



# **FOD Transmitter User's Guide**

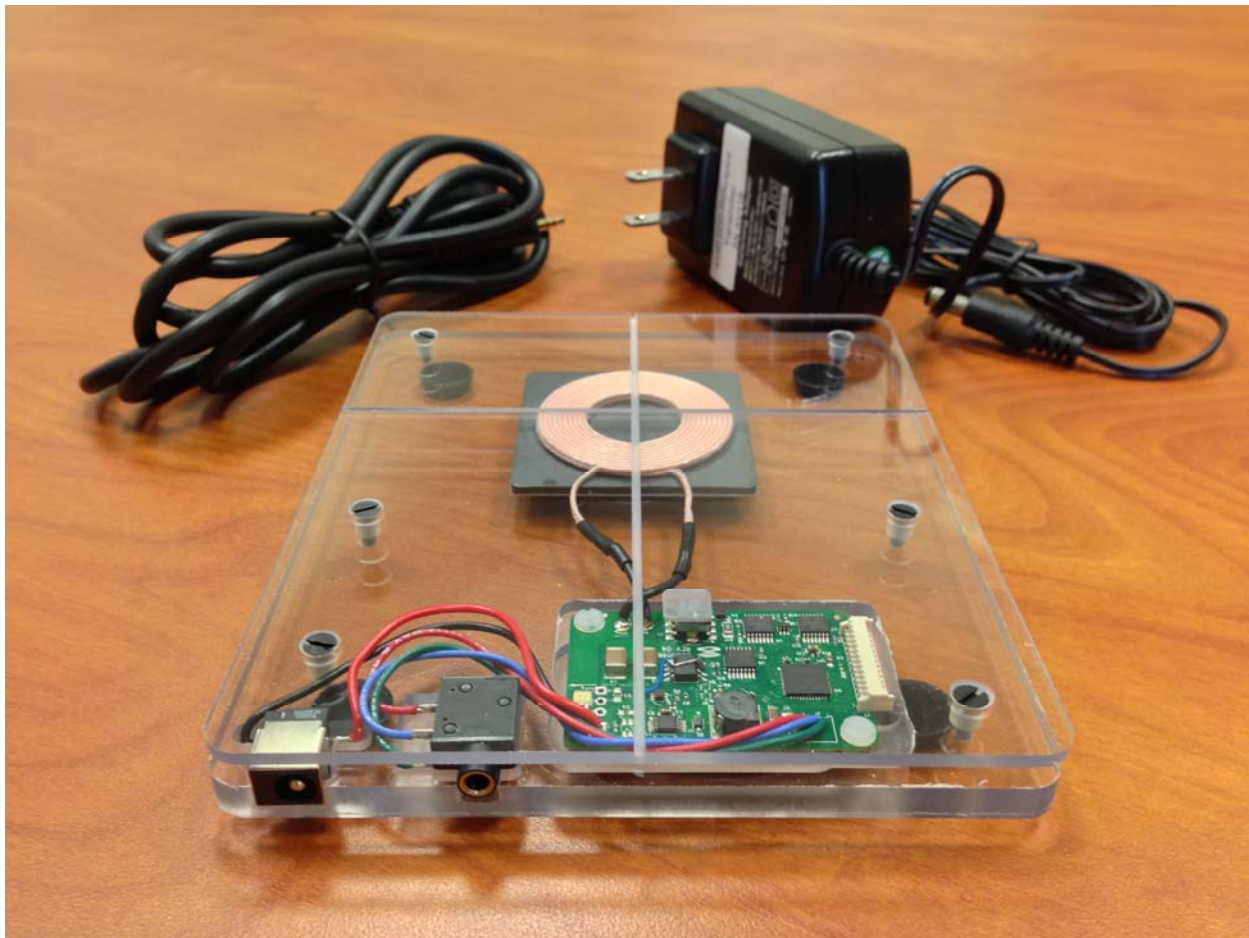
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## General Description

The AVID FOD (Foreign Object Detection) Transmitter is a standard WPC Qi V1.1 wireless power transmitter that has been calibrated and characterized to accurately measure and report transmitted power information. The FOD TX device is useful for testing all Qi receiver devices, for characterizing and optimizing V1.1 (and newer) receiver device FOD functionality and for doing mobile device Qi pre-compliance testing.

