MLCC Market Update

July 12, 2018
MLCC Market Update

Causal Factors

Supplier Action Plan

TTI Action Plan

Existing Alternatives

Final Thoughts
MLCC Market Update

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Final Thoughts
Causal Factors

Strong Economy + Technological Advancements

- MLCC market demand has risen dramatically over the past 18 months largely due to simultaneous growth in virtually all market segments.
- Additionally, increased technology in the strong automotive, industrial and telecom markets have pushed demand beyond all anticipation.

Automotive
- Powertrain
- Safety & Comfort
- Body Electronics
- Infotainment & Telematics Systems

Data
- Smart Phones
- Mobile Internet
- 5G

MLCC content by power train (number of Pure ICE=1)

MLCC content per phone increases along with the mobile phone upgrade:
- Low-end: 400
- Mid: 650
- High-end: 900
- iPhone 6: 700
- iPhone 7: 900
- iPhone X: 1100

Number of MLCCs per phone
Causal Factors

Raw Material Cost Trends

Direct materials like bonding wire, lead frame, lead wire, etc. are all affected by metals price increases. For more information, please see TTI MarketEYE @ www.ttiinc.com/content/ttiinc/en/resources/tools/material-costs.html

<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Price</th>
<th>Ceramic</th>
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<tbody>
<tr>
<td>Base Metals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminum</td>
<td></td>
<td>Low</td>
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<tr>
<td>Copper</td>
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<td>Med</td>
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<tr>
<td>Zinc</td>
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<td>Nickel</td>
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<td>Platinum</td>
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<td>Med</td>
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<tr>
<td>Palladium</td>
<td></td>
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<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil</td>
<td></td>
<td>Low</td>
</tr>
</tbody>
</table>

** If non-RoHS compliant part
Causal Factors

Supplier Reluctance to Add Capacity

- MLCC unit output has increased every year while revenues remained flat
- Suppliers adding capacity with more balanced and/or measured objective
- Demand growing 25%-35% while capacity grows 10%-25%
- Forecasted to require a couple years to level out

Ceramic Capacitor Market

~50% volume increase for no value given investment required & overall low ROI
many suppliers have changed their strategy

<table>
<thead>
<tr>
<th>Year (FY)</th>
<th>World Value</th>
<th>World Volumes</th>
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<tr>
<td>1996</td>
<td>$1.0</td>
<td>50 T</td>
</tr>
<tr>
<td>1997</td>
<td>$1.2</td>
<td>100 T</td>
</tr>
<tr>
<td>1998</td>
<td>$1.5</td>
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<td>$3.2</td>
<td>500 T</td>
</tr>
<tr>
<td>2006</td>
<td>$3.5</td>
<td>550 T</td>
</tr>
<tr>
<td>2007</td>
<td>$3.8</td>
<td>600 T</td>
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<tr>
<td>2008</td>
<td>$4.0</td>
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<td>$4.5</td>
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</tr>
<tr>
<td>2012</td>
<td>$5.0</td>
<td>850 T</td>
</tr>
<tr>
<td>2013</td>
<td>$5.2</td>
<td>900 T</td>
</tr>
<tr>
<td>2014</td>
<td>$5.5</td>
<td>950 T</td>
</tr>
<tr>
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<td>1100 T</td>
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<tr>
<td>2018</td>
<td>$6.5</td>
<td>1150 T</td>
</tr>
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</table>

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Causal Factors

Supplier Decisions to Cease Production

- Several larger suppliers have elected to end of life (EOL) less profitable, commodity products.
- Capacity and resources are being redirected to smaller, more economical case sizes and market segments promising more reasonable returns.

<table>
<thead>
<tr>
<th>Global Supplier Migration from Larger Case Low Capacitance to Smaller Case Size High Capacitance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size(inch):</td>
</tr>
<tr>
<td>1005</td>
</tr>
<tr>
<td>0201</td>
</tr>
<tr>
<td>0402</td>
</tr>
<tr>
<td>0603</td>
</tr>
<tr>
<td>0805</td>
</tr>
<tr>
<td>1206</td>
</tr>
<tr>
<td>&gt;=1210</td>
</tr>
</tbody>
</table>
MLCC Market Update

- Causal Factors
- Supplier Action Plan
- TTI Action Plan
- Existing Alternatives
- Final Thoughts
Supplier Action Plans

Effect on Distribution

- **Product Allocation and Limiting of New Orders**
  - Distribution is allowed to purchase in levels equivalent to 2016/17 volumes
  - Not able to handle the upside of new customers or increased demand

- **Increasing Manufacturing Capacity**
  - 30% capacity will not satisfy current demand
  - Capital equipment lead times running 12-24 months

- **Increasing Distributor Buy Prices**
  - Increasing pricing on new business
  - Not extending debit renewals
  - Re-pricing open backlog and contract pricing

- **Expiring Special Costs**
  - MPP volume pricing increasing or being removed
  - Affecting existing orders
Constrained Suppliers on TTI’s Linecard

As of July 1, 2018

Commercial and automotive ceramic capacitors
Select values in 0201 through 2220 case sizes
Low CV and high CV in all dielectrics

Commercial, automotive and specialty (Flexterm, high temp, high volt, fail safe)
Series Cxxxx, all values in 0201 through 2225 case sizes
Low CV and high CV

Commercial and automotive
Low CV and high CV
GR*, GC* and ZR* series monolithic ceramic capacitors
Limited values affected in 0201 and 0402
Most values 0603 and greater
All dielectrics

