User's Guide TPS389006Q1EVM Multichannel Voltage Supervisor with I²C User Guide

TEXAS INSTRUMENTS

ABSTRACT

This user guide describes the operational use of the TPS389006Q1EVM evaluation module (EVM) as a reference design for engineering demonstration and evaluation of the TPS389006-Q1 Multichannel Overvoltage and Undervoltage I²C Programmable Voltage Supervisor and Monitor. This guide contains the EVM schematic, bill of materials (BOM), assembly drawing, and top and bottom board layouts.

Table of Contents

1 Introduction	
1.1 Related Documentation	4
1.2 TPS389006-Q1 Applications	4
2 Schematic, Bill of Materials, and Layout	5
2.1 TPS389006Q1EVM Schematic	6
2.2 TPS389006Q1EVM Bill of Materials	8
2.3 Lavout and Component Placement	
2.4 Layout	11
3 EVM Connectors	
3.1 EVM Test Points	13
3.2 EVM Jumpers	14
4 EVM Setup and Operation	15
4.1 Setup and GUI Installations	16
4.2 Quick Start to TPS389006Q1EVM GUI	20
4.3 Example Operation of TPS389xxx-Q1	25
5 Revision History	26

List of Figures

Figure 1-1. TPS389006Q1EVM Board Top	3
Figure 1-2. TPS389006Q1EVM Board Bottom	4
Figure 2-1. TPS389006Q1EVM Main Schematic	6
Figure 2-2. TPS389006Q1EVM I ² C Schematic with Buffers	7
Figure 2-3. Component Placement—Top Assembly	. 11
Figure 2-4. Component Placement—Bottom Assembly	11
Figure 2-5. Layout—Top	11
Figure 2-6. Layout—Bottom	.11
Figure 2-7. Top Layer	.12
Figure 2-8. Bottom Layer	. 12
Figure 2-9. Top Solder Mask	
Figure 2-10. Bottom Solder Mask	. 12
Figure 3-1. TPS389006Q1EVM Jumper Locations	. 14
Figure 4-1. TPS389006Q1EVM Connection Description	
Figure 4-2. Setup License Agreement Window	. 17
Figure 4-3. Setup Destination Window	. 17
Figure 4-4. Setup Window - Start Menu Selection	.18
Figure 4-5. Setup Window - Additional Tasks	
Figure 4-6. Setup Installation Window	. 19
Figure 4-7. Installation Complete Window	. 19
Figure 4-8. Fusion Welcome Window	.20
Figure 4-9. Fusion Scan Window	.21
Figure 4-10. Fusion Scan Selection Window	.21

1



Figure 4-11. Fusion Scan Window - Scanning for TPS389006Q1EVM	22
Figure 4-12. Fusion Scan Window - Scan for TPS389006Q1EVM Completed	
Figure 4-13. Fusion Digital Power Device GUI - TPS389006Q1EVM (screenshot #1)	
Figure 4-14. Fusion Digital Power Device GUI - TPS389006Q1EVM (screenshot #2)	
Figure 4-15. Fusion Digital Power Device GUI - TPS389006Q1EVM (screenshot #3)	
Figure 4-16. TPS389006Q1EVM Monitoring Four (4) Voltage Supply Rails	
Figure 4-17. TPS389006Q1EVM GUI Setup for Monitoring Four (4) Voltage Supply Rails	

List of Tables

Table 2-1. BOM	8
Table 3-1. Test Points	. 13
Table 3-2. List of On-board Jumpers	. 14

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1 Introduction

The TPS389006Q1EVM is an evaluation module (EVM) for the TPS389006-Q1 Multichannel Overvoltage and Undervoltage I²C Programmable Voltage Supervisor and Monitor. Test points are provided to give the user additional access, if needed, for oscilloscope or multi-meter measurements.

The TPS389006Q1EVM comes pre-populated with TPS38900603NRTERQ1. This IC variant is configured for six integrated multichannel window inputs to monitor six distinct input voltage rails with two remote sense pins. The device also includes internal glitch immunity and noise filters to eliminate false resets resulting from erroneous signals. The TPS389006-Q1 device does not require any external resistors for setting overvoltage and undervoltage reset thresholds which optimizes and improves the reliability for safety systems.

I²C functionality gives flexibility in selecting thresholds, reset delays, glitch filters, and pin functionality. This device offers CRC error checking, sequence logging during turn ON or turn OFF, and a built-in ADC for voltage readouts to provide redundant error checking. In addition, TPS389006-Q1 offers a sync feature for tagging rails as they come up. Rail tagging works across multiple instances of TPS389006-Q1 devices. If users need a different TPS389006-Q1 variant, the existing device must be removed from the board. The EVM board is designed to support all possible options by changing jumper configurations and is capable of daisy-chaining, via 10-pin ribbon, up to three evaluation boards.



Figure 1-1. TPS389006Q1EVM Board Top

3



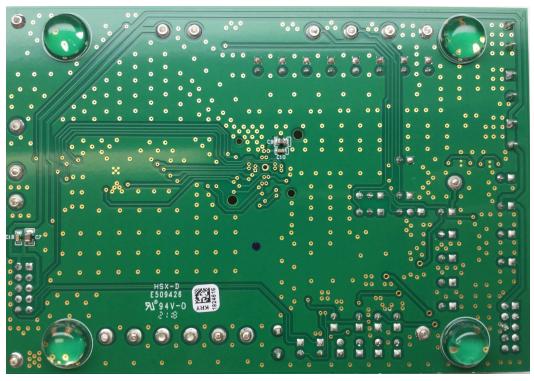


Figure 1-2. TPS389006Q1EVM Board Bottom

1.1 Related Documentation

Datasheet: TPS389006-Q1 Multichannel Overvoltage and Undervoltage I²C Programmable Voltage Supervisor and Monitor

1.2 TPS389006-Q1 Applications

- Advanced Driver Assistance System (ADAS)
- Sensor fusion
- Medical robotics
- Industrial robotics



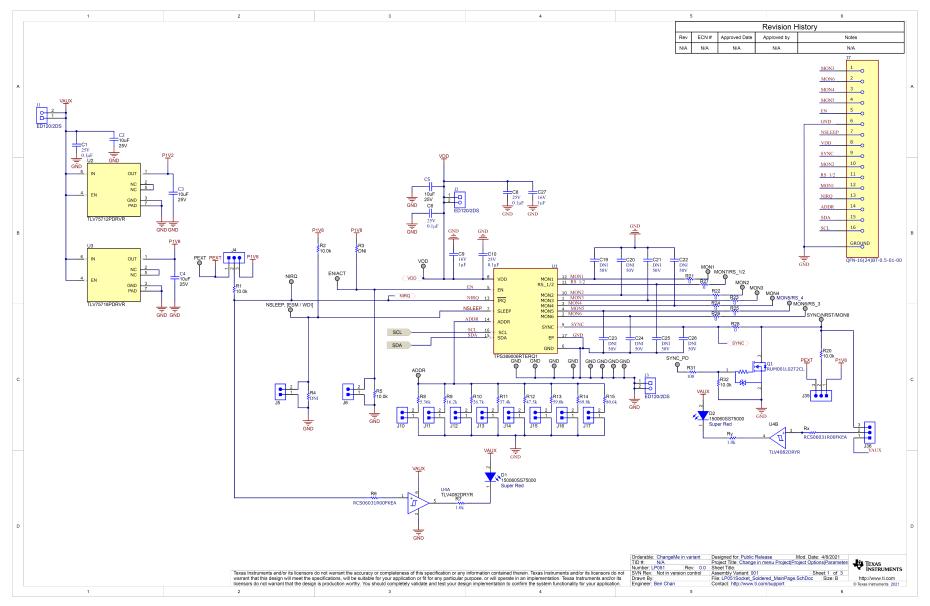
2 Schematic, Bill of Materials, and Layout

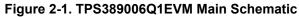
This section provides a detailed description of the TPS389006Q1EVM schematic, bill of materials (BOM), and layout.

