bq25606 PWR772 Evaluation Module

This user's guide provides detailed testing instructions for the bq25606 evaluation module (EVM). Also included are descriptions of the necessary equipment, equipment setup, test procedures, the printed-circuit board layouts, schematics, and the bill of materials (BOM).

Throughout this user's guide, the abbreviations *EVM*, *bq25606EVM*, *PWR772*, and the term *evaluation module* are synonymous with the bq25606 evaluation module, unless otherwise noted.

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Trademarks

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1 Introduction

1.1 EVM Features

For detailed features and operation, refer to Table 1 for a list of devices and their data sheets.

Table 1. Device Data Sheets

Device	Data Sheet	EVM Label	Variant
bq25606	SLUSCK6	BQ25606EVM-772	004

The bq25606 evaluation module (EVM) is a standalone charger module without I^2C control.

1.2 I/O Descriptions

Table 2 lists the jumper connections available on this EVM.

Table 2. EVM Connections

Jack	Description
J1-VAC	Input positive terminal
J1-GND	Ground Input: negative terminal (ground terminal)
J2-PMID	PMID pin connection
J2-GND	Ground
J3	Output mini-USB port
J4-SYS	Connected to system
J4-GND	Ground
J5-BATSNS_ICHG	BATSNS or ICHG pin connection
J5-BAT	Connected to battery pack positive node
J5-GND	Ground
J6	I2C 4-pin connector
J7	USB-TO-GPIO connector (Not populated)

Table 3 lists the EVM jumper connections.

Table 3. EVM Jumper Connections and Shunt Installation

Jack	Description	bq25606 Setting
JP1	PSEL pin selection	Not installed
JP2	$\overline{CE}$ pin setting: pull low to enable the charge	Installed
JP3	OTG pin setting: pull high to enable OTG mode	Short OTG to GND
JP4	STAT, $\overline{PG}$, $\overline{CE}$, INT, and OTG pins pullup source (SYS or BAT)	Short to SYS
JP5	TS pin to GND	Not installed
JP6	TS resistor divider pullup source (REGN) connection	Installed
JP7	Internal 10 kΩ to GND to TS pin	Installed
JP8	BATSNS selection	Not installed
JP9	$\overline{QON}$ and VSET pin setting	Not installed
JP10	STAT pin setting	Installed
JP11	Add SYS cap	Not installed
JP12	SDA and $\overline{PG}$ pin setting	Installed
JP13	D+ and PSEL to J3	Not Installed
JP14	D– and $\overline{PG}$ to J3	Not Installed
JP15	D– and $\overline{PG}$ pin setting	Not installed
JP16	Add VBUS cap	Not installed

Table 3. EVM Jumper Connections and Shunt Installation (continued)

Jack	Description	bq25606 Setting
JP17	Add PMID cap	Not installed
JP18	Add AT cap	Not installed
S1	$\overline{QON}$ control	Default open
S2	Switch to short indicator LEDs	Default open

Table 4 lists the recommended operating conditions for this EVM.

Table 4. Recommended Operating Conditions

Symbol	Description	MIN	TYP	MAX	Unit
Supply voltage, V_{VBUS}	Input voltage from AC adapter	3.9	5.0	13.5	V
Battery voltage, V_{BAT}	Voltage applied at V_{BAT} terminal	0	4.208	4.4	V
I_{BAT}	Fast charging current	0		3.0	A
	Discharging current through internal MOSFET	6.0			A
Supply current, I_{IN}	Maximum input current from AC adapter input	0		3.0	A

2 Test Summary

2.1 Equipment

This section includes a list of supplies required for testing this EVM.

1. Power supply: Power supply #1 (PS#1): a power supply capable of supplying 5 V at 3 A is required. While this part can handle larger voltage and current, it is not necessary for this procedure.
2. Load #1:
   - (4-quadrant supply, constant voltage < 4.5 V) A 0–20 V, 0–5 A, > 30-W system, DC electronic load and setting as constant voltage load mode

     or
   - Kepco load: BOP 20–5M, DC 0 to ±20 V, 0 to ±5 A (or higher)
3. Load #2: Use with Boost Mode, VAC to GND load, 10 Ω, 5 W or greater.
4. Meters:
   - Six Fluke 75 multimeters, (equivalent or better)

     or
   - Four equivalent voltage meters and two equivalent current meters. The current meters must be capable of measuring 5-A+ current

2.2 Equipment Setup

Use the following list to set up the equipment:

1. Set PS#1 for 5-V DC, 3-A current limit and then turn off the supply.
2. Connect the output of PS#1 in series with a current meter (multimeter) to J1 (VAC and GND). It is recommended to connect one voltage meter across TP24 and TP27 to measure the input current sensing resistor voltage. The sensing resistor is 10 mΩ.
3. Connect one voltage meter across TP21 (VAC) and TP18 (GND), connect another voltage meter across TP1 (VBUS) and TP18 (GND).
4. Turn on Load #1, set to constant voltage mode and output to 2.5 V. Turn off (disable) load. Connect load to J5 (BAT and GND).
5. Connect one voltage meter across TP9 (BAT) and TP17 (GND) to measure the battery voltage and another voltage meter across TP28 and TP29 to measure the battery current sensing resistor voltage. The sensing resistor is 10 mΩ. An alternate method is to use the optional current meter in series to measure the battery current.

