

TPS2553Q1EVM (HVL125A) Precision Current Limiting Switch User Guide

The Texas Instruments TPS2553Q1EVM evaluation module (EVM) helps designers evaluate the operation and performance of the TPS2553-Q1. This user's guide describes the TPS2553Q1EVM evaluation module (EVM). This guide contains the EVM schematic, bill of materials (BoM), assembly drawing, and top and bottom board layouts.

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1 Introduction

The TPS2553Q1EVM is an evaluation module (EVM) for an automotive power-distribution switch with adjustable current-limiting outputs provided by Texas Instruments. The EVM has an operating voltage range of around 2.5 V to 6.5 V, and has four different output current limits, based on jumper placement on the board. The output current limits range from 100 mA to 1500 mA. There is also onboard functionality for manual setting of the enable pin or using a jumper solution for using the auto-retry feature of the device. The provided test points give the user access to multiple ground points and all critical node voltages.

The PCB top-side accepts a power distribution switch in a SOT23-6 package. This switch has an enable input, a fault output for overcurrent or reverse voltage conditions, and overtemperature shutdown.



Figure 1. TPS2553Q1EVM Board

1.1 Related Documentation

- TPS2553-Q1 Precision Adjustable Current-Limited Power-Distribution Switches datasheet, [SLVSBDO](#)

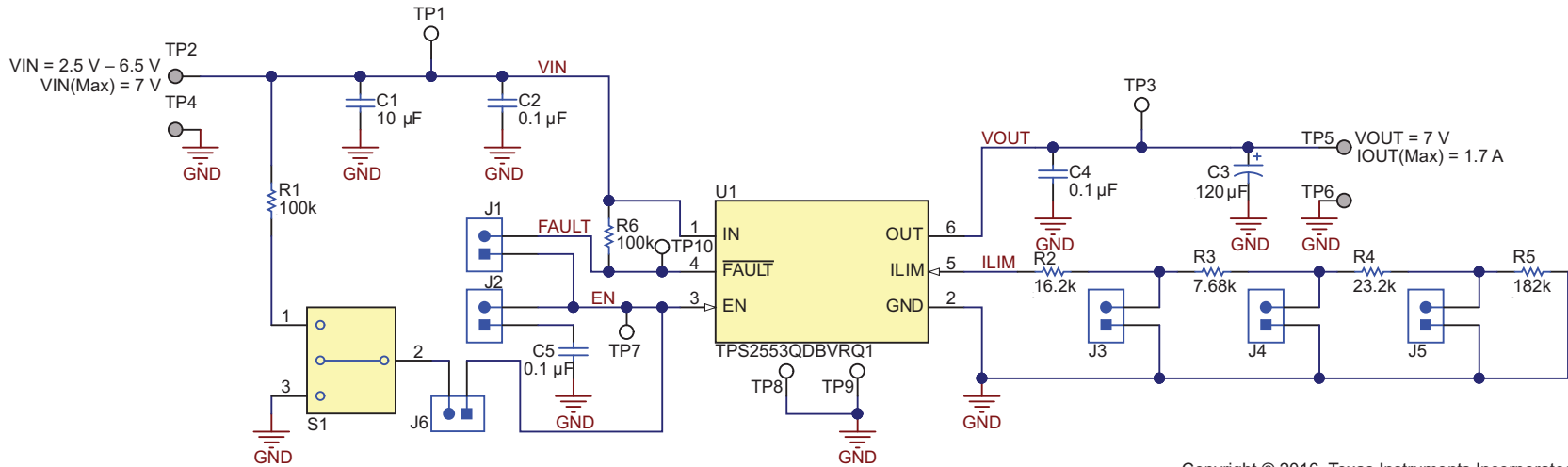
1.2 TPS2553-Q1 Applications

- Automotive ECU Supply Rail Power Distribution and Switching
- Precision Current Limiting
- USB Ports and Hubs

2 Schematic, Bill of Materials, and Layout

This section provides a detailed description of the TPS2553Q1EVM schematic, bill of materials (BOM), and layout.

2.1 Schematic



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Figure 2. TPS2553Q1EVM Schematic

2.2 Bill of Materials

Table 1. BOM

DESIGNATOR	QUANTITY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
!PCB1	1		Printed Circuit Board		MSA016	Any
C1	1	10µF	CAP, CERM, 10 µF, 10 V, ± 20%, X6S, AEC-Q200 Grade 2, 0603	0603	GRT188C81A106ME13D	MuRata
C2, C4, C5	3	0.1µF	CAP, CERM, 0.1 µF, 50 V, ± 10%, X7R, AEC-Q200 Grade 1, 0603	0603	CGA3E2X7R1H104K080AA	TDK
C3	1	120µF	CAP, TA, 120 µF, 20 V, ± 20%, 0.085 ohm, SMD	Case Code R	594D127X0020R2T	Vishay-Sprague
J1, J2, J3, J4, J5, J6	6		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions
R1, R6	2	100k	RES, 100 k, 1%, 0.1 W, 0603	0603	CRCW0603100KFKEA	Vishay-Dale
R2	1	16.2k	RES, 16.2 k, 1%, 0.1 W, 0603	0603	CRCW060316K2FKEA	Vishay-Dale

Table 1. BOM (continued)

