



SEMICONDUCTOR SUPPLY CHAIN UPDATE

DISTRIBUTION INSIGHTS – MARCH 2018

Important disclosures can be found in Appendix

Bookings/orders tracking inline to slightly ahead of seasonal trends in C1Q, initial outlook into C2Q remains favorable; lead times in discretives/passives remains extended despite pockets of increased output capacity

Datapoints

1. C1Q/C2Q orders tracking in-line or better than seasonal/expectations on strong demand and stretched lead times
2. Industrial, auto, distribution remain the key demand drivers; mobile seeing some improvement post Chinese New Year
3. Passive & discrete demand noted as growing faster than analog/semis helped by stretched lead times & allocation concerns
4. No signs of lead time contraction or order cancellations despite modest capacity expansion from select suppliers/categories
5. Distribution book-to-bills remains strong at above 1, customers & distributors looking to lock in additional supply
6. Lead times still quoted 30+ weeks in passives/discretives with some orders quoted for delivery into mid-CY19
7. MCU lead times extending for NXP/TI/ST – ST viewed as seeing the longest lead times in quoting into CY19
8. TI viewed as supply constrained in certain product segments, and turning away additional orders for C1H18
9. Pricing continues moving higher in passives & discretives and in some analog semis
10. At least one passive/discrete supplier appears to have altered distribution margins, effectively raising prices on distributors
11. Multiple passive & discrete suppliers appear to be adding as much as 15%+ capacity with output in late CY17 and throughout 2018

Conclusion

Our research findings are similar to the last several reports on the analog market. Demand appears to be tracking at least in-line with expectations, if not better than expected, and forecasts call for at least a seasonal, if not better, C2Q18. Industrial and distribution/channel demand remains the strongest relative end market, and content additions in automotive are expected to remain a strong demand driver. Smartphone started off C1Q18 slower but has shown some improvement following Chinese New Year, particularly within select tier-1 branded China OEMs. Consumer and computing segments are viewed as tracking largely seasonal with the high-end of computing and data center seeing continued strong demand.

Stretched lead times and rising prices remain the predominant topics of discussion in our channel research. The issue is most acute in passives and discretives, but pockets of higher-end analog including MCUs are seeing stretched or stretching lead times as well. Some capacity has been added for capacitors, resistors, diodes, and other lower-end product lines, but lead times have not yet shown any signs of contraction and prices continue to trend higher. There is a growing concern and consensus in the supply chain that these product lines lead times are likely to remain stretched through CY18 and likely at least early CY19. Double bookings do continue to get mentioned in our research, but we are not seeing typical correction signs yet in our research – lead times aren't contracting, inventory appears short or in-line, pricing has continued moving higher, and we have not yet heard of any order cancellations.

