bq50002A Wireless Power TX EVM

The bqTESLA™ wireless power transmitter evaluation module from Texas Instruments is a high-performance, easy-to-use development module for the design of wireless power solutions. The bq50002A evaluation module (EVM) provides all the basic functions of a Qi-compliant, wireless charger pad. The 5-V input, single coil transmitter enables designers to speed the development of their end-applications. The EVM supports both the Qi WPC 1.0, WPC 1.1, and WPC 1.2 receivers and will support output power up to 5 W.

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1 Applications

The bq50002AEVM-607 evaluation module demonstrates the transmitter portion of the bqTESLA™ wireless power system. This transmitter EVM is a complete transmitter-side solution that powers a bqTESLA receiver. The EVM requires a single 5-V power supply capable of up to 2.0 A to operate and combines the transmitter electronics, input power circuit, LED indicators, and the transmitting coil on the single printed-circuit board (PCB). The open design allows easy access to key points of the electrical schematic.

This EVM has the following features:

- Qi-Certified WPC 1.2 solution for 5-W operation
- 5-V input and fixed operation voltage
- Enhanced Foreign Object Detection (FOD)
- WPC 1.2 FOD
- Transmitter-coil mounting pad providing the correct receiver interface
- Highly-integrated analog front end including LDO, FETs, drivers, current sense amplifier, and de-modulation circuit
- Standard WPC A11-type transmitter coil with no magnet
- LED and audio indication of power transfer

2 bq50002AEVM-607 Electrical Performance Specifications

Table 1 provides a summary of the EVM performance specifications. All specifications are given for an ambient temperature of 25°C.

Table 1. bq50002AEVM-607 Electrical Performance Specifications

Parameter		Notes and Conditions	Min	Typ	Max	Unit
Input Characteristics						
V_{IN}	Input voltage		4.5	5	5.5	V
I_{IN}	Input current	V_{IN} = Nom, I_{OUT} = 1 A at 5 V		1.4		A
	Input no-load current	V_{IN} = Nom, I_{OUT} = 0 A		165		mA
	Input stand-by current	V_{IN} = Nom		4		mA
Output Characteristics – Receiver bq51013BEVM-764						
V_{OUT}	Output voltage	V_{IN} = Nom, I_{OUT} = 1 A , V_{OUT} = 5 V	4.95	5.00	5.04	V
	Output ripple	V_{IN} = Nom, I_{OUT} = 1.0 A, V_{OUT} = 5 V			200	mV_{PP}
I_{OUT}	V_{IN} = Min to Max	V_{IN} = Min to Max, V_{OUT} = 5 V	0		1.5	A
Systems Characteristics						
F_S	Switching frequency	During power transfer	110		205	kHz
ηpk	Peak efficiency	V_{IN} = Nom, P Out RX = 3 W		74		%
η	Full-load efficiency	V_{IN} = Nom, I_{OUT} = Max		71		%

3 Modifications

See the datasheet for bq50002A (SLUSBW1) or bq500511A (SLUSCN3) when changing components.

FOD – R27 threshold and R26 FOD_Cal (see Section 6.3.8)

4 Connector and Test Point Descriptions

4.1 Input/Output Connections

The connection points are described in Section 4.1.1 through Section 4.1.4.

4.1.1 J1 – V_{IN}

Input power 5 V ±500 mV, return at J3.

4.1.2 J2 – USB Input

USB input connection.

4.1.3 J3 –GND

Return for input power, input at J1.

4.1.4 J4 – Serial Interface

I^2C interface connection to communicate with the IC. Used with bqStudio tool to monitor behavior

4.2 Test Point Descriptions

The test points are described in Section 4.2.1 through Section 4.2.56.

4.2.1 TP1 – CS+

Current sense amplifier positive input.

4.2.2 TP2 – CS–

Current sense amplifier negative input.

4.2.3 TP3 – V_{IN}

Input power, 5 V ±500 mV.

4.2.4 TP4 – GND

Return for input power.

4.2.5 TP5 –DMIN1

Modulation signal input from coil for DEMOD Channel 1.

4.2.6 TP6 –SW1

Switch node of the half bridge MOSFETs.

4.2.7 TP7 – GND

Low-noise ground test point (TP).

4.2.8 TP8 –Low-Noise Analog Ground

Low-noise ground TP.

4.2.9 TP9 – GND

Low-noise ground TP.

4.2.10 TP10 – GND

Low-noise ground TP.

4.2.11 TP11 – PGND

Return for SW1.

4.2.12 TP12 – DMIN2

Modulation signal input from coil for DEMOD Channel 2.

4.2.13 TP13 – PEAK

Peak detection.

4.2.14 TP14 – SW2

Switch node of the half-bridge MOSFETs.

4.2.15 TP15 – BP3

Output of 3-V LDO.

4.2.16 TP16 – TANK

Coil signal at junction between transmitter coil and resonant capacitors.

4.2.17 TP17 – PGND

Return for SW2.

4.2.18 TP18 – PWM1/CLK

Input to control half-bridge MOSFETs connected to SW1 when PWM_CTRL is high. The operating frequency/pulse width changes up or down depending on every rising edge of this periodic signal when PWM_CTRL is low.

4.2.19 TP19 – PWM2/UPDN

Input to control half-bridge MOSFETs connected to SW2 when PWM_CTRL is high. Increase or decrease power transfer when PWM_CTRL is low.

4.2.20 TP20 – CSO

Output of the current sense amplifier.

4.2.21 TP21 – DMOUT1

Demodulated 2-kHz bit stream from demodulation channel 1.

4.2.22 TP22 – DMOUT2

Demodulated 2-kHz bit stream from demodulation channel 2.

4.2.23 TP23 – BUZZ

DC output when power transfer is started. Can be used to drive a DC style buzzer or LED. See data sheet for more information.

4.2.24 TP24 – LED_B

Status indication, typically RED.

4.2.25 TP25 – LED_A

Status indication, typically GREEN.

4.2.26 TP26 – LED_C

Status indication, typically ORANGE.

4.2.27 TP27 – LED_MODE

LED mode selection.