6. Install shunts as shown in Table 3.

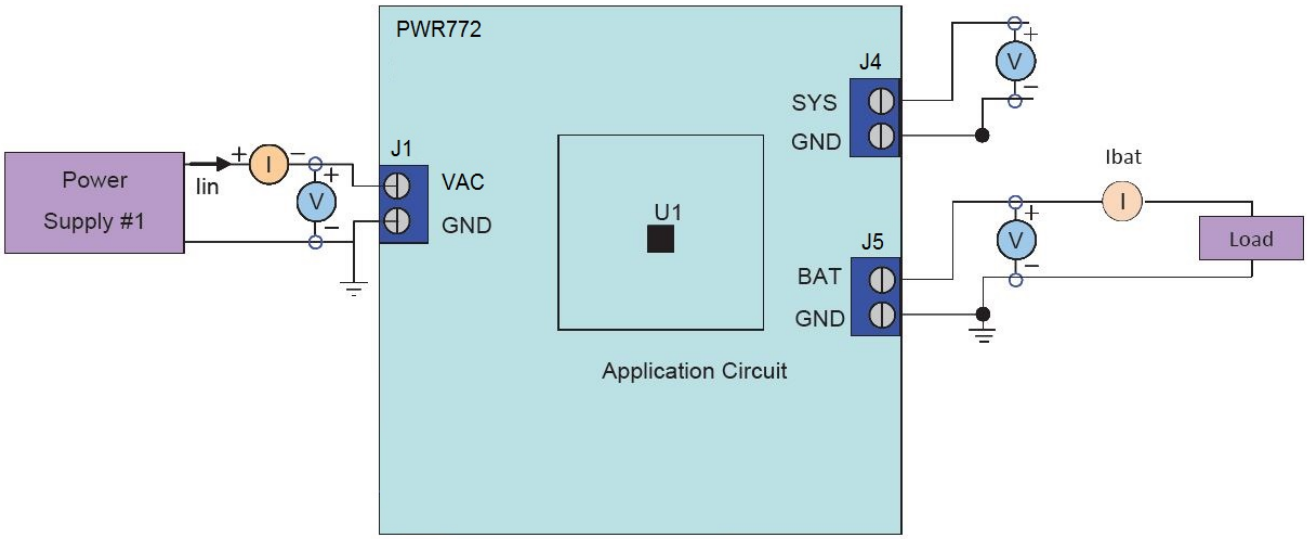

Figure 1. Original Test Setup for bq25606 EVM

2.3 Test Procedure

2.3.1 Charger Mode Verification

1. Enable Load #1 from Section 2.2, Step 4.
2. Measure the voltage across J4 and J5 as follows:
   - Measure → V(TP8(SYS), TP17(GND)) = 3.65 V (typical)
   - Measure → V(TP9(BAT), TP17(GND)) = 2.5 V (typical)
   - Measure → IBAT (= pre-charge current)
3. Change Load #1 to 3.7 V
   - Measure → V(TP8(SYS), TP17(GND)) = 3.8 V (typical)
   - Measure → V(TP9(BAT), TP17(GND)) = 3.7 V (typical)
   - Measure → IBAT (= fast charge current)
4. Adjust R10 to change charging current.
5. Adjust R11 to change input current limit.
6. Turn off and disconnect Load #1.
7. Turn off and disconnect PS#1.

2.3.2 Boost Mode Verification

1. Do not install JP3.
2. If the constant voltage load connected from BAT to GND is not a four-quadrant supply (sources current), remove the load and use the power source disconnected in step 1, set to 3.7 V and 2-A current limit and connect between BAT and GND.
3. Apply 10 Ω (5 W or greater) across J1 VAC(+) to GND(–).
4. Verify V_{VBUS} to GND since VBUS is the actual boost mode output voltage.
   Measure → V_{VBUS} = 5.15 V (Typical)
5. Turn off and disconnect power supply.
6. Remove 10-Ω resistor at VAC.

