



# **TSDMRX-5V/10W-EVM**

## **Wireless Charging Receiver**

**WIRELESS CHARGING**

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## **User Guide**

# **TSDMRX-5V/10W-EVM**

## **Dual-Mode (Qi and PMA) Receiver**

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# Introduction

The Semtech TSDMRX-5V/10W-EVM is an evaluation platform for test and experimentation of a wireless charging receiver based on the Semtech TS81000 Wireless Power Receiver communications and control unit for wireless charging applications. TS51111 is a fully-integrated synchronous rectifier, and SC414 is 6A integrated FET Regulator. This evaluation module provides a complete system solution for both Qi and PMA standards of power receiver, making this receiver an ideal platform for powering the majority of wireless transmitter in use today.

## Objectives

The objective of this User Guide is to provide a fast, easy and thorough method to experiment with and evaluate the Semtech solutions for wireless charging systems. Sufficient information is provided to support the engineer in all aspects of adding wireless charging support to their products. Semtech offers a range of solutions to meet the needs of a wide range of system developers. Developers are provided with all the information on how this EVM was built as a starting point for their own designs using the TS81000 and other Semtech components.

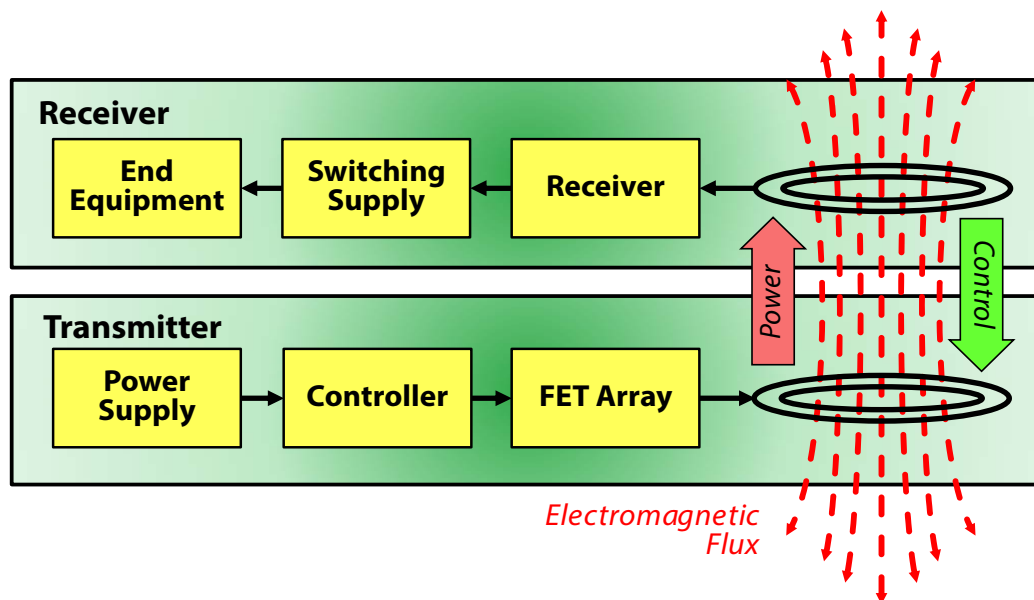
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# Wireless Charging Concepts

Wireless power transfer is, essentially, a transformer. Power is provided to a primary coil which produces an electromagnetic (EM) field. In this field, a secondary coil is placed. The EM field induces a current into the secondary coil, providing power to whatever it is connected to.

However, unlike a conventional power transformer that operates at line frequencies and requires an iron core for efficiency, wireless power systems are designed to operate in the 100 kHz range, and thus can perform efficiently with an air core. As such, the primary and secondary windings, if closely spaced, can be in separate devices, the primary being part of a transmitter and the secondary within a receiver. This implementation can also be described as a radio broadcast process, and as such, these transformer coils can also be seen as antennas with equal validity, and the two terms will be used interchangeably in this text.