4.2.28 TP28 – T_SENSE

Temperature sensing for safety shutdown.

4.2.29 TP29 – FOD_CAL

FOD calibration.

4.2.30 TP30 – FOD_THR

FOD threshold.

4.2.31 TP31 – V_SENSE

Input voltage sense.

4.2.32 TP32 – FLIM

Leave floating to conform to WPC specification 205-kHz maximum operating frequency.

4.2.33 TP33 – ILIM

ILIM can be used to restrict the input current in order to operate with a limited input voltage source. Leave this pin open if no fixed current limit should be used.

4.2.34 TP34 – Reserved IC Pin 5

Unused.

4.2.35 TP35 – Unused IC Pin 7

Leave this pin open.

4.2.36 TP36 – Unused IC Pin 25

Leave this pin open.

4.2.37 TP37 – Unused IC Pin 27

Leave this pin open.

4.2.38 TP38 - Unused IC Pin 17

Leave this pin open.

4.2.39 TP39 - Unused IC Pin 6

Leave this pin open.

4.2.40 TP40 - Unused IC Pin 24

Leave this pin open.

4.2.41 TP41 - Unused IC Pin 26

Leave this pin open.

4.2.42 TP42 - Unused IC Pin 18

Leave this pin open.

4.2.43 TP43 – CLK_IN

CLK_OUT signal from the internal oscillator of the bq50002A.

4.2.44 TP44 – MODE

Control of frequency/pulse width of the internal generated oscillator signal.

4.2.45 TP45 – SDA

I^2C data.

4.2.46 TP46 – SCL

I^2C clock.

4.2.47 TP47 – 3-V Rail Resistor Divider

4.2.48 TP49 – Floating Test Point

4.2.49 TP50 – Floating Test Point

4.2.50 TP51 – GND

4.2.51 TP52 - Floating Test Point

4.2.52 TP53 - Floating Test Point

4.2.53 TP54 – GND

4.2.54 TP55 – Floating Test Point

4.2.55 TP56 – Floating Test Point

4.2.56 TP57 – GND

5 Schematic and Bill of Materials

This section includes the schematics and bill of materials for the EVM.

Figure 1 illustrates the schematics for this EVM.

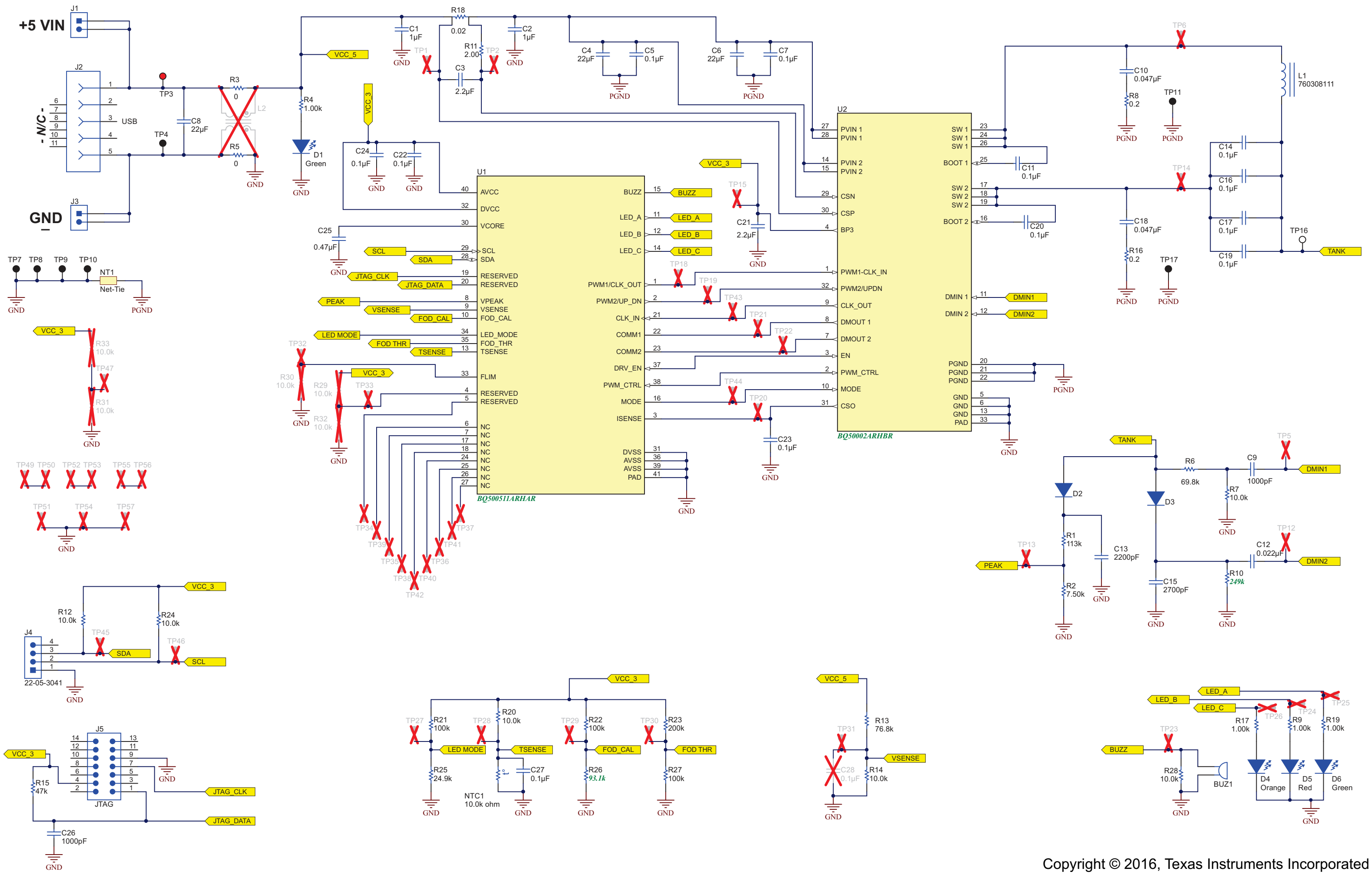

Figure 1. bq50002AEVM-607 Schematic

Table 2 contains the BOM for this EVM.

