

TPS25921X-637EVM: Evaluation Module for TPS25921X

This user's guide describes the evaluation module (EVM) for the TPS25921. The TPS25921X is an eFuse with precision current limit, 4.5-V to 18-V supply voltage operation, programmable undervoltage, overvoltage, overcurrent and inrush current protection features.

Contents

1	Introduction	2
1.1	EVM Features	2
1.2	EVM Applications	2
2	Description	3
3	Schematics	4
4	General Configurations	5
4.1	Physical Access	5
4.2	Test Equipment and Setup	6
4.3	Test Setup and Procedures	7
5	EVM Assembly Drawings and Layout Guidelines.....	11
5.1	PCB Drawings	11
6	Bill of Materials (BOM).....	14

List of Figures

1	TPS25921X EVM Schematic.....	4
2	EVM Setup with Test Equipment	7
3	J3= No Jumper Current Limit (1.5 A) Test Auto Retry (CH1)	10
4	J7 = No Jumper Current Limit (1.5A) Test with Latch (CH2)	10
5	Top Side Placement	11
6	Top Layer	12
7	Bottom Layer.....	13

List of Tables

1	TPS25921X EVM Options and Settings	3
2	Input and Output Connector Functionality	5
3	Test Points Description	5
4	Jumper and LEDs Descriptions	6
5	Power Supply Setting for PWR637.....	8
6	Default Jumper Setting for PWR637	8
7	PWR637 DMM Readings at Different Test Points.....	8
8	PWR637 Oscilloscope Setting for Current Limit Test	9
9	PWR637 Jumper Settings for Current Limits	9
10	TPS25921XEVM-637 Bill of Materials	14

1 Introduction

The TPS25921XEVM allows reference circuit evaluation of TI's TPS25921X devices. The TPS25921X devices are available with both latching and auto-retry operation.

1.1 EVM Features

- General TPS25921XEVM features include:
 - 4.5-V to 18.0-V (TYP) operation
 - CH1 Rising input voltage turn-on threshold – 4.5 V (TYP)
 - CH1 rising input voltage turn-off threshold (OVP) – 17 V (TYP)
 - CH1 Falling Input voltage turn-off threshold (UVLO) –4.2 V (TYP)
 - CH2 Rising Input voltage turn-on threshold – 4.5 V (TYP)
 - CH2 Rising Input voltage turn-off threshold (OVP) – 17 V (TYP)
 - CH2 Falling Input voltage turn-off threshold (UVLO) – 4.2 V (TYP)
 - 0.5-A to 1.5-A programmable current limit
 - Programmable undervoltage lockout/overvoltage
 - Programmable VOUT slew rate
 - Latched-off TPS25921LD
 - Auto-retry TPS25921AD
- Push button RESET signal
- On-board transorb is for overvoltage input protection
- Common diode at output prevents a negative spike when the load is removed

1.2 EVM Applications

- Set-top boxes, DVD and Blu-ray™ units
- HDD and SSD drives
- Thunderbolt host ports
- Hot-swap boards
- PCI/PCIe cards
- White goods/appliances
- Servers

Blu-ray is a trademark of Blu-ray Disc Association.
All other trademarks are the property of their respective owners.

2 Description

The TPS25921XEVM-637 enables full evaluation of the TPS25921X devices. The EVM supports two versions (Auto-Retry and Latched) of the devices on two Channels (CH1 and CH2, respectively). Input power is applied at J1 (CH1) and, J5 (CH2) while J2 and (CH1)/J6 (CH2) provide the output connection to the load. Refer to the schematic in [Figure 1](#), and EVM test setup in [Figure 2](#).

D1/C1(CH1), D5/C9 (CH2) provide input protection for the TPS25921X (U1 and U2, respectively) while D2/C2-C6 (CH1), D6/C10-C14 (CH2) provide output protection and inrush current demand from the load. S1 and S2 allow U1 and U2, respectively, to be RESET or disabled. A power good (PG) indicator is provided by D3, D7 for CH1 and CH2, respectively, and circuit faults can be observed with D4. Scaled channel current can be monitored at TP10 and TP20 with a scale factor of approximately 1 V/A.

Table 1. TPS25921X EVM Options and Settings

Part Number	EVM Function	VIN Range	UVLO		OVP	Current Limit			Fault Response	
			CH1	CH2		Lo Setting	No Jumper	Middle Setting	CH1	CH2
TPS25921XE VM-637	eFuse with Precision Current Limit	4.5 V–18 V	4.2 V	4.2 V	17 V	0.5 A	1.5 A	1:00 AM	Auto- retry	Latched

3 Schematics

Figure 1 illustrates the schematic for this EVM.

