumstances arise that change the original estimates of revenues, costs, or the extent of progress toward completion, revisions to the estimates are made. These revisions may result in increases or decreases in estimated revenues or costs. Losses on fixed-price solution implementation contracts are recognized in the period when they become probable. Revisions in profit estimates are reflected in the period in which the conditions that require the revisions become known and can be estimated (the cumulative catch-up method).

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On occasion, the Company includes its products as a component of its fixed-price service contracts. In such instances, the Company determines whether the services performed and products included are distinct. In most cases, the arrangement is a single performance obligation and therefore, follows the pattern of transfer as the service is provided. The Company applies a measure of progress (typically hours-to-hours or cost-to-cost) to any fixed consideration. As a result, revenue is generally recognized over the period the services are performed using the percentage-of-completion method. This results in revenue recognition that corresponds with the value to the client of the services transferred to-date relative to the remaining services promised.

The Company also licenses our Design-for-Inspection ("DFI") system as a separate component of fixed-price service contracts. The Company allocates revenue to all deliverables based on their SSPs. In such instances, the Company applies judgment to estimate the range of SSPs for each performance obligation.

The Company licenses some of its software products separately from solution implementations, primarily its Exensio software platform and related products. The majority of these products are delivered as on-premise software licenses, while others can be delivered entirely or partially through Software-as-a-Service (SaaS) or cloud delivery models. Revenue from perpetual (one-time charge) license software is recognized at the time of the inception of the arrangement when control transfers to the client, if the software license is distinct from the services offered by the Company. Revenue from post-contract support subscription is recognized over the contract term on a straight-line basis, because the Company is providing (i) a service of standing ready to provide support, when-and-if needed, and (ii) unspecified software upgrades on a when-and-if available basis over the contract term. Revenue from time-based license software is allocated to each performance obligation and is recognized either at a point-in-time or over-time. The license component is recognized at the time of the delivery of the software license, with the post-contract support subscription component being recognized ratably over for the committed term of the contract. Revenue from software hosting or SaaS arrangements that allow for the use of a hosted software product or service over a contractually determined period of time without taking possession of software are accounted for as subscriptions and recognized as revenue ratably, on a straight-line basis, over the coverage period beginning on the date the service is made available to customers.

Gainshare Performance Incentives — Contracts to provide yield improvement services have historically included two components: (1) a fixed fee for performance by the Company of services delivered over a specific period of time; and (2) a Gainshare performance incentive component where the customer pays a variable fee, usually after the fixed fee period has ended, related to the usage of the Company's intellectual property. Revenue derived from Gainshare performance incentives is contingent upon the Company's customers reaching certain defined production yield levels. Gainshare performance incentive periods are usually subsequent to the delivery of all contractual services and performance obligations. The Company records Gainshare revenue as a usage-based royalty based on customers' usage of intellectual property and records it in the same period in which the usage occurs.

The following table summarizes the effects of adopting Topic 606 on the financial statement line items of the Company's consolidated statement of operations and comprehensive income (loss) for the year ended December 31, 2018:

(In thousands)	As reported under Topic 606	Adjustments	Balances under Topic 605
Design-to-silicon-yield solutions	\$ 60,081	\$ (711)	\$ 59,370
Gainshare performance incentives	25,713	(470)	25,243
Total revenue	85,794	(1,181)	84,613
Gross profit	42,991	(1,181)	41,810
Selling, general and administrative	23,934	(75)	23,859
Total operating expenses	52,943	(75)	52,868
Loss from operations	(9,952)	(1,106)	(11,058)
Loss before taxes	(9,459)	(1,106)	(10,565)
Income tax benefit	(1,743)	(235)	(1,978)
Net loss	\$ (7,716)	\$ (870)	\$ (8,586)

Disaggregation of revenue

In accordance with ASC 606-10-50, the Company disaggregates revenue from contracts with customers into geographical regions, major contract performance obligations, and timing of transfer of goods and services. The Company has determined that disaggregating revenue into these categories achieves the disclosure objective to depict how the nature, amount, timing, and uncertainty of revenue and cash flows are affected by economic factors.

The following table shows the revenues from contracts with customers by the nature of transactions for the year ended December 31, 2018 (in thousands):

	Year Ended
	December 31, 2018
Licenses and Gainshare Performance Incentives	\$ 31,336
Support and services	53,486
Other	972
Total	<u>\$ 85,794</u>

Licenses and Gainshare Performance Incentives revenue is comprised of (i) the software license fees for perpetual and time-based software license contracts where the standalone selling prices are estimable by the Company, or distinct and separate performance obligations; and (ii) the variable fee component of the Company's yield improvement service contracts, or Gainshare Performance Incentives, which is usually recognized as revenue subsequent to the delivery of all contractual services and performance obligations. The services component of such contracts, including recurring fees for unspecified software updates and technical support, is presented as support and services.

Under Topic 606, the Company's performance obligations are satisfied either at a point-in-time or over-time Revenue from performance obligations, satisfied over time and at a point-in-time, accounted for approximately 63% and 37% for the year ended December 31, 2018, respectively. International revenues accounted for approximately 60%, 61% and 64% of total revenues for the year ended December 31, 2018, 2017 and 2016, respectively. See Note 11, Customer and Geographic Information.

Significant Judgments

More judgments and estimates are required under Topic 606 than were required under Topic 605. Due to the complexity of certain contracts, the actual revenue recognition treatment required under Topic 606 for the Company's arrangements may be dependent on contract-specific terms and may vary in some instances.

In services arrangements, the Company typically satisfies the performance obligation and recognizes revenue over time. In service arrangements, the performance obligation is satisfied over time either because the client controls the asset as it is created (e.g., when the asset is built at the customer site) or because the Company's performance does not create an asset with an alternative use and the Company has an enforceable right to payment plus a reasonable profit for performance completed to-date. In most other services arrangements, the performance obligation is satisfied over time because the client simultaneously receives and consumes the benefits provided as the Company performs the services.

For revenue under project-based contracts for fixed-price solution implementation services, revenue is recognized as services are performed using the percentage-of-completion method based on costs or the labor-hours input method, whichever is the most appropriate measure of the progress towards completion of the contract. Due to the nature of the work performed in these arrangements, the estimation of percentage-of-completion is complex, subject to many variables and requires significant judgment. Key factors reviewed by the Company to estimate costs to complete each contract are future labor and product costs and expected productivity efficiencies. If circumstances arise that change the original estimates of revenues, costs, or extent of progress toward completion, revisions to the estimates are made. These revisions may result in increases or decreases in estimated revenues or costs, and such revisions are reflected in revenue on a cumulative catch-up basis in the period in which the circumstances that gave rise to the revision become known.

The Company is required to record Gainshare performance incentives revenue in the same period in which the usage occurs. Because the Company generally does not receive the acknowledgment reports during a given quarter within the time frame necessary to adequately review the reports and include the actual amounts in its quarterly results for such quarter, the Company accrues the related revenue based on estimates of customer's underlying sales achievement. The Company estimation process can be based on historical data, trends, seasonality, changes in the contract rate, knowledge of the changes in the industry, and changes in the customer's manufacturing environment learned through discussions with customers and sales personnel. As a result of accruing revenue for the quarter based on such estimates, adjustments will be required in the following quarter to true-up revenue to the actual amounts reported.

