User's Guide
SLUUB49–July 2014

bq25071 EVM User's Guide

The bq25071 evaluation module (EVM) is a complete charger module for evaluating the QFN packaged 1-A battery charge solution for single-cell, LiFePO4 battery-powered systems used in a wide range of portable applications

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1 Introduction

1.1 bq25071 Features

The bq25071 is a highly integrated, linear, LiFePO4 battery charger targeted at space-limited portable applications. It accepts power from either a USB port or AC adapter and charges a single-cell LiFePO4 battery with up to 1 A of charge current. Key integrated circuit (IC) features include:

- 30-V Input rating, with 10.5-V overvoltage protection (OVP)
- Programmable charge current through ISET and EN terminals
- 50-mA Integrated Low Dropout Linear Regulator (LDO)
- Soft-start feature to reduce inrush current
- Battery NTC monitoring
- Charging status Indication

For details, see the bq25071 data sheet (SLUSBK6).

1.2 bq25071 EVM - 658 Features

The bq25071 EVM on PWR658 PCB is a complete charger module for evaluating the linear battery charge solution for single-cell, Li-$FePO_4$ battery-powered systems used in a wide range of portable applications. Key EVM features include:

- Programmable charge current via external resistors, potentiometer and digital input pins
- Battery NTC thermistor optionally simulated by potentiometer
- Accepts adapter input operating range of 3.75 V – 10.2 V
- LED indication for charge
- Test points for key signals available for testing purposes; easy probe hook-up

1.3 Schematic

Figure 1 illustrates the bq25071 EVM schematic.

