



## ABSTRACT

This document describes the known exceptions to the functional specifications (advisories).

---

## Table of Contents

<b>1 Functional Advisories</b> .....	2
<b>2 Preprogrammed Software Advisories</b> .....	2
<b>3 Debug Only Advisories</b> .....	2
<b>4 Fixed by Compiler Advisories</b> .....	2
<b>5 Nomenclature, Package Symbolization, and Revision Identification</b> .....	4
5.1 Device Nomenclature.....	4
5.2 Package Markings.....	4
5.3 Memory-Mapped Hardware Revision (TLV Structure).....	4
<b>6 Advisory Descriptions</b> .....	6
<b>7 Revision History</b> .....	16

## 1 Functional Advisories

Advisories that affect the device's operation, function, or parametrics.

✓ The check mark indicates that the issue is present in the specified revision.

Errata Number	Rev C	Rev B	Rev A
<a href="#">ADC50</a>	✓	✓	✓
<a href="#">ADC63</a>	✓	✓	✓
<a href="#">BSL18</a>			✓
<a href="#">CPU46</a>	✓	✓	✓
<a href="#">CS13</a>	✓	✓	✓
<a href="#">GC4</a>	✓	✓	✓
<a href="#">GC5</a>	✓	✓	✓
<a href="#">PMM32</a>	✓	✓	✓
<a href="#">PORT28</a>	✓	✓	✓
<a href="#">RTC15</a>	✓	✓	✓
<a href="#">USCI42</a>	✓	✓	✓
<a href="#">USCI45</a>	✓	✓	✓
<a href="#">USCI47</a>	✓	✓	✓
<a href="#">USCI50</a>	✓	✓	✓

## 2 Preprogrammed Software Advisories

Advisories that affect factory-programmed software.

✓ The check mark indicates that the issue is present in the specified revision.

The device does not have any errata for this category.

## 3 Debug Only Advisories

Advisories that affect only debug operation.

✓ The check mark indicates that the issue is present in the specified revision.

Errata Number	Rev C	Rev B	Rev A
<a href="#">EEM23</a>	✓	✓	✓

## 4 Fixed by Compiler Advisories

Advisories that are resolved by compiler workaround. Refer to each advisory for the IDE and compiler versions with a workaround.

✓ The check mark indicates that the issue is present in the specified revision.

Errata Number	Rev C	Rev B	Rev A
<a href="#">CPU21</a>	✓	✓	✓
<a href="#">CPU22</a>	✓	✓	✓
<a href="#">CPU40</a>	✓	✓	✓

Refer to the following MSP430 compiler documentation for more details about the CPU bugs workarounds.

### TI MSP430 Compiler Tools (Code Composer Studio IDE)

- [MSP430 Optimizing C/C++ Compiler](#): Check the `--silicon_errata` option

- [MSP430 Assembly Language Tools](#)

**MSP430 GNU Compiler (MSP430-GCC)**

- [MSP430 GCC Options](#): Check -msilicon-errata= and -msilicon-errata-warn= options
- [MSP430 GCC User's Guide](#)

**IAR Embedded Workbench**

- [IAR workarounds for msp430 hardware issues](#)

## 5 Nomenclature, Package Symbolization, and Revision Identification

The revision of the device can be identified by the revision letter on the [Package Markings](#) or by the [HW\\_ID](#) located inside the TLV structure of the device.

### 5.1 Device Nomenclature

To designate the stages in the product development cycle, TI assigns prefixes to the part numbers of all MSP MCU devices. Each MSP MCU commercial family member has one of two prefixes: MSP or XMS. These prefixes represent evolutionary stages of product development from engineering prototypes (XMS) through fully qualified production devices (MSP).

**XMS** – Experimental device that is not necessarily representative of the final device's electrical specifications

**MSP** – Fully qualified production device

Support tool naming prefixes:

**X**: Development-support product that has not yet completed Texas Instruments internal qualification testing.

**null**: Fully-qualified development-support product.

XMS devices and X development-support tools are shipped against the following disclaimer:

"Developmental product is intended for internal evaluation purposes."

MSP devices have been characterized fully, and the quality and reliability of the device have been demonstrated fully. TI's standard warranty applies.

