User's Guide
SBAU227–March 2014

TPS56C20EVM-614 12-A, SWIFT Regulator Evaluation Module

This user's guide describes the characteristics, operation, and use of the TPS56C20EVM-614 evaluation module (EVM). The document includes performance specifications, test setup and results, the printed-circuit board (PCB) layout, a schematic, and a bill of materials (BOM).

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1 Introduction

The TPS56C20 is a synchronous DC-DC converter. The TPS56C20 is a buck converter whose output voltage can be adjusted using the feedback resistor divider network or using VID commands from an I2C interface bus. It is a single, adaptive on-time, D-CAP2™ mode converter requiring a very low external component count. The D-CAP2 control circuit is optimized for low-ESR output capacitors such as POSCAP or SP-CAP, or ceramic types. The D-CAP2 control circuit features fast transient response with no external compensation. The reference design internally sets the switching frequency at a nominal 500 kHz. The design integrates the high- and low-side switching MOSFETs and the gate drive circuitry. The low drain-to-source on resistance of the MOSFETs allows the TPS56C20 to achieve high efficiencies and helps keep the junction temperature low at high output currents. The TPS56C20 DC/DC synchronous converter provides up to a 12-A output from an input voltage source of 4.5 V to 17 V. The output voltage range is from 0.6 V to 1.87 V. The rated input voltage and output current range for the evaluation module are given in Table 1.

The TPS56C20EVM-614 evaluation module is a single, synchronous buck converter providing 1.1 V at 12 A from 4.5-V to 17-V input.

Table 1. Input Voltage and Output Current Summary

EVM	Input Voltage Range	Output Current Range
TPS56C20EVM-614	VIN = 4.5V to 17V	0A to 12A

2 Performance Specification Summary

A summary of the TPS56C20EVM-614 performance specifications is provided in Table 2. Specifications are given for an input voltage of VIN = 12V and an output voltage of 1.1V, unless otherwise noted. The ambient temperature is 25°C for all measurement, unless otherwise noted.

Table 2. TPS56C20EVM-614 and Performance Specifications Summary

Parameter	Test Conditions	Min	Typ	Max	Units
Input voltage range (V_{IN})		4.5	12	17	V
Output voltage			1.1		V
Operating frequency	V_{IN} = 12 V, I_O = 12 A		500		kHz
Output current range		0		12	A
Over current limit	V_{IN} = 12 V	13.2	20		A
Output ripple voltage	V_{IN} = 12 V, I_O = 12 A		25		mV_{PP}

3 Modifications

The design of the TPS56C20EVM-614 provides access to all the four devices of the IC family: TPS56520, TPS56720, TPS56920, and TPS56C20. The module ships with a TPS56C20 IC soldered but the user can replace the TPS56C20 with any of the other three ICs to test their performance.

3.1 Output Voltage Set Point

To change the output voltage of the TPS56C20EVM-614, change the value of resistor R7. Calculate the value of R7 for a specific output voltage between 0.6 V to 1.87 V using Equation 1.

$$V_{OUT} = 0.6 \times (1 + R7 / R8) \quad (1)$$

Table 3 lists the R7 values for common output voltages. For higher output voltages, a feed forward capacitor (C12) may be required to improve phase margin. The evaluation module provides pads to include the component (C12). NOTE: the values given in Table 3 are standard values and not the exact value.

Table 3. Output Voltages

Output Voltage (V)	R7 (kΩ)	R8 (kΩ)	C12 (pF)	L1 (µH)			C6 + C7 (µF)
				MIN	TYP	MAX	
0.8	7.33	22					
1	14.7	22		1.0	1.5	2.2	44 – 100
1.1	18.2	22		1.0	1.5	2.2	44 – 100
1.2	22	22		1.0	1.5	2.2	44 – 100
1.5	33	22		1.0	1.5	2.2	44 – 100
1.8	44.2	22	Optional	1.0	1.5	2.2	44 – 100

3.2 Output Voltage Set Point Using I2C Interface

The engineer can change the TPS56C20 output voltage by using an I2C interface which can dynamically scale the output voltage in the range of 0.6 V to 1.87 V. Section 3.2.1, Section 3.2.2, and Section 3.2.3 explain the procedure to download all the software required and how to communicate between the evaluation module and the PC. The design includes an easy-to-use GUI so that the design engineer can test the I2C functionality without much prior experience. The test requires a PC running the Microsoft® Windows® operating system, the TI USB2ANY interface, and USB2ANY_GUI software. The design engineer can purchase the TI USB2ANY interface from the TI website.

3.2.1 PC Preparation

Use the following steps to prepare the PC for use:

1. Turn on the PC and boot up the Windows operating system.
2. Copy the provided file “PC-Software.zip” to a directory on the system hard drive.
3. Uncompress the files to that directory.
4. From the directory listing, unzip the USB2ANY_SDK_SETUP program files and run the USB2ANY_SDK_Setup.exe with the default settings.
5. From the directory listing, unzip the TPS56X20 I2C TEST PANEL file and run the SETUP file from the TPS56X20 I2C TEST PANEL Installer.
6. Reboot the PC after installing both pieces of software.

3.2.2 Connect the PC

Use the following steps to connect the PC to the TI USB2ANY interface:

1. Connect the provided USB cable between the PC USB port and the TI USB2ANY interface as illustrated in Figure 1.
2. Connect the supplied 10 conductor ribbon cable between the TI USB2ANY interface and PWR614 J4 connector.
3. Turn on or enable the input voltage power supply.

Figure 1. USB2ANY Connection

3.2.3 Voltage Scaling Procedure

Set voltage scaling by using the following steps:

1. Go to Program Files and click on the TPS56X20 I2C TEST PANEL Application. The TPS56X20 I2C TEST PANEL will load as shown in Figure 2.