Contract Balances

The Company performs its obligation under a contract with a customer by transferring products or services in exchange for consideration from the customer. The timing of the Company's performance often differs from the timing of the customer's payment, which results in the recognition of a receivable, a contract asset, or a contract liability. The Company classifies the right to consideration in exchange for products or services transferred to a client as either a receivable or a contract asset. A receivable is a right to consideration that is unconditional as compared to a contract asset which is a right to consideration that is conditional upon factors other than the passage of time. The majority of the Company's contract assets represent unbilled amounts related to fixed-price solution implementation service contracts when the costs or labor-hours input method of revenue recognition is utilized and revenue recognized exceeds the amount billed to the client, and the right to consideration is subject to milestone completion or client acceptance. The contract assets are generally classified as current and are recorded on a net basis with deferred revenue (i.e. contract liabilities) at the contract level. The contract assets are included in prepaid expenses and other current assets in the consolidated balance sheets at beginning of 2018. The contract assets that were recognized at the beginning of 2018 was \$1.9 million. The contract assets included in prepaid expenses and other current assets in the accompanying consolidated balance sheet was \$2.7 million as December 31, 2018. The change in the contract assets balance during the period relates to the recording of revenues for which the right to consideration is subject to milestone completion or client acceptance and movement of previously recorded contract assets to receivables as the right to consideration becomes unconditional. Deferred revenues consist substantially of amounts invoiced in advance of revenue recognition and is recognized as the revenue recognition criteria are met. Deferred revenues that will be recognized during the succeeding twelve-month period is recorded as current deferred revenues and the remaining portion is recorded as non-current deferred revenues. This balance was recorded in the other non-current liabilities in the accompanying consolidated balance sheets. The non-current portion of deferred revenue was \$1.0 million and \$0.9 million, respectively, as of December 31, 2018 and January 1, 2018.

During the year ended December 31, 2018, the Company recognized \$6.3 million of revenue that was included in the total deferred revenue balance, as adjusted for Topic 606, at the beginning of 2018.

At December 31, 2018, the aggregate amount of the transaction price allocated to the remaining performance obligations related to customer contracts that were unsatisfied or partially unsatisfied was approximately \$47.1 million. Given the applicable contract terms, the majority of this amount is expected to be recognized as revenue over the next two years, with the remainder in the following five years. This amount does not include contracts to which the customer is not committed, nor contracts with original expected lengths of one year or less, nor contracts for which we recognize revenue equal to the amount we have the right to invoice for services performed, or future sales-based or usage-based royalty payments in exchange for a license of intellectual property. This amount is subject to change due to future revaluations of variable consideration, terminations, other contract modifications, or currency adjustments. The estimated timing of the recognition of remaining unsatisfied performance obligations is subject to change and is affected by changes to the scope, changes in timing of delivery of products and services, or contract modifications.

Payment terms and conditions vary by contract type, although terms generally include a requirement of payment within 30 to 90 days. In instances where the timing of revenue recognition differs from the timing of invoicing, the Company has determined that its contracts generally do not include a significant financing component. The primary purpose of invoicing terms is to provide customers with simplified and predictable ways of purchasing the Company's products and services, and not to facilitate financing arrangements.

During the year ended December 31, 2018, the amount of revenue recognized from significant performance obligations satisfied (or partially satisfied) in previous periods was \$1.8 million. This amount primarily represents changes of estimated percentage-of-completion based contracts and changes in estimated Gainshare performance incentives for those customers that reported actual Gainshare revenue with some time lag.

Costs to obtain or fulfill a contract

The Company capitalizes the incremental costs to obtain or fulfill a contract with a customer, including direct sales commissions and related fees, when it expects to recover those costs. As a result, these costs will need to be capitalized and amortized over an appropriate period, which may exceed the initial contract term. The incremental costs of obtaining a contract are costs that would not have been incurred if the contract had not been obtained. The Company uses the portfolio method to recognize the amortization expense related to these capitalized costs related to initial contracts and renewals and such expense is recognized over the period associated with the revenue of the related portfolio. Total capitalized direct sales commission costs as of December 31, 2018, were \$0.5 million and the amortization of these assets were \$0.4 million for the year ended December 31, 2018. There was no impairment loss in relation to the costs capitalized for the periods presented. Certain eligible initial project costs are capitalized when the costs relate directly to the contract, the costs generate or enhance resources of the Company that will be used in satisfying the performance obligation in the future, and the costs are expected to be recovered. These costs primarily consist of transition and set-up costs related to the installation of systems and processes and other deferred fulfillment costs eligible for capitalization. Capitalized costs are amortized consistent with the transfer to the client of the services to which the asset relates and are recorded as a component of cost of revenues. The Company also incurred certain direct costs to provide solution implementation services in relation to the specific anticipated contracts. The Company recognizes such costs as a component of cost of revenues, the timing of which is dependent upon identification of a contract arrangement. The Company also defers costs from arrangements that required us to defer the revenues, typically due to the pattern of transfer of the performance obligations in the contract. These costs are recognized in proportion to the related revenue. At the end of the reporting period, the Company evaluates its deferred costs for their probable recoverability. The Company recognizes impairment of deferred costs when it is determined that the costs no longer have future benefits and are no longer recoverable. The deferred costs balance was \$0.2 million and \$0.6 million as of December 31, 2018 and December 31, 2017, respectively. The balance was included in prepaid expenses and other current assets and other non-current assets in the accompanying consolidated balance sheets.

3. PROPERTY AND EQUIPMENT

Property and equipment consist of (in thousands):

	December 31,	
	2018	2017
Computer equipment	\$ 10,536	\$ 10,729
Software	4,112	3,348
Furniture, fixtures, and equipment	4,688	3,676
Leasehold improvements	5,474	1,980
Test equipment	14,697	13,796
Construction-in-progress	20,293	12,527
	<u>59,800</u>	<u>46,056</u>
Less: accumulated depreciation and amortization	(24,119)	(20,670)
Total	\$ 35,681	\$ 25,386

Test equipment includes DFI assets at customer sites that are contributing to DFI solution revenues. The construction-in-progress balance related to construction of DFI assets totaled \$17.4 million and \$10.9 million as of December 31, 2018, and December 31, 2017, respectively. Depreciation and amortization expense for years ended December 31, 2018, 2017, and 2016 was \$5.0 million, \$4.8 million and \$3.6 million, respectively.

4. GOODWILL AND INTANGIBLE ASSETS

As of December 31, 2018 and 2017, the carrying amount of goodwill was \$1.9 million.

Intangible assets balance was \$5.1 million and \$6.1 million as of December 31, 2018, and December 31, 2017, respectively. Intangible assets as of December 31, 2018 and 2017, consist of the following (in thousands):

(Dollars in thousands)	Amortization Period (Years)	December 31, 2018			December 31, 2017		
		Gross Carrying Amount	Accumulated Amortization	Net Carrying Amount	Gross Carrying Amount	Accumulated Amortization	Net Carrying Amount
Customer relationships	1 - 9	\$ 6,740	\$ (4,514)	\$ 2,226	\$ 6,740	\$ (4,145)	\$ 2,595
Developed technology	4 - 9	15,820	(13,404)	2,416	15,820	(12,829)	2,991
Tradenname	2 - 7	790	(648)	142	790	(622)	168
Patent	7 - 10	1,800	(1,520)	280	1,800	(1,480)	320
Total		\$ 25,150	\$ (20,086)	\$ 5,064	\$ 25,150	\$ (19,076)	\$ 6,074

The weighted average amortization period for acquired identifiable intangible assets was 5.9 years as of December 31, 2018. Intangible asset amortization expense for years ended December 31, 2018, 2017, and 2016 was \$1.0 million, \$0.9 million and \$0.8 million, respectively. The Company expects annual amortization of acquired identifiable intangible assets to be as follows (in thousands):

Year Ending December 31,

2019	\$	1,009
2020		1,009
2021		833
2022		626
2023		626
2024 and thereafter		961
Total future amortization expense	\$	5,064

Intangible assets are amortized over their useful lives unless these lives are determined to be indefinite. Intangible assets are reviewed for impairment whenever events or changes in circumstances indicate that the carrying amount of an asset or asset group may not be recoverable. During year ended December 31, 2018, there were no indicators of impairment related to the Company's intangible assets.

5. COMMITMENTS AND CONTINGENCIES

Leases

The Company leases administrative and sales offices and certain equipment under noncancelable operating leases, which contain various renewal options and, in some cases, require payment of common area costs, taxes and utilities. These operating leases expire at various times through 2028. Rent expense was \$2.5 million, \$2.3 million and \$2.2 million in 2018, 2017, and 2016, respectively.