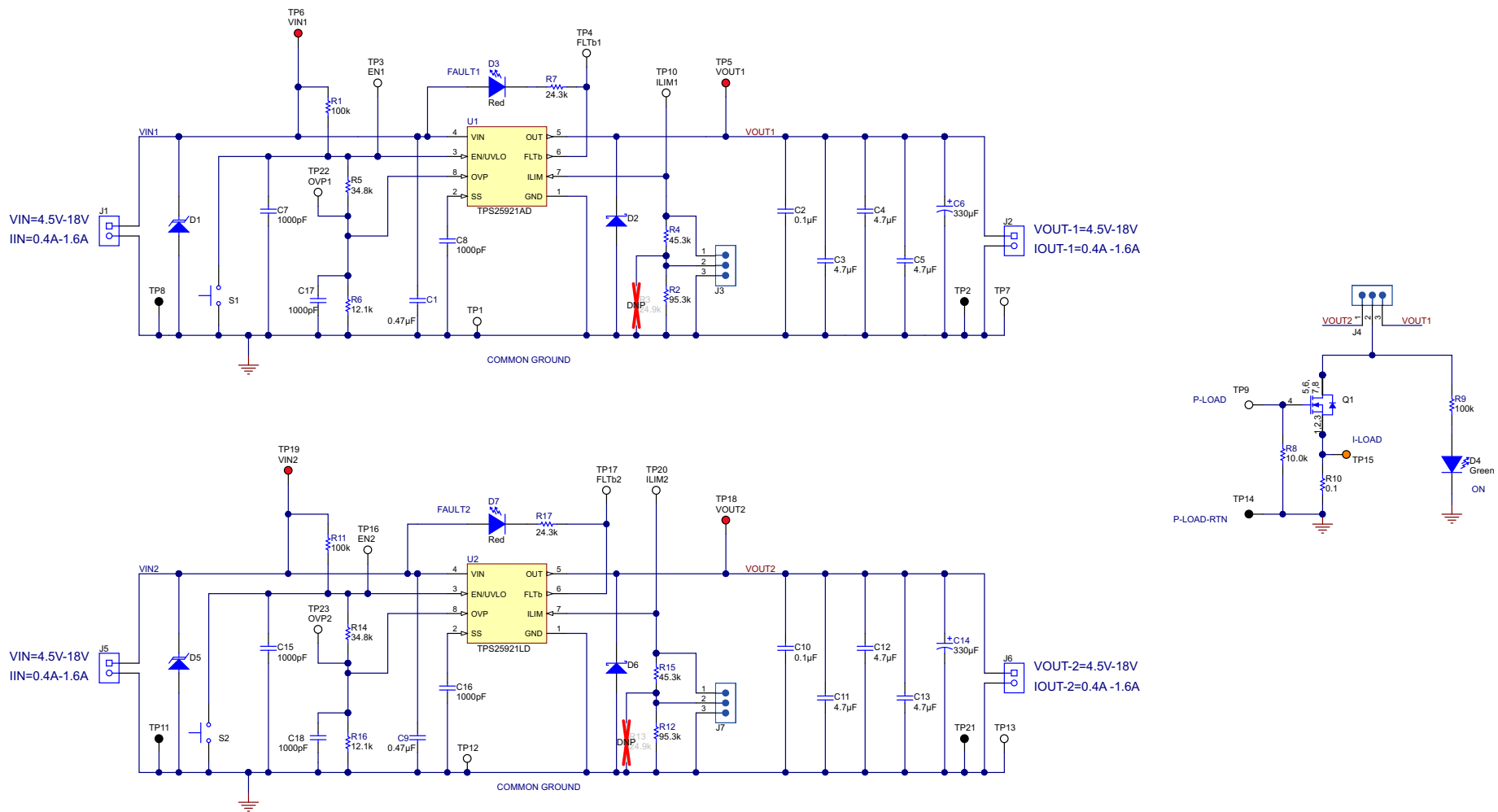


Figure 1. TPS25921X EVM Schematic

4 General Configurations

This section describes the physical access, test equipment and set up, and the test setup and procedures for this EVM.

4.1 Physical Access

Table 2 lists the TPS25921XEVM-637 input and output connector functionality.

Table 2. Input and Output Connector Functionality

Connector		Label	Description
J1	CH1	VIN1(+), GND(-)	CH1 Input power supply to the EVM
J2		VOUT1(+),GND(-)	CH1 Output power from the EVM
J5	CH2	VIN2(+), GND(-)	CH2 Input power supply to the EVM
J6		VOUT2(+),GND(-)	CH2 Output power from the EVM

Table 3 describes the test point availability.

Table 3. Test Points Description

Channel	Test Points	Label	Description
CH1	TP6	VIN1	CH1 Input power supply to the EVM
	TP3	EN1	CH1 Active high enable and under voltage input
	TP22	OVP1	CH1, Active high overvoltage input
	TP10	IMON1	CH1 Current monitor. Load current $\approx 1 \times$ voltage on TP10
	TP5	VOUT1	CH1 Output from the EVM
	TP4	FLTb1	CH1, Fault test point
	TP1	GND	GND
	TP2	GND	GND
	TP7	GND	GND
	TP8	GND	GND
CH2	TP19	VIN2	CH2 Input power supply to the EVM
	TP16	EN2	CH2 Active high enable and under voltage input
	TP23	OVP2	CH2, Active high overvoltage input
	TP20	IMON2	CH2 Current monitor. Load current $\approx 1 \times$ voltage on TP20
	TP18	VOUT2	CH2 Output from the EVM
	TP20	FLTb2	CH2, Fault test point
	TP11	GND	GND
	TP12	GND	GND
	TP13	GND	GND
	TP21	GND	GND

Table 4 describes the jumper functionality.

