



# **FOD Receiver User's Guide**

Rev 3, 07/18/2013

## General Description

The AVID FOD (Foreign Object Detection) Receiver is a standard WPC V1.1 wireless power receiver (5.0W) that has been calibrated and characterized to accurately measure and report received power information. This RX device is useful for testing transmitter devices, for characterizing and optimizing V1.1 (and newer) transmitter's FOD functionality, and for doing Qi pre-compliance testing.

Here are the main features of the AVID FOD Receiver:

- Fully functional V1.1 Qi Receiver
- Uses "naked" RX coil as specified for TPR#5 in the WPC Part 3 spec. Coil is isolated from the electronics and mounted in plastic frame that mates with the foreign object holders for good alignment
- Factory calibrated and characterized using calibrated AVID FOD Transmitter
- Accurately measures and reports PPR (received power) values per WPC V1.1 spec
- Calculates and sends additional 16-bit PPR values (proprietary packet 0x28) that can be decoded and reported using the AVID FOD Transmitter and AVID V1.1 Sniffer
- Programmable PPR offset and internal loads (DIP switch settings)
- External load board (included) has minimum, maximum and in-between loads for testing and characterizing transmitters and for running Qi pre-compliance tests
- Supports internal loads up to 2.0 Watts in 0.25 Watt increments (DIP switch settings) and external loads up to 5.0 Watts maximum.