2.3.3 Helpful Tips

- The leads and cables to the various power supplies, batteries, and loads have resistance. The current meters also have series resistance. The charger dynamically reduces charge current depending on the voltage sensed at its VBUS pin (using the VINDPM feature), BAT pin (as part of normal termination), and TS pin (through its battery temperature monitoring feature via battery thermistor). Therefore, voltmeters must be used to measure the voltage as close to the IC pins as possible instead of relying on the digital readouts of the power supply. If a battery thermistor is not available, make sure shunts JP6 and JP7 are in place.
- When using a source meter that can source and sink current as your battery simulator, TI highly recommends adding a large (1000+ μF) capacitor at the EVM BAT and GND connectors in order to prevent oscillations at the BAT pin due to mismatched impedances of the charger output and source meter input within their respective regulation loop bandwidths. Configuring the source meter for 4-wire sensing eliminates the need for a separate voltmeter to measure the voltage at the BAT pin. When using 4-wire sensing, always ensure that the sensing leads are connected in order to prevent accidental overvoltage by the power leads.
- For precise measurements of charge current and battery regulation near termination, the current meter in series with the battery or battery simulator should not be set to auto-range and may need be removed entirely. An alternate method for measuring charge current is to either use an oscilloscope with Hall effect current probe or place a 1% or better, thermally capable (for example, 0.010 Ω in 1210 or larger footprint) resistor in series between the BAT pin and battery and measure the voltage across that resistor. The bq25606EVM has the sensing resistors onboard.

3 PCB Layout Guideline

Minimize the switching node rise and fall times for minimum switching loss. Proper layout of the components minimizing high-frequency current path loop is important to prevent electrical and magnetic field radiation and high-frequency resonant problems. This PCB layout priority list must be followed in the order presented for proper layout:

1. Place the input capacitor as close as possible to the PMID pin and GND pin connections and use the shortest copper trace connection or GND plane.
2. Place the inductor input terminal as close to the SW pin as possible. Minimize the copper area of this trace to lower electrical and magnetic field radiation but make the trace wide enough to carry the charging current. Do not use multiple layers in parallel for this connection. Minimize parasitic capacitance from this area to any other trace or plane.
3. Put an output capacitor near to the inductor and the IC. Tie ground connections to the IC ground with a short copper trace connection or GND plane.
4. Route analog ground separately from the power ground. Connect analog ground and connect power ground separately. Connect analog ground and power ground together using a power pad as the single ground connection point or use a 0-Ω resistor to tie analog ground to power ground.
5. Use a single ground connection to tie the charger power ground to the charger analog ground just beneath the IC. Use ground copper pour but avoid power pins to reduce inductive and capacitive noise coupling.
6. Place decoupling capacitors next to the IC pins and make the trace connection as short as possible.
7. It is critical that the exposed power pad on the backside of the IC package be soldered to the PCB ground. Ensure that there are sufficient thermal vias directly under the IC connecting to the ground plane on the other layers.
8. The via size and number should be enough for a given current path.

See the EVM design for the recommended component placement with trace and via locations. For the QFN information, see *Quad Flatpack No-Lead Logic Packages* and *QFN/SON PCB Attachment*.

4 Board Layout

Figure 2 through Figure 9 show the EVM PCB layout images.