5



2.1 TPS389006Q1EVM Schematic







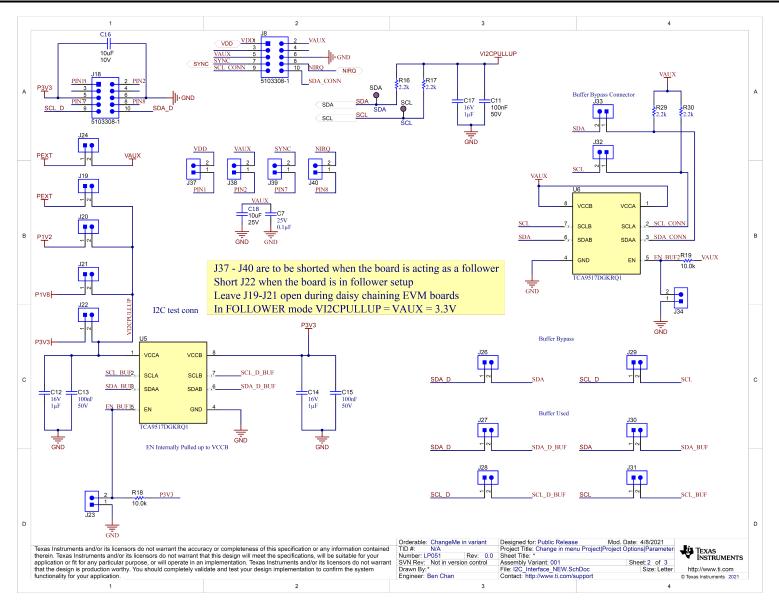


Figure 2-2. TPS389006Q1EVM I²C Schematic with Buffers



2.2 TPS389006Q1EVM Bill of Materials

Table 2-1. BOM						
DESIGNATOR	QTY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
РСВ	1	LP051	Printed Circuit Board		TPS389006Q1EVM	Any
C1, C6, C7, C8, C10	5	0.1 µF	CAP, CERM, 0.1 μF, 25 V, +/- 10%, X5R, 0603	0603	CL10A104KA8NNNC	Samsung Electro- Mechanics
C2, C3, C4, C5, C18	5	10 µF	10 µF ±10% 25 V Ceramic Capacitor X7S 0805 (2012 Metric)	0805	C2012X7S1E106K125AC	TDK
C9, C12, C14, C17, C27	5	1 µF	CAP, CERM, 1 μF, 16 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0805	0805	C0805C105K4RACAUTO	Kemet
C11	1	0.1 µF	CAP, CERM, 0.1 μF, 50 V, +/- 10%, X7R, 0603	0603	06035C104KAT2A	AVX
C13, C15, C19(DNI), C20(DNI), C21(DNI), C22(DNI), C23(DNI), C24(DNI), C25(DNI), C26(DNI)	2	0.1 µF	CAP, CERM, 0.1 µF, 50 V, +/- 10%, X7R, 0805 (C19 - C26 DO NOT POPULATE)	0805	C0805C104K5RACTU	Kemet
C16	1	10 µF	10 μF ±10% 10 V Ceramic Capacitor X5R 0603 (1608 Metric)	0603	C1608X5R1A106K080AC	TDK
D1, D2	2	Super Red	LED, Super Red, SMD	LED_0603	150060SS75000	Wurth Elektronik
EN/ACT, MON1, MON2, MON3, MON4, MON5/ RS_4, MON6/ RS_3, MON7, NIRQ, NSLEEP/, SYNC/NRST/ MON8, SYNC_PD, TP6a, TP6b, TP6c, TP6d, TP_ADDR, TP_EXT, VDD	19	Turret	Terminal, Turret, TH, Triple	Keystone 1598-2	1598-2	Keystone
GND1, GND2, GND3, GND4	4	Test Point (SMD)	Test Point, Miniature, SMT	Miniature, SMT	5019	Keystone
H1, H2, H3, H4	4	Bumpon Pad	Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon	SJ-5303 (CLEAR)	3M
J1, J2, J3	3	Terminal Block	Terminal Block, 5.08 mm, 2x1, Brass, TH	2x1 5.08 mm Terminal Block	ED120/2DS	On-Shore Technology
J4, J35, J36	3	Header	Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec
J5, J6, J10, J11, J12, J13, J14, J15, J16, J17, J19, J20, J21, J22, J23, J24, J26, J27, J28, J29, J30, J31, J32, J33, J34, J37, J38, J39, J40	29	Header	Header, 100mil, 2x1, Gold, TH	2x1 Header	TSW-102-07-G-S	Samtec
J7	1	Socket	QFN CLAMSHELL 16 PIN RTE THRU HOLE WITH CENTER GND	16-Pin Socket	QFN-16(24)BT-0.5-01	Enplas
J8, J18	2	Shrouded Header	Header (shrouded), 100mil, 5x2, Gold, TH	5x2 Shrouded header	5103308-1	TE Connectivity

8



Table 2-1. BOM (continued)						
DESIGNATOR	QTY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
Q1	1	MOSFET	MOSFET N-CH 20 V, 0.1 A, VMT3	SOT723	RUM001L02T2CL	ROHM Semiconductor
R1, R18, R19, R32	4	10 kΩ	RES, 10.0 kΩ, 1%, 0.1 W, 0603	0603	RC0603FR-0710KL	Yageo
R2, R5, R20	3	10 kΩ	RES, 10.0 kΩ, 1%, 0.1 W, 0603	0603	RCG060310K0FKEA	Vishay Draloric
R3(DNI)	0	10 kΩ	RES, DNP, 1%, 0.1 W, 0603 (DO NOT POPULATE)	0603	RCG060310K0FKEA	Vishay Draloric
R4(DNI)	0	21 kΩ	RES, DNP, 1%, 0.1 W, 0603 (DO NOT POPULATE)	0603	RC0603FR-0721KL	Yageo
R6, Rx	2	1Ω	1 Ohms ±1% 0.25 W, ¼ W Chip Resistor 0603 (1608 Metric) Automotive AEC-Q200, Pulse Withstanding Thick Film	0603	RCS06031R00FKEA	Vishay
R7, Ry	2	1 kΩ	RES, 1.0 kΩ, 5%, 0.125 W, AEC- Q200 Grade 0, 0805	0805	ERJ-6GEYJ102V	Panasonic
R8	1	5.36 kΩ	RES, 5.36 k, 1%, 0.125 W, AEC- Q200 Grade 0, 0805	0805	ERJ-6ENF5361V	Panasonic
R9	1	16.2 kΩ	RES, 16.2 kΩ, 1%, 0.125 W, AEC- Q200 Grade 0, 0805	0805	ERJ-6ENF1622V	Panasonic
R10	1	26.7 kΩ	RES, 26.7 kΩ, 1%, 0.125 W, AEC- Q200 Grade 0, 0805	0805	ERJ-6ENF2672V	Panasonic
R11	1	37.4 kΩ	RES, 37.4 kΩ, 1%, 0.125 W, AEC- Q200 Grade 0, 0805	0805	ERJ-6ENF3742V	Panasonic
R12	1	47.5 kΩ	RES, 47.5 kΩ, 1%, 0.125 W, AEC- Q200 Grade 0, 0805	0805	ERJ-6ENF4752V	Panasonic
R13	1	59 kΩ	RES, 59 kΩ, 1%, 0.125 W, AEC- Q200 Grade 0, 0805	0805	ERJ-6ENF5902V	Panasonic
R14	1	69.8 kΩ	RES, 69.8 kΩ, 1%, 0.125 W, AEC- Q200 Grade 0, 0805	0805	ERJ-6ENF6982V	Panasonic
R15	1	80.6 kΩ	RES, 80.6 kΩ, 1%, 0.125 W, AEC- Q200 Grade 0, 0805	0805	ERJ-6ENF8062V	Panasonic
R16, R17, R29, R30	4	2.2 kΩ	RES, 2.2 kΩ, 5%, 0.1 W, 0603	0603	RC0603JR-072K2L	Yageo
R21, R22, R23, R24, R25, R26, R27, R28	8	0 Ω	RES, 0 Ω, 5%, 0.125 W, 0805	0805	RC0805JR-070RL	Yageo
R31	1	100 Ω	RES, 100 Ω, 5%, 0.125 W, AEC- Q200 Grade 0, 0805	0805	ERJ-6GEYJ101V	Panasonic
SCL, SDA	2	Test Points	Test Point, Multipurpose, Purple, TH	Purple Multipurpose Testpoint	5129	Keystone
U1	0	IC	ASIL-D Multichannel Overvoltage and Undervoltage I2C Programmable Voltage Supervisor and Monitor	WQFN16	TPS38900603NRTERQ1	TI
U2	1	IC	1 A Low-Quiescent-Current Low- Dropout (LDO) Regulator, 1.2 V, DRV0006A (WSON-6)	WSON-6	TLV75712PDRVR	TI
U3	1	IC	1 A Low-Quiescent-Current Low- Dropout (LDO) Regulator, 1.8 V,DRV0006A (WSON-6)	WSON-6	TLV75718PDRVR	TI
U4	1	IC	Dual-Channel, Low-Power Comparator with Integrated Reference	SON6	TLV4082DRYR	TI
U5, U6	2	IC	Automotive, Level-Shifting I ² C Bus Repeater, DGK0008A (VSSOP-8)	VSSOP-8 (DGK0008A)	TCA9517DGKRQ1	ТІ

9



Table 2-1. BOM (continued)

DESIGNATOR	QTY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
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 2-3 and Figure 2-4 show the top and bottom assemblies of the printed circuit board (PCB) to show the component placement on the EVM.