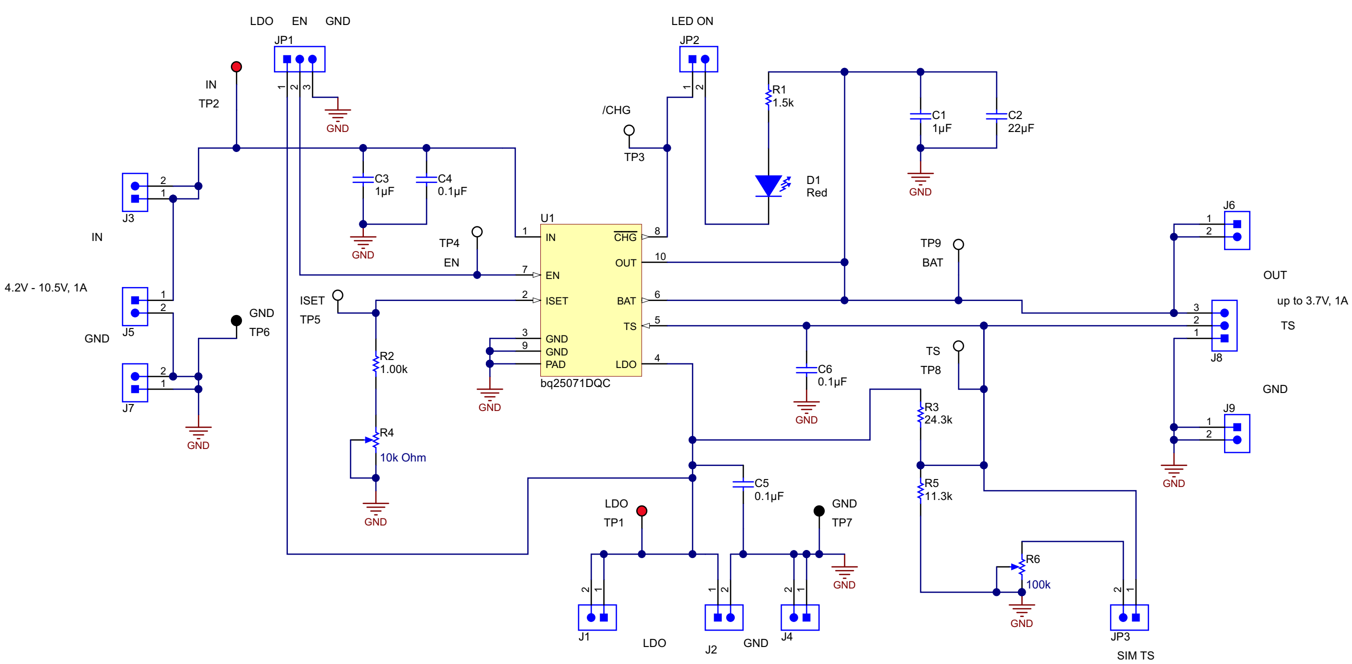

Figure 1. bq25071 EVM (PWR658) Schematic

1.4 I/O Description

Header or Terminal Block	Description
J1	Header for connecting LDO pin reference voltage to external load or measurement device positive connection
J2	Terminal block for connecting LDO reference voltage and GND pins to external load positive and negative connections
J3	Header for connecting IN pin to input supply or measurement device positive connection
J4	Header for connecting LDO GND to external load or measurement device negative connection
J5	Terminal block for connecting IN and GND pins to input supply positive and negative connections
J6	Header for connecting OUT pin to battery or measurement device positive connection
J7	Header for connecting GND pin to input supply or measurement device negative connection
J8	Terminal block for connecting OUT and GND pins to battery positive and negative connections and battery's NTC thermistor
J9	Header for connecting GND pin to battery or measurement device negative connection

1.5 Test Points

Test Point	Description
TP1	Test point connecting to LDO pin
TP2	Test point connecting to IN pin
TP3	Test point connecting to /CHG pin
TP4	Test point connecting to EN pin
TP5	Test point connecting to ISET pin
TP6	Test point connecting to board GND plane
TP7	Test point connecting to board GND plane
TP8	Test point connecting to TS pin
TP9	Test point connecting to OUT=BAT pin

1.6 Control and Key Parameters Setting

Jumper	Description	Default Factory Setting
JP1	EN = LDO: Disables the IC. EN = GND: Places the IC in user programmable mode using the ISET input where the input current is programmed. EN floating: Places the IC in USB500 mode.	GND
JP2	LED ON: Connects /CHG pin to LED	Installed
JP3	SIM TS: Connectors R6 potentiometer to TS pin as an NTC thermistor simulator	Installed

1.7 Recommended Operating Conditions

			MIN	TYP	MAX	UNIT
V_{IN}	Supply voltage	Operating input voltage from AC adapter (No charging for V_{IN} < VINDPM threshold = 4.4V)	3.75		10.2	V
V_{BAT}	Fully charged Battery voltage	Maximum voltage allowed at VBAT terminal	3.455	3.5	3.539	V
$I_{IN(LIM)}$	Input (charge) current	Maximum input current limit and therefore charge current	0.100		1.0	A
V_{LDO}	LDO output voltage	I_{LDO} = 0 to 50 mA	4.7	4.9	5.1	
I_{LDO}	Maximum LDO Output Current		60			mA
T_J	Operating junction temperature range		–40		150	°C

2 Test Summary

This procedure describes one test configuration of the bq25071EVM-658 evaluation board for bench evaluation.

2.1 Definitions

The following naming conventions are followed.

VXXX :	External voltage supply name (VIN, VUSB)
LOAD#:	External load name
V(TPyyy):	Voltage at internal test point TPyyy. For example, V(TP12) means the voltage at TP12.
V(Jxx):	Voltage at header Jxx
V(XXX, YYY):	Voltage across point XXX and YYY.
I(JXX(YYY)):	Current going out from the YYY terminal of header XX.
Jxx(BBB):	Terminal or pin BBB of header xx
JPx ON :	Internal jumper Jxx terminals are shorted.
JPx OFF:	Internal jumper Jxx terminals are open.
JPx (-YY-)	ON: Internal jumper Jxx adjacent terminals marked as YY are shorted.
Measure: → A, B	Check specified parameters A, B. If measured values are not within specified limits the unit under test has failed.
Observe → A, B	Observe if A, B occur. If they do not occur, the unit under test has failed.

Assembly drawings have location for jumpers, test points, and individual components.