DESIGNATOR	QUANTITY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
R3	1	7.68k	RES, 7.68 k, 1%, 0.1 W, 0603	0603	CRCW06037K68FKEA	Vishay-Dale
R4	1	23.2k	RES, 23.2 k, 1%, 0.1 W, 0603	0603	CRCW060323K2FKEA	Vishay-Dale
R5	1	182k	RES, 182 k, 1%, 0.1 W, 0603	0603	CRCW0603182KFKEA	Vishay-Dale
S1	1		Switch, Slide, SPDT, On-Off-On, 3 Pos, 0.05A, 48 V, TH	9.5x5mm	AS1E-2M-10-Z	Copal Electronics
SH-J1, SH-J2, SH-J3	3	1x2	Shunt, 100mil, Flash Gold, Black	Closed Top 100mil Shunt	SPC02SYAN	Sullins Connector Solutions
TP1, TP3, TP7, TP8, TP9, TP10	6		Test Point, Miniature, SMT	Testpoint_Keystone_Miniature	5015	Keystone
TP2, TP4, TP5, TP6	4		PCB Pin, Swage Mount, TH	PCB Pin(2505-2)	2505-2-00-44-00-00-07-0	Mill-Max
U1	1		PRECISION ADJUSTABLE CURRENT-LIMITED POWER-DISTRIBUTION SWITCHES, DBV0006A	DBV0006A	TPS2553QDBVRQ1	Texas Instruments
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A

2.3 Layout and Component Placement

Figure 3 and Figure 4 top and bottom overviews of the printed circuit board (PCB) show the component placement of the EVM.

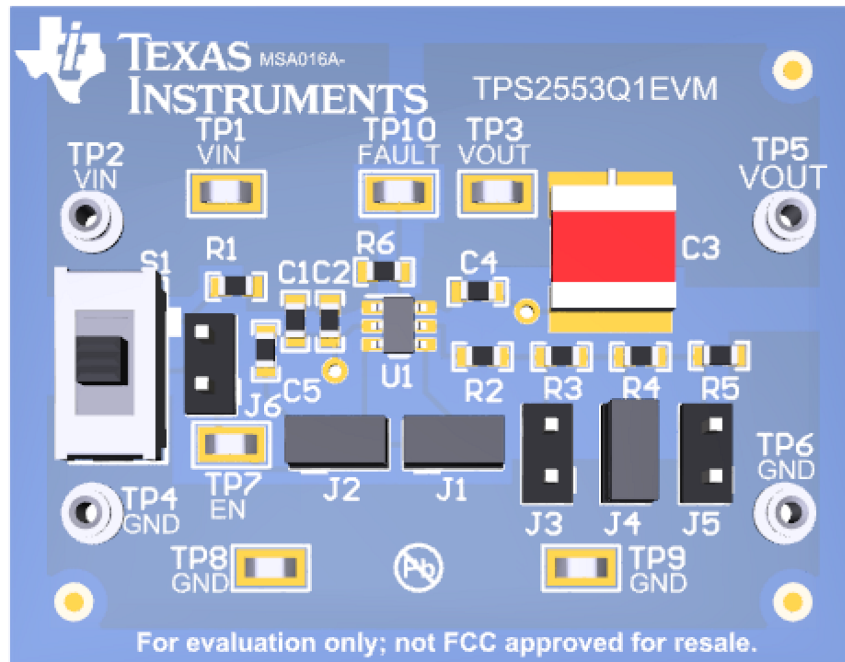


Figure 3. EVM Board Image for TPS2553Q1EVM (Top View)

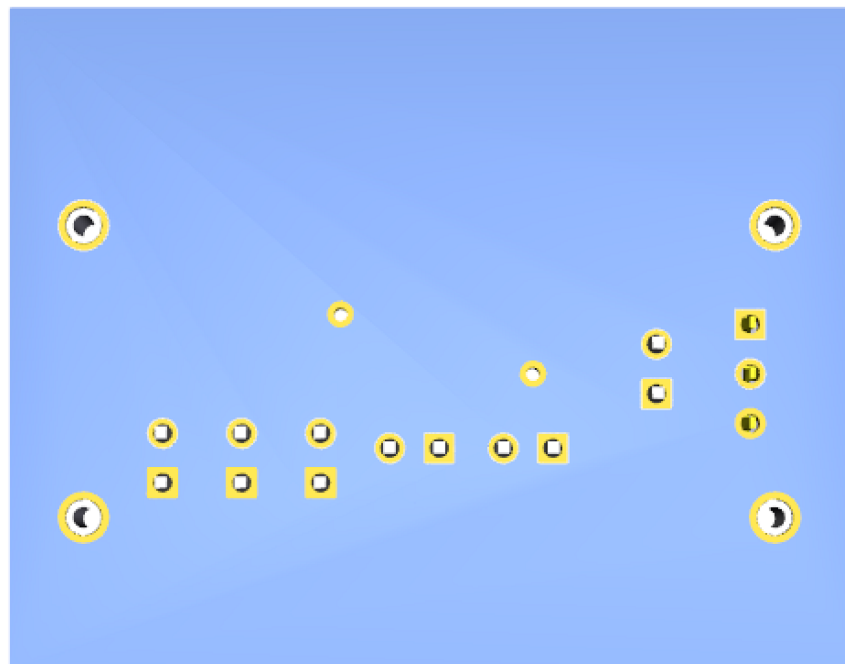


Figure 4. EVM Board Image for TPS2553Q1EVM (Bottom View)