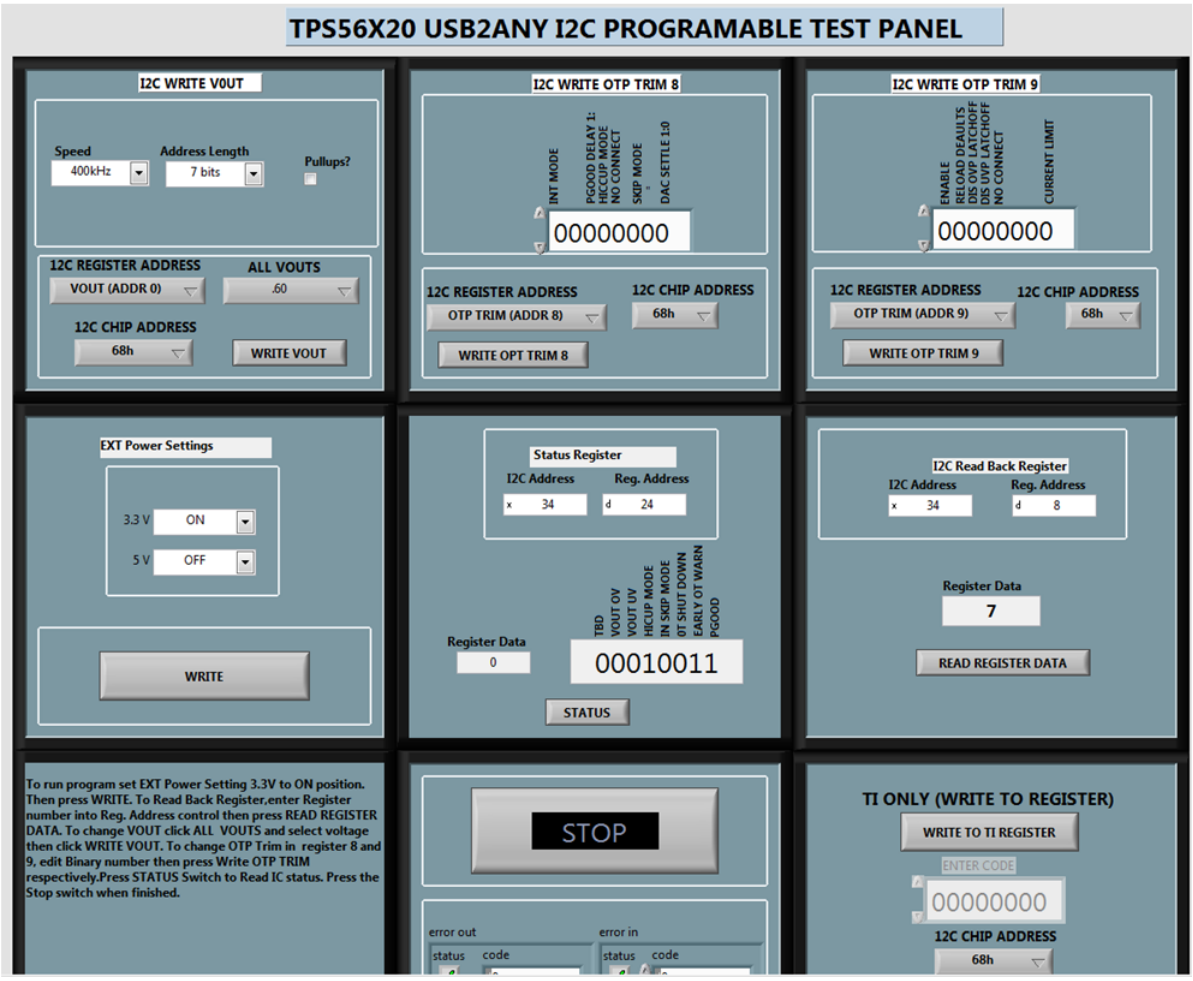


Figure 2. TPS56X20 I2C TEST PANEL

2. As a first step before sending a V_{OUT} command, click the write command On the EXT Power Settings block as shown in Figure 3.

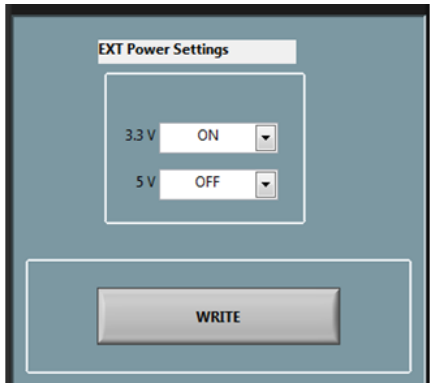


Figure 3. EXT Power Settings

3. Go to the VOUTS control block and click on the ALL VOUTS control, illustrated in Figure 4. The drop down menu gives an option to select different VOUT.

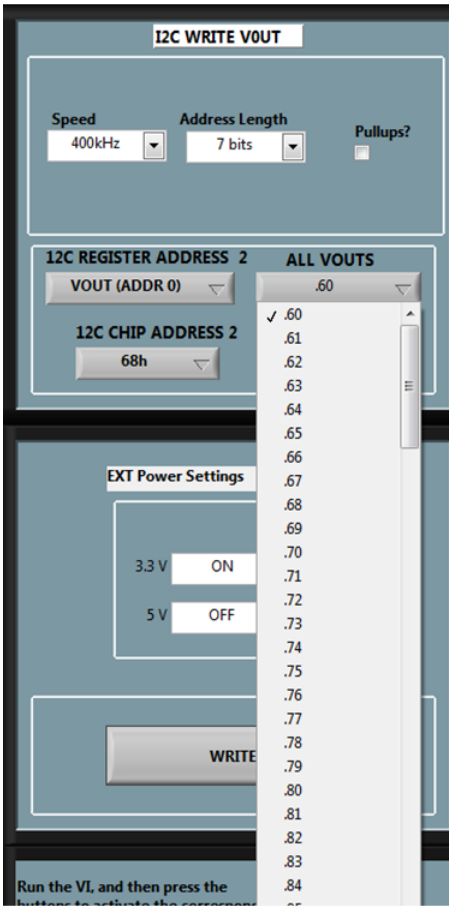


Figure 4. ALL VOUTS Control

4. Select a particular value and click on WRITE VOUT switch.

Observe that the Voltage at TP6 relative to TP7 is changed to the programmed VOUT value.

3.3 Output Filter and Closed Loop Response

The TPS56C20 relies on the output filter characteristics to ensure stability of the control loop. The recommended output filter components for common output voltages are in Table 3. It may be possible for other output filter component values to provide acceptable closed loop characteristics.