Figure 2-5 and Figure 2-6 show the top and bottom layouts, Figure 2-7 and Figure 2-8 show the top and bottom layers, and Figure 2-9 and Figure 2-10 shows the top and bottom solder masks of the EVM.

2.4 Layout

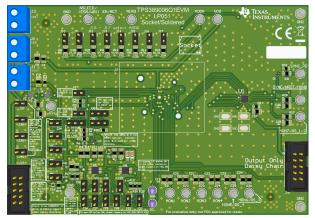


Figure 2-3. Component Placement—Top Assembly

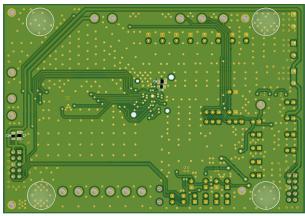


Figure 2-4. Component Placement—Bottom Assembly

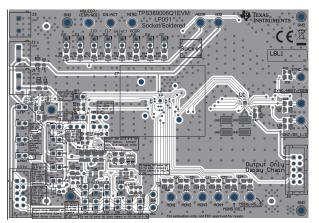


Figure 2-5. Layout-Top

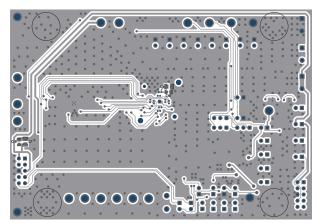
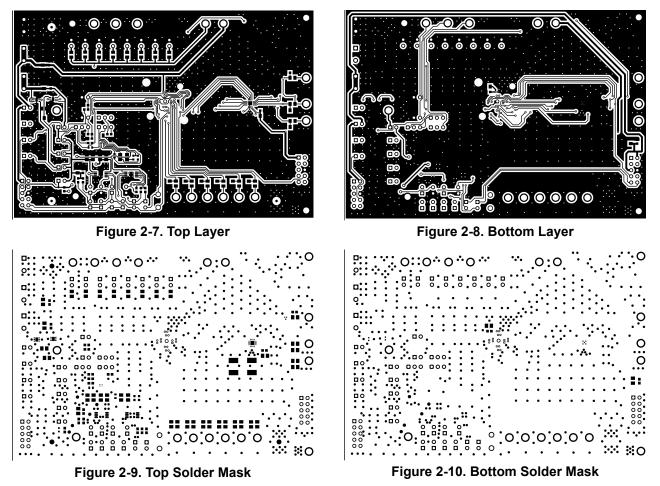


Figure 2-6. Layout—Bottom







3 EVM Connectors

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. Each device has an independent supply connection, but all grounds are connected on the board.

3.1 EVM Test Points

Table 3-1 lists the EVM test points as well as their functional descriptions. All TPS389006-Q1 pins have a corresponding test point on the EVM. These test points are located close to the pins for more accurate measurements. In addition to the test points listed below, the EVM also has four additional GND test points.

TEST POINT SILKSCREEN LABEL	FUNCTION	DESCRIPTION	
MON1	Connection to MON1 pin	Allows the user to monitor voltage rail #1	
MON2	Connection to MON2 pin	Allows the user to monitor voltage rail #2	
MON3	Connection to MON3 pin	Allows the user to monitor voltage rail #3	
MON4	Connection to MON4 pin	Allows the user to monitor voltage rail #4	
MON5/RS_4	Connection to MON5 pin	Allows the user to monitor voltage rail #5	
MON6/RS_3	Connection to MON6 pin	Allows the user to monitor voltage rail #6	
MON7/RS_1/2	Connection to RS_1/2 pin	Allows the user to remote sense MON1 or MON2	
SYNC/NRST/MON8	Connection to SYNC pin	SYNC pin indicates the number of monitored rails that have exited fault status and assigns tag values to each monitor voltage rail	
SYNC_PD	Connection to SYNC_PD	Forcing the SYNC pin to toggle during test and increments an internal tag counter for each of the monitored channel (for debug purposes only)	
ADDR	Connection to ADDR pin	Allows the user to measure the I ² C address voltage	
NIRQ	Connection to NIRQ pin	Allows the user to monitor the interrupt (NIRQ) output	
EN/ACT	Connection to ACT pin	Allows the user to set the ACT input to VDD or GND	
SLEEP/ESM/WDI	Connection to SLEEP pin	Allows the user to set SLEEP input	
SCL	Connection to SCL pin	Allows the user to monitor the clock signal input	
SDA	Connection to SDA pin	Allows the user to monitor the data signal input	
PEXT	External power supply	Allows the user to apply a power supply voltage that is not provided from the EVM	
GND	GND for EVM	GND for EVM	

Table 3-1. Test Points



3.2 EVM Jumpers

Table 3-2 lists the jumpers on the TPS389006Q1EVM. As ordered, the EVM will have thirty-five (35) jumpers installed. Figure 3-1 is provided as visual aid.

JUMPER	JUMPER CONFIGUATION	DESCRIPTION
J1	VAUX	For connecting VAUX power to the EVM
J2	VDD	For connecting VDD power to the EVM
J3	GND	For connecting GND to the EVM
J4	Shunted (default) Pin 2 to Pin 3	For connecting ACT, NIRQ, and SLEEP to P1V8 or PEXT (Any external power)
J5 and J6	Open	For manually pulling down SLEEP and ACT pins to GND
J10, J11, J12, J13, J14, J15, J16, and J17	J15 shunted	Shunting any one of J10-J17 jumpers will select the I 2 C address for TPS389006-Q1 IC on the EVM
J19, J20, and J21	Open	For connecting to the on-board I^2C buffer and pull-up voltage rail to either P1V8, PEXT or P1V2. Only shunt one of these jumpers at a time. Please remove the shunt of J22 when using one of these jumpers.
J22	Shunt	For connecting to the on-board buffer I ² C and pull-up voltage rail to P3V3. During "daisy-chain" configuration, J22 will need to be shunted and J19, J20, and J21 will need to be open on the secondary EVMs.
J23	Shunted	Disables (U5) I ² C buffer
J24	Open	Connects PEXT to VAUX
J26 and J29	Shunted	Shunting both J26 and J29 will bypass the I 2 C (U5) buffer for SDA and SCL signal lines
J27, J28, J30, and J31	Open	Shunting these jumpers will buffer SCL and SDA I ² C signal lines by using the on-board (U5) buffer.
J32 and J33	Shunted	Shunting both J32 and J33 will bypass the I ² C (U6) buffer for SDA and SCL signal lines
J34	Shunted	Disables (U6) I ² C buffer
J35	Shunted (default) Pin 1 to Pin 2	SYNC pin is pulled up to P1V8
J36	Shunted (default) Pin 2 to Pin 3	Input to one of (U4) comparators to indicate the SYNC pin has "tagged" a voltage rail that is not in a fault condition
J37, J38, J39, J40	Open	If multiple EVMs are connected in a "daisy-chain" configuration, the following EVM boards will need to have J37, J38, J39, and J40 all shunted. By shunting these jumpers, VDD, VAUX, SYNC, and NIRQ signals will be provided as inputs from the primary EVM board. Also, J22 will need to be shunted and J19, J20, and J21 will need to be open on the secondary EVMs during "daisy-chain" configuration.

Table 3-2. List of On-board Jumpers

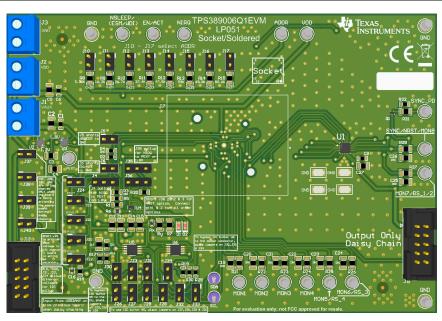


Figure 3-1. TPS389006Q1EVM Jumper Locations



4 EVM Setup and Operation

This section describes the functionality and operation of the TPS389006Q1EVM. Refer to the TPS389006-Q1 Multichannel Overvoltage and Undervoltage I²C Programmable Voltage Supervisor and Monitor datasheet for details on the electrical characteristics of the device.

The TPS389006Q1EVM comes with the TPS38900603NRTERQ1 IC meaning the device is capable of monitoring up to six separate voltage rails. The EVM is capable of many different configurations in order to fully evaluate the functionality of all the TPS389006-Q1 device variants. The default jumper configuration of the TPS389006Q1EVM is mentioned in Table 3-2.