Here are the main features of the FOD Transmitter:

- Fully functional V1.1 Qi Transmitter
- Uses A10 TX coil as specified for TPT#2 in the WPC Part 3 spec
- Factory calibrated and characterized using AudioDev FOD calibrator unit
- Accurately measures and reports PPT (transmitted power) values per WPC V1.1 spec
- USB/serial port for displaying transmitted power, received power, power loss, and other parameters
- Decodes and displays 16-bit PPR values sent by AVID FOD Receiver and AVID V1.1 Receiver Simulator (proprietary packet 0x28)
- Programmable PPT offset, FOD threshold, and FOD shutdown timeout values (serial port commands)
- Can be run in open loop (fixed frequency) mode to help characterize receivers and to verify transmitted power accuracy using the AudioDev calibrator system
- Can be run in signal strength mode to help center align mobile devices (max signal strength)



**AVID FOD Transmitter, DC Adapter, and FTDI USB Serial Cable**

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2112 Case Parkway South, Twinsburg, Ohio 44087 • Phone 330.487.0770

Website: [www.avid-tech.com](http://www.avid-tech.com) E-Mail: [wirelesspower@avid-tech.com](mailto:wirelesspower@avid-tech.com)

## Basic Setup and Operation

To operate the FOD Transmitter, first connect power by plugging in the 19.0V DC adapter supplied with the unit. The 5.0 mm DC barrel connector on the power supply cord mates with a DC jack on the transmitter. **To maintain good power measurement accuracy, always use the supplied DC adapter to power the transmitter and make sure the transmitter is not operated on or near metal desks or other large metal objects during testing.**

When the FOD transmitter is first powered up, the LED status indicator on the transmitter circuit board will flash once but will normally remain off until a receiver device is placed on the transmitter.

Any Qi compliant receiver (mobile device) should operate normally on this transmitter (base station). Place the receiver device on top of the transmitter coil platform. There are cross hairs etched into the coil platform to indicate the center position of the transmitter coil for rough device alignment. When a Qi compliant receiver is placed on the transmitter and power transfer begins, the status LED will light up solid amber color to indicate valid operation. If an error condition such as FOD fault occurs at power up or during power transfer, the status LED will change to solid red.

## USB Serial Interface

The FOD Transmitter has a serial interface that facilitates communication with any USB-enabled computer and provides continuous status information as well as a means to program various features of the transmitter. Connect the included FTDI USB to Serial cable to your computer's USB port and into the serial connector on the transmitter. Earlier FOD transmitters used a 6-pin header for the serial port. Newer units use a audio jack connector for the serial port. For the 6-pin header, verify that pin 1 of both header connectors (indicated by an arrow on each connector housing) are aligned properly. The wires on the FOD transmitter and the FTDI cable may not match colors.

You may need to install drivers to use the FTDI USB serial adaptor cable. These drivers can be downloaded from the FTDI website at:

<http://www.ftdichip.com/Drivers/VCP.htm>

Once the drivers are installed the FTDI cable will be recognized as a serial COM port on your PC when connected. To determine which COM port number the FTDI cable is assigned to, open the Windows device manager under control panel.

Any terminal emulation program or other application program that provides user access to the assigned COM port can be used to display FOD Transmitter data and to send commands to the FOD Transmitter. A free terminal emulator program called TeraTerm can be downloaded at:

<http://logmett.com/index.php?/download/tera-term-477-freeware.html>

Select the COM port and use the following settings when establishing the serial connection:

<b>Baud Rate</b>	19200
<b>Data</b>	8 bits
<b>Parity</b>	None
<b>Stop</b>	1 bit
<b>Flow Control</b>	None

## Serial Port Display

If the USB cable is already plugged in and the terminal program is running when the FOD Transmitter is powered up, the transmitter will display a "splash screen" that includes basic information such as the part name and the software revision. This is a good indication that the transmitter is operating properly and the USB serial interface is configured and working properly.