4 Test Setup and Results

This section describes how to properly connect, set up, and use the TPS56C20EVM-614. The section also includes test results typical for the evaluation modules and efficiency, output load regulation, output line regulation, load transient response, output voltage ripple, start-up, and shutdown.

4.1 Input/Output Connections

The TPS56C20EVM-614 provides input/output connectors and test points as shown in Table 4. The design requires a power supply capable of supplying 4 A to connect to J1 through a pair of 20-AWG wires. The design requires the load to connect to J3 through a pair of 20-AWG wires. The maximum load current capability is 12 A. Wire lengths must be minimized to reduce losses in the wires. Test point TP3 provides a place to monitor the VIN input voltages with TP4 (which provides a convenient ground reference). The design uses TP6 to monitor the output voltage with TP7 as the ground reference.

Table 4. Connection and Test Points

Reference Designator	Function
J1	PVIN input voltage connector (See Table 1 for PVIN range)
J2	VIN input voltage connector. Not normally used
J3	VOUT, 1.1V at 12A maximum
JP1	PVIN to VIN jumper. Normally closed
JP2	I2C interface pull up jumper for SDA
JP3	I2C interface pull up jumper for SCL
JP4	I2C interface grounding jumper for A1
JP5	I2C interface grounding jumper for A0
JP6	Enable Jumper. Close to disable, open to enable
TP1	GND test point for VIN connector
TP2	VIN test point
TP3	PVIN test point
TP4	GND test point for PVIN connector
TP5	SW test point
TP6	Output voltage test point at VOUT connector
TP7	GND test point at VOUT connector
TP9	Analog GND test point
TP10	Test point in voltage divider network. Used for loop response measurements

4.2 Start Up Procedure

Using the following procedure ensures a successful start up:

1. Make sure that the Enable jumper JP6 is closed to shunt EN to GND, disabling the output.
2. Apply the appropriate V_{IN} voltage to PVIN (J1-1) and GND (J1-2).

4.3 Efficiency

Figure 5 shows the efficiency for the TPS56C20EVM-614 at an ambient temperature of 25°C.

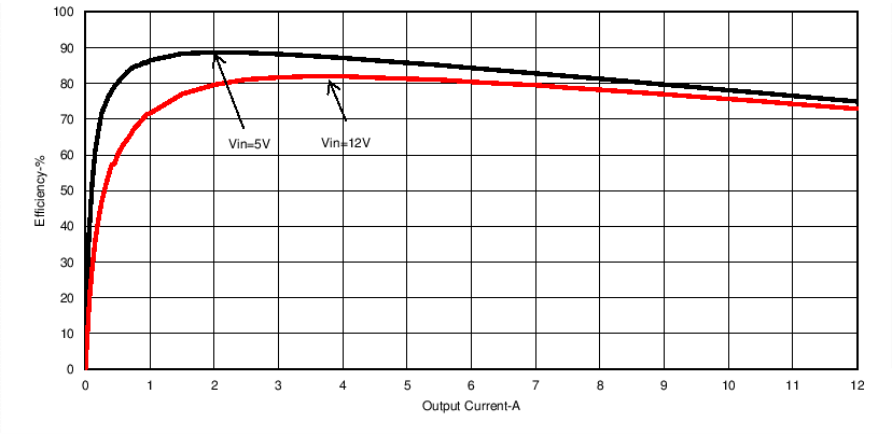


Figure 5. TPS56C20EVM-614 Efficiency

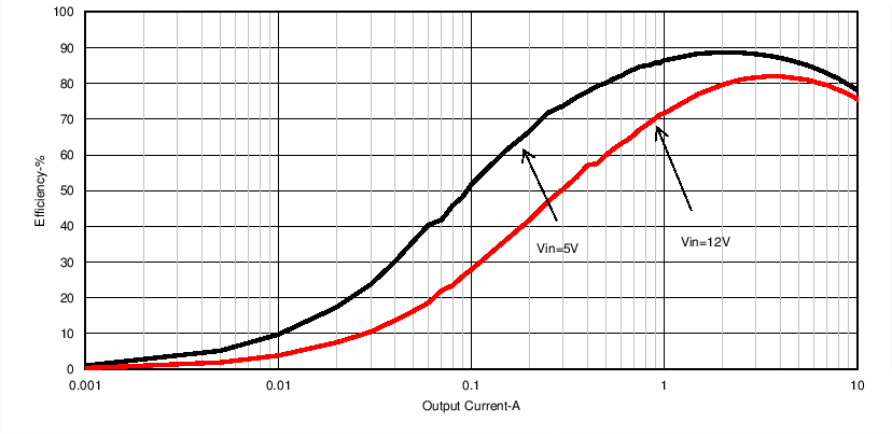


Figure 6. TPS56C20EVM-614 Efficiency (Low Current)

4.4 Load Regulation

Figure 7 shows the load regulation for the TPS56C20EVM-614.

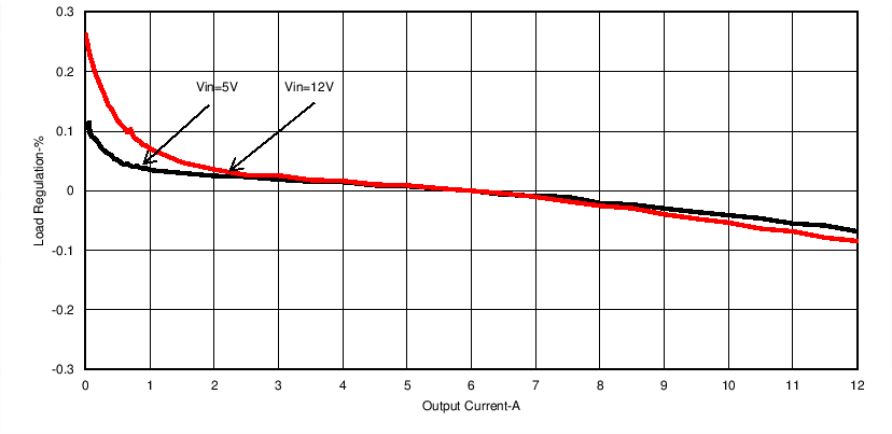


Figure 7. TPS56C20EVM-614 Load Regulation

4.5 Line Regulation

Figure 8 shows the line regulation for the TPS56C20EVM-614.

