This getting started guide reviews the contents of the MSP430FR6047 ultrasonic sensing evaluation module and tells you how to quickly get started with the MSP430FR6047 device for a water flow meter solution. The information in this guide also applies to the MSP430FR6043 ultrasonic sensing evaluation module when used in the water metering configuration. For more information on the EVM430-FR6043 in water metering configuration, see the Optimized ultrasonic sensing metrology reference design for water flow measurement.

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Introduction

Thank you for requesting the MSP430FR6047 sample kit. This getting started guide reviews the contents of your kit and provides an overview on how to quickly get started with the MSP430FR6047 experimental device for water flow meter solution.

1.1 Package Contents

The package includes:

a. USS evaluation module (EVM) version 2.0 hardware that has the MSP430FR6047 device with interfaces to a transducer pair: http://www.ti.com/tool/EVM430-FR6047

b. The graphical user interface (GUI) to control the configurable parameters of the transducers and view the results including the delta time of flight (dToF), absolute time of flight (aToF), measured flow rate, and ADC waveforms: http://software-dl.ti.com/msp430/msp430_public_sw/mcu/msp430/USSSWLib/USSSWLibWater/latest/index_FDS.html

c. An application example project that is supported by Code Composer Studio™ IDE (CCS) or IAR Embedded Workbench® IDE. This project uses TI’s Ultrasonic Sensing Solution (USS) Library and interfaces to the GUI: http://software-dl.ti.com/msp430/msp430_public_sw/mcu/msp430/USSSWLib/USSSWLibWater/latest/index_FDS.html

d. The USS library and supporting documentation of the APIs that are available in the library: http://software-dl.ti.com/msp430/msp430_public_sw/mcu/msp430/USSSWLib/USSSWLibWater/latest/index_FDS.html

1.2 What is Not Included

An Audiowell flow sensor with brass pipe is used as an example in this document. This sensor is available from the Audiowell Electronics website.

1.3 System Requirement

The system requires the latest Java and Uniflash standalone flash tool. If not already installed, they are available from https://java.com/en/download/ and http://www.ti.com/tool/UNIFLASH, respectively.
2 Connect the EVM to the Flow Meter

This section describes the hardware connections. For more details of hardware connections, see the EVM430-FR6047 Hardware Guide.

1. Connect the EVM430-FR6047 to the flow meter (see Figure 1).

![Figure 1. EVM430-FR6047 Connected to Flow Meter](image1)

2. Connect the jumpers as shown in Figure 2. The COMM_IRQ, COMM_SDA, and COMM_SCL jumpers on the J5 header are required for communication with the GUI. TEST and RST jumpers on J2 are required to program the board. The POW_SEL switch should be in the middle position (ezFET), J1 in the right position, and both J3 jumpers set to use USB power. The jumper locations are highlighted in Figure 2.

![Figure 2. EVM430-FR6047 Jumper Settings](image2)
3. Make sure that there is water in the flow meter.
4. Connect a USB cable from the PC to the EVM and verify that LED D201 (power good) is illuminated and LED D202 (HID enumeration) blinks on the EVM.

**NOTE:** If LED3 is lit, this indicates an error. Connecting to the GUI will show the error in the errors tab. If the error is "No signal detected in up and downstream channel", refer to Section 4.3 to ensure a proper signal is obtained.

5. More details on hardware configuration can be found in the Ultrasonic Sensing Metrology Subsystem Reference Design for Water Flow Measurement design guide and an overview video at Getting Started with the MSP430FR6047 Ultrasonic sensing EVM.

### 3 Flashing the EVM and Installing the GUI

After you connect the EVM to the PC, flash the latest version of the water metering software to the EVM. You can use the Uniflash tool to flash the EVM.

1. Install the Uniflash tool on your PC.
3. Open Uniflash and select the MSP430FR6047 device.

![Select MSP430FR6047 Device](image)

**Figure 3. Select MSP430FR6047 Device**

4. Choose Connection.
5. Choose image to load. Default image is installed in `C:\ti\msp\UltrasonicWaterFR604x_revision_number\image`
6. Click Load Image.

![Load Image](image)

**Figure 4. Load Image**


A shortcut named `USS` is installed to the Texas Instruments folder in the Windows Start menu to launch the Ultrasonic Sensing Design Center GUI.
4 USS GUI

4.1 Connecting to the Platform

After you have installed the GUI and flashed the image to the EVM, run the USS GUI. Connect to the platform by clicking "Connect" in the "Communications" menu. The GUI reports the connection as shown in Figure 5.

![USS GUI Connected to EVM](image)

Figure 5. USS GUI Connected to EVM
4.2 Configuration Parameters

4.2.1 Basic Configuration Parameters

Figure 6 shows the primary configuration parameters.

