Semicconductors
Analog Renaissance 2.0 - Semis You Can Own Through the Next 4 Cycles

July 9, 2019

Key Takeaway
We updated our Analog Renaissance Report from 2017. Four takes: 1) Consolidation is better and faster than we thought, 2) Big get bigger, rich get richer, 3) Expect more M&A, 4) Our 3-to-5-yr EPS Bull case is 50%/100% above CY19 consensus. We think the drivers are 15-yr secular ones (Consolidation + Tectonic Shift to IoT), and that TXN and ADI are ownable through the next 4 cycles. ON is our top mid-cap play.

Many have Semiconductor Scars, but Evidence Compelling that Analog is Changing...

FCF/Shr for our analog group took a hit during the financial crisis, but stayed positive through the whole crisis, furthermore it largely increased monotonically through the 2015 and 2018 inventory corrections, and for 2018, is at the highest levels ever. Capital return per share has grown with FCF, FCF margins are expanding and fixed costs are declining. EBIT margins for our analog sample set increased by 1,000 bps over the past 5 years and remain near all time highs, despite the inventory correction.

Two Secular Trends Driving the Change
We think there are two main secular drivers for analog companies that will remain in play for the next 10 years: 1) Consolidation - which is not only driving pricing power, but also leverage on OpEx; 2) Richer Product Mix - Our “4th Tectonic Shift in Computing” framework shows that growth in computing is shifting away from a highly concentrated handset and PC customer base with massive pricing power, to a set of highly fragmented IoT customers (Industrial, Auto, IoT) with low pricing power.

Four Updates to our Original Analog Renaissance Report
1) Consolidation is Better Than We Thought. In this report we look at segment HHI vs aggregate. Through this lens, the industry looks more concentrated, and is consolidating faster than we originally thought.

2) Big Get Bigger - Rich Get Richer. We show that over the past 5 years, the analog companies with the largest revenues, market share and composite HHI also had the highest share gain and largest positive change in operating margin. We view TXN and ADI as the best ideas on this theme. Our 3-yr EPS bull-case for ADI and TXN is $8.47 and $8.09, 60% above CY19 consensus.

3) Expect More M&A. We estimate there are still over 100 analog companies that account for over 50% of the analog market. Our updated M&A framework indicates MTSI, SLAB, SMTC, LSCC, POWI, VICR, CRUS, DLG are potentially attractive targets.

4) EPS Sensitivity Analysis 50-100% EPS Upside over 3-to-5 years. ...for our larger cap analog companies - We think TXN and ON have the best chance to hit our bull case based on the high percentage of their manufacturing that they do in-house, which should allow for lower cost structure and better fixed cost absorption. In TXN’s case, we also think it benefits from scale (See #2 above).
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Links to Related Research
1Q19 Wrap: Semi Cycle Pattern Trumping Tariff Tiffs
Analog Renaissance - Are the Old Semiconductor Investing Tools Broken?
The 4th Tectonic Shift in Computing: To a Parallel Processing / IoT Model
Section 1. Summary
Summary – Stocks to Own Through the Next 4 Cycles

Many Investors Have Semiconductor Scars...
Semis have a bad reputation with many long-time technology investors. It is easy to understand why - those with any history remember how bad it could get, high capital intensity, negative leverage, unpredictable inventory corrections, along with excessive option usage and irresponsible M&A. Being at the back of the supply chain meant visibility for Semis is barely one layer deep into their own distributors, so management teams would typically not see an inventory correction until after it happened. When the correction hit, Semis would report negative levered revisions, with deeper cuts to estimates than most dreamed. The cuts played through in the stocks - between 2000 and 2002, the SOX (Philly Semi Index) declined by 80% peak-to-trough, and during the financial crisis, it declined by 60%. Any tech investor who has been around for more than a decade can tell you a half-dozen stories about semiconductor management teams that “drove me off a cliff.”

…but Evidence is Compelling that Analog is Changing
We think the evidence is compelling that things are changing, particularly for the analog stocks. Chart 2 shows FCF/Shr for a group of our largest "Analog Renaissance" plays. FCF/Shr took a hit during the financial crisis, but stayed positive through the whole crisis. During the US and European debt crises, FCF/Shr declined a bit, but by and large not as much as during the financial crisis. FCF/Shr largely increased monotonically through the 2015 and 2018 inventory corrections, and for 2018, are at the highest levels ever, despite two quarters of downward revisions in 2H18. Capital return per share has grown with FCF, and many have the policy to return 100% of it to shareholders (all earnings go to shareholders...novel concept, right?). FCF margins continue to expand and fixed costs as a percent of sales are on the decline, which has translated to more predictable and stable operating models. Finally, EBIT margins for our sample set increased by 1,000 bps over the past 5 years and remain near all time highs. The important question is whether these are cyclical or secular phenomena.

Two Secular Trends Driving the Change
We think they are secular, and that the two main drivers of 1,000 bps of operating margin expansion over the past 5 years will be in place for the next 10, namely: 1) Consolidation - which is not only driving pricing power, but also leverage on OpEx. The beauty of analog is that product cycles are measured in 10’s of years, so consolidation today carries benefits for a decade. We would expect continued improvements to the analog business model for the next 10 years even if consolidation stopped today (we don’t think it will). 2) Richer Product Mix - Our “4th Tectonic Shift in Computing” framework shows that growth in computing is shifting away from a highly concentrated handset and PC customer base with massive pricing power, to a set of highly fragmented IoT customers (Industrial, Auto, IoT) with low pricing power. We’ve shown that Tectonic Shifts in Computing typically last for 15 years, and we believe that this shift to an IoT/Parallel Processing model has at least another 10 years to go.

Four Updates to our Original Analog Renaissance Report
This report is an update to our original “Analog Renaissance” report published in 2017. We offer three new analyses with this report: 1) Consolidation is Better Than We Thought. We originally looked at the Herfindahl Index (HHI - measure of industry concentration) for the whole analog industry. Our original analysis showed that the industry was becoming more
concentrated, but that in aggregate it was still at a low level. In this report we look at the HHI for the individual analog segments, which paints a picture of the group that is more concentrated than we originally calculated. This "higher resolution view" of consolidation better explains the 1,000 bps margin expansion over the past 5 years. The whole industry benefits from this phenomenon, but when we calculate the "composite HHI" for each company (HHI weighted by segment), ADI, MXIM, TXN and MCHP appear particularly advantaged.

2) **Big Get Bigger - Rich Get Richer.** Perhaps a socially unacceptable concept, but the cold, hard truth is this is what happened in HDD and DRAM (see Appendix 3 for the HDD and DRAM case studies) as those markets consolidated, and what is happening to the analog industry today. We show that over the past 5 years, the companies with the largest revenues, market share and composite HHI also had the highest share gain and largest positive change in operating margin. We view TXN and ADI as the best ideas on this theme.