Table 4. Jumper and LEDs Descriptions

Jumper	Label	Description
J3	0.5 A–1.0 A	CH1 current setting (no jumper sets 1.5 A)
J7	0.5 A–1.0 A	CH2 current setting (no jumper sets 1.5 A)
D3 (Red)	D2	CH1 circuit fault indicator. LED turns on when the internal MOSFET is disabled due to a fault condition such as overload, short circuit, or undervoltage and so forth.
D7 (Red)	D3	CH2 circuit fault indicator. LED turns on when the internal MOSFET is disabled due to a fault condition such as overload, short circuit, or undervoltage and so forth.
D4 (Green)	D4	CH1 and CH2 power good indicator. This LED turns on from: VOUT1, if the jumper is installed in position 2-3 VOUT2, if the jumper is installed in position 1-2

4.2 Test Equipment and Setup

4.2.1 Power Supplies

One adjustable power supply: 0- to 20-V output, 0- to 3-A output current limit.

4.2.2 Meters

One DMM minimum needed and may require more, if simultaneous measurements are needed.

4.2.3 Oscilloscope

A DPO2024 or Lecroy 424 oscilloscope or equivalent, three 10X voltage probes, and a DC current probe

4.2.4 Loads

One resistive load or equivalent which can tolerate up to 3 ADC load at 12 V and are capable of the output short.

4.3 Test Setup and Procedures

Figure 2 shows a typical test setup for the TPS25921XEVM. Connect J3/J8 to the power supply and J2/J7 to the load.

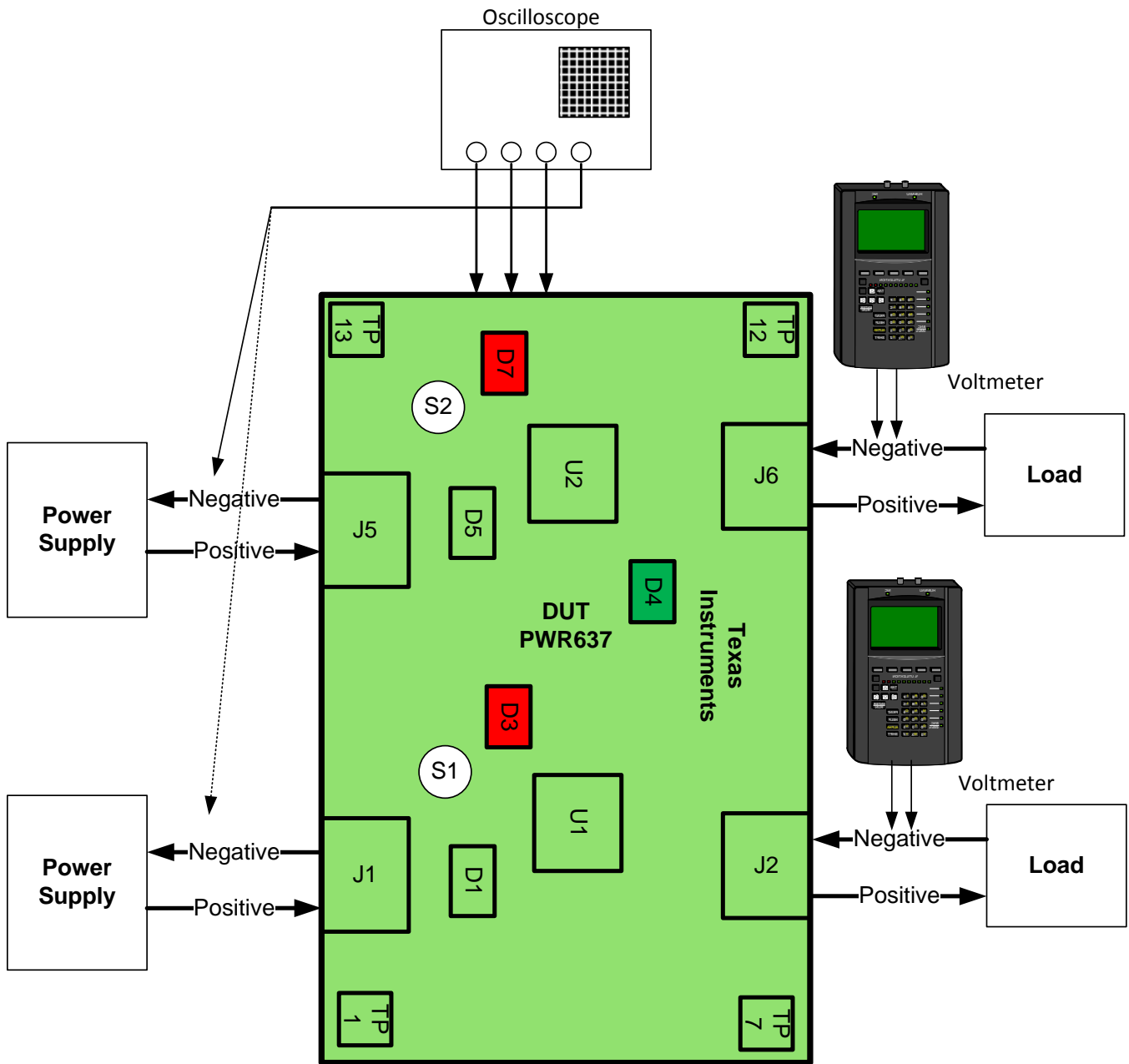


Figure 2. EVM Setup with Test Equipment

4.3.1 Test Procedure

Use the following steps to test the EVM:

1. Set the power-supply output VIN to 0 V.
2. Turn on the power supply and set the output voltage and current limit according to [Table 5](#).