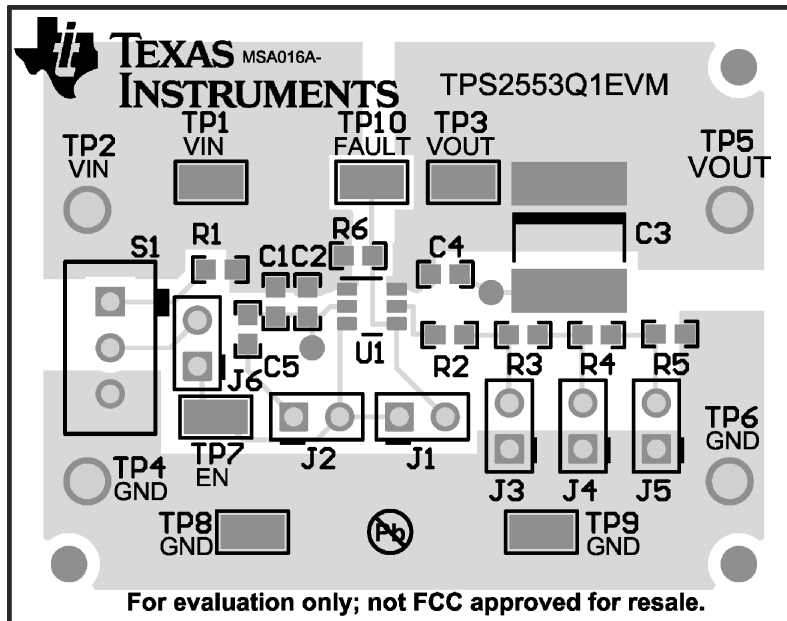


Figure 5. Layout—Top Composite

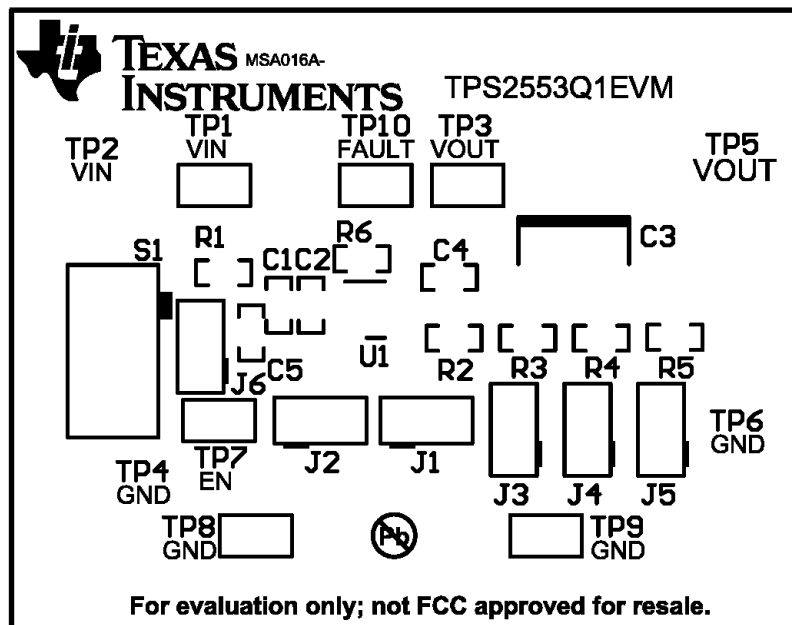


Figure 6. Top Overlay

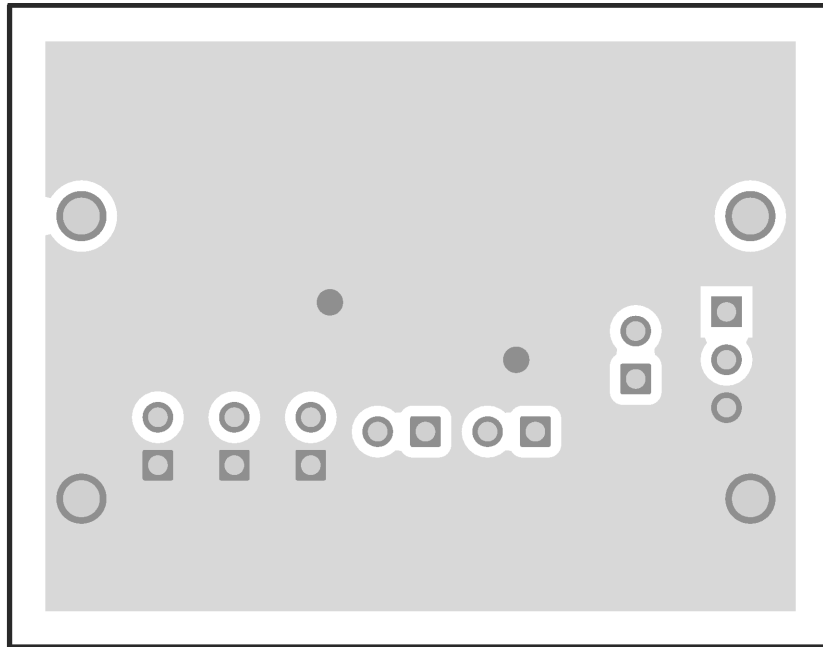


Figure 7. Layout—Bottom Composite

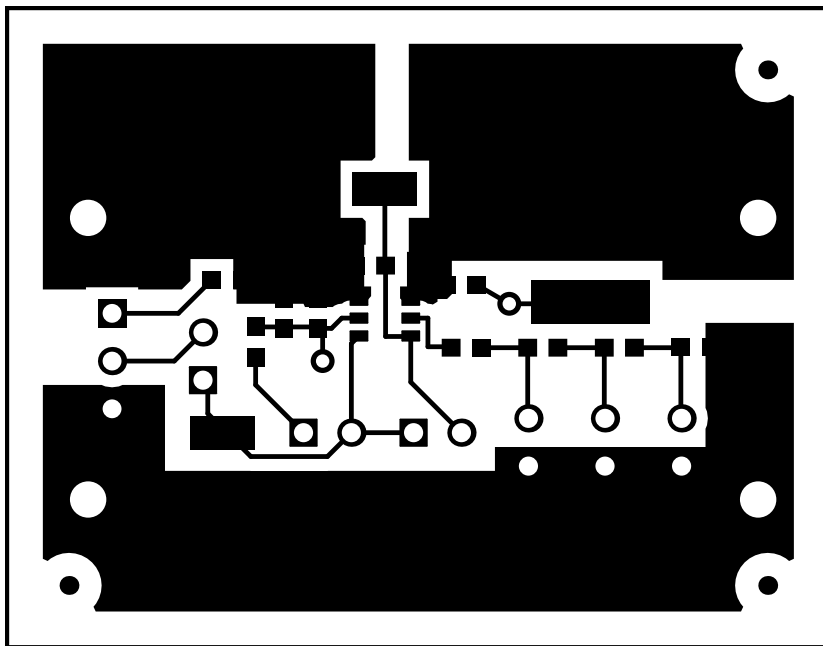


Figure 8. Top Layer

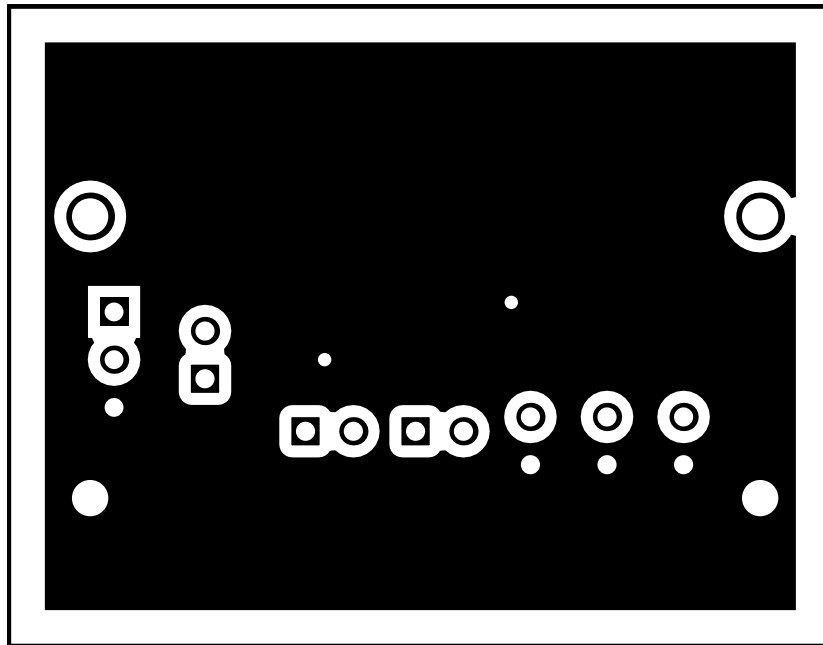


Figure 9. Bottom Layer

3 Setup and Operation

This section describes the connectors, jumpers, and test points on the EVM as well as how to connect, set up, and properly use the EVM. An example of the EVM operation is also included.

3.1 Connectors

There are several types of Input/Output (I/O) connections on the EVM including:

- Input/Output Turret Connections: For both positive and negative (GND) input and output supplies, banana-plug compatible
- Test Points: For the fault, enable, input, output, and ground connected pins
- Two-Pin Jumpers: For the feedback R_{lim} on the I_{lim} pin used for current limiting. In this way, four adjustable current limits are available via jumper
- Two-Pin Jumpers: For manual enable, or auto-retry functionality

Table 2 lists the test points and functional descriptions.

Table 2. Test Point Descriptions

TEST POINT NUMBER	TEST POINT SILKSCREEN LABEL	FUNCTION	DESCRIPTION
TP1	VIN	Voltage Monitoring and Probing	Input voltage monitoring
TP2	VIN	Voltage Input	Input voltage connection
TP3	VOUT	Voltage Monitoring and Probing	Output voltage monitoring
TP4	GND	GND	Input ground connection
TP5	VOUT	Voltage Output	Output voltage connection
TP6	GND	GND	Output ground connection
TP7	EN	Voltage Monitoring and Probing	Enable signal voltage monitoring
TP8	GND	Voltage Monitoring and Probing	Ground connection point
TP9	GND	Voltage Monitoring and Probing	Ground connection point
TP10	FAULT	Voltage Monitoring and Probing	Fault signal voltage monitoring

3.2 Jumper Settings and Configuration