Wireless power systems differ in another major aspect from conventional transformers, in that they are intelligently managed. A transmitter will only provide power when a receiver is present, and only produce the amount of power requested by the receiver. In addition, the system is capable of recognizing when the electromagnetic field has been interrupted by an unintended element, a 'foreign object', and will shut down the transfer to prevent any significant amount of power being absorbed by anything but a proper receiver. The intelligent management of the wireless power transmission process is achieved through the programming of the TS80000, which first searches for a receiver. Once found, the receiver informs the transmitter of its power requirements, and transmission begins. The system then verifies the right amount of power is being sent, and that none is being lost to foreign objects. The receiver will continually provide ongoing requests for power to maintain the transaction. If the requests cease, the transaction terminates. Via this protocol, even complex charging patterns can be supported, as the transmitter can provide varying amounts of power at different times, as requested by the receiver. Should the receiver require no further power, such as when a battery charge is completed, it can request no further power be sent, and the transmitter will reduce its output accordingly.

Wireless power systems have been broken into three basic power categories. "Wearable" devices, such as headsets, wrist-band devices, medical sensors, and so forth, all operate in the low power range, up to 5 watts. Medium power devices, in the 5- to 15-watt range, include most handheld devices, such as cell phones, tablets, and medical electronics. High power wireless systems are intended to support devices such as power tools, radio controlled ("RC") devices such as drones, and other equipment requiring 15 to 100 watts of power.

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## Product Description

TS51111 is a fully-integrated synchronous rectifier for wireless charging applications with additional integrated components to minimize system BOM. TS81000 is a power receiver communications and control unit for wireless charging applications. The TS81000 can support Qi compliant, PMA compliant and proprietary applications. The TS81000 performs the necessary coding of packets to send commands to the transmitter to adjust the power level accordingly. All the necessary function components occupy a 16mmX25mm of PCB area.

### EVB Jumper introduction

1. J1 is coil connector;
2. J2 is input connector, micro-USB connector is used. Micro-USB is selected firstly when there are both micro-USB connector input and Tx board wireless charge input.
3. J3 and J4 are output connectors in parallel, J3 is for USB output, and J4 for output current up to 2A.
4. J5, J6 is programme updated for TS51111 connector, and normally not used.

## Standard Use

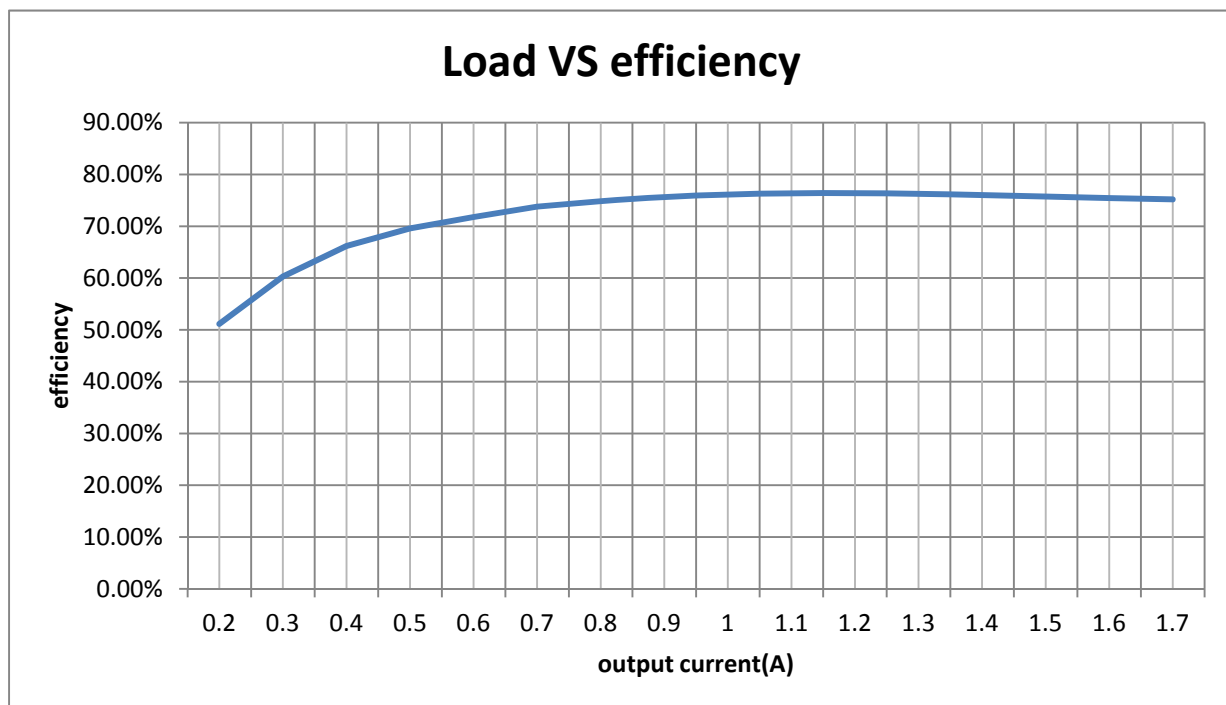
1. Power up TSDMTX-19V1-EVM from Semtech, or any other Dual Mode(Qi+PMA) up to 15W transmitter;
2. Place Rx EVB boards on top of the Tx EVM;
3. Connect e-load to J4 between VOUT+ and GND on Rx board;
4. Set the required output current (0A-2A) with electrical loads in CC mode and start the evaluations.