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Future minimum lease payments under noncancelable operating leases at December 31, 2018, are as follows (in thousands):

Year Ending December 31,

2019	\$	1,677
2020		1,811
2021		1,653
2022		1,484
2023		1,127
2024 and thereafter		3,673
Total future minimum lease payments	\$	<u>11,425</u>

Indemnifications

The Company generally provides a warranty to its customers that its software will perform substantially in accordance with documented specifications typically for a period of 90 days following delivery of its products. The Company also indemnifies certain customers from third-party claims of intellectual property infringement relating to the use of its products. Historically, costs related to these guarantees have not been significant. The Company is unable to estimate the maximum potential impact of these guarantees on its future results of operations.

Purchase obligations

The Company has purchase obligations with certain suppliers for the purchase of goods and services entered in the ordinary course of business. As of December 31, 2018, total outstanding purchase obligations were \$8.7 million, which are primarily due within the next 12 months.

Indemnification of Officers and Directors

As permitted by the Delaware general corporation law, the Company has included a provision in its certificate of incorporation to eliminate the personal liability of its officers and directors for monetary damages for breach or alleged breach of their fiduciary duties as officers or directors, other than in cases of fraud or other willful misconduct.

In addition, the Bylaws of the Company provide that the Company is required to indemnify its officers and directors even when indemnification would otherwise be discretionary, and the Company is required to advance expenses to its officers and directors as incurred in connection with proceedings against them for which they may be indemnified. The Company has entered into indemnification agreements with its officers and directors containing provisions that are in some respects broader than the specific indemnification provisions contained in the Delaware general corporation law. The indemnification agreements require the Company to indemnify its officers and directors against liabilities that may arise by reason of their status or service as officers and directors other than for liabilities arising from willful misconduct of a culpable nature, to advance their expenses incurred as a result of any proceeding against them as to which they could be indemnified, and to obtain directors' and officers' insurance if available on reasonable terms. The Company has obtained directors' and officers' liability insurance in amounts comparable to other companies of the Company's size and in the Company's industry. Since a maximum obligation of the Company is not explicitly stated in the Company's Bylaws or in its indemnification agreements and will depend on the facts and circumstances that arise out of any future claims, the overall maximum amount of the obligations cannot be reasonably estimated.

Litigation

From time to time, the Company is subject to various claims and legal proceedings that arise in the ordinary course of business. The Company accrues for losses related to litigation when a potential loss is probable and the loss can be reasonably estimated in accordance with FASB requirements. As of December 31, 2018, the Company was not party to any material legal proceedings, thus no loss was probable and no amount was accrued.

6. STOCKHOLDERS' EQUITY

Stock Repurchase Program

On October 25, 2016, the Board of Directors adopted a program that was effective immediately to repurchase up to \$25.0 million of the Company's common stock both on the open market and in privately negotiated transactions over the next two years. On May 29, 2018, the Board of Directors terminated that 2016 stock repurchase program, and adopted a new program to repurchase up to \$25.0 million of the Company's common stock both on the open market and in privately negotiated transactions, from time to time, over the next two years. During the year ended December 31, 2018, the Company repurchased 437,000 shares for \$5.2 million under the 2016 program and no shares were repurchased under the 2018 program. As of December 31, 2018, the Company had repurchased 1,279,000 shares at an average price of \$14.59 per share under the 2016 program, for a total purchase of \$18.7 million. Under the 2018 program, as of December 31, 2018, \$25.0 million of the Company's common stock remained available for future repurchases.

7. EMPLOYEE BENEFIT PLANS

Employee Stock Purchase Plan

In July 2001, the Company adopted a ten-year Employee Stock Purchase Plan ("ESPP") under which eligible employees can contribute up to 10% of their compensation, as defined in the ESPP, towards the purchase of shares of PDF common stock at a price of 85% of the lower of the fair market value at the beginning of the offering period or the end of the purchase period. The ESPP consists of twenty-four-month offering periods with four six-month purchase periods in each offering period. Under the ESPP, on January 1 of each year, starting with 2002, the number of shares reserved for issuance will automatically increase by the lesser of (1) 675,000 shares, (2) 2% of the Company's outstanding common stock on the last day of the immediately preceding year, or (3) the number of shares determined by the board of directors. At the annual meeting of stockholders on May 18, 2010, the Company's stockholders approved an amendment to the ESPP to extend it through May 17, 2020. As of December 31, 2018, 8,734,000 shares of the Company's common stock have been reserved for issuance under the ESPP. During 2018, 2017, and 2016, the number of shares issued were 201,000, 200,000, and 173,000, respectively, at a weighted average price of \$9.12, \$9.33, and \$9.00 per share, respectively. As of December 31, 2018, 4,738,000 shares were available for future issuance under the ESPP. The weighted average estimated fair value of shares granted under the ESPP during 2018, 2017, and 2016 was \$3.62, \$5.22, and \$3.69 per share, respectively. As of December 31, 2018, there was \$1.5 million of unrecognized compensation cost related to the ESPP. That cost is expected to be recognized over a weighted average period of 1.58 years.

Stock Incentive Plans

On November 16, 2011, the Company's stockholders approved the 2011 Stock Incentive Plan (as amended, the "2011 Plan"). Under the 2011 Plan, the Company may award stock options, stock appreciation rights, stock grants or stock units covering shares of the Company's common stock to employees, directors, non-employee directors and contractors. The aggregate number of shares reserved for awards under this plan is 9,050,000 shares, plus up to 3,500,000 shares previously issued under the 2001 Plan that are forfeited or repurchased by the Company or shares subject to awards previously issued under the 2001 Plan that expire or that terminate without having been exercised or settled in full on or after November 16, 2011. In case of awards other than options or stock appreciation rights, the aggregate number of shares reserved under the plan will be decreased at a rate of 1.33 shares issued pursuant to such awards. The exercise price for stock options must generally be at prices no less than the fair market value at the date of grant. Stock options generally expire ten years from the date of grant and become vested and exercisable over a four-year period.

In 2001, the Company adopted a 2001 Stock Plan (the "2001 Plan"). In 2003, in connection with its acquisition of IDS Systems Inc., the Company assumed IDS' 2001 Stock Option / Stock Issuance Plan (the "IDS Plan"). Both of the 2001 and the IDS Plans expired in 2011. Stock options granted under the 2001 and IDS Plans generally expire ten years from the date of grant and become vested and exercisable over a four-year period. Although no new awards may be granted under the 2001 or IDS Plans, awards made under the 2001 and IDS Plans that are currently outstanding remain subject to the terms of each such plan.

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As of December 31, 2018, 9.6 million shares of common stock were reserved to cover stock-based awards under the 2011 Plan, of which 3.0 million shares were available for future grant. The number of shares reserved and available under the 2011 Plan includes 0.5 million shares that were subject to awards previously made under the 2001 Plan and were forfeited, expired or repurchased by the Company after adoption of the 2011 Plan through December 31, 2018. As of December 31, 2018, there were no outstanding awards that had been granted outside of the 2011, 2001 or the IDS Plans (collectively, the "Stock Plans").

The Company has elected to use the Black-Scholes-Merton option-pricing model, which incorporates various assumptions including volatility, expected life, interest rate and expected dividend. The expected volatility is based on the historical volatility of the Company's common stock over the most recent period commensurate with the estimated expected life of the Company's stock options. The expected life of an award is based on historical experience and on the terms and conditions of the stock awards granted to employees. The interest rate assumption is based upon observed Treasury yield curve rates appropriate for the expected life of the Company's stock options.