The jumpers onboard the TPS2553Q1EVM may be put into two functional categories. The first set of jumpers may either manually set the enable signal to a logic high or low, or utilize the auto-retry functionality of the device. See the TPS2553-Q1 datasheet for additional information. The auto-retry time is dependant on the RC delay given by R6 and C5 on the EVM. Either J6 or J1 and J2 should be active to exercise these two modes of operation. Table 3 includes jumper settings for auto-retry mode along with the wait time in between tries.

Table 3. Manual Enable or Auto-Retry Jumpers

DEVICE MODE	JUMPERS	AUTO RETRY TIME (ms)
Auto-Retry	J1 AND J2	10
Manual Enable	J6	

A more detailed overview of the current limiting options on the EVM is given in Table 4. The EVM is designed with feedback resistance such that the minimum current limit satisfies the listed applications and current values in the table. The actual output current values may be slightly higher. To achieve current limits in Table 4, use only one jumper at a time on jumpers J3, J4, and J5.

Table 4. Current Limiting Jumpers

POWER REQUIREMENT	JUMPER	I_{OSmin} (mA)	R_{ILIM} (k Ω)
1 Low-Power USB device	Remove all jumpers	100	229.08
1 High-Power USB device	J5	500	47.08
2 High-Power USB devices	J4	1000	23.88
3 High-Power USB devices	J3	1500	16.2

Table 5 includes abridged EVM electrical characteristics. For a full functional description of the TPS 2553-Q1 device, refer to the TPS2553-Q1 datasheet.

Table 5. EVM Electrical Characteristics

PARAMETER	CONDITION	MIN	TYP	MAX	UNIT
Input Voltage, V_{IN}	TP2	2.5		6.5	V
Output Current, I_{OUT}	TP5			1.7	A
Continuous FAULT Sink Current	J1 AND J2, or J6			10	mA

3.3 EVM Setup

The EVM setup section details what test equipment the user needs to use the EVM and how to properly setup the EVM environment.