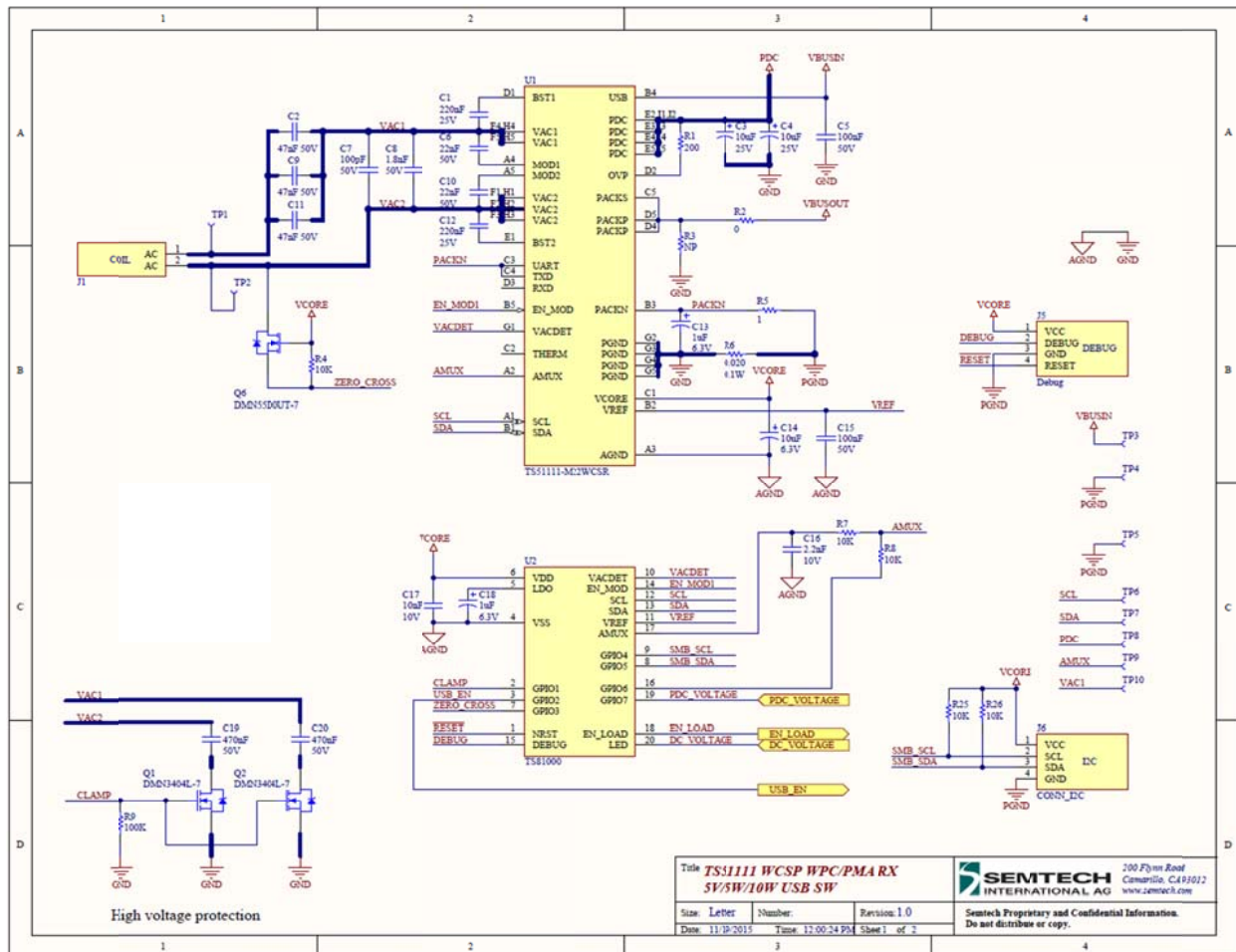
**Caution:** maximum load transients on the output of the RX EVM should NOT exceed 5W per second. A 100% load transient is not valid in a typical application use case.