Table 5. Power Supply Setting for PWR637

EVM	Channel	Voltage Set Point	Power Supply Current Limit
PWR637	CH1(J1)	12 ±0.2 VDC	3 A ±0.25 ADC
	CH2(J5)		

3. Turn off the power supply. Hook up CH1 and CH2 of the PWR637 assembly as shown in [Figure 2](#).
4. The default EVM jumper setting is shown in [Table 6](#).

Table 6. Default Jumper Setting for PWR637

J3 (CH1)	J7 (CH2)	J4 (VOUT1)
2-3	2-3	2-3

5. CH1 and CH2 can be tested one by one for PWR637.
6. Ensure that the output load is disabled and the power supply is set properly for the design under test (DUT). Connect the negative probe of DMM to TP1, TP7, TP12, or TP13 (GND). Turn on the power supply, and verify that the voltages shown in [Table 7](#) are obtained.

Table 7. PWR637 DMM Readings at Different Test Points

Voltage Test on (CH1)	Measured Voltage Reading	Voltage Test on (CH2)	Measured Voltage Reading
VIN1 (TP6)	12 ±0.5 VDC	VIN2 (TP19)	12 ±0.5 VDC
EN1 (TP3)	3.84 ±0.3 VDC	EN2 (TP16)	3.84 ±0.3 VDC
OVP1 (TP22)	0.988 ±0.2 VDC	OVP2 (TP23)	0.988 ±0.2VDC
VOUT1 (TP5)	12 ±0.5 VDC	VOUT2 (TP16)	12 ±0.5 VDC
FLTb1 (TP4)	10.6 ±0.6 VDC	FLTb2 (TP17)	10.6 ±0.6VDC
ILIM1(TP10)	0.451 ±0.1 VDC (for J3 jumper in 2-3)	ILIM2(TP20)	0.451 ±0.1 VDC (for J7 jumper in 2-3)
	1 ±0.1 VDC (for J3 jumper in 1-2)		1 ±0.1 VDC (for J7 jumper in 1-2)
	1.43 ±0.15 VDC (for no jumper in J3)		1.43 ±0.15 VDC (for no jumper in J7)

4.3.1.1 CH1 (J1)

Use the following steps to test CH1 (J1).

1. Press the EVM RST switch, S1, and verify that the voltage at VOUT1 (TP5) starts falling slowly below 12 V and the FLTb1 red LED (D3) turns ON. Release S1.
2. Reduce the input voltage on VIN1 and monitor VOUT1. Verify that VOUT1 (TP5) starts falling and is fully turned off when VIN1 (TP6) reaches 4.2 V (M0.3 V). Verify that the FLTb1 red LED (D3) turns ON.
3. Adjust the power supply voltage to 12 V.
4. Increase the input voltage on VIN1 and monitor VOUT1. Verify that VOUT1 (TP5) starts increasing and then turns off when VIN1 (TP6) exceeds 17 V (M1 V). Verify that the FLTb1 red LED (D3) turns ON.
5. Adjust the power supply voltage to 12 V.
6. Turn off the power supply.

4.3.1.2 For CH2 (J5)

Use the following steps to test CH2 (J5).

1. Press the EVM RST switch, S2 and verify that the voltage at VOUT2 (TP16) starts falling slowly below 12 V and the red FLTb2 LED (D7) turns ON. Release S2.
2. Reduce the input voltage on VIN2 and monitor VOUT2. Verify that VOUT2 (TP16) starts falling and is fully turned off when VIN2 (TP15) reaches 4.2 V (± 0.3 V). Verify that FLTb2 red LED (D7) turns ON.
3. Adjust the power supply voltage to 12 V.
4. Increase the input voltage on VIN2 and monitor VOUT2. Verify that VOUT2 (TP16) starts increasing and then turns off when VIN2 (TP19) exceeds 17 V (± 1 V). Verify that the FLTb2 red LED (D7) turns ON.
5. Adjust the power supply voltage to 12 V.
6. Turn off the power supply.

4.3.1.3 Current Limit Test

Use the following steps to conduct the current limit test.

1. Verify all three current limits (CH1 and CH2, with only 1 channel powered at a time) and verify the latch and auto-retry feature. Setup the oscilloscope as shown in [Table 8](#).

Table 8. PWR637 Oscilloscope Setting for Current Limit Test⁽¹⁾⁽²⁾

Oscilloscope Setting	CH1 Probe Points	CH2 Probe Points
Channel 1 = 5 V/div	TP5 = VOUT1	TP18 = VOUT2
Channel 2 = 5 V/div	TP6 = VIN1	TP19 = VIN2
Channel 4 = 1 A/div	Input current into J1 +ve wire	Input current into J5 +ve wire
Trigger source = Channel 4		
Trigger level = 0.6 A ± 0.1 A		
Trigger polarity = +ve		
Trigger mode = Single sequence		
Time base	200 ms/div	40 ms/div

⁽¹⁾ If an electronic load is used, ensure that the output load is set to constant resistance mode and not constant current mode.

