The bq24160/161/163/168 evaluation module is a complete charger module for evaluating compact, flexible, high-efficiency, USB-friendly, switch-mode charge management solution for single-cell, Li-ion and Li-polymer batteries used in a wide range of portable applications.

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1 Introduction

1.1 bq2416x IC Features

The bq24160/161/163/168 integrates a synchronous PWM controller, power MOSFETs, input-current sensing, high-accuracy current and voltage regulation, charge termination and power path management into a small WCSP package. The charge parameters can be programmed through an I²C interface. Key IC features include:

- High-efficiency, fully integrated, NMOS-NMOS, synchronous buck charger with 1.5-MHz frequency
- Integrated power FETs for up to 2.5-A charge rate
- Power path management between battery and system voltages

For details, see the bq24160/161/163/168 data sheet (SLUSAO0).

1.2 bq24160/161/163/168 EVM Features

The bq24160/161/163/168 evaluation module (EVM) is a complete charger module for evaluating compact, flexible, high-efficiency, USB-friendly, switch-mode battery charge and power path management solution for single-cell, Li-ion and Li-polymer battery-powered systems used in a wide range of portable applications. Key EVM features include:

- 153-mm × 153-mm × 1.2-mm footprint for entire solution
- Input power connectors for both USB input and ac adapter
- Programmable battery voltage, charge current, input current, and status via I²C™ interface
- IN operating range of 4.2 V – 10 V (bq24160/161/163) or 4.2 V – 6 V (bq24168)
- USB operating range of 4.2 V – 6 V
- LED indication for status signals
- Test points for key signals available for testing purposes. Easy probe hook-up
1.3 Schematic

Figure 1. bq24160/161/163/168EVM (HPA721) Schematic

NOTE: EVMs with a printed-circuit board label that contain the suffix -X may have been assembled with incorrectly marked ICs. Regardless of the IC's marking, the EVM was assembled with the correct part number as specified in the EVM bill of material.
1.4 I/O Description

<table>
<thead>
<tr>
<th>Header/Terminal Block</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1–TS</td>
<td>External thermistor positive terminal</td>
</tr>
<tr>
<td>J1–GND</td>
<td>Ground terminal for external thermistor</td>
</tr>
<tr>
<td>J2–BAT</td>
<td>Battery positive header</td>
</tr>
<tr>
<td>J3–BAT</td>
<td>Battery positive terminal</td>
</tr>
<tr>
<td>J3–GND</td>
<td>Battery negative terminal</td>
</tr>
<tr>
<td>J4–IN</td>
<td>Adapter positive header</td>
</tr>
<tr>
<td>J5–IN</td>
<td>Adapter positive terminal</td>
</tr>
<tr>
<td>J5–GND</td>
<td>Adapter negative terminal</td>
</tr>
<tr>
<td>J6–GND</td>
<td>Battery negative terminal</td>
</tr>
<tr>
<td>J7–GND</td>
<td>Adapter negative terminal</td>
</tr>
<tr>
<td>J8–USB</td>
<td>USB positive header</td>
</tr>
<tr>
<td>J9–USB</td>
<td>USB positive terminal</td>
</tr>
<tr>
<td>J9–GND</td>
<td>USB negative terminal</td>
</tr>
<tr>
<td>J10–SYS</td>
<td>System output positive header</td>
</tr>
<tr>
<td>J11–GND</td>
<td>USB negative header</td>
</tr>
<tr>
<td>J12</td>
<td>USB Miniconnector</td>
</tr>
<tr>
<td>J13–SYS</td>
<td>System output positive terminal</td>
</tr>
<tr>
<td>J13–GND</td>
<td>System output negative terminal</td>
</tr>
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<td>J14–GND</td>
<td>System output negative header</td>
</tr>
<tr>
<td>J15–DRV</td>
<td>DRV reference voltage positive header</td>
</tr>
<tr>
<td>J16–DRV</td>
<td>DRV reference voltage positive terminal</td>
</tr>
<tr>
<td>J16–GND</td>
<td>DRV reference voltage negative terminal</td>
</tr>
<tr>
<td>J17</td>
<td>USB-TO-GPIO box connector</td>
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</table>

