COMPLIANCE TESTING OF QI PRODUCTS

Mr. C.H. Lam, Senior Wireless Charging Specialist
Intertek Hong Kong, Electrical & Wireless
12 May 2017
AGENDA

01 Introduction of Qi Compliance Test
02 Introduction of Qi Test Equipment
03 Base Station Test
04 Mobile Device Test
05 Intertek Wireless Charging Service
INTRODUCTION OF QI COMPLIANCE TEST
INTRODUCTION OF QI COMPLIANCE TEST

Compliance Testing

- All devices shall comply to the compliance tests specified in Qi specification, Part 3: Compliance test.
- Compliance test services are only offered by the WPC Authorized Test Labs (ATL).
- ATL shall use the validated test equipment for compliance test. The test equipment has been validated by WPC-TXT team and approved by the CCT.
INTRODUCTION OF QI COMPLIANCE TEST

- Currently there are 14 Authorized Test Labs
- 3 ATL offering full compliance testing services -> BPP, BPP+FOD and EPP.
- 9 ATL only offering BPP compliance testing services.
- 2 ATL only offering partial BPP compliance testing services.
  - BPP = Baseline Power Profile <=5 Watt
  - BPP + FOD = Baseline Power Profile + FOD extension <=5 Watt
  - EPP = Extended Power Profile <=15 Watt

Source: WPC
INTRODUCTION OF QI TEST EQUIPMENT
INTRODUCTION OF QI COMPLIANCE TEST

VALIDATED TEST EQUIPMENT

• NOK9 – supplier of validated test equipment.
• CATS I, test equipment for BPP product.
• CATS II, test equipment for EPP product.
INTRODUCTION OF QI COMPLIANCE TEST

CATS I, TEST EQUIPMENT
INTRODUCTION OF QI COMPLIANCE TEST

CATS II, TEST EQUIPMENT
Conformance to Power Transmitter designs

Conformance to communications interface requirements
- Load modulation, Frequency modulation

Conformance to system control requirements
- Selection phase, Ping phase, Identification & configuration phase, Negotiation phase, Power transfer phase

Conformance to system performance requirements
- Guaranteed power, Thermal performance, Foreign object detection, User interface, Maximum voltage
### Required Test Equipment

<table>
<thead>
<tr>
<th>Test Power Receiver (TPR #)</th>
<th>Baseline Power Profile</th>
<th>Baseline Power Profile + FOD extension</th>
<th>Extended Power Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1C</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1D</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1E</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1F</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MP1A</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>MP1B</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>MP1C</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>MP3</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>THERMAL</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Two basic types Power Transmitter Reference Designs

**Type A** Power Transmitter Reference Designs.
- Have one or more coils.
- Activate a single coil at a time.
- Receiver can placed on it either Guided positioning or Free Positioning.
- Total 31 BPP Power Transmitter Reference Designs – A2 to A4, A6 to A8, A10 to A34
- Total 8 EPP Power Transmitter Reference Designs – MP-A1 to A8

**Type B** Power Transmitter Reference Designs.
- Array type coils.
- Activate one or more coil at a time.
- Receiver can placed on it Free Positioning
- Total 7 BPP Power Transmitter Reference Designs – B1 to B7
- Total 1 EPP Power Transmitter Reference Designs – MP-B1
BASE STATION TEST
CONFORMANCE TO SYSTEM CONTROL REQUIREMENTS
5.4.1 Guaranteed power – For BPP
5.4.1 Guaranteed power – For EPP

