Information Meeting 2018
The marriage of new technologies and applications keeps the market expanding!

The advent of new markets and players creates need for electronic components.

Business opportunities expand for Murata, which has a wide variety of product lineup and a broad customer base!
High-reliability in-vehicle MLCCs are increasingly demanded among MLCCs.

--> MLCC manufacturers will be selected that can guarantee the technologies and supply capabilities required for automotive applications.

MLCC demand forecast (quantity based)

Technologies required of high-reliability in-vehicle products

- High temperature guarantee (Up to 125°C)
- Measures against risk of short circuit (Use of resin electrodes)
- High temperature environment
  Use of high-power electronic circuits
- Long-term reliability
  (Compliance with domestic and foreign standards)
- High voltage support
  (Supports 100 V)

Need arises for smaller ECUs in order to provide more in-vehicle space

--> Accelerates need for smaller MLCCs with larger capacitance
The progress in electrification will result in a rapid increase in the number of MLCCs to 3,000-8,000 per vehicle!

Image processing to allow for autonomous driving

Fast processing of data from various sensors results in higher power consumption.

-- Greater MLCC capacity and a larger number of MLCCs used per vehicle.

The quantities of MLCC used are as follows:

<table>
<thead>
<tr>
<th>PowerTrain</th>
<th>Conventional</th>
<th>Low-end</th>
<th>Mid-class</th>
<th>High-end</th>
<th>Ultra High-end</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure ICE</td>
<td>450~600</td>
<td>600~800</td>
<td>800~1,000</td>
<td>1,900~2,300</td>
<td>2,700~3,100</td>
</tr>
<tr>
<td>ISS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Micro HEV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild, Strong HEV, PHEV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADAS</td>
<td>2,000~2,400</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety ※</td>
<td>450~700</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comfort</td>
<td>500~800</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infortainment</td>
<td>400~700</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>1,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

※Safety=AIRBAG,ABS,TPMS etc (Based on our estimate) *as of FY2018

The demand forecast for MLCC by level is as follows:

<table>
<thead>
<tr>
<th>Level</th>
<th>Lv.1</th>
<th>Lv.2</th>
<th>Lv.3</th>
<th>Lv.4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2,000</td>
<td>3,000</td>
<td>4,000</td>
<td>Over 4,000</td>
</tr>
</tbody>
</table>

ADAS / Autonomous driving, Average numbers of hardware at different levels

LV1 LV4

Ultrasonic sensors Camera RADAR LiDAR (Based on our estimate)
In-vehicle Capacitor Lineup

xEV Technology Trend

- Ceramic Capacitor Module (For DC-LINK Snubber)
- Safety Capacitor (For OBC Y-Capacitor)
- Silicon Capacitor (For Snubber)
- Metal Terminal Capacitor
- High Temperature Film Capacitor (For DC-LINK)
- Ceramic Capacitor Module (For Resonance Capacitor)
- High Temperature Film Capacitor (Single) (For Smoothing)

EV/PHV
Electric Vehicle, Plug-in Hybrid Electric Vehicle

HEV
Hybrid Electric Vehicle (inc. 48V)

WPT
Wireless Power Transfer

Auto Drive Technology Trend

- Silicon Capacitor & IPD (For Photo Diode & Laser Diode)
- Automotive Grade High Q MLCC (For V2X)
- Automotive Grade MLCC
- Automotive Grade Low ESL MLCC (For Application Processor)
- Silicon Capacitor (For Application Processor)

Information Gathering
Sensor, Camera, Radar, LiDAR, V2X, etc..

Data Analysis
Application Processor, A/I, etc..

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Strengthening MLCC Production System

MLCC production bases

China Wuxi

A new production building will be completed in December 2019

Singapore

A new production building will be completed in December 2019

Philippines

A production building was constructed in FY 2017

Fukui Murata

Izumo Murata

A new production building will be completed in November 2019

To meet vigorous demand, we will strive to increase production capacity, mainly for small MLCCs with high capacitance as well as high-reliability ones!
Examples of Development of In-vehicle Products

- High Temperature Film capacitor for smooth application (under development) Self-recovery function, 125°C guaranteed
- Bi-Directional DC-DC Converter (under development) High power, Low profile, Light weight
- 0603 size GHz band-compatible noise filter for vehicles
- WiFi Modules V2X Modules
- Reliable MLCCs (greater heat resistance)
- Film capacitors
- Ultrasonic sensor (under development) Improved short distance detection performance (10 cm or less)
- 6DoF-compatible MEMS sensor (under development) All-in-one packaged, Conforming to AEC-Q100
- EMI Suppression Filters Power inductors (higher large-current capability)
- Timing devices
- Reliable MLCCs (higher voltage applied, and higher large-current capability)
- Advanced safety system
- Not only in-vehicle MLCCs but also other various products are under development based on in-vehicle trends!
Connected Car (C2X/V2X)

Exchanging information with pedestrians to alert the driver

Vehicles mutually exchange information on their locations and speeds to avoid collision

Exchanging information with traffic lights and other elements of infrastructure to ensure safety at places with poor visibility

North America and Europe have plans to introduce the IEEE 802.11p V2X communication method starting in 2021.