The fair value of equity awards granted was estimated on the date of grant with the following weighted average assumptions:

	Stock Plans			Employee Stock Purchase Plan		
	2018	2017	2016	2018	2017	2016
Expected life (in years)	4.43	4.42	4.40	1.25	1.25	1.25
Volatility	43.91%	41.5%	43.2%	42.85%	40.63%	44.0%
Risk-free interest rate	2.73%	1.81%	1.34%	2.48%	1.25%	0.50%
Expected dividend	—	—	—	—	—	—

Stock-based compensation is estimated at the grant date based on the award's fair value and is recognized on a straight-line basis over the vesting periods, generally four years. As stock-based compensation expense recognized is based on awards ultimately expected to vest, it has been reduced for estimated forfeitures. Forfeitures are estimated at the time of grant and revised, if necessary, in subsequent periods if actual forfeitures differ from those estimates.

Stock-based compensation expenses related to the Company's stock plans and employee stock purchase plan were allocated as follows (in thousands):

	Years Ended December 31,		
	2018	2017	2016
Costs of Design-to-silicon-yield solutions	\$ 3,554	\$ 4,606	\$ 4,427
Research and development	3,260	3,518	3,087
Selling, general and administrative	3,481	3,686	3,488
Stock-based compensation expenses	\$ 10,295	\$ 11,810	\$ 11,002

The stock-based compensation expense for the years ended December 31, 2018, 2017, and 2016 in the table above includes expense related to cash-settled stock appreciation rights ("SARs") granted to certain employees which totaled to a credit of \$24,000, a credit of \$30,000, and an expense of \$116,000, respectively. The Company accounted for these awards as liability and the amount was included in accrued compensation and related benefits.

Additional information with respect to options under the Plans is as follows:

	Outstanding Options		Weighted Average Remaining Contractual Term (Years)	Aggregate Intrinsic Value (in thousands)
	Number of Options (in thousands)	Weighted Average Exercise Price per Share		
Outstanding, January 1, 2016	1,764	\$ 7.88		
Granted (weighted average fair value of \$5.36 per share)	99	\$ 14.55		
Exercised	(393)	\$ 7.56		
Canceled	(31)	\$ 13.82		
Expired	(75)	\$ 13.80		
Outstanding, December 31, 2016	1,364	\$ 8.00		
Granted (weighted average fair value of \$5.92 per share)	150	\$ 16.28		
Exercised	(440)	\$ 6.42		
Canceled	(25)	\$ 15.03		
Expired	(4)	\$ 16.46		
Outstanding, December 31, 2017	1,045	\$ 9.65		
Granted (weighted average fair value of \$4.08 per share)	116	\$ 10.35		
Exercised	(81)	\$ 6.93		
Canceled	(30)	\$ 13.41		
Expired	(23)	\$ 13.16		
Outstanding, December 31, 2018	1,027	\$ 9.75	4.35	\$ 1,121
Vested and expected to vest, December 31, 2018	1,006	\$ 9.68	4.25	\$ 1,121
Exercisable, December 31, 2018	796	\$ 8.69	3.05	\$ 1,121

The aggregate intrinsic value in the table above represents the total intrinsic value based on the Company's closing stock price of \$8.43 as of December 31, 2018, which would have been received by the option holders had all option holders exercised their options as of that date. The total intrinsic value of options exercised during the years ended December 31, 2018, 2017, and 2016 was \$0.4 million, \$5.3 million, and \$4.4 million, respectively.

As of December 31, 2018, there was \$1.0 million of total unrecognized compensation cost, net of forfeitures, related to unvested stock options. That cost is expected to be recognized over a weighted average period of 3.06 years. The total fair value of options vested during the year ended December 31, 2018, was \$0.4 million.

Nonvested shares (restricted stock units) were as follows:

	Shares	Fair Value
	(in thousands)	
Nonvested, January 1, 2016	1,166	\$ 17.03
Granted	963	\$ 14.41
Vested	(472)	\$ 17.00
Forfeited	(115)	\$ 15.73
Nonvested, December 31, 2016	1,542	\$ 15.50
Granted	849	\$ 16.43
Vested	(646)	\$ 16.26
Forfeited	(128)	\$ 15.71
Nonvested, December 31, 2017	1,617	\$ 15.66
Granted	983	\$ 8.66
Vested	(596)	\$ 15.84
Forfeited	(169)	\$ 14.83
Nonvested, December 31, 2018	1,835	\$ 11.93

As of December 31, 2018, there was \$17.6 million of total unrecognized compensation cost related to restricted stock rights. That cost is expected to be recognized over a weighted average period of 2.8 years. Restricted stock units do not have rights to dividends prior to vesting.

401(k) Savings Plan

In 1999, the Company established a 401(k) tax-deferred savings plan, whereby eligible employees may contribute up to 15% of their eligible compensation with a maximum amount subject to IRS guidelines in any calendar year. Company contributions to this plan are discretionary; no such Company contributions have been made since the inception of this plan.

8. RESTRUCTURING CHARGES

On September 27, 2018, the Board of Directors of the Company approved a reduction in its workforce to reduce expenses and align its operations with evolving business needs. Notifications to the affected employees began on October 24, 2018.

In the fourth quarter of 2018, the Company recorded charges of \$576,000 for employee separation charges, all of which were recorded as operating expenses in the consolidated statement of operations and comprehensive income (loss) for the year ended December 31, 2018.

Of the \$576,000 for employee separation charges, the Company paid \$332,000 during the fourth quarter of 2018 and cash payments for the remaining restructuring liabilities of \$244,000 as of December 31, 2018 are expected to be made in fiscal 2019. The Company is in the process of implementing the restructuring plan and the remaining charges expected to be incurred could be significant.

9. INCOME TAXES

On December 22, 2017, the 2017 Tax Cuts and Jobs Act (TCJA) was enacted into law and the new legislation contains several key tax provisions that affected the Company, including a one-time mandatory transition tax on accumulated foreign earnings and a reduction of the corporate income tax rate from 35% to 21% effective January 1, 2018, among others. The Company is required to recognize the effect of the tax law changes in the period of enactment, such as determining the transition tax, remeasuring its U.S. deferred tax assets and liabilities as well as reassessing the net realizability of its deferred tax assets and liabilities. In December 2017, the SEC staff issued Staff Accounting Bulletin No. 118, Income Tax Accounting Implications of the Tax Cuts and Jobs Act (SAB 118), which allowed the Company to record provisional amounts during a measurement period not to extend beyond one year of the enactment date. As a result, the Company previously provided a provisional estimate of the effect of the TCJA in its financial statements. In the fourth quarter of 2018, the Company completed its analysis to determine the effect of the TCJA and recorded immaterial adjustments as of December 31, 2018.

Effective January 1, 2018, the TCJA created a new requirement to include in U.S. income global intangible low-taxed income (“GILTI”) earned by controlled foreign corporations (“CFCs”). The GILTI must be included currently in the gross income of the CFCs’ U.S. shareholder. Under U.S. GAAP, the Company is allowed to make an accounting policy choice of either (1) treating taxes due on future U.S. inclusions related to GILTI as a current-period expense when incurred (the “period cost method”) or (2) factoring such amounts into a company’s measurement of its deferred taxes (the “deferred method”). During the first quarter of 2018, the Company selected the period cost method in recording the tax effects of GILTI in its financial statements.

The Company has not provided for any foreign withholding tax for any undistributed earnings for its foreign subsidiaries as of December 31, 2018. The Company intends to permanently reinvest the foreign earnings outside of the U.S.

	Year Ended December 31,		
	2018	2017	2016
	(In thousands)		
U.S.			
Current	\$ (84)	\$ (141)	\$ 410
Deferred	(4,171)	(471)	208
Foreign			
Current	347	254	329
Withholding	2,165	1,654	2,898
Deferred	—	(33)	8
Total provision (benefit)	<u>\$ (1,743)</u>	<u>\$ 1,263</u>	<u>\$ 3,853</u>

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During the years ended December 31, 2018, 2017 and 2016, income (loss) before taxes from U.S. operations was \$(11.1) million, \$(1.2) million and \$11.3 million, respectively, and income before taxes from foreign operations was \$1.6 million, \$1.1 million and \$1.6 million, respectively.