3) **Expect More M&A.** While the industry has benefited from consolidation, we estimate that over 100 companies still account for over 50% of the analog market. Chart 19 shows the M&A framework we introduced in March 2015 (Semiconductor M&A Handbook - More to Come). The framework suggests that M&A has a high probability of success when companies with low cost structures and higher valuation multiples (Southeast on chart) acquire companies that have higher cost structures and lower valuation multiples (Northwest on chart). This framework indicates MTSI, SLAB, SMTC, LSCC, POWI, VICR, CRUS, DLG as being potentially attractive targets.

4) **EPS Sensitivity Analysis 25-100% EPS Upside over 3-5 years.** We show that over the past 5 years, the larger analog stocks have posted a revenue CAGR of 5% and operating margin expansion of 250 bps per year. Our base case assumes 6% revenue CAGR and 100 bps of op margin expansion per year, and our bull case assumes 9% revenue CAGR and 200 bps of op margin expansion per year, which translates to EPS growth for our 3-yr Base/Bull case scenario of 25%/50%, and for our 5-yr Base/Bull case scenario of 50%/100%. We think TXN and ON have the best chance to hit our bull case based on the high percentage of their manufacturing that they do in-house, which should allow for lower cost structure and better fixed cost absorption. In TXN’s case, we also think it benefits from scale (See #2 above).

**Top Ideas**

Between the late 80-90s, INTC outperformed the market by 10x because it was a critical supplier in the PC Era, and between the late 90s-20teens, QCOM and ARM outperformed the market by 10x because they were the critical suppliers into the Cellphone Era. We view the analog and MCU players as critical suppliers into the IoT Era and expect them to materially outperform the market during the IoT / Parallel Processing Era of Computing.

We think that the secular trends identified in this report are positive for the industry as a whole, but we would highlight TXN and ADI as the largest beneficiaries of these trends in the analog market, based largely on their size and relative market share. Simply put, the big get bigger and rich get richer. We would also highlight ON Semi as a top mid-cap idea based on its position as a consolidator in the discrete and lower-end analog market, which has the most to benefit in a benign pricing environment.

**Chart 1 - Summary of Base and Bull Cases**

<table>
<thead>
<tr>
<th></th>
<th>Consensus CY19E EPS</th>
<th>Jefferies 3-yr Base</th>
<th>Jefferies 3-yr Bull</th>
<th>Jefferies 5-yr Base</th>
<th>Jefferies 5-yr Bull</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADI</td>
<td>$5.27</td>
<td>$7.23</td>
<td>$8.47</td>
<td>$8.80</td>
<td>$11.36</td>
</tr>
<tr>
<td>MCHP</td>
<td>$6.18</td>
<td>$8.10</td>
<td>$9.60</td>
<td>$9.39</td>
<td>$12.29</td>
</tr>
<tr>
<td>MXIM</td>
<td>$2.53</td>
<td>$3.16</td>
<td>$3.71</td>
<td>$3.79</td>
<td>$4.91</td>
</tr>
<tr>
<td>ON</td>
<td>$1.78</td>
<td>$2.39</td>
<td>$3.06</td>
<td>$3.02</td>
<td>$4.38</td>
</tr>
<tr>
<td>TXN</td>
<td>$5.16</td>
<td>$6.96</td>
<td>$8.09</td>
<td>$8.25</td>
<td>$10.53</td>
</tr>
</tbody>
</table>

Source: Jefferies, FactSet
We plot Free Cash Flow per share for our sample of analog companies. We note that FCF/Shr took a hit during the financial crisis, but stayed positive through the whole crisis. During the US and European debt crises, FCF/Shr declined a bit, but by and large not as much as during the financial crisis. FCF/Shr largely increased monotonically through the 2015 and 2018 inventory corrections, and for 2018, are at the highest levels ever, despite two quarters of downward revisions in 2H18.

Capital return per share has grown with FCF, and many have a policy to return 100% of it to shareholders - shareholders get 100% of the earnings.
Our index of analog companies has outperformed the S&P 500 since the 2015 inventory corrections.

Over the past 5 years, aggregate gross and operating margins for our sample of companies increased by 8% and 13%, or by 159bps/yr and 258bps/yr. During that period, revenue growth for the group has been 30% or 5% CAGR.

Compared to 2014, we noted that the current levels (1Q19TTM) of depreciation are lower for most of the analog companies in our sample implying more stable operating models which should translate to premium PE multiples.

All of the analog players in our sample have similar or higher FCF margins in 1Q19 (TTM) as compared to 2014.
The total Analog market has 2 players with dominant market share (TXN, ADI) accounting for 49% of the market, with the 3rd place accounting only for 5% of the market.

Looking at the analog market subsegments, the HHI looks more compelling and more easily explains the recent 1,000 bps expansion of operating margins.

Among the 4 largest analog companies in our sample, ADI has the highest composite HHI, compared to MXIM, TXN and MCHP. Importantly, all have increased.
## Chart 12 - Semiconductor Commentary on Pricing Power - 2019

<table>
<thead>
<tr>
<th>Date</th>
<th>Company</th>
<th>Commentary</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-Jun</td>
<td>MCHP</td>
<td>CFO: But what we’ve seen in this cycle which is different than others is ASPs or the average selling prices, the pricing pressure that’s coming in other cycles, really haven’t been there. And we think that’s a factor of industry consolidation and a lot of the poor players in terms of pricing model, business model had been taken out through acquisitions. And so, prices have held up quite well and that has obviously helped in where gross margins are...</td>
</tr>
<tr>
<td>10-Jun</td>
<td>MCHP</td>
<td>CFO: we’re having great success in holding pricing flat. We’re being fair with our customers; we’re not raising prices on customers, but really holding pricing flat in this environment. And that’s a change from where it was just a few years ago where you’d see 1%, 2%, 3% ASP decline per year and essentially give away some of the upside that we were seeing in unit growth in ASP decline.</td>
</tr>
<tr>
<td>29-May</td>
<td>MCHP</td>
<td>CFO: And so we’ve seen pricing be very, very stable in this environment. When we compete against our top tier competitors, we’re competing against product specs and technical support and it’s not a pricing discussion. Obviously, price is important to the customer, but that’s not what ultimately wins you that design.</td>
</tr>
<tr>
<td>14-May</td>
<td>MXIM</td>
<td>CFO: It’s a favorable pricing environment.</td>
</tr>
<tr>
<td>29-Apr</td>
<td>ON</td>
<td>CEO: We’re not seeing any pricing declines at all. In fact, it’s less than normal right now.</td>
</tr>
<tr>
<td>13-Feb</td>
<td>MCHP</td>
<td>CFO: We’re in a – we believe a good environment from ASP perspective. We’ve been holding ASPs relatively flat with customers and having good success with that. And so, as our cost structures improve, we think that we can continue to get gross margin improvement over the course of time as the revenue environment becomes a little bit more constructive.</td>
</tr>
<tr>
<td>12-Feb</td>
<td>MXIM</td>
<td>CFO: “But both from a revenue growth point of view from the ability to continue to, kind of, improve utilization and really loading in our one factory left up in Oregon, I think our mix of shifting more to industrial helps us. I think the pricing environment is favorable in semiconductors’ given consolidation. I think there’s a number of factors.”</td>
</tr>
<tr>
<td>5-Feb</td>
<td>TXN</td>
<td>Head of IR: “And as our customers go through and decide which product they’re going to use, there can be tens, if not hundreds of specs that an engineer is considering. And the average sales price of a product in the market overall is about $0.35. And out of those hundreds of specifications they’re looking at, pricing is always a concern, but it just very rarely is one of the top concerns. So you can’t sell a $0.35 part for $3.50. But that’s just not usually one of the top things that a customer is concerned about. But really looking at the functionality of the device and how it works inside of their design.”</td>
</tr>
<tr>
<td>4-Feb</td>
<td>ON</td>
<td>CEO: Our annual contracts are usually completed, and they show up in our books in the first quarter here, as you mentioned. Those numbers were better than we’ve had, quite benign, and should not be declining – or should not provide a decline in ASP for the first quarter.</td>
</tr>
<tr>
<td>7-Feb</td>
<td>NXP</td>
<td>CEO: I would say that the general environment on pricing is okay. I don’t think that that we would say that it’s poor for us at all. I think if anything we’re trying to whittle down, when you go through the annual price negotiations with the OEMs and the tier ones, it’s an arm wrestling that takes place. And we try to get it down slightly and, it’s under the contract, and we try to reduce it slightly, and they try to get a little more. But I don’t think there’s a significant change in environment that we see associated with that. And on most of the Industrial &amp; IoT, you said that price with the design wins and then you have a built in reduction that takes place associated with those that we honor contracts for them... But I wouldn’t say that the pricing environment is problematic. It’s very healthy right now.</td>
</tr>
<tr>
<td>3-Jan</td>
<td>ON</td>
<td>CEO: So other than China construction-related things, everything else actually does look very good. We’re seeing the push for the higher efficiency being well received and customers willing to pay additional for that, which is great for a pricing environment.</td>
</tr>
</tbody>
</table>

