

TPS65903x-Q1 EVM User's Guide

This user's guide describes the characteristics, operation, and use of the TPS65903x-Q1 EVM. An EVM description, GUI description, interface requirements, and complete schematic are included.

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1 Introduction

The TPS659038-Q1 and TPS659039-Q1 devices are power-management integrated circuits (PMICs) for automotive applications. The device provides seven configurable step-down converters, with up to 9 A of output current for memory, processor core, input/output (I/O), or preregulation of LDOs. The TPS659038-Q1 device contains 11 LDO regulators while the TPS659039-Q1 device contains 6 LDO regulators for external use. For more details, see the device data sheet, [TPS65903x-Q1 Automotive Power Management Unit \(PMU\) for Processor](#).

1.1 EVM Overview

The features of this EVM are as follows:

- Allows monitoring of all LDO and SMPS output voltages.
- Allows loading of all SMPS outputs.
- Allows access to the GPIOs and other logic signals to test functionality.
- Optimized layout for stable operation of all SMPS.
- Onboard MSP430™ microcontroller to enable communication with the PMIC.
- Graphical User Interface (GUI) on Windows® to allow access to the registers of the PMIC through USB-I2C.

1.2 EVM with Components Identified

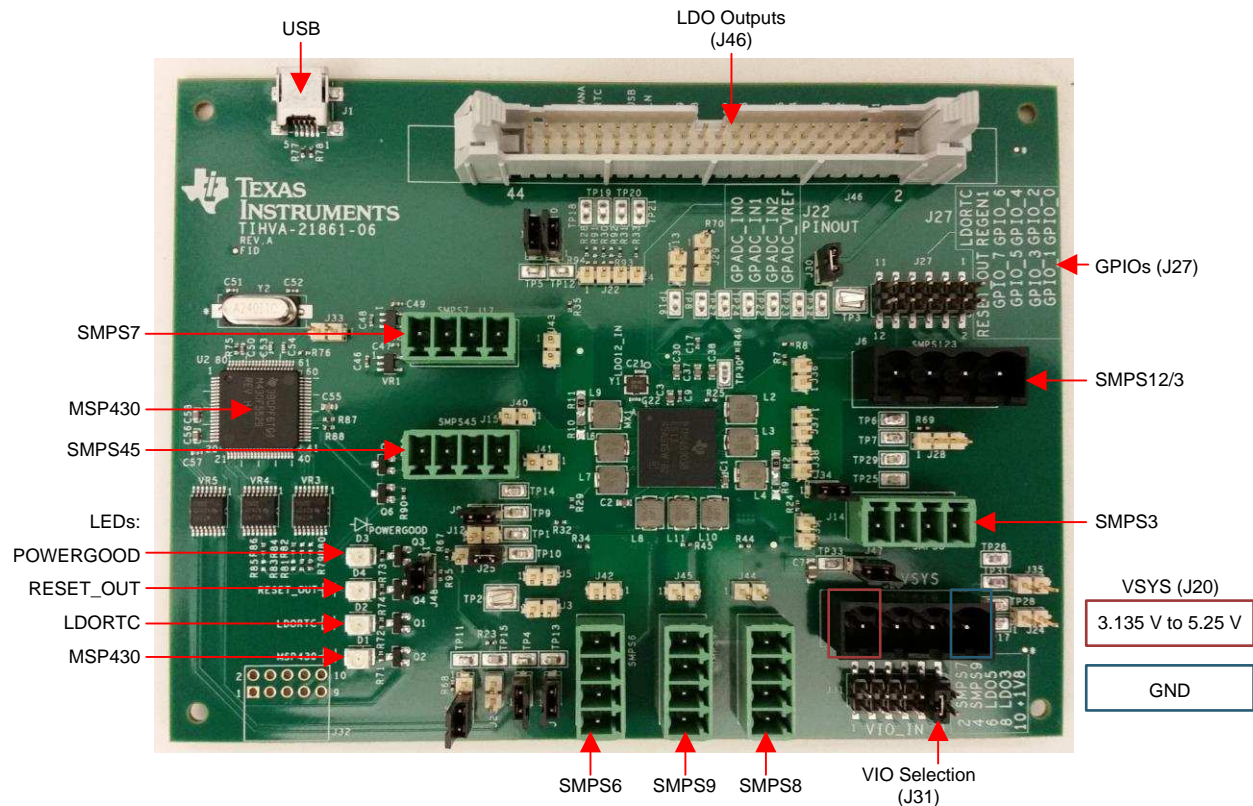


Figure 1. EVM

LEDs —Display status of POWERGOOD, RESET_OUT, LDORTC and power supply of MSP430

USB —Connection to PC to enable communication through the GUI

MSP430 —Microcontroller used to convert USB data to I²C format

SMPSxx —Monitor point for SMPS outputs

J46 —Monitor point for LDO outputs

J31 —Jumper used to select VIO voltage. J31 requires a jumper installed (only one), and by default is in position 10, 1V8.