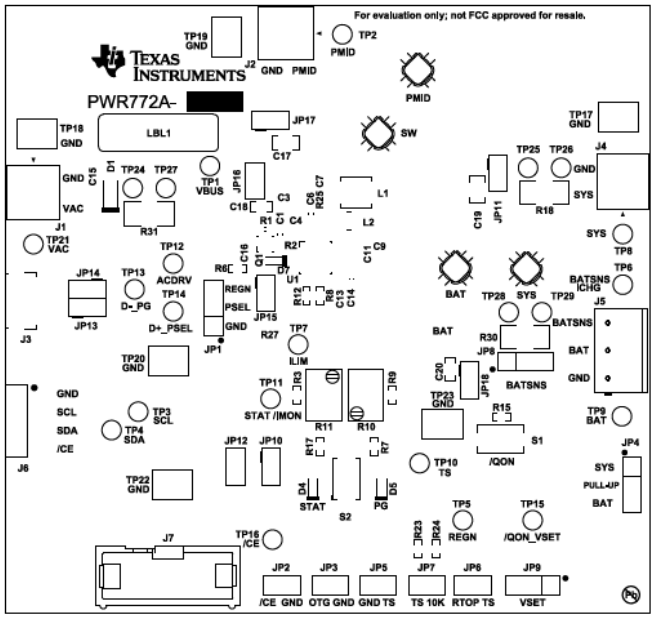

Figure 2. bq25606EVM Top Overlay

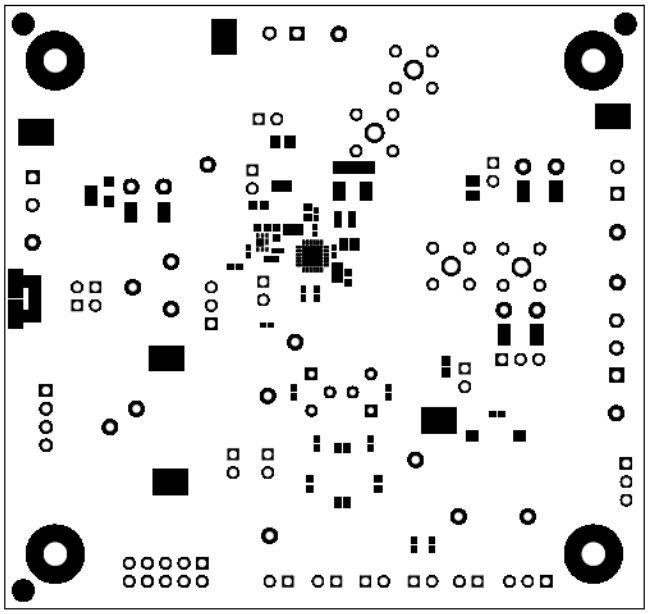

Figure 3. bq25606EVM Top Solder Mask

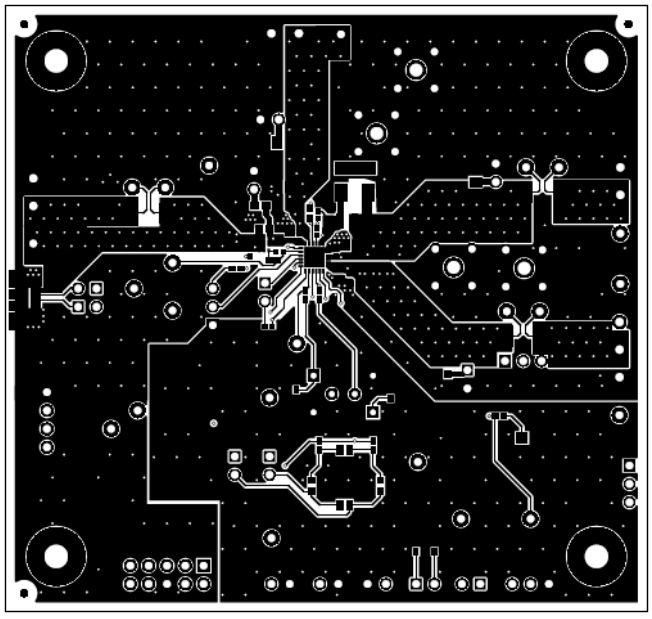

Figure 4. bq25606EVM Top Layer

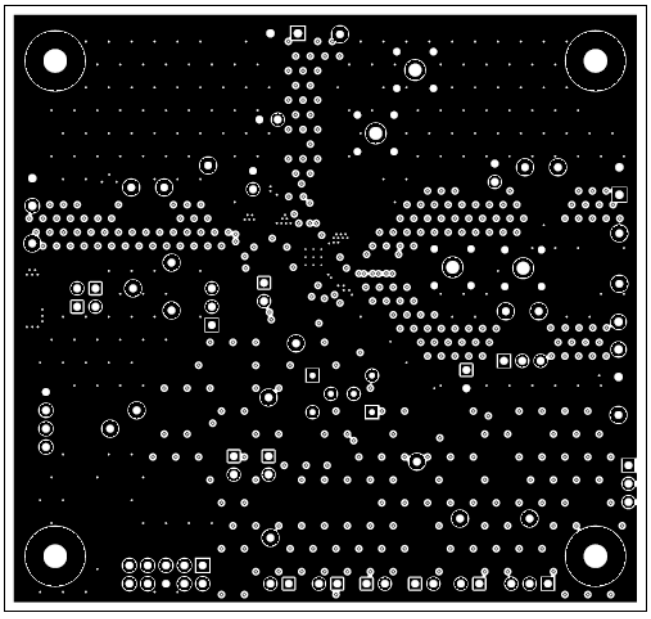

Figure 5. bq25606EVM Signal Layer 1

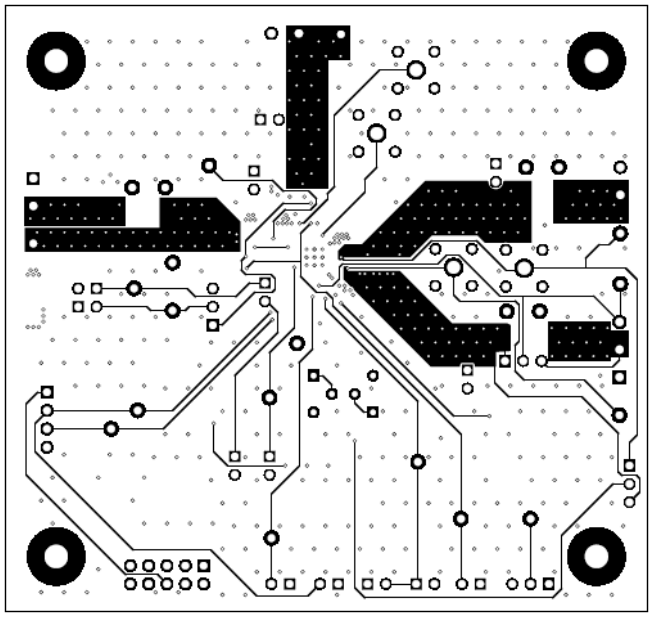