Commercial and automotive ceramic capacitors
Series Cxxxx and CGA
Select values in 0201-2220 case sizes
Low CV and high CV in all dielectrics

Commercial ceramic capacitors
Series CCxxxx
Select values in 0201-2220 case sizes
Low CV and high CV in all dielectrics
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TTI Action Plan

TTI Allocation is Currently Based on 2016/17 Receipts

- Increased On-hand and On-order Inventory Levels
  - Began increasing purchasing volumes from all suppliers in 3Q16
  - 2H’16 began purchasing alternative part numbers for back-up
  - Current backlog exceeds $100M compared to $20M in May 2016

- Created a special allocation product team lead by industry and product experts to manage and assist our sales teams, suppliers and customers

- Began allocating constrained product and declining orders from new customers
  - Supporting the customers who have supported us
  - Fairly dividing based on customer historical usage
### Potential Gaps in Supply – Comparative Data

TTI North America’s percentage of MLCC sales by case size and value.

<table>
<thead>
<tr>
<th>Size (inch):</th>
<th>~1nF</th>
<th>~100nF</th>
<th>~220nF</th>
<th>~470nF</th>
<th>1μF</th>
<th>2.2μF</th>
<th>4.7μF</th>
<th>10μF</th>
<th>22μF</th>
<th>47μF</th>
<th>100μF</th>
<th>220/330μF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1005</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>0201</td>
<td>0.29%</td>
<td>3.68%</td>
<td>0.31%</td>
<td>0.04%</td>
<td>0.00%</td>
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<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
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<tr>
<td>0402</td>
<td>3.60%</td>
<td>19.17%</td>
<td>0.94%</td>
<td>0.61%</td>
<td>4.37%</td>
<td>0.68%</td>
<td>0.47%</td>
<td>0.17%</td>
<td>0.00%</td>
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<tr>
<td>0603</td>
<td>3.80%</td>
<td>18.96%</td>
<td>1.94%</td>
<td>0.48%</td>
<td>3.11%</td>
<td>0.97%</td>
<td>0.73%</td>
<td>1.30%</td>
<td>0.33%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
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<tr>
<td>0805</td>
<td>0.83%</td>
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<td>1.37%</td>
<td>5.31%</td>
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<td>1206</td>
<td>0.19%</td>
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<td>0.49%</td>
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<td>1.50%</td>
<td>0.40%</td>
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<td>0.02%</td>
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<td>0.77%</td>
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<td>0.63%</td>
<td>1.01%</td>
<td>0.50%</td>
<td>0.24%</td>
<td>0.18%</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

**Highlighted Square Code:**
- Green = Capacitance ratings and case sizes where additional capacity is being added.
- Yellow = Reduced capacity levels by major MLCC suppliers but lesser supply chain impact due to percentages of overall business levels.
- Red = Reduced capacity levels by major MLCC suppliers AND high supply chain impact due to percentage of overall business levels.

**TTI Suppliers to consider for these affected values:**

- 0402 .1μF
- 0603 .1μF
- 0805 .1μF

### Causal Factors

**Near Term**

- YAGEO
- VISHAY

**Long Term**

- AVX
- KEMET
TTI Action Plan

TTI Allocation is Currently Based on 2016/17 Receipts

- Created New Reports and Cross Reference Tools to Share with Customers
  - Provide best insight of potential supply issues
  - Provide alternates for 95% of allocated product lines

- TTI has #1 Market Share in these Products
  - Largest customer to the manufacturer

- We are in this for long-term growth and partnership, not short term gain

*TTI remains committed to assured supply of highly constrained and allocated products to our existing customers. It is our objective to ensure our existing customers continue to have access at previous year consumption levels.*
MLCC Market Update

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Assess Your Options

Is Your Design Affected by the MLCC Shortage?

Y

Can you accept an Alternate Supplier or a Product Upgrade?

Y

Qalify Alternate Suppliers Immediately. Evaluate Upgrades:
• Can you use a higher voltage part?
• Can you use a tighter tolerance part?
• Is AECQ200 a requirement or an option?
• Is a Flexible termination product required?

N

Can you accept a Smaller Package?

Y

Determine if your pad layout will accommodate 0402 or smaller

N

Can you Re-Design?

Y

• First option – smaller pads
• Second option – alternative technology

N

Strategically align with a strong distribution partner, don’t inflate your requirements

Y

Be prepared for possible price and lead-time increases
What are Your Alternatives

Alternative Capacitor Technologies

- Tantalum (MnO2)
  - Cost effective when de-rated properly (50% voltage)
  - A-case generally fits 1206 pads
- Hybrid Polymer Tantalum
  - Low ESR
  - No ignition
  - High capacitance
  - (10%-20% V de-rating)
- Aluminum Polymer
  - Very low ESR
  - Good for low voltage applications
- Film
  - Good for higher voltages
  - Robust with long life
- SMT Aluminum Electrolytic
  - Good for bulk decoupling and higher voltages
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Final Thoughts

- TTI is #1 Distributor of MLCC products in North America and Globally
  - TTI is very important to each supplier
  - We are getting our unfair share, unfortunately sometimes that is not enough – please explore your options with your TTI sales team

- Generate Awareness
  - Inform people within your organization
  - Share the market conditions with your end customers

- Work with TTI on Solutions
  - Your success is our success
Thank You