Table 2. Bill of Materials(1)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
U1	1		Low-Cost 5-V Wireless Power Transmitter Controller for WPC v1.2 A11 Transmitters, RHA0040D	RHA0040A	BQ500511ARHAR	Texas Instruments	BQ500511ARHAT	Texas Instruments
U2	1		Low-Cost 5-V Wireless Power Transmitter Analog Front End for WPC v1.2 A11 Transmitters RHB0032E	RHB0032E	BQ50002ARHBR	Texas Instruments	BQ50002ARHBT	Texas Instruments
L1	1	6.3uH	Inductor, 6.3 µH, 13 A, 0.017 ohm, TH	TH, Dia 53mm, Pin spacing 14.2mm	760308111	Wurth Elektronik		
BUZ1	1		Buzzer, Piezo, 4kHz, 12.2mm, TH	12.2x4.0mm	PS1240P02CT3	TDK		
C1, C2	2	1uF	CAP, CERM, 1 µF, 25 V, +/- 10%, X7R, 0603	0603	GRM188R71E105KA12D	Murata		
C3	1	2.2uF	CAP, CERM, 2.2 µF, 10 V, +/- 10%, X7R, 0603	0603	GRM188R71A225KE15D	Murata		
C4, C6	2	22uF	CAP, CERM, 22uF, 25V, +/-20%, X5R, 0805	0805	GRM21BR61E226ME44	Murata		
C5, C7, C11, C20, C22, C23, C24, C27	8	0.1uF	CAP, CERM, 0.1uF, 25V, +/-10%, X7R, 0603	0603	C1608X7R1E104K	TDK		
C8	1	22uF	CAP, CERM, 22uF, 25V, +/-10%, X7R, 1210	1210	GRM32ER71E226KE15L	Murata		
C9, C26	2	1000pF	CAP, CERM, 1000pF, 50V, +/-5%, C0G/NP0, 0603	0603	C1608C0G1H102J	TDK		
C10, C18	2	0.047uF	CAP, CERM, 0.047uF, 50V, +/-10%, X7R, 0603	0603	C1608X7R1H473K	TDK		
C12	1	0.022uF	CAP, CERM, 0.022 µF, 50 V, +/- 10%, X7R, 0603	0603	C1608X7R1H223K	TDK		
C13	1	2200pF	CAP, CERM, 2200 pF, 50 V, +/- 10%, X7R, 0603	0603	GRM188R71H222KA01D	Murata		
C14, C16, C17, C19	4	0.1uF	CAP, CERM, 0.1 µF, 25 V, +/- 5%, C0G/NP0, 1206	1206	C3216C0G1E104J	TDK		
C15	1	2700pF	CAP, CERM, 2700pF, 50V, +/-5%, C0G/NP0, 0603	0603	C1608C0G1H272J	TDK		
C21	1	2.2uF	CAP, CERM, 2.2uF, 16V, +/-10%, X5R, 0603	0603	GRM188R61C225KE15D	Murata		
C25	1	0.47uF	CAP, CERM, 0.47uF, 10V, +/-10%, X7R, 0603	0603	GRM188R71A474KA61D	Murata		
D1, D6	2	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190KGKT	Lite-On		
D2, D3	2	100V	Diode, Switching, 100V, 0.2A, SOD-323	SOD-323	MMDL914-TP	Micro Commercial Components		
D4	1	Orange	LED, Orange, SMD	1.6x0.8x0.8mm	LTST-C190KFKT	Lite-On		
D5	1	Red	LED, Red, SMD	Red LED, 1.6x0.8x0.8mm	LTST-C190CKT	Lite-On		
NTC1	1	10.0k ohm	Thermistor NTC, 10.0k ohm, 1%, 0603	0603	NTCG163JF103F	TDK		
R1	1	113k	RES, 113 k, 0.1%, 0.1 W, 0603	0603	RG1608P-1133-B-T5	Susumu Co Ltd		
R2	1	7.50k	RES, 7.50 k, 0.1%, 0.1 W, 0603	0603	RT0603BRD077K5L	Yageo America		
R3, R5	2	0	RES, 0 ohm, 5%, 0.25W, 1206	1206	CRCW12060000Z0EA	Vishay-Dale		
R4, R9, R17, R19	4	1.00k	RES, 1.00 k, 1%, 0.1 W, 0603	0603	CRCW06031K00FKEA	Vishay-Dale		
R6	1	69.8k	RES, 69.8k ohm, 1%, 0.1W, 0603	0603	RC0603FR-0769K8L	Yageo America		
R7, R12, R20, R24, R28	5	10.0k	RES, 10.0k ohm, 1%, 0.1W, 0603	0603	RC0603FR-0710KL	Yageo America		
R8, R16	2	0.2	RES, 0.2 ohm, 5%, 0.25W, 0805	0805	ERJ-S6SJR20V	Panasonic		
R10	1	249k	RES, 249 k, 1%, 0.1 W, 0603	0603	RC0603FR-07249KL	Yageo America		

(1) Unless otherwise noted in the Alternate Part Number and/or Alternate Manufacturer columns, all parts may be substituted with equivalents.