Figure 6. bq25606EVM Signal Layer 2

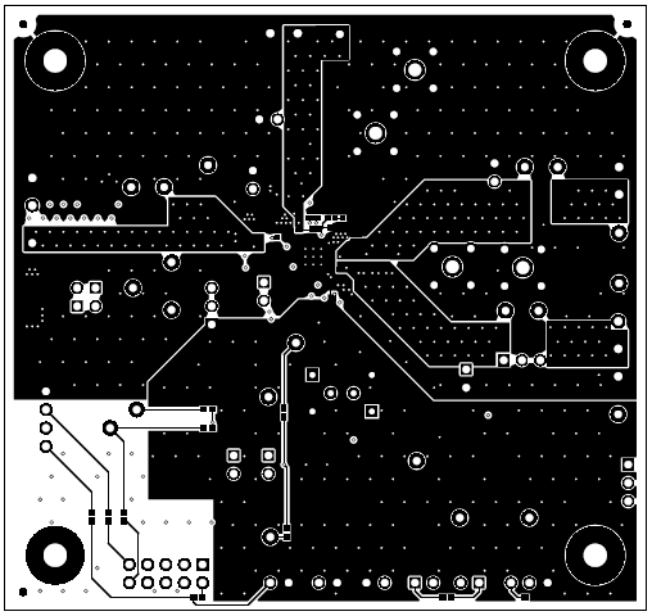

Figure 7. bq25606EVM Bottom Layer

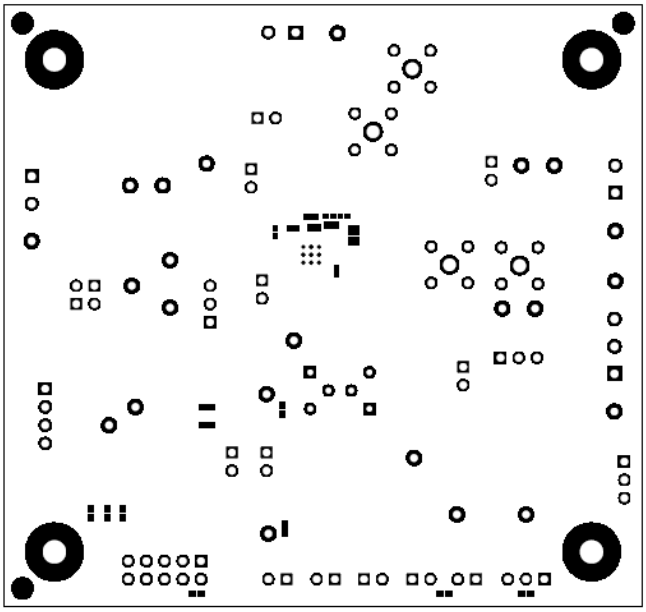

Figure 8. bq25606EVM Bottom Solder Mask

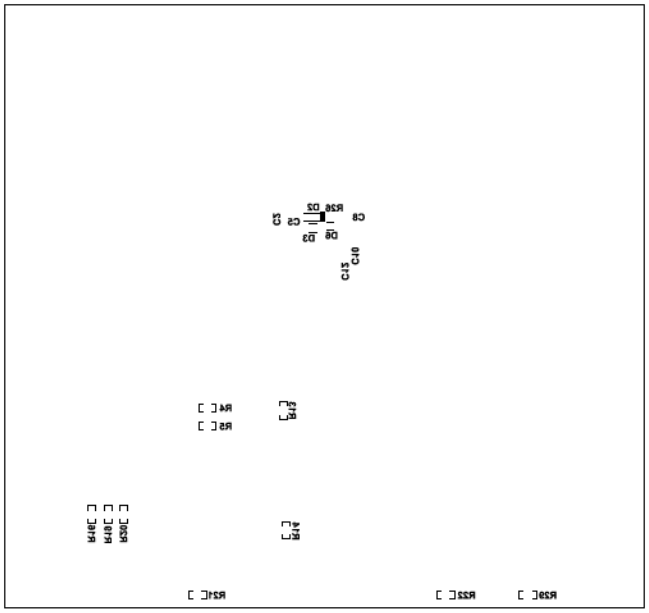

Figure 9. bq25606EVM Bottom Overlay

5 Schematic

Figure 10 shows the schematic for the bq25606 EVM.