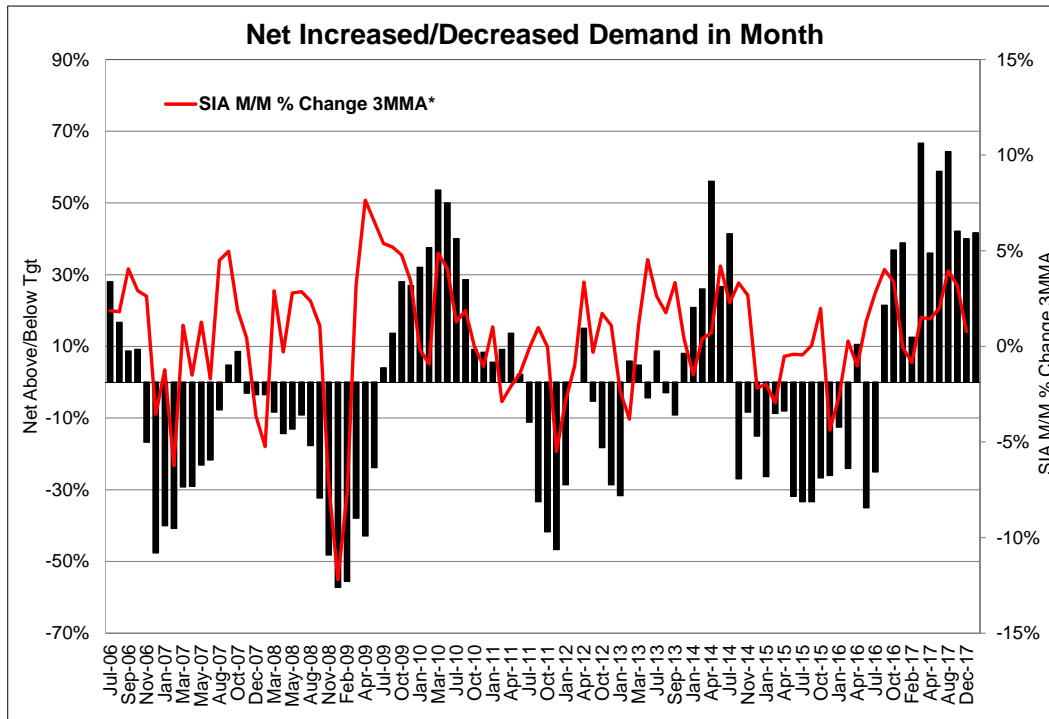


The report below is comprised of our research throughout the semiconductor supply chain in North American, Europe, and Asia with a goal to gain a better understanding of trends within the analog semiconductor industry.

Survey Results and Expectations

Survey Question: How was demand versus expectations? What will the current quarter grow sequentially?

Answer: Demand in-line or better for C1Q18 on healthy bookings led by industrial/auto & lead time extensions



Source: Cleveland Research Company; Semiconductor Industry Association

For Feb/Mar, 0% indicated that sales were below expectations (vs. 0% the last four survey); 58% indicated that sales were in-line (vs. 60% last survey); and 42% indicated that sales exceeded targets (vs. 40% last survey).

Demand in C1Q18 appears to be tracking in-line (or slightly better than expected) and relatively seasonal for broad based analog semis. Following similar trends seen throughout CY17, our research suggests demand/orders for lower-end active/passive commodities including discretes/MOSFETS, resistors, capacitors continue to significantly outpace suppliers production capacity. Industrial and auto remain the strongest end markets, and bookings continue to track better in distribution/channel than direct. Industrial appears strong across end segments led by test equipment and factory automation, military, and automotive as suppliers continue to benefit from ongoing semi content growth within the market despite slowing unit builds/deliveries growth.

Consumer and compute segments appear seasonally slower and was viewed as the lone end market segment that was viewed as softer, relatively to initial expectations Q/Q. Notebook is viewed as relatively in-line however orders are still viewed as stronger into high-end notebook segment which we view as accretive to overall semi content which we believe is helping to offset pockets of softness in the broader based notebook/PC market this quarter. Mobile orders have shown material weakness in early C1Q18, particularly from the major branded China OEMs, but orders from some China OEMs including Vivo, Oppo, and Xiaomi have begun to improve following Chinese New Year. Other tier-one OEMs are viewed as likely to work through an inventory adjustment in C1Q18.