3.3.1 Recommended Test Equipment

The following is the recommended test equipment:

- Two-channel storage oscilloscope
- Current probe
- Voltage probe
- Adjustable DC-power supply with at least 2.5-V to 6.5-V output and a 10-A current limit
- Digital Multimeter or Volt-Ohm meter
- Passive or active load capable of handling up to 3 A

3.4 Basic Operation

3.4.1 Measuring Turnon and Turnoff Delays and Rise and Fall Times

Users should read the TPS2553-Q1 Datasheet before using the EVM. Figure 10 shows the recommended test setup for measuring the delay and rise and fall times. In Figure 10, the jumpers shown on the EVM diagram are the ones that must be connected to ensure correct operation. Test points for voltage probing are also highlighted in the figure. It is recommended to use at least a 5-W power resistor in this setup, because of the high current output.

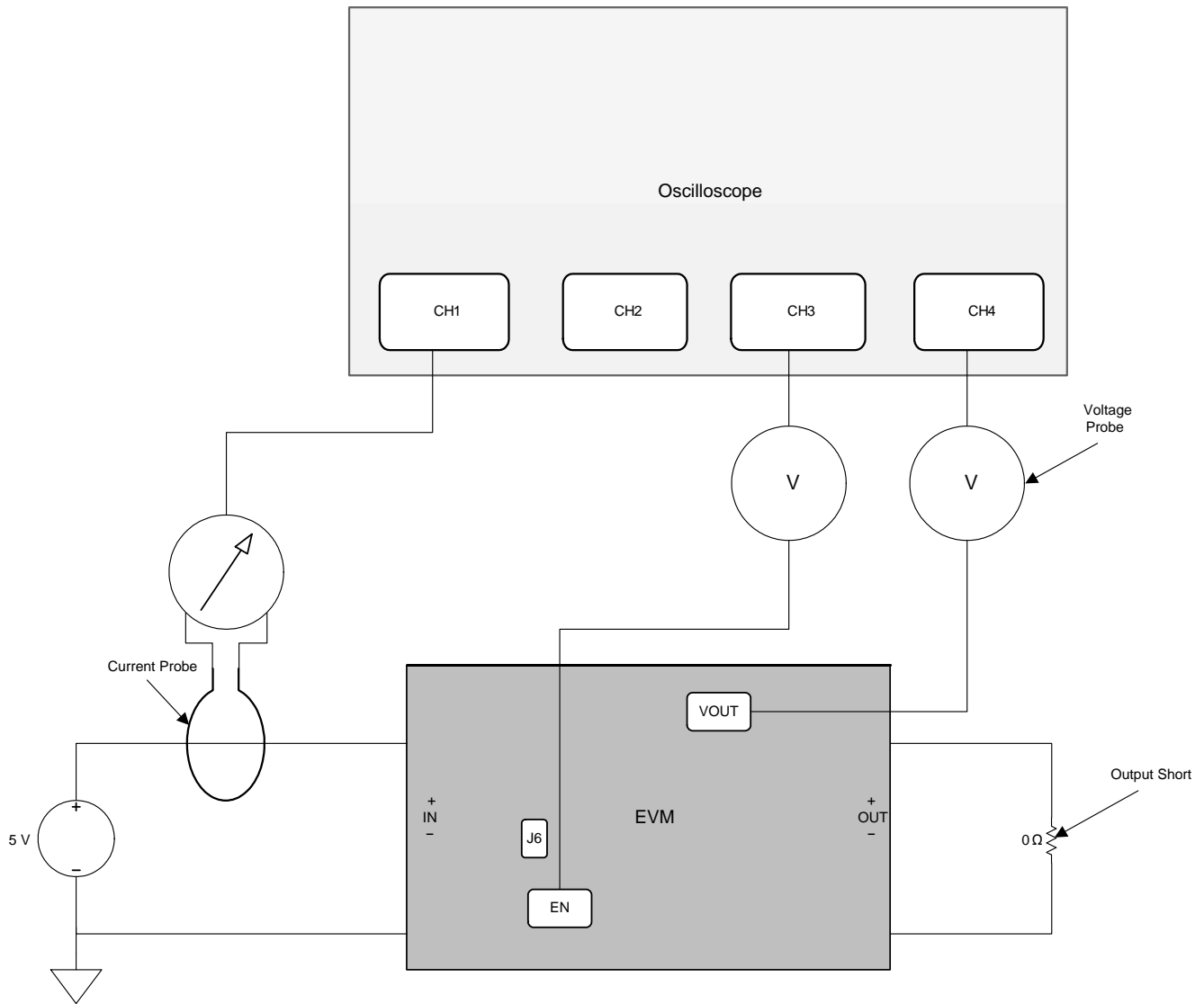
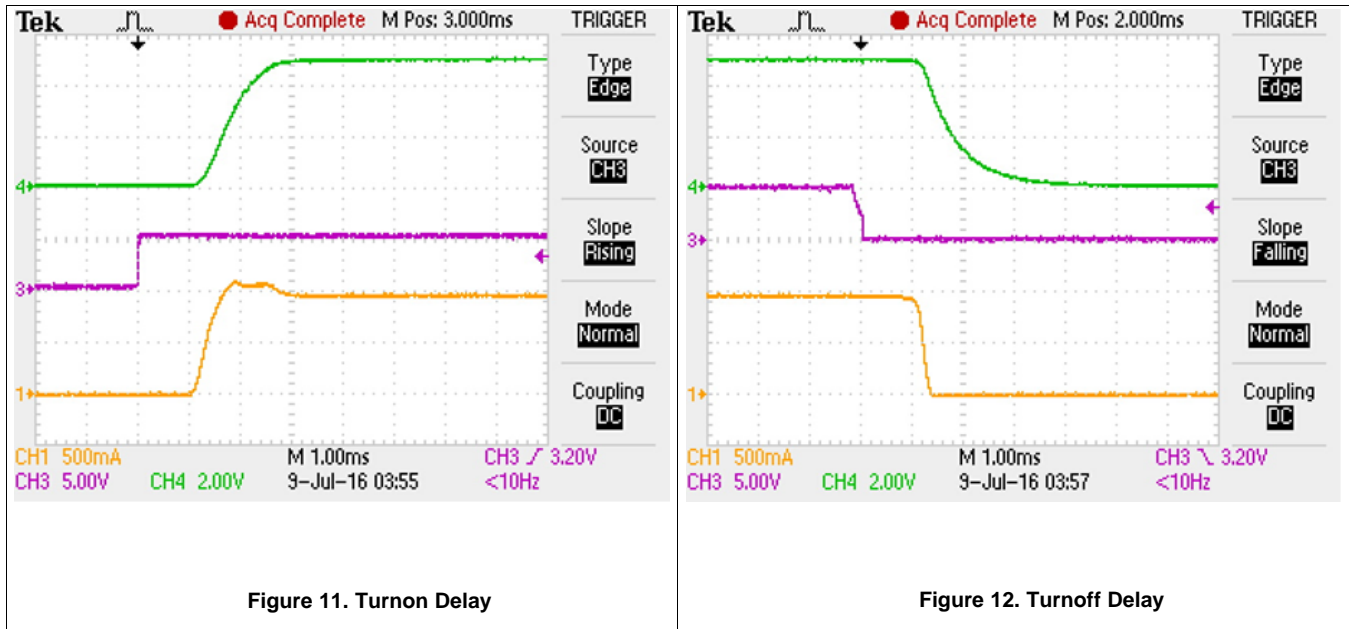