Table 2. Bill of Materials[(1)] (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
R11	1	2.00	RES, 2.00, 1%, 0.1 W, 0603	0603	CRCW06032R00FKEA	Vishay-Dale		
R13	1	76.8k	RES, 76.8 k, 0.1%, 0.1 W, 0603	0603	RG1608P-7682-B-T5	Susumu Co Ltd		
R14	1	10.0k	RES, 10.0 k, 0.1%, 0.1 W, 0603	0603	RT0603BRD0710KL	Yageo America		
R15	1	47k	RES, 47k ohm, 5%, 0.1W, 0603	0603	RC0603JR-0747KL	Yageo America		
R18	1	0.02	RES, 0.02, 0.5%, 0.5 W, 1206 sense	1206 sense	LVK12R020DER	Ohmite		
R21, R22, R27	3	100k	RES, 100 k, 1%, 0.1 W, 0603	0603	RC0603FR-07100KL	Yageo America		
R23	1	200k	RES, 200 k, 1%, 0.1 W, 0603	0603	RC0603FR-07200KL	Yageo America		
R25	1	24.9k	RES, 24.9 k, 1%, 0.1 W, 0603	0603	RC0603FR-0724K9L	Yageo America		
R26	1	93.1k	RES, 93.1 k, 1%, 0.1 W, 0603	0603	RC0603FR-0793K1L	Yageo America		
C28	0	0.1uF	CAP, CERM, 0.1uF, 25V, +/-10%, X7R, 0603	0603	C1608X7R1E104K	TDK		
L2	0		Coupled inductor, 2.5 A, 0.034 ohm, SMD	SMD, 5x5mm	DLW5BTM102TQ2K	Murata		

6 Test Setup

6.1 Equipment

6.1.1 bqTESLA™ Receiver

Use the bq51013B-764 (HPA764) or bq51020EVM-520, a low-power Qi-compliant receiver.

6.1.2 Voltage Source

The input voltage source must provide a regulated DC voltage of 5 V and deliver at least 2.0-A continuous load current; current limit must be set to 2 A.

> **CAUTION**
>
> To help assure safety integrity of the system and minimize risk of electrical shock hazard, always use a power supply providing suitable isolation and supplemental insulation (double insulated). Compliance to IEC 61010-1, Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use, Part 1, General Requirements, or its equivalent is strongly suggested, including any required regional regulatory compliance certification approvals. Always select a power source that is suitably rated for use with this EVM as referenced in this user manual.
>
> External Power Supply Requirements:
>
> Nom Voltage: 5.0 VDC
>
> Max Current: 2.0 A
>
> Efficiency Level V
>
> External Power Supply Regulatory Compliance Certifications: Recommend selection and use of an external power supply which meets TI's required minimum electrical ratings in addition to complying with applicable regional product regulatory/safety certification requirements such as (by example) UL, CSA, VDE, CCC, PSE, and so forth.

6.1.3 Meters

Monitor the output voltage at the bq51013BEVM-764 test point TP7 with a voltmeter. Monitor the input current into the load with an appropriate ammeter. You can also monitor the transmitter input current and voltage, but the meter must use the averaging function for reducing error, due to communications packets.

6.1.4 Loads

A resistive load box that can be set to 10 kΩ, 10 Ω, and 5 Ω, power rating of at least 5 W; or an electronic load that can be set to 0 mA, 500 mA and 1.0 A at 5 V.

6.1.5 Oscilloscope

Use a dual-channel oscilloscope with appropriate probes to observe the RECT signal at bq51013BEVM-764 TP3 and other signals.

6.1.6 Recommended Wire Gauge

For proper operation, use 22-AWG wire when connecting the EVM to the input supply and the bq51013BEVM-764 to the load.

6.1.7 EV2400 Communication Kit

EV2400-USB-Based PC Interface Kit.

6.1.8 Software

BQSTUDIO Battery Management Studio Software.

6.2 Equipment Setup

The following sections describe the steps for setting up the equipment.

6.2.1 PWR607 Input Supply

Set the input supply voltage to 5.0 V and current limit to 2.0 A before connecting to the UUT. Turn power supply off.

The input power supply positive lead is connected to J1. The power supply return lead is connected to J2 GND.

6.2.2 Oscilloscopes With Current Probe

Connect current probe to measure input current on positive power lead.

6.2.3 HPA764 Load

The load is connected between J3 OUT and J4 GND of the RX. Set the load resistance to 10-kΩ or 0 mA.

6.2.4 Jumper Settings

Unit Under Test, PWR607-No jumper installed.

bqTesla Receiver

- HPA764-JP1 → EN1 and LOW shorted
- HPA764-JP2 → EN2 and LOW shorted
- HPA764-JP3 → TS and DIS shorted
- HAP764-JP6 → ILIM and FIX shorted
- HPA764 → R3 set to 0, full CCW

6.2.5 Meters

Connect ammeter to measure UUT input current from power supply. Connect voltmeter to UUT and monitor input voltage at J1.

HPA764 connect voltmeter to monitor output voltage at TP7 and voltmeter to measure unregulated voltage at TP12. HPA764 connect current meter to monitor output current to load.

6.2.6 Connector

A USB mini cable with red (+) and black (–) banana plugs and green/white wires shorted together. Note red lead will connect to pin 1 and black lead will connect to pin 5. Test cable should be 6- to 12-in long.

6.3 EVM Procedure

6.3.1 Set Input Voltage

Verify that the power supply is adjusted and connected according to Section 6.1.2. Verify that the jumper settings are completed according to Section 6.2.4.

6.3.2 Start-Up No Receiver

Do not place any receiver on PWR607 for this test.

Turn on power supply and observe that:

1. Input voltage at J1 is 4.9 V to 5.1 V and current is less than 100 mA with a high-to-low fluctuation or

toggling.

2. On UUT PWR607, Power On green LED D1 is ON
3. On UUT PWR607 LED D4, D5 and D6 are OFF
4. **Using current probe, monitor input current and observe digital pin will occur every 5 s for 70 ms.**

6.3.3 Receiver In Place – No Load

Place HPA764 on PWR607 above the TX Coil, load should be set to 10 kΩ or 0 mA.

Observe that:

1. On HPA764, LED D1 is ON
2. On HPA764, voltage at TP7 should be 4.9 V to 5.1 V
3. On HPA764, voltage at TP12 should be 7.0 V to 7.5 V, voltage will fluctuate.
4. On UUT PWR607 during power transfer (HPA764 D1 ON):
   (a) LED D6, flashing Green
   (b) Input current should be less than 300 mA

6.3.4 Receiver In Place – 1.0-A Load

With the HPA764 in place on the PWR607, above TX Coil set output load current to 950 mA to 1050 mA.

Input voltage at UUT J1 should be 4.9 V to 5.1 V, adjust input supply if necessary.