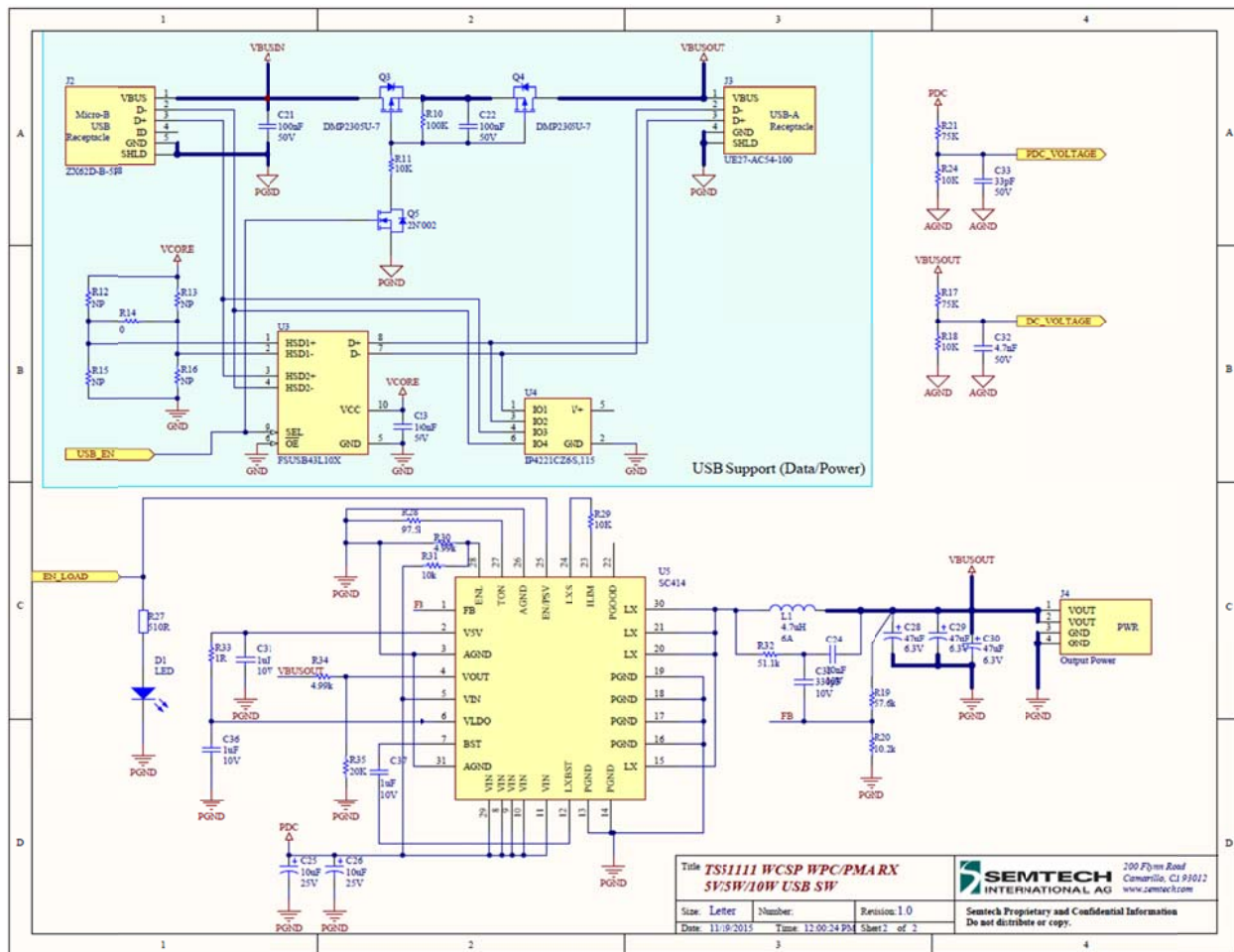
For best performance, Rx EVM should be located right in the center of Tx EVM plastic.