J27 —Jumper that provides access to the GPIOs

J20 —VSYS power supply input. J20 is the same connector as SMPS123, and must not be confused to prevent applying VSYS to SMSP123-output.

1.3 Power-Supply Requirements and Connections

Only one power supply is needed to power the VSYS domain of the PMIC. Apply 3.135 VDC to 5.25 VDC to the J20 connector of the TPS65903EVM to supply power to the PMIC device. Four-wire sensing of the input power supply is recommended and can be achieved through the middle two terminals of J20.

Power for the MSP430 and the two fixed voltage LDOs (3.3-V and 1.8-V outputs) is supplied through the USB connection, as shown in [Figure 2](#).

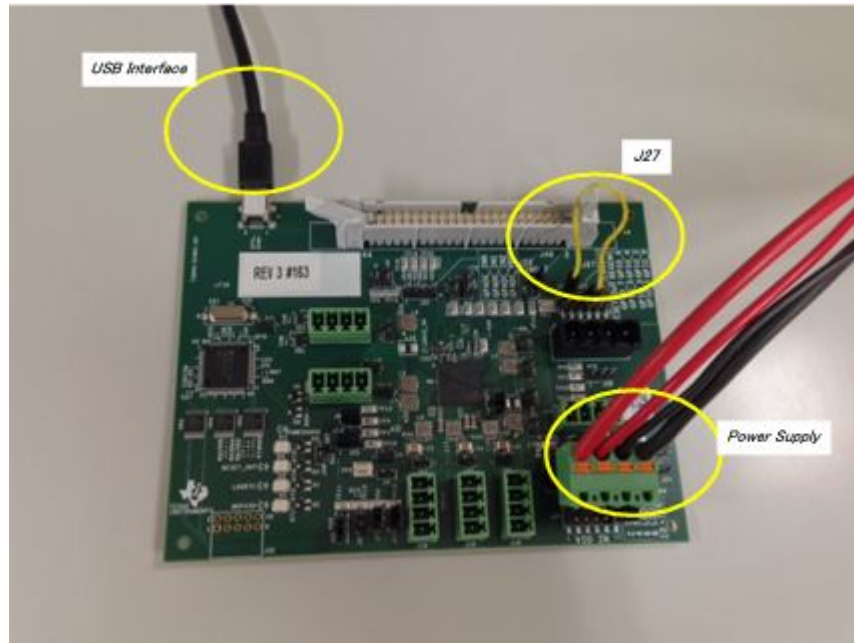


Figure 2. Power Supply

1.4 Default Jumper Settings

Table 1 lists the options for each header and the default jumper settings for the TPS659038EVM.

Table 1. Default Jumper Settings for the TPS659038EVM

Reference	Jumper Setting	Function	Default
J3	Closed	I2C1_SCL and I2C1_SDA are shorted	Open
	Open	I2C1_SCL and I2C1_SDA are separated	
J5	Closed	I2C2_SCL and I2C2_SDA are shorted	Open
	Open	I2C2_SCL and I2C2_SDA are separated	
J7	Closed	PWRDOWN pin is controlled by MSP430	Closed
	Open	PWRDOWN pin is floating	
J8	Closed	NRESWARM pin is controlled by MSP430	Closed
	Open	NRESWARM is floating	
J9	Closed	ENABLE1 pin is controlled by MSP430	Closed
	Open	ENABLE1 is floating	
J10	Closed	NSLEEP pin is controlled by MSP430	Closed
	Open	NSLEEP is floating	
J11	Closed	RESET_IN pin is controlled by MSP430	Closed
	Open	RESET_IN is floating	
J12	Closed	INT pin is connected to MSP430	Open
	Open	INT pin is floating	
J13	Closed	SYNCD CDC pin is connected to GND	Open
	Open	SYNCD CDC pin is floating	
J22	1	GPADC_IN0	Open
	2	GPADC_IN1	
	3	GPADC_IN2	
	4	GPADC_VREF	
J23	Open	POWERGOOD pin is floating	Open
	Closed	POWERGOOD pin is connected to GND	
J24	Open	CLK32KGO pin is floating	Open
	Closed	CLK32KGO pin is connected to GND	
J25	Jumper b/w 1 and 2	BOOT0 is tied to LDORTC	Jumper b/w 2 and 3
	Jumper b/w 2 and 3	BOOT0 is tied to GND	
J26	Jumper b/w 1 and 2	BOOT1 is tied to LDORTC	Jumper b/w 2 and 3
	Jumper b/w 2 and 3	BOOT1 is tied to GND	

Table 1. Default Jumper Settings for the TPS659038EVM (continued)