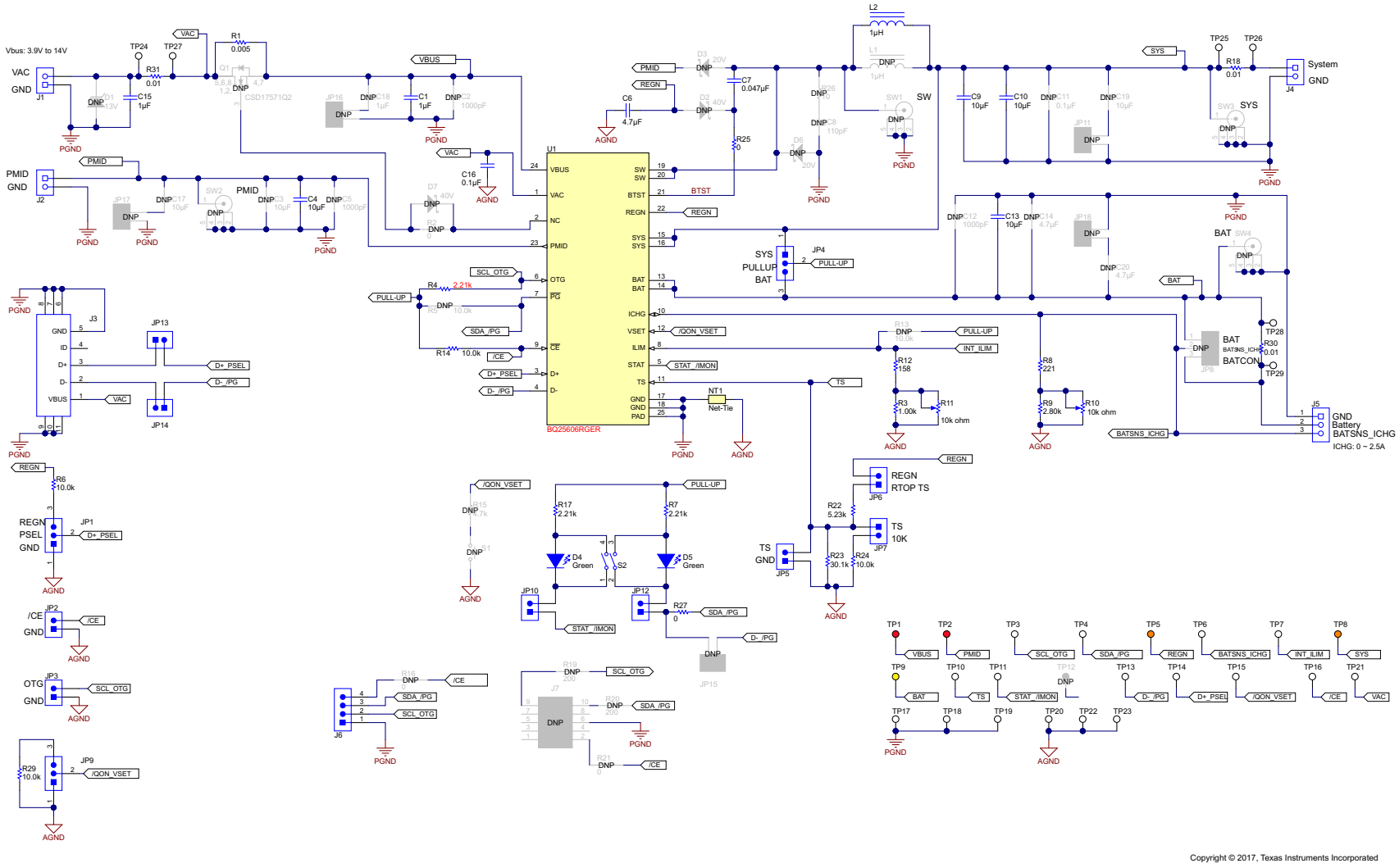

Figure 10. Schematic for bq25606EVM-772

6 Bill of Materials

Table 5 lists the bq25606EVM-772 BOM.