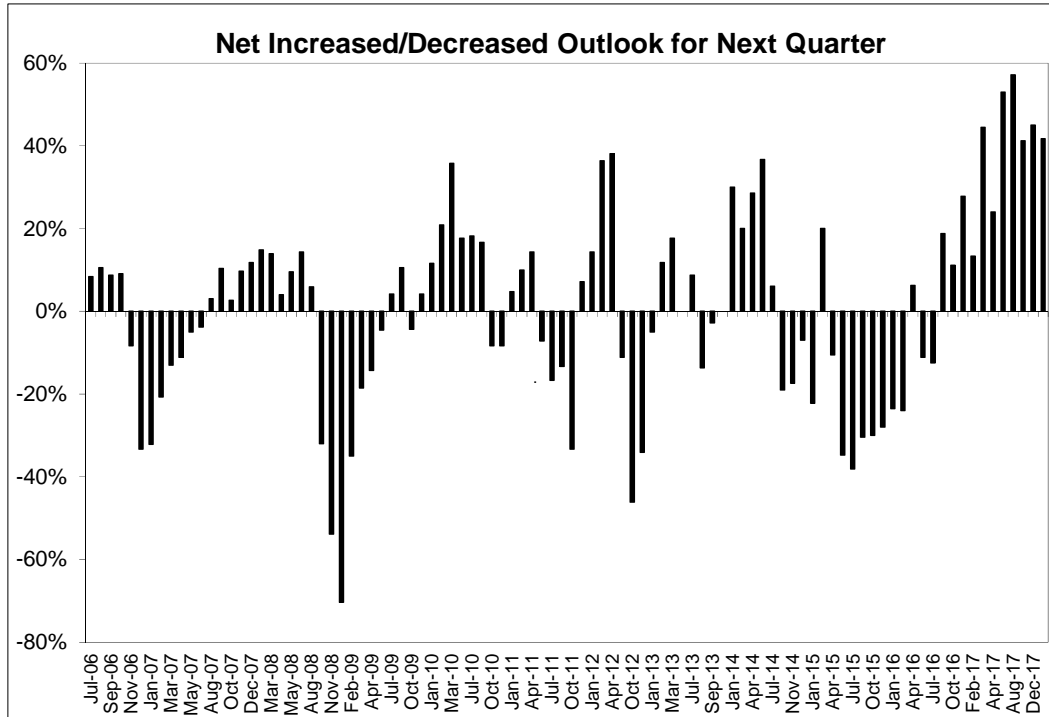
Access to supply remains the primary concern in passive/discrete product lines. There have been capacity additions by some suppliers in these segments and more additions are expected throughout CY18, but we have yet to see lead times in these product categories contract. For the past several quarters we have heard On Semi, Murata, Diodes, Vishay, AVX, Murata, ST, and several other suppliers/lines in semiconductors and memories are being constrained by available wafer supply, back-end package and testing capacity, or other commodity/component shortages. We do not believe higher performance analog lead times are suffering



to the same extent from the issues highlighted above. As a result, we believe these suppliers are likely to better capitalize on the healthy/steady improvement in bookings/orders, due to the relative lack of production capacity constraints.

Survey Question: How have your sales targets changed? What is your outlook for the upcoming quarter?

Answer: Expecting continued tight supply & strong demand/guides into C2Q



Source: Cleveland Research Company

For Feb/Mar, 0% of channel contacts revised sales targets down (vs. 0% the last five surveys); 58% maintained current sales targets (vs. 55% last survey); and 42% revised sales targets up (vs. 45% last survey).