Source: Jefferies, company data, FactSet

Analog companies continue to report secular improvements in the pricing environment. We think that better pricing is driven more by secular dynamics associated with increased industry concentration.
Secular Analog Demand – Tectonic Shift to Parallel Processing and IoT Computing Paradigm

In our July, 2017 note: “4th Tectonic Shift in Computing,” we observed that the computing paradigm shifted every 15 years (10x units, 1/10th cost, 1/10th footprint), and argued that it is currently shifting to a parallel processing / IoT model. We believe the current shift is being driven by both the low cost of storing the data that the IoT devices are generating, as well as improvements in parallel processing technologies like neural networking. As the data from the IoT devices is being processed in an AI framework, higher utility is being driven into those devices, increasing demand for them. The higher utility / increased demand feedback loop is becoming a virtuous circle.

We argued that analog companies, TXN, ADI, MCHP, ON and MXIM were plays on this Tectonic Shift theme as companies that supply components that enable the IoT devices.


Please see important disclosure information on pages 48 - 55 of this report.
Chart 14 - HDD Market Share Over Time

Source: Jefferies, Gartner. HDD market share calculated based on units shipped.

Consolidation case studies of DRAM and HDD industries (See Appendix 3) suggest that the natural order of tech industries is to have 2-to-3 players dominate the market. For example, In DRAM the top 3 players combined represent 95% of the market while in HDD top 3 players represent 100% of the market.

Chart 15 - DRAM Market Share

Source: Jefferies, Gartner. * DRAM market share calculated based upon revenue.

We plotted analog companies’ revenues and change of market share over the past 5 years and saw a strong correlation within the data set (R-sq of 62%). We see this as a confirmation of our thesis that scale is competitive advantage in analog space and over time "the big get bigger".

Chart 16 - Change in Market Share vs. 2018 Revenue

Source: Jefferies, Gartner, company data; ADI revenue and market share excl. LLTC; ON excl. FCS and Renesas excl. Intersil; *Gartner estimates for General Purpose Analog Revs

We looked at the increase in profitability and the relationship between the Composite Herfindahl index and the size of the company. We observe that the industry leaders (TXN, ADI) have seen the most improvement in operating margin over the last 5 years, leading us to conclude that "the rich are get richer".

Chart 17 - Delta in Op Margins from 2013-18 vs. 2018 Revs

Source: Jefferies, FactSet, company data

Please see important disclosure information on pages 48 - 55 of this report.
We plotted annual revenues and change in operating margins over the last 5 years for the largest analog companies. We show that over the past 5 years, the companies with the largest revenues, market share and composite HHI also had the highest share gain and largest positive change in operating margin.

Conclusion: the big are getting bigger and the rich are getting richer.

According to our semi M&A framework (See note Semis M&A Handbook: More to Come), semiconductor M&A often succeeds when companies with a low cost structure and higher valuation (Southeast on chart) acquired companies with high cost structures and low valuations (Northwest on chart). By acquiring Northwest companies can win twice: 1) lower costs and increase earnings, and 2) get a better multiple on the higher earnings stream.

We estimate that there are still over 100 analog companies so we expect more consolidation. This framework suggests that those companies to the Northwest of the dotted red line could potentially be attractive targets.
Section 2. Analog HHI Analysis
### 2.1. Total Analog Industry Concentration Analysis

**Chart 20 - Analog Segments Revenue**

- **Voltage Regulator/Reference**
- **Data Converter/Switch/Multiplexer**
- **Amplifier & Other Analog***
- **Amplifier/Comparator**
- **Interface**
- **Other**

The total Analog market has grown at 5%/3% CAGR for the 5/10 years

The Voltage Regulator / Reference segment has grown at a CAGR of 5%/4% for the past 5/10 years

Data Converter / Switch / Multiplexer has grown at 6%/5% CAGR for the same periods

Amplifier & Other Analog has grown at 4%/2% CAGR for the 5/10 years

**Source:** Gartner, *Amplifier & Other includes Amplifier/Comparator, Interface and Other after Gartner switched to aggregate presentation in 2015.

**Chart 21 - Total Analog Market Segments Proportions**

- **Amplifier/Other Analog**
- **Voltage Regulator/Reference**
- **Data Converter/Switch/Multiplexer**

The largest segment of the Total Analog market is Voltage Regulator/Reference, representing 50% of Analog revenues

Data Converters, Switches and Multiplexes segment account for 20% of the Analog market

Amplifiers and Other Analog represent 30%. Within Amplifiers and Other Analog, Amplifiers comprise 60%+ of the Amplifiers & Other segment (based on market data from 2015)

**Source:** Jefferies, Gartner. Analog segments proportions calculated based upon revenue in 2017, latest actual full year data.

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Chart 22 - Total Analog Market Share

The Total Analog market has consolidated over the last 10 years. Notable acquisitions that have changed the competitive landscape:

- Texas Instruments + National Semi
- ON + Fairchild
- Linear + Analog Devices
- Richtech + MediaTek
- Renesas + Intersil + Integrated Devices

We expect the analog industry to become even more concentrated over the next 5-to-10 years.