The F1, Gap, and Gain parameters are the only parameters which should be initially adjusted. All other parameters should be set to their default values for 1-MHz transducers. These parameters control the excitation, amplification, and ADC capture time between the ultrasonic transducers connected to the platform.

Set the "Transmit Frequency" to the nominal frequency of the transducers in kHz (for example, set to 1000 for 1-MHz transducers). Tune this parameter after the frequency sweep (described in Section 4.5) is conducted. After the other parameters have been properly determined, tune the transmit frequency to give a better signal response as described in Section 4.3.

Set the "Gap between pulse start and ADC capture" based on the anticipated ultrasonic time of flight for a given flow tube with enough additional capture time to address signal shifts due to temperature variations.

The "GUI Based Gain Control" controls the gain of the integrated PGA. Set this parameter to give an ADC capture of no more than ±900 ADC counts in the ADC capture tab. Although the system should be operable with signals down to ±150 ADC counts, setting the gain to give higher ADC counts reduces the standard deviation in measurements.
For example, a DN-25 pipe might have an ultrasonic path which corresponds to a time of flight of approximately 65 µs. This is based on an ultrasonic path between transducers of approximately 9.5 cm and the speed of sound in water (1450 m/s). An appropriate "Gap" that would ensure there is enough time before the signal to accommodate shifts due to temperature variations might therefore be 60 µs. The ultrasonic distance between transducers will affect how much additional margin is required to address shifts in the signal due to temperature and flow variations. For example, a pipe with an ultrasonic path of 19 cm might require 10 µs of additional capture time preceding the signal.

The "Number of Pulses" affects the strength of the signal and the standard deviation of the dToF waveform at zero flow. An increase in the number of pulses should give a lower standard deviation in dToF. There is also a tradeoff with respect to power consumption and interference. As the number of pulses is increased, earlier parts of the excitation signal can interfere with the latter part of the transmitted signal when traveling along alternative ultrasonic paths. The default setting for this parameter should be used as a starting point.

The "UPS and DNS gap" is the time between upstream and downstream measurements. The time required between measurements is governed by the ultrasonic propagation time. Larger pipes require a larger gap. There also needs to be enough time between UPS and DNS excitations to ensure the DNS signal does not have interference from residual reflections of the UPS signal. The default setting for this parameter should be used as a starting point.

The "UPS0 to UPS1 Gap" is the time between the end of a set of measurements and the beginning of the next set of measurements. Power consumption is directly affected by the measurement rate. A UPS0 to UPS1 gap of 1 second consumes roughly twice as much power as a UPS0 to UPS1 gap of 2 seconds. The default setting for this parameter should be used as a starting point.

Set the "Meter Constant" to give a volumetric result that is consistent with a reference meter under flow. Specifics on the calibration procedure for determining the meter constant can be found in the "Calibration User's Guide". The default setting for this parameter should be used as a starting point.

After the desired set of configuration parameters has been set, you should click the "Request Update" button to send these parameters to the platform. The "Save Configuration" button will save the current set of parameters to a file. The "Load Configuration" button loads a previously saved set of configuration parameters from a file. The timing diagram for the configuration can be seen at the bottom of the GUI screen (see Figure 7). The timing diagram represented in this figure is representative and is not exact.

![Figure 7. Configuration Timing Diagram](image-url)
4.2.2 Advanced Configuration Parameters

The "Advanced Parameters" tab provides access to a variety of more advanced configuration parameters (see Figure 8).

![Figure 8. Advanced Parameters Tab](image)

Set the "Signal Sampling Frequency" to 3.6 MHz for 1-MHz transducers and 8 MHz for 2-MHz transducers. Other options including 3.4, 3.8, and 4 MHz can also be used for 1-MHz transducers.

The "Delta ToF Offset" is an adjustment to the differential ToF during the calculation of volume flow rate inside the ultrasonic flow meter library. Developers can optionally make their custom calculation of the volume flow rate based on the ToF values provided by the library. See the "Calibration User's Guide" for more details. The "Abs ToF Additional Delay" is an adjustment to the absolute ToF to account for any additional delays. The value depends on the shape of the signal and the envelope threshold. Developers can optionally set this value to zero and make their own adjustments of the absolute ToF in the application layer.

Increase the "Capture Duration" for configurations with a larger number of pulses, or decrease it for configurations with smaller number of pulses to ensure the signal is fully captured with enough margin for shifts over the intended operating temperature range.