Predictions show that prototype devices (XMS) have a greater failure rate than the standard production devices. TI recommends that these devices not be used in any production system because their expected end-use failure rate still is undefined. Only qualified production devices are to be used.

TI device nomenclature also includes a suffix with the device family name. This suffix indicates the temperature range, package type, and distribution format.

### 5.2 Package Markings

**YQW24**

**DSBGA (YQW), 24 pin**



# = Die revision  
○ = Pin 1 location  
N = Lot trace code

**RGE24**

**QFN (RGE), 24 Pin**



# = Die revision  
○ = Pin 1 location  
N = Lot trace code

### 5.3 Memory-Mapped Hardware Revision (TLV Structure)

Die Revision	TLV Hardware Revision
Rev C	11h
Rev B	11h

<b>Die Revision</b>	<b>TLV Hardware Revision</b>
Rev A	10h

Further guidance on how to locate the TLV structure and read out the HW\_ID can be found in the device User's Guide.

## 6 Advisory Descriptions

<b>ADC50</b>	<b>ADC Module</b>
<b>Category</b>	Functional
<b>Function</b>	Erroneous ADC conversion result for internal temperature sensor in LPM3 mode
<b>Description</b>	When ACLK is used as ADC clock source and device is in LPM3 mode while sampling the on-chip temperature sensor, the ADC may generate erroneous conversion results.
<b>Workaround</b>	<p>1) Use SMCLK or MODCLK as the ADC clock source. A 100us sampling time is required if triggering ADC conversion from LPM3.</p> <p>OR</p> <p>2) Use LPM0 or Active Mode.</p>
<b>ADC63</b>	<b>ADC Module</b>
<b>Category</b>	Functional
<b>Function</b>	ADCHI/ADCLO may be reset unexpectedly when ADCCTL2 high byte is written byte-wise
<b>Description</b>	ADCHI/ADCLO may be reset unexpectedly when ADCCTL2 high byte is written byte-wise.
<b>Workaround</b>	Write to ADCCTL2 high byte in word-wise method.
<b>BSL18</b>	<b>BSL Module</b>
<b>Category</b>	Functional
<b>Function</b>	Empty reset vector does not invoke BSL
<b>Description</b>	An empty reset vector (for example, as on an un-programmed device) should invoke the BSL, but it does not on affected devices.
<b>Workaround</b>	Use the dedicated TEST and RST pins to perform hardware BSL invocation, or perform software BSL invocation from the main application. See the MSP430FR4xx and MSP430FR2xx Bootloader (BSL) Users Guide <a href="#">SLAU610</a> for more information on BSL entry.
<b>CPU21</b>	<b>CPU Module</b>
<b>Category</b>	Compiler-Fixed
<b>Function</b>	Using POPM instruction on Status register may result in device hang up
<b>Description</b>	When an active interrupt service request is pending and the POPM instruction is used to set the Status Register (SR) and initiate entry into a low power mode, the device may hang up.
<b>Workaround</b>	<p>None. It is recommended not to use POPM instruction on the Status Register.</p> <p>Refer to the table below for compiler-specific fix implementation information.</p>

IDE/Compiler	Version Number	Notes
IAR Embedded Workbench	Not affected	
TI MSP430 Compiler Tools (Code Composer Studio)	v4.0.x or later	User is required to add the compiler or assembler flag option below. --silicon_errata=CPU21
MSP430 GNU Compiler (MSP430-GCC)	MSP430-GCC 4.9 build 167 or later	

## CPU22

### CPU Module

#### Category

Compiler-Fixed

#### Function

Indirect addressing mode with the Program Counter as the source register may produce unexpected results

#### Description

When using the indirect addressing mode in an instruction with the Program Counter (PC) as the source operand, the instruction that follows immediately does not get executed. For example in the code below, the ADD instruction does not get executed.

```
mov @PC, R7
add #1h, R4
```

#### Workaround

Refer to the table below for compiler-specific fix implementation information.