The TPS389006Q1EVM comes with USB to GPIO connector, I²C bus repeaters, comparators, two LDOs, socket and solder down footprints, the ability to monitor up to eight (8) voltage rails, the option to daisy-chain up to three EVMs at a time via 10-pin connector, jumper selectable I²C address, I²C pullup voltage options, and TPS38900603NRTERQ1 IC. The TPS389006Q1EVM also provides the ability for each monitored rail to be voltage divided down by resistor dividers on each of the monitored/input lines. The user must choose appropriately sized resistors such that the divided voltage is above, below or within the window of the voltage threshold depending on the type of input sensing topology is setup for each monitored input channel. Consult the Device Threshold Table in the TPS389006-Q1 datasheet to ensure proper voltage monitored values.

The TPS389006Q1EVM is designed to be daisy-chain where the primary board is connected to the USB to GPIO connector (J18) and its output connector (J8) provides VDD, VAUX, SYNC, SCL, SDA, NIRQ, and GND to the secondary board's (J18) connector via a 10-pin ribbon cable. When the daisy-chain option is being used, jumpers on the secondary board (J19-J22 and J37-J40) must be configured properly or else possible damage to the IC or EVM may occur. Jumper settings of J19, J20, and J21 must be left open whereas J22, J37, J38, J39, and J40 need to be shunted with jumpers for proper setup of the secondary board during daisy-chain setup. Also, the I²C rail voltage for the secondary board in the daisy-chain mode is defined as VI2CPULLUP = VAUX = 3.3 V. See Figure 2-2 for reference.

Equipment Needed for TPS389006Q1EVM Evaluation

- TPS389006Q1EVM
- TI's USB Interface Adapter (with ribbon cable)
- Power Supply (3.3 V)
- Multimeters
- Multi-channel Oscilloscope (review evaluation waveforms)
- Jumper Wires/Cables



4.1 Setup and GUI Installations

4.1.1 TPS389006Q1EVM Hardware Setup

Follow the steps below for TPS389006Q1EVM hardware setup:

- 1. Connect VAUX (J1) and VDD (J2) to 3.3 V from the power supply.
- 2. Connect GND (J3) to ground from the power supply.
- 3. Make sure the jumpers are connected as per the guidelines in the Table 3-2.
- 4. Before allowing the output of the power supply to be engaged, check if the power supply voltage is set at 3.3 V and the power supply output current is limited to 10 mA.
- 5. Connect the TI's USB Interface Adapter to J18 (USB2GPIO Connector) using a 10-pin ribbon cable.
- 6. Connect the TI's USB Interface Adapter to the computer's USB port.
- 7. Connect any voltage supply rail that needs monitoring to any of the voltage monitoring inputs (MON1 MON8).
- 8. The description of the TPS389006Q1EVM connections can be found in Figure 4-1.

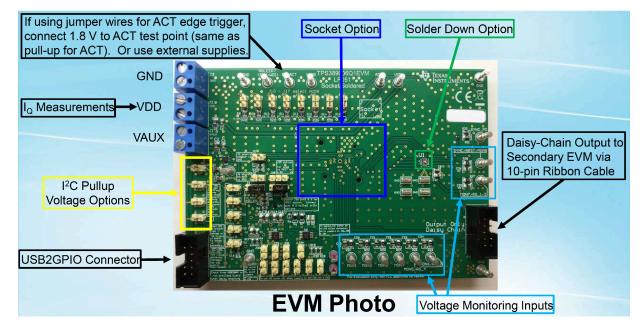


Figure 4-1. TPS389006Q1EVM Connection Description



4.1.2 TPS389006Q1EVM Software Setup

Follow the steps below for TPS389006Q1EVM GUI software installation:

- 1. Install the GUI
 - a. Download the Fusion Digital Power Designer Platform GUI for TPS389006Q1EVM
 - b. Open the downloaded file.
 - c. In the Welcome Wizard window, click Next.
 - d. Accept the license agreement and then click Next.

📸 Setup - Fusion Digital Power Designer 🦳 🗌	×
License Agreement Please read the following important information before continuing.	J)
Please read the following License Agreement. You must accept the terms of this agreement before continuing with the installation.	
Important - Please read the following license agreement carefully. This is a legally binding agreement. After you read this license agreement, you will be asked whether you accept and agree to the terms of this license agreement. Do not click "I have read and agree" unless: (1) you are authorized to accept and agree to the terms of this license agreement on behalf of yourself and your company; and (2) you intend to enter into and to be bound by the terms of this legally binding agreement on behalf of yourself and your company.	
 I accept the agreement I do not accept the agreement 	
< Back Next > Cano	

Figure 4-2. Setup License Agreement Window

e. The default destination folder works best. Click Next.

👸 Setup - F	usion Digital Power Designer		_		×
	estination Location should Fusion Digital Power Designe	r be installed?		Q	
1	Setup will install Fusion Digital Pow	ver Designer into t	he following fol	lder.	
To con	tinue, click Next. If you would like to	select a different	folder, click Bro	owse.	
rogran	n Files (x86)\Texas Instruments\Fus	ion Digital Power [Designer	rowse	
At leas	t 72.6 MB of free disk space is requir	ed.			
		< Back	Next >	Can	cel

Figure 4-3. Setup Destination Window



f. Click Next for the Select Start Menu Folder option.

👸 Setup - Fusion Digital Power Designer	_		×
Select Start Menu Folder Where should Setup place the program's shortcuts?		G	
Setup will create the program's shortcuts in the following S	tart Men	u folder.	
To continue, dick Next. If you would like to select a different folder,	click Bro	owse.	
Texas Instruments\Fusion Digital Power Designer	Br	rowse	
Don't create a Start Menu folder			
< Back Nex	t >	Can	cel

Figure 4-4. Setup Window - Start Menu Selection

g. There is no need to install additional options for this EVM. Click Next.

🐻 Setup - Fusion Digital Power Designer	_		×
Select Additional Tasks Which additional tasks should be performed?		(
Select the additional tasks you would like Setup to perform Power Designer, then click Next.	while installing F	usion Digita	al
Additional icons:			
Create a desktop icon			
Create a Quick Launch icon			
Other desktop shortcuts			
SMBus I2C SAA Debug Tool			
UCD9xxx Device GUI			
Additional Tasks:			
Add application directory to your system PATH			
< Back	Next >	Can	icel

Figure 4-5. Setup Window - Additional Tasks



h. Finally click Install to install the Fusion software.

🔀 Setup - Fusion Digital Power Designer 🦳 —		- ×
Ready to Install		
Setup is now ready to begin installing Fusion Digital Power Designer on your computer.		
Click Install to continue with the installation, or click Back if you want to review change any settings.	or	
Destination location:		^
C:\Program Files (x86)\Texas Instruments\Fusion Digital Power Designer		
		×
<	>	
	-	
< Back Install	Ca	ancel

Figure 4-6. Setup Installation Window

i. Click on Finish to complete the installation setup and launch the software.

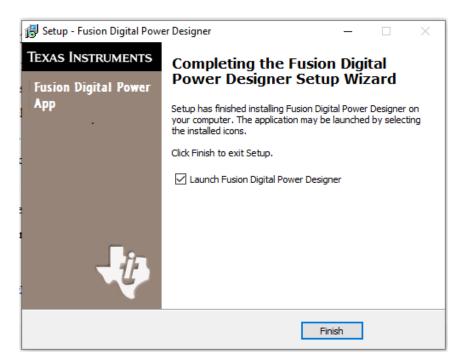


Figure 4-7. Installation Complete Window



4.2 Quick Start to TPS389006Q1EVM GUI

Please follow the steps below precisely to quickly evaluate the TPS389006-Q1. In this quick start, the TPS389006Q1EVM will be setup to monitor several power supply rails after the ACT pin is triggered.

- 1. Make the hardware connections and software installation described in Section 4.1 have been completed. Feel free to skip the GUI installation if the Fusion Digital Power Designer for TPS389006Q1EVM GUI has been installed already.
- 2. Power the EVM by turning on the power supply. Note that the voltage and current limits at the power supply should be set at 3.3 V and 10 mA.
- 3. Once the TI's USB Interface Adapter is connected to EVM and the laptop, launch the evaluation software Fusion Digital Power Designer.
- 4. Click on I2C GUI on the bottom right of GUI.