Reference	Jumper Setting	Function	Default
J27	1	GPIO_0	Jumper b/w 8 and 11 to tie POWERHOLD pin to VRTC
	2	GPIO_1	
	3	GPIO_2	
	4	GPIO_3	
	5	GPIO_4	
	6	GPIO_5	
	7	GPIO_6	
	8	GPIO_7	
	9	REGEN1	
	10	RESET_OUT	
	11	LODRTC	
	12	GND	
J28	1	VSYS	Open
	2	PWRON	
	3	GND	
J29	1	VSYS	Open
	2	PWRON	
	3	GND	
J30	-	Reserved	Closed
J31	1	VIO_IN	Jumper b/w 9 and 10
	2	SMSP7	
	3	VIO_IN	
	4	SMSP9	
	5	VIO_IN	
	6	LDO5	
	7	VIO_IN	
	8	LDO3	
	9	VIO_IN	
	10	+1V8	
	11	VIO_IN	
	12	+3V3	
J34	Open	All LDO_INs are floating	Closed
	Closed	All LDO_INs are connected to VSYS	
J35	Open	VPROG/TESTV is floating	Open
	Closed	VPROG/TESTV is connected to GND	
J36	—	SMPS12/3	Open
J37	—	SMPS12/3	Open
J38	—	SMPS12/3	Open
J39	—	SMPS3	Open
J40	—	SMPS45	Open
J41	—	SMPS45	Open
J42	—	SMPS6	Open
J43	—	SMPS7	Open
J44	—	SMPS8	Open
J45	—	SMPS9	Open
J47	Open	VCC1 isn't shorted to VSYS	Closed
	Closed	VCC1 is shorted to VSYS	
J48	Open	POWERGOOD is floating	Closed
	Closed	POWERGOOD is pulled up to 3.3V	

Table 1. Default Jumper Settings for the TPS659038EVM (continued)

Reference	Jumper Setting	Function	Default
J46	1	LDO1	
	2	LDO1_SENSE	
	3	LDO1_GND_SENSE	
	4	LDO2	
	5	LDO2_SENSE	
	6	LDO2_GND_SENSE	
	7	LDO3	
	8	LDO3_SENSE	
	9	LDO3_GND_SENSE	
	10	LDO4	
	11	LDO4_SENSE	
	12	LDO4_GND_SENSE	
	13	LDO5	
	14	LDO5_SENSE	
	15	LDO5_GND_SENSE	
	16	LDO6	
	17	LDO6_SENSE	
	18	LDO6_GND_SENSE	
	19	LDO7	
	20	LDO7_SENSE	
	21	LDO7_GND_SENSE	
	22	LDO8	
	23	LDO8_SENSE	
	24	LDO8_GND_SENSE	
	25	LDO9	
	26	LDO9_SENSE	
	27	LDO9_GND_SENSE	
	28	LDOLN	
	29	LDOLN_SENSE	
	30	LDOLN_GND_SENSE	
	31	LDOUSB	
	32	LDOUSB_SENSE	
	33	LDOUSB_GND_SENSE	
	34	LDORTC	
	35	LDORTC	
	36	GND	
	37	LDOVANA	
	38	LDOVANA	
	39	GND	
	40	GND	
	41	GND	
	42	GND	
	43	GND	
	44	GND	