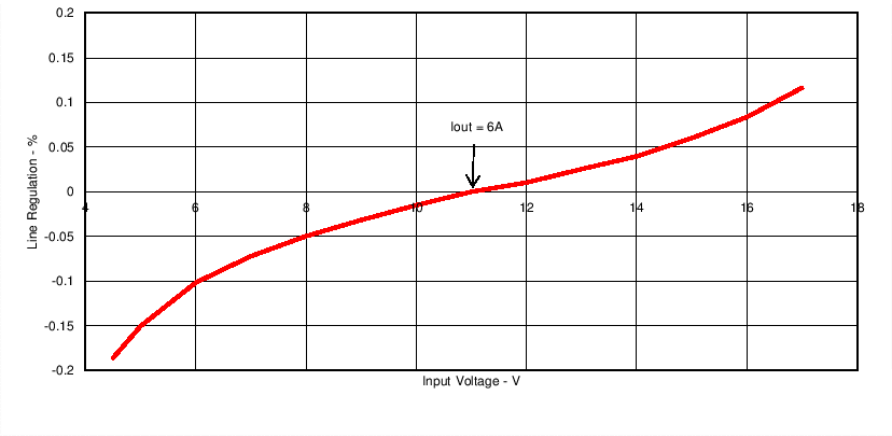


Figure 8. TPS56C20EVM-614 Line Regulation

4.6 Load Transient Response

Figure 9 shows the TPS56C20EVM-614 response to load transient. The current step is from 50 mA to 12 A (0% to 100% of rated load), with a slew rate of 500 mA/µs. Figure 9 shows the total peak-to-peak output voltage variation.

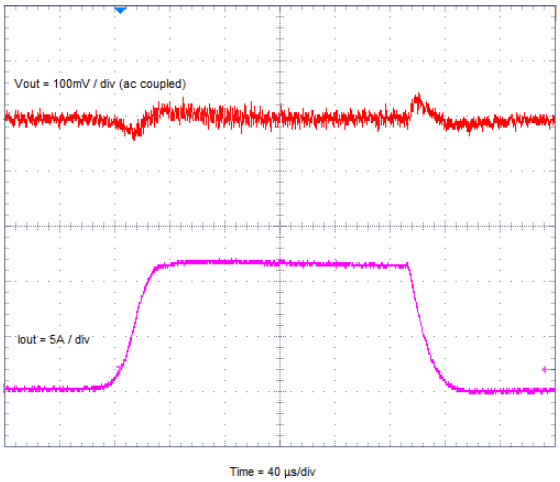


Figure 9. TPS56C20EVM-614 Load Transient Response

4.7 Output Voltage Ripple

Figure 10 shows the TPS56C20EVM-614 output voltage ripple. The output current is the rated full load of 12 A.

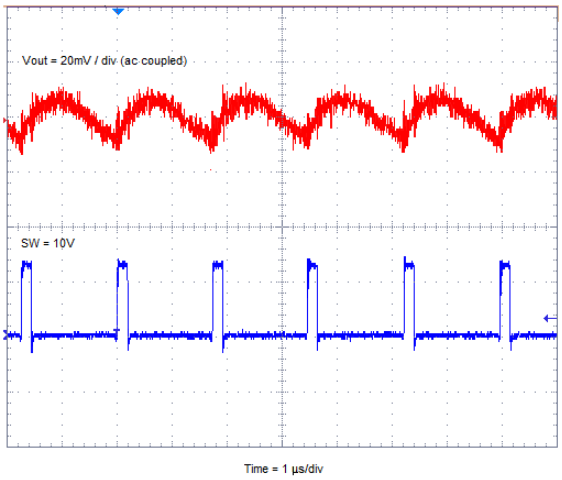


Figure 10. TPS56C20EVM-614 Output Voltage Ripple

4.8 Start Up

Figure 11 shows the TPS56C20EVM-614 start up waveform as relative to V_{IN}.

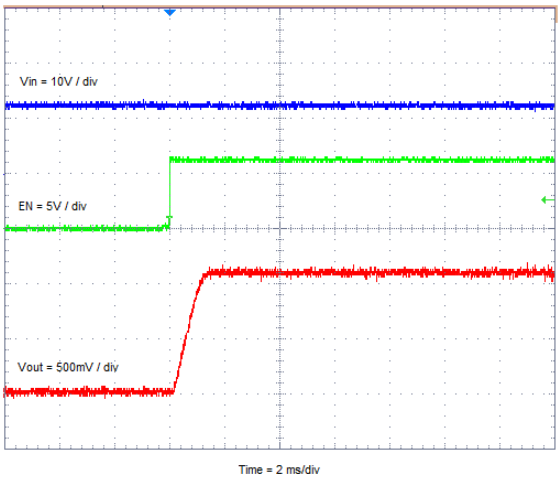


Figure 11. TPS56C20EVM-614 Start Up Relative to V_{IN}

Figure 12 shows the TPS56C20EVM-614 Start Up waveform is relative to Enable(EN).

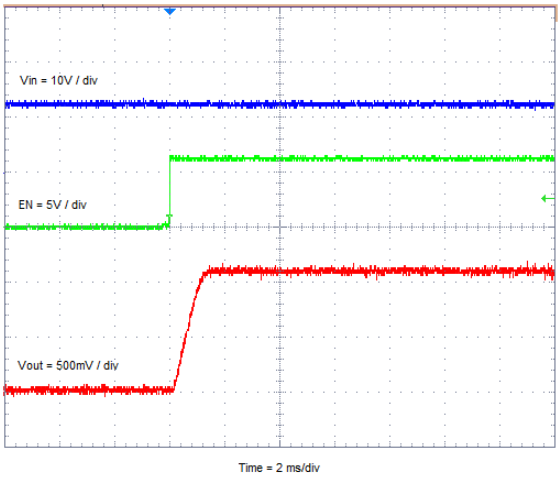


Figure 12. TPS56C20EVM-614 Start Up Relative to Enable

4.9 Shut Down

Figure 13 shows the TPS56C20EVM-614 shut down waveform relative to V_{IN}.