⁽²⁾ Measuring current limit values on the oscilloscope can easily cause 8% error from anticipated values listed in [Table 8](#).

2. The jumper setting for the different current limit test is shown in [Table 9](#).

Table 9. PWR637 Jumper Settings for Current Limits

Jumper Position		Load Current Limit
J3 (CH1)	J7 (CH2)	
2-3	2-3	1.0 A ± 0.08 A
1-2	1-2	0.5 A ± 0.04 A
No jumper	No jumper	1.50 A ± 0.12 A

3. Set the output load at 5.0 $\Omega \pm 0.5\Omega$ on CH1 and then enable the load. Turn on the VIN1 power supply and verify that input current is limited, as per the setting in the [Table 9](#). Verify the device is in auto-retry mode and that the FLTb1 RED LED (D3) turns on and off as shown in [Figure 3](#). The level of the current pulse should match with the load current limit (based on the respective jumper setting), as shown in [Table 9](#).

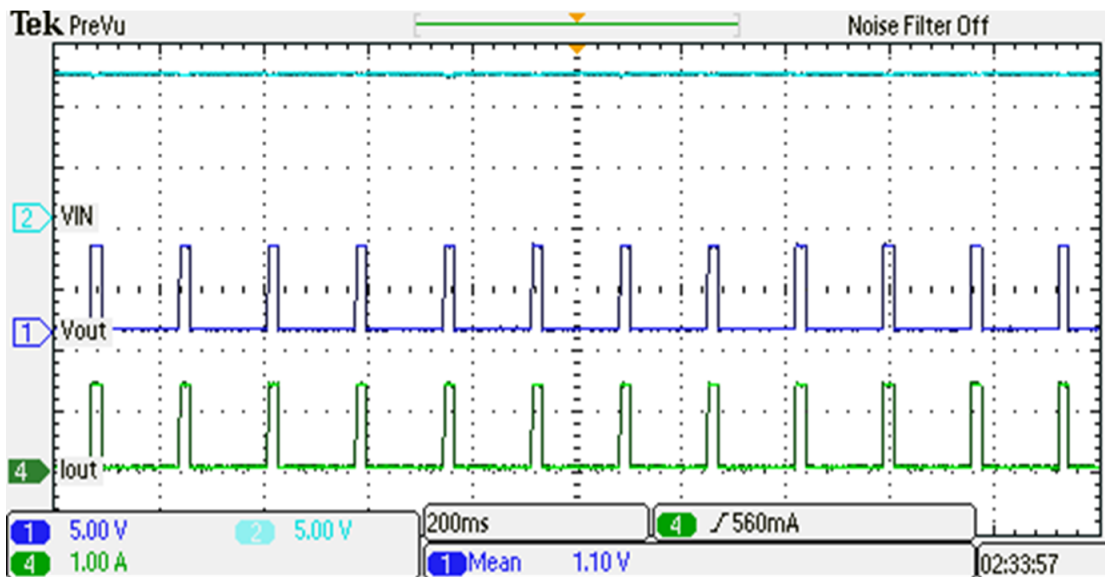


Figure 3. J3= No Jumper Current Limit (1.5 A) Test Auto Retry (CH1)

- Set the output load at $5.0\ \Omega \pm 0.5\ \Omega$ on CH2 and then enable the load. Turn on the VIN2 power supply and verify that input/output current is limited as per the setting in Table 9. Verify the device is in latched-off mode and that the FLTb2 RED LED (D7) turns ON as shown in Figure 4. The level of the current pulse should match with the load current limit (based on the respective jumper setting) as shown in Table 9.