IDE/Compiler	Version Number	Notes
IAR Embedded Workbench	Not affected	
TI MSP430 Compiler Tools (Code Composer Studio)	v4.0.x or later	User is required to add the compiler or assembler flag option below. --silicon_errata=CPU22
MSP430 GNU Compiler (MSP430-GCC)	MSP430-GCC 4.9 build 167 or later	

## CPU40

### CPU Module

#### Category

Compiler-Fixed

#### Function

PC is corrupted when executing jump/conditional jump instruction that is followed by instruction with PC as destination register or a data section

#### Description

If the value at the memory location immediately following a jump/conditional jump instruction is 0X40h or 0X50h (where X = don't care), which could either be an instruction opcode (for instructions like RRCM, RRAM, RLAM, RRUM) with PC as destination register or a data section (const data in flash memory or data variable in RAM), then the PC value is auto-incremented by 2 after the jump instruction is executed; therefore, branching to a wrong address location in code and leading to wrong program execution.

For example, a conditional jump instruction followed by data section (0140h).

```
@0x8012 Loop DEC.W R6
@0x8014 DEC.W R7
```

@0x8016 JNZ Loop  
@0x8018 Value1 DW 0140h

**Workaround**

In assembly, insert a NOP between the jump/conditional jump instruction and program code with instruction that contains PC as destination register or the data section.

Refer to the table below for compiler-specific fix implementation information.

IDE/Compiler	Version Number	Notes
IAR Embedded Workbench	IAR EW430 v5.51 or later	For the command line version add the following information Compiler: --hw_workaround=CPU40 Assembler:-v1
TI MSP430 Compiler Tools (Code Composer Studio)	v4.0.x or later	User is required to add the compiler or assembler flag option below. --silicon_errata=CPU40
MSP430 GNU Compiler (MSP430-GCC)	Not affected	

**CPU46****CPU Module****Category**

Functional

**Function**

POPM performs unexpected memory access and can cause VMAIFG to be set

**Description**

When the POPM assembly instruction is executed, the last Stack Pointer increment is followed by an unintended read access to the memory. If this read access is performed on vacant memory, the VMAIFG will be set and can trigger the corresponding interrupt (SFRIE1.VMAIE) if it is enabled. This issue occurs if the POPM assembly instruction is performed up to the top of the STACK.

**Workaround**

If the user is utilizing C, they will not be impacted by this issue. All TI/IAR/GCC pre-built libraries are not impacted by this bug. To ensure that POPM is never executed up to the memory border of the STACK when using assembly it is recommended to either

1. Initialize the SP to
  - a. TOP of STACK - 4 bytes if POPM.A is used
  - b. TOP of STACK - 2 bytes if POPM.W is used

OR

2. Use the POPM instruction for all but the last restore operation. For the the last restore operation use the POP assembly instruction instead.

For instance, instead of using:

```
POPM.W #5, R13
```



Use:

POPM.W #4, R12 POP.W R13
-----------------------------

Refer to the table below for compiler-specific fix implementation information.

IDE/Compiler	Version Number	Notes
IAR Embedded Workbench	Not affected	C code is not impacted by this bug. User using POPM instruction in assembler is required to implement the above workaround manually.
TI MSP430 Compiler Tools (Code Composer Studio)	Not affected	C code is not impacted by this bug. User using POPM instruction in assembler is required to implement the above workaround manually.
MSP430 GNU Compiler (MSP430-GCC)	Not affected	C code is not impacted by this bug. User using POPM instruction in assembler is required to implement the above workaround manually.

## CS13

### CS Module

#### Category

Functional

#### Function

Device may enter lockup state during transition from AM to LPM3/4 if DCO frequency is above 2 MHz.

#### Description

The device might enter lockup state if DCO frequency is above 2 MHz and two events happen at the same time:

- 1) The device transitions from AM to LPM3/4 (e.g. during ISR exits or Status Register modifications)
- 2) An interrupt is requested (e.g. GPIO interrupt).

This condition can be recovered by BOR/Power cycle.

#### Workaround

1. Use DCOCLK at 2MHz or lower.

OR

2. Use LPM0/x.5 instead of LPM3/4.

OR

3. Use external high-frequency crystal if it is available on the device.

OR

4. Set DCOCLK to 2MHz or lower before entering LPM3/4, then restore DCOCLK after

wake-up. Note using peripherals using clocks derived from DCOCLK might be affected during this interval.