Figure 10. Test Setup for Turnon and Turnoff Delay

Figure 11 shows the turnon delay of the switch into a 5-ohm load. The enable is triggered by flipping the onboard switch to the low position. Figure 12 shows the turnoff delay of the switch with the same 5-ohm load. Returning the enable switch to its original position achieves turnoff.



3.4.2 Measuring Short-Circuit Output-Current Limit

Figure 13 shows the recommended test setup for measuring the short-circuit output-current limit. Add an external switch to control when the short circuit branch is active. This allows the user to exercise the device in full load to short circuit scenarios. The enable switch should be pulled low and apply the J6 jumper for this test setup. Changing the R_{LIM} jumpers in this setup allows the user to adjust the output short-circuit current.

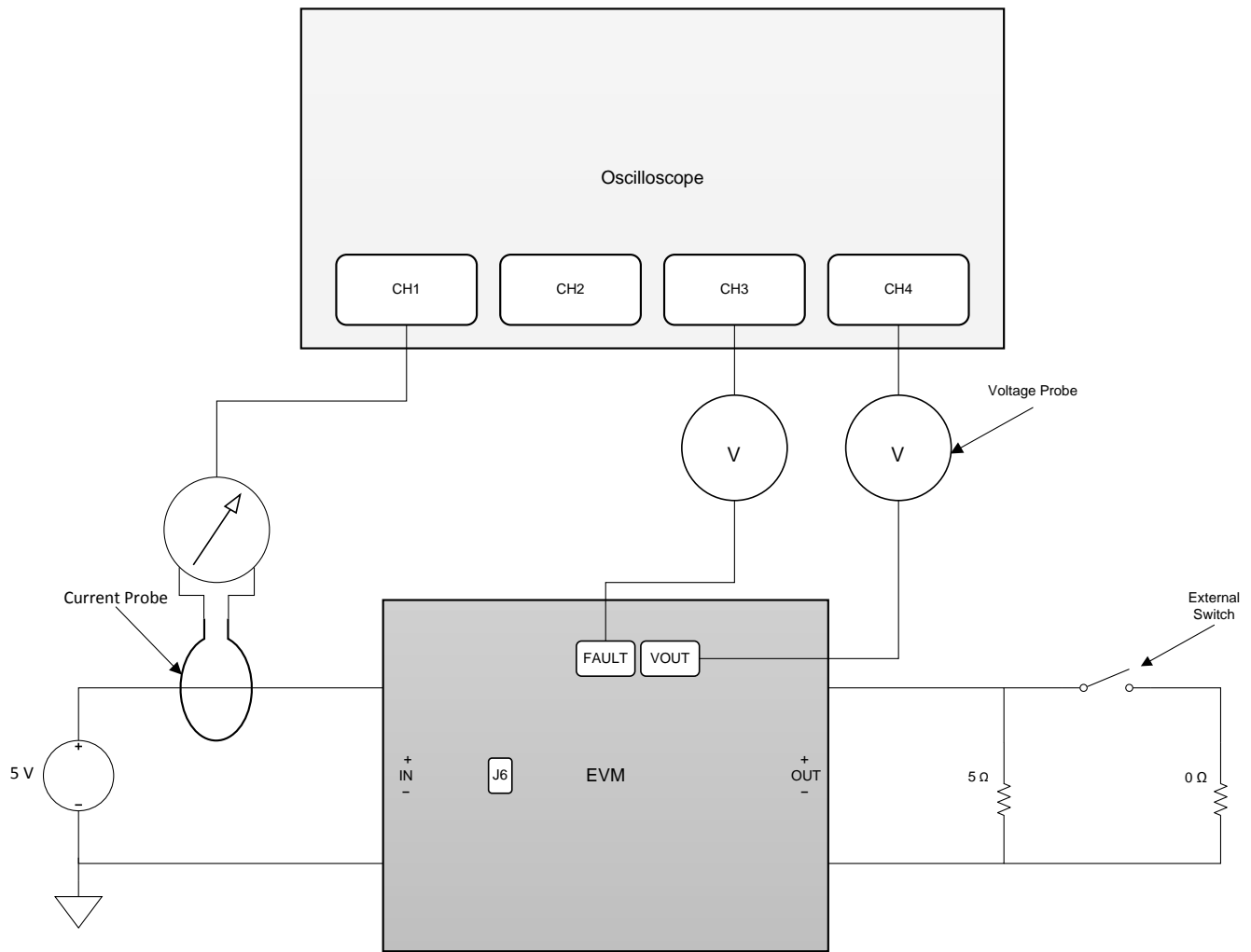
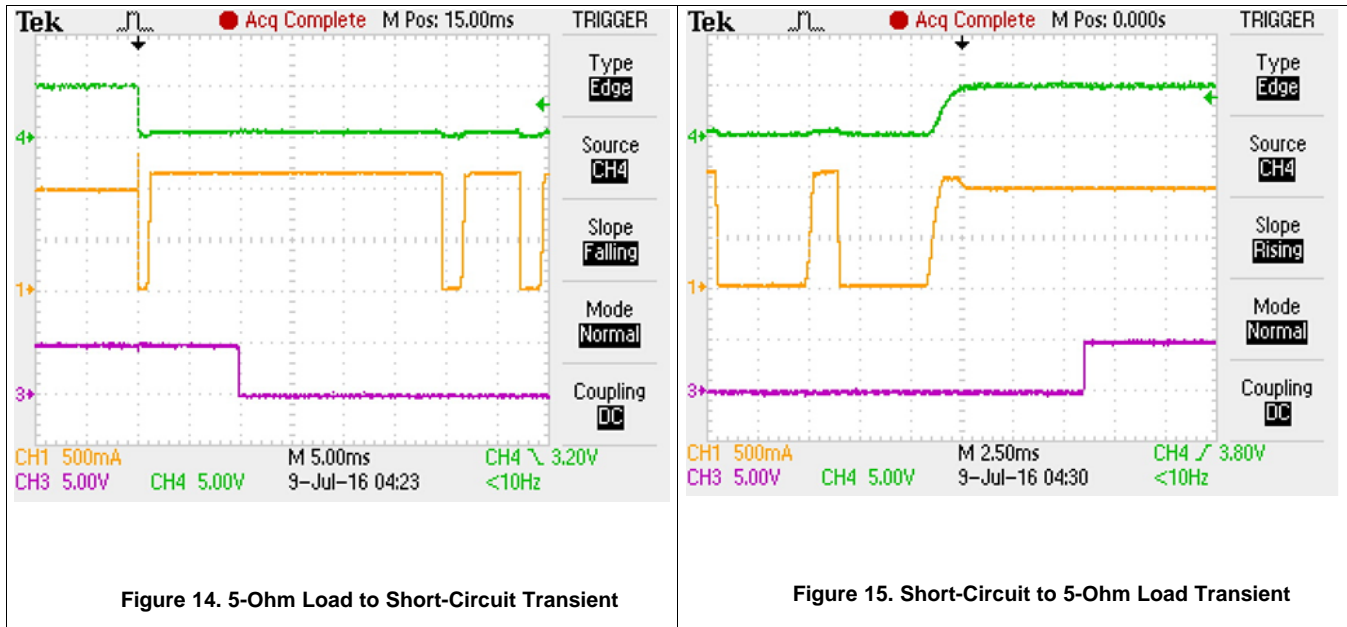