The income tax provision (benefit) differs from the amount estimated by applying the statutory federal income tax rate (21% for 2018, and 35% for 2017 and 2016) for the following reasons (in thousands):

	Year Ended December 31,		
	2018	2017	2016
Federal statutory tax provision	\$ (1,986)	\$ (26)	\$ 4,534
State tax provision	(133)	(110)	283
Stock compensation expense	768	(944)	45
Tax credits	(2,682)	(2,769)	(4,000)
Foreign tax, net	2,104	1,641	2,852
Tax law changes	—	3,247	—
Other	186	224	139
Tax provision (benefit)	<u>\$ (1,743)</u>	<u>\$ 1,263</u>	<u>\$ 3,853</u>

As of December 31, 2018, the Company had Federal and California net operating loss carry-forwards (“NOLs”) of approximately \$9.9 million and \$5.9 million, respectively. The Federal and California NOLs begin expiring after 2019 and 2028, respectively.

As of December 31, 2018, the Company had federal and state research and experimental and other tax credit (“R&D credits”) carry-forwards of approximately \$13.6 million and \$17.7 million, respectively. The federal credits begin to expire after 2025, while the California credits have no expiration. The extent to which the federal and state credit carry forwards can be used to offset future tax liabilities, respectively, may be limited, depending on the extent of ownership changes within any three-year period as provided in the Tax Reform Act of 1986 and the California Conformity Act of 1987.

The Company assesses its deferred tax assets for recoverability on a regular basis, and where applicable, a valuation allowance is recorded to reduce the total deferred tax asset to an amount that will, more likely than not, be realized in the future. As of December 31, 2018 and 2017, the Company believes that most of its deferred tax assets are “more-likely-than not” to be realized with the exception of California R&D tax credits that have not met the “more-likely-than not” realization threshold criteria because on an annual basis and pursuant to current law, the Company generates more California credits than California tax. As a result, at December 31, 2018 and 2017, the excess credits of \$9.7 million and \$9.0 million, respectively continued to be subject to a full valuation allowance. In addition, the Company had approximately \$0.1 million of California NOL carryforward from its acquisition of Synticity. The Company evaluated positive and negative evidence and concluded that it was more likely than not that the California NOL would not be fully realizable. As a result of management’s evaluation, the Company recorded full valuation allowance against its deferred tax assets related to its California NOL. The Company will continue to review its deferred tax assets in accordance with the applicable accounting standards. Net deferred tax assets balance as of December 31, 2018 and 2017 was \$18.3 million and \$15.5 million, respectively.

The components of the net deferred tax assets are comprised of (in thousands):

	December 31,	
	2018	2017
Deferred tax assets		
Net operating loss carry forward	\$ 2,720	\$ 1,318
Research and development and other credit carry forward	17,750	16,626
Foreign tax credit carry forward	3,994	1,754
Accruals deductible in different periods	2,198	3,285
Intangible assets	1,081	1,325
Stock-based compensation	1,109	1,166
Valuation allowance	(9,808)	(9,126)
Subtotal	<u>\$ 19,044</u>	<u>\$ 16,348</u>
Deferred tax liabilities		
Fixed assets	(710)	(835)
Net deferred tax assets	<u>\$ 18,334</u>	<u>\$ 15,513</u>

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In accordance with the accounting standard relating to accounting for uncertain tax positions, the Company classifies its liabilities for income tax exposures as long-term. The Company includes interest and penalties related to unrecognized tax benefits within the Company's income tax provision. As of December 31, 2018 and 2017, the Company had accrued interest and penalties related to unrecognized tax benefits of \$0.8 million and \$0.7 million, respectively. In the years ended December 31, 2018, 2017, and 2016, the Company recognized charges for interest and penalties related to unrecognized tax benefits of \$84,000, \$135,000, and \$72,000, respectively, in the consolidated statements of operations and comprehensive income (loss).

The Company's total amount of unrecognized tax benefits, excluding interest and penalties, as of December 31, 2018 was \$13.3 million, of which \$7.8 million, if recognized, would impact the Company's effective tax rate. As of December 31, 2018, the Company has recorded unrecognized tax benefits of \$3.0 million, including interest and penalties of \$0.8 million, as long-term income taxes payable in its consolidated balance sheet. The remaining \$10.3 million has been recorded net of our deferred tax assets, of which \$5.5 million is subject to a full valuation allowance. The Company does not expect the change in unrecognized tax benefits over the next twelve months to materially impact its results of operations and financial position.

The Company conducts business globally and, as a result, files numerous consolidated and separate income tax returns in the U.S. federal, various state and foreign jurisdictions. Because the Company used some of the tax attributes carried forward from previous years to tax years that are still open, statutes of limitation remain open for all tax years to the extent of the attributes carried forward into tax year 2002 for federal and California tax purposes. The Company is not subject to income tax examinations in any other of its major foreign subsidiaries' jurisdictions.

A reconciliation of the beginning and ending amount of unrecognized tax benefits is as follows (in thousands):

	Amount
Gross unrecognized tax benefits, January 1, 2016	\$ 10,979
Increases in tax positions for current year	1,118
Increase in tax positions for prior years	112
Lapse in statute of limitations	(269)
Gross unrecognized tax benefits, December 31, 2016	11,940
Increases in tax positions for current year	1,166
Increases in tax positions for prior years	—
Lapse in statute of limitations	(217)
Gross unrecognized tax benefits, December 31, 2017	12,889
Increases in tax positions for current year	664
Increases in tax positions for prior years	—
Lapse in statute of limitations	(261)
Gross unrecognized tax benefits, December 31, 2018	<u>\$ 13,292</u>

We do not provide deferred taxes on undistributed earnings of our foreign subsidiaries as we intend to indefinitely reinvest those earnings.

Valuation allowance for deferred tax assets is summarized:

	Balance at Beginning of Period	Charged to Costs and Expenses	Deductions/ Write-offs of Accounts	Balance at End of Period
Valuation allowance for deferred tax assets				
2018	\$ 9,126	\$ 682	\$ —	\$ 9,808
2017	\$ 6,798	\$ 2,328	\$ —	\$ 9,126
2016	\$ 6,205	\$ 593	\$ —	\$ 6,798

10. NET INCOME (LOSS) PER SHARE

Basic net income (loss) per share is computed by dividing net income by weighted average number of common shares outstanding for the period (excluding outstanding stock options and shares subject to repurchase). Diluted net income per share is computed using the weighted-average number of common shares outstanding for the period plus the potential effect of dilutive securities which are convertible into common shares (using the treasury stock method), except in cases in which the effect would be anti-dilutive. The following is a reconciliation of the numerators and denominators used in computing basic and diluted net income (loss) per share (in thousands except per share amount):

	Year Ended December 31,		
	2018	2017	2016
Numerator:			
Net income (loss)	\$ (7,716)	\$ (1,337)	\$ 9,103
Denominator:			
Basic weighted-average shares outstanding	32,169	32,038	31,373
Effect of dilutive options and restricted stock	—	—	1,058
Diluted weighted-average shares outstanding	32,169	32,038	32,431
Net income (loss) per share – Basic	\$ (0.24)	\$ (0.04)	\$ 0.29
Net income (loss) per share – Diluted	\$ (0.24)	\$ (0.04)	\$ 0.28

For the years ended December 31, 2018 and 2017, because the Company was in a loss position, basic net loss per share is the same as diluted net loss per share as the inclusion of the potential common shares would have been anti-dilutive.

The following table sets forth potential shares of common stock that are not included in the diluted net income (loss) per share calculation above because to do so would be anti-dilutive for the periods indicated (in thousands):

	Years Ended December 31,		
	2018	2017	2016
Outstanding options	669	751	134
Nonvested shares of restricted stock units	1,060	411	18
Employee Stock Purchase Plan	237	214	121
Total	1,966	1,376	273

11. CUSTOMER AND GEOGRAPHIC INFORMATION

Operating segments are defined as components of an enterprise about which separate financial information is available that is evaluated regularly by the chief operating decision maker, or group, in deciding how to allocate resources and in assessing performance.