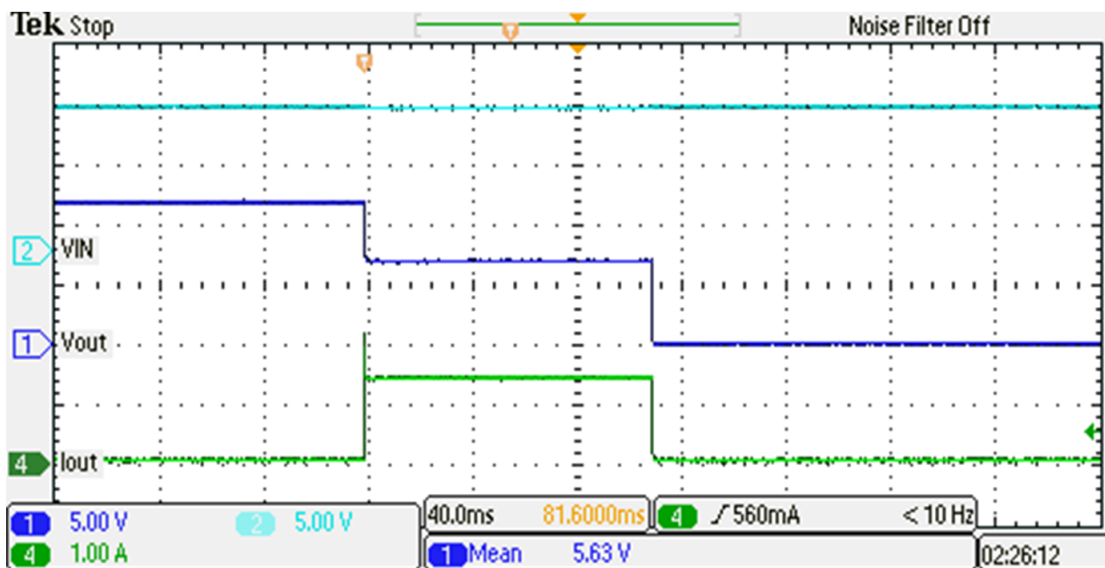


Figure 4. J7 = No Jumper Current Limit (1.5A) Test with Latch (CH2)

- Set the input power supply to zero volts and disconnect all equipment from the DUT.

5 EVM Assembly Drawings and Layout Guidelines

5.1 PCB Drawings

Figure 5 through Figure 7 show component placement and layout of the EVM.