2 EVM Schematics

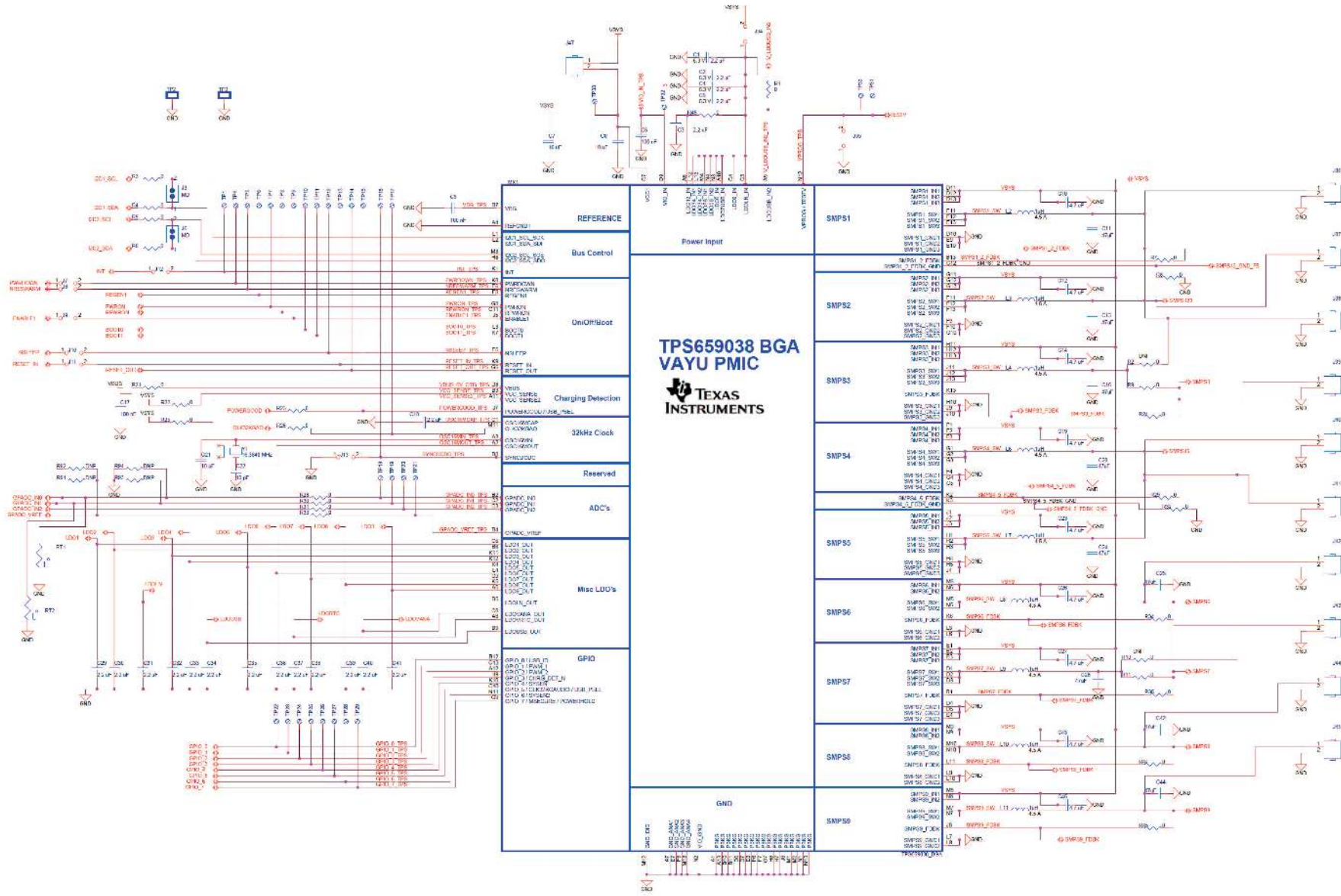


Figure 3. EVM Schematic

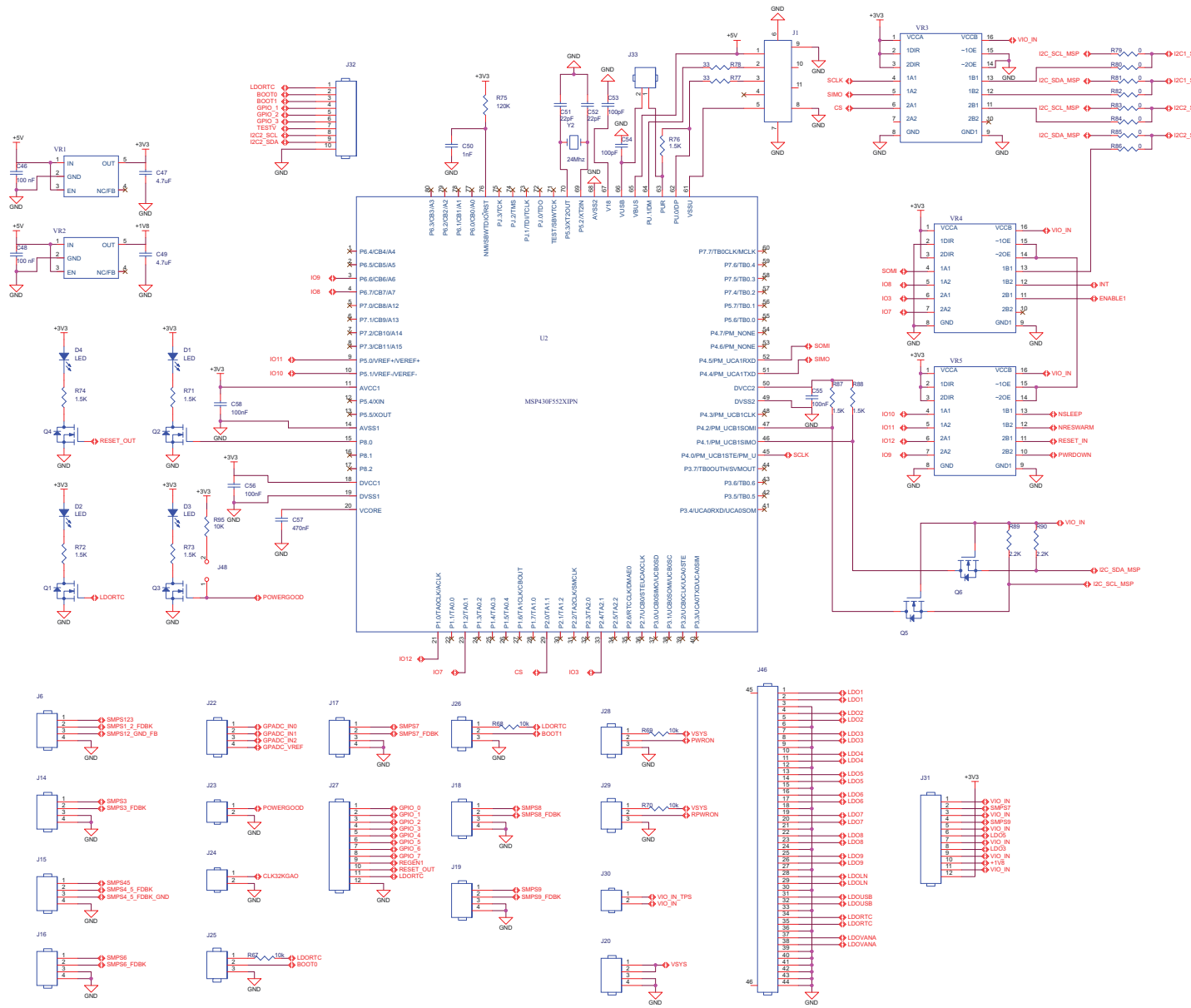


Figure 4. EVM Schematic

3 EVM BOM

Table 2 is for TPS65903x-Q1 EVM. The latest BOM is included in the TPS65903x-Q1 data sheet.

Table 2. EVM BOM

Item	Manufacturer	Manufacturer Part No.	Quantity	Reference	PCB Footprint	Value
1	Murata	GRM188R61A225KE34D	5	C1, C2, C3, C4, C5	cns_0603	2.2µF/0603/10V
2	Murata	GRM155R61A104KA01D	1	C6	cns_0402	100nF/0402/10V
3	Murata	GRM21BR61A106KE19L	1	C7	cns_0805	10µF/0805/10V
4	KEMET	C0603C106M9PAC	1	C8	cns_0603	10µF/6.3V
5	Murata	GRM155R60J104KA01D	4	C9, C17, C46, C48	cns_0402	100nF/0402/6.3V
6	Murata	GRM21BR71A475KA73K	9	C10, C12, C14, C19, C23, C26, C27, C43, C45	cns_0805	4.7µF/0805/10V
7	Murata	GRM32ER71A476ME15	9	C11, C13, C15, C20, C24, C25, C28, C42, C44	cns_1210_02	47µF/1210/10V
8	Murata	GRM32ER71A476ME15	0	C16, C59	cns_1210_02	47µF/1210/10V - DNP
9	Murata	GRM155R60J225ME15D	14	C18, C29, C30, C31, C32, C33, C34, C35, C36, C37, C38, C39, C40, C41	cns_0402	2.2µF/0402/6.3V
10	Murata	GRM155C1H120GA01D	2	C21, C22	cns_0402	12pF/0402/50V
11	Murata	GRM155R60J475ME87	2	C47, C49	cns_0402	4.7µF/0402/6.3V
12	Murata	GRM155R71H102KA01D	1	C50	0402	1nF/0402/50V