The Company's chief operating decision maker, the chief executive officer, reviews discrete financial information presented on a consolidated basis for purposes of regularly making operating decisions, allocation of resources, and assessing financial performance. Accordingly the Company considers itself to be in one operating and reporting segment, specifically the licensing and implementation of yield improvement solutions for integrated circuit manufacturers.

The Company had revenues from individual customers in excess of 10% of total revenues as follows:

Customer	Year Ended December 31,		
	2018	2017	2016
A	37%	40%	41%
B	*	*%	11%

* represents less than 10%

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The Company had accounts receivable balances (including amounts that are unbilled) from individual customers in excess of 10% of the gross accounts receivable balance as follows:

Customer	December 31,	
	2018	2017
A	35%	41%
C	21%	15%

Revenues from customers by geographic area based on the location of the customers' work sites are as follows (in thousands):

	Year Ended December 31,					
	2018		2017		2016	
	Revenues	Percentage of Revenues	Revenues	Percentage of Revenues	Revenues	Percentage of Revenues
United States	\$ 34,179	40%	\$ 39,631	39%	\$ 38,748	36%
China	17,465	20	17,872	18	11,436	11
Taiwan	7,890	9	12,494	12	15,216	14
Germany	5,324	6	9,990	10	17,253	16
Rest of the world	20,936	25	21,884	21	24,808	23
Total revenue	<u>\$ 85,794</u>	<u>100%</u>	<u>\$ 101,871</u>	<u>100%</u>	<u>\$ 107,461</u>	<u>100%</u>

Long-lived assets, net by geographic area is as follows (in thousands):

	December 31,	
	2018	2017
United States	\$ 35,173	\$ 24,883
Rest of the world	508	503
Total long-lived assets, net	<u>\$ 35,681</u>	<u>\$ 25,386</u>

12. FINANCIAL INSTRUMENTS

Fair value is the exit price, or the amount that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants as of the measurement date. The multiple assumptions used to value financial instruments are referred to as inputs, and a hierarchy for inputs used in measuring fair value is established, that maximizes the use of observable inputs and minimizes the use of unobservable inputs by requiring that the most observable inputs be used when available. Observable inputs reflect assumptions market participants would use in pricing an asset or liability based on market data obtained from independent sources while unobservable inputs reflect a reporting entity's pricing based upon its own market assumptions. These inputs are ranked according to a fair value hierarchy that prioritizes the inputs to valuation techniques used to measure fair value into three broad levels.

Level 1 - Inputs are quoted prices in active markets for identical assets or liabilities.

Level 2 - Inputs are quoted prices for similar assets or liabilities in an active market, quoted prices for identical or similar assets or liabilities in markets that are not active, inputs other than quoted prices that are observable and market-corroborated inputs which are derived principally from or corroborated by observable market data.

Level 3 - Inputs are derived from valuation techniques in which one or more significant inputs or value drivers are unobservable.

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The following table represents the Company's assets measured at fair value on a recurring basis as of December 31, 2018, and the basis for that measurement (in thousands):

Assets	Total	Quoted Prices in Active Markets for Identical Assets (Level 1)	Significant Other Observable Inputs (Level 2)	Significant Unobservable Inputs (Level 3)
Money market mutual funds	\$ 27,068	\$ 27,068	\$ —	\$ —

The following table represents the Company's assets measured at fair value on a recurring basis as of December 31, 2017 and the basis for that measurement (in thousands):

Assets	Total	Quoted Prices in Active Markets for Identical Assets (Level 1)	Significant Other Observable Inputs (Level 2)	Significant Unobservable Inputs (Level 3)
Money market mutual funds	\$ 26,638	\$ 26,638	\$ —	\$ —

The Company enters into foreign currency forward contracts to reduce the exposure to foreign currency exchange rate fluctuations on certain foreign currency denominated monetary assets and liabilities, primarily on third-party accounts payables and intercompany balances. The primary objective of the Company's hedging program is to reduce volatility of earnings related to foreign currency exchange rate fluctuations. The counterparty to these foreign currency forward contracts is a large global financial institution that the Company believes is creditworthy, and therefore, the Company believes the credit risk of counterparty nonperformance is not significant. These foreign currency forward contracts are not designated for hedge accounting treatment. Therefore, the change in fair value of these contracts is recorded into earnings as a component of other income (expense), net, and offsets the change in fair value of the foreign currency denominated assets and liabilities, which is also recorded in other income (expense), net. For the years ended December 31, 2018, 2017, and 2016, the Company recognized a realized loss of \$0.7 million, a realized gain of \$0.7 million, and a realized loss of \$0.4 million, respectively on the contracts, which is recorded in interest and other income (expense), net in the Company's Consolidated Statements of Operations and Comprehensive Income (Loss).

The Company carries these derivatives financial instruments on its Consolidated Balance Sheets at their fair values. The Company's foreign currency forward contracts are classified as Level 2 because it is not actively traded and the valuation inputs are based on quoted prices and market observable data of similar instruments. As of December 31, 2018, the Company had one outstanding forward contract with a notional amount of \$8.2 million and recorded \$55,000 in other current liability associated with this outstanding forward contract.

13. SELECTED QUARTERLY FINANCIAL DATA (UNAUDITED)

The following is a summary of the Company's quarterly consolidated results of operations (unaudited) for the fiscal years ended December 31, 2018 and 2017.

	Year Ended December 31, 2018			
	Q1	Q2	Q3	Q4
	(In thousands, except for per share amounts)			
Total revenues	\$ 24,737	\$ 21,119	\$ 20,213	\$ 19,725
Gross profit	\$ 13,255	\$ 10,202	\$ 9,530	\$ 10,004
Net loss	\$ (424)	\$ (2,096)	\$ (2,082)	\$ (3,114)
Net loss per share:				
Basic	\$ (0.01)	\$ (0.07)	\$ (0.06)	\$ (0.10)
Diluted	\$ (0.01)	\$ (0.07)	\$ (0.06)	\$ (0.10)

	Year Ended December 31, 2017			
	Q1	Q2	Q3	Q4
	(In thousands, except for per share amounts)			
Total revenues	\$ 24,289	\$ 24,289	\$ 26,517	\$ 26,776
Gross profit	\$ 12,858	\$ 12,910	\$ 14,086	\$ 14,495
Net income (loss)	\$ 517	\$ 189	\$ 590	\$ (2,634)
Net income (loss) per share:				
Basic	\$ 0.02	\$ 0.01	\$ 0.02	\$ (0.08)
Diluted	\$ 0.02	\$ 0.01	\$ 0.02	\$ (0.08)

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

The required disclosure related to our previous change in independent registered public accounting firm can be found in our Current Report on Form 8-K filed with the SEC on September 18, 2018.

Item 9A. Controls and Procedures

Evaluation of Disclosure Controls and Procedures

Our management, with the participation of our principal executive officer and principal financial and accounting officer, evaluated the effectiveness of our "disclosure controls and procedures" as defined in Exchange Act Rules 13a-15(e) and 15d-15(e) as of December 31, 2018, in connection with the filing of this Annual Report on Form 10-K. Based on that evaluation, as of December 31, 2018, our principal executive officer and principal financial and accounting officer concluded that our disclosure controls and procedures were effective to ensure that information we are required to disclose in reports that we file or submit under the Exchange Act is recorded, processed, summarized and reported within the time periods specified in the rules and forms of the SEC and is accumulated and communicated to our management as appropriate to allow timely decisions regarding required disclosure

Management's Report on Internal Control over Financial Reporting

Our management is responsible for establishing and maintaining adequate internal control over financial reporting, as defined in Rules 13a-15(f) and 15d-15(f) under the Exchange Act, for the Company. Our management, with the participation of our principal executive officer and principal financial and accounting officer, assessed the effectiveness of our internal control over financial reporting as of December 31, 2018. This evaluation was based on the framework established in *Internal Control—Integrated Framework (2013)* issued by the Committee of Sponsoring Organizations of the Treadway Commission ("COSO"). Based on our assessment under the COSO framework, our management concluded that our internal control over financial reporting was effective as of December 31, 2018.