Companies with 1.0-2.5% market share in declining order are MediaTek, Monolithic Power Systems, Infineon, Power Integrations, NXP, Nisshinbo, Sanken, Qualcomm, Diodes and Minebea Mitsumi.

Chart 23 - Total Analog Herfindahl Index

Total Analog segment HHI has increased to 13.5% from 6.0% over the last 10 years, which we think explains a lot of the positive pricing commentary from and margin expansion at the analog companies.

On an aggregate basis, the HHI is still low, which suggests there is a lot more consolidation to go.

Source: Jefferies, Gartner. The Herfindahl Index is calculated by summing the squares of the market shares of top 50 industry participants.
Consistent with previous case studies we have published on industry concentration (See Appendix 3 for HDD and DRAM case studies), analog EBIT margins have increased as the industry consolidated.

On a segment level within the analog industry, Converter & Switch and Amplifier & Other have seen the most consolidation over the past 5-to-10 years, which we think will particularly benefit TXN and ADI over the next 5-10 years, given their 5-10 year product cycles.

Analog stocks have outperformed the industry as the HHI has increased.

Source: Jefferies, Gartner, FactSet. Average Analog EBIT margin calculation includes ADI+LLTC, MXIM, ON+FCS and TXN.
2.2. Voltage Regulator / Reference Concentration Analysis

The Voltage Regulator market is the largest and the most fragmented analog segment but it is still consolidating. Notable acquisitions that have changed the competitive landscape:

- Texas Instruments + National Semi
- ON + Fairchild
- Linear + Analog Devices
- Richtech + MediaTek
- Renesas + Intersil

TXN and ADI are the market leaders with 26% and 11% share

Others with 1.0-2.0% market share in declining order are Nisshinbo, Minebea Mitsumi, Diodes, Dialog Semiconductor, Lite-On Semiconductor, MCHP, Ablic, Cirrus Logic, Qualcomm

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The HHI index for Voltage Regulator / Reference segment of Analog Market was 9.6% in 2018, up from 5.3% in 2009

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Source: Jefferies, Gartner. The Herfindahl Index is calculated by summing the squares of the market shares of top 50 industry participants.
2.3. Data Converter / Switch / Multiplexer Concentration Analysis

Data Converter/Switch is the most concentrated analog segment. Notable acquisitions that have changed the competitive landscape:

- Analog Devices + Linear
- Texas Instruments + National Semi
- Cirrus Logic + Wolfson
- On + Fairchild

Analog Devices has 43% share of the market, while Texas Instruments controls 24% of the market. Notably, for the period 2002-2018, TXN increased market share by 10%, while ADI gained 4%.

ADI and TXN are the market leaders with 43% and 24% share.

Others with 0.5%-1.0% market share in declining order are CEC Huada Semiconductor, Mercury Systems, Diodes, ON Semiconductor, Cobham, Renesas, Toshiba and Nuvoton Technology.

The Data Converter / Switch / Multiplexer HHI is at 26%, up from 17% in 2013, crossing into "Concentrated" HHI level.

Source: Jefferies, Gartner. The Herfindahl Index is calculated by summing the squares of the market shares of top 50 industry participants.
2.4. Amplifiers and Other Analog Concentration Analysis

The other Analog segment includes Amplifiers, Comparators, Interface, Clock, Timing and Other Analog.

Notable acquisitions that have changed the competitive landscape:
- Analog Devices + Linear Technology
- Texas Instruments + National Semi.
- Renesas + Intersil
- NXP + Freescale
- On + Fairchild
- Rohm + Poweration

TXN and ADI have the leading market shares with 38% and 21%, respectively

Others with 1.0% - 1.7% market share in declining order are Silicon Laboratories, Skyworks Solutions, Nisshinbo, Diodes, MegaChips, Toshiba, Rohm, Mercury Systems and Cobham

This segment has seen the greatest consolidation over the past 8 years with 1270bps increase in its HHI since 2010
Section 3. M&A Analysis
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According to our semi M&A framework (see note Semis M&A Handbook: More to Come), semiconductor M&A often succeeded when companies with low cost structure and higher valuation (Southeast on chart) acquired companies with high cost structure and low valuations (Northwest on chart). By acquiring Northwest, acquirers can win twice: 1) lower costs and increase earnings, and 2) get a better multiple on the higher earnings stream.

Within Voltage Regulator / Reference space our framework suggests that SLAB, SMTC, POWI, VICR, Lite-on, CRUS, AMS, DLG, Ricoh, MediaTek and AOSL might be attractive targets.
Data Converter / Switch / Multiplexer is moderately concentrated according to our HHI analysis, but also has fewer public players. Our M&A framework suggests that CRUS, AMS, Ricoh and Nuvoton might be attractive candidates in this segment.

The Amplifier and Other Analog segment has recently reached moderate concentration levels according to our HHI analysis and similarly to Data Converter / Switch / Multiplexer has fewer potential public targets. Our framework agrees CY could be a good target (recently announced to be acquired by IFX), and SLAB, CRUS and Anpec might be attractive targets.
Section 4. Analog Players' EPS Sensitivity Analysis
Section 4. Analog Players’ EPS Sensitivity Analysis

4.1. ADI Sensitivity Analysis

Chart 38 - ADI Revenue Split

Based on data provided by ADI, we estimate that Data Converter is the largest analog segment for the company, followed by Amplifiers and Other Analog and then by Power Management (Voltage Reg/Ref). We note that “Other” category includes some analog devices that fall outside of the general purpose analog devices categories.

Chart 39 - ADI Composite HHI, EBIT and Stock

Over the past 10 years, ADI’s Composite HHI increased by 690bps, its EBIT increased by 1,000bps and its stock outperformed SPX by 174%.

Chart 40 - ADI FCF/Share and Net Capital Return/Share

ADI FCF/share doubled over the past 3 years and increased steadily over the past 16 years, through the great recession and six inventory corrections. ADI’s capital return fell below FCF/share as it delevered from its LLTC acquisition.
Over the past five years, ADI and LLTC pro-forma revenues have increased at 9% CAGR, while gross and operating margins have expanded by 52 bps/yr and 162 bps/yr, respectively.

In the chart to the left, we show actual pro-forma TTM revenue, gross and operating margins through C1Q19, and forecasted bear, base and bull case projections for each for the next 5 years.

ADI's target model of 70%-plus GM and OM of 39%-45% is in-line with our 5yr base case GM and slightly more conservative than our OM base case.

Our 3-yr and 5-yr base case for EPS assumes 6% revenue CAGR and a 100 bps/yr improvement in operating margins. Our 3-yr and 5-yr bull case assumes 9% revenue CAGR and a 200 bps/yr improvement in operating margins.

Our 5-yr base and bull case targets translate to EPS that is 67% and 116% higher than CY19 consensus estimates of $5.27.