Table 5. bq25606EVM-772 BOM

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
!PCB	1		Printed circuit board		PWR772	Any		
C1	1	1 µF	Capacitor, ceramic, 1 µF, 35 V, ± 10%, X5R, 0603	0603	GMK107BJ105KA-T	Taiyo Yuden		
C4	1	10 µF	Capacitor, ceramic, 10 µF, 25 V, ± 10%, X7S, 0805	0805	GRM21BC71E106KE11L	Murata		
C6	1	4.7 µF	Capacitor, ceramic, 4.7 µF, 16 V, ± 10%, X5R, 0603	0603	GRM188R61C475KAAJ	Murata		
C7	1	0.047 µF	Capacitor, ceramic, 0.047 µF, 25 V, ± 10%, X7R, 0402	0402	GRM155R71E473KA88D	Murata		
C9, C10, C13	3	10 µF	Capacitor, ceramic, 10 µF, 10 V, ± 10%, X7R, 0805	0805	GRM21BR71A106KE51L	Murata		
C15	1	1 µF	Capacitor, ceramic, 1 µF, 25 V, ± 10%, X7R, 0805	0805	GRM219R71E105KA88D	Murata		
C16	1	0.1 µF	Capacitor, ceramic, 0.1 µF, 25 V, ± 10%, X7R, 0402	0402	GRM155R71E104KE14D	Murata		
D4, D5	2	Green	LED, Green, SMD	1.6 × 0.8 × 0.8 mm	LTST-C190GKT	Lite-On		
J1, J2, J4	3		Connector Terminal Block, 2 POS, 3.81 mm, TH	2 POS Terminal Block	1727010	Phoenix Contact		
J3	1		Connector, Receptacle, Micro-USB Type B, R/A, Bottom Mount SMT	7.5 × 2.45 × 5 mm	0473460001	Molex		
J5	1		Terminal Block Receptacle, 3 × 1, 3.81 mm, R/A, TH	Term Block, 3 pos	1727023	Phoenix Contact		
J6	1		Header (friction lock), 100 mil, 4x1, R/A, TH	4 × 1 R/A Header	22-05-3041	Molex		
JP1, JP4, JP9	3		Header, 100 mil, 3 × 1, Tin, TH	Header, 3 PIN, 100 mil, Tin	PEC03SAAN	Sullins Connector Solutions		
JP2, JP3, JP5, JP6, JP7, JP10, JP12, JP13, JP14	9		Header, 100 mil, 2 × 1, Tin, TH	Header, 2 PIN, 100 mil, Tin	PEC02SAAN	Sullins Connector Solutions		
L2	1	1 µH	Inductor, 1 µH, 3.2 A, 0.028 Ω, SMD	2.5 × 2 mm	MPIM252010F1R0M-LF	Microgate		
LBL1	1		Thermal Transfer Printable Labels, 0.650" W × 0.200" H - 10,000 per roll	PCB Label 0.650" H × 0.200" W	THT-14-423-10	Brady		
R1	1	0.005	Resistor, 0.005, 1%, 0.25 W, AEC-Q200 Grade 1, 0603	0603	ERJ3LWFR005V	Panasonic		
R3	1	1.00 k	Resistor, 1.00 k, 1%, 0.063 W, 0402	0402	CRCW04021K00FKED	Vishay-Dale		
R4, R7, R17	3	2.21 k	Resistor, 2.21 k, 1%, 0.063 W, 0402	0402	CRCW04022K21FKED	Vishay-Dale		
R6, R14, R24, R29	4	10.0 k	Resistor, 10.0 k, 1%, 0.063 W, 0402	0402	CRCW040210K0FKED	Vishay-Dale		
R8	1	221	Resistor, 221, 1%, 0.063 W, 0402	0402	CRCW0402221RFKED	Vishay-Dale		
R9	1	2.80 k	Resistor, 2.80 k, 1%, 0.063 W, 0402	0402	CRCW04022K80FKED	Vishay-Dale		
R10, R11	2	10 kΩ	Trimmer, 10 kΩ, 0.25W, TH	4.5 × 8 × 6.7 mm	3266W-1-103LF	Bourns		
R12	1	158	Resistor, 158, 1%, 0.063 W, 0402	0402	CRCW0402158RFKED	Vishay-Dale		
R18, R30, R31	3	0.01	Resistor, 0.01, 1%, 1 W, 2010	2010	WSL2010R0100FEA18	Vishay-Dale		
R22	1	5.23 k	Resistor, 5.23 k, 1%, 0.063 W, 0402	0402	CRCW04025K23FKED	Vishay-Dale		
R23	1	30.1 k	Resistor, 30.1 k, 1%, 0.063 W, 0402	0402	CRCW040230K1FKED	Vishay-Dale		
R25, R27	2	0	Resistor, 0, 5%, 0.063 W, 0402	0402	CRCW04020000Z0ED	Vishay-Dale		
S2	1		Switch, SPST, 2 POS, 25 mA, 24 VDC, SMD	3.71 × 5.8 mm	218-2LPST	CTS Electrocomponents		
SH-JP2, SH-JP3, SH-JP4, SH-JP6, SH-JP7, SH-JP10, SH-JP12, SH-JP13, SH-JP14	9	1 × 2	Shunt, 100 mil, Gold plated, Black	Shunt	969102-0000-DA	3M	SNT-100-BK-G	Samtec