Figure 13. Test Setup for Short-Circuit Output Current-Limit

Figure 14 shows the load transient where the resistance of the load changes from 5 ohms to 0 ohms (output short-circuit). After the fault pin is asserted low, the device begins to thermal cycle. Figure 15 shows the device recovering when the 5-ohm load is reapplied. The device exits the thermal cycling stage and returns to a current of around 1 A.



3.4.3 Using Auto-Retry Functionality

Figure 16 shows the recommended test setup for using and measuring the auto-retry functionality of the TPS2553Q1 device. The J6 jumper must be removed and the J1 and J2 jumpers must be applied for this test. The J1 and J2 jumpers are shown in Figure 16 for clarity. Note that the device must be constantly shorted for auto-retry operation to be viewed.

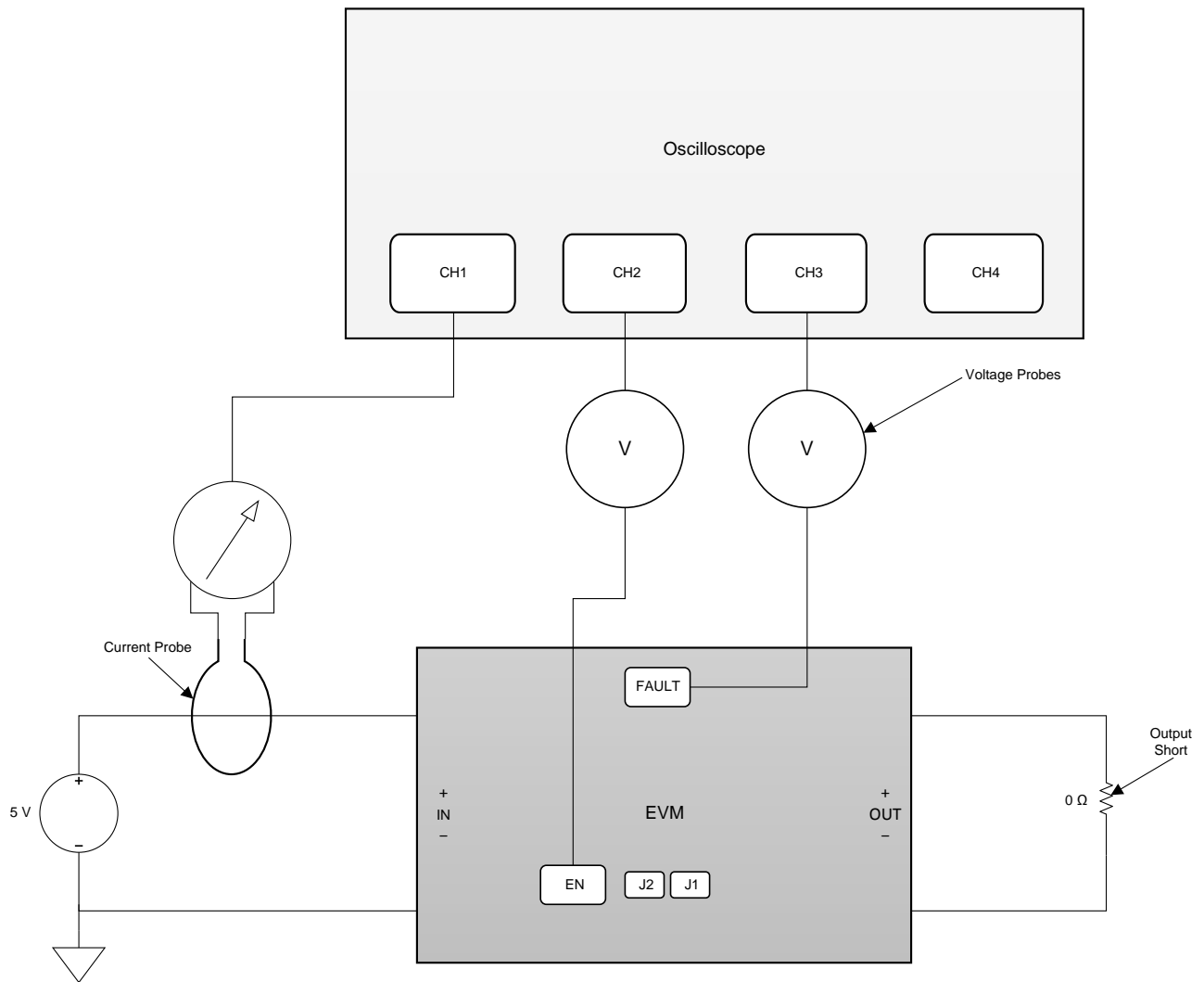
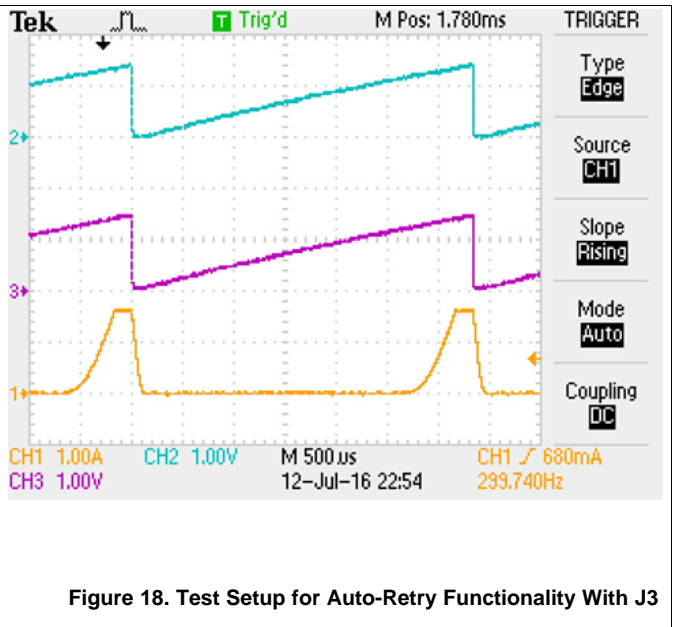
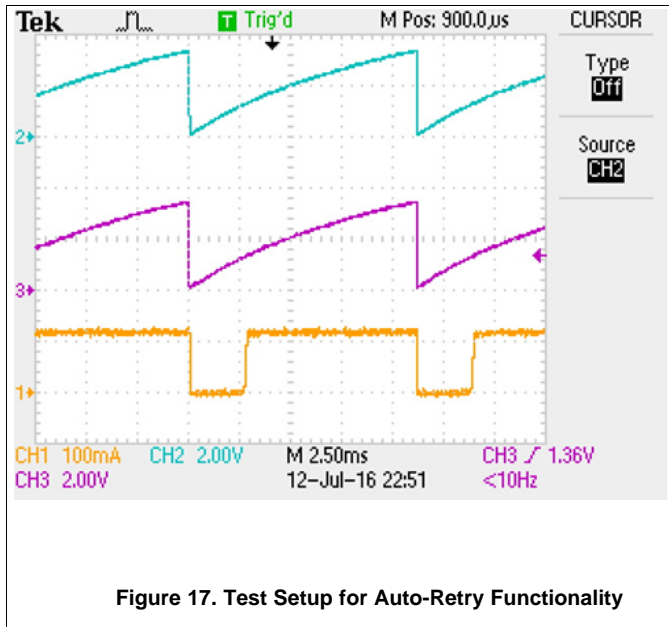


Figure 16. Test Setup for Auto-Retry Functionality

Figure 17 shows the device in auto-retry mode with no current limiting jumpers applied (very high R_{ILIM} value). The retry time is around 11.1 ms for this setup. Figure 18 shows the device in auto-retry mode with J3 asserted on the TPS2553Q1EVM. The retry time is around 3.7 ms for this setup. Note that the device in Figure 18 is in auto-retry mode, as well as performing thermal cycling because of the overcurrent level present.



Revision History

DATE	REVISION	NOTES
October 2016	*	Initial release

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3. *Regulatory Notices:*
 - 3.1 *United States*
 - 3.1.1 *Notice applicable to EVMs not FCC-Approved:*

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

CAUTION

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

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

FCC Interference Statement for Class A EVM devices

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

FCC Interference Statement for Class B EVM devices

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

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

3.2 Canada

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

Concerning EVMs Including Radio Transmitters:

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

Concernant les EVMs avec appareils radio:

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

Concerning EVMs Including Detachable Antennas:

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

Concernant les EVMs avec antennes détachables

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

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

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

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

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

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4 *EVM Use Restrictions and Warnings:*

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

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

4.3 *Safety-Related Warnings and Restrictions:*

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