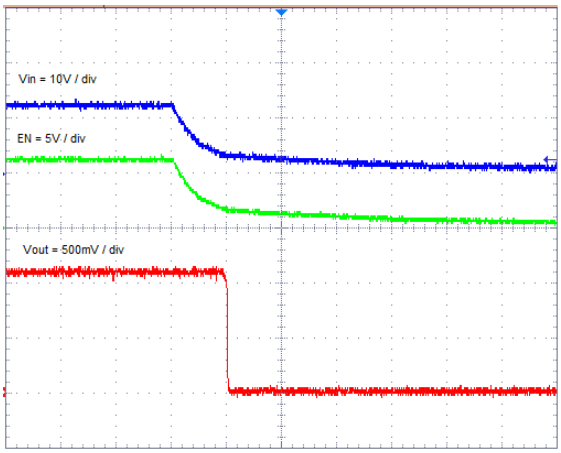


Figure 13. TPS56C20EVM-614 Shut Down Relative to V_{IN}

Figure 14 shows the TPS56C20EVM-614 Shut Down waveform relative to Enable(EN).

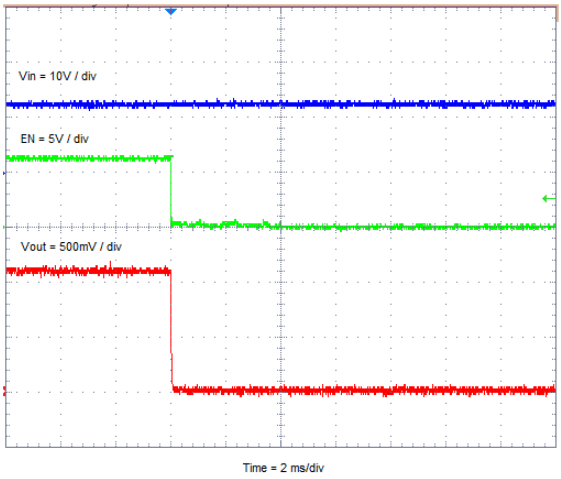


Figure 14. TPS56C20EVM-614 Shut Down Relative to Enable

5 Board Layout

This section provides a description of the TPS56C20EVM-614, PCB layout, and layer illustrations.

5.1 Board Layout

Figure 15 through Figure 19 show the board layout for the TPS56C20EVM-614. The top layer contains the main power traces for PVIN, VIN, VOUT, SWITCH node, and a huge area filled with ground. Many of the signal traces are also located on the top side. The design locates the input decoupling capacitors and the voltage set point resistor divider network components as close to the IC as possible. The input and output connectors, test points, and most of the components are located on the top side. The analog ground (which is used as a return for the I2C interface signals) connects to the power ground at only one point on the top layer. Internal layer 1 and internal layer 2 are filled with power ground. The bottom layer contains a few traces like the I2C connections and the output voltage trace to the J3 connector.