1.5 Test Points

<table>
<thead>
<tr>
<th>Test Point</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP1</td>
<td>Kelvin to VIN</td>
</tr>
<tr>
<td>TP2</td>
<td>STAT</td>
</tr>
<tr>
<td>TP3</td>
<td>Kelvin to BAT</td>
</tr>
<tr>
<td>TP4</td>
<td>Kelvin to USB</td>
</tr>
<tr>
<td>TP5</td>
<td>DRV</td>
</tr>
<tr>
<td>TP6</td>
<td>INT</td>
</tr>
<tr>
<td>TP7</td>
<td>Kelvin to SYS</td>
</tr>
<tr>
<td>TP8</td>
<td>GND</td>
</tr>
<tr>
<td>TP9</td>
<td>GND</td>
</tr>
<tr>
<td>TP10</td>
<td>SW</td>
</tr>
<tr>
<td>TP11</td>
<td>SCL</td>
</tr>
<tr>
<td>TP12</td>
<td>SDA</td>
</tr>
<tr>
<td>TP13</td>
<td>TS</td>
</tr>
</tbody>
</table>

1.6 Control and Key Parameters Setting
### Test Summary

This procedure describes one test configuration of the HPA721 evaluation board for bench evaluation.

### 2.1 Definitions

The following naming conventions are followed.

- **VXXX**: External voltage supply name (VADP, VBT, VSBT)
- **LOADW**: External load name (LOADR, LOADI)
- **V(TPyyy)**: Voltage at internal test point TPyyy. For example, V(TP12) means the voltage at TP12.
- **V(Jxx)**: Voltage at header Jxx
- **V(TP(XXX))**: Voltage at test point XXX. For example, V(ACDET) means the voltage at the test point which is marked as ACDET.

### 1.7 Recommended Operating Conditions

<table>
<thead>
<tr>
<th>Description</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage, $V_{IN}$</td>
<td>4.2</td>
<td>10</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Supply voltage, $V_{IN}$</td>
<td>4.2</td>
<td>6</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>USB voltage, $V_{USB}$</td>
<td>4.2</td>
<td>6</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>System voltage, $V_{SYS}$</td>
<td>3.3</td>
<td>VBATR EG+4.17 %</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>System voltage, $V_{SYS}$</td>
<td>3.1</td>
<td>VBATR EG+4.17 %</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Battery voltage, $V_{BAT}$</td>
<td>3</td>
<td>4.2</td>
<td>4.44</td>
<td>V</td>
</tr>
<tr>
<td>Supply current, $I_{IN(MAX)}$</td>
<td>1.5</td>
<td>2.5</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Supply current, $I_{USB(MAX)}$</td>
<td>0.1</td>
<td>0.5</td>
<td>1.5</td>
<td>A</td>
</tr>
<tr>
<td>Fast charge current, $I_{CHRG(MAX)}$</td>
<td>0.550</td>
<td>2.5</td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>

### Operating junction temperature range, $T_J$

-40 to 125°C
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 #1 (PS #1) capable of supplying 6 V at 3 A is required.
2. If not using a battery as the load, then power supply #2 (PS #2) capable of supplying up to 5 V at 5 A is required to power the circuit shown in Figure 2.

2.2.2 Load #1 Between BAT and GND
Testing with an actual battery is the best way to verify operation in the system. If a battery is not available, then a battery or circuit similar to the one shown in Figure 2 can simulate a battery when connected to a power supply.

2.2.3 Load #2 Between SYS and GND
Although not required, a resistive load capable of sinking up to 3 A can be used.
2.2.4 Meters

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

2.2.5 Computer

A computer with at least one USB port and a USB cable is required. The bq2416x evaluation software must be properly installed.

2.2.6 HPA172 Communication Kit (USB TO GPIO)

A HPA172 USB-to-I2C communication kit is required.

2.2.7 Software

Download BQ2416xSW.zip from the charger's product folder, unzip the file, and double-click on the SETUP.EXE file. Follow the installation steps.

Because the bq24160, bq24161, and bq24163 have the watchdog timers enabled, it is recommended that you set the software's Reset Watchdog Timer to reset every 5 seconds. Otherwise, after 30 seconds of operation, the IC enters Default mode. Note that the 27-minute safety timer is not reset by this function and eventually times out if charging does not complete, unless the Safety Timer Time Limit is expanded or disabled via the GUI. One way to reset the safety timer is to allow the 30-second watchdog timer to expire. See Figure 3 in the data sheet for more information about the timers.