**EEM23*****EEM Module*****Category**

Debug

**Function**

EEM triggers incorrectly when modules using wait states are enabled

**Description**

When modules using wait states (USB, MPY, CRC and FRAM controller in manual mode) are enabled, the EEM may trigger incorrectly. This can lead to an incorrect profile counter value or cause issues with the EEMs data watch point, state storage, and breakpoint functionality.

**Workaround**

None.

**Note**

This erratum affects debug mode only.

**GC4*****GC Module*****Category**

Functional

**Function**

Unexpected PUC is triggered

**Description**

During execution from FRAM a non-existent uncorrectable bit error can be detected and trigger a PUC if the uncorrectable bit error detection flag is set (GCCTL0.UBDRSTEN = 1). This behavior appears only if:

(1) MCLK is sourced from DCO frequency of 16 MHz

OR

(2) MCLK is sourced by external high frequency clock above 12 MHz at pin HFXIN

OR

(3) MCLK is sourced by High-Frequency crystals (HFXT) above 12 MHz.

This PUC will not be recognized by the SYSRSTIV register (SYSRSTIV = 0x00).

A PUC RESET will be executed with not defined reset source.

Also the corresponding bit error detection flag is not set (GCCTL1.UBDIFG = 0).

**Workaround**

1. Check the reset source for SYSRSTIV = 0 and ignore the reset.

OR

2. Set GCCTL0.UBDRSTEN = 0 to prevent unexpected PUC.

OR

3. Set the MCLK to maximum 12MHz to leverage the uncorrectable bit error PUC feature.

**GC5*****GC Module*****Category**

Functional

<b>Function</b>	Nonexistent FRAM failures can be detected after wake-up from LPM 1/2/3/4
<b>Description</b>	<p>The FRAM bit error detection may indicate bit errors, even the memory has no failure, after wakeup from LPM1/2/3/4.</p> <p>Based on the setting inside the FRAM controller registers (GCCTL0), following behaviors can appear.</p> <ol style="list-style-type: none"> <li>1. Unexpected PUC for an uncorrectable FRAM error can be triggered and causing the corresponding value in the SYSRSTIV register. This happens only if GCCTL0.UBDRSTEN =1.</li> <li>2. Unexpected NMI for an uncorrectable FRAM error can be triggered and causing the corresponding value in the SYSSNIV register. This happens only if the GCCTL0.UBDIE = 1.</li> <li>3. Unexpected NMI for a correctable FRAM error can be triggered and causing the corresponding value in the SYSSNIV register. This happens only if the GCCTL0.CBDIE =1.</li> </ol>
<b>Workaround</b>	<ol style="list-style-type: none"> <li>1. Disable PUC (GCCTL0.UBDRSTEN=0), UBDIE and CBDIE interrupts (GCCTL0.UBDIE=0 and GCCTL0.CBDIE=0) prior to entering LPM 1/2/3/4.</li> <li>2. After LPM wake up, clear GCCTL1.UBDIFG and GCCTL1.CBDIFG, and then reinitialize the GCCTL0 register after the first valid FRAM access has been completed. For the valid FRAM access the user has to consider possible cache hits which depends on implementation.</li> </ol>

## PMM32

### *PMM Module*

---

<b>Category</b>	Functional
<b>Function</b>	Device may enter lockup state or execute unintentional code during transition from AM to LPM3/4
<b>Description</b>	<p>The device might enter lockup state or start executing unintentional code resulting in unpredictable behavior depending on the contents of the address location- if any of the two conditions below occurs:</p> <p>Condition1:</p> <p>The following three events happen at the same time:</p> <ol style="list-style-type: none"> <li>1) The device transitions from AM to LPM3/4 (e.g. during ISR exits or Status Register modifications),</li> </ol> <p>AND</p> <ol style="list-style-type: none"> <li>2) An interrupt is requested (e.g. GPIO interrupt),</li> </ol> <p>AND</p> <ol style="list-style-type: none"> <li>3) MODCLK is requested (e.g. triggered by ADC) or removed (e.g. end of ADC conversion).</li> </ol> <p>Modules which can trigger MODCLK clock requests/removals are ADC, eUSCI and CapTlvate (if exist).</p>

If clock events are started by the CPU (e.g. eUSCI during SPI master transmission), they can not occur at the same time as the power mode transition and thus should not be affected. The device should only be affected when the clock event is asynchronous to the power mode transition.