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After displaying the splash screen, the FOD Transmitter remains in an idle pinging state until a receiver is placed on the transmitter and detected. When a valid Qi receiver device is detected, the receiver signal strength and ID information are displayed. If the receiver is a V1.0 device, the transmitter will display operating frequency and input power information each time a rectified power packet message is sent by the receiver. If the receiver is a V1.1 (or newer) FOD capable device, the FOD Transmitter will additionally output FOD status information (PPT, PPR and Ploss) each time a received power packet message is sent by the receiver. Below are examples of the information displayed by the FOD Transmitter during power up and during normal operation while charging a V1.1 mobile device:

**Splash Screen sent by FOD Transmitter****/// Event**

AVID\_FOD\_REFERENCE\_TRANSMITTER

/// FOD TX powered up

Built: Dec 14 2012 13:52:42

v1.1.2349

NumberOfChannels: 1

NumberOfCoilsPerChannel: 1

**Receiver ID information sent by FOD Transmitter****/// Event**

Device Detected

/// V1.1 RX placed on FOD TX

Signal Strength: 137

Ping Frequency: 175000Hz

ID: v1.1, Mfg: 0x0017, Id: 0x00000162

EXTID: 0x00B9BA090101C308

Holdoff Time: 5ms, Max Pwr: 5000mW

FOD Window: 64ms, FOD Offset: 12ms

**Operating and FOD information sent by FOD Transmitter****/// Event**

Frequency: 128901Hz

/// 1st received power packet

Vin: 19238mV, Iin: 150mA, Pinput: 2899mW, Icoil: 940mA

PPT Offset: +0mW, PPT (w/ offset): +2758mW, FOD Threshold: 300mW

PPR (8-bit): +2890mW, PLoss: -132mW, FOD: PASS

PPR (16-bit): +2926mW, PLoss: -168mW, FOD: PASS

Frequency: 128901Hz

/// 2nd received power packet

Vin: 19238mV, Iin: 150mA, Pinput: 2899mW, Icoil: 940mA

PPT Offset: +0mW, PPT (w/ offset): +2758mW, FOD Threshold: 300mW

PPR (8-bit): +2890mW, PLoss: -132mW, FOD: PASS

PPR (16-bit): +2926mW, PLoss: -168mW, FOD: PASS

Frequency: 128901Hz

/// 3rd received power packet

Vin: 19238mV, Iin: 150mA, Pinput: 2896mW, Icoil: 940mA

PPT Offset: +0mW, PPT (w/ offset): +2755mW, FOD Threshold: 300mW

PPR (8-bit): +2890mW, PLoss: -135mW, FOD: PASS

PPR (16-bit): +2926mW, PLoss: -171mW, FOD: PASS

CEP Timeout

/// RX removed from FOD TX

Below are brief descriptions of each parameter that is displayed by the FOD Transmitter:

Message	Description
<b>Device Detected</b>	Displayed when valid Qi receiver device is placed on the transmitter
<b>Signal Strength</b>	Signal strength packet sent by the receiver. If Position Mode is enabled, this message is repeatedly displayed while a receiver is present.
<b>Ping Frequency</b>	Transmitter frequency used for device ID ping
<b>ID</b>	Identification packet sent by the receiver. WPC version, mfg code, and mfg ID
<b>EXTID</b>	Extended identification packet (optionally sent by the receiver)
<b>Holdoff Time</b>	Power control hold off time sent by the receiver
<b>Max Pwr</b>	Maximum power the receiver device supports
<b>FOD Window</b>	Window size for power sample averaging
<b>FOD Offset</b>	Start time offset for power sampling window
<b>Frequency</b>	Transmitter operating frequency during power transfer
<b>Vin</b>	Transmitter DC input voltage measured (millivolts)
<b>Iin</b>	Transmitter DC input current measured (milliamps)
<b>Pinput</b>	Transmitter DC power input calculated (milliwatts)
<b>Icoil</b>	Transmitter coil current measured (milliamps)
<b>PPT Offset</b>	Transmitter transmitted power (PPT) offset value – programmable
<b>PPT (w/ offset)</b>	Transmitter transmitted power value measured with PPT offset added
<b>FOD Threshold <sup>1</sup></b>	Transmitter FOD power loss threshold setting – programmable
<b>PPR (8-bit)</b>	V1.1 received power packet value sent by receiver
<b>PPR (16-bit)</b>	AVID Receiver high resolution received power packet value Only displayed if AVID V1.1 or FOD RX device is used
<b>PLoss</b>	Power loss calculated = PPT – PPR
<b>FOD <sup>1</sup></b>	Pass if Ploss <= FOD Threshold. Fail if Ploss > FOD Threshold

- <sup>1</sup> By default even when Ploss exceeds the FOD threshold setting, the AVID FOD Transmitter will continue power transfer for testing purposes. Use the shutdown, fault count, and fault timeout commands (see below) to terminate power transfer after the FOD threshold is exceeded.