Also, it is generally helpful to activate the Write On Change functions, in the upper left of the GUI window, to ON. The Write On Change function writes any changes to the GUI's check boxes, drop-down boxes, and registers to the IC. Otherwise, the user must click the WRITE button to write changes to the software. It is recommended that the user periodically click the READ button to find the IC's instantaneous status. Alternatively, the AutoRead function can be activated to periodically update the GUI with the IC's status.

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 6-V, 3-A current limit and then turn off supply.
3. If BAT_Load as shown in Figure 1 is used, connect Power Supply #2 (PS #2) set to approximately 3.6 V to the input side (PS #2+/−) of BAT_Load, then turn off PS #2.
4. Connect the output side of the battery or BAT_Load in series with current meter (multimeter) #2 (CM #2) to J2 and J6 or J3 (BAT, GND). Ensure that a voltage meter is connected across J2 or TP3 and J6 or TP9 (BAT, GND).
5. Connect VM #3 across J10 or TP7 and J14 or TP9 (SYS, GND).
6. Connect VM #4 across J15 or TP5 and J14 or TP9 (DRV, GND).
7. Connect J17 to HPA172 kit by the 10-pin ribbon cable. Connect the USB port of the HPA172 kit to the USB port of the computer. The connections are shown in Figure 3.
8. Ensure jumpers are at the default factory settings per Section 1.6
9. After the preceding steps have been performed, the test setup for HPA721 is configured as is shown in Figure 4.

Figure 3. Connections of HPA172 Kit

Figure 4. Original Test Setup for bq24160/161/163/168EVM (HPA721)
10. Turn on the computer. Open the bq2416x evaluation software. The main window of the software is shown in Figure 5.

![Figure 5. Main Window of bq2416xSW Evaluation Software](image)

### 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 simulated battery if needed.

#### 2.4.1 Charge Voltage and Current Regulation of IN

1. Ensure that the Section 2.3 steps are followed.
2. Connect the output of Power Supply #1 (PS #1) in series with current meter (multimeter) #1 (CM #1) to J4 and J7 or J5 (IN, GND).
3. Connect voltage meter 1 (VM #1) across J4 or TP1 and J7 or TP8 (IN, GND).
4. Move JP5 to HI.
5. Turn on PS #1 and PS #2 if used.
6. Return JP5 to LO.
7. Software setup:
   - Press the READ button to obtain the current settings.
Test Summary

- Set **Write On Change** to ON if not already set.
- Set **Reset Watchdog Timer** to update every 5 seconds.
- Set **Supply Precedence** to IN if not already set.
- Uncheck **Disable Charging** if checked.
- Check **Enable STAT/INT Outputs**.
- Set **Battery Regulation Voltage** to 4.20 V.
- Set **IN Input Current Limit** to 2.5 A.
- Set **Charge Current** to 1000 mA.
- Click the **READ** button at the top of the window and confirm that the previous settings remain.

8. For the bq24160 EVM, enable PS #2 and adjust PS #2 so that the voltage measured by VM #2, across BAT and GND, measures 3.2 V ± 50 mV. For the bq24161/163/168 EVMs, enable PS #2 and adjust PS #2 so that the voltage measured by VM #2, across BAT and GND, measures 2.5 V ± 50 mV.

9. Adjust the power supply so that VM #1 still reads 6 V ± 100 mV, if necessary, then

\[
\text{Measure on CM#2} \rightarrow I_{\text{CHRG}} = 1000 \text{ mA} \pm 100 \text{ mA}
\]
\[
\text{Measure on CM#1} \rightarrow I_{\text{IN}} = 700 \text{ mA} \pm 70 \text{ mA}
\]