Observe that:

1. On HPA764 LED D1 is ON
2. On HPA764, voltage at TP7 should be 4.9 V to 5.1 V
3. On HPA764, voltage at TP12 should be 5.1 V to 5.3 V
4. On UUT, PWR607 LED D6 Flashing Green
5. On UUT, PWR607 input current should be less than 1700 mA

6.3.5 Efficiency

Measure the system efficiency by measuring the output voltage, output current, input voltage, and input current and calculate efficiency as the ratio of the output power to the input power. Connect voltage meters at the input and output of TX and RX. Average the input current; the comm pulses modulate the input current, distorting the reading. Figure 2 shows efficiency.

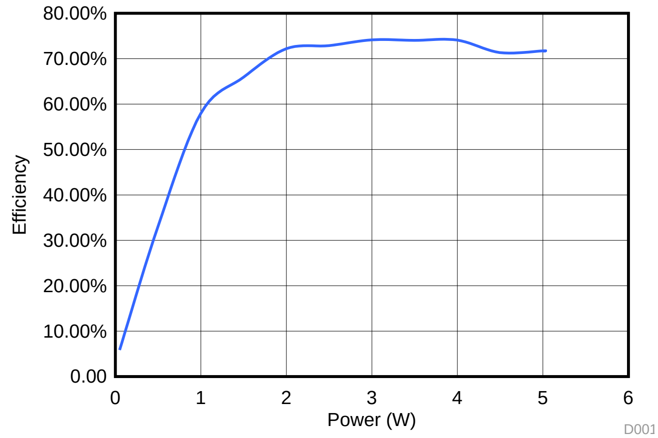

Figure 2. Efficiency vs Power, bq50002AEVM-607 TX and bq51013BEVM-764 Receiver

6.3.6 Start Up Receiver Placed on Transmitter

The transmitter will send an analog ping about every 400 ms. If a receiver is present, it will power up and reply then begin power transfer. Figure 3 is a scope capture of the bq50002A EVM beginning a power transfer with the bq51013B EVM.

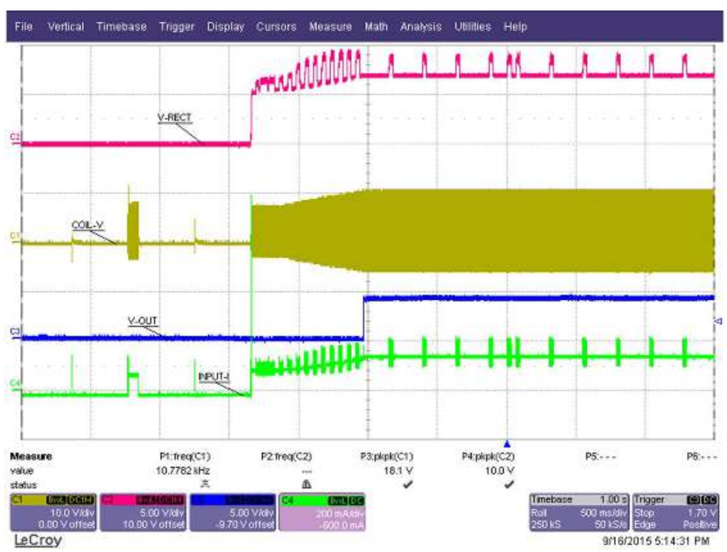

Figure 3. Start Up

6.3.7 TS Fault

With HPA764 and PWR607 operating in the configuration from Section 6.3.4, on the EVM HPA764, adjust R3 to 0 Ω. Next, move the TS Jumper JP3 from TS-DS to TS-EN. UUT PWR607 Red fault LED, D5 should light.

6.3.8 Foreign Object Detection (FOD)

The bq50002A EVM supports FOD in order to meet the requirements of the WPC V1.2 specification. Continuously monitoring input power, known losses, and the value of power reported by the receiver device being charged, the bq500511A can estimate how much power is unaccounted for and presumed lost due to metal objects placed in the wireless power transfer path. If this unexpected loss exceeds the threshold set by the FOD resistors, a fault is indicated and power transfer is halted.

Three key measurements for the TX FOD calculation:

- **Input Power** – Product of input voltage and current. Input voltage is measured at BQ500511A pin 9 though R13 and R14. Input current is measured using sense resistor R18 at bq50002A pin 29 and 30. Both measurements must be very accurate.
- **Power Loss in Transmitter** – This is an internal calculation based on the operating point of the transmitter. The calculation is adjusted using FOD_CAL resistor, R26. This calculation changes with external component changes in the power path such as resonant capacitors and TX coil. Recalculation of R26 and R27 is required.
- **Receiver Reported Power** – The receiver calculates and reports power it receives in the message packet Received Power Packet.

The FOD threshold on the EVM is set to 400 mW when R27 is set to 100 kΩ. Increasing R27 increases the threshold and reduces the sensitivity to foreign objects. This loss threshold is determined after making a measurement of transmitter performance using a FOD calibration receiver similar to a unit manufactured by Avid® Technology. Contact Texas Instruments for the FOD calibration procedure for the bq50002A.

6.3.9 Thermal Performance

This section shows a thermal image of the bq50002AEVM-607. A 1000-mA load is used at the receiver output, bq51013BEVM-764. Output power is approximately 5 W, 1 A at 5 V. The highest temperature point in Figure 4 is 35.6°C