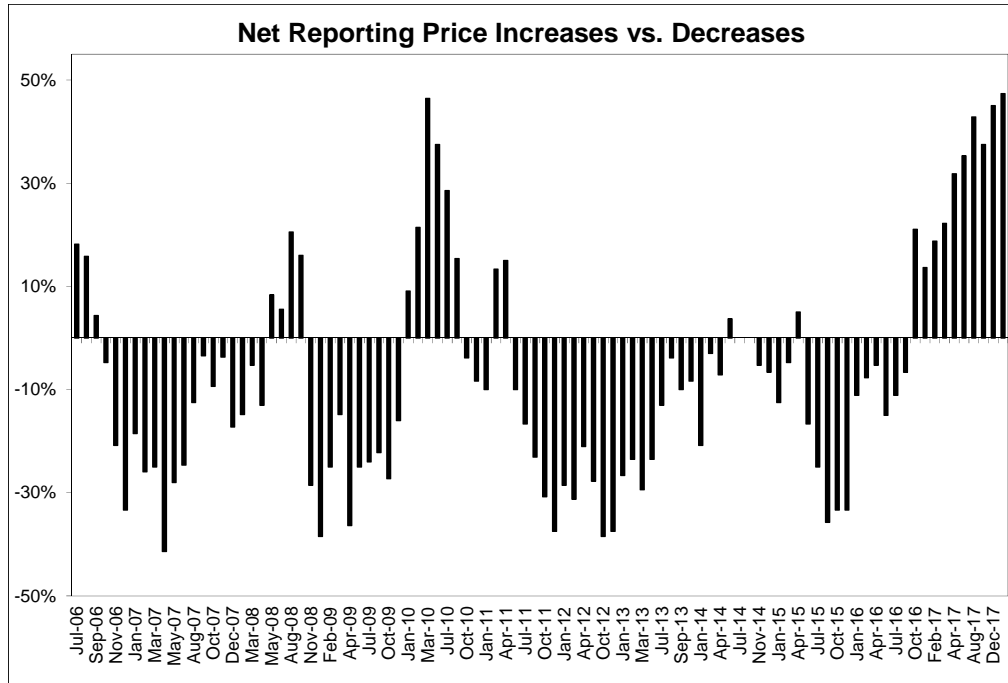
Book-to-bill ratios have remained stronger than normal/seasonal, particularly through distribution and particularly in discretives and passives. Based on current backlogs/order forecasts, we are forecasting shipments to trend seasonally higher in C2Q18 and again in C3Q18. Forecasts for CY18 growth for analog semis overall remains in the mid/high-single digits Y/Y. Industrial and auto are again expected to remain the key growth drivers in the near-term, and demand is expected to improve seasonally in consumer, mobile, and computing.

Communications equipment has shown some improvement since Chinese New Year which we expect could continue to be a mild tailwind for performance analog suppliers including Analog, Maxim, and TI. Demand has been for 4G with 5G in China not expected to pick-up until C1H19. The focus in CY18 appears to be on lowering the infrastructure costs of 5G to make government plans for a CY19 roll-out more feasible. Data center demand in China and overall Asia also appears to have improved since Chinese New Year. We expect data center to remain a consistent demand driver for all of tech throughout CY18+.

Access to supply remains a concern throughout the supply chain, particularly in passives and discrete. There has been consistent concern over customers pulling ahead some orders to enhance their ability to secure product and hedge against worsening shortages. We have not seen typical signs of a pending cyclical correction – there are limited or no calls of elevated inventory or contracting lead times or order cancellations in our research. The supply chain remains cognizant of the potential for and risk of double orders however to date despite pockets of increased capacity coming on we have yet to see any material decline in bookings and/or lead times.