13	TDK	C1005C0G1H220J	2	C51, C52	0402	22pF/0402/50V
14	Murata	GRM1555C1H101JZ01D	2	C53, C54	0402	100pF/0402/50V
15	Murata	GRM188R71C104KA01	3	C55, C56, C58	0603	100nF/0603/16V
16	AVX	04026D474KAT2A	1	C57	0402	470nF/0402/50V
17			0	C60, C61	0603	4.7nF/0603/16V - DNP
17	Osram	LO T67K-L1M2 24	1	D1	PLCC-2	LO T67K-L1M2-24
18	Osram	LY T67K-K2M1 26	3	D2, D3, D4	PLCC-2	LY T67K-K2M1 26
19	Hirose	UX60-MB-5ST	1	J1	0.354 X 0.303 Inches	UX60-MB-5ST
20	Digi-Key	277-6735-ND	2	J6, J20	5.08MM	CONN HEADER 4POS
21	Digi-Key	277-1223-ND	6	J14, J15, J16, J17, J18, J19	3.81MM	CONN HEADER VERT 4POS
22	Sullins	PEC04SAAN	1	J22	2.54MM	CONN HEADER .100 SINGL STR 4POS
23	Sullins	PEC02SAAN	27	J3, J5, J7, J8, J9, J10, J11, J12, J13, J23, J24, J30, J33, J34, J35, J36, J37, J38, J39, J40, J41, J42, J43, J44, J45, J47, J48	2.54MM	CONN HEADER .100 SINGL STR 2POS
24	Sullins	PEC03SAAN	4	J25, J26, J28, J29	2.54MM	CONN HEADER .100 SINGL STR 3POS
25	TE Connectivity	146130-5	2	J27, J31	2.54MM	CONN HDR BRKWAY 12POS DUAL SMD
26	Sullins	PEC36DBAN	1	J32	.500 x .378 inch	Header, Right Angle 10 pins [72 pins strip] (DNP)
27	FCI	71918-144LF	1	J46	2.54MM	CONN HEADER 44POS DUAL VERT PCB

Table 2. EVM BOM (continued)