-nsion d	igital P	omer	Dəsigi	191					
/ersion 7.6.		21-08-12	2]						
lo Devices Fo to compatible PMBu ower is supplied to	s devices wer		se check that	the serial cab	le end of your USE	3 adapter is a	ttached to yo	ur device and	
canning Mode:	Device	IDAndCod	eAndICDev	iceID					
USB Adapter Fir USB Adapter ID:			100						
Bus Speed:	Packet F	Error Check	ing: ALEF	RT Pullup:	2.2 kΩ	\checkmark			
○ 100 kHz	Enable	led	CLO	CK Pullup:	2.2 kΩ				
• 400 kHz	🔿 Disat	oled	DAT	A Pullup:	2.2 kΩ				
Signals									
SMBALERT#:	ACK: High) (Refresh						
Control Lines:	#1	#2	#3	#4	#5				
(dick to set)	🔿 High	🔘 High	🔘 High	🔘 High	🔾 High		Refres	h All	
(even to be of	Low	Low	Low	Low	Low				

Figure 4-8. Fusion Welcome Window



5. Click on Change Scan Mode to select TPS389xxx and then click OK.

👆 Texas Instruments - Fusio	on Digital Power Designer			. 🗆 🗙
File Tools				
Q Scan for TPS389xxx Chang	e Scan Mode Start Polling Polling Interval	1000 ms		
# Address A	Device			
	~^			
6				
Log				
	1			
Timestamp	Message			، اف
Copy Log Clear Log				Include poling activities
Fusion Digital Power Designer v	7.6.7.5.Alpha (For WCM testing) No Adapter		Not Saved	TEXAS INSTRUMENTS fusion digital power

Figure 4-9. Fusion Scan Window

 Decos Instruments - Fusi File Tools 	n Digital Power Designer				_ 0
Chang	e Scan Mode Start Polling Polling Interval	1000 ms			
# Address 🛆	Device				
Device Scan Editor					
Set All Addresses To:	Skip TPS638x0/53831	rPS596xx TPS38700x	TPS389xxx XPS53830 (TPS542A50 TPS54xC2x	-
1d 0x01 TPS389xxx	✓ 18d 0x12 TPS389xxx	✓ 34d 0x22 TPS389xxx	Sod 0x32 TPS389xxx	66d 0x42 TPS389xxx	≥ 82d 0x52
2d 0x02 TPS389xxx	✓ 19d 0x13 TPS389xxx	✓ 35d 0x23 TPS389xxx	✓ 51d 0x33 TPS389xxx	✓ 67d 0x43 TPS389xxx	⊻ 83d 0x53
3d 0x03 TPS389xxx	✓ 20d 0x14 TPS389xxx	✓ 36d 0x24 TPS389xxx	✓ 52d 0x34 TPS389xxx	✓ 68d 0x44 TPS389xxx	⊻ 84d 0x54
4d 0x04 TPS389xxx 5d 0x05 TPS389xxx	 ✓ 21d 0x15 TPS389xxx ✓ 22d 0x16 TPS389xxx 	 ✓ 37d 0x25 TPS389xxx ✓ 38d 0x26 TPS389xxx 	 ✓ 53d 0x35 TPS389xxx ✓ 54d 0x36 TPS389xxx 	 ✓ 69d 0x45 TPS389xxx ✓ 70d 0x46 TPS389xxx 	 ✓ 85d 0x55 ✓ 86d 0x56
6d 0x06 TPS369xxx	 22d 0x16 (F3389xxx) 23d 0x17 (F5389xxx) 	✓ 388 0x28 TF5389x0x	✓ 55d 0x37 TPS389xxx	✓ 71d 0x47 TPS389xxx	✓ 850 0x55
7d 0x07 TPS389xxx	✓ 24d 0x18 TPS389xxx	✓ 40d 0x28 TPS389xxx	✓ 56d 0x38 TPS989xxx	✓ 72d 0x48 TPS389xxx	⊻ 88d 0x58
8d 0x08 TPS389xxx	25d 0x19 TPS389xxx	41d 0x29 TPS389xxx	57d 0x39 TPS389xxx	73d 0x49 TPS389xxx	✓ 89d 0x59
9d 0x09 TPS389xxx	✓ 26d 0x1A TPS389xxx	✓ 42d 0x2A TPS389xxx	S8d 0x3A TPS389xxx	✓ 74d 0x4A TPS889xxx	90d 0x5A
10d 0x0A TPS389xxx	✓ 27d 0x1B TPS389xxx	✓ 43d 0x28 TPS389xxx	✓ 59d 0x38 TPS389xxx	✓ 75d 0x48 TPS689xxx	⊻ 91d 0x58
11d 0x0B TPS389xxx	✓ 28d 0x1C TPS389xxx	✓ 44d 0x2C TPS389xxx	60d 0x3C TPS389xxx	✓ 76d 0x4C TPS389xxx	⊻ 92d 0x5C
13d 0x0D TPS389xxx	✓ 29d 0x1D TPS389xxx	✓ 45d 0x2D TPS389xxx	✓ 61d 0x3D TPS389xxx	✓ 77d 0x4D TPS389xxx	⊻ 93d 0x5D
14d 0x0E TPS389xxx	✓ 30d 0x1E TPS389xxx	✓ 46d 0x2E TPS389xxx	✓ 62d 0x3E TP\$389xxx	✓ 78d 0x4E TPS389xxx	✓ 94d 0x5E
15d 0x0F TPS389xxx	 ✓ 31d 0x1F TPS389xxx ✓ 32d 0x20 TPS389xxx 	 ✓ 47d 0x2F TPS389xxx ✓ 48d 0x30 TPS389xxx 	 ✓ 63d 0x3F TPS389xxx ✓ 64d 0x40 TPS389xxx 	 ✓ 79d 0x4F TPS389xxx ✓ 80d 0x50 TPS389xxx 	95d 0x5F
17d 0x11 TPS389xxx	✓ 33d 0x21 TPS389xxx	✓ 49d 0x30 TPS389xxx	✓ 65d 0x41 TPS389xxx	✓ 81d 0x51 TPS389xxx	97d 0x61
<		"	ж		
sion Digital Power Designer v	7.6.7.5.Alpha (For WCM testing) No Adapter		Not Saved	- Texas	INSTRUMENTS fusion digital po

Figure 4-10. Fusion Scan Selection Window



6. Scan for the TPS389006Q1EVM by clicking on "Scan for TPS389xxx" on top left of the window.

End State Poling Poling Interval 1000 ms Image: State Mode State Poling Poling Interval 1000 ms	🌵 Texas Instruments - F	usion Digital Power Designer			_ 0 🛛
# Address \Device tog	File Tools				
	Q Scan for TPS389xxx Ch	hange Scan Mode 🕨 Start Polling Polling Interva	al 1000 ms		
	# Address	△ Device			
Imestamp Message					
Tmestanp Message					
Timestamp Message					
	Timestamp	Message			
					Include polling activities
Fusion Digital Power Designer v7.6.7.5.Alpha (For WCM testing) No Adapter Nusion digital P	Fusion Digital Power Design	ner v7.6.7.5.Alpha (For WCM testing) No Adapter		Not Saved	TEXAS INSTRUMENTS fusion digital power

Figure 4-11. Fusion Scan Window - Scanning for TPS389006Q1EVM

7. Once the EVM is discovered, select "Click to Configure".

🕀 Texas Instruments -	- Fusion Digital Power Designer		_ • •
File Tools			
Scan for TPS389xxx	Change Scan Mode Start Polling Polling Interval 1000 ms		
# Address	Device TP5389004		- f
1 04h (4d)	TP\$389004	Click to Co	ntiqure
Timestamp	Message		4
14:24:52.440	Scanning USB Adapter #1 at address 121d (TPS389xxx) for devices		
14:24:52.472	I2CRead (Address 121d, Cmd 0x00): NACK <empty></empty>		
14:24:52.498	Scanning USB Adapter #1 at address 122d (TPS389xxx) for devices		
14:24:52.529	I2CRead (Address 122d, Cmd 0x00): NACK <empty></empty>		
14:24:52.558	Scanning USB Adapter #1 at address 123d (TPS389xxx) for devices		
14:24:52.593	I2CRead (Address 123d, Cmd 0x00): NACK <empty></empty>		
14:24:52.620	Scanning USB Adapter #1 at address 124d (TPS389xxx) for devices		
14:24:52.655	I2CRead (Address 124d, Cmd 0x00): NACK <empty></empty>		
14:24:52.689	Scanning USB Adapter #1 at address 125d (TPS389xxx) for devices		
14:24:52.727	I2CRead (Address 125d, Cmd 0x00): NACK <empty></empty>		
14:24:52.752	Scanning USB Adapter #1 at address 126d (TPS389xxx) for devices		
14:24:52.781	I2CRead (Address 126d, Cmd 0x00): NACK <empty></empty>		
14:24:52.806	Found 1 device.		() ()
Copy Log Clear L	Log		Include poling activities
		10	
Fusion Digital Power Desi	igner v7.6.7.5.Alpha (For WCM testing) USB Adapter v1.0.11 [PEC; 400 kHz]	Not Saved	TEXAS INSTRUMENTS fusion digital power

Figure 4-12. Fusion Scan Window - Scan for TPS389006Q1EVM Completed

Once "Click to Configure" has been selected the Fusion Digital Power Device GUI for the TPS389006-Q1 will appear as shown below. The GUI screenshot shows the General Config, Sequencing, Clear/Reset, Telmetry, and Polling (Plotting the monitored voltage rails) sub-windows.