09:27:57 Sent Control Error: 0
09:27:57 Received Power (Oct): Made 0: 6184 mw
09:27:57 FSK word:ack t:0123 - 6092 s:139 - 1.5 po:0/0 pm:0/0
09:27:57 Sent Control Error: 0
09:27:57 Sent Control Error: 0
09:27:57 Sent Control Error: 0
09:27:57 Sent Control Error: -13
09:27:58 Sent Control Error: -14
09:27:58 Sent Control Error: -19
09:27:58 Sent Control Error: 2
09:27:59 Sent Control Error: -2
09:27:59 Sent Control Error: 0
09:27:59 Received Power (Oct): Made 0: 8386 mw
09:27:59 FSK word:ack t:0246 - 8217 s:4.8 - 3.9 po:0/-1 pm:1/0
09:27:59 Sent Control Error: 0
09:27:59 Sent Control Error: 0
09:28:00 Sent Control Error: 0
09:28:00 Sent Control Error: 0
09:28:00 Sent Control Error: 0
09:28:00 Sent Control Error: 0
09:28:00 Sent Control Error: 0
09:28:01 Sent Control Error: 0
09:28:01 Received Power (Oct): Made 0: 8396 mw
09:28:01 FSK word:ack t:0246 - 8217 s:4.8 - 3.9 po:0/-1 pm:1/0
09:28:01 Sent Control Error: 0
09:28:01 Sent Control Error: 0
09:28:01 Sent Control Error: 0
09:28:01 Sent Control Error: 0
09:28:01 Sent Control Error: 0
09:28:01 Sent Control Error: 0
09:28:03 Sent Control Error: 7
09:28:03 Received Power (Oct): Made 0: 10834 mw
09:28:03 FSK word:ack t:0243 - 8216 s:5.3 - 4.5 po:1/-1 pm:1/-1
09:28:03 Sent Control Error: 1
09:28:03 Sent Control Error: 1
09:28:03 Sent Control Error: 1
09:28:04 Sent Control Error: 1
09:28:04 Sent Control Error: 0
09:28:04 Sent Control Error: -1
09:28:04 Sent Control Error: -1
09:28:05 Sent Control Error: -1
09:28:05 Sent Control Error: -1
09:28:05 Received Power (Oct): Made 0: 10456 mw
09:28:05 FSK word:ack t:0243 - 8216 s:5.3 - 4.6 po:0/-1 pm:1/0
09:28:05 Sent Control Error: -1
09:28:05 Sent Control Error: -1
09:28:05 Sent Control Error: -1
09:28:05 Sent Control Error: -1
09:28:05 Sent Control Error: -1
09:28:05 Sent Control Error: 0
09:28:07 Sent Control Error: 0
09:28:07 Received Power (Oct): Made 0: 10176 mw
09:28:07 FSK word:ack t:0243 - 8217 s:5.3 - 4.6 po:0/-1 pm:1/0
09:28:07 Sent Control Error: 0
5.4.2 Thermal Performance
5.4.3 Foreign Object Detection

- 5.4.3.1 Object heating prevention

Source: Nok9
5.4.3 Foreign Object Detection

5.4.3.1 Object heating prevention

Total 12 time FO tests with TPR#5, the result PASS if:

- The BSUT shall be terminate power transfer, or
- The temperature meet below limit when loading the maximum load.

<table>
<thead>
<tr>
<th>Distance *</th>
<th>Foreign Object #1</th>
<th>Foreign Object #1 off centre</th>
<th>Foreign Object #2</th>
<th>Foreign Object #3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0mm</td>
<td>&lt; 60°C</td>
<td>&lt; 60°C</td>
<td>&lt; 60°C</td>
<td>&lt; 80°C</td>
</tr>
<tr>
<td>2mm</td>
<td>&lt; 60°C</td>
<td>&lt; 60°C</td>
<td>&lt; 60°C</td>
<td>&lt; 80°C</td>
</tr>
<tr>
<td>5mm</td>
<td>&lt; 60°C</td>
<td>&lt; 60°C</td>
<td>&lt; 60°C</td>
<td>&lt; 80°C</td>
</tr>
</tbody>
</table>

* Means distance between representative Foreign Object and the Interface Surface of TPR#5
5.4.3 Foreign Object Detection

- 5.4.3.2 Heating prevention

  - Total 6 time FO tests with TPR#MP3, the result PASS if:
    - The BSUT shall be terminate power transfer, or
    - The temperature meet below limit when loading the maximum load.

<table>
<thead>
<tr>
<th>Distance *</th>
<th>Foreign Object #1</th>
<th>Foreign Object #1 off centre</th>
<th>Foreign Object #2</th>
<th>Foreign Object #3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0mm</td>
<td>&lt; 60°C</td>
<td>&lt; 60°C</td>
<td>&lt; 60°C</td>
<td>&lt; 80°C</td>
</tr>
<tr>
<td>2mm</td>
<td>&lt; 60°C</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5mm</td>
<td>&lt; 60°C</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Means distance between representative Foreign Object and the Interface Surface of TPR#5
5.4.3 Foreign Object Detection

• 5.4.3.3 FOD before power transfer

• The purpose of these tests is to verify that a BSUT:
  • does not falsely detect a Foreign Object that is not present
  • can detect the presence of a Foreign Object before proceeding to the power transfer phase
  • can prevent heating of a Foreign Object that is positioned at a critical location
5.4.3 Foreign Object Detection

- 5.4.3.4 FOD calibration

- The purpose of this test is to verify that the BSUT does not stay in the *calibration* phase for more than 10 seconds.
5.4.3 Foreign Object Detection

5.4.3.5 FOD during power transfer

- The purpose of these tests is to verify that a BSUT can
  - prevent heating of a Foreign Object that is moved to a critical position during the power transfer phase;
  - can detect the appearance of a Foreign Object during the power transfer phase sufficiently fast;
  - suppress its Response to Power Receiver Packets; and
  - can restart the power transfer on request of a Power Receiver.
## User Interface