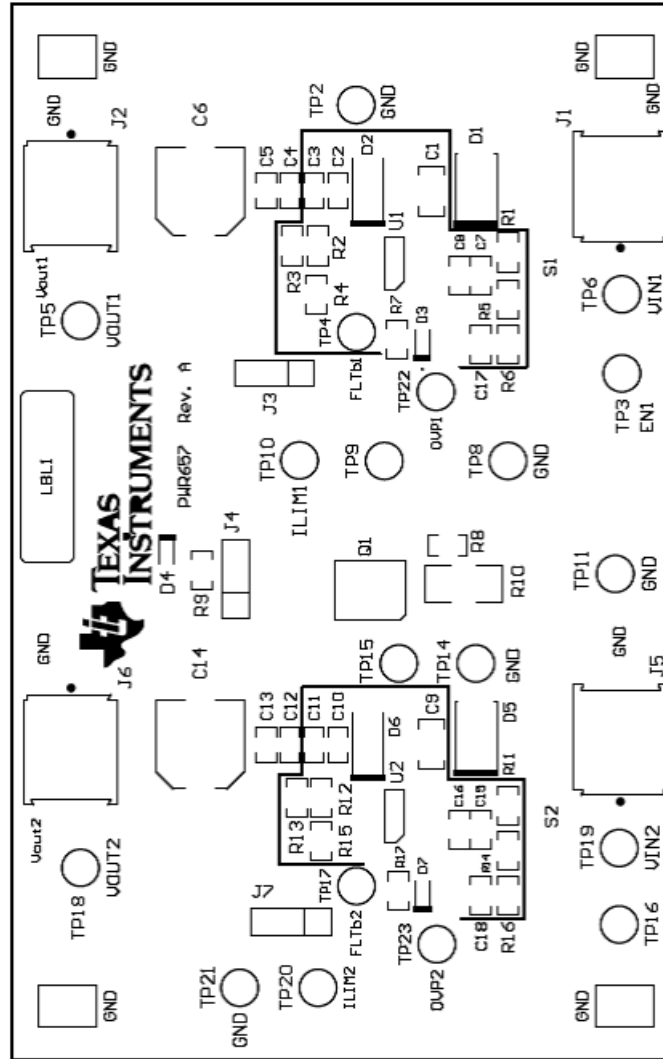


Figure 5. Top Side Placement

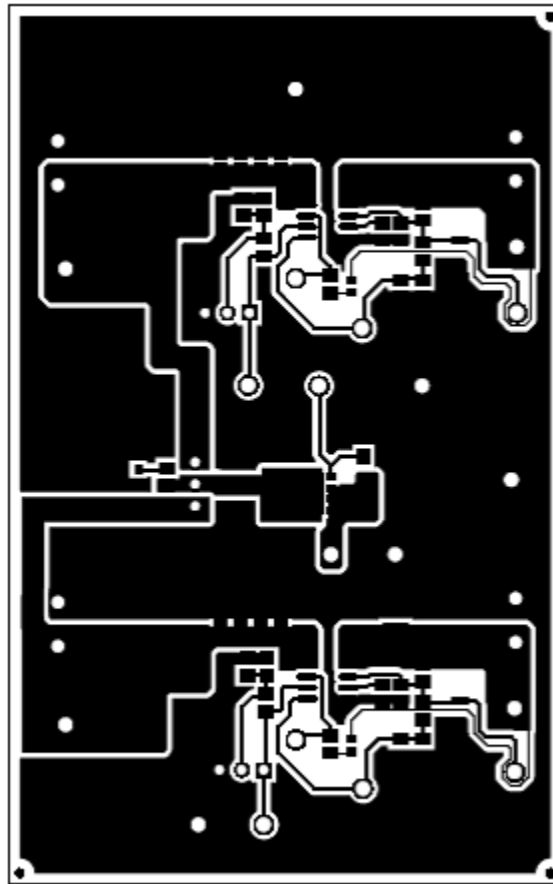


Figure 6. Top Layer

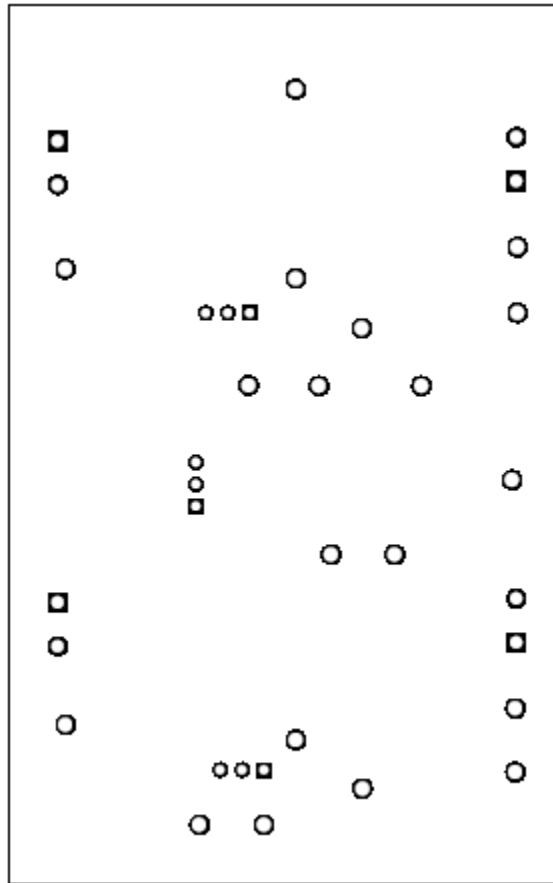


Figure 7. Bottom Layer

6 Bill of Materials (BOM)

Table 10 lists the BOM for this EVM.

Table 10. TPS25921XEVM-637 Bill of Materials⁽¹⁾

Designator	Qty	Value	Description	PackageReference	PartNumber	Manufacturer	Alternate PartNumber	Alternate Manufacturer
PCB	1		Printed Circuit Board		PWR637	Any	-	-
C1, C9	2	0.47uF	CAP, CERM, 0.47uF, 50V, +/-10%, X7R, 1206	1206	12065C474KAT2A	AVX		
C2, C10	2	0.1uF	CAP, CERM, 0.1uF, 25V, +/-10%, X7R, 0805	0805	08053C104KAT2A	AVX		
C3, C4, C5, C11, C12, C13	6	4.7uF	CAP, CERM, 4.7uF, 25V, +/-10%, X5R, 0805	0805	C2012X5R1E475K125AB	TDK		
C6, C14	2	330uF	CAP, AL, 330uF, 25V, +/-20%, 0.16 ohm, SMD	HA0	EMZA250ADA331MHA0G	Nippon Chemi-Con		
C7, C8, C15, C16	4	1000pF	CAP, CERM, 1000pF, 50V, +/-10%, X7R, 0805	0805	08055C102KAT2A	AVX		
D1, D5	2	18V	Diode, TVS, Uni, 18V, 600W, SMB	SMB	SMBJ18A-13-F	Diodes Inc.	-	-
D2, D6	2	20V	Diode, Schottky, 20V, 3A, SMA	SMA	B320A-13-F	Diodes Inc.		
D3, D7	2	Red	LED, Red, SMD	Red LED, 1.6x0.8x0.8mm	LTST-C190CKT	Lite-On		
D4	1	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On		
H1, H2, H3, H4	4		Bumpon, Cylindrical, 0.312 X 0.200, Black	Black Bumpon	SJ61A1	3M		
J1, J2, J5, J6	4		Terminal Block, 2x1, 5.08mm, TH	10.16x15.2x9mm	282841-2	TE Connectivity		
J3, J4, J7	3	1x3	Header, TH, 100mil, 1x3, Gold plated, 230 mil above insulator	PBC03SAAN	PBC03SAAN	Sullins Connector Solutions	Equivalent	Any
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		
Q1	1	30V	MOSFET, N-CH, 30V, 100A, SON 5x6mm	SON 5x6mm	CSD17301Q5A	Texas Instruments		None
R1, R11	2	100k	RES, 100k ohm, 1%, 0.125W, 0805	0805	CRCW0805100KFKEA	Vishay-Dale		
R2, R12	2	95.3k	RES, 95.3k ohm, 1%, 0.125W, 0805	0805	CRCW080595K3FKEA	Vishay-Dale		
R4, R15	2	45.3k	RES, 45.3k ohm, 1%, 0.125W, 0805	0805	CRCW080545K3FKEA	Vishay-Dale		
R5, R14	2	34.8k	RES, 34.8k ohm, 1%, 0.125W, 0805	0805	CRCW080534K8FKEA	Vishay-Dale		
R6, R16	2	12.1k	RES, 12.1k ohm, 1%, 0.125W, 0805	0805	CRCW080512K1FKEA	Vishay-Dale		
R7, R17	2	10.0k	RES, 10.0k ohm, 1%, 0.125W, 0805	0805	CRCW080510K0FKEA	Vishay-Dale		
R8	1	10.0k	RES, 10.0k ohm, 1%, 0.125W, 0805	0805	CRCW080510K0FKEA	Vishay-Dale		
R9	1	10.0k	RES, 10.0k ohm, 1%, 0.125W, 0805	0805	CRCW080510K0FKEA	Vishay-Dale		
R10	1	0.1	RES, 0.1E, 1%, 0.5W, 2010	2010	WSL2010R1000FEA	Vishay-Dale	Equivalent	Any
S1, S2	2		Switch, Push Button, SMD	2.9x2x3.9mm SMD	SKRKAEE010	Alps	Equivalent	Any
SH-J3, SH-J4, SH-J7	3	1x2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M	SNT-100-BK-G	Samtec
TP1, TP7, TP12, TP13	4	SMT	Test Point, SMT, Compact	Testpoint_Keystone_Compact	5016	Keystone	Equivalent	Any
TP2, TP8, TP11, TP14, TP21	5	Black	Test Point, TH, Multipurpose, Black	Keystone5011	5011	Keystone	Equivalent	Any
TP3, TP4, TP9, TP10, TP16, TP17, TP20, TP22, TP23	9	White	Test Point, TH, Multipurpose, White	Keystone5012	5012	Keystone	Equivalent	Any
TP5, TP6, TP18, TP19	4	Red	Test Point, TH, Multipurpose, Red	Keystone5010	5010	Keystone	Equivalent	Any
TP15	1	Orange	Test Point, TH, Multipurpose, Orange	Keystone5013	5013	Keystone	Equivalent	Any
U1	1		4.5-18V eFuse with Precision Current Limit, D0008A	D0008A	TPS25921AD	Texas Instruments		None
U2	1		4.5-18V eFuse with Precision Current Limit, D0008A	D0008A	TPS25921LD	Texas Instruments		None