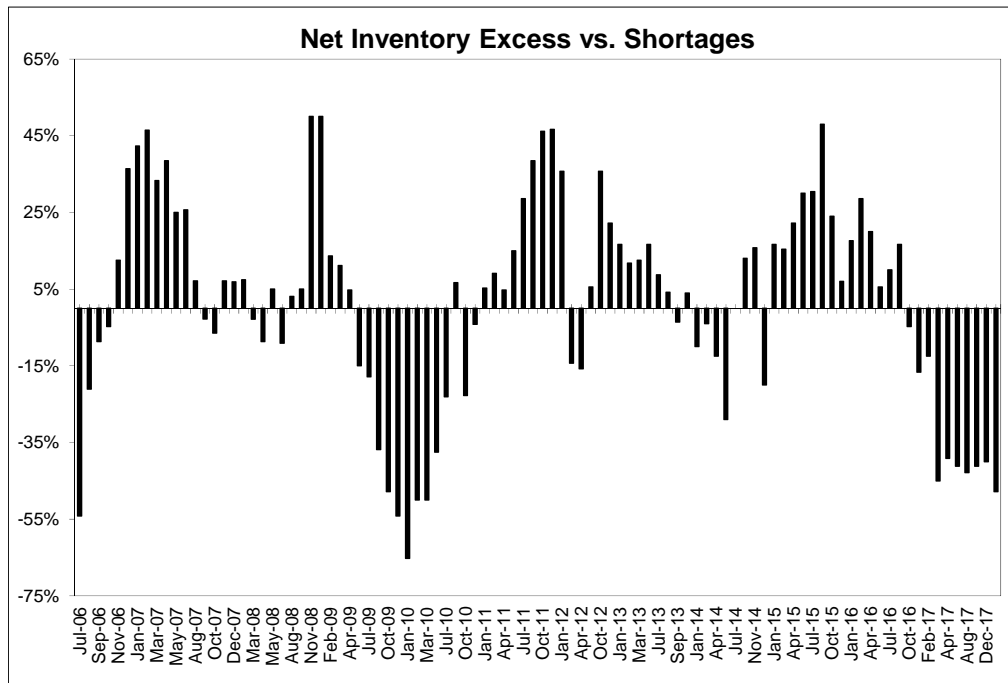


Survey Question: How are inventory levels? Any change in pricing?
Answer: Pricing leveled off in some categories, inventory viewed as remaining lean



Source: Cleveland Research Company

For Feb/Mar, 0% reported price declines (vs. 0% last five surveys); 53% reported flat pricing (vs. 55% in last survey); and 47% reported increased pricing (vs. 45% in last survey).



Source: Cleveland Research Company

For Feb/Mar, 4% reported inventory excess (vs. 0% last survey); 44% reported in-line inventory (vs. 60% last survey); and 52% reported some shortages (vs. 40% last survey).



Pricing trends across the supply chain, particularly within discretes/passives continues to remain in the favor of suppliers. Suppliers appear to be passing through part/part price increases in several categories, particularly in passive/discretes from On Semi, AVX, Murata, Vishay, KEMET, Hitano, and Nexperia. Other suppliers are finding different ways to effectively raise pricing including having reduced or working on reducing distribution payouts, charging expedite fees, or passing through what they claim are raw material price increases. Memory pricing has continued to move broadly higher, particularly in segments serving auto and industrial including SLC/MLC planar NAND and NOR flash. NOR pricing is noted as having at least doubled over the past year.

By product set, MLCCs are generally noted as seeing the worst shortages and longest lead times. Capacity has been added by some suppliers into the capacitor market, and more is planned for later in CY18, but there is a growing consensus in the supply chain that MLCC shortages will continue into or possibly through CY19. Murata is estimated to be the largest supplier at ~45% share in the segment, and they are noted as having added a significant amount of capacity already in CY18, but their lead times being quoted haven't changed. MLCCs are an example of an issue across the industry – supplier consolidation has cut the number of customer options and cut the absolute capacity, and further M&A is likely.

Consolidation appears to have affected the supply situation in passives and discretes more than higher-end analog components, but MCUs have seen massive consolidation with Freescale, Atmel, Spansion, and several other private lines being acquired over the past several years. The impact has been similar with Microchip gaining pricing power, and all suppliers seeing lead times stretch, particularly ST who appears to be quoting deliveries into CY19. M&A is also driving concerns on longevity of supply in some product categories and from some suppliers. In memory, niche suppliers like IOTS and AP Memory are benefiting from other suppliers leaving lower end flash markets, but it is much more difficult in higher-end analog where products are not as swappable as memory or passives/discretes.

Equipment lead times are also noted as stretching, particularly in back-end assembly/test operations. In some categories equipment delivery that had been under 10 months is now stretched out to 15+ months, and the delays are noted as limiting the industry's ability to expand capacity significantly in the near-term. Capacity that is installed has been running at full utilization for several months/quarters, and we are beginning to see some concern in the supply chain that product quality is worsening due the extended period of high utilization.

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