P5389004 Device Specific Registers												
General Config			Clear/Reset	_				(Y Max 50	00 🔄 Y Min 🛛 0.00 🗄	9 (+)	
VHON_HISC (11h)	INT_CONTROL (1Bh)	Enable Interrupt (1Ch)	- VMON_CTL						1			
Timestamp Overwrite Enable SEQ Overwrite Enable	Register ORC	ECC single-error correction fault Built-in-test-complete	FORCE_NI	RQ ③ NIRQ pin ○ NIRQ pin			gisters faults	Monitor Comparator Offset Companyations	Y Max 1	1.00 🕀 Y Min 🛛 0.00	중 🖉 Show chart info	
Require PEC PEC Enable	PEC	Built-in test complete fail	FORCE_SIT	NC StrNC pin StrNC pin			ionitoring logic	Clear PROTL/PROT2 registers	Show vak	e on plot Reg Codes	✓ + 041 (2)	
Sequence Timeout (A5h & A6h)	SEQ REC CTL (A0h)	SEQ ENTER ACK	SLEEP_PW/				and UWHF only) ACTIVE state)	Reset SYNC Counter	READ_VINI READ_VINI 10	0x40 S READ_VIN2		
Pulse Width Duration (A7h)	SEQ ON ACK	Record Type ON	Telemetry									
			SYNC COUNT	0								
Sequencing				MONA	MONS	MON2	MONI		8			
	MONA MONS MONS	MON1	READ_VIN	0.2 V	0.2.V	0.2 V	0.2 V					
Power ON Order (B0h : B3h)	1 - 1 - 1	• 1 •	SEQ ON Order	0	0	0	0					
Power OFF Order (C0h : C3h)	1 • 1 • 1	• 1 •	SEQ OFF Order	0	0	0	0		6			
Sleep Exit Order (D0h : D3h)	1 • 1 • 1	• 1 •	SEQ EXS Order	0	0	0	0					
ileep Enter Order (E0h : E3h)	1 1 1 1		SEQ ENS Order	0	0	0	0					
seep ester order (conness)		· .	SEQ Timestamp	0 s	0 s	0 s	0 s					
interrupt Enable									4			
/oltage Range and Threshold			Status Register	5					2			
Voltage Range and Threshold			E Status Register					e	2			
									2			

Figure 4-13. Fusion Digital Power Device GUI - TPS389006Q1EVM (screenshot #1)

9. The GUI screenshot below continues to show the additional sub-windows that are in the GUI for the TPS389006-Q1. The GUI screenshot includes the **Interrupt Enable**, **Voltage Range and Threshold**, **Status Registers**, and Polling (Plotting the monitored voltage rails) sub-windows.

	ce Specific Registe										
errupt Enal	le					2 ^ [Status Registers				✓ ^ Y Max 50.00 ⊕ Y Min 0.00 ⊕ (+)
		HONA	MONS	HON2	MONI		INT_SRC (10h)	INT_MONITOR (11h)		INT_UVHF (12h)	
	UV (13h)						7 OTHER	7 SEQ_ON		7 RSVD	
ligh Pass Ell	OV (15h)						6 RSVD	6 Bit6		6 RSVD	Y Max 10.00 💬 Y Min 0.00 💮 🗹 Show chart info
	07 (130)						5 RSVD	5 SEQ_EXS		S RSVD	Show value on plot Reg Coder - V +
							4 RSVD	4 SEQ_ENS		4 RSVD	READ_VIN1 0x40 🔀 READ_VIN2 0x41 🚷
w Pass EN	UV (14h)						3 RSVD	3 OV_LF		3 UV_HF4 013	READ_VINI 0x42 CREAD_VINH 0x43 C
w rass th	OV (16h)						2 TEST	2 OV_HF		2 UV_HF3 013	10
		0		0			1 CONTROL 0 MONITOR	1 UV_LF		1 UV_HF2 011	
	ON (17h)	-		-			0 MONITOR	0 UV_HF		0 UV_HF1 000	
SEQ EN											
	OPF (18h)						INT_UVLF (14h)	INT_OVHF (16h)		INT_OVLF (18h)	8
	EXS (19h)						7 RSVD	7 RSVD		7 RSVD	
	ENS (1Ah)			П			6 RSVD	6 RSVD		6 RSVD	
							5 RSVD	5 RSVD		S RSVD	
							4 RSVD	4 RSVD		4 RSVD	6
AMSK EN	OW (Ath)		\checkmark	\checkmark	v		3 UV_LF4	3 OV_HF4		3 OV_LF4 000	
	OFF (A2h)		~				2 UV_U/3	2 OV_HF3		2 OV U/3	
	EXS (A3h)	2	2	2	 12		1 UV_LF2	1 OV_HF2		1 OV_LF2 013	
							0 UV_LF1	0 OV_HF1		0 OV_LF1 013	4
	ENS (A+h)	\checkmark	\swarrow	2	2		1 11-11				
Enable	Monitoring (15h)						INT_SEQ_ON (IAh) 7 RSVD	INT_SEQ_OFF (1ch) 7 RSVD		INT_SEQ_EXS (1Eh) 7 RSVD	
							6 RSVD	6 RSVD		6 RSVD	
age Range	and Threshold					N	5 RSVD	5 RSVD		5 RSVD	
	HON4	MON3	MON2	MONI			4 RSVD	4 RSVD		4 RSVD	
Voltage Sca	ling (1Fh) ———		10.000.000	100000			3 SEO ON4	3 SEQ OFF4		3 SEQ EXS4 013	
	ix 💌	ix 💌	ix 🔻	1x	•		2 SEQ_ON3	2 SEQ_OFF3		2 SEQ_EX53 013	00:00 00:00 00:00 00:
Threshold (20h, 21h, 22h, 23h	+ (N-1)*0x	10 where N	is channe	el number)		1 SEQ_ON2	1 SEQ_OFF2		1 SEQ_EXS2 011	
			0.200 🕀				0 SEQ_ON1	0 SEQ_OFF1		0 SEQ_EXS1 000	
ligh Pass	01000 [2]						0 SEQ_ONI	Sec_on1		o sequest	
	× 0.200 🕀	0.200 🕀	0.200 🕀	0.200 🗄	원 M						
	N 0.200 🕀	0.200 🕀	0.200 🕀	0.200 🗄	哥ν		INT_SEQ_ENS (20h)	INT_CONTROL (22h)		INT_TEST (23h)	
ow Pass							7 RSVD	7 RSVD		7 RSVD	
	[≫] 0.200 ⊕	0.200 🕀	0.200 🕀	0.200 🕃	ΞV		6 RSVD	6 RSVD		6 RSVD	
Debounce (24h + (N-1)+0x10	where N is	hannel nur	nber)			S RSVD	5 RSVD 4 CRC		S RSVD	
c	V 0.1 [v]	0.1	0.1 🔍	0.1	× 105		4 RSVD 3 SEQ_EN54			4 RSVD 3 ECC_SEC 000	
4		0.1	0.1					3 NIRQ			
							2 SEQ_ENS3	2 TSD		2 ECC_DED [11]	
			10 where N	is channe	I number)			1 SYNC	833	1 I_BIST_C 000	
Low Freque							0 SEQ ENS1	0 PFC		0 BIST CTC	

Figure 4-14. Fusion Digital Power Device GUI - TPS389006Q1EVM (screenshot #2)



