

# MSPM0L222x-Q1, MSPM0L122x-Q1 Automotive Mixed-Signal Microcontrollers

## 1 Features

- AEC-Q100 Grade 1 qualified for automotive applications
- **Support for FuSa**
  - ISO26262 ASIL B
- **Core**
  - Arm® 32-bit Cortex®-M0+ CPU with memory protection unit, frequency up to 32MHz
- [PSA-L1 Certified](#)
- **Operating characteristics**
  - Extended temperature: –40°C up to 125°C
  - Wide supply voltage range: 1.62V to 3.6V
- **Memories**
  - Up to 256KB of flash memory with ECC
    - Dual-bank with address swap with OTA updates
  - 32KB of SRAM with ECC or parity
  - 32B backup memory<sup>1</sup>
- **High-performance analog peripherals**
  - 12-bit 1.68MSPS analog-to-digital converter (ADC), up to 26 external channels
  - Configurable 1.4V or 2.5V internal shared voltage reference (VREF)
  - Comparator (COMP) with 8-bit reference DAC
  - Integrated temperature sensor
- **User interface**
  - Ultra-low power segmented LCD controller supporting up to 8×51 and 4×55 LCD displays<sup>2</sup>
- **Optimized low-power modes**
  - RUN: 106µA/MHz (CoreMark)
  - STOP: 54µA at 32kHz
  - STANDBY<sub>1</sub>: 1.2µA (VDD), 1.1µA (VBAT) with 32kHz, LFXT, RTC, and SRAM and registers fully retained
  - SHUTDOWN: 80nA (VDD), 1.1µA (VBAT) with 32kHz, LFXT, RTC, and I/O wake-up capability
- **Intelligent digital peripherals**
  - 7-channel DMA controller
  - 15-channel event fabric signaling system
  - Six timers supporting up to 18 PWM outputs, all operational down to STANDBY mode
    - One 16-bit advanced timer with deadband
    - One 32-bit general-purpose timer
    - Four 16-bit general-purpose timers
  - Window-watchdog timer (WWDT)
  - Independent watchdog timer (IWDT) residing in the VBAT island
- **Communication interfaces**
  - Five UART modules, with two supporting LIN, IrDA, DALI, smart card, Manchester
  - Three I<sup>2</sup>C modules supporting SMBus/PMBus and wakeup from STOP mode, with two supporting up to FM+ (1Mbps)
  - Two SPI modules supporting up to 16Mbps
- **Clock system**
  - Internal 4MHz to 32MHz oscillator with up to ±1.2% accuracy (SYSOSC)
  - Internal 32kHz oscillator (LFOSC) with ±3% accuracy<sup>1</sup>
  - External 4MHz to 32MHz crystal oscillator (HFXT)
  - External 32kHz crystal oscillator (LFXT)<sup>1</sup>
  - External LF<sup>1</sup> and HF digital clock inputs
  - Digital clock output
- **Data integrity and encryption**
  - AES accelerator with support for GCM/GMAC, CCM/CBC-MAC, CBC, CTR
  - Secure Key Storage for up to four AES keys
  - Flexible firewalls for protecting code and data
  - True random number generator (TRNG)
  - Cyclic redundancy checker (CRC-16, CRC-32)
- **VBAT island (auxiliary supply)<sup>1</sup>**
  - Independent supply with dedicated VBAT pin
  - Internal super-capacitor charger
  - Real-time clock (RTC)
  - Tamper detection with timestamp
  - Independent watchdog timer (IWDT)
  - Scratch Pad Memory (SPM)
- **Flexible I/O features**
  - Up to 73 total GPIOs
  - Up to 5 GPIOs supplied by VBAT pin<sup>1</sup>
- **Development support**
  - 2-pin serial wire debug (SWD)
- **Package options**
  - 80-pin LQFP
  - 64-pin LQFP
  - 48-pin LQFP, VQFN<sup>3</sup>
  - 32-pin VQFN<sup>3</sup>
  - 24-pin VQFN<sup>3</sup>
- **Family members** (also see [Device Comparison](#))
  - MSPM0L2228: 256KB flash, LCD
  - MSPM0L2227: 128KB flash, LCD
  - MSPM0L1228: 256KB flash
  - MSPM0L1227: 128KB flash
- **Development kits and software** (also see [Tools and Software](#))

<sup>1</sup> Part of the LFSS (Low Frequency Subsystem) supplied by the VBAT pin residing in the VBAT island

<sup>2</sup> MSPM0L222x devices only

<sup>3</sup> VQFN packages have wettable flanks.



- LP-MSPM0L2228 LaunchPad™ development kit
- MSP Software Development Kit (SDK)
- [Automotive Motor Control](#)
- [DC to AC Inverters](#)
- [Automotive Interior Lighting](#)
- [Door handle modules](#)
- [Kick to open modules](#)
- [Vehicle Occupancy Detection](#)
- [Seat Comfort Module](#)

## 2 Applications

- [Automotive body electronics and Lighting](#)
- [Automotive Gateway](#)
- [Steering Wheel Systems](#)

## 3 Description

MSPM0Lx22x microcontrollers (MCUs) are part of the highly integrated, ultra-low-power [32-bit MSPM0 MCU family](#) based on the Arm® Cortex®-M0+ 32-bit core platform, operating at up to 32MHz frequency. These MCUs offer a blend of cost optimization and design flexibility for applications requiring 128KB to 256KB of flash memory in small packages (down to 4mm x 4mm) or high pin count packages (up to 80 pins). These devices include a VBAT backup island, an optional segmented LCD controller (on MSPM0L222x), cybersecurity enablers, and high-performance integrated analog, and provide excellent low-power performance across the operating temperature range.

Up to 256KB of embedded flash program memory with built-in error correction code (ECC) and up to 32KB SRAM with ECC and parity protection is provided. The flash memory is organized into two main banks to support field firmware updates, with address swap support provided between the two main banks. An additional 32-byte backup memory is provided in the VBAT island, supplied by the VBAT pin and retained even when the main supply (VDD) is lost.

The VBAT island provides a fully independent auxiliary power domain (separate from the main supply) which supplies low frequency modules from an alