Test Manufacturing Challenges in the New Era
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Abstract:

In the new digital era of consumer electronics, there is an onslaught of demand that drives the semiconductor industry towards high frequency wireless chips, low power technologies, MEMS, RF enabled sensors and controllers for Internet of things (IoT). This compounds the test challenges faced in the production mode with tiny chip size, high complexity chips, faster time to market, lower costs, reduced ASP’s, higher parallelism, Excellent Yield requirements and Absolutely zero defects (ppb) in a high quality production environment. The aim is to bring to discussion how OSAT can make a difference in the success of Next Generation technologies with Vendors and Customers.
IC Industry needs a new paradigm shift in Testing of new Era chips of IoT, MEMS, Extremely high frequency devices and Wireless with higher data rate & connectivity

- High Market Growth mainly from Wearables, Smart phones, Home and Industry Automation...
- IoT also empowers the growth in Secured network chips
- Increased market for Predictive Applications using Car Radars with High frequency range of 76-81GHz.
IoT revolution and Wearables Market Growth
“The IoT is the network of dedicated physical objects that contain embedded technology to sense or interact with their internal state or external environment,” said Dean Freeman, an analyst at Gartner. “The IoT comprises an ecosystem that includes things, communication, applications and data analysis. Automotive is a big component of IoT, home will play a large role, as will office buildings.”
“anything” .....
No longer human dependent ……
Wearable Market Growth by Category

World Market for Wearable Technology – By Product ($US million)

Wearables will be a $30B Market by 2018!

Source: IHS, June 2014

MEMS and sensor shipments for wearable device

Source: IHS MEMS & Sensors for wearables report - 2014
Security Devices in IoT & High Frequency Automotive Applications
IoT will depend heavily on Secure IC’s

Source: www.eurosmart.com
Security Market is facing *unprecedented growth*!

**IoT is fueled by many connected “things” requiring security... Key Growth Drivers in 2015**

**Government:**
ICAO Standard 3.10.1 of Annex 9 will Mandates Machine Readable Travel Documents Effective November 2015. Estimated 90% of the world’s passports will have Smart Chip by 2016.

**M2M:**
Oberthur is estimating 14B/u needed to support Machine-to-Machine secure communication by 2020.

**ePayment:**
1. The EMV (Euro Pay, Master Card, Visa) is mandating secure chips in credit cards effective October 2015
2. Proliferation of the POS and wide adoption of *mobile-pay* by mobile phones
Security Market Growth Projection Understated

Outlook: Expect FY14 actuals to reflect higher growth and more aggressive CAGR. Will reset the market value & growth projections with clearer product definition.
Automotive Radar 76 GHz to 79GHz

**Advanced Driver Assistance Systems**

<table>
<thead>
<tr>
<th>Application</th>
<th>Detection Range</th>
<th>Safety Aspect</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptive Cruise Control</td>
<td>200 meters</td>
<td>Normal driving; accident avoidance</td>
<td>• 77 GHz Radar</td>
</tr>
<tr>
<td>Pre-Crash</td>
<td>30 meters</td>
<td>Accident; mitigation of impact</td>
<td>• 77 GHz/24 GHz Radar</td>
</tr>
<tr>
<td>Lane Departure Warning</td>
<td>60 meters</td>
<td>Normal driving; accident avoidance</td>
<td>• Vision sensor</td>
</tr>
<tr>
<td>Blind Spot Detection</td>
<td>20 meters</td>
<td>Normal driving; accident avoidance</td>
<td>• 24 GHz Radar/ Vision sensor</td>
</tr>
<tr>
<td>Stop and Go</td>
<td>30 meters</td>
<td>Normal driving; accident avoidance</td>
<td>• 77 GHz/24 GHz Radar</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 76/81 GHz Radar</td>
</tr>
</tbody>
</table>

**PROS:**
- Long range detection capability
- Immune to weather conditions
- Immune to light conditions
- Unaffected by dirt

**CONS:**
- Cannot detect lane marking
- Cannot read traffic signs
- Inadequate for pedestrian detection

1. **Convenient Driving and Automated Driving in 2030**

2. **Road Transport**
   - Adaptive Cruise Control
   - Forward / Rear / Side Collision Avoidance
   - Blind Spot Assistance
   - Parking Assistance

Source: Teradyne
Test Challenges & OSAT Roles
Product Test Challenges in the New Era

- Sensitive Consumer Products
- Complex Automotive Products
- Highly Secured Products