2.2 Recommended Test Equipment

2.2.1 Power Supplies

1. Power supply number 1 (PS#1) capable of supplying up 10.2 V and at least 1.0 A is required.
2. If battery as the load, then a second power supply (PS#2), capable of supplying up to 5 V at 5 A, as shown in Figure 2.

2.2.2 Load Number 1 Between BAT and GND

Testing with an actual battery is the best way to verify operation in the system. If a battery is unavailable, then sourcemeter like a Keithley 2420, capable of both sourcing and sinking current, or a circuit similar to the one shown in Figure 2 can simulate a battery when connected to PS#2.

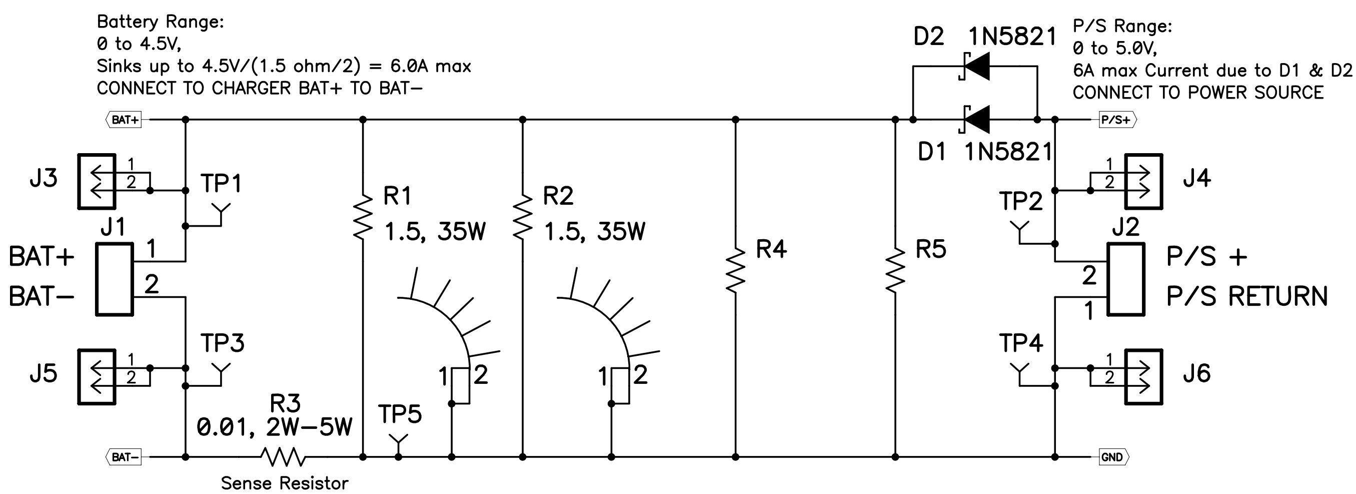

Figure 2. BAT Load (PR1010) Schematic

2.2.3 Meters

Three equivalent voltage meters (VM#x) and two equivalent current meters (CM#x) are required. The current meters must be able to measure at least 3-A current.

2.3 Recommended Test Equipment Setup

1. For all power connections, use short, twisted-pair wires of appropriate gauge wire for the amount of the current.
2. Set power supply #1 (PS#1) for 5 V ±100 mV DC, 1.5-A current limit and then turn off supply. Set power supply #2 (PS#2) for 3.4 V and then turn off supply.
3. Connect a voltage meter (VM#1) across J3 or TP2 (IN) and J7 (GND)
4. If BAT_Load (PR1010), as shown in Figure 2, is used, connect the PR1010 BAT+ terminal of PR1010 in series with a current meter (CM#1) to OUT of J8 or J6. Connect PR1010 BAT – to GND of J8 or J9. Connect the P/S+ and P/S return side of PR1010 to PS#2, set the voltage to 3.1 V +50 mV then disable PS#2.

CAUTION

The heat sinks on PR1010 will be very hot.

5. Connect a voltage meter (VM#2) across J6 (OUT) and J9 (GND).
6. Connect a DMM capable of measuring both voltage and resistance across TP5 (ISET) and TP7 (GND).