**Note:** If a WPC V1.0 receiver device is placed on the FOD Transmitter, FOD (power loss) information will not be calculated or displayed.

## Serial Port Commands

The AVID FOD Transmitter supports several serial port commands for configuration and testing. Below is a list of the commands, their syntax, descriptions, and default values. Type the command in the terminal emulator window and **press the <enter> key to execute the command**. Commands can be executed at any time, but AVID recommends only entering commands while the transmitter is idle.

Below are brief descriptions of the commands supported by the FOD Transmitter:

Command	Syntax	Description	Default
<b>Set FOD Threshold</b> <sup>1</sup>	FT<value>	<value> = integer between 0 and 30000 mW	300
<b>Set PPT Offset</b> <sup>2</sup>	PO<value>	<value> = integer between -1000 and 1000 mW	0
<b>Shutdown on FOD Fault after Timeout</b> <sup>3</sup>	SD<value>	<value> = 0 to continue power after FOD timeout <value> = 1 to shut down power after FOD timeout	0
<b>FOD Fault Count</b> <sup>3</sup>	FC<value>	<value> = integer between 1 and 255	1
<b>FOD Fault Timeout</b> <sup>3</sup>	TO<value>	<value> = integer between 1 and 120,000 mSec	20,000
<b>Position Mode</b> <sup>4</sup>	PM<value>	<value> = 0 to disable position mode <value> = 1 to enable position mode	0
<b>Closed Loop Mode</b>	CL	Run transmitter in normal closed loop mode	On
<b>Open Loop Mode at fixed frequency</b> <sup>5</sup>	OL<value>	<value> = 110000 to 205000 Hz (coil on @ freq) <value> = 0 (coil off)	Off
<b>Display FOD</b>	F	Display FOD parameters while running open loop	

- 1 Ploss calculated greater than FOD threshold for Fault Count number of received power packets in a row will trigger the FOD fault timeout period. The status LED will turn red as long as the FOD fault persists or until the receiver is removed.
- 2 PPT offset is added to the calculated transmitted power value. PPT offsets are used for testing purposes such as when emulating TPT#2 for mobile device pre-compliance testing.
- 3 If shutdown is enabled and Ploss is greater than the FOD threshold for Fault Count number of received power packets in a row, the transmitter will trigger the FOD fault timeout, stop power transfer after the FOD timeout period, and remain idle for 5 minutes or until the receiver is removed.
- 4 When position mode is enabled, the FOD transmitter will run in a loop displaying the signal strength packet, resetting, and starting again so the user can find and mark the center position (highest signal strength location) for their mobile device. This is very useful for doing Qi pre-compliance testing.
- 5 In open loop mode the FOD transmitter runs at a fixed operating frequency and ignores RX communication packets. No control loop takes place. **!!!! CAUTION: Operating the FOD Transmitter in open loop mode at lower frequencies can create an over voltage condition and damage receiver devices. AVID recommends starting at higher operating frequencies and working toward lower frequencies until the desired power level is achieved.**

### V1.1 Receiver (Mobile Device) FOD Characterization

V1.1 Qi compliant receiver (mobile device) product developers can use the AVID FOD Transmitter tool to characterize and adjust their mobile device power loss measurements. The FOD Transmitter has been calibrated and characterized using the AudioDev WPC approved V1.1 calibration tool and the results show good correlation between transmitted power and received power to within about 20 mW accuracy over a 0.25 W to 6.0 W load range.

AVID recommends characterizing mobile devices over their full operating load (or charging) range and at several spatial orientations such as the 5 positions called out for Qi compliance testing (centered 0,0), (0,5), (0,-5), (5,0) and (-5,0) mm.

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To use the AVID FOD Transmitter to characterize a mobile device, use the following procedure:

- 1) Connect the FOD Transmitter USB serial cable to a computer and run a terminal emulator program to display transmitter status messages (see above).
- 2) Place the mobile device under test on the FOD transmitter center aligned and record the received power and transmitted power values displayed in the terminal emulator window.
- 3) Repeat the steps above at several load points spanning the full power range of the mobile device and at several spatial positions.
- 4) Record/plot the received vs. the transmitted power values for each load point and position tested. The data should show good correlation. If the difference (Ploss) is greater than 350 mW at any of the load points, make adjustments to the mobile device to improve the received power values. Also, if the Ploss values displayed by the FOD Transmitter are positive when the mobile device is center aligned (see below), the mobile device should be adjusted to increase its received power values (over report more).