- 212 BILLION
  Total number of available sensor enabled objects by 2020

- 30 BILLION
  Sensor enabled objects connected to networks by 2020

- Next generation safety system layout
  - 79 GHz MRR
  - 79 GHz LRR
  - 77 GHz MRR
  - 77 GHz LRR
  - 79 GHz SRR
Sensitive Consumer Products Test Challenges

Testing of IoT – MCU, RF and Sensors (MEMS)
MEMS – Combination of Mechanical and Electrical operations in Single chip
Motion, Sound & RF
Pressure Sensor, Gyroscope, Accelerometer

MEMS Solutions

Complex Process flows
Low Cost
High Parallelism
Multi-axis Rotation Handler Prober / Requirement

Strip Test Solutions
Complex Automotive Products Test Challenges

- Test Spectrum beyond standard ATE (76GHz to 81GHz)
- Complex Mechanical Integration (Interference)
- Higher Silicon Integration
- Precision Temperature controls
- Extreme Operating Environments

DUT Closer to Measuring Instruments

High Frequency Test Sockets & pins

High Temperature @ 150C / 200C
Cold Temperature @ -45C / -65C
Highly Secured Products Test Challenges

• Test Infrastructure
• Isolated Server Setups and Connections
• Test Program controls and Data Transfer
• Security Certifications
• Complex process controls
• High Yield
Test Manufacturing Challenges in the New Era

- **Hardware**
  - High Frequency Sockets, pin, Closer DUT
  - Tester / Handler Capabilities
  - Low K Wafers Changing Probecard
  - Cold Test & Precision Temperature controls

- **OEE**
  - Excellent Yield, Best MTBF
  - Integrated Solutions
  - Auto Socket Cleaning, Retest, Inline EQ
  - Man Machine Ratio and Productivity

- **Quality**
  - Robust Inprocess and Quality controls
  - Automated Test Program Controls
  - Secured Data Transfer
  - Real time Data analysis

- **Test Expertise**
  - Automotive, RF
  - Medical, Security Products
  - Thin Wafers Handling
  - WLCSP Singulated testing
  - Frame Prober / Strip Testing
Wafer Probe Solutions

RF Probing Solution

- Direct Docking
- RF trimming (<1.2nH) & Full RF probing solution
- Membrane
- Ceramic Blade
- Parallel - 32 sites
- High Temperature @ 125C
- Cold Temperature @ -40C
- Vertical probe card
- Common FT & WS Fixtures

Other technical capability:
- Fine pitch
- Micro bump probing
- Elastomer Contactor
- High pin-count > 2000 pins

Logic & MSLP probing Solution

- Wafer Ring Probing
- 125C
- 25C
QFN Strip Test - Process Flow

Conventional QFN Process Flow

ASSEMBLY
- FOL
- MOLD / PLATE
- TOP MARK
- SINGULATE (FULL SAW)

TEST
- TEST
- SINGULATE, GRAVITY, HANDLER
- INSPECTION
- PACK

QFN Strip Test Process Flow

ASSEMBLY
- FOL
- MOLD / PLATE
- ISOLATE (HALF SAW)
- 2D MARK
- STRIP TEST

TEST
- TOP MARK
- SINGULATE (FULL SAW)
- INSPECTION
- PACK
OSAT Roles can make a difference in the success of Next Generation technologies with Vendors and Customers

- **Excellent Quality and Lowest Cost** are Key words of Success.

- Next Generation Technologies does **not really mean** next generation of Testers requirement.

- Based on the product requirements, **OSAT can make difference by engaging with customers and vendors in design phase.**
OSAT Roles can make a difference in the success of Next Generation technologies with Vendors and Customers

- Partnering with customer in Quality and Cost of Test
  Ex. Choice of Testers, DoE / FMEA

- Service Provider from design phase
  Ex. Test Development / Engineering capability, Equipment capability

- Real time data Analysis Controls and Action
  Excellent OEE, stabilized Yield
  Cloud based Data management & Transfer*

- Process Optimization and Handling Complex Circuits in packages < 1x1 mm
  Multi-insertion flows, Handler and Handling Challenges, Cold Test at WLCSP

- Stabilize Production planning & Faster to Market with Greater cycle time
Test Manufacturing Challenges in the New Era

Summary:

✓ IoT Revolution defines a new era for consumer electronics

✓ The demand for these new generation technologies poses challenges to semiconductor manufacturing industry in complexity of process flows, smaller package geometrics, faster time-to-market, cost-reduction, volume, yield, quality, etc...

✓ Excellent quality and lowest cost are key words for success.
END