High Q and Broadband Ceramic Capacitors Overview
World Best Product

Key Components for IT & Energy Industry Based on Advanced Materials

AMOTECH HIGH Q AND BROADBAND CERAMIC CAPACITORS
AMOTECH CERAMIC CAPACITOR

IC and Systems Package Application

For Flip chip & Wire bonding at mmWave

- Broadband capacitor - ABC series

For Wire bonding

- Single layer capacitor - ASC series

For Wireless application

- High Q MLCC - ACQ series

For Space saving

- Large capacitance – ACS, ACX series

For EMI solution

- 3 Terminal Capacitor - AFC series
PRODUCT REVIEW

- **High Q MLCC**
  - 1111, 0805, 0603 inch for Macro-cell
  - 0402, 0201 inch for Small-cell, CPE
  - C0G base Low ESR

- **Large Capacitance MLCC**
  - 0402 – 1210 inch
  - High reliability X7R base
  - 50, 100V

- **Broadband capacitor**
  - 0201, 0402 inch plating
  - Up to 40GHz solution
  - X7R / X5R base

- **Single layer capacitor (under development)**
  - 10 mil, 15 mil (0.25mm, 0.38mm)
  - Gold plating
  - High Capacitance with Low loss
  - High K material

- **3 Terminal filter**
  - 0603 – 1806 inch
  - High reliability X7R base
  - 50, 100V
BROADBAND CAP. FOR mmWAVE & OPTICAL DEVICE

- ABC series
  - Customizable size
  - Low insertion loss
  - Ultra broadband up to 40Ghz
  - Low loss dielectric
  - RoHS compliant
Optical Transceiver & Capacitor

- Optical Transceiver Block Diagram & Circuit

- DC Blocking Cap → Broadband Cap (BBC) 16 pcs x System
- DC Bias Cap : RF Amp Block → SLC (High Voltage)
ADVANTAGE OF FEED-THROUGH CAPACITOR

DC power line ripple

<table>
<thead>
<tr>
<th>Capacitance</th>
<th>Inductance (Shunt)</th>
<th>Inductance (Series)</th>
<th>Voltage</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Capacitance</td>
<td>Low parasitic inductance</td>
<td>High Series inductance</td>
<td>Low voltage – mobile, Infotainment High Voltage – Industrial,</td>
<td>Depend on internal design</td>
</tr>
</tbody>
</table>
### MAIN CHARACTERISTICS

<table>
<thead>
<tr>
<th>Lot No.</th>
<th>L (mm)</th>
<th>W (mm)</th>
<th>T (mm)</th>
<th>Capacitance</th>
<th>Layout</th>
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</thead>
<tbody>
<tr>
<td>AMOTECH #1 S2KBA120002A S20A 11AA</td>
<td>0.66 ± 0.03</td>
<td>0.35 ± 0.03</td>
<td>0.35 ± 0.03</td>
<td>100nF</td>
<td></td>
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<tr>
<td>AMOTECH #2 S2KBA116003A S20A 21BA</td>
<td>0.60 ± 0.03</td>
<td>0.30 ± 0.03</td>
<td>0.30 ± 0.03</td>
<td>100nF</td>
<td></td>
</tr>
<tr>
<td>AMOTECH #3 S2KBA120005A S20A 10CA</td>
<td>0.60 ± 0.03</td>
<td>0.30 ± 0.03</td>
<td>0.30 ± 0.03</td>
<td>10nF</td>
<td></td>
</tr>
</tbody>
</table>
AMOTECH BROADBAND CAPACITOR

Applications

- Wide frequency range **DC blocking**
- Optical devices
- mmWave devices

※ HIGH Q CAPACITOR VS BROADBAND CAPACITOR

NOTE: Reducing self resonance of capacitor.

AC pass band
(~ 20GHz, ~40GHz, ~60GHz)
PRODUCT LINE UP

- ABC series (AMOTECH BROADBAND CAPACITOR)
  - Wide frequency range DC blocking (ABCN series: ~ 20GHz, U series: ~ 40GHz)
  - Low insertion loss
  - 0603 ~ 1005 mm / 6.3 ~ 10V