Item	Manufacturer	Manufacturer Part No.	Quantity	Reference	PCB Footprint	Value
28	Vishay	IHLP1616ABER1R0M11	9	L2, L3, L4, L6, L7, L8, L9, L10, L11		1 μ H/4.5A
29	Vishay	IHLP1616ABER1R0M11	0	L5, L12		1 μ H/4.5A - DNP
30	TI	TPS6591038_BGA	1	MX1		TPS659038 (customer supplied)
31	Fairchild	BSS138	6	Q1, Q2, Q3, Q4, Q5, Q6	SOT23	BSS138
32	Panasonic	ERJ-2GE0R00X	28	R1, R3, R4, R5, R6, R7, R8, R21, R22, R23, R24, R25, R26, R28, R29, R30, R31, R32, R33, R34, R35, R44, R45, R46, R79, R81, R84, R86	r-s_0402	0_0402 (0 Ω)
33	Panasonic	ERJ-2GE0R00X	0	R80, R82, R83, R85	r-s_0402	0_0402 (0 Ω) - DNP
34	Panasonic	ERJ-2RKF1002X	4	R67, R68, R69, R70	r-s_0402	10K_0402 (10 K Ω)
35	Panasonic	ERA-2AEB152X	7	R71, R72, R73, R74, R76, R87, R88	r-s_0402	1.5k_0402 (1.5 K Ω)
36	Panasonic	ERJ-2RKF1203X	1	R75	r-s_0402	120k_0402 (120 K Ω)
37	Yageo	RC0402FR-0733RL	2	R77, R78	r-s_0402	33_0402 (33 Ω)
38	Yageo	RC0402FR-072K2L	2	R89, R90	r-s_0402	2.2k_0402 (2.2 K Ω)
39			0	R91, R92, R93, R94	r-s_0402	0402 Resistor - DNP
41			0	R96, R97	r-s_0603	4.7_0603 (4.7 Ω) - DNP
42			0	RT1, RT2	0402	0402 RTC - DNP
41	TE Connectivity	1625854-3 (RCU-0C)	31	TP1, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20, TP21, TP22, TP23, TP24, TP25, TP26, TP27, TP28, TP29, TP30, TP31, TP32, TP33	1.60mm x 0.8mm x 1.15mm	0603 Probe Pad
42	Keystone	5016	2	TP2, TP3		Test Point SMD
43	TI	MSP430F5529IPN	1	U2		MSP430F55XIPN
44	TI	TPS76333DBVT	1	VR1	DBV	TPS76333DBVT
45	TI	TPS76318DBVT	1	VR2	DBV	TPS76318DBVT
46	TI	SN74AVC4T245PW	3	VR3, VR4, VR5	PW	SN74AVC4T245PW
47	Epson	FA-238 16.3840MB-C	1	Y1		16.384MHz
48	Abracon	ABLS-24.000MHZ-K4F-T	1	Y2	3.7x12.7 mm	24MHz

4 Powering up the Device

To turn on the device, perform the following steps:

1. Turn off the supply voltage, unplug the USB, and close the GUI.
2. While the power supply is disabled, connect it to the EVM through the J20 connector.
3. Plug the USB cable to the EVM and the computer. The MSP430 LED should blink a few times and then stay on.
4. Set the power supply to a voltage between 3.135 V and 5.25 V. Turn on the supply voltage. The LDORTC LED should light up.
5. Launch the GUI on the computer. All sequenced rails will power up to the predefined voltage.
6. Under the *DUT_Control* tab, send a logic high signal to the RESET_IN pin by checking the box next to RESET_IN and clicking *Write Static*. The RESET_OUT LED should light up, and the PMIC is now enabled.

5 TPS65903x-Q1EVM Graphical User Interface (GUI)

The GUI for TPS659038EVM gives the user the ability to interact with the internal registers of the device while also allowing control of some input pins. The GUI can be downloaded here. The TPS659038EVM GUI installation requires the LabVIEW run-time engine, which can be downloaded from the National Instruments website.

5.1 GUI Tabs

The TPS659038EVM GUI has two tabs. The first tab is labeled Registers, and the second tab is labeled *DUT_Control*.

5.1.1 DUT_Control

The digital input signals to the PMIC are controlled through the DUT_Control tab of the GUI. There are six pins controlled by the GUI. To send a logic low to any of the pins, uncheck the corresponding box and click *Write Static*. To send a logic high to any of the pins, check the corresponding box and click *Write Static*.