--> V2X wireless communication modules and software are now being developed at Murata.

- Stable characteristics at high temperatures
- Competitive software support services allow us to get involved in the early phase of customers' design/development process.
Growth of the smartphone market

Outlook for smartphone unit sales growth

Although the growth in the total number is slowing down, the proportions of LTE-Advanced and 5G-compatible terminals are increasing.

MLCC capacitance history

Trend in MLCCs for smartphones

- Improved IC performance
- Use of more sensors per phone
- Use of multi-cameras
- Use of larger batteries

Power consumption is still increasing, maintaining demand for smaller MLCCs with larger capacitance.

Availability for high temperature and high voltage applications as well as low profile design are increasingly demanded toward 5G!
RF Module Solution

Evolution of modules for different models

<table>
<thead>
<tr>
<th></th>
<th>LTE/LTE-Advanced</th>
<th>5G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tx-MOD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEMiD+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MMMBPA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAMiD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-Module</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4×4 MIMO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle Class</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low End</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- : Installed  ☆ : New function

<< RF module trends >>
- Demand is expanding for receiving modules which bring high areal benefit
- Smaller and lower-profile modules are used for effective use of space on boards

The filter, which is one of key parts, becomes more important! In-house production of small components brings more benefits than before!
Strategies for SAW Filters

Projected demand for filters

- Response to the increasing demand for filters including those for modules
- Use of high-frequency, composite, small filters toward 5G

SAW filter business strategy

- Improve productivity and yield by rationalizing facilities
- Expand the advantage over competitors by downsizing
- Realize superior characteristics
- Expand the market share of filters for modules

The total demand for filters is expected to increase mainly for those for modules.

We will expand the conventional SAW/I.H.P. SAW product lineup to expand the filter business.
Future Development of MetroCirc™

Features of MetroCirc™
- High frequency characteristics
- Highly multilayered
- Low water absorbency
- Flexibility

Strategy for MetroCirc™
- Strength of MetroCirc™
- Product Innovation
- Process Innovation

Creation and realization of customer value

✓ We will further improve technologies, including improvement of high frequency characteristics and realization of various 3D structures.
✓ We will promote innovation of our production system and realize quick customer response.

--> Create and realize customer value, aiming for continuous growth and expanded profitability!

High frequency characteristics of MetroCirc™

Having superior characteristics in the millimeter wave band, MetroCirc™ can differentiate itself from other products.

Transmission loss [dB/100mm] vs Frequency [GHz]
Work on 5G Technology

- The lineup for Sub-6 GHz is being expanded.
- The frequency used for 5G (mmWV) has a strong directivity, and therefore Small cell base station will increase.

--> We will accelerate development aiming for dissemination after 2020.
Priority Initiatives in Battery Business

Future prospects for cylindrical batteries

- Focus on growing markets (gardening tools / electric tools)
- Gain competitive advantage with reliability and high power
- Enhance capacity systematically

Improvement of mobile laminate

- Process improvement
- Facility rationalization
- Productivity improvement

Response to new technologies and markets

- Strengthening chemical technology
- Development of laminating technology
- 5G compatibility
- Wearable/Hearable

Production process review

Efforts on all-solid-state batteries

<table>
<thead>
<tr>
<th>Structure/appearance</th>
<th>Feature</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid electrolyte</td>
<td>- Uses an incombustible solid material</td>
<td>- Non-ignitable and incombustible</td>
<td>- Difficult to upsize</td>
</tr>
<tr>
<td>Electrode</td>
<td>External terminal</td>
<td>Simply structured</td>
<td>Makes it difficult to generate high currents</td>
</tr>
<tr>
<td>Cleaning</td>
<td>Health care</td>
<td>- &gt; Contains not too many components</td>
<td></td>
</tr>
</tbody>
</table>

Priority Initiatives in Battery Business:

- Affinity to MLCCs in terms of structure and production process
- Commercialization for wearable applications in FY 2019

(Mil cells)

- 15% annual growth

(Based on our estimate)
All things are digitalized and mutually connected via the Internet: From “a closed world” to “a connected world”
Spread of IoT Business

*Wireless communication*: Ensuring a connection with a target without crosstalk in a network comprised of multiple devices.

*Sensors*: Murata is a comprehensive component manufacturer with strong components.

*Software*: Software technology developed in the markets for mobile phones and Wi-Fi.