The effectiveness of the Company's internal control over financial reporting as of December 31, 2018, has been audited by BPM LLP, the Company's independent registered public accounting firm, as stated in their report which appears in this Annual Report on Form 10-K.

Changes in Internal Control over Financial Reporting

There were no changes in internal control over financial reporting during the fourth quarter ended December 31, 2018, which has materially affected, or is reasonably likely to materially affect, our internal control over financial reporting.

Item 9B. Other Information.

None.

PART III

Pursuant to Paragraph (3) of the General Instructions to Form 10-K, certain of the information required by Part III of this Form 10-K is incorporated by reference from our Proxy Statement as set forth below. The Proxy Statement is expected to be filed within 120 days of December 31, 2018.

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

Information with respect to our directors appears in our Proxy Statement under “Proposal No. 1 — Election of Directors — Nominees for the Board of Directors” and is incorporated herein by reference. Information with respect to our executive officers appears in Part I, Item 1 — “Executive Officers” of this Form 10-K.

Information with respect to compliance with Section 16(a) of the Exchange Act, appears in our Proxy Statement under “Section 16 Beneficial Ownership Reporting Compliance” and is incorporated herein by reference.

Our Board of Directors has adopted a Code of Ethics (“Code of Ethics”), which is applicable to our principal executive officer, our principal financial and accounting officer and employees of the Company. Our Code of Ethics is available on our website at www.pdf.com, on the investor relations page. The Company’s website address provided is not intended to function as a hyperlink, and the information on the Company’s website is not, and should not be considered, part of this Annual Report on Form 10-K and is not incorporated by reference herein. You may also request a copy of our Code of Ethics in writing by sending your request to PDF Solutions, Inc., Attention: Investor Relations, 2858 De La Cruz Blvd., Santa Clara, California 95050. If we make any substantive amendments to the Code of Ethics or grant any waiver, including any implicit waiver, from a provision of the Code of Ethics to our Chief Executive Officer or Chief Financial Officer, we will disclose the nature of such amendment or waiver on our website or in a current report on Form 8-K.

Item 11. *Executive Compensation.*

The information required by this item is incorporated herein by reference to the section entitled “Compensation of Executive Officers and Other Matters — Executive Compensation” in our Proxy Statement.

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

The information required by this item is incorporated herein by reference to the section entitled “Security Ownership of Certain Beneficial Owners and Management” in our Proxy Statement. Also incorporated by reference is the information in the table under the heading “Equity Compensation Plan Information” in our Proxy Statement.

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

The information required by this item is incorporated herein by reference to the section entitled “Certain Relationships and Related Transactions and Directors Independence” in our Proxy Statement.

Item 14. *Principal Accountant Fees and Services.*

Information with respect to Principal Accountant Fees and Services is incorporated by reference to “Proposal No. 2: Ratification of Appointment of Independent Registered Public Accounting Firm” in our Proxy Statement.

PART IV

Item 15. Exhibits and Financial Statement Schedules

(a) The following documents are filed as part of this report:

- (1) Consolidated Financial Statements and Reports of Independent Registered Public Accounting Firms

The following documents are included as Part II, Item 8 of this Form 10-K:

	Page
Reports of BPM LLP, Independent Registered Public Accounting Firm	37
Report of PricewaterhouseCoopers, Independent Registered Public Accounting Firm	39
Consolidated Balance Sheets as of December 31, 2018 and 2017	40
Consolidated Statements of Operations and Comprehensive Income (Loss) for the Years Ended December 31, 2018, 2017 and 2016	41
Consolidated Statements of Stockholders' Equity for the Years Ended December 31, 2018, 2017 and 2016	42
Consolidated Statements of Cash Flows for the Years Ended December 31, 2018, 2017 and 2016	43
Notes to Consolidated Financial Statements	44

- (2) Financial Statement Schedules

All financial statement schedules have been omitted, since the required information is not applicable or is not present in amounts sufficient to require submission of the schedule, or because the information required is included in the consolidated financial statements and notes thereto included in this Form 10-K.

- (3) Exhibits required by Item 601 of Regulation S-K

See Item 15(b) below.

- (b) Exhibits

INDEX TO EXHIBITS

Exhibit Number	Description
3.01	Third Amended and Restated Certificate of Incorporation of PDF Solutions, Inc. (incorporated herein by reference to registrant's Registration Statement on Form S-1/A filed July 9, 2001)
3.02	Amended and Restated Bylaws of PDF Solutions, Inc. (incorporated herein by reference to registrant's Quarterly Report on Form 8-K filed January 28, 2019)
3.02	Amended and Restated Bylaws of PDF Solutions, Inc. (incorporated herein by reference to registrant's Quarterly Report on Form 10-Q filed August 9, 2005)
4.01	Specimen Stock Certificate (incorporated herein by reference to registrant's Quarterly Report on Form 10-Q filed September 6, 2001)
10.01	Form of Indemnification Agreement between PDF Solutions, Inc. and certain of its executive officers and directors (incorporated herein by reference to registrant's Registration Statement on Form S-1 filed August 7, 2000)
10.02	Form of Indemnification Agreement between PDF Solutions, Inc. and certain of its senior executive officers and directors (incorporated herein by reference to the registrant's Annual Report on Form 10-K filed March 16, 2009)*
10.03	PDF Solutions, Inc. 2001 Stock Plan (incorporated herein by reference to registrant's Quarterly Report on Form 10-Q filed May 10, 2007) and related agreements (incorporated herein by reference to registrant's Quarterly Report on Form 10-Q filed August 9, 2011)*
10.04	PDF Solutions, Inc. 2001 Employee Stock Purchase Plan (incorporated herein by reference to registrant's proxy statement dated April 6, 2010)*

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10.05	IDS Software, Inc. 2001 Stock Option/Stock Issuance Plan and related agreements (incorporated herein by reference to registrant's Registration Statement on Form S-8 filed October 17, 2003)*
10.06	PDF Solutions Inc. Fourth Amended and Restated 2011 Stock Incentive Plan (incorporated herein by reference to Appendix A to the registrant's proxy statement dated April 14, 2017)*
10.07	Form of Stock Option Agreement (Non-statutory) under PDF Solutions, Inc. 2011 Stock Incentive Plan (incorporated herein by reference to registrant's Annual Report on Form 10-K filed March 15, 2012)*
10.08	Form of Stock Unit Agreement under PDF Solutions, Inc. 2011 Stock Incentive Plan (incorporated herein by reference to registrant's Annual Report on Form 10-K filed March 15, 2012)*
10.09	Form of Stock Appreciation Right Agreement under PDF Solutions, Inc. 2011 Stock Incentive Plan (incorporated herein by reference to registrant's filing on Form 10-Q filed November 9, 2012)
10.10	Employment confirmation to John Kibarian from PDF Solutions, Inc. dated October 13, 2009 (incorporated herein by reference to registrant's Annual Report on Form 10-K filed March 15, 2012)*
10.11	Employment confirmation to Kimon Michaels from PDF Solutions, Inc. dated October 13, 2009 (incorporated herein by reference to registrant's Annual Report on Form 10-K filed March 15, 2012)*
10.12	Offer Letter to Gregory Walker from PDF Solutions, Inc. dated November 1, 2011 (incorporated herein by reference to registrar's Quarterly Report on Form 10-Q filed November 9, 2011)*
10.13	Offer letter to Cornelius D. Hartgring from PDF Solutions, Inc. dated August 29, 2002 (incorporated herein by reference to registrant's Annual Report on Form 10-K filed March 26, 2003)*
10.14	Carmel Corporate Plaza Office Lease between PDF Solutions, Inc. and 15015 Avenue of Science Associates LLC dated as of April 1, 2003 (incorporated by reference to registrant's Quarterly Report on Form 10-Q filed May 14, 2003)
10.15	Employment Agreement, dated February 26, 2016, with Kwang-Hyun Kim (incorporated herein by reference to registrant's Current Report on Form 8-K, filed March 3, 2016)*
10.16	Employment offer to Christine A. Russell, dated July 31, 2018 (incorporated herein by reference to registrant's filing on Form 10-Q filed on November 9, 2018)*
21.01	Subsidiaries of Registrant †
23.01	Consent of BPM LLP, Independent Registered Public Accounting Firm†
23.02	Consent of PricewaterhouseCoopers, Independent Registered Public Accounting Firm†
31.01	Certifications of the principal executive officer and principal financial and accounting officer pursuant to Exchange Act Rules 13a-14(a) and 15d-14(a), as adopted pursuant to Section 302 of the Sarbanes-Oxley Act of 2002†
31.02	Certifications of the principal executive officer and principal financial and accounting officer pursuant to Exchange Act Rules 13a-14(a) and 15d-14(a), as adopted pursuant to Section 302 of the Sarbanes-Oxley Act of 2002†
32.01	Certification pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002**
32.02	Certification pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002**
101.INS	XBRL Instance Document†
101.SCH	XBRL Taxonomy Extension Schema Document†
101.CAL	XBRL Taxonomy Extension Calculation Linkbase Document†
101.DEF	XBRL Taxonomy Extension Definition Linkbase Document†
101.LAB	XBRL Taxonomy Extension Labels Linkbase Document†
101.PRE	XBRL Taxonomy Extension Presentation Linkbase Document†