### Measure Efficiency

By measuring the power from the receiver's VOUT+ and VOUT- pins of the receiver in comparison to the power entering the transmitter EVM, you can determine the efficiency of the power transfer through the system. The diagram below, for the EVMs used here, demonstrates efficiency is a function of output current, and runs about 75% at beyond the mid-power point, assuring good efficiency and minimal heat dissipation concerns.







## B. Bill Of Materials “BOM”

Below is a listing of the parts used in the TSDMRX-5V/10W-EVM. An excel spreadsheet file with this information is available on the Semtech website as an added convenience.

|    | Designator                                        | Qty. | Manufacturer Code  | Footprint    | Manufacturer                                              |
|----|---------------------------------------------------|------|--------------------|--------------|-----------------------------------------------------------|
| 1  | C3, C4, C25, C26                                  | 4    |                    | 1206         | 1206 10uF 25V X7R                                         |
| 2  | C1, C12                                           | 2    |                    | 402          | 0402 220nF 25V                                            |
| 3  | C5, C15, C21, C22, C23                            | 5    | C0603C104K5RAC7867 | 402          | 0402 100nF 50V                                            |
| 4  | C6, C10                                           | 2    |                    | 402          | 0402 22nF 50V                                             |
| 5  | C7                                                | 1    |                    | 402          | 0402 100pF 50V                                            |
| 6  | C8                                                | 1    |                    | 402          | 0402 1.8nF 50V                                            |
| 7  | C13, C18                                          | 2    |                    | 402          | 0402 1uF 6.3V                                             |
| 8  | C16                                               | 1    |                    | 402          | 0402 2.2nF 10V                                            |
| 9  | C17, C24                                          | 2    |                    | 402          | 0402 10nF 10V                                             |
| 10 | C32                                               | 1    |                    | 402          | 0402 4.7nF 50V                                            |
| 11 | C33                                               | 1    |                    | 402          | 0402 33pF 50V                                             |
| 12 | R2, R14                                           | 2    |                    | 402          | 0402 0R                                                   |
| 13 | R3, R12, R13, R15, R16                            | NP   |                    | 402          | NP                                                        |
| 14 | R4, R7, R8, R11, R18, R24, R25, R26, R29, R31     | 10   |                    | 402          | 0402 10K                                                  |
| 15 | R20                                               | 1    |                    | 402          | 0402 10.2K                                                |
| 16 | R5, R33                                           | 2    |                    | 402          | 0402 1R                                                   |
| 17 | R30, R34                                          | 2    |                    | 402          | 0402 4.99K                                                |
| 18 | R35                                               | 1    |                    | 402          | 0402 20K                                                  |
| 19 | R28                                               | 1    |                    | 402          | 0402 97.6K                                                |
| 20 | R19                                               | 1    |                    | 402          | 0402 57.6K                                                |
| 21 | R32                                               | 1    |                    | 402          | 51.1K                                                     |
| 22 | R9, R10                                           | 3    |                    | 402          | 0402 100K                                                 |
| 23 | R17, R21                                          | 2    |                    | 402          | 0402 75K                                                  |
| 24 | D1                                                | 1    |                    | 402          | 0402 Green                                                |
| 25 | R27                                               | 1    |                    | 402          | 0402 510R                                                 |
| 26 | C14                                               | 1    |                    | 603          | 0603 10uF 6.3V                                            |
| 27 | C31, C36, C37                                     | 3    |                    | 402          | 0402 1uF 10V                                              |
| 28 | C19, C20                                          | 2    | UMK107ABJ474KA-T   | 603          | 0603 470nF 50V                                            |
| 29 | R6                                                | 1    | WSL0603R0200FEA    | 603          | 0603 0.02R 0.1W                                           |
| 30 | C28, C29, C30                                     | 3    |                    | 805          | 0805 22uF25V X7R                                          |
| 31 | C35                                               | 1    |                    | 402          | 0402 330pF 10V                                            |
| 32 | R1                                                | 1    |                    | 805          | 0805 200R                                                 |
| 33 | C2, C9, C11                                       | 3    | CGA5H2C0G1H473J    | 1206 or 0805 | 1206 47nF 50V COG                                         |
| 34 | J4, J5, J6                                        | 3    | Connector 1x4Pin   | HDR          | HDR 1x4Pin 2.54mm                                         |
| 35 | U4                                                | 1    | IP4221CZ6-S,115    | DFN1410-6N   | USB ESD Protection                                        |
| 36 | L1                                                | 1    |                    |              | 4.7uH 6A                                                  |
| 37 | U3                                                | 1    | FSUSB43L10X        | QFN          | USB Data Switch                                           |
| 38 | Q1, Q2                                            | 2    | DMN3404L-7         | SOT23-3N     | N-Channel Power MOSFET                                    |
| 39 | Q3, Q4                                            | 2    | DMP2305U-7         | SOT23-3N     | P-Channel Power MOSFET                                    |
| 40 | Q5                                                | 1    | 2N7002             | SOT23-3N     | N-channel Enhancement Mode Field-effect Transistor        |
| 41 | U2                                                | 1    | TS81000-QFNR       | UFQFPN       | Wireless Power Receiver Controller                        |
| 42 | J3                                                | 1    | CONN_USB_A_Plug    | USB_A        | USB, Receptacle, 4 Position, Through-Hole                 |
| 43 | J2                                                | 1    | ZX62D-B-5P8        | USB_Micro-B  | Micro-B USB, Receptacle, 5 Position, SMT and Through-Hole |
| 44 | U1                                                | 1    | TS51111-M22WCSR    | WCSP         | Synchronous Rectifier and Direct Charging IC              |
| 45 | J1                                                | 1    | 760308103215       |              |                                                           |
| 46 | TP1, TP2, TP3, TP4, TP6, TP7, TP8, TP10, TP5, TP9 | 10   | Test Point         |              |                                                           |
| 47 | U5                                                | 1    | SC414MLTRT         | MLPQ-28 4X4  |                                                           |
| 48 | Q6                                                | NP   |                    |              |                                                           |