<table>
<thead>
<tr>
<th>ABCU</th>
<th>Voltage</th>
<th>Material code</th>
<th>Size</th>
<th>Capacitance</th>
<th>Cp. Tolerance</th>
<th>Plating</th>
<th>Taping</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABCU10201X103PNG</td>
<td>10V</td>
<td>P</td>
<td>0201inch/0603㎜</td>
<td>10nF, X7S</td>
<td>~ 40 GHz</td>
<td>Ni barrier, Sn plating</td>
<td></td>
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<tr>
<td>ABCU10201X103PGDG</td>
<td>10V</td>
<td>P</td>
<td>0201inch/0603㎜</td>
<td>100nF, X7S</td>
<td>~ 40 GHz</td>
<td>Ni barrier, Au plating</td>
<td></td>
<td></td>
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<tr>
<td>ABCU10S02X104PNG</td>
<td>10V</td>
<td>G</td>
<td>0402inch/1005㎜</td>
<td>10nF, X7S</td>
<td>~ 40 GHz</td>
<td>Ni barrier, Sn plating</td>
<td></td>
<td></td>
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<tr>
<td>ABCU10S02X104PGDG</td>
<td>10V</td>
<td>G</td>
<td>0402inch/1005㎜</td>
<td>100nF, X7S</td>
<td>~ 40 GHz</td>
<td>Ni barrier, Au plating</td>
<td></td>
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</tr>
</tbody>
</table>
AMOTECH SOLUTION

SMALL/MACRO CELL

- High Q
- Chip Coupler
- Substrate Coupler
- 5G ANT

4G Base Station

Traditional Basestation

Massive MIMO

Small Cells for Densification

Core Network

GaN

- 3 Term
- High Q
- BBC
- SLC

OPTICAL TRANSCEIVER

- BBC
- SLC
AMOTECH TECHNICAL ADVANTAGE

- Technical advantage

**Material**
- Acquired material technology derived from MLCC investment.
  - In house process of *high K material; X5R, X7R, Y5V*

**Design**
- High Frequency Design & Measurement
  - High frequency modeling software (ANSYS-HFSS, ADS)
  - *70GHz measurement system* from mmWave technology

**Process**
- In-house Plating tech
  - Gold, Nickel, Tin
  - *Plasma processing; surface flatness, migration prevent*

**Production**
- Small size product mass production experience
  - *Monthly 200Mpcs* production of 0201, 01005
HIGH Q MULTILAYER CERAMIC CAPACITOR

- ACQ (High Q) series
  - Variable Size
  - Low ESR
  - High working Voltage
  - High self resonance frequencies
  - Stable C0G dielectric with PME (Precious Metal Electrode)
  - RoHS compliant

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Ordering No.</th>
<th>Size</th>
<th>Rated Voltage</th>
<th>Capacitance</th>
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<tr>
<td>ACQ01X2BN</td>
<td>A60Z</td>
<td>0201</td>
<td>200V</td>
<td>Under development</td>
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<tr>
<td></td>
<td>T200T</td>
<td>0603</td>
<td></td>
<td></td>
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<tr>
<td>ACQ02X2BN</td>
<td>A60L</td>
<td>0402</td>
<td>250V</td>
<td>0.1~27pF</td>
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<tr>
<td></td>
<td>T250T</td>
<td>1005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACQ03X2BN</td>
<td>A60S</td>
<td>0603</td>
<td>250V</td>
<td>0.1~100pF</td>
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<tr>
<td></td>
<td>T250T</td>
<td>1608</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACQ05X2BN</td>
<td>A60F</td>
<td>0805</td>
<td>250V</td>
<td>10~240pF</td>
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<tr>
<td></td>
<td>T250T</td>
<td>2012</td>
<td></td>
<td></td>
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<tr>
<td>ACQ11X5BN</td>
<td>A80B</td>
<td>1111</td>
<td>500V</td>
<td>1.2~100pF</td>
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<tr>
<td></td>
<td>T500T</td>
<td>2828</td>
<td></td>
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</table>
Superior Performance for High Q MLCC

- 25-35% lower ESR against best industry standard, extended HF performance
- lower ESR may allow use of smaller capacitor size, replacing 0603 with 0402 for smaller board size

**Ultra-Low ESR, High Q Performance**

![Graphs showing low ESR and high Q performance](image-url)
### HIGH Q MLCC FOR RF APPLICATION