10. The last GUI screenshot below shows the last five registers in the Status Registers sub-window.

eral Config	INT_SEQ_ON (1Ab)	INT SEO OFF (1Ch)	INT_SEQ_EXS (1Eh)	Y Max 50.00 + Y Min 0.00 + +
	2 000	7 RSVD	7 RSVD	
auencing	6 RSVD	6 RSVD	6 RSVD	(
errupt Enable	5 RSVD	5 RSVD	5 RSVD	Y Max 10.00 문 Y Min 0.00 문
Itage Range and Threshold	4 RSVD	4 RSVD	4 RSVD	
NONA NONA NONA NONA	3 SEQ_0N4 000	3 SEQ_OFF4 000	3 SEQ_EXS4 000	Show value on plot Reg Coder
Voltage Scaling (1Fh)	2 SEQ_ON3 000	2 SEQ_OFF3	2 SEQ_EXS3 033	READ_VIN1 0x40 🚱 READ_VIN2 0x41 🚱
1x 🕶 1x 💌 1x 💌	1 SEQ_ON2 000	1 SEQ_OFF2 000	1 SEQ_EXS2 011	READ_VING 0x42 🔇 READ_VINA 0x43 🔇
Threshold (20h, 21h, 22h, 23h + (N-1)*0x10 where N is channel number)	0 SEQ_ON1 @	0 SEQ_OFF1 000	0 SEQ_EXS1 000	10
<i>UV</i> 0.200 ⊕ 0.200 ⊕ 0.200 ⊕ <i>ν</i>				
ligh Pass	INT_SEQ_ENS (20h)	INT CONTROL (22h)	INT TEST (23h)	
ØV 0.200 ⊕ 0.200 ⊕ 0.200 ⊕ V	7 RSVD	7 RSVD	7 RSVD	8
UV 0.200 ⊕ 0.200 ⊕ 0.200 ⊕ 0.200 ⊕ ν	6 RSVD	6 RSVD	6 RSVD	•
DV 0.200 0 0.200 0 0.200 0 0.200 0 0.200 0 V	5 RSVD	5 RSVD	S RSVD	
0,200 0.200 0.200 0.200 0.200 0	4 RSVD	4 CRC 000	4 RSVD	
Debounce (24h + (N-1)*0x10 where N is channel number)	3 SEQ_ENS4 0	3 NIRQ [10	3 ECC_SEC 013	6
OV 0.1 V 0.1 V 0.1 V 0.1 V 40	2 SEQ_ENS3 00	2 TSD [11]	2 ECC_DED 010	•
UV 0.1 V 0.1 V 0.1 V 0.1 V MS	1 SEQ_ENIS2 0	1 SYNC 00	1 I_BIST_C 000	
	0 SEQ_ENS1 (0)	0 PEC	0 BIST 000	
Low Frequency Path (\$) (25h + (H-1)*0x10 where H is channel number) 1000 • 1000 • 1000 • 1000 • He	VMON_STAT (30h)	TEST_INFO (31h)	OFF_STAT (32h)	
	7 FAILSAFE	7 RSVD	7 RSVD	
	6 ST_BIST_C	6 RSVD	6 RSVD	2
	5 ST_VDD	5 ECC_SEC	5 RSVD	
	4 ST_NRQ	4 ECC_DED	4 RSVD	
	3 ST_ACTSLP 2 ST_ACTSHDN	3 BIST_VM 2 BIST_NVM	3 M0N4 2 M0N3	
	2 ST_ACTSHDN 1 ST_SYNC	2 BIST_NWH 1 BIST_L	2 MON3 1 MON2	0
	0 RSVD	0 BIST_A	0 MON1	00:00 00:00 00:00 00:00
	SEQ_REC_STAT (34h)	SEQ_OW_STAT (35h)		
	7 REC_ACTIVE	7 RSVD		
	6 SEQ_REC_BIT1	6 RSVD		
	5 SEQ_REC_BITO	5 RSVD		
	4 TS_RDY	4 T5_0W		
	3 SEQ_ON_RDY	3 SEQ_ON_OW		
	2 SEQ_OFF_RDY 1 SEQ_EXS_RDY	2 SEQ_OFF_OW 1 SEQ_EXS_OW		
	0 SEQ_ENS_RDY	0 SEQ_ENS_OW		
	U SCENS_NOT	·		
			J	

Figure 4-15. Fusion Digital Power Device GUI - TPS389006Q1EVM (screenshot #3)



4.3 Example Operation of TPS389xxx-Q1

The example below shows a TPS389004-Q1 monitoring four (4) voltage supply rails on the TPS389006Q1EVM. Please follow the steps in Section 4.1.1 and Section 4.1.2 before evaluating the TPS389004-Q1. In this example, the TPS389006Q1EVM will be setup to monitor several power supply rails after the ACT pin is asserted. Below, Figure 4-16 shows how the TPS389006Q1EVM was setup to monitor four (4) voltage supply rails.

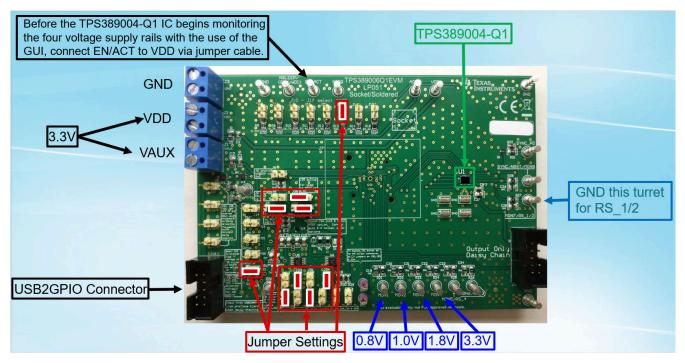


Figure 4-16. TPS389006Q1EVM Monitoring Four (4) Voltage Supply Rails

- 1. Connect the TPS389006Q1EVM VDD and VAUX inputs to a 3.3 V external power supply. Note that the voltage and current limits of the power supply should be set at 3.3 V and 10 mA.
- Connect the TPS389006Q1EVM with TI's USB Interface Adapter ribbon to J18 (USB2GPIO connector). Connect the USB plug from the USB Interface Adapter to the computer's USB port. The TI USB Interface Adapter will communicate to the TPS389004-Q1 IC via I²C protocols.
- 3. Ensure the jumper settings, highlighted in red in Figure 4-16, are set on the TPS389006Q1EVM.
- 4. Ground turret (MON7/RS_1/2).
- 5. Apply 0.8 V to MON1, 1.0 V to MON2, 1.8 V to MON3, 3.3 V to MON4 to the turrets of TPS389006Q1EVM.
- 6. Final Connections should look similar to Figure 4-16.
- 7. Open up the Fusion Digital Power Designer GUI on the computer and follow Section 4.2.
- 8. Once the EVM is discovered and **Click to Configure** has been selected, the GUI will look like Figure 4-13, Figure 4-14, Figure 4-15.
- Scroll to the bottom of the Interrupt Enable sub-window and enable all four monitoring inputs by clicking the empty boxes. The GUI screenshot, Figure 4-17 below, shows all the monitoring inputs being selected in the highlighted "black-box".
- 10. In the Voltage Range and Theshold sub-window, enter the undervoltage (UV) and overvoltage (OV) threshold values for the monitoring inputs. One thing to note, any monitoring inputs that are higher than 1.5 V needs to select "4x" in the Voltage Scaling (1Fh) field. The GUI screenshot below, highlighted by a "yellow-box", shows what has been described above.
- 11. Once steps 9 and 10 are completed, press "**Write to Hardware**" and the USB Interface Adapter will communicate to the TPS389004-Q1 IC. Next, press "**Start Polling**" and both the Telemetry (shown in the highlighted orange-box) and the graphical waveform of the monitored inputs (shown in the highlighted red-box) will be shown in the GUI.

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- 12. If one of the monitored inputs senses a fault, an interupt indicator will be displayed (illumination of a red LED) on the TPS389006Q1EVM. Also, one of the bit registers found in the **Status Registers** sub-window, highlighted in the green-box, will also show a fault in red color.
- 13. In order to clear the fault interupt, press "Stop Polling", go to the Status Registers sub-window, locate the red color fault interupt and click on "CLR" and click on "Write to Hardware". This procedure will clear the fault interupt and allow the device to continue to monitor the input channels.
- 14. Steps 8 through 13 refers to Figure 4-17 below.