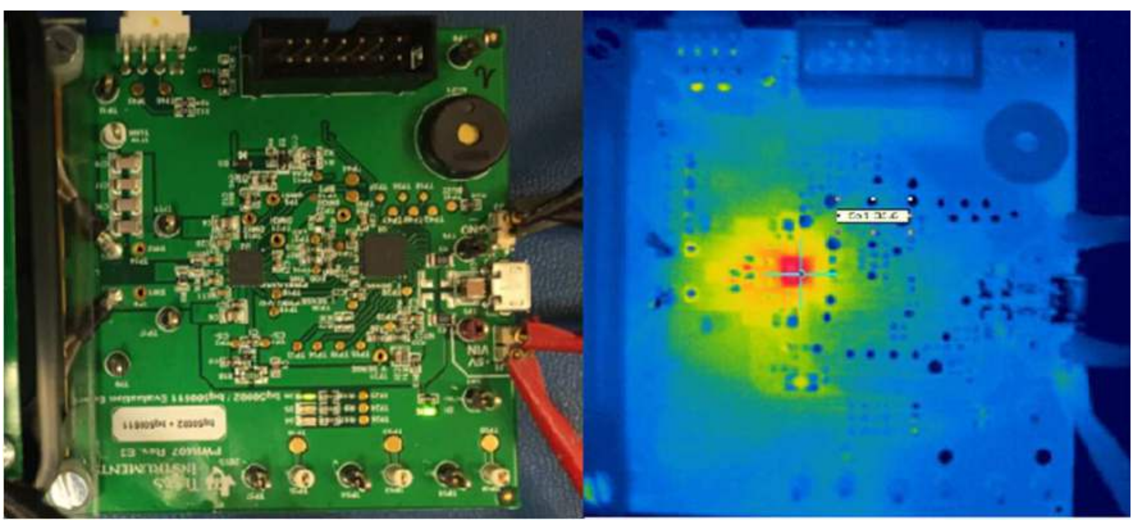

Figure 4. Thermal Performance

7 I²C Interface and bqStudio

This section includes setup and use instructions for the EV2400 and bqStudio. This software is used to read the internal registers of the bq500511A.

7.1 EV2400 Set Up

Connect J4 to EV2400 kit by 4-pin cable. Connect the USB port of the EV2400 kit to the USB port of the computer. The connections are shown in Figure 5.

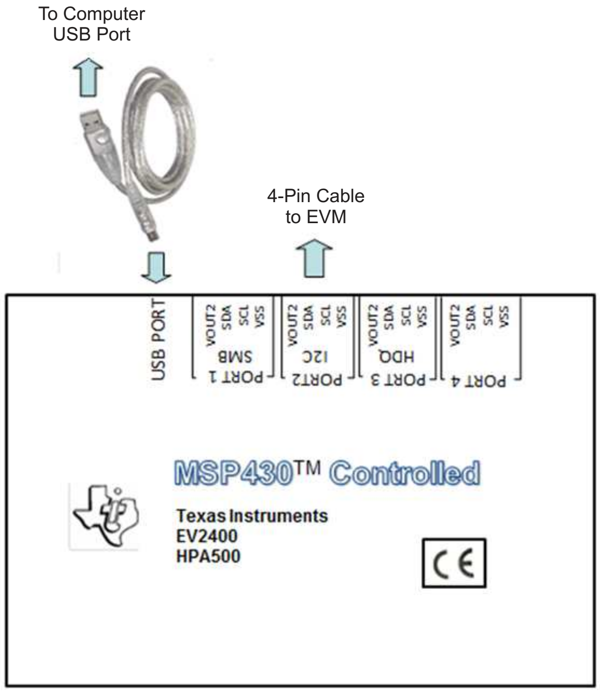

Figure 5. Connections of the EV2400 kit

7.2 bqStudio

Turn on the input power supply, verify the input voltage at J1 is 4.9 V to 5.1 V and the current is less than 100 mA. Turn on the computer and open the bqStudio software. At the first selection screen (Target Selection Wizard), select *Wireless Charging*. At the next selection screen (Target Selection Wizard), select “WChg_1_00-bq50002.bqz”. The main window of the software is shown in Figure 6.

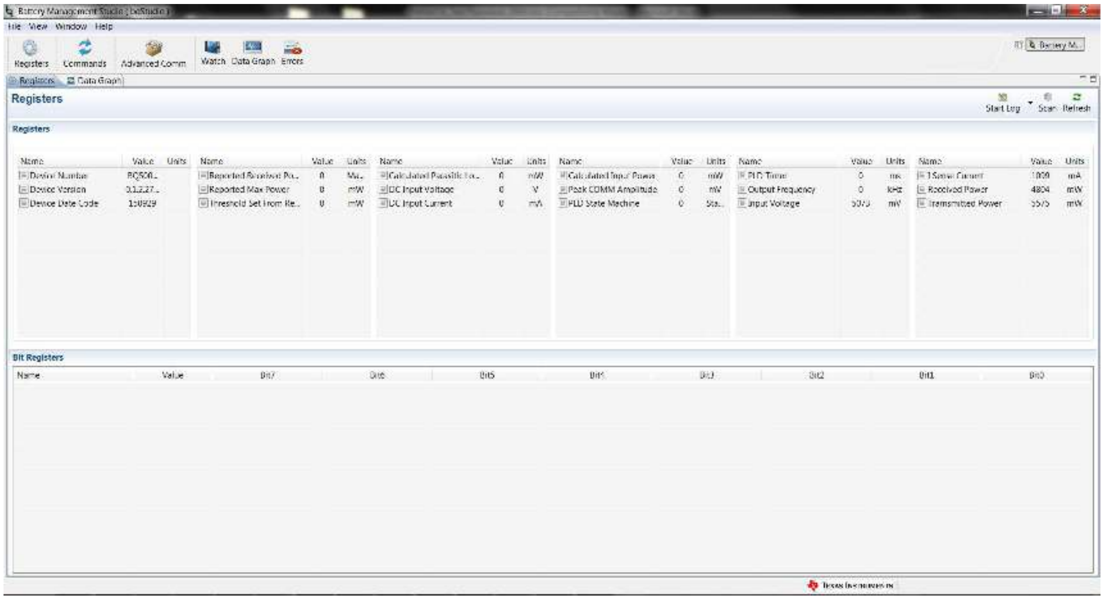

Figure 6. bqStudio Window

8 bq50002AEVM-607 Assembly Drawings and Layout

Figure 7 through Figure 10 show the design of the bq50002EVM PCB. The EVM has been designed using a 4-layer, 2-oz, copper-clad circuit board, 13.2 cm × 7.24 cm with all components in a 4.0-cm x 5.0-cm active area on the top side and all active traces on the top and bottom layers to allow the user to easily view, probe, and evaluate bq50002A analog frontend IC and bq500511A control IC in a practical application. Moving components to both sides of the PCB or using additional internal layers offers additional size reduction for space-constrained systems. Gerber files are available for download from the EVM product folder (bq50002AEVM-607).