The "Interpolation Correction Table Size" determines the number of points used to correct for the interpolation used in the AbsToF algorithm. Designs requiring more accurate results can use a larger interpolation table. For details on this table, see the "Calibration User’s Guide".
The “Algorithm Option” determines which algorithm is used. Only the lobe algorithm is currently available for water metering. A detailed explanation of how this algorithm works can be found in the Ultrasonic Sensing Metrology Subsystem Reference Design for Water Flow Measurement design guide.

The “Envelope Crossing Threshold” determines which lobe the AbsToF algorithm will lock onto. Set this threshold to lock onto the earliest lobe peak that is above the noise. In the example shown in Figure 9, this lobe peak corresponds to a threshold of approximately 22%. Additional information regarding the envelope crossing threshold can be found in the Optimized ultrasonic sensing metrology reference design for water flow measurement.

The “Search Range” parameter is specific to gas algorithms and is not currently used by the “Lobe” algorithm.

"User Param #6" is reserved for future use.

"User Param #10" is reserved for future use.

4.2.3 Conditional Parameters

Modify the following parameters only under specific conditions.

The “ULP Bias Delay” determines when the bias circuit is turned on. The relevant timing diagrams for the operation of the ULP bias circuit can be found in the MSP430FR58xx, MSP430FR59xx, and MSP430FR6xx Family User’s Guide. For low current consumption, the recommended value is 3.
The “Start PPG Count” determines when the PPG is started. The timing diagrams for the operation of the ULP bias circuit can be found in the *MSP430FR58xx, MSP430FR59xx, and MSP430FR6xx Family User's Guide*. For low current consumption, the recommended value is 10000 nanoseconds. The only scenario in which this value should be changed is when the time of flight between transducers is less than 30 µs. Use a corresponding increase in this parameter to enable more closely spaced transducers. For transducers spaced 25 µs apart, increase this count to 15000 ns.

The “Turn on ADC Count” determines when the ADC is turned on. The relevant timing diagrams for the operation of the ULP bias circuit can be found in the *MSP430FR58xx, MSP430FR59xx, and MSP430FR6xx Family User's Guide*. Do not modify this parameter.

The “Start PGA and IN Bias Count” determines when the PGA and in Bias Circuit is turned on. The relevant timing diagrams for the operation of the ULP bias circuit can be found in the *MSP430FR58xx, MSP430FR59xx, and MSP430FR6xx Family User's Guide*. Do not modify this parameter.

The “USS XTAL Settling Count” determines how much time is allowed for crystal or resonator settling. Based on internal experiments, 120 µs is suggested for resonators, and 5000 µs is suggested for crystals.

The "Search Range" parameter is specific to gas algorithms and is not currently used by the "Lobe" algorithm.

### 4.2.4 Configuration Tuning

After a working configuration has been set, you can experiment with changes to that working set to tune the system for optimum performance and power. *Table 1* indicates how changes in specific configuration parameters change system performance.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Change to Parameter Affects...</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Power Consumption</td>
</tr>
<tr>
<td>Number of Pulses</td>
<td>✔</td>
</tr>
<tr>
<td>UPS0 to UPS1 Gap</td>
<td>✔</td>
</tr>
<tr>
<td>GUI Based Gain Control</td>
<td></td>
</tr>
<tr>
<td>Transmit Frequency</td>
<td></td>
</tr>
<tr>
<td>Envelope Crossing Threshold</td>
<td></td>
</tr>
<tr>
<td>Capture Duration</td>
<td>✔</td>
</tr>
</tbody>
</table>
4.3 Capturing the ADC Signals

To capture the ADC signal, go to the "ADC Capture" tab and click the "Capture" button. If you are using an AudioWell DN-25 meter, you should see a signal that looks like Figure 10 at zero flow.

Figure 10. Captured ADC Signal

If the capture looks different, check these items first.

- Reduce the gain in your configuration parameters to –6.5 dB. Because the captured signal is windowed, the tail of the signal may be slightly truncated without changing the results.
- Adjust the Gap between pulse start and ADC capture. Figure 11 shows an example where the gap is set too long. Figure 12 shows an example where the gap is set too short.
Figure 11. Gap Between Pulse Start and ADC Capture Set Too Long

Figure 12. Gap Between Pulse Start and ADC Capture Set Too Short
• If no signal is observed, check the transducer connections to the platform. Connect the transducers as shown in Section 2.
• Be sure that the pipe is filled with water. If no water is in the pipe or the transducers are not connected properly to the EVM, the captured signal may look similar to Figure 13.