Murata will provide total solutions combining sensors, wireless technology and software to help build infrastructure for the "Internet of Things"
Various Initiatives on IoT Technology

**<Case 1> Sensor Data Platform “NAONA”**
Visualize and provide spatial information, such as the atmosphere of a place and the intimacy among people.

- **“Visualization of meeting quality”**
  -- Analyze and visualize the quality of conversation and communication in meetings based on voice characteristics and volume.

- **Support nursery school teachers at nursery schools**
  -- Demonstration experiments are being carried out to grasp remotely the situation of a room with children.

**<Case 2> Operation rate improvement solution (m-FLIP™)**
Provides solutions that maximize the operation rate of manufacturing equipment by utilizing IoT technology and our know-how in improvement activity.

**<Case 3> Road surface detection system**
Provides solutions that utilize for road conservation information obtained from vehicles with sensors. A demonstration experiment is in progress in Kyoto.

We will provide the “information” obtained as a service to help customers solve problems.
Healthcare & Medical

A chest sensor collects vital sign information.

Data compaction using a special algorithm enables the collection and analysis of vital sign data with low power consumption.

We aim for business expansion leveraging synergy effects of Murata's technical capabilities and M&A companies' solution technologies.

Capacitors for Medical Devices

Components

RFID

Microblower

Metal mesh Devices

Auto Control Cuff Pressure

Medical equipment

WiFi / Cellular

Bedside Monitor

Central Station Monitor

App

We have provided services in India since 2017. Under trial at a medical institution in the US.

Healthcare & Medical Solutions
Mid-term Direction 2021

- Implementation of Portfolio Management
- Establishment of Advanced Supply System & Exponential Productivity Enhancement
- Harmony among people, organization and society

- OP income = Min. 17%
- ROIC(pre-tax basis) = Min. 20%
- Sales = JPY2 trillion

Assumed foreign exchange: 110 YEN / USD
Net Sales and New Products Ratio on sales/ R&D expense and R&D ratio on sales

Fiscal year 2017
- R&D expense: 94.2 billion yen
- R&D Ratio on sales: 6.9%

Fiscal year 2018 (estimate)
- R&D expense: 100.0 billion yen
- R&D Ratio on sales: 6.2%
M&A / Business Alliance

- **Mergers & acquisitions of energy, medical, and wireless communication businesses for further growth**

- **Toko, Inc.** became a consolidated subsidiary of Murata
  - Coils

- **Primatec**
  - Acquisition of Primatec Inc.
  - LCP (liquid crystal polymer) electronic materials

- **Shizuki**
  - Joint venture establishment with Shizuki Electric Co., Inc.
  - **Film Capacitor**
  - Acquisition of IPDIA S.A.
  - **Silicon Capacitors**

- **Arctic Sand**
  - Acquisition of Arctic Sand Technologies, Inc.
  - **Design and sale of Low-power semiconductors**
  - **RFID system integration**

- **ID-Solutions & Murata Company**
  - Acquisition of ID-Solutions S.r.l.

- **Sony**
  - Acquisition of Battery Business from Sony Corporation
  - **Lithium-ion Secondary Batteries**

- **Vios Medical**
  - Acquisition of Vios Medical, Inc.
  - Development of chest sensors, and development and provision of software and cloud services needed to monitor the sensors

- **Primatec**
  - Acquisition of Peregrine Semiconductor
  - **RF solutions incl. RF switches**
Our basic policy of profit distribution to shareholders is to prioritize the sharing of gains through payment of dividends, and to steadily raise them by increasing profit per share.
This report contains forward-looking statements concerning Murata Manufacturing Co., Ltd. and its group companies' projections, plans, policies, strategies, schedules, and decisions. These forward-looking statements are not historical facts; rather, they represent the assumptions of the Murata Group (the “Group”) based on information currently available and certain assumptions we deem as reasonable. Actual results may differ materially from expectations due to various risks and uncertainties. Readers are therefore requested not to rely on these forward-looking statements as the sole basis for evaluating the Group. The Company has no obligation to revise any of the forward-looking statements as a result of new information, future events or otherwise.

Risks and uncertainties that may affect actual results include, but are not limited to, the following: (1) economic conditions of the Company's business environment, and trends, supply-demand balance, and price fluctuations in the markets for electronic devices and components; (2) price fluctuations and insufficient supply of raw materials; (3) exchange rate fluctuations; (4) the Group's ability to provide a stable supply of new products that are compatible with the rapid technical innovation of the electronic components market and to continue to design and develop products and services that satisfy customers; (5) changes in the market value of the Group's financial assets; (6) drastic legal, political, and social changes in the Group's business environment; and (7) other uncertainties and contingencies.

The Company undertakes no obligation to publicly update any forward-looking statements included in this report.
Thank you