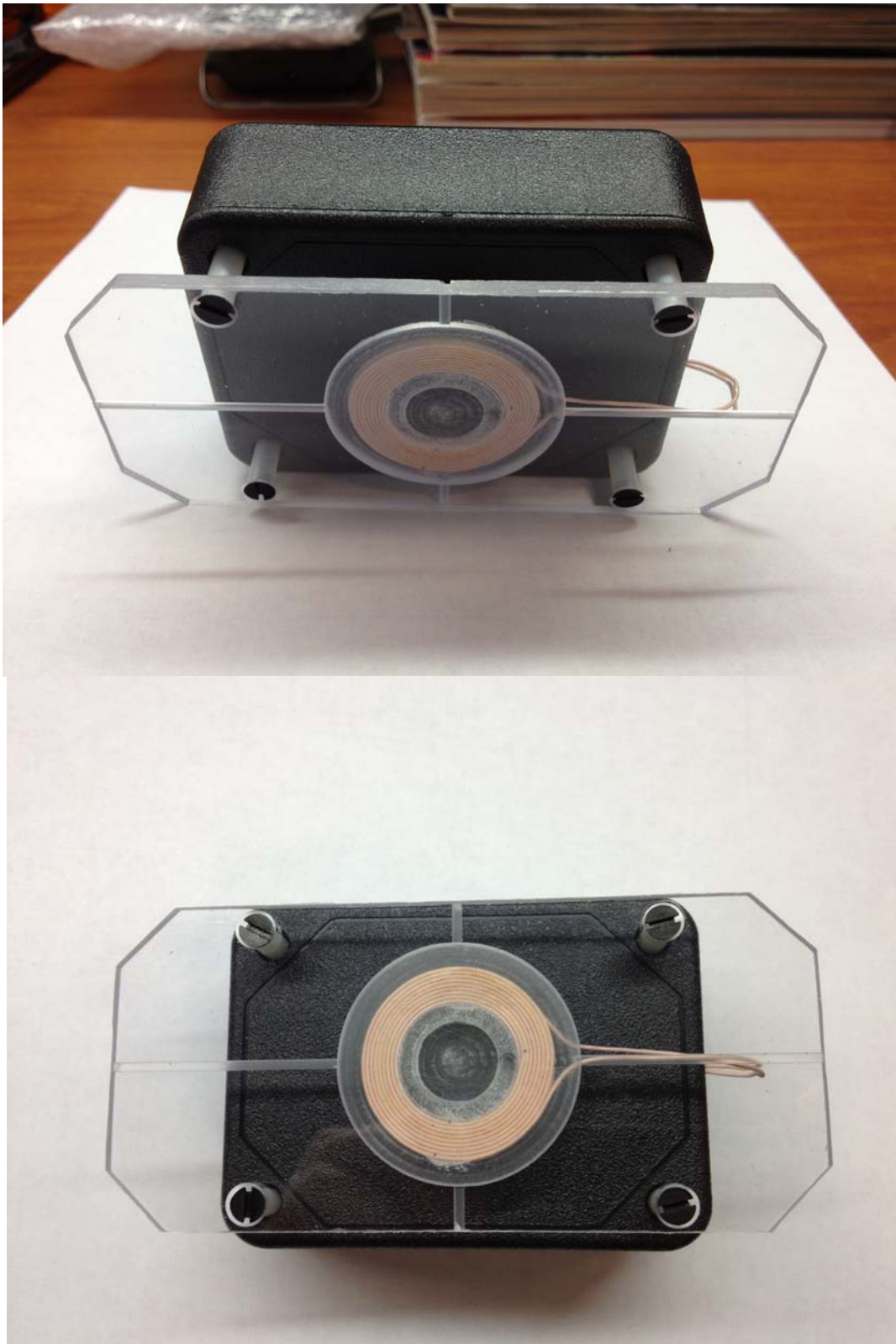


**AVID FOD Receiver, Top View**

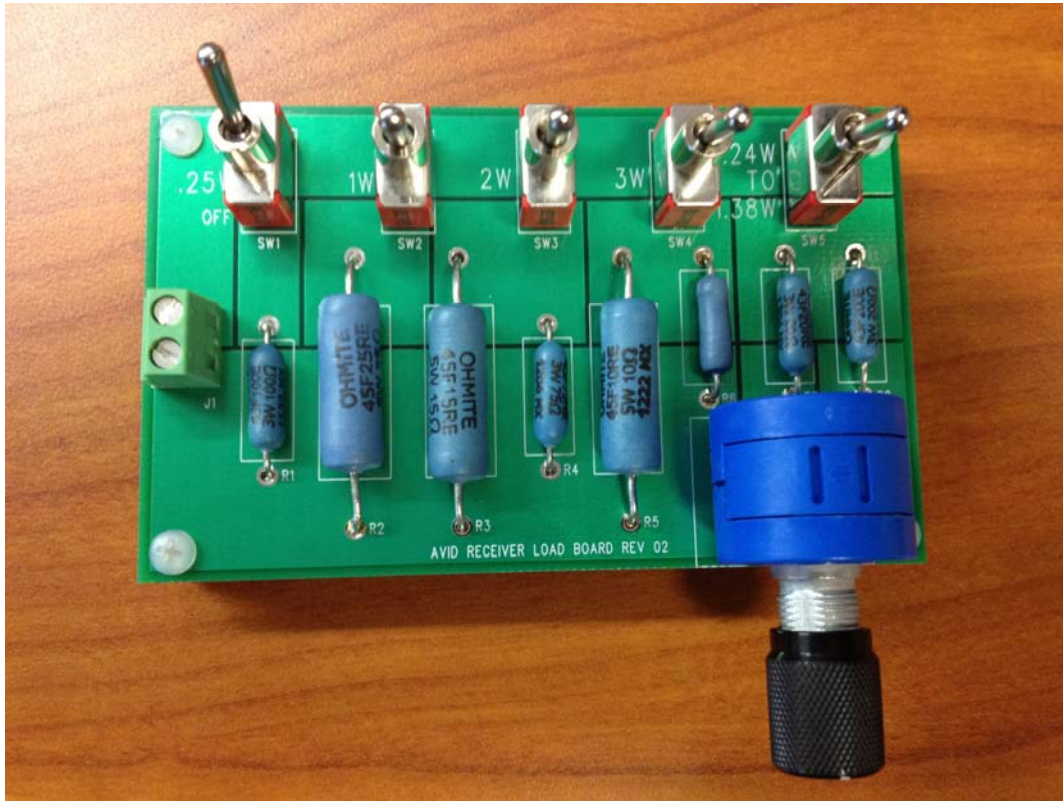
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**AVID FOD Receiver, Side and Bottom Views**