The device can recover from this lockup condition by a PUC/BOR/Power cycle (e.g. enable Watchdog to trigger PUC).

Condition2:

The following events happen at the same time:

1) The device transitions from AM to LPM3/4 (e.g. during ISR exits or Status Register modifications),

AND

2) An interrupt is requested (e.g. GPIO interrupt),

AND

3) Neither MODCLK nor SMCLK are running (e.g. requested by a peripheral),

AND

4) SMCLK is configured with a different frequency than MCLK.

The device can recover from this lockup condition by a BOR/Power cycle.

#### Workaround

1. Use LPM0/1/x.5 instead of LPM3/4.

OR

2. Place the FRAM in INACTIVE mode before any entry to LPM3/4 by clearing the FRPWR bit and FRLPMPWR bit (if exist) in the GCCTL0 register. This must be performed from RAM as shown below:

```
// define a function in RAM
#pragma CODE_SECTION(enterLpModeFromRAM, ".TI.ramfunc")
void enterLpModeFromRAM(unsigned short lowPowerMode);

//call this function before any entry to LPM3/4
void enterLpModeFromRAM(unsigned short lowPowerMode)
{
    FRCTL0 = FRCTLPW;
    GCCTL0 &= ~(FRPWR+FRLPMPWR); //clear FRPWR and FRLPMPWR
    FRCTL0_H = 0; //re-lock FRCTL
    __bis_SR_register(lowPowerMode);
}
```

#### PORT28

#### **PORT Module**

---

#### Category

Functional

#### Function

Pull-down resistor of TEST/SBWTCK pin

<b>Description</b>	The device's internal pull-down resistor on the TEST/SBWTCK pin gets disabled if the SYS control bit SFRRPCR.SYSRSTRE is cleared. This can lead to increased current consumption and unintentionally-enabled JTAG access to the device.
<b>Workaround</b>	<p>1) Do not clear the SFRRPCR.SYSRSTRE bit, use the SFRRPCR.SYSRSTRUP bit to define direction of the internal resistor on RST/NMI/SBWTDIO pin instead.</p> <p>OR</p> <p>2) Ensure a zero voltage level of TEST/SBWTCK pin by connecting the pin to an external component (e.g. external pull-down resistor) on the PCB.</p>

## **RTC15** *RTC Module*

---

<b>Category</b>	Functional
<b>Function</b>	RTC Counter stops operating if RTC Counter clock source is changed from XT1CLK to another source while XT1CLK is stopped
<b>Description</b>	If XT1CLK is used as the clock source for the RTC Counter and XT1CLK stops (e.g. oscillator fault), if the RTC Counter clock source is changed by user software (e.g. in the clock fault handling ISR) from XT1CLK to a different clock source while XT1CLK is stopped the RTC Counter hangs. In this hang state, the RTC Counter stops operating and cannot be restarted without a device reset via the hardware RST pin, a power-cycle of the device, or recovery of XT1CLK oscillation.
<b>Workaround</b>	<p>To change the RTC Counter clock source due to an oscillator fault, in the ISR for handling the OFIFG fault, use this software sequence:</p> <p>1) Change the RTC Counter clock source away from XT1CLK normally</p> <p>2) Reconfigure the XIN pin as a GPIO output, then toggle the GPIO twice with at least 2 rising or falling edges.</p> <p>At this point the RTC Counter will be able to resume operation.</p>

## **USCI42** *USCI Module*

---

<b>Category</b>	Functional
<b>Function</b>	UART asserts UCTXCPITIFG after each byte in multi-byte transmission
<b>Description</b>	UCTXCPTIFG flag is triggered at the last stop bit of every UART byte transmission, independently of an empty buffer, when transmitting multiple byte sequences via UART. The erroneous UART behavior occurs with and without DMA transfer.
<b>Workaround</b>	None.