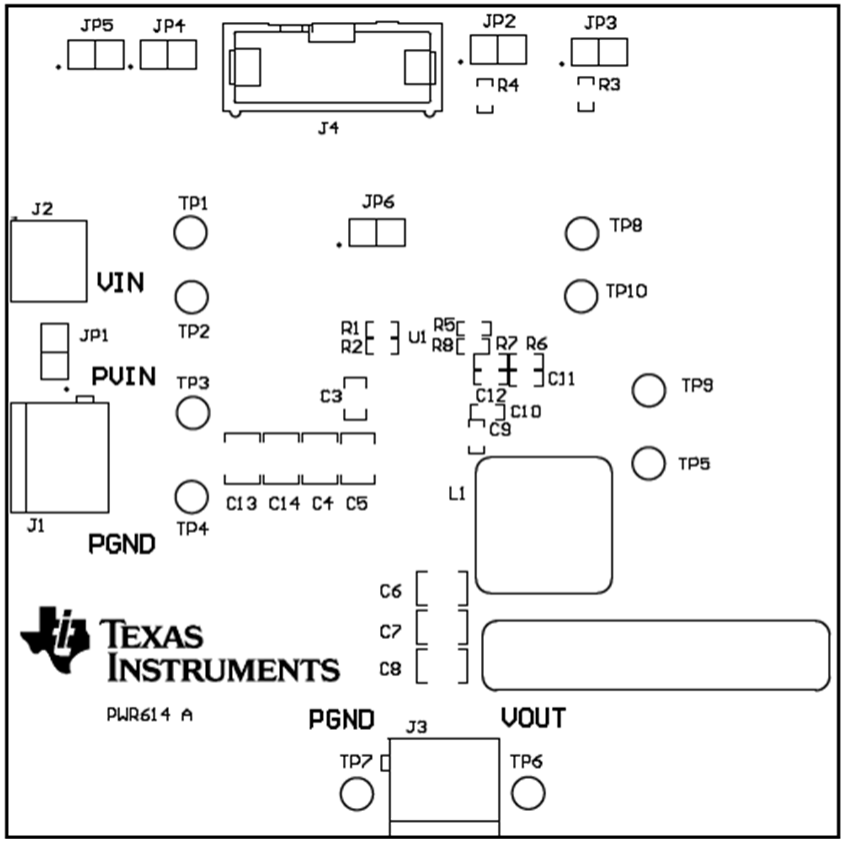


Figure 15. Top Assembly

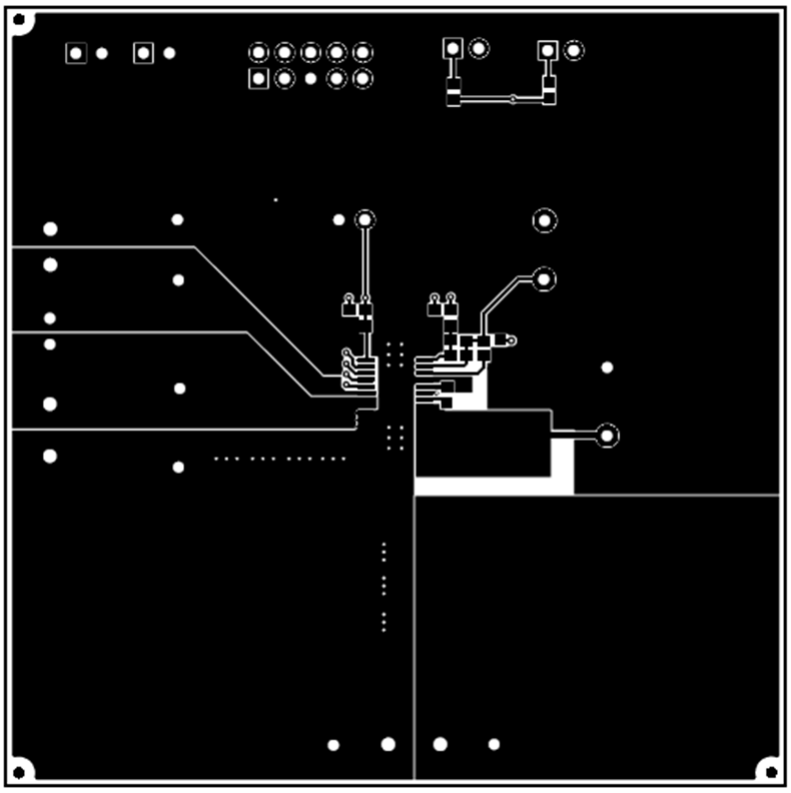


Figure 16. Top Layer

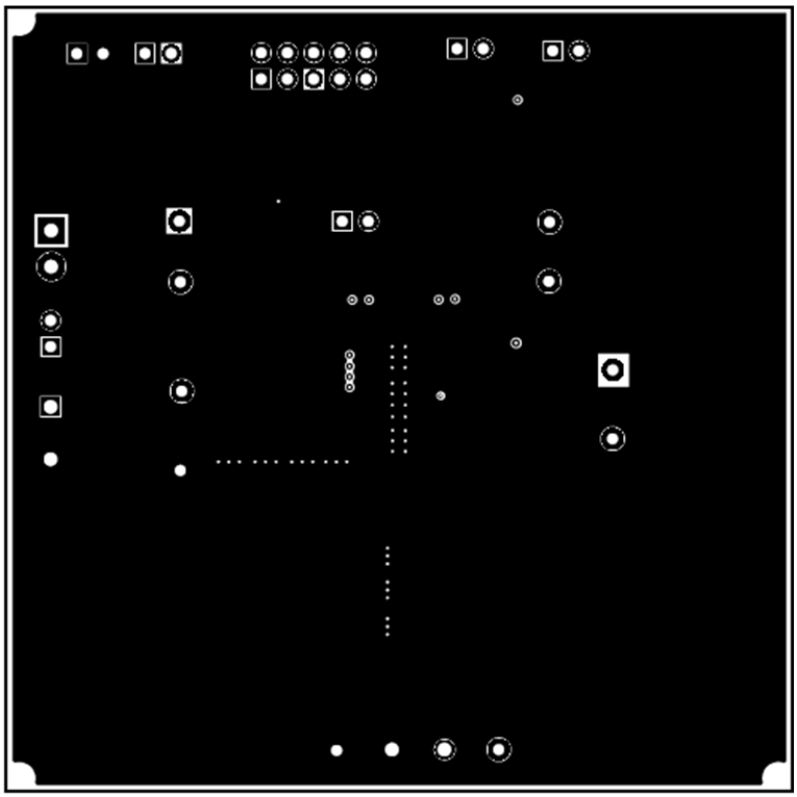


Figure 17. Internal Layer 1

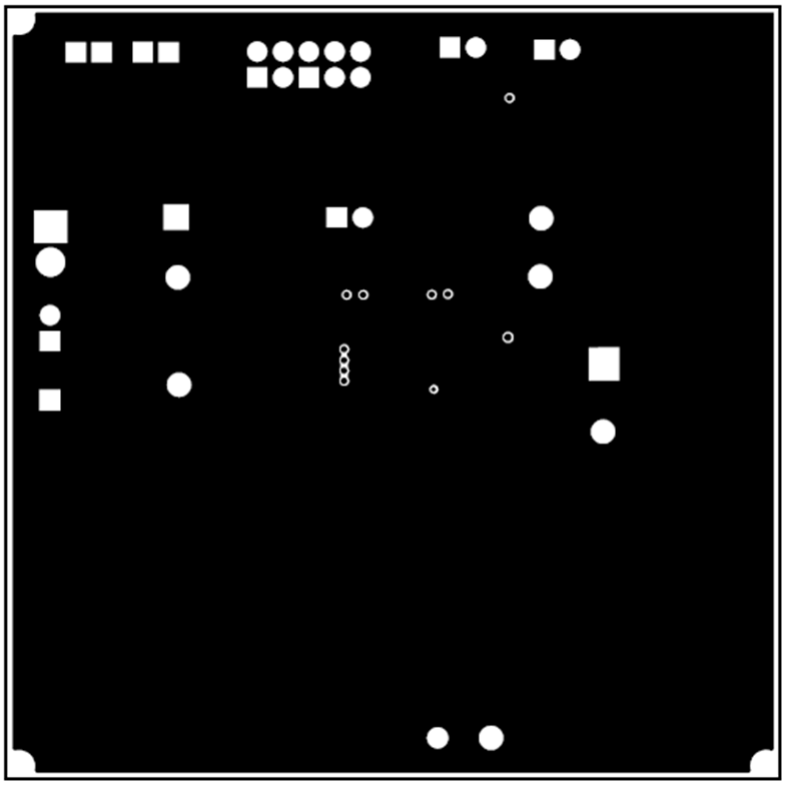


Figure 18. Internal Layer 2

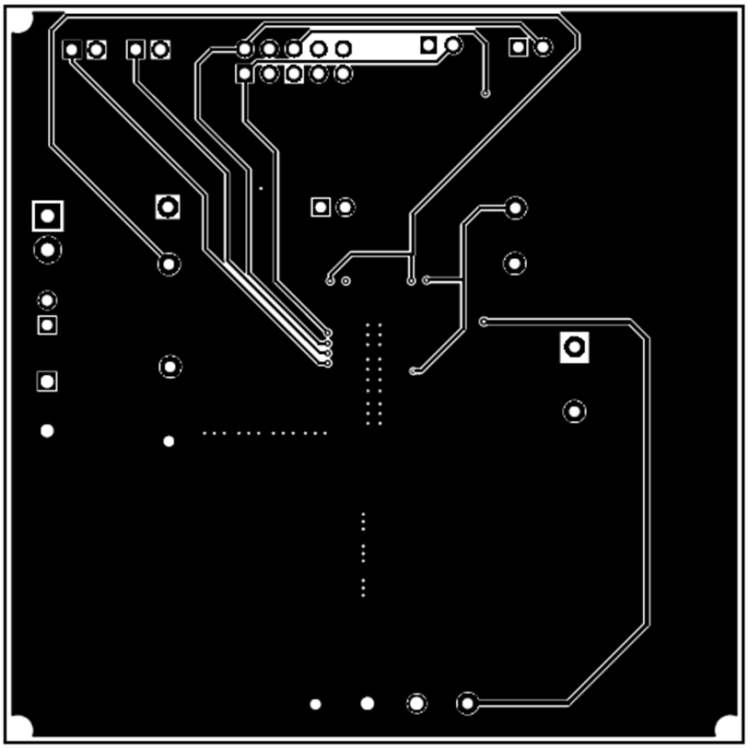


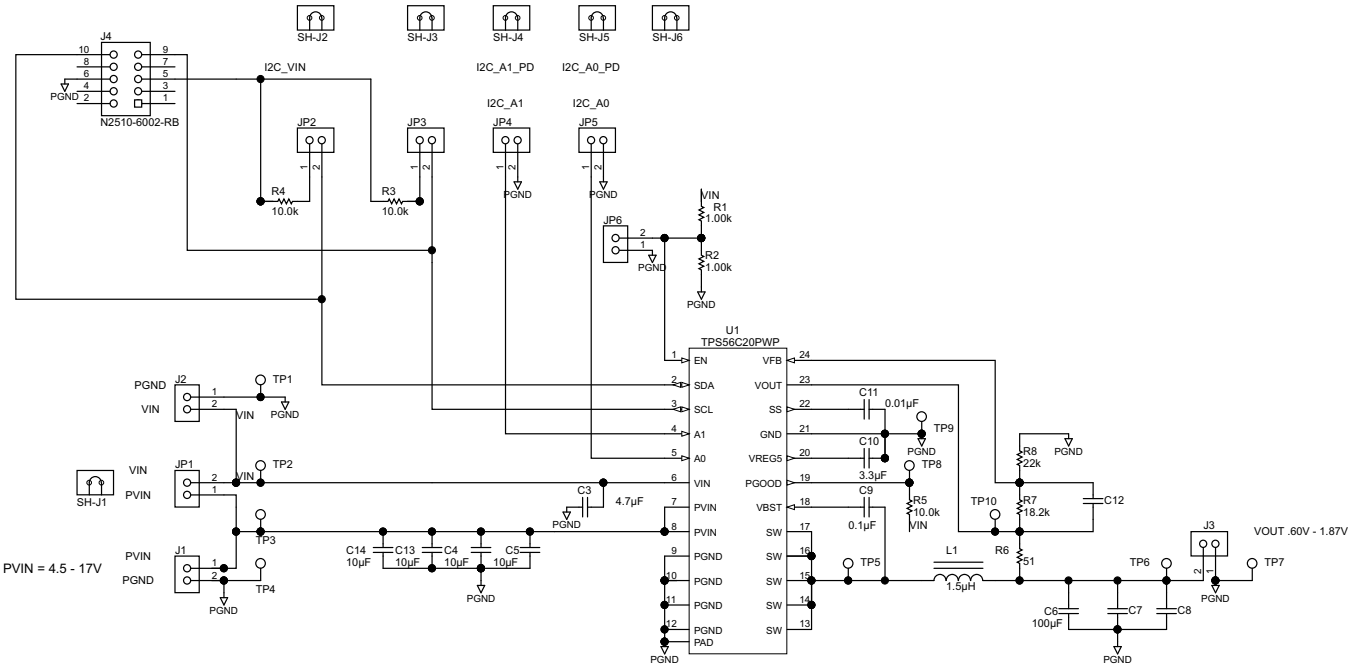
Figure 19. Bottom Layer

6 Schematic, Bill of Materials and Reference

This section presents the TPS56C20EVM-614 schematic, bill of materials (BOM), and reference.

6.1 Schematic

Figure 20 shows the schematic for the TPS56C20EVM.



NOTE: TPS56520,720,920 C10=2.2uF

NOTE: TPS56C20 C10=3.3uF

NOTE: TPS56520: Wurth 1.5uH Inductor:74437346015

NOTE: TPS56720,TPS56920: Wurth 1.5uH Inductor:744311150

NOTE: TPS56C20: Wurth 1.5uH Inductor:744323150

Figure 20. TPS56C20EVM-614 Schematic Diagram

6.2 Bill of Materials

Table 5 lists the BOM for the TPS56C20EVM.