2.4 Recommended Test Procedure

The following test procedure may be useful for evaluating the charger IC outside of a real system, if no battery is available to connect to the output and a circuit similar to PR1010 is used to simulate a battery.

2.4.1 Charge Voltage and Current Regulation

1. Ensure that the *Section 2.3* steps are followed.
2. Enable PS#1 and PS#2.
3. Adjust PS#2 so that the voltage measured by VM#2, across BAT and GND, measures 2.9 V–3.0 V.
4. Adjust the PS#1 so that VM#1 still reads 5.0 V +100 mV

   Measure on CM#2 → I(BAT) = 900–1100 mA

   Observe D1 ($\overline{CHG}$) is on
5. Remove shunt on JP1.
6. Adjust the PS#1 so that VM#1 still reads 5.0 V +100 mV

   Measure on CM#2 → I(BAT) = 400–500 mA

   Observe D1 ($\overline{CHG}$) is on
7. Place shunt on JP1 to LDO.
8. Adjust the PS#1 so that VM#1 still reads 5.0 V +100 mV

   Measure on CM#2 → I(BAT) = 0 mA

   Observe D1 ($\overline{CHG}$) is off
9. Turn off PS#1 and PS#2 when complete.

2.4.2 Helpful Hints

1. The leads and cables to the various power supplies have resistance. The current meters also have series resistance. Therefore, voltmeters must be used to measure the voltage as close to the IC pins as possible instead of relying on each supply's digital measurement.
2. When using a sourcemeter as your battery simulator, it is highly recommended to add a large (1000 µF) capacitor at the EVM OUT/BAT and GND connectors in order to prevent oscillations at the BAT pin due to mismatched impedances of the charger output and sourcemeter input within their respective regulation loop bandwidths. Configuring the sourcemeter for 4-wire sensing eliminates the need for a separate voltmeter to measure the voltage at the BAT pin. When using 4-wire sensing, the 1000-µF capacitor across is required and the sensing leads must be connected before connecting the power leads in order to prevent accidental overvoltage by the power leads.
3. To observe the taper current as the battery voltage approaches the set regulation voltage, allow the battery to charge, or if using BAT_Load (PR1010), slowly increase the PS2 voltage powering BAT_Load (PR1010). Use VM#2 across OUT/BAT and GND to measure the battery voltage seen by the IC.
4. For precise measurements of charge current and battery regulation near termination, remove the current meter in series with the battery or battery simulator. An alternate method for measuring charge current is to either use an oscilloscope with hall-effect current probe or place a 1% or better, thermally capable (for example, 0.010 Ω in 1210 or larger footprint) resistor in series between the OUT/BAT or GND pins and battery and measure the voltage across that resistor. PR1010 resistor R3 is such a resistor.

3 PCB Layout Guidelines

1. Place of the IN capacitor as close as possible between the IN and GND pin. Place the OUT capacitor as close as possible between the OUT and GND pin. The BAT pin is a sense pin.
2. The PCB must have a ground plane (return) connected directly to the return of all components through vias (two vias per capacitor for power-stage capacitors, one via per capacitor for small-signal components). TI also recommends to put vias inside the PGND pads for the IC, if possible. A star ground design approach is typically used to keep circuit block currents isolated (high-power/low-power small-signal), which reduces noise-coupling and ground-bounce issues. A single ground plane for this design gives good results. With this small layout and a single ground plane, no ground-bounce issue occurs, and having the components segregated minimizes coupling between signals.
3. The high-current charge paths into IN and out OUT must be sized appropriately for the maximum charge current in order to avoid voltage drops in these traces. The GND pin must be connected to the ground plane to return current through the internal low-side FET.
4. The package's power pad should be connected to as much copper as possible on the top ground plane and through several vias to the bottom ground plane for optimal thermal performance.

4 Bill of Materials and Board Layout

4.1 Bill of Materials

Table 1 lists the BOM for this EVM.