* Indicates management contract or compensatory plan or arrangement.

† Filed herewith.

** Furnished, and not filed.

Item 16. Form 10-K Summary

Not applicable.

SIGNATURES

Pursuant to the requirements of Section 13 or 15(d) of the Securities Exchange Act of 1934, the Registrant has duly caused this report to be signed on its behalf by the undersigned, thereunto duly authorized.

PDF SOLUTIONS, INC.

By: /s/ John K. Kibarian

 John K. Kibarian
 President and Chief Executive Officer
 (Principal executive officer)

By: /s/ Christine A. Russell

 Christine A. Russell
 Executive Vice President, Finance and Chief Financial
 Officer
 (Principal financial and accounting officer)

Date March 7, 2019

Pursuant to the requirements of the Securities Exchange Act of 1934, this report has been signed below by the following persons on behalf of the registrant and in the capacities and on the dates indicated.

Date	Signature	Title
March 4, 2019	<u>/s/ JOHN K. KIBARIAN</u> John K. Kibarian	Director, President and Chief Executive Officer (Principal executive officer)
March 4, 2019	<u>/s/ CHRISTINE A. RUSSELL</u> Christine A. Russell	Executive Vice President, Finance and Chief Financial Officer (Principal financial and accounting officer)
March 4, 2019	<u>/s/ JOSEPH R. BRONSON</u> Joseph R. Bronson	Lead Independent Director
March 4, 2019	<u>/s/ MARCO IANSITI</u> Marco Iansiti	Director
March 4, 2019	<u>/s/ KIMON MICHAELS</u> Kimon Michaels	Director
March 4, 2019	<u>s/ Gerald Z. Yin</u> Gerald Z. Yin	Director
March 4, 2019	<u>s/ Michael B. Gustafson</u> Michael Gustafson	Director

Subsidiaries of Registrant**Name of Entity****Jurisdiction of Incorporation or Organization**

PDF Solutions GmbH

Germany

PDF Solutions KK

Japan

PDF Solutions SARL

France

PDF Solutions Semiconductor Technology (Shanghai) Co. Ltd.

China

PDF Solutions Semiconductor Technology (Korea) Limited

Korea

PDF Solutions International Services, Inc.

Delaware

PDF Solutions Asia Services, Inc.

Delaware

PDF Solutions Semiconductor Technology Taiwan Ltd.

Taiwan

PDF Solutions Pacific Services, Inc.

Delaware

PDF Solutions Canada Ltd

Canada

Syntricity, Inc.

California

CONSENT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

We hereby consent to the incorporation by reference and in the Registration Statements on Form S-8 (Nos. 333-202455, 333-180324, 333-159211, 333-149281, 333-141660, 333-133332, 333-112728, 333-109809 and 333-102509) of PDF Solutions, Inc. of our reports dated March 7, 2019 relating to the consolidated financial statements as of and for the year ended December 31, 2018 and the effectiveness of internal control over financial reporting as of December 31, 2018, which appear in this Annual Report on Form 10-K.

/s/ BPM LLP
San Jose, California
March 7, 2019

CONSENT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

We hereby consent to the incorporation by reference in the Registration Statements on Form S-8 (Nos. 333-202455, 333-180324, 333-159211, 333-149281, 333-141660, 333-133332, 333-112728, 333-109809, and 333-102509) of PDF Solutions, Inc. of our report dated March 16, 2018 relating to the financial statements, which appears in this Form 10-K.

/s/ PricewaterhouseCoopers LLP
San Jose, California
March 7, 2019

CERTIFICATIONS

I, John K. Kibarian, certify that:

1. I have reviewed this annual report on Form 10-K of PDF Solutions, Inc.;

2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;

3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the period presented in this report;

4. The registrant's other certifying officer(s) and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:

(a) Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;

(b) Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;

(c) Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and

(d) Disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and

5. The registrant's other certifying officer(s) and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of registrant's board of directors (or persons performing the equivalent functions):

(a) All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and

(b) Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

/s/ John K. Kibarian

John K. Kibarian

President and Chief Executive Officer

(principal executive officer)

March 7, 2019

CERTIFICATIONS

I, Christine A. Russell, certify that:

1. I have reviewed this annual report on Form 10-K of PDF Solutions, Inc.;

2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;

3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;

4. The registrant's other certifying officer(s) and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:

(a) Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;

(b) Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;

(c) Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and

(d) Disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and

5. The registrant's other certifying officer(s) and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of registrant's board of directors (or persons performing the equivalent functions):

(a) All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and

(b) Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

/s/ Christine A. Russell

Christine A. Russell

Executive Vice President, Finance and Chief Financial Officer

(Principal financial and accounting officer)

March 7, 2019

**CERTIFICATION PURSUANT TO
18 U.S.C. SECTION 1350,
AS ADOPTED PURSUANT TO
SECTION 906 OF THE SARBANES-OXLEY ACT OF 2002**

In connection with the Annual Report of PDF Solutions, Inc. (the "Company") on Form 10-K for the year ended December 31, 2018 as filed with the Securities and Exchange Commission on March 7, 2019 (the "Report"), I, John K. Kibarian, President and Chief Executive Officer of the Company, certify, pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002, that, to my knowledge:

- (1) The Report fully complies with the requirements of section 13(a) or 15(d) of the Securities Exchange Act of 1934; and
- (2) The information contained in the Report fairly presents, in all material respects, the financial condition and result of operations of the Company.

/s/ John K. Kibarian

John K. Kibarian

President and Chief Executive Officer

(principal executive officer)

March 7, 2019

**CERTIFICATION PURSUANT TO
18 U.S.C. SECTION 1350,
AS ADOPTED PURSUANT TO
SECTION 906 OF THE SARBANES-OXLEY ACT OF 2002**

In connection with the Annual Report of PDF Solutions, Inc. (the "Company") on Form 10-K for the year ended December 31, 2018 as filed with the Securities and Exchange Commission on March 7, 2019 (the "Report"), I, Christine A. Russell, Executive Vice President, Finance and Chief Financial Officer of the Company, certify, pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002, that, to my knowledge:

- (1) The Report fully complies with the requirements of section 13(a) or 15(d) of the Securities Exchange Act of 1934; and
- (2) The information contained in the Report fairly presents, in all material respects, the financial condition and result of operations of the Company.

/s/ Christine A. Russell

Christine A. Russell

*Executive Vice President, Finance and Chief Financial
Officer*

(principal financial and accounting officer)

March 7, 2019