Table 5. bq25606EVM-772 BOM (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
TP1, TP2	2		Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone		
TP3, TP4, TP6, TP7, TP10, TP11, TP13, TP14, TP15, TP16, TP21, TP24, TP25, TP26, TP27, TP28, TP29	17		Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone		
TP5, TP8	2		Test Point, Miniature, Orange, TH	Orange Miniature Testpoint	5003	Keystone		
TP9	1		Test Point, Miniature, Yellow, TH	Yellow Miniature Testpoint	5004	Keystone		
TP17, TP18, TP19, TP20, TP22, TP23	6		Test Point, Compact, SMT	Testpoint_Keystone_Compact	5016	Keystone		
U1	1		BQ25606RGER, RGE0024H (VQFN-24)	RGE0024H	bq25606RGER	Texas Instruments	bq25606RGET	Texas Instruments
C2, C5, C12	0	1000 pF	Capacitor, ceramic, 1000 pF, 50 V, ± 5%, C0G/NP0, 0402	0402	GRM1555C1H102JA01D	Murata		
C3, C17	0	10 µF	Capacitor, ceramic, 10 µF, 25 V, ± 10%, X5R, 0805	0805	GRM21BR61E106KA73L	Murata		
C8	0	110 pF	Capacitor, ceramic, 110 pF, 25 V, ± 5%, C0G/NP0, 0402	0402	GRM1555C1E111JA01D	Murata		
C11	0	0.1 µF	Capacitor, ceramic, 0.1 µF, 25 V, ± 20%, X7R, 0402	0402	C1005X7R1E104M050BB	TDK		
C14, C20	0	4.7 µF	Capacitor, ceramic, 4.7 µF, 16 V, ± 10%, X5R, 0603	0603	GRM188R61C475KAAJ	Murata		
C18	0	1 µF	Capacitor, ceramic, 1 µF, 35 V, ± 10%, X5R, 0603	0603	GMK107BJ105KA-T	Taiyo Yuden		
C19	0	10 µF	Capacitor, ceramic, 10 µF, 10 V, ± 10%, X7R, 0805	0805	GRM21BR71A106KE51L	Murata		
D1	0	13 V	Diode, TVS, Uni, 13 V, W, SOD-123W	SOD-123W	PTVS13VS1UR,115	NXP Semiconductor		
D2, D7	0	40 V	Diode, Schottky, 40 V, 0.38 A, SOD-523	SOD-523	ZLLS350TA	Diodes Inc.		
D3, D6	0	20 V	Diode, Schottky, 20 V, 1 A, 152AD	152AD	NSR10F20NXT5G	ON Semiconductor		
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A		
H1, H2, H3, H4	0		Machine Screw, Round, #4 - 40 × 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	BampersandF Fastener Supply	-	-
H5, H6, H7, H8	0		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone	-	-
J7	0		Header (shrouded), 100 mil, 5x2, High-Temperature, Gold, TH	5 × 2 Shrouded header	N2510-6002-RB	3M		
JP8	0		Header, 100 mil, 3 × 1, Tin, TH	Header, 3 PIN, 100 mil, Tin	PEC03SAAN	Sullins Connector Solutions		
JP11, JP15, JP16, JP17, JP18	0		Header, 100 mil, 2 × 1, Tin, TH	Header, 2 PIN, 100 mil, Tin	PEC02SAAN	Sullins Connector Solutions		
L1	0	1 uH	Inductor, Wirewound, 1 µH, 4 A, 0.041 Ω, SMD	4.06 × 4.06 mm	74437321010	Wurth Elektronik		
Q1	0	30 V	MOSFET, N-CH, 30 V, 22 A, DQK0006C (WSON-6)	DQK0006C	CSD17571Q2	Texas Instruments		
R2, R16, R21	0	0	Resistor, 0, 5%, 0.063 W, 0402	0402	CRCW04020000Z0ED	Vishay-Dale		
R5, R13	0	10.0 k	Resistor, 10.0 k, 1%, 0.063 W, 0402	0402	CRCW040210K0FKED	Vishay-Dale		
R15	0	4.7 k	Resistor, 4.7 k, 5%, 0.063 W, 0402	0402	CRCW04024K70JNED	Vishay-Dale		
R19, R20	0	200	Resistor, 200, 1%, 0.063 W, 0402	0402	CRCW0402200RFKED	Vishay-Dale		
R26	0	10	Resistor, 10, 5%, 0.063 W, 0402	0402	CRCW040210R0JNED	Vishay-Dale		
S1	0		Switch, Normally open, 2.3-N force, 200-k operations, SMD	KSR	KSR221GLFS	CampersandK Components		

Table 5. bq25606EVM-772 BOM (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
SH-JP1, SH-JP5, SH-JP8, SH-JP9, SH-JP11, SH-JP15, SH-JP16, SH-JP17, SH-JP18	0	1 × 2	Shunt, 100-mil, Gold plated, Black	Shunt	969102-0000-DA	3M	SNT-100-BK-G	Samtec
SW1, SW2, SW3, SW4	0		Compact Probe Tip Circuit Board Test Points, TH, 25 per	TH Scope Probe	131-5031-00	Tektronix		
TP12	0		Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone		

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from June 2, 2017 to September 30, 2017 **Page**

- Changed *Schematic for bq25606EVM-772* 9
- Changed bq25606EVM-772 BOM 10

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying 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 set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   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 a nonconforming EVM if (a) the nonconformity was 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, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, 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.

WARNING

Evaluation Kits 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 shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 *Regulatory Notices:*

3.1 *United States*

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

FCC NOTICE: 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 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. 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。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

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 to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。 技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

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東京都新宿区西新宿 6 丁目 2 4 番 1 号

西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*

6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

   8.1 *General Limitations*. IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

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