**AVID Receiver Load Board**

## Basic Setup and Operation

To operate the FOD Receiver, first set the DIP switches on top of the unit to program the internal load and the PPR offset values (see below) as desired. The FOD receiver can be operated using internal loads up to 2.0 Watts, but AVID recommends leaving the Load DIP switches all off and connecting the external load board to the output screw terminals for testing because this will isolate the load from the receiver and keep the electronics at a more even temperature. Next, place the FOD Receiver on any Qi transmitter for characterization and testing.

The “Power” and “Status” LEDs on top of the FOD Receiver indicate the operational state of the receiver. The Power LED will light solid blue as long as the receiver is receiving enough power from the transmitter to power up its internal electronics. The Status LED will light solid green when the receiver is receiving enough power to supply the internal or external load and to regulate its output voltage to +5.0V. When the FOD Receiver is first placed on a transmitter, it connects a minimum internal load of 100 ohms (to ensure robust communications). Next the receiver adjusts its bridge voltage to about 5.8V and then connects the internal or external load and disconnects the minimum 100 ohm load. If an external load is connected to the terminal block on the receiver and current flow is detected through the output, all internal loads are disconnected otherwise the internal load programmed on the DIP switches is left connected. Once the load is connected, the receiver will send error messages to regulate the output to +5.0V +/- 5%.

The FOD Receiver should operate normally on any Qi transmitter (base station). If the FOD Receiver is powered up and regulating its output voltage, the status LED will remain green or amber. If the FOD Receiver cannot regulate its output voltage the status LED will turn off. If an error occurs (see below) the status LED will blink red. **To maintain good power measurement accuracy, always make sure the FOD Receiver is not operated on or near metal desks or other large metal objects during testing.**

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Below are brief descriptions of the functionality supported by the FOD Receiver:

| Function                   | Description   |
|----------------------------|---|
| <b>Power LED</b>           | Solid blue when FOD Receiver receives sufficient power from the transmitter to power its internal circuitry   |
| <b>Status LED</b>          | Solid green when FOD Receiver receives sufficient power from the transmitter to power its internal load and regulate to +5.0V +/-5%<br>Solid amber when FOD Receiver receives sufficient power from the transmitter to power an external load and regulate to +5.0V +/-5%<br>Blinking red indicates various error codes (see quick start guide below) |
| <b>VBRIDGE Pin</b>         | Rectified bridge voltage measurement test point   |
| <b>COMM Pin</b>            | Communication modulator digital signal test point   |
| <b>GND Pins</b>            | Internal circuitry ground reference   |
| <b>TEST DIP Switches</b>   | PPR offset multiplier (6 bits) 0 to 63. This value is multiplied by the PPR offset step size to get the resulting PPR offset value in mW  |
| <b>COMM DIP Switches</b>   | PPR step size (2 bits). This value is multiplied by the PPR offset multiplier to get the resulting PPR offset value in mW<br>00 = -5 mW, 01 = -10 mW, 10 = +5 mW, 11 = +10 mW   |
| <b>LOAD DIP Switches</b>   | Internal load (4 bits) 0 to 8 (positions 9-15 reserved)<br>This value is multiplied by 0.25 to get the resulting internal load in Watts<br>If external load $\geq 0.25W$ is sensed, all internal loads are switched off   |
| <b>Terminal Block</b>      | For connecting external loads. When operating properly the FOD Receiver will provide +5.0V +/- 5% at this output  |
| <b>External Load Board</b> | Can be used to connect and switch on/off various external loads for characterizing V1.1 transmitters and running FOD pre-compliance tests   |

## V1.1 Transmitter (Base Station) FOD Characterization

V1.1 Qi compliant transmitter (base station) product developers can use the AVID FOD Receiver tool and the AVID external load board (or user supplied load) to characterize and adjust the transmitter power measurements. The FOD Receiver has been characterized using the AudioDev WPC approved V1.1 Test Transmitter and the results show good correlation between transmitted power and received power to within about 50 mW accuracy over a 0.25 W to 6.0 W load range.