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Source: Jefferies, company data, FactSet

Source: Jefferies, company data, FactSet

Please see important disclosure information on pages 48 - 55 of this report.
4.2. MCHP Sensitivity Analysis

Chart 43 - MCHP Revenue Split (2018)

We estimate analog revenues at 25-30% of MCHP sales and MCUs at 55-60% of its sales.

Chart 44 - MCHP Composite HHI, EBIT and Stock

Over the past 10 years MCHP’s Composite HHI has increased by 450bps, its EBIT margin increased by 2,510bps and its stock outperformed the SPX by 143%.

Chart 45 - MCHP FCF/Share and Net Capital Return/Share

MCHP’s FCF/share doubled over the past 4 years and increased steadily over the past 16 years through the great recession and six inventory corrections. MCHP’s main capital return vehicle is its dividend, as its main use of cash recently is to pay down debt from its MSCC acquisition.
Over the past five years, MCHP and ATML, MSCC pro-forma revenues have increased at a 5% CAGR, while gross and operating margins have expanded by 225 bps/yr and 162 bps/yr, respectively.

In the chart to the left, we show actual TTM revenue, gross and operating margins through C1Q19, and forecasted bear, base and bull case projections for each for the next 5 years.

MCHP’s long term model is 63% non-GAAP GM and 40.5% OM, which we view as conservative.

Our 3-yr and 5-yr base case for EPS assumes 6% revenue CAGR and a 100 bps/yr improvement in operating margins. Our 3-yr and 5-yr bull case assumes 9% revenue CAGR and a 200 bps/yr improvement in operating margins.

Our 5-yr base and bull case targets translate to EPS that is 52% and 99% higher than CY19 consensus estimates of $6.18.
4.3. MXIM Sensitivity Analysis

Chart 48 - MXIM: Revenue Split

Analog represents ~90% of the MXIM’s revenues. According to Gartner, MXIM holds the #3 market share position in Total Analog and the #3-5 positions in all analog segments. In Amplifiers & Other, it holds the #3 position with 6% market share. ASSPs reflect mostly analog devices that do not fall into the general purpose device category.

Source: Jefferies, Gartner, company data

Chart 49 - MXIM Composite HHI, EBIT and Stock

Over the past 10 years MXIM’s Composite HHI has increased by 775bps, its EBIT margin increased by 849bps and its stock outperformed the SPX by 168%.

Source: Jefferies, Gartner, FactSet. Composite HHI calculated from Analog. Performance Relative to SPX is calculated from 31-Dec-01.

Chart 50 - MXIM FCF/Share and Net Capital Return/Share

Over the past 10 years MXIM’s FCF/share more than doubled during multiple inventory corrections. MXIM’s capital return exceeded its FCF/share due to its excess cash.

Source: Jefferies, company data
Over the past five years, MXIM revenues remained flat, while gross and operating margins have expanded by 176 bps/yr and 270 bps/yr, respectively. In the chart to the left, we show actual TTM revenue, gross and operating margins through C1Q19, and forecasted bear, base, and bull case projections for each for the next 5 years.

MXIM’s target model is 70% GM and 40% OM and is in-line with our base case scenario.

Our 3-yr and 5-yr base case for EPS assumes 6% revenue CAGR and a 100 bps/yr improvement in operating margins. Our 3-yr and 5-yr bull case assumes 9% revenue CAGR and a 200 bps/yr improvement in operating margins.

Our 5-yr base and bull case targets translate to EPS that is 50% and 94% higher than CY19 consensus estimates of $2.53.
4.4. ON Sensitivity Analysis

Chart 53 - ON: Revenue Split

- **Other Non-Analog**: 22%
- **CMOS Image Sensors**: 10%
- **Other Analog (ASICs, ASSPs)**: 17%
- **Discrete**: 36%
- **Voltage Regulator / Reference**: 12%
- **Data Converter / Switch / Multiplexer**: 1%
- **Amplifiers and Other Analog**: 2%
- **Other Non-Analog (ASICs, ASSPs)**: 17%

Source: Jefferies, Gartner, company data

ON has about 30-35% exposure to the analog market, along with high relative share in auto image sensors and #2 share in discretes, behind only IFX.

#4 share in Voltage Reg/Ref (5% mkt share)

#5 share in Data Converter (4% mkt share)

#3 share in Amplifiers & Other (6% mkt share)

Chart 54 - ON Composite HHI, EBIT and Stock

- Over the past 10 years ON's composite HHI has increased by 350bps, its EBIT margin increased by 856bps; meanwhile the stock has outperformed the SPX by 208%.

After Sanyo in 2011 and managing the impact of a tsunami, nuclear disaster and floods, ON's EBIT margins bottomed in 2012 and have improved by 750bps. We expect OMs to expand another 600bps.

Source: Jefferies, Gartner, FactSet. Composite HHI calculated from Analog and Discrete. Performance Relative to SPX is calculated from 31-Dec-01.

Chart 55 - ON FCF/Share and Net Capital Return/Share

ON's FCF/share has doubled over its baseline 10 years ago as it successfully integrated FCS. The company started returning cash to shareholders again in 2019 as it approached its target leverage ratio.

Source: Jefferies, company data
Over the past five years, ON and FCS pro-forma revenues have increased at a 7% CAGR, while gross and operating margins have expanded by 115 bps/yr and 193 bps/yr, respectively.

In the chart to the left, we show actual TTM revenue, gross and operating margins through C1Q19, and forecasted bear, base and bull case projections for each for the next 5 years.

ON’s 2022 target model of 43% GM and 22% OM is in-line with our base case on the OM, and falls in-between our base and bull cases on GM.

Our 3-yr and 5-yr base case for EPS assumes 6% revenue CAGR and a 100 bps/yr improvement in operating margins. Our 3-yr and 5-yr bull case assumes 9% revenue CAGR and a 200 bps/yr improvement in operating margins.

Our 5-yr base and bull case targets translate to EPS that is 70% and 146% higher than CY19 consensus estimates of $1.78.
4.5. TXN Sensitivity Analysis
Chart 58 - TXN Revenue Split (2018)

TXN reports Analog to represent 66% of the total revenues. Voltage Reg/Ref segment is the largest for TXN and represents ~30% of TXN's revenues, followed by Amplifiers & Other Analog. In both of these segments TXN holds the leading market share, while in Data Converter segment TXN is in second place after ADI.

Notably TXN's market share in Amplifiers & Other Analog has increased by 2% from 2017 to 2018.

Source: Jefferies, TXN, Gartner. Revenue split provided based on TXN 2018 segment and product line data.

Note: TXN reported the following revenues split for 2018: Analog - 66%, Embedded Processing - 23% and Other - 9%.

Chart 59 - TXN Composite HHI, EBIT and Stock

Over the past 10 years, TXN's Composite HHI increased by 643bps, its EBIT increased by 2,140bps and its stock outperformed SPX by 331%.

Source: Jefferies, Gartner, FactSet. Composite is calculated from Analog and MCU. Performance Relative to SPX is calculated from 31-Dec-01.