**Note:** Mobile devices should over report their received power values to account for tolerances and spatial movements (see pre-compliance test definitions below). Because of this over-reporting, when the mobile device is center aligned with no additional z-gap and no foreign objects present, the power loss values displayed by the FOD Transmitter should be zero or negative. If the power loss numbers are positive under these conditions, the mobile device should be adjusted to over report by higher values.

## Mobile Device Qi Pre-Compliance Testing

V1.1 QI compliant receiver (mobile device) product developers can use the AVID FOD Transmitter tool to run Part 3 FOD pre-compliance tests.

Annex D of WPC low power specification Part 1 specifies that a mobile device shall over report its received power (PPR) by a maximum of 250 mW. During the WPC interim extension period in effect until May 2014, the over reporting allowance has been increased to 350 mW.

$$(PPR - 250 \text{ mW}) \leq PPM \leq PPR$$

$$(PPR - 350 \text{ mW}) \leq PPM \leq PPR \quad ** \text{ Use this equation during the WPC interim period}$$

PPM is the actual received power determined by the mobile device by measuring its load power and adding estimated parasitic power losses. Mobile devices should over report their received power (the received power packet value sent to the transmitter) to account for tolerances and spatial variations in the system. The minimum a mobile device should over report is 2x the transmitted power accuracy tolerance of the test transmitter (TPT#2) or 40 mW. In summary, mobile devices should send received power values to the transmitter (PPR) to meet the following requirements:

$$(PPM+40) \leq PPR \leq (PPM+250)$$

$$(PPM+40) \leq PPR \leq (PPM+350) \quad ** \text{ Use this equation during the WPC interim period}$$

The FOD received power test in Part 3 checks to make sure a mobile device accurately reports its received power values. To do this, the mobile device is placed on the test transmitter (TPT#2) in five different positions (cross shape with 5.0 mm offsets from center aligned) and the transmitted power and received power values are recorder and compared. Per WPC Part 3, TPT#2 is required to over report its transmitted power by 20 mW to account for accuracy tolerance. At all 5 positions (0,0), (0,5), (0,-5), (5,0) and (-5,0) the received power values must meet the following conditions to pass compliance:

$$(PPR - 250 \text{ mW}) \leq PPT \leq PPR$$

$$(PPR - 350 \text{ mW}) \leq PPT \leq PPR \quad ** \text{ Use this equation during the WPC interim period}$$

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Website: [www.avid-tech.com](http://www.avid-tech.com) E-Mail: [wirelesspower@avid-tech.com](mailto:wirelesspower@avid-tech.com)

## Mobile Device Received Power Compliance Testing

To use the AVID FOD Transmitter to emulate TPT#2 and run FOD pre-compliance tests on a mobile device, use the following procedure:

- 1) Connect the USB serial cable to a computer and run a terminal emulator program to display status messages from the FOD Transmitter and to allow command entry (see above).
- 2) After the FOD Transmitter "splash screen" message is displayed, enter the following serial command to program the transmitter PPT offset to +20 mW.

PO20 <enter>

- 3) Run Position Mode by entering the following serial command:

PM1 <enter>

- 4) Place the mobile device on the transmitter and reposition the mobile device until the signal strength values being displayed are maximized. This is the center aligned position (0,0).
- 5) Exit Position Mode by entering the following serial command:

PM0 <enter>

- 6) Record PPT (w/ offset) and PPR values displayed in the terminal emulator window for 1 minute. The number of values recorded will vary depending on how often the mobile device sends received power packets, but the number should range from about 12 to 20 sets of values.
- 7) Check the PPR values to make sure they meet the condition  $(PPR - 350 \text{ mW}) \leq PPT \leq PPR$
- 8) Repeat steps 6 and 7 for positions (0,5), (0,-5), (5,0) and (-5,0) mm.

If the mobile device meets the requirements above for reporting its received power, then the product will likely pass the FOD compliance tests at an approved Qi compliance lab. If the mobile device does not meet the requirements for reported received power, make adjustments to the mobile device received power values per the receiver IC manufacturer's recommendations and repeat the tests above.

It is also recommended to run the above tests at various receiver loads (or device charged states) to make sure the mobile device reports accurate received power values over its full load range.

**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.**