	re X Discard Char	nges C Ri	fresh All S	itore to NVM	Restore from NVM C	lear Paults Stop P	-oning Chick to disable	lest Mode									
189004 Devi	ce Specific Registe	-	_														
	EXS (19h)						^		prins consideu by intern		Monitor Comparator Offset Compensations	^	Y Max 50.0	0 🕀 Y Min	0.00 🚭	H	
	ENS (IAh)								pin is force asserted (low		Compensators	3 -				0	
					_				pin is controlled by seque pin is forced asserted (low		Clear PROT1/PROT2 registers						X
AMSK EN	ON (A1h)							() () () () () () () () () () () () () (Power (reduce monitoring,			5 II.		.00 🕀 Y Min	See 2	Show chart in	fo
A108.04	OFF (A2h)								Power (full monitoring, sar		Reset SYNC Counter				xder RE 🔽	Careford P.	
	EXS (A3h)												READ_VIN1 READ_VIN3	0x40 😵 1		0x41 🔀	
	ENS (A4h)							Telemetry				2	4	•	CENU_TIM		
	1				_			SYNC_COUNT 1									
Enable	Monitoring (1Eh)		~		2			MONA	MON3 MON	2 MON1		_					
								READ_VIN 3.36 V	1.84 V 1.02	V 0.815 V		_					3.36
ltage Range	and Threshold							SEQ ON Order 1 SEO OFF Order 2	1	1 1			3.2				
	MON4	MON3	MON2	MONI				SEQ DIS Order	0	0 0							
- Voltage Sca					3			SEQ ENS Order	0	0 0							
	4x 🔻	4x 💌	1x 💌	1x 💌				and The second s	°.								
								SEQ Timestamp SE-05 s	5E-05 s 5E-05				2.4				
	20h, 21h, 22h, 23h							SEQ TIMEstamp SE-05 a	5E-05 s 5E-05	5 30-03 5			2.4				
	20h, 21h, 22h, 23h № 2.50 🜩	+ (N-1)*0x	10 where N 0.600 💭	is channel n 0.600 🕀 I				Status Registers	5E-05 s 5E-05	s 30-05 s		V	2.4		1		
ligh Pass	₩ 2.50 🜩				, · · ·				SE-OS s SE-OS		INT_UVHF (12h)	8	1.6				1.84
igh Pass	AV 2.50 ⊕ AV 4.00 ⊕	1.50 🜩	0.600 🕀	0.600 🕀 1	,			Status Registers INT_SRC (10h) 7 OTHER	INT_MONI	TOR (11h)	7 RSVD						1.84
ligh Pass	/V 2.50 ⊕ 2V 4.00 ⊕ /V 2.50 ⊕	1.50 ÷ 2.20 ÷ 1.50 ÷	0.600 (m) 1.200 (m) 0.600 (m)	0.600 + 1 1.000 + 1 0.600 + 1	, ,			Status Registers INT_SRC (10h) 7 OTHER 6 RSVD	INT_MONI 7 SEQ_C 6 Bit6	ITOR (11h)	7 RSVD 6 RSVD						1.84
High Pass C Low Pass C	// 2.50 ⊕ // 4.00 ⊕ // 2.50 ⊕ // 4.00 ⊕	1.50 ÷ 2.20 ÷ 1.50 ÷ 2.20 ÷	0.600 ÷ 1.200 ÷ 0.600 ÷ 1.200 ÷	0.600 () 1.000 () 0.600 () 1.000 ()	, ,			Status Registers INT_SRC (10h) 7 OTHER	INT_MONI	TTOR (11h)	7 RSVD 6 RSVD 5 RSVD		1.6				1.02
High Pass	// 2.50 ± // 4.00 ± // 2.50 ± // 4.00 ± 240 + (N-1) ⁻ 0×10	1.50 ÷ 2.20 ÷ 1.50 ÷ 2.20 ÷	0.600 (*) 1.200 (*) 0.600 (*) 1.200 (*) nannel nun	0.600 () 1.000 () 0.600 () 1.000 ()				Status Registers INT_SRC (10h) 7 OTHER 6 RSVD 5 RSVD	INT_HOND 7 SEQ_C 6 Bt6 5 SEQ_L	TTOR (11h) N XS INS	7 RSVD 6 RSVD						
High Pass Low Pass - Debounce (N 2.50 ⊕ OV 4.00 ⊕ N 2.50 ⊕ OV 4.00 ⊕ OV 4.00 ⊕ OV 4.00 ⊕ OV 0.1 ♥	1.50 ± 2.20 ± 1.50 ± 2.20 ± 2.20 ± 0.1 ×	0.600 ÷ 1.200 ÷ 0.600 ÷ 1.200 ÷ nannet nun 0.1 ∨	0.600 + 1 1.000 + 1 0.600 + 1 1.000 + 1	1			Status Registers JHT_SRC (10h) 7 0THER 6 5 8SYD 4 8SYD 3 2 TET	INT_MONI 7 SEQ_C 6 Bit5 5 SEQ_L 4 SEQ_L 3 OV_LU 2 OV_H	TTOR (11h)	7 RSVD 6 RSVD 5 RSVD 4 RSVD		1.6				1.02
High Pass	N 2.50 ⊕ OV 4.00 ⊕ N 2.50 ⊕ OV 4.00 ⊕ OV 4.00 ⊕ OV 4.00 ⊕ OV 0.1 ♥	1.50 ÷ 2.20 ÷ 1.50 ÷ 2.20 ÷	0.600 (*) 1.200 (*) 0.600 (*) 1.200 (*) nannel nun	0.600 () 1.000 () 0.600 () 1.000 ()	1			Status Registers INT_SRC (10h) 7 01HR 6 RSVD 3 RSVD 3 RSVD 2 TEST 1 CONTROL	INT_HON 7 SEQ_C 6 Bt5 5 SEQ_L 4 SEQ_L 3 OU_L 2 OV_H 1 UV_LU	TTOR (11h) IN	7 RSVD 6 RSVD 5 RSVD 4 RSVD 3 UV_HF4		1.6				1.02
High Pass Low Pass - Debounce (0 U	N 2.50 ⊕ OV 4.00 ⊕ N 2.50 ⊕ OV 4.00 ⊕ OV 4.00 ⊕ OV 4.00 ⊕ OV 0.1 ♥	1.50 ± 2.20 ± 1.50 ± 2.20 ± 2.20 ± 0.1 ± 0.1 ±	0.600 ÷ 1.200 ÷ 0.600 ÷ 1.200 ÷ nannei nun 0.1 ∨ 0.1 ∨	0.600 + 1 1.000 + 1 0.600 + 1 1.000 + 1 1.000 + 1 0.1 + 1 0.1 + 1	1 1 1 18 18			Status Registers JHT_SRC (10h) 7 0THER 6 5 8SYD 4 8SYD 3 2 TET	INT_MONI 7 SEQ_C 6 Bit5 5 SEQ_L 4 SEQ_L 3 OV_LU 2 OV_H	TTOR (11h) IN	7 RSVD 6 RSVD 5 RSVD 4 RSVD 3 UV_HF4 2 UV_HF3		1.6	26:		:20 2/	1.02
High Pass Low Pass - Debounce (0 U	N' 2.50 \oplus N' 4.00 \oplus N' 2.50 \oplus N'' 2.50 \oplus N'' 4.00 \oplus $24H + (N-1)^{+}0X10^{+}V$ V'' V'' 0.1 \vee V'' 0.1 \vee N'' 0.1 \vee	1.50 ± 2.20 ± 1.50 ± 2.20 ± 2.20 ± 0.1 ± 0.1 ±	0.600 ÷ 1.200 ÷ 0.600 ÷ 1.200 ÷ nannei nun 0.1 ∨ 0.1 ∨	0.600 + 1 1.000 + 1 0.600 + 1 1.000 + 1 1.000 + 1 0.1 + 1 0.1 + 1	us us unber)			Status Registers INT_SRC (10h) 7 01HR 6 RSVD 3 RSVD 3 RSVD 2 TEST 1 CONTROL	INT_HON 7 SEQ_C 6 Bt5 5 SEQ_L 4 SEQ_L 3 OU_L 2 OV_H 1 UV_LU	TTOR (11h) IN	7 RSVD 6 RSVD 5 RSVD 4 RSVD 3 UV_HF4 2 UV_HF3 1 UV_HF2		0.8	26:0	26:	20 20	1.02

Figure 4-17. TPS389006Q1EVM GUI Setup for Monitoring Four (4) Voltage Supply Rails

5 Revision History

DATE	REVISION	NOTE
February 2022	*	Initial Release

STANDARD TERMS FOR EVALUATION MODULES

- 1. Delivery: TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
 - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software
 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
- 2 Limited Warranty and Related Remedies/Disclaimers:
 - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
 - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

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

NOTE:

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

3 Regulatory Notices:

3.1 United States

3.1.1 Notice applicable to EVMs not FCC-Approved:

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

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

CAUTION

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

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

FCC Interference Statement for Class A EVM devices

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

FCC Interference Statement for Class B EVM devices

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

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

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

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

Concerning EVMs Including Detachable Antennas:

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

Concernant les EVMs avec antennes détachables

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

- 3.3 Japan
 - 3.3.1 Notice for EVMs delivered in Japan: Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に 輸入される評価用キット、ボードについては、次のところをご覧ください。 http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page
 - 3.3.2 Notice for Users of EVMs Considered "Radio Frequency Products" in Japan: EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

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

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

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- 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。
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- 3.3.3 Notice for EVMs for Power Line Communication: Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page 電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page
- 3.4 European Union
 - 3.4.1 For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):

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

4 EVM Use Restrictions and Warnings:

- 4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
- 4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
- 4.3 Safety-Related Warnings and Restrictions:
 - 4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.
 - 4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and handling and use of the EVM by User or its employees, and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.
- 4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.
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