Chart 60 - TXN FCF/Share and Net Capital Return/Share

TXN's FCF/share doubled over the past 5 years and increased steadily over the past 16 years, through the great recession and six inventory corrections. TXN's capital return exceeded its FCF/share due to its excess cash.

Source: Jefferies, company data.
Over the past five years, TXN revenues have increased at a 5% CAGR, while gross and operating margins have expanded by 278 bps/yr and 414 bps/yr, respectively.

In the chart to the left, we show actual TTM revenue, gross and operating margins through 1Q19, and forecasted bear, base and bull case projections for each for the next 5 years.

TXN does not provide the details on target margins.

Our 3-yr and 5-yr base case for EPS assumes 6% revenue CAGR and a 100bps/yr improvement in operating margins. Our 3-yr and 5-yr bull case assumes 9% revenue CAGR and a 200 bps/yr improvement in operating margins.

Our 5-yr base and bull case targets translate to EPS that is 60% and 104% higher than CY19 consensus estimates of $5.16.
Appendices
Appendix 1. Analog Primer

Total Analog market has grown at 5%/3% CAGR for the 5/10 years

The Voltage Regulator / Reference segment has grown at a CAGR of 5%/4% for the past 5/10 years

Data Converter / Switch / Multiplexer has grown at 6%/5% CAGR for the same periods

Amplifier & Other Analog has grown at 4%/2% CAGR for the 5/10 years

The largest segment of the Total Analog space is the Voltage Regulator/Reference segment, representing 50% of Analog revenues

Data Converters, Switches and Multiplexes account for 20% of the Analog market

Amplifiers and Other Analog represent 30%. Within Amplifiers and Other Analog, Amplifiers comprise 60%+ of the Amplifiers & Other segment (based on market data from 2015)
### Chart 65 - Main Types of Analog Devices

<table>
<thead>
<tr>
<th>Category</th>
<th>Analog Type of Device</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage Regulator / Reference</td>
<td>Voltage Regulator</td>
<td>A circuit which is connected between the power source and a load, which provides a constant voltage despite variations in input voltage or output load.</td>
</tr>
<tr>
<td></td>
<td>Voltage Reference</td>
<td>An electronic device which produces a constant voltage regardless of the loading on the device, temperature changes, passage of time and power supply variations.</td>
</tr>
<tr>
<td>Data Converter / Switch / Multiplexer</td>
<td>Data Converter</td>
<td>A/D or D/A converter: An electronic circuit that converts analog signals to digital, or vice-versa. An analog signal is a continuously varying voltage or current. Its digital counterpart is a stream of digital numbers, each representing the amplitude of the analog signal at a moment in time.</td>
</tr>
<tr>
<td></td>
<td>Switch</td>
<td>A switching device capable of switching or routing analog signals based on the level of a digital control signal. Commonly implemented using a “transmission gate,” an analog switch performs a function similar to that of a relay. For example, an analog switch can turn an audio signal on or off based on a MUTE signal, or analog switches could send one of two signals to a headphone amplifier. Most commonly implemented using CMOS technology integrated circuits.</td>
</tr>
<tr>
<td></td>
<td>Multiplexer</td>
<td>An array of analog switches, usually on a single CMOS chip, that allows one input signal to be routed to any of several output lines, depending on the value of a set of digital control lines. A multiplexer can also be used in the opposite direction, allowing the array to connect one of several input lines to the output, depending on the control lines. Several of these can be implemented on one chip to make a multi-channel version.</td>
</tr>
<tr>
<td></td>
<td>Amplifier</td>
<td>An electrical circuit that produces an output that is a replica of the input. The output may be scaled or have increased drive, or it may provide isolation (so changes in output conditions do not affect the input or other outputs). It may perform other transformations (e.g., filtering or logarithmic drive).</td>
</tr>
<tr>
<td></td>
<td>Comparator</td>
<td>A comparator is a device that accepts two analog inputs, compares the inputs, and produces a binary output that is a function of which input is higher. If the non-inverting (+) input is greater than the inverting (-) input, then the output goes high. If the inverting (-) input is greater than the non-inverting (+) input, then the output goes low.</td>
</tr>
<tr>
<td>Amplifier and Other Analog</td>
<td>Interface</td>
<td>An IC that is used to connect sensors and other devices. It collects input at the interface collects data from the sensor and the output of the interface sends the data to a computer or other suitable device. Sensor interface chips may be used in many types of sensors and sensing devices, including accelerometers, strain gauges, piezoresistive pressure sensors, load cells, thermistors, and other bridge-type sensors. Sensor interface and excitation IC chips are often self-calibrating, which enables them to get high accuracy data from sensors that may not be ideal. Basic sensor interface chips typically include sensor-excitation circuitry, a programmable gain amplifier, and an analog output. Other types of sensor interface chips include other components, such as digital-to-analog converters (DAC), analog-to-digital converters (ADC), electrically-erasable programmable read-only memory chips (EEPROMs), and other components to manage temperature drift. A sensor IC chip also can perform signal conditioning such as gain and offset adjustment and linearity correction.</td>
</tr>
</tbody>
</table>

Source: Jefferies, Analog companies websites
Appendix 2. Tectonic Shifts in Computing - PC and Cellphone Case Studies

Secular Analog Demand – Tectonic Shift to Parallel Processing and IoT Computing Paradigm

In our July, 2017 note: “4th Tectonic Shift in Computing,” we observed that the computing paradigm shifted every 15 years (10x units, 1/10th cost, 1/10th footprint), and argued that it is currently shifting to a parallel processing / IoT model. We believe the current shift is being driven by both the low cost of storing the data that the IoT devices are generating, as well as improvements in parallel processing technologies like neural networking. As the data from the IoT devices is being processed in an AI framework, higher utility is being driven into those devices, increasing demand for them. The higher utility / increased demand feedback loop is becoming a virtuous circle.

We argued that the analog companies, TXN, ADI, MCHP, MXIM and ON are plays on this Tectonic Shift theme as companies that supply critical components that enable the IoT devices.

Chart 66 - Tectonic Shifts in the Computing Paradigm over the Past 60 years

Source: See page 10 for the detailed list

Please see important disclosure information on pages 48 - 55 of this report.
INTC and MSFT have been critical suppliers of components into the PC “Bill of Materials” or BOM, during the PC Era. INTC’s IPO was in 1971, MSFT’s was in 1986.

INTC supplies MPUs into PC, which can account for 20-25% of the total BOM of the PC.

MSFT supplies software into the PC that can account for 15-20% of the PC BOM.

During the PC Era, as defined by unit shipments from the left chart, we estimate that MSFT stock appreciated by 166x, and INTC appreciated by 75x, both of which compare favorably to the SPX which appreciated by 8x.
QCOM and ARMH have been critical suppliers of components into the cell phone. QCOM and ARMH went public in 1991 and 1998, respectively.