If the transmitter under test has a means of providing an indication of its transmitted power values during power transfer, then it is possible to use the AVID FOD Receiver to characterize the transmitter's power loss measurements and FOD thresholds.

To use the AVID FOD Receiver to characterize a transmitter, use the following procedure:

- 1) Connect the external load board to the FOD Receiver terminal block and switch on the 0.25 W load only. The on position for the switches is toward the edge of the load board.
- 2) Place the FOD Receiver on the transmitter, center aligned, and record the transmitted power and received power values. If the transmitter does not already provide the received power values to the user, the AVID Qi Sniffer V1.1 can be used to capture the received power values including 16-bit high resolution values reported by the AVID FOD Receiver.
- 3) Repeat step 2 at several external load points such as at 1.0 W increments up to 5.0 W.
- 4) Plot the received power vs. transmitted power values for each load point. The data should show good correlation. If the difference is greater than 100 mW at any of the load points, make adjustments to the transmitter to improve the power measurements.

## Base Station Qi Pre-Compliance Testing

V1.1 Qi compliant transmitter (base station) product developers can use the AVID FOD Receiver tool, the AVID external load board (or electronic load), and a set of WPC defined Foreign Objects to run Qi FOD Part 3 pre-compliance tests. AVID Technologies supplies (separately) the WPC defined foreign objects with an alignment frame and spacers that can be used for this testing.

The Part 3 Base Station FOD compliance tests use two test receivers: TPR#5 and TPR#6. These receivers use a low-loss coil with no shield to minimize parasitic losses.

TPR#5 is configured to output 5.0V +/-20% and to use a received power window size of 64 ms and a window offset size of 16 ms. TPR#5 is also configured to over report its received power values by 235 mW. During the WPC interim extension period in effect until May 2014, TPR#5 shall instead over report its received power values by 35 mW:

$$\text{TPR\#5 PPR} = (\text{PPM} + 235)$$

$$\text{TPR\#5 (INT) PPR} = (\text{PPM} + 35) \quad \text{** Use this equation during the WPC interim period}$$

PPM is the actual received power determined by the test receiver by measuring its load power and adding estimated parasitic power losses.

TPR#6 is identical to TPR#5 except TPR#6 is configured to under report its received power values by 15 mW. During the WPC interim extension period in effect until May 2014, TPR#6 shall instead under report its received power values by 115 mW.

$$\text{TPR\#6 PPR} = (\text{PPM} - 15)$$

$$\text{TPR\#6 (INT) PPR} = (\text{PPM} - 115) \quad \text{** Use this equation during the WPC interim period}$$

## Base Station Thermal Compliance Testing

The Part 3 Base Station FOD thermal compliance tests consist of measurements that check the temperature rise (at +25 deg C ambient) of four different WPC defined foreign objects while they are placed between the test receiver (TPR#5) and the base station during power transfer. Each object has an allowed temperature limit as defined in the table below.

WPC Defined Foreign Objects:

| Object | Configuration             | Temperature Limit |
|--------|---------------------------|-------------------|
| #1     | Steel disc centered       | 60 deg C          |
| #2     | Aluminum ring centered    | 60 deg C          |
| #3     | Aluminum foil centered    | 80 deg C          |
| #4     | Steel disc offset 15.5 mm | 60 deg C          |

If any of the foreign objects reaches or exceeds the temperature limits above during testing, the transmitter's FOD measurements, thresholds, or reaction time may need to be adjusted to meet compliance.