10. Turn off PS #1 and PS #2.

2.4.2 Charge Voltage and Current Regulation of USB

1. Ensure that the **Section 2.3** steps are followed.
2. Connect the output of Power Supply #1 (PS #1) in series with current meter (multimeter) #1 (CM #1) to J8 and J11 or J9 (USB, GND).
3. Connect a voltage meter 1 (VM #1) across J8 or TP4 and J11 or TP8 (USB, GND).
4. Move JP5 to HI.
5. Turn on PS #1 and PS #2 if used.
6. Return JP5 to LO.
7. Software setup:
   - Press the **READ** button to obtain the current settings.
   - Set **Write On Change** to ON if not already set.
   - Set **Reset Watchdog Timer** to update every 5 seconds.
   - Set **Supply Precedence** to USB if not already set.
   - Uncheck **Disable Charging** if checked.
   - Check **Enable STAT/INT Outputs**.
   - Set **Battery Regulation Voltage** to 4.20 V.
   - Set **USB Input Current Limit** to 1500 mA.
   - Set **Charge Current** to 1000 mA.
   - Click the **READ** button at the top of the window, and confirm that the previous settings remain.

8. For the bq24160 EVM, enable PS #2 and adjust PS #2 so that the voltage measured by VM #2, across BAT and GND, measures 3.2 V ± 50 mV. For the bq24161/163/168 EVMs, enable PS #2 and adjust PS #2 so that the voltage measured by VM #2, across BAT and GND, measures 2.5 V ± 50 mV.

9. Adjust the power supply so that VM #1 still reads 6 V ± 100 mV if necessary then

\[
\text{Measure on CM#2} \rightarrow I_{\text{CHRG}} = 1000 \text{ mA} \pm 100 \text{ mA}
\]
\[
\text{Measure on CM#1} \rightarrow I_{\text{IN}} = 700 \text{ mA} \pm 70 \text{ mA}
\]

10. Turn off PS #1 and PS #2.

2.4.3 Helpful hints

1. 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 PS #2 voltage powering BAT_Load (PR1010). Use VM #2 across BAT and GND to measure the battery voltage seen by the IC.
2. To observe the $V_{\text{INDPM}}$ function, lower the current limit on PS #1.

3. To observe battery supplement mode, apply a resistive load across SYS and GND that is higher than the maximum charge current.

3 Printed-Circuit Board Layout Guideline

1. To obtain optimal performance, the power input capacitors, connected from the PMID input to PGND, must be placed as close as possible to the bq2416x.

2. Place 4.7-$\mu$F input capacitor as close to PMID pin and PGND pin as possible to make the high-frequency current loop area as small as possible. Place 1-$\mu$F input capacitor GNDs as close to the respective PMID capacitor GND and PGND pins as possible to minimize the ground difference between the input and PMID_.

3. The local bypass capacitor from SYS to GND must be connected between the SYS pin and PGND of the IC. The intent is to minimize the current path loop area from the SW pin through the LC filter and back to the PGND pin.

4. Place all decoupling capacitors close to their respective IC pins and as close as to PGND (do not place components such that routing interrupts power stage currents). All small control signals must be routed away from the high-current paths.

5. 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). It is also recommended 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 exists, and having the components segregated minimizes coupling between signals.

6. The high-current charge paths into IN, USB, BAT, SYS, and from the SW pins must be sized appropriately for the maximum charge current in order to avoid voltage drops in these traces. The PGND pins must be connected to the ground plane to return current through the internal low-side FET.

7. For high-current applications, the balls for the power paths must be connected to as much copper in the board as possible. This allows better thermal performance because the board conducts heat away from the IC.
4 Bill of Materials and Board Layout