QCOM supplies application and baseband processors into the cellphone, and both ARMH and QCOM have supplied critical IP that go into those cell phone processors.

We estimate that their combined content can account for 15-20% of the BOM of a cell phone.

During the Cell Phone / Datacenter Era, we estimate that ARMH stock appreciated by 30x, and QCOM appreciated by 22, both of which compare favorably to the SPX which appreciated by 2.8x.

We estimate the Parallel Processing / IoT Era is two years underway. Relative to the Cellphone Era, NVDA would be here at 6.6x indexed return over two years.

Source: Jefferies, IHS

Source: Jefferies, FactSet
Chart 71 - Critical Components of FitBit BOM

- MCU (18% of BOM), $3.20
- Analog + Connectivity (28% of BOM), $5.00
- Other (memory, battery, wristband, 54%), $9.80

FitBit BOM = $18

Source: Jefferies, Electronics360

Chart 72 - Critical Components of Nest Thermostat BOM

- MCU (17% of BOM), $12
- Analog + Connectivity (21%), $14
- Other (display, memory, enclosure, 63%), $44

Nest Thermostat BOM = $70

Source: Jefferies, Electronics360

Chart 73 - Critical Components of Apple Watch BOM

- Application Processor (14% of BOM), $10
- Analog + Connectivity (24%), $17
- Other (display, memory, enclosure, 62%), $44

Apple Watch BOM = $71

Source: Jefferies, MacRumors.com

Chart 74 - Critical Components of Average IoT BOM

- MCU (17% of BOM), $12
- Analog + Connectivity (21%), $14
- Other (display, memory, enclosure, 63%), $44

Average IoT BOM = $53

Source: Jefferies, Electronics360, MacRumors.com
Critical components plays like TXN appear to be off to a good start during the IoT / Parallel Processing Era, having outperformed the SPX since the end of 2015.

Assuming 10-15 years between Tectonic Shifts in computing, we think that they are well positioned to benefit from a long run of sustainable growth in secular demand and outperformance during the IoT/Parallel Processing Era.

Source: Jefferies, FactSet
Appendix 3. HHI Primer and Case Studies (HDD+DRAM)

The Herfindahl-Hirschman Index (aka “Herfindahl Index” or “HHI”) is a quantitative measure of the competitiveness of an industry. It is calculated by summing the squares of the market share of the top 50 companies in an industry. The higher the index, the higher the industry concentration, and lower the competitiveness of the industry. For example, one company with 100% share would return an HHI of 100% (a monopoly). By contrast, 100 companies with 1% share each would return an HHI of 1% (highly competitive industry).

HHI Implementation by FTC and DoJ

The HHI is used by the FTC and DoJ for the purposes of assessing the impact of a merger on an industry’s competitiveness. These Agencies have defined three buckets for the index, and apply the following general standards:

1. HHI < 15% = Unconcentrated Market, which we would describe as highly competitive. Mergers that result in a 1% or less increase in the HHI are unlikely to have adverse competitive effects and normally require no further analysis.

2. HHI between 15% and 25% = Moderately Concentrated. Mergers that result in a 1% or more increase in the HHI raise significant competitive concerns and often warrant scrutiny.

3. HHI > 25% = Highly Concentrated or a less competitive industry. Mergers that result in an increase of the HHI of between 100 and 200 points potentially raise significant competitive concerns and often warrant scrutiny. Mergers that result in a 2% or higher increase in the HHI are viewed as enhancing market power.

The HHI is named after two economists, Orris Herfindahl and Albert Hirschman. The index was derived to measure the concentration of an industry was first published in 1945 by Hirschman (National Power and the Structure of Foreign Trade, Berkeley). A variation of that metric used today was published by Herfindahl in 1950 (Concentration in the US Steel Industry, Doctoral Dissertation, Columbia University)

Please see important disclosure information on pages 48 - 55 of this report.
The HDD industry has consolidated from over a dozen companies 25 years ago, to three main competitors.

The Herfindahl Index inflected into the Concentrated tier in 2013 and has remained above 35% since.

More recently, the HHI declined as Toshiba regained share.
Chart 78 - Herfindahl Index vs. HDD EBIT Margin

Profitability of WDC and STX improved as the industry consolidated, and then declined as Toshiba regained share.

Chart 79 - Herfindahl Index vs. Relative Stock Performance

WDC and STX stock prices also improved with the increasing HDD Herfindahl Index, and then declined as Toshiba regained share.
The DRAM industry has consolidated from 24 companies in 1987 to 3 major competitors with 95% of the market in 2018.

The DRAM HHI has increased dramatically between 2008 and 2017 and remained above 30% since 2014, well into the “Concentrated” industry category.

This suggests to us that the recent positive inflection in MU fundamentals are much more secular, rather than cyclical in nature.

Source: Jefferies, Gartner. DRAM market share calculated based upon revenue.

Source: Jefferies, Gartner. DRAM market shares calculated based on revenues.

Please see important disclosure information on pages 48 - 55 of this report.
We look at MU EBIT margin as a proxy for the DRAM space given it is the only pure play DRAM company. The EBIT margin has increased with the Herfindahl Index, even if with a degree of volatility.

Pricing in DRAM has also improved as the industry has become more concentrated.
### Appendix 4. Valuations Table

#### Chart 84 - Coverage Fundamentals Table

<table>
<thead>
<tr>
<th>Ticker</th>
<th>Rating</th>
<th>Price Target</th>
<th>7/3/19 Price</th>
<th>Market Cap (m)</th>
<th>Cash (m)</th>
<th>Debt (m)</th>
<th>Net Debt (m)</th>
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<td>10,307</td>
<td>9,876</td>
<td>41.51</td>
<td>5.7x</td>
<td>5.4x</td>
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<td>694</td>
<td>502</td>
<td>7.64</td>
<td>3.3x</td>
<td>2.9x</td>
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<td>n.m.</td>
<td>(0.55)</td>
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<td>16,446</td>
<td>1,898</td>
<td>992</td>
<td>(906)</td>
<td>(3.33)</td>
<td>6.9x</td>
<td>6.3x</td>
<td>21x</td>
<td>18x</td>
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<td>NXPI</td>
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<td>18.05</td>
<td>3.7x</td>
<td>3.4x</td>
<td>18x</td>
<td>15x</td>
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<td>ON</td>
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<td>1.7x</td>
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<td>TSEM</td>
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<td>0.9x</td>
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<td>113,407</td>
<td>5,328</td>
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<td>32,220</td>
<td>80.94</td>
<td>6.5x</td>
<td>5.9x</td>
<td>15x</td>
<td>13x</td>
<td>21.22</td>
<td>22.65</td>
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<td>52.46</td>
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<td>455</td>
<td>26</td>
<td>0.57</td>
<td>6.9x</td>
<td>5.7x</td>
<td>18x</td>
<td>15x</td>
<td>1.63</td>
<td>2.16</td>
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<tr>
<td>RMBS</td>
<td>Hold</td>
<td>13.00</td>
<td>12.14</td>
<td>1,336</td>
<td>306</td>
<td>165</td>
<td>(141)</td>
<td>(1.28)</td>
<td>3.4x</td>
<td>2.8x</td>
<td>13x</td>
<td>13x</td>
<td>0.90</td>
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<tr>
<td>SGH</td>
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<td>24.34</td>
<td>562</td>
<td>126</td>
<td>208</td>
<td>81</td>
<td>3.53</td>
<td>0.6x</td>
<td>0.5x</td>
<td>8x</td>
<td>n.m.</td>
<td>3.45</td>
<td>3.21</td>
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<td>5.3x</td>
<td>4.8x</td>
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Source: Jefferies, company data, FactSet