## C. Board Layout

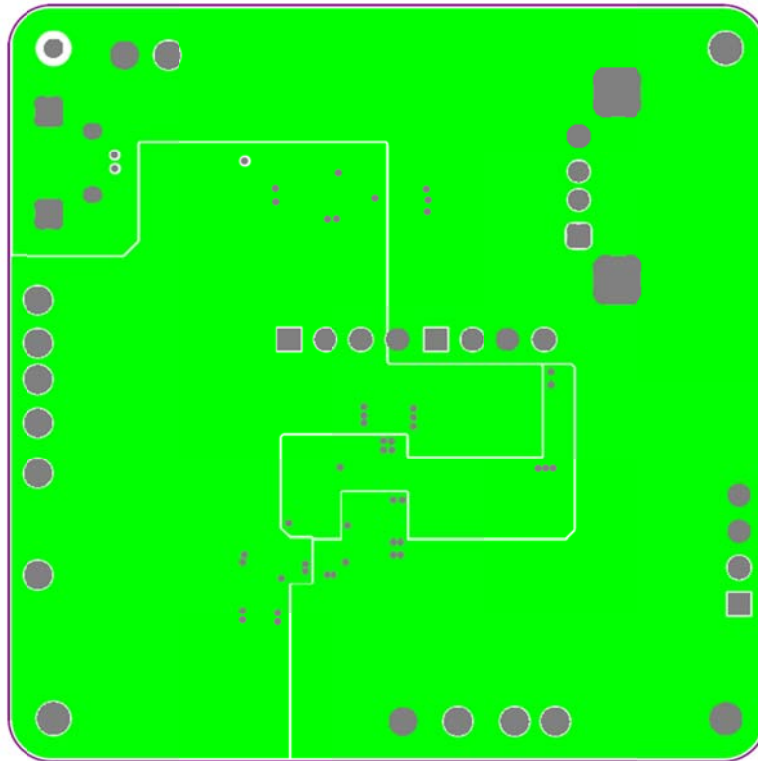
The diagram below shows the locations of the components used in the TSDMRX-5V/10W-EVM PCB.