<table>
<thead>
<tr>
<th>AMOTECH</th>
<th>MURATA</th>
<th>ATC</th>
<th>KNOWLES(DLI)</th>
<th>TEMEX</th>
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<tbody>
<tr>
<td>1111inch /2828mm</td>
<td>A80B0R1BT500T</td>
<td>GQM22M5C2HR30B</td>
<td>800B0R1BT500T</td>
<td>1111J500P100BQT</td>
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<tr>
<td></td>
<td></td>
<td>B01D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0805inch /2012mm</td>
<td>A60F0R1BT250T</td>
<td>GQM2195C2ER10BB</td>
<td>600F0R1BT250T</td>
<td>0805J250P100BQT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0603inch /1608mm</td>
<td>A60S0R1BT250T</td>
<td>GQM1875C2ER10BB</td>
<td>600S0R1BT250T</td>
<td>0603J250P100BQT</td>
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<tr>
<td></td>
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<td>12D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0402inch /1005mm</td>
<td>A60L0R1BT200T</td>
<td>GQM1555C2DR10B</td>
<td>600L0R1BT200T</td>
<td>0402J200P100BQT</td>
</tr>
<tr>
<td></td>
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<td>B01D</td>
<td></td>
<td></td>
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<tr>
<td>0402inch /1005mm</td>
<td>A60L0R1BT250T</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0201inch /0603mm</td>
<td>A60Z0R1BT200T</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To replace 0603inch/1608mm 608mm 250V type

To replace 0402inch/1005mm 1005mm 200V type

※ BLUE CODE : SIZE CODE
RED CODE : CAPACITANCE & IT’S TOLERANCE
GREEN CODE : VOLTAGE CODE
ADVANTAGE OF AMOTEC HIGH Q MLCC

- Basis of using AMOTEC high Q MLCC

Higher Q & Higher BDV for PME

* Lower ESR & High Breakdown voltage

<table>
<thead>
<tr>
<th></th>
<th>BDV</th>
<th>ESR 3.5G</th>
</tr>
</thead>
<tbody>
<tr>
<td>M com (BME)</td>
<td>2.0 kV</td>
<td>100mohm</td>
</tr>
<tr>
<td>A com (PME)</td>
<td>2.9 kV</td>
<td>110mohm</td>
</tr>
<tr>
<td>Amotech (PME)</td>
<td>2.9 kV</td>
<td>80mohm</td>
</tr>
</tbody>
</table>

- Enough Power Rate

* 80W test pass @ 3.5GHz, 10pF

<table>
<thead>
<tr>
<th>Power</th>
<th>AMOTECH 0402</th>
<th>AMOTECH 0603</th>
</tr>
</thead>
<tbody>
<tr>
<td>50W</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>60W</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>70W</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>80W</td>
<td>Pass</td>
<td>Pass</td>
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</table>
# PROCESS TECHNOLOGY

<table>
<thead>
<tr>
<th>KEY PROCESS</th>
<th>KPI - MLCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dielectric Powder</td>
<td>50nm</td>
</tr>
<tr>
<td>Dielectric Thickness</td>
<td>1um</td>
</tr>
<tr>
<td>Internal electrode</td>
<td>Ni, Cu – 0.5um</td>
</tr>
<tr>
<td>Stacking</td>
<td>600 layers</td>
</tr>
<tr>
<td>Compression</td>
<td>2000 atm</td>
</tr>
<tr>
<td>Binder Burnout</td>
<td>Carbon 1 ppm ↓</td>
</tr>
<tr>
<td>Sintering</td>
<td>300°C/min, Precise deoxidation atmosphere</td>
</tr>
</tbody>
</table>
품질 인증

Quality : IATF 16949:2016

Environment : ISO 14001:2015
Mass production line

Target: Ensure product reliability
Qualified AEC-Q200

IQC
- Powder Analysis
  - Particle size, Composition, Dielectric constant
- Paste
  - Solid contents, Viscosity, Thixotropic index

Pre-Inspection (Half-finished good)
- Cp/Df, IR, Section Analysis, Appearance, Dimension
- Time, Space deviation Management

PQC
- X’s Factor management (measurement)
  - Slurry viscosity, Casting “T”, Printing “T”, Firing profile, Plating thickness, ...
- Pre-inspection (Half-finished good)
  - Cp/Df, IR, Section Analysis, Appearance, Dimension
- Time, Space deviation Management

Statistical analysis of indicator trends (Data Monitoring)

OQC
- Final inspection
  - Cp/Df, IR, Solderability
  - Reliability (High temp. Operation Life test)
- VOC → VOP is linked to utilize it as an opportunity for improvement
- Continuous review and operation of measures to identify defects in a short period of time → Zero Defect

Customer-oriented thinking (Prevent defect recurrence)

Quality control of Raw material
Preemptive quality accident prevention activities
Feedback continuously occurred Problem and anti-missive activities

Raw material Analysis

Quality control of Raw material analysis
Reliability test equipment

- Low/High Temp. Chamber
- Temp Cycle Chamber
- Temp & Humidity Chamber
- * Ion Migration Evaluation System
- ESD Tester
- Vibrator
- Mechanical Shocker
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