Table 1. Bill of Materials – PWR658(1)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
C1	1	1 µF	CAP, CERM, 1 µF, 10 V, +/-10%, X5R, 0603	0603	C1608X5R1A105K	TDK
C2	1	22 µF	CAP, CERM, 22 µF, 10 V, +/-20%, X5R, 0603	0603	CL10A226MP8NUNE	Samsung
C3	1	1 µF	CAP, CERM, 1 µF, 25 V, +/-10%, X5R, 0603	0603	C1608X5R1E105K080AC	TDK
C4	1	0.1 µF	CAP, CERM, 0.1 µF, 25 V, +/-10%, X7R, 0603	0603	06033C104KAT2A	AVX
C5, C6	2	0.1 µF	CAP, CERM, 0.1 µF, 16 V, +/-5%, X7R, 0603	0603	0603YC104JAT2A	AVX
D1	1	Red	LED, Red, SMD	Red LED, 1.6x0.8x0.8mm	LTST-C190CKT	Lite-On
J1, J3, J4, J6, J7, J9, JP2, JP3	8		Header, 2x1, 100 mil, SMT	Header, 2x1, 100mil, TH	800-10-002-10-001000	Mill-Max
J2, J5	2		Terminal Block, 6 A, 3.5 mm Pitch, 2-Pos, TH	7.0x8.2x6.5mm	ED555/2DS	On-Shore Technology
J8	1		Terminal Block, 6 A, 3.5 mm Pitch, 3-Pos, TH	10.5x8.2x6.5mm	ED555/3DS	On-Shore Technology
JP1	1		Header, 3x1, 100mil, SMT	Header, 3x1, 100mil, TH	800-10-003-10-001000	Mill-Max
R1	1	1.5 kΩ	RES, 1.5 kΩ, 5%, 0.1 W, 0603	0603	CRCW06031K50JNEA	Vishay-Dale
R2	1	1.00 kΩ	RES, 1.00 kΩ, 1%, 0.1 W, 0603	0603	CRCW06031K00FKEA	Vishay-Dale
R3	1	24.3 kΩ	RES, 24.3 kΩ, 1%, 0.1 W, 0603	0603	CRCW060324K3FKEA	Vishay-Dale
R4	1	10 kΩ	Trimmer, 10 kΩ, 0.25 W, TH	4.5x8x6.7mm	3266W-1-103LF	Bourns
R5	1	11.3 kΩ	RES, 11.3 kΩ, 1%, 0.1 W, 0603	0603	CRCW060311K3FKEA	Vishay-Dale
R6	1	100 kΩ	Trimmer, 100 kΩ, 0.25 W, TH	4.5x8x6.7mm	3266W-1-104LF	Bourns
SH-JP1, SH-JP2, SH-JP3	3	1x2	Shunt, 100 mil, Gold plated, Black	Shunt	969102-0000-DA	3M
TP1, TP2	2	Red	Test Point, Compact, Red, TH	Red Compact Testpoint	5005	Keystone
TP3, TP4, TP5, TP8, TP9	5	White	Test Point, Compact, White, TH	White Compact Testpoint	5007	Keystone
TP6, TP7	2	Black	Test Point, Compact, Black, TH	Black Compact Testpoint	5006	Keystone
U1	1		bq25071 1 A, Single-Input, Single-Cell LiFePO4 Linear Battery Charger with 50 mA LDO, DQC0010A	DQC0010A	bq25071DQC	Texas Instruments

(1) Unless otherwise noted, all parts can be substituted with equivalents.

4.2 Board Layout

Figure 3 and Figure 4 illustrate the PCB layouts for this EVM.