To use the AVID FOD Receiver to emulate TPR#5 and run the foreign object thermal pre-compliance tests on a base station, use the following procedure:

- 1) Set the DIP switches on the AVID FOD Receiver to emulate TPR#5 as follows:

TEST = 000111 (PPR offset multiplier = 7)  
COMM = 10 (PPR offset step = +5 mW)  
LOAD = 0000 (no internal load)

- 2) Connect the external load board to the FOD Receiver and switch on the 0.25W (100 ohm) load only on the far left of the load board near the terminal block connector.
- 3) Connect foreign object #1 (steel disc) K-type thermocouple connector to a suitable thermometer or DMM that can measure temperature of a K-type thermocouple.
- 4) Fit the clear plastic alignment frame on top of the foreign object holder.
- 5) Place the foreign object and alignment frame on the base station under test and align the center of the foreign object holder with the center of the base station transmitter coil. The AVID foreign object holders have score marks that indicate the center lines.
- 6) Place the AVID FOD Receiver in the alignment frame on top of the foreign object and make sure the receiver and foreign object are still center aligned with the transmitter coil.
- 7) Increase the load on the external load until the transmitter hits its power loss (FOD) threshold and terminates (or lowers) its transmitted power. If you are using the AVID supplied external load board, leave the 0.25W load switched on, switch on the variable (0.24 W to 1.38 W) load, and slowly adjust the potentiometer until right at the point the power loss threshold is hit.
- 8) Reduce the external load by 50 mA. If you are using the AVID supplied external load board this can be accomplished by switching off the 0.25W (100 ohm) load.
- 9) Run the transmitter for 10 minutes (or until the transmitter terminates power transfer) and record the temperature of the foreign object.

If the transmitter terminates power transfer before 10 minutes during any of these tests, repeat steps 6 and 7 above and reduce the load slightly until the transmitter runs for 10 minutes OR until the minimum load of 0.25 W (50.0 mA) is reached. At the minimum load, if the transmitter still terminates power before 10 minutes, the temperature of the object is recorded at the point where power transfer was terminated.

The steps above are repeated as follows:

- Using object #1 with 2.0 mm spacer placed between the foreign object and the AVID FOD receiver
- Using object #1 with 5.0 mm spacer placed between the foreign object and the AVID FOD receiver
- Using foreign object #2
- Using foreign object #3
- Using foreign object #4

The steel disc objects present lower power losses and temperature rises than the other objects. For the steel objects, the thermal test may run for the full 10 minutes. The transmitter FOD power loss threshold should be set to keep the temperature of the objects below the limit at the end of the 10 minute test.

The aluminum foil and ring objects present higher power losses and temperature rises than the steel discs. For these objects, even at the minimum 50 mA load the thermal test may not run the full 10 minutes before the transmitter reaches its FOD power loss threshold. In this case the transmitter FOD threshold and reaction time should be adjusted to keep the foreign object temperature below the limit when the threshold is reached and the transmitter either terminates or reduces power.

If the transmitter can be adjusted to keep the foreign objects below the temperature limits for all of the above tests, then the product will likely pass the FOD thermal compliance tests at an approved Qi compliance lab. If not, adjust the transmitter FOD power loss thresholds and reaction time accordingly.

## Base Station Guaranteed Power Compliance Testing

The Part 3 Base Station FOD guaranteed power compliance test consists of a measurement that checks to make sure the base station under test can deliver 5.0 Watts to a test receiver (TPR#6) that has no foreign object present, but is simulating power loss into a foreign object by under reporting its received power.

To use the AVID FOD Receiver to emulate TPR#6 and run the guaranteed power pre-compliance tests on a base station, use the following procedure:

- 1) Set the DIP switches on the AVID FOD Receiver to emulate TPR#6 as follows:

TEST = 010111 (PPR offset multiplier = 23)  
COMM = 00 (PPR offset step = -5 mW)  
LOAD = 0000 (no internal load)

- 2) Connect the external load board to the FOD Receiver and switch on the 0.25W load only.
- 3) Place the FOD Receiver on the base station and make sure it is center aligned with the transmitter coil. Wait until the base station begins power transfer.
- 4) Switch on the 1W load on the external load board. Allow the base station to continue power transfer for 10 seconds.
- 5) Switch on the 2W load on the external load board. Allow the base station to continue power transfer for 10 seconds.
- 6) Switch on the 3W load and switch off the 0.25W and 1W loads on the external load board (total = 5W load). Allow the base station to continue power transfer for 5 minutes.
- 7) Measure the voltage at the terminal block output on the FOD Receiver and make sure it is between 4.75V and 5.25V (regulation tolerance of the FOD Receiver).