4.1 Bill of Materials

Table 1. Bill of Materials - HPA721

<table>
<thead>
<tr>
<th>Count</th>
<th>RefDes</th>
<th>Value</th>
<th>Description</th>
<th>Size</th>
<th>Part Number</th>
<th>MFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>-001</td>
<td>2</td>
<td>2</td>
<td>C1, C3</td>
<td>1 µF</td>
<td>Std</td>
<td>Std</td>
</tr>
<tr>
<td>-002</td>
<td>2</td>
<td>2</td>
<td>C2, C5</td>
<td>1 µF</td>
<td>Std</td>
<td>Std</td>
</tr>
<tr>
<td>-003</td>
<td>1</td>
<td>1</td>
<td>C4, C12</td>
<td>47 µF</td>
<td>Std</td>
<td>Std</td>
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<tr>
<td>-004</td>
<td>0</td>
<td>0</td>
<td>C6, C10</td>
<td>Open</td>
<td>Std</td>
<td>Std</td>
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<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>C7, C8</td>
<td>4.7 µF</td>
<td>Std</td>
<td>Std</td>
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<td>C9</td>
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<td>Std</td>
<td>Std</td>
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<td>C11</td>
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<td></td>
<td>2</td>
<td>2</td>
<td>D1, D2</td>
<td>Green</td>
<td>Std</td>
<td>Std</td>
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<td></td>
<td>6</td>
<td>6</td>
<td>J1, J3, J5, J9, J13, J16</td>
<td>ED555/2DS</td>
<td>Terminal Block, 2-pin, 6-A, 3.5mm</td>
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<td>1</td>
<td>1</td>
<td>J12</td>
<td>UX60-MB-5ST</td>
<td>Connector, Recpt, USB-B, Mini, 5-pins, SMT</td>
<td>TI</td>
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<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>J17</td>
<td>N2510-6002-RB</td>
<td>Connector, Male Straight 2x5 pin, 100mil spacing, 4 Wall</td>
<td>TI</td>
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<tr>
<td></td>
<td>9</td>
<td>9</td>
<td>J2, J4, J6, J7, J8, J10, J11, J14, J15</td>
<td>PEC02SAAN</td>
<td>Header, Male 2-pin, 100mil spacing</td>
<td>TI</td>
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<td>JP1, JP2, JP5</td>
<td>PEC03SAAN</td>
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<td>PEC02SAAN</td>
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<td>1</td>
<td>JP4</td>
<td>PEC03SAAN</td>
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</tr>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>L1</td>
<td>1.5µH</td>
<td>Inductor, SMT, 3.5A, 70 mW</td>
<td>TI</td>
</tr>
<tr>
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<td>1</td>
<td>1</td>
<td>Q1</td>
<td>CSD25401Q3</td>
<td>MOSFET, PChan, -20V, 60A, 8.7 mΩ</td>
<td>TI</td>
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<td></td>
<td>1</td>
<td>1</td>
<td>R1</td>
<td>1870</td>
<td>Resistor, Chip, 1/16W, 1%</td>
<td>TI</td>
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<td></td>
<td>1</td>
<td>1</td>
<td>R2</td>
<td>50.0k</td>
<td>Potentiometer, 3/8 Cermet, 12-Turn</td>
<td>TI</td>
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<td>R3</td>
<td>4120</td>
<td>Resistor, Chip, 1/16W, 1%</td>
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<td></td>
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<td>R4</td>
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<td>Resistor, Chip, 1/16W, 1%</td>
<td>TI</td>
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Alternate: SPM4012T-1R5M Alternate: FDS0415-H-1R5M Alternate: Toko
Table 1. Bill of Materials - HPA721 (continued)

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4.2 Board Layout

Figure 6. Top Assembly Layer

Figure 7. Top Layer
Figure 8. First Internal Layer

Figure 9. Second Internal Layer
Figure 10. Bottom Layer
EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

Texas Instruments (TI) provides the enclosed Evaluation Board/Kit/Module (EVM) under the following conditions:

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods.

Should this evaluation board/kit not meet the specifications indicated in the User’s Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

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As noted in the EVM User’s Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

For EVMs not subject to the above rules, this evaluation board/kit/module is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and is not considered by TI to be a finished end product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

**General Statement for EVMs including a radio**

*User Power/Frequency Use Obligations*: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user’s sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this is strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

**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**

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.
REGULATORY COMPLIANCE INFORMATION (continued)

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.

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.

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.
【Important Notice for Users of this Product in Japan】

This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product 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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

Texas Instruments Japan Limited
(address) 24-1, Nishi-Shinjuku 6 chome, Shinjukku-ku, Tokyo, Japan

http://www.tij.co.jp

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EVALUATION BOARD/KIT/MODULE (EVM)
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Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.

2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.

3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.

4. You will take care of proper disposal and recycling of the EVM’s electronic components and packing materials.

Certain Instructions. It is important to operate this EVM within TI’s recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User’s Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, some circuit components may have case temperatures greater than 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

Agreement to Defend, Indemnify and Hold Harmless. You agree to defend, indemnify and hold TI, its licensors and their representatives harmless from and against any and all claims, damages, losses, expenses, costs and liabilities (collectively, "Claims") arising out of or in connection with any use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

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