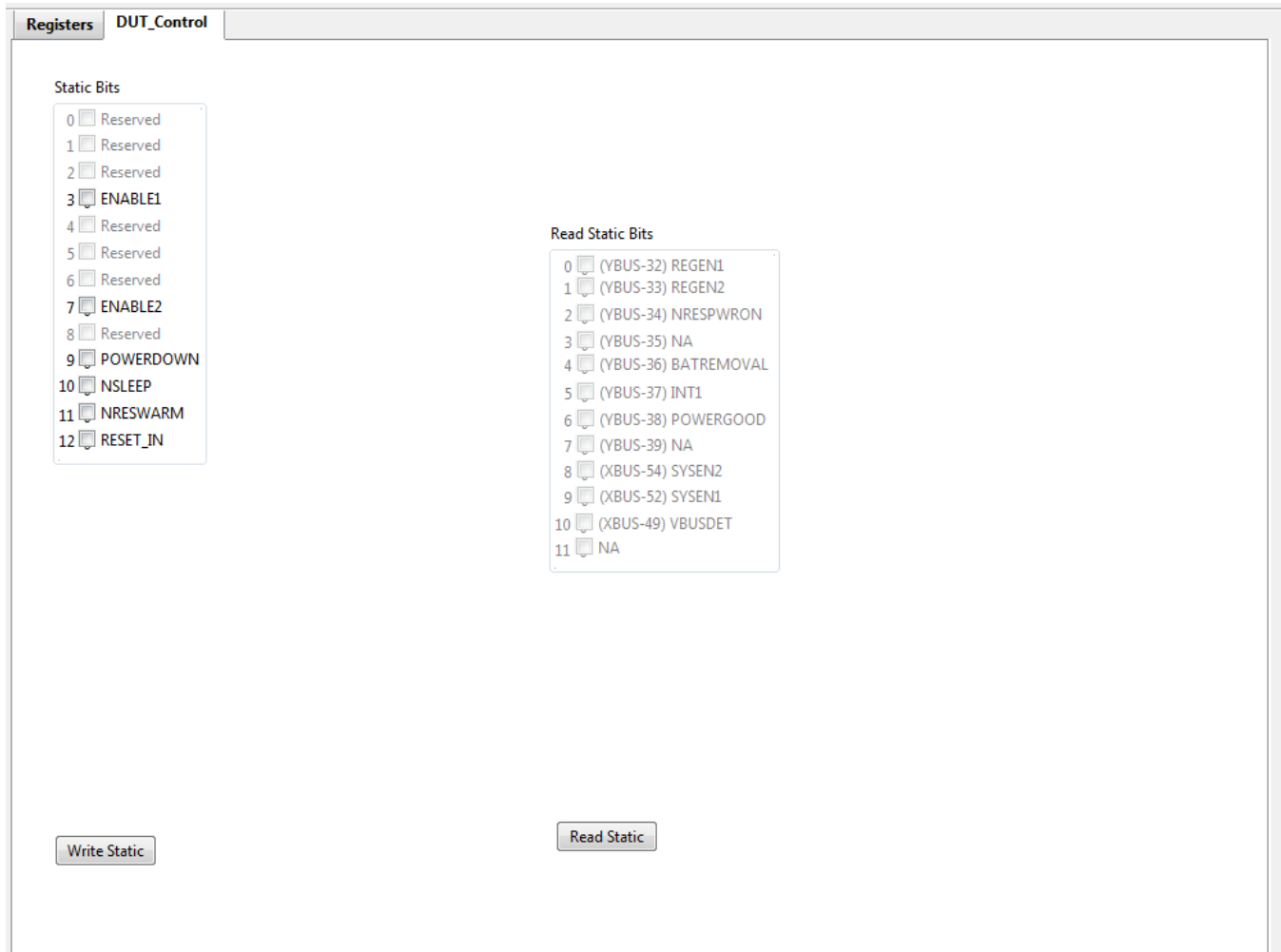


Figure 5. DUT_Control

5.1.2 Registers

I²C communication with the device uses the Registers tab of the GUI. There are five groups of registers. Clicking the + symbol next to the group lists all the registers in that group. A second column next to the register name shows the address offset of that register.

To read data from the register, select the appropriate register and click *Read*. The register data appears in the left column, and the hexadecimal value of the register appears in the *Read Data* field. To write data to the register, check the appropriate boxes in the right column and click *Write*, or enter the hex value in the *Write Data* field and click *Write*. The bits of the register are labeled on the left, with bit 0 in the top box and bit 7 in the bottom.

The screenshot shows the 'Registers' tab in the GUI, specifically the 'DUT_Control' group. It features a 'Register Map' table, a 'Write Data' section, a 'Read Data' section, an 'I2C Write Control' section, and a 'Register Data' section.

Block / Register Name	Address	Default	Mode	Size
PMU_CONFIG	0xB2	0x0	R	8
SPARE	0xB4	0x0	R	8
SW_REVISION	0xB7	0x0	R	8
PMU_SECONDARY_INT2	0xB9	0x0	R	8
SMPS12_CTRL	0x20	0x0	R	8
SMPS12_TSTEP	0x21	0x0	R	8
SMPS12_FORCE	0x22	0x0	R	8
SMPS12_VOLTAGE	0x23	0x0	R	8
SMPS3_CTRL	0x24	0x0	R	8
SMPS3_VOLTAGE	0x27	0x0	R	8
SMPS45_CTRL	0x28	0x0	R	8
SMPS45_TSTEP	0x29	0x0	R	8
SMPS45_FORCE	0x2A	0x0	R	8
SMPS45_VOLTAGE	0x2B	0x0	R	8
SMPS6_CTRL	0x2C	0x0	R	8
SMPS6_TSTEP	0x2D	0x0	R	8
SMPS6_FORCE	0x2E	0x0	R	8
SMPS6_VOLTAGE	0x2F	0x0	R	8
SMPS7_CTRL	0x30	0x0	R	8
SMPS7_VOLTAGE	0x33	0x0	R	8
SMPS8_CTRL	0x34	0x0	R	8
SMPS8_TSTEP	0x35	0x0	R	8
SMPS8_FORCE	0x36	0x0	R	8
SMPS8_VOLTAGE	0x37	0x0	R	8
SMPS9_CTRL	0x38	0x0	R	8
SMPS9_VOLTAGE	0x3R	0x0	R	8