![Figure 13. Captured ADC Signal With No Water or Bad Connection](image)

To save the capture, click the "Save Capture" button and provide a filename. To continuously capture to a file, click the "Continuous Capture" button and provide a filename.
4.4 Capturing Waveforms

After you have a good ADC capture, go to the "Waveforms" tab to capture some waveforms. In the "Waveforms" tab, click the "Start" button to start capturing waveforms. The GUI displays the Delta ToF, Absolute ToF, and Volume Flow Rate waveforms (see Figure 14). Real time statistics are also available below each waveform. A typical standard deviation value of Delta ToF can be seen in the red box shown in Figure 14.

![Figure 14. Capturing Waveforms](image)

The frequency of measurement updates can be increased by reducing the "UPS0 to UPS1 Gap" in the "Configuration" tab.

After capturing waveforms for some time, you can save them to a file using the "Save Waveforms" button. The "Lock All" button stops updates, and the "Reset Graphs" button erases all previously captured data.
4.5 Frequency Response

The frequency response of the meter can be determined in the GUI to ensure the excitation frequency is optimal. A "Frequency Sweep" is initiated by first setting the desired starting excitation frequency in the "Configuration" tab. After this has been set, set the number of "Captures" and "Step Size" to cover the band of interest. In Figure 15, the sweep is configured to go from 800 kHz to 1208 kHz. The "Frequency Sweep" button requests a file name and then initiates the sweep.

![Frequency Sweep Peaks](image)

Figure 15. Frequency Sweep Peak Amplitudes

From this sweep, 1020 kHz appears to be a good excitation frequency for this meter. The process for tuning the configuration to an optimal value can be summarized as follows:

NOTE: Steps 1 to 3 should have already been completed in Section 4.3.

1. Set the "Transmit Frequency" to the nominal frequency of the transducer.
2. Adjust the "Gap between pulse start and ADC capture" and "Capture Duration" parameters to capture the complete signal in the "ADC Capture" window.
3. Adjust the "Gain" setting to get a signal which has an amplitude of ±900 ADC counts.
4. Set the "Transmit Frequency" to a frequency which is 200 kHz less than the nominal frequency of the transducer and conduct a frequency sweep which ends at a frequency 200 kHz greater than the nominal frequency of the transducer.
5. Identify the peak amplitude of the "Frequency Sweep" and set the "Transmit Frequency" to this value.
5 Meter Characterization

Meter characterization comprises standard deviation, zero flow drift, and flow testing.

5.1 Single Shot Standard Deviation

The standard deviation in dToF (and volume) is often used as a measure for the accuracy with which flow measurements can be made. Although it is possible to average across several measurements, the amount of time and power required to do this may not meet application requirements.

Standard deviation testing is typically conducted at room temperature over a period of 30 minutes with a 1 measurement per second rate to ensure a statistically valid average. The standard deviation is reported with the mean in the "Waveform Tab" of the GUI. Figure 16 shows the single-shot STD of blocks of 200 measurements. Each plot represents single-shot STD of 200 measurements. The plot clearly shows the variation of single-shot STD is just ± 2 ps, and the average is < 25 ps.

![Single shot STD estimation](image)

**Figure 16. Single Shot Standard Deviation**

5.2 Zero Flow Drift Testing

Zero flow drift testing is often used as a measure of the minimum detectable flow of a meter and accuracy in low flow. The minimum detectable flow of a meter is related to the zero flow drift and the sensitivity of the meter. A meter with higher sensitivity and lower zero flow drift will have a smaller minimum detectable flow. The minimum detectable flow is limited by the drift in dToF over temperature. This test is typically conducted in an oven with a temperature profile ranging from 5°C to 85°C over a period of 4 to 24 hours, depending on the robustness of the test. These tests are conducted with both the meter and electronics in the oven as well as with just the meter in the oven to ensure the electronics do not contribute to the drift. More detailed information on zero flow drift testing can be found in the *Ultrasonic Sensing Metrology Subsystem Reference Design for Water Flow Measurement* design guide.
5.3 Flow Testing

Flow testing is typically conducted with a reference meter and a temperature controlled water circulation system. Figure 17 shows a typical flow test setup. This setup includes a large water tank, two reference meters, and a Device Under Test (DUT). Flow is recorded at various flow rates by one of the two reference meters and the DUT. The temperature of the water is varied by addition of ice or hot water to the tank with a thermocouple recording the water temperature. A video discussing flow measurements and setup can be found at Ultrasonic Water Flow Meter Demonstration.

Flows are typically captured over several minutes and averaged to compare accuracies between a reference meter and the DUT. Figure 18 shows comparative flow tests results for a meter at various flows rates.
NOTE: Measurements at room temperature

**Figure 18. Audiowell Meter Measurements**

For more details on water flow testing, see the *MSP430FR6047 and Ultrasonic Software Based Water Flow Meter Measurement Results* application report.
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 DEGREATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.
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 radiélectrique 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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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 proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

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