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

Table 10. TPS25921XEVM-637 Bill of Materials⁽¹⁾ (continued)

Designator	Qty	Value	Description	PackageReference	PartNumber	Manufacturer	Alternate PartNumber	Alternate Manufacturer
C17, C18	2	1000pF	CAP, CERM, 1000pF, 50V, +/-10%, X7R, 0805	0805	08055C102KAT2A	AVX		
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A		
R3, R13	0	24.9k	RES, 24.9k ohm, 1%, 0.125W, 0805	0805	CRCW080524K9FKEA	Vishay-Dale		

ADDITIONAL TERMS AND CONDITIONS, WARNINGS, RESTRICTIONS, AND DISCLAIMERS FOR EVALUATION MODULES

Texas Instruments Incorporated (TI) markets, sells, and loans all evaluation boards, kits, and/or modules (EVMs) pursuant to, and user expressly acknowledges, represents, and agrees, and takes sole responsibility and risk with respect to, the following:

1. User agrees and acknowledges that EVMs are intended to be handled and used for feasibility evaluation only in laboratory and/or development environments. Notwithstanding the foregoing, in certain instances, TI makes certain EVMs available to users that do not handle and use EVMs solely for feasibility evaluation only in laboratory and/or development environments, but may use EVMs in a hobbyist environment. All EVMs made available to hobbyist users are FCC certified, as applicable. Hobbyist users acknowledge, agree, and shall comply with all applicable terms, conditions, warnings, and restrictions in this document and are subject to the disclaimer and indemnity provisions included in this document.
2. Unless otherwise indicated, EVMs are not finished products and not intended for consumer use. EVMs are intended solely for use by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.
3. User agrees that EVMs shall not be used as, or incorporated into, all or any part of a finished product.
4. User agrees and acknowledges that certain EVMs may not be designed or manufactured by TI.
5. User must read the user's guide and all other documentation accompanying EVMs, including without limitation any warning or restriction notices, prior to handling and/or using EVMs. Such notices contain important safety information related to, for example, temperatures and voltages. For additional information on TI's environmental and/or safety programs, please visit www.ti.com/esh or contact TI.
6. User assumes all responsibility, obligation, and any corresponding liability for proper and safe handling and use of EVMs.
7. Should any EVM not meet the specifications indicated in the user's guide or other documentation accompanying such EVM, the EVM may be returned to TI within 30 days from the date of delivery for a full refund. THE FOREGOING LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY TI TO USER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. TI SHALL NOT BE LIABLE TO USER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES RELATED TO THE HANDLING OR USE OF ANY EVM.
8. No license is granted under any patent right or other intellectual property right of TI covering or relating to any machine, process, or combination in which EVMs might be or are used. TI currently deals with a variety of customers, and therefore TI's arrangement with the user is not exclusive. TI assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or services with respect to the handling or use of EVMs.
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
Copyright © 2014, Texas Instruments Incorporated

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>

【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】本開発キットは技術基準適合証明を受けておりません。本製品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

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。

日本テキサス・インスツルメンツ株式会社

東京都新宿区西新宿6丁目24番1号

西新宿三井ビル

<http://www.tij.co.jp>

Texas Instruments Japan Limited

(address) 24-1, Nishi-Shinjuku 6 chome, Shinjuku-ku, Tokyo, Japan

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

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.

Products

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
OMAP Applications Processors	www.ti.com/omap
Wireless Connectivity	www.ti.com/wirelessconnectivity

Applications

Automotive and Transportation	www.ti.com/automotive
Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Video and Imaging	www.ti.com/video

TI E2E Community

e2e.ti.com