Table 5. TPS56C20EVM-614 Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C3	1	4.7uF	CAP, CERM, 4.7uF, 10V, +/-10%, X5R, 0805	0805	0805ZD475KAT2A	AVX
C4, C5, C13, C14	4	10uF	CAP, CERM, 10uF, 35V, +/-10%, X7R, 1210	1210	GRM32ER7YA106KA12L	MuRata
C6	1	100uF	CAP, CERM, 100uF, 6.3V, +/-20%, X5R, 1210	1210	C1210C107M9PACTU	Kemet
C9	1	0.1uF	CAP, CERM, 0.1uF, 25V, +/-10%, X7R, 0603	0603	06033C104KAT2A	AVX
C10	1	3.3uF	CAP, CERM, 3.3uF, 25V, +/-10%, X5R, 0603	0603	C1608X5R1E335K080AC	TDK
C11	1	0.01uF	CAP, CERM, 0.01uF, 50V, +/-5%, X7R, 0603	0603	C0603C103J5RACTU	Kemet
J1, J3	2		TERMINAL BLOCK 5.08MM VERT 2POS	TERM_BLK, 2pos, 5.08mm	ED120/2DS	On-Shore Technology, Inc.
J2	1		Terminal Block, 6A, 3.5mm Pitch, 2-Pos, TH	7.0x8.2x6.5mm	ED555/2DS	On-Shore Technology, Inc.
J4	1		Header (shrouded), 100mil, 5x2, High-Temperature, Gold, TH	5x2 Shrouded header	N2510-6002-RB	3M
JP1, JP2, JP3, JP4, JP5, JP6	6		Header, TH, 100mil, 2x1, Gold plated, 230 mil above insulator	TSW-102-07-G-S	TSW-102-07-G-S	Samtec, Inc.
L1	1	1.5uH	Inductor, Shielded Drum Core, WE-Superflux200, 1.5uH, 12A, 0.0066 ohm, SMD	WE-HC5	744323150	Wurth Elektronik eiSos
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650"H x 0.200"W	THT-14-423-10	Brady
R1, R2	2	1.00k	RES, 1.00k ohm, 1%, 0.1W, 0603	0603	CRCW06031K00FKEA	Vishay-Dale
R3, R4, R5	3	10.0k	RES, 10.0k ohm, 1%, 0.1W, 0603	0603	CRCW060310K0FKEA	Vishay-Dale
R6	1	51	RES, 51 ohm, 5%, 0.1W, 0603	0603	CRCW060351R0JNEA	Vishay-Dale
R7	1	18.2k	RES, 18.2k ohm, 1%, 0.1W, 0603	0603	CRCW060318K2FKEA	Vishay-Dale
R8	1	22k	RES, 22k ohm, 5%, 0.1W, 0603	0603	CRCW060322K0JNEA	Vishay-Dale
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6	6	1x2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M
TP1	1	Black	Test Point, TH, Miniature, Black	Keystone5001	5001	Keystone
TP2, TP5, TP8, TP10	4	Red	Test Point, TH, Miniature, Red	Keystone5000	5000	Keystone
TP3, TP6	2	Red	Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone
TP4, TP7, TP9	3	Black	Test Point, Miniature, Black, TH	Black Miniature Testpoint	5001	Keystone
U1	1		4.5V to 17V Input, 12A/9A/7A/5A Output, Synchronous Step-Down Voltage Regulator with Voltage Margining, PWP0024G	PWP0024G	TPS56C20PWP	Texas Instruments

6.3 Reference

TPS56C20,TPS56920, TPS56720, TPS56520 data sheet (SLVSCB6).

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9. User assumes sole responsibility to determine whether EVMs may be subject to any applicable federal, state, or local laws and regulatory requirements (including but not limited to U.S. Food and Drug Administration regulations, if applicable) related to its handling and use of EVMs and, if applicable, compliance in all respects with such laws and regulations.
10. User has sole responsibility to ensure the safety of any activities to be conducted by it and its employees, affiliates, contractors or designees, with respect to handling and using EVMs. Further, user is responsible to ensure that any interfaces (electronic and/or mechanical) between EVMs 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.
11. User shall employ reasonable safeguards to ensure that user's use of EVMs will not result in any property damage, injury or death, even if EVMs should fail to perform as described or expected.
12. User shall be solely responsible for proper disposal and recycling of EVMs consistent with all applicable federal, state, and local requirements.

Certain Instructions. User shall operate EVMs within TI's recommended specifications and environmental considerations per the user's guide, accompanying documentation, and any other applicable requirements. Exceeding the specified ratings (including but not limited to input and output voltage, current, power, and environmental ranges) for EVMs may cause property damage, personal injury or death. If there are questions concerning these ratings, 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 result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the applicable EVM user's 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, some circuit components may have case temperatures greater than 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using EVMs' schematics located in the applicable EVM user's guide. When placing measurement probes near EVMs during normal operation, please be aware that EVMs may become very warm. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use EVMs.

Agreement to Defend, Indemnify and Hold Harmless. User agrees to defend, indemnify, and hold TI, its directors, officers, employees, agents, representatives, affiliates, 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 and/or use of EVMs. User's indemnity shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if EVMs fail to perform as described or expected.

Safety-Critical or Life-Critical Applications. If user intends to use EVMs in evaluations of safety critical applications (such as life support), and a failure of a TI product considered for purchase by user for use in user's product would reasonably be expected to cause severe personal injury or death such as devices which are classified as FDA Class III or similar classification, then user must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

RADIO FREQUENCY REGULATORY COMPLIANCE INFORMATION FOR EVALUATION MODULES

Texas Instruments Incorporated (TI) evaluation boards, kits, and/or modules (EVMs) and/or accompanying hardware that is marketed, sold, or loaned to users may or may not be subject to radio frequency regulations in specific countries.

General Statement for EVMs Not Including a Radio

For EVMs not including a radio and not subject to the U.S. Federal Communications Commission (FCC) or Industry Canada (IC) regulations, TI intends EVMs to be used only for engineering development, demonstration, or evaluation purposes. EVMs are not finished products typically fit for general consumer use. EVMs may nonetheless generate, use, or radiate radio frequency energy, but have not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or the ICES-003 rules. Operation of such EVMs may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

General Statement for EVMs including a radio

User Power/Frequency Use Obligations: For EVMs including a radio, the radio included in such EVMs is intended for development and/or professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability in such EVMs and their development application(s) must comply with local laws governing radio spectrum allocation and power limits for such EVMs. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by TI unless user has obtained appropriate experimental and/or development licenses from local regulatory authorities, which is the sole responsibility of the user, including its acceptable authorization.

U.S. Federal Communications Commission Compliance

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 could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

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 its own expense.

FCC Interference Statement for Class B EVM devices

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.

Industry Canada Compliance (English)

For EVMs Annotated as IC – INDUSTRY CANADA Compliant:

This Class A or B digital apparatus complies with Canadian ICES-003.

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

Concerning EVMs Including Radio Transmitters

This device complies with Industry Canada licence-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.

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.

Canada Industry Canada Compliance (French)

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

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.

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.

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

Important Notice for Users of EVMs Considered "Radio Frequency Products" in Japan

EVMs entering Japan are NOT certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If user uses EVMs in 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.

http://www.tij.co.jp

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In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

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