## **USCI45** *USCI Module*

---

<b>Category</b>	Functional
<b>Function</b>	Unexpected SPI clock stretching possible when UCxCLK is asynchronous to MCLK
<b>Description</b>	In rare cases, during SPI communication, the clock high phase of the first data bit may be stretched significantly. The SPI operation completes as expected with no data loss. This

issue only occurs when the USCI SPI module clock (UCxCLK) is asynchronous to the system clock (MCLK).

**Workaround** Ensure that the USCI SPI module clock (UCxCLK) and the CPU clock (MCLK) are synchronous to each other.

## USCI47

### *USCI Module*

---

**Category** Functional

**Function** eUSCI SPI slave with clock phase UCCKPH = 1

**Description** The eUSCI SPI operates incorrectly under the following conditions:

1. The eUSCI\_A or eUSCI\_B module is configured as a SPI slave with clock phase mode UCCKPH = 1

AND

2. The SPI clock pin is not at the appropriate idle level (low for UCCKPL = 0, high for UCCKPL = 1) when the UCSWRST bit in the UCxxCTLW0 register is cleared.

If both of the above conditions are satisfied, then the following will occur:

eUSCI\_A: the SPI will not be able to receive a byte (UCAxRXBUF will not be filled and UCRXIFG will not be set) and SPI slave output data will be wrong (first bit will be missed and data will be shifted).

eUSCI\_B: the SPI receives data correctly but the SPI slave output data will be wrong (first byte will be duplicated or replaced by second byte).

**Workaround** Use clock phase mode UCCKPH = 0 for MSP SPI slave if allowed by the application.

OR

The SPI master must set the clock pin at the appropriate idle level (low for UCCKPL = 0, high for UCCKPL = 1) before SPI slave is reset (UCSWRST bit is cleared).

OR

For eUSCI\_A: to detect communication failure condition where UCRXIFG is not set, check both UCRXIFG and UCTXIFG. If UCTXIFG is set twice but UCRXIFG is not set, reset the MSP SPI slave by setting and then clearing the UCSWRST bit, and inform the SPI master to resend the data.

## USCI50

### *USCI Module*

---

**Category** Functional

**Function** Data may not be transmitted correctly from the eUSCI when operating in SPI 4-pin master mode with UCSTEM = 0

**Description** When the eUSCI is used in SPI 4-pin master mode with UCSTEM = 0 (STE pin used as an input to prevent conflicts with other SPI masters), data that is moved into UCxTXBUF while the UCxSTE input is in the inactive state may not be transmitted correctly. If the eUSCI is used with UCSTEM = 1 (STE pin used to output an enable signal), data is transmitted correctly.

**Workaround** When using the STE pin in conflict prevention mode (UCSTEM = 0), only move data into UCxTXBUF when UCxSTE is in the active state. If an active transfer is aborted

by UCxSTE transitioning to the master-inactive state, the data must be rewritten into UCxTXBUF to be transferred when UCxSTE transitions back to the master-active state.

## 7 Revision History

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

### Changes from October 9, 2019 to May 19, 2021

**Page**

• Changed the document format and structure; updated the numbering format for tables, figures, and cross references throughout the document.....	6
• CPU21 was added to the errata documentation.....	6
• CPU22 was added to the errata documentation.....	6
• CPU40 was added to the errata documentation.....	6
• CPU46 was added to the errata documentation.....	6
• BSL18 was added to the errata documentation.....	6
• GC5 was added to the errata documentation.....	6
• GC4 was added to the errata documentation.....	6
• RTC15 was added to the errata documentation.....	6
• PMM32 was added to the errata documentation.....	6
• PORT28 was added to the errata documentation.....	6
• ADC50 was added to the errata documentation.....	6
• ADC63 was added to the errata documentation.....	6
• CS13 was added to the errata documentation.....	6
• USCI42 was added to the errata documentation.....	6
• USCI45 was added to the errata documentation.....	6
• USCI47 was added to the errata documentation.....	6
• USCI50 was added to the errata documentation.....	6
• EEM23 was added to the errata documentation.....	6
• YQW24 was added to errata documentation.....	6
• RGE24 was added to errata documentation.....	6

---



## IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to TI's Terms of Sale (<https://www.ti.com/legal/termsofsale.html>) or other applicable terms available either on [ti.com](https://www.ti.com) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2021, Texas Instruments Incorporated