<table>
<thead>
<tr>
<th></th>
<th>Object placed</th>
<th>Transfer in progress</th>
<th>Transfer complete</th>
<th>Fault</th>
<th>Multiple devices 1)</th>
<th>Limited power 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indication to user</td>
<td>within 0.5s</td>
<td>active</td>
<td>within 3s</td>
<td>within 3s</td>
<td>active</td>
<td>active with loading resistor 8ohm and/or 3.5ohm</td>
</tr>
</tbody>
</table>

1) Only for transmitter that is able to support multiple receiver at the same time
2) Only for transmitter take input power from a USB Micro-B or Micro-AB receptacle
5.4.10 Maximum voltage

- The purpose of this test is to verify that the BSUT will not generate an over-voltage condition in a Power Receiver.
- For EPP only
MOBILE DEVICE TEST

01 Conformance to Power Receiver design requirements

02 Conformance to communications interface requirements
  - Load modulation, Frequency demodulation

03 Conformance to system control requirements
  - Selection and ping phase, Identification & configuration phase, Negotiation phase, Power transfer phase, Power receiver reset

04 Conformance to system performance requirements
  - Guaranteed power, FOD before power transfer, FOD calibration
# Required Test Equipment

<table>
<thead>
<tr>
<th>Test Power Transmitter (TPT #)</th>
<th>Baseline Power Profile</th>
<th>Baseline Power Profile + FOD extension</th>
<th>Extended Power Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MP1</td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>QFACTOR</td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
</tbody>
</table>
MOBILE DEVICE TEST
CONFORMANCE TO SYSTEM CONTROL REQUIREMENTS

Ping Phase:
0x01 - signal strength : 0x70
vr (% of Vmax) (output rect. circuit) : 43.720

Identification Phase:
0x71 - identification packet :
Major version : 0x01
Minor version : 0x01
Manufacturer code : 0x0030
Basic Device Identifier :
Extension Packet :

Configuration Phase:
0x51 - Configuration Packet :
Power Class :
Maximum Power :
Prop :
Count :
Window Size :
Window Offset :
Neg :
FSK Polarit :
FSK Depth :

Negotation Phase:
Received Negotiated Packets
MDT Response :
0x22 - FCD status :
ACK
MDT Response :
0x07 - PT Identification :
ACK
MDT Response :
0x07 - PT Capability :
ACK
MDT Response :
0x20 - Received Power Packet Type' :
ACK
MDT Response :
0x20 - Guaranteed Power' :
ACK
MDT Response :
0x20 - Maximum Power' :
ACK
MDT Response :
0x20 - End Negotiation' :
ACK
MDT Response :

Successfully Negotiated
Negotiated Received Power Packet Header :
Negotiated Guaranteed Power :
Negotiated Maximum Power :

intertek.com.hk
6.5.1 Guaranteed power – For BPP
6.5.2 FOD before power transfer

- The purpose of this test is to verify that the MDUT reports its Reference Quality Factor with sufficient accuracy.

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Centre</th>
<th>Top</th>
<th>Bottom</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5V</td>
<td>Measure Q value</td>
<td>Measure Q value</td>
<td>Measure Q value</td>
<td>Measure Q value</td>
<td>Measure Q value</td>
</tr>
<tr>
<td>1.2V</td>
<td>Measure as above location which has the lowest value</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

intertek.com.hk
6.5.3 FOD Calibration

- The purpose of this test is to verify that the MDUT provides appropriate calibration data in the *calibration* phase.
<table>
<thead>
<tr>
<th></th>
<th>Walk-in Testing</th>
<th>Pre-Compliance Testing</th>
<th>Compliance Testing</th>
<th>Certification Package (Including failure verified modification)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline Power Profile</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Testing Time</td>
<td></td>
<td>5 working days</td>
<td>8 working days</td>
<td>20 working days</td>
</tr>
<tr>
<td>Sample</td>
<td></td>
<td>1 pc</td>
<td>5 pcs</td>
<td>5 pcs</td>
</tr>
<tr>
<td><strong>Extended Power Profile</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Testing Time</td>
<td></td>
<td>8 working days</td>
<td>10 working days</td>
<td>25 working days</td>
</tr>
<tr>
<td>Sample</td>
<td></td>
<td>1 pc</td>
<td>5 pcs</td>
<td>5 pcs</td>
</tr>
</tbody>
</table>
C.H. Lam, Senior Wireless Charging Specialist

+852 2173 8434
chiho.lam@intertek.com
intertek.com.hk

Eric Ge, Senior Wireless Charging Business Consultant

+852 2173 8534
eric.ge@intertek.com
intertek.com.hk