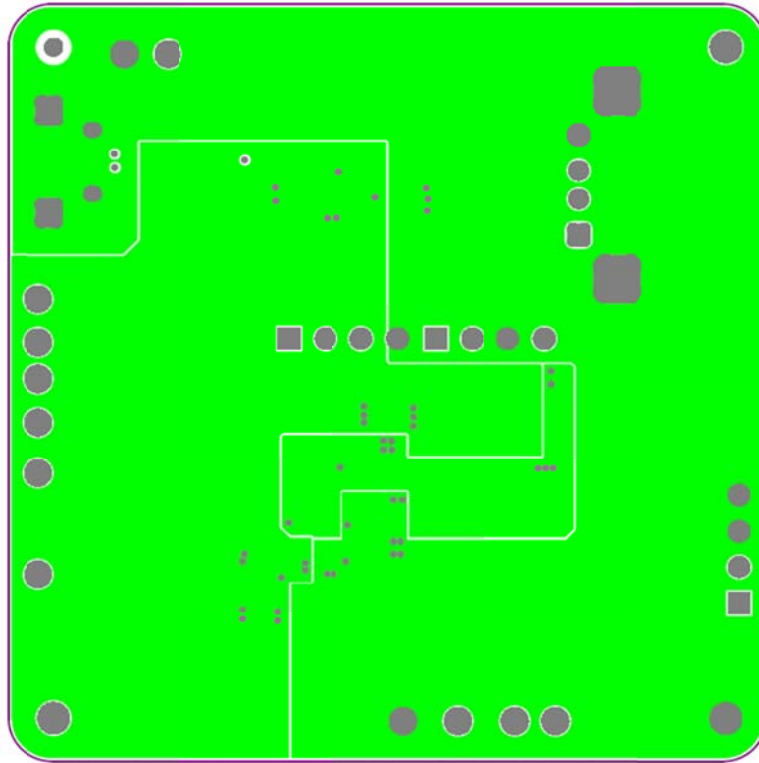
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## D.Board Layers

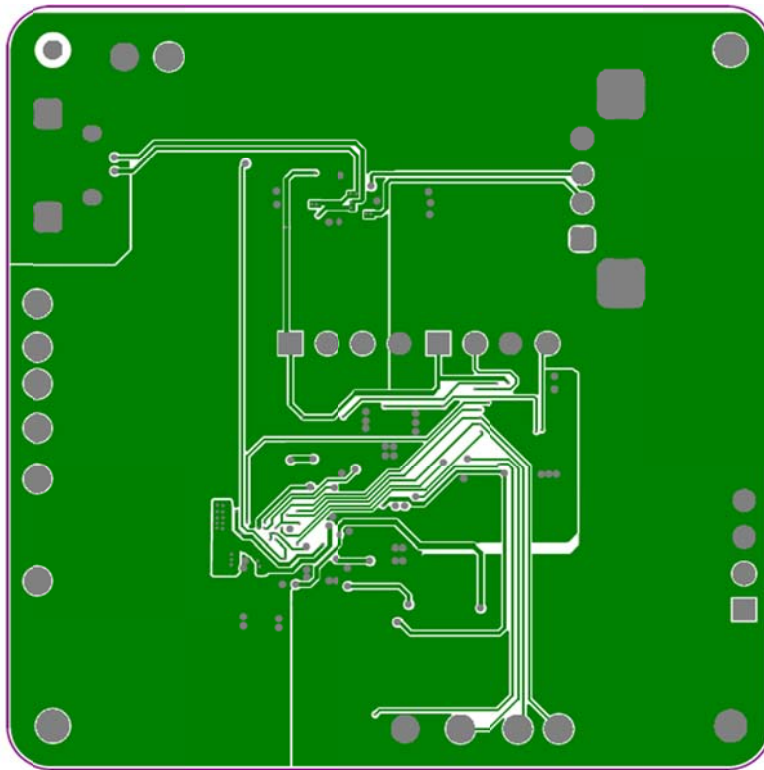
The TSDMXR-5V/10W-EVM PCB is based on a four layer design as shown below. The ground plane in layer two is recommended to reduce noise and signal crosstalk. The EVM placed all components on the top of the board for easier evaluation of the system. End product versions of this design can be made significantly smaller by distributing components on both sides of the board. The Gerber files for this artwork can be downloaded from the Semtech web page.