Write Data: x0

Read Data: x0

I2C Write Control: Speed: 100kHz, Address Length: 7 bits, Pullups: OFF

Register Data:

- 0 MODE_ACTIVE[0]
- 1 MODE_ACTIVE[1]
- 2 MODE_SLEEP[2]
- 3 MODE_SLEEP[3]
- 4 STATUS[4]
- 5 STATUS[5]
- 6 ROOF_FLOOR_EN
- 7 WR_S

Description: SMPS12 control register. WR_S: Warm reset sensitivity. 0: Re-load the default value (from OTP) in SMPS12_VOLTAGE.VSEL and SMPS12_FORCE.VSEL register and re-load the default value (reset value) in SMPS12_FORCE.CMD during Warm Reset. 1: Maintain current voltage during Warm Reset (Registers remain unchanged - no voltage change). ROOF_FLOOR_EN: Roof Floor enable bit (only for DVS)

Figure 6. Registers

5.2 Running a Script with the GUI

The script editor is used to automate a series of register writes, static bit writes, and delays. To launch the script window from the main GUI menu, go to *Tools* → *Show Script Window*. The Script Editor opens with a blank window. To record a script, click *Start/Rec*, and run the commands from the main GUI. After each register write or static bit, the script editor records the command that was run. When finished, click *Stop*.

To run the script again, click *Run*. To save the script that was created, click *Save*, and select the destination for the script file. Click *Load* to load a previously saved script.

The two commands are:

- `tlv_write_reg_i2c1(REGISTER_NAME, VALUE)`, where the value is the decimal value to write.
- `wait(TIME_IN_MS)`

The script in [Figure 7](#) turns on SMPS12 to 1.1 V, waits 2 ms, and then turns on SMPS3 to 1.35 V. These commands can be used to run a power up and power down sequence quickly, eliminating the need to manually turn on each rail.

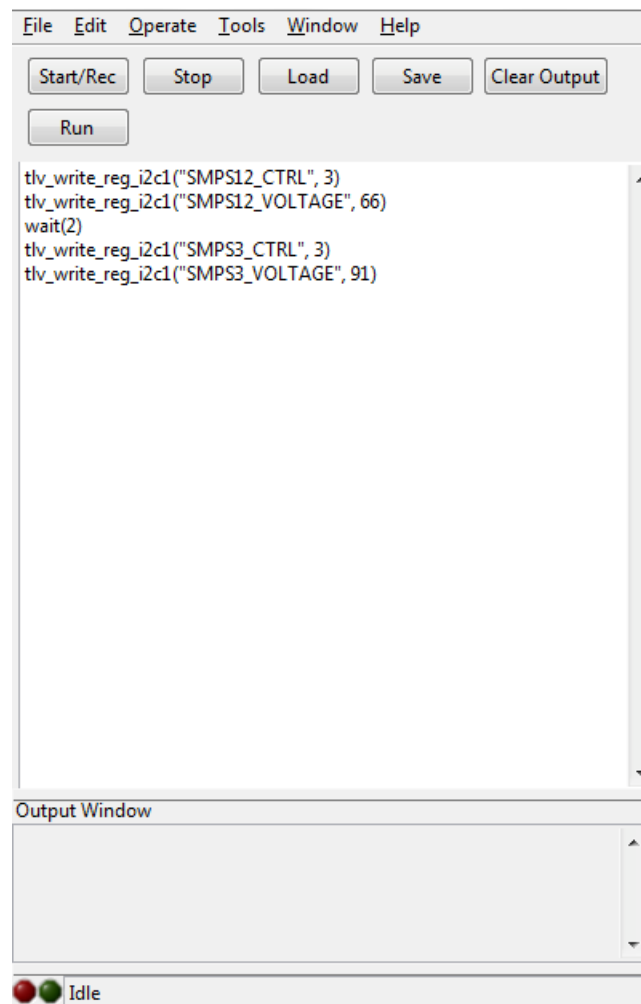


Figure 7. Sample Script

Revision History

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

Changes from Original (July 2014) to A Revision	Page
• First public release of document	1

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 semiconductor 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.
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/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 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。
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3.4 *European Union*

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

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

4 *EVM Use Restrictions and Warnings:*

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

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

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

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

6. *Disclaimers:*
- 6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.
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- 8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMNITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.
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10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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