A 4-layer PCB design is recommended to provide a good low-noise ground plane for all circuits. A 2-layer PCB presents a high risk of poor performance. Grounding between the bq50002A GND pins and filter capacitor returns should be a good low-impedance path.

Coil Grounding – A ground plane area under the coil is recommended to reduce noise coupling into the receiver. The ground plane for the EVM is slightly larger than the coil footprint and grounded at one point back to the circuit area.

Note: The clear plastic cover thickness (0.93 in or 2.4 mm) is the z-gap thickness for the transmitter.

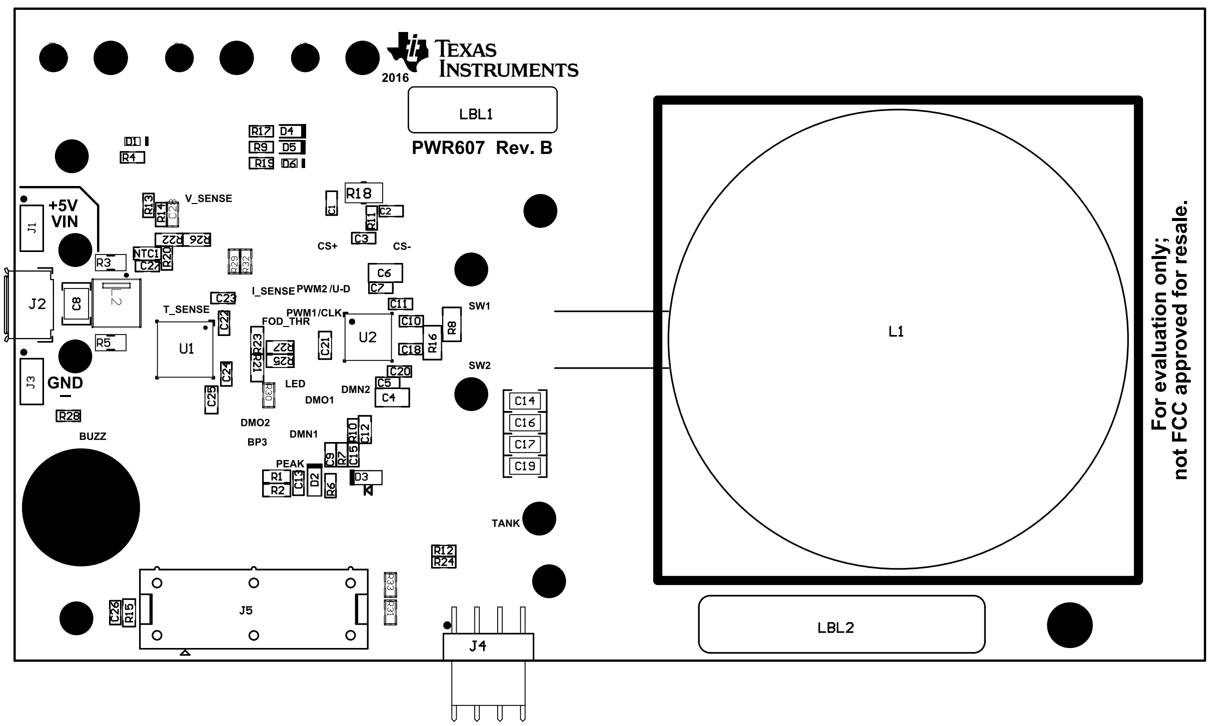

Figure 7. Assembly Top

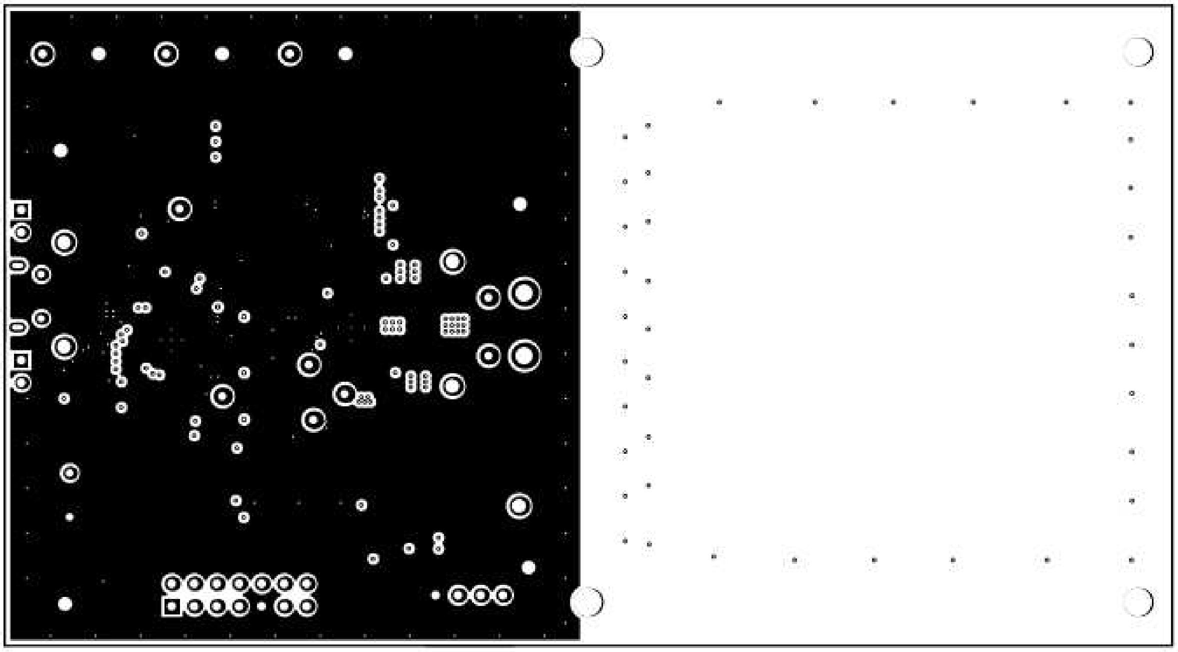

Figure 8. Inner Layer 1

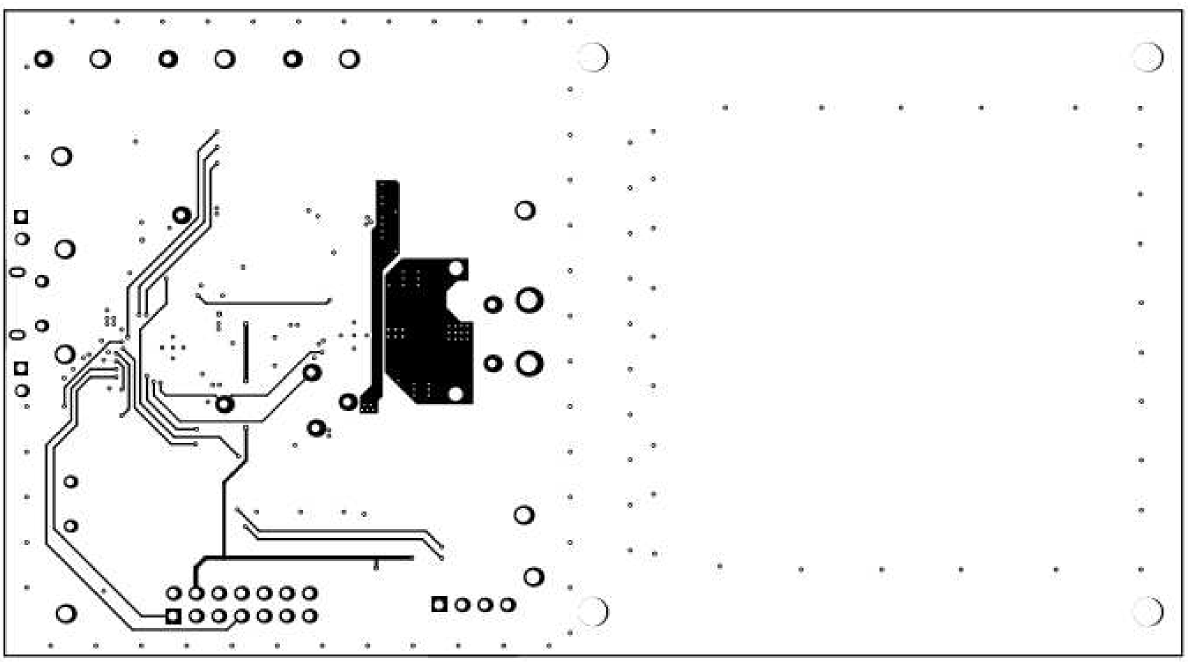

Figure 9. Inner Layer 2

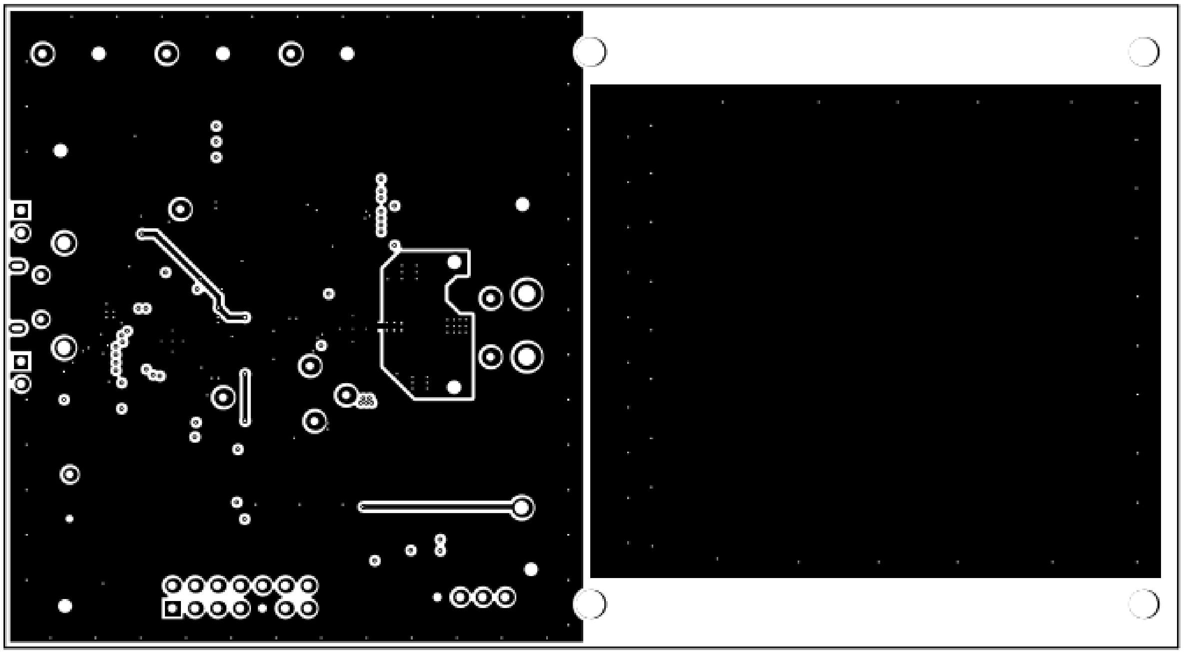

Figure 10. Bottom Layer

9 Reference

For additional information about the bq50002AEVM-607 low-power, wireless, power evaluation kit from Texas Instruments, visit the product folder on the TI Web site at http://www.ti.com/product/bq50002A

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1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.

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2 *Limited Warranty and Related Remedies/Disclaimers*:

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   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for any defects that are caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.

   2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

3 *Regulatory Notices:*

   3.1 *United States*

   3.1.1 *Notice applicable to EVMs not FCC-Approved:*

   This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

   3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

   CAUTION

   This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

   Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

   FCC Interference Statement for Class A EVM devices

   NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d’usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered “Radio Frequency Products” in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry’s Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

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