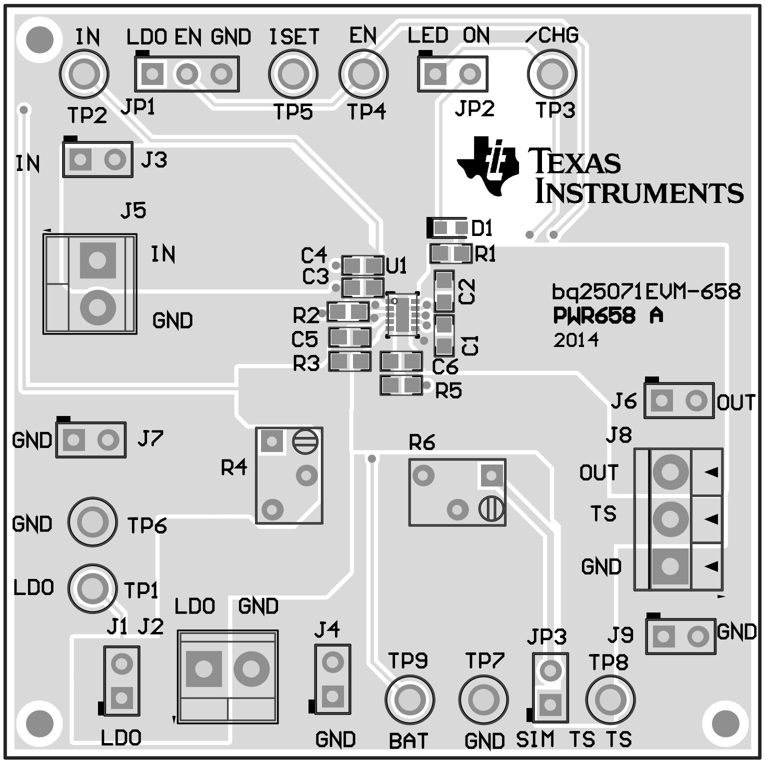

Figure 3. Top Assembly Layer

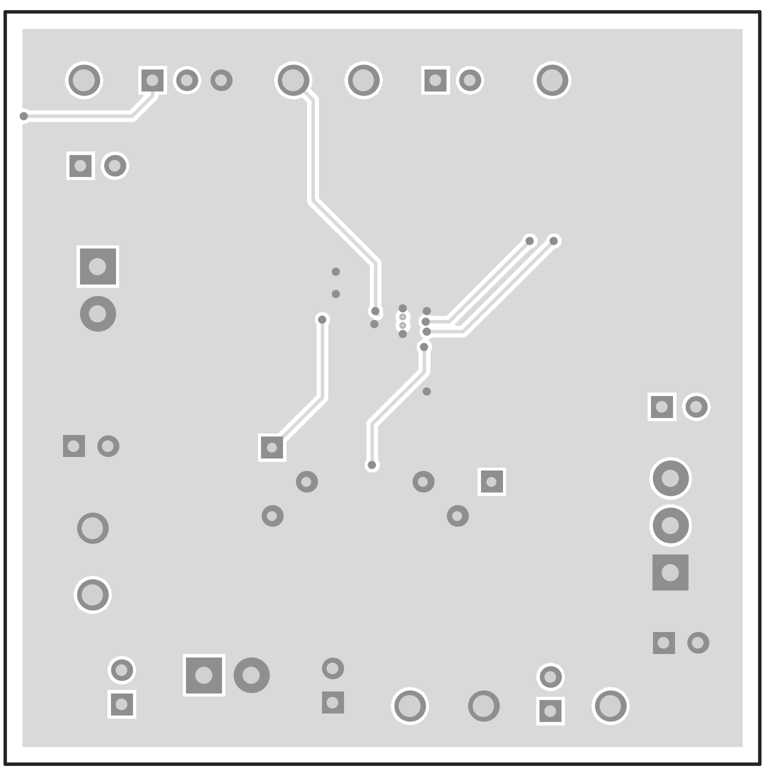

Figure 4. Bottom Layer

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General Statement for EVMs including a radio

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Caution

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Changes or modifications could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

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

FCC Interference Statement for Class B EVM devices

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

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

Industry Canada Compliance (English)

For EVMs Annotated as IC – INDUSTRY CANADA Compliant:

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

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

Concerning EVMs Including Radio Transmitters

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

Concerning EVMs Including Detachable Antennas

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Canada Industry Canada Compliance (French)

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

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

Concernant les EVMs avec appareils radio

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

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

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

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

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

If user uses EVMs in Japan, user is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

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

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なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします

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

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