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Company Valuation/Risks

**Analog Devices, Inc.**
ADI trades at NTM P/Es ranging from 14x to 22x. Our $125 PT assumes a P/E of 20x applied to our CY20 ADI EPS estimate of $6.27. We expect P/E to expand as the company enters capital return cycle. Downside risks include integration risk with the LLTC acquisition, weakening of consumer, automotive, and communications infrastructure markets.

**Maxim Integrated Products, Inc.**
Our $71 PT assumes a P/E multiple of 24x applied to our CY2020 EPS estimate of $2.95, exceeding the recent range of 15x-23x. Downside risks include share loss at mobile/wearables OEMs, a slowdown in its Auto or Industrial businesses, extended inventory recession or macro-driven downturn.

**Microchip Technology Inc.**
Our base-case price target of $112 assumes a 15x multiple on our C2020 EPS estimate of $7.49. Multiple of 15x falls within MCHP’s 5-yr range before correction of 9x-18x. Risks to our thesis: 1) increasing competition in the MCU market; 2) failure to successfully integrate acquisitions; and, 3) a pronounced cyclical inventory correction.

**ON Semiconductor Corporation**
Our ON price target of $29 is based on C2020 EPS of $2.2 and a P/E ratio of 13x, above the mid point of the 5-yr range of 8x-15x, which we think is justified due to 1) ON’s competitive positioning and our view that the analog group in general and ON specifically will benefit from demand dynamics described in our “4th Tectonic Shift in Computing Thesis,” and our view that it will benefit from a sustained period of upward revisions 2) GM margin expansion potential based on our view that analog industry consolidation will positively impact the pricing environment and ON’s margins combined with additional margin tailwinds from ON’s recently announced M&A deals and margin mix shift in 2H19 3) bottoming out fundamentals. Downside risks include: 1) share loss; 2) inventory correction; and 3) ASP compression.

**Texas Instruments Incorporated**
Our $137 PT assumes a 20.5x multiple on our 2020 EPS est. of $6.68. A 20.5x P/E is in the middle of the 5-yr range of 16x-25x and we think warranted given its exposure to secular trends (IoT, Auto, Industrial, Consolidation). Downside risks include inventory correction, macro and/or geopolitical-driven demand weakness and multiple compression.

**Analyst Certification:**
I, Mark Lipacis, certify that all of the views expressed in this research report accurately reflect my personal views about the subject security(ies) and subject company(ies). I also certify that no part of my compensation was, is, or will be, directly or indirectly, related to the specific recommendations or views expressed in this research report.

I, Natalia Winkler, CFA, certify that all of the views expressed in this research report accurately reflect my personal views about the subject security(ies) and subject company(ies). I also certify that no part of my compensation was, is, or will be, directly or indirectly, related to the specific recommendations or views expressed in this research report.

I, Vedvati Shrotre, certify that all of the views expressed in this research report accurately reflect my personal views about the subject security(ies) and subject company(ies). I also certify that no part of my compensation was, is, or will be, directly or indirectly, related to the specific recommendations or views expressed in this research report.

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**Investment Recommendation Record**
(Article 3(1)e and Article 7 of MAR)

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<th>Recommendation Published</th>
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Within the past twelve months, Jefferies LLC and/or its affiliates received compensation for products and services other than investment banking services from non-investment banking, securities related compensation for client services it provided to Analog Devices, Inc.
Jefferies Group LLC, its affiliates or subsidiaries expect to receive or intend to seek compensation for investment banking services from Microchip Technology Inc. within the next three months.

Explanation of Jefferies Ratings

Buy - Describes securities that we expect to provide a total return (price appreciation plus yield) of 15% or more within a 12-month period.
Hold - Describes securities that we expect to provide a total return (price appreciation plus yield) of plus 15% or minus 10% within a 12-month period.
Underperform - Describes securities that we expect to provide a total return (price appreciation plus yield) of minus 10% or less within a 12-month period.

The expected total return (price appreciation plus yield) for Buy rated securities with an average security price consistently below $10 is 20% or more within a 12-month period as these companies are typically more volatile than the overall stock market. For Hold rated securities with an average security price consistently below $10, the expected total return (price appreciation plus yield) is plus or minus 20% within a 12-month period. For Underperform rated securities with an average security price consistently below $10, the expected total return (price appreciation plus yield) is minus 20% or less within a 12-month period.

NR - The investment rating and price target have been temporarily suspended. Such suspensions are in compliance with applicable regulations and/or Jefferies policies.
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NC - Not covered. Jefferies does not cover this company.
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Jefferies Franchise Picks include stock selections from among the best stock ideas from our equity analysts over a 12 month period. Stock selection is based on fundamental analysis and may take into account other factors such as analyst conviction, differentiated analysis, a favorable risk/reward ratio and investment themes that Jefferies analysts are recommending. Jefferies Franchise Picks will include only Buy rated stocks and the number can vary depending on analyst recommendations for inclusion. Stocks will be added as new opportunities arise and removed when the reason for inclusion changes, the stock has met its desired return, if it is no longer rated Buy and/or if it triggers a stop loss. Stocks having 120 day volatility in the bottom quartile of S&P stocks will continue to have a 15% stop loss, and the remainder will have a 20% stop. Franchise Picks are not intended to represent a recommended portfolio of stocks and is not sector based, but we may note where we believe a Pick falls within an investment style such as growth or value.

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Other Companies Mentioned in This Report

- Analog Devices, Inc. (ADI: $111.83, BUY)
- Maxim Integrated Products, Inc. (MXIM: $60.08, BUY)
- Microchip Technology Inc. (MCHP: $87.93, BUY)
- ON Semiconductor Corporation (ON: $19.51, BUY)
- Texas Instruments Incorporated (TXN: $114.93, BUY)

Please see important disclosure information on pages 48 - 55 of this report.
Notes: Each box in the Rating and Price Target History chart above represents actions over the past three years in which an analyst initiated on a company, made a change to a rating or price target of a company or discontinued coverage of a company.

Legend:
I: Initiating Coverage
D: Dropped Coverage
B: Buy
H: Hold
UP: Underperform

Please see important disclosure information on pages 48 - 55 of this report.
## Distribution of Ratings

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<th>IB Serv./Past12 Mos.</th>
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<tr>
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<td>Count</td>
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<td>UNDERPERFORM</td>
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