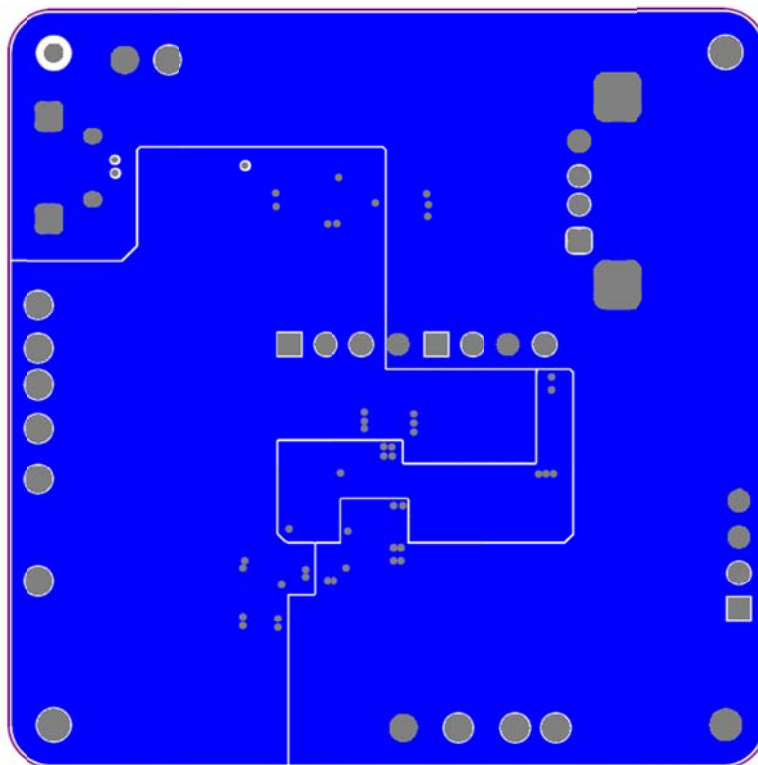
Top Layer



Ground Plane



Signal Layer



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Bottom Layer

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## FAQs

Q: Where can I find more information on the Qi and PMA standards?

A: There are a number of websites that address this subject. A good starting point for Qi would be: <http://www.wirelesspowerconsortium.com/technology/how-it-works.html> . PMA, which is now joined with A4WP, is now called AirFuel. Information on them can be found at the following website: <http://www.airfuel.org/technologies/inductive> .

Q: Does the EVM part number represent something in particular?

A: Yes. The part number is broken into a prefix, main body, and suffix, separated by dashes. The prefix is comprised of three two letter groupings that each help define the product represented. As such, the part number can be read as follows:

Prefix characters:

|                     |                     |                              |
|---------------------|---------------------|------------------------------|
| 1+2 = Company :     | TS = Triune/Semtech |                              |
| 3+4 = Environment : | DM = Dual Mode      | WI = Wearable Infrastructure |
| 5+6 = Type :        | TX = Transmit       | RX = Receiver                |

Mid-section = Device Voltage and/or Wattage.

Suffix = Equipment type:

EVM = Evaluation Module  
MOD = Production Module

Therefore, the TSDMRX - 5V /10W– EVM is a Dual Mode, 5 volt Receiver Evaluation Module provided by Semtech, power up to 10W.

Q: What if my questions weren't answered here?

A: Go to the Semtech website as described on the next page. An updated FAQ for the TSDMRX-5V/10W-EVM is maintained there and may contain the answers you're looking for.

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## Next Steps

For more information on the TSDMRX-5V10W-EVM, go to the Semtech webpage at:

<http://www.semtech.com/power-management/wireless-charging-ics/evaluation-kits>

There you can find the downloadable copies of the schematic, BOM, and board artwork, as well as additional information on how to obtain Semtech wireless power products, from the chip level all the way to complete board modules, as your needs require.

You may also scan the bar code below to go directly to the Semtech web page for further TSDMRX-5V10W-EVM information:





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## **Contact Information**

**Semtech Corporation**  
200 Flynn Road, Camarillo, CA 93012  
Phone: (805) 498-2111, Fax: (805) 498-3804  
[www.semtech.com](http://www.semtech.com)

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Телефон: 8 (812) 309-75-97 (многоканальный)

Факс: 8 (812) 320-03-32

Электронная почта: [ocean@oceanchips.ru](mailto:ocean@oceanchips.ru)

Web: <http://oceanchips.ru/>

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, д. 2, корп. 4, лит. А