If the voltage measured in step 7 is between 4.75V and 5.25V, then the product will likely pass the FOD guaranteed power compliance tests at an approved Qi compliance lab. If the voltage is not between 4.75V to 5.25V, make adjustments to the base station device to improve the power transfer performance and repeat the tests above.

**NOTE:** AVID FOD TOOLS ARE NOT APPROVED FOR FINAL QI COMPLIANCE TESTING. THEY ARE DESIGNED TO BE USED FOR DEVELOPMENT AND PRE-COMPLIANCE TESTING BY CUSTOMERS DESIGNING and PROTOTYPING WPC V1.1 WIRELESS POWER PRODUCTS.



**AVID FOD Receiver Quick Start Guide:**

**SYSTEM MONITORING:**

VBRIDGE: (5.0V +/- 0.5V)  
Receiver DC Bridge Voltage  
COMM. (0 - 3.3V Logic)  
Modulation Signal

**5V, 0-1A OUTPUT:**

Internal load is disabled  
when external load (>0.25W)  
is connected.

**CONFIGURATION SWITCHES:**

**TEST** Position 1-6  
PPR offset multiplier

**LOAD** Position 1-4  
Selects internal load  
0-2W, in 0.25W Steps

**COMM** Position 5  
PPR offset polarity  
Position 6  
PPR offset step size

All switches can be changed  
during run time.

**POWER LED:**

|   |  |
|---|--|
| ● | Wireless power present<br>(Blue Solid) |
| ○ | Wireless power removed<br>(OFF)        |

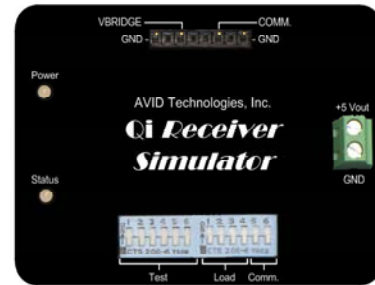
**STATUS LED:**

|   |  |
|---|--|
| ● | Output power good<br>(Green Solid)   |
| ● | Output power good<br>External load detected<br>Internal load disabled<br>(Amber Solid) |
| ● | n/a (Red Solid)  |

**ERROR BLINK PATTERNS:**  
(Only valid for Test 0)

|     |  |
|-----|--|
| ●   | Over temperature<br>(Red Single Blink Pattern)   |
| ●●  | Output overload<br>(Red Double Blink Pattern)    |
| ●●● | Input over voltage<br>(Red Triple Blink Pattern) |

**FOD Receiver**  
Quick Start Guide



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FOD Receiver

| TEST Switch (PPR offset mult) |        |                        |
|-------------------------------|--------|------------------------|
| 0                             | 000000 | PPR offset = 0 x step  |
| 1                             | 000001 | PPR offset = 1 x step  |
| ...                           | ...    | ...                    |
| 63                            | 111111 | PPR offset = 63 x step |

| COMM Switch (PPR offset step) |    |                |
|-------------------------------|----|----------------|
| 0                             | 00 | Negative 5 mW  |
| 1                             | 01 | Negative 10 mW |
| 2                             | 10 | Positive 5 mW  |
| 3                             | 11 | Positive 10 mW |

| LOAD Switch |      |                      |
|-------------|------|----------------------|
| 0           | 0000 | 0.00 W internal load |
| 1           | 0001 | 0.25 W internal load |
| 2           | 0010 | 0.50 W internal load |
| 3           | 0011 | 0.75 W internal load |
| 4           | 0100 | 1.00 W internal load |
| 5           | 0101 | 1.25 W internal load |
| 6           | 0110 | 1.50 W internal load |
| 7           | 0111 | 1.75 W internal load |
| 8           | 1000 | 2.00 W internal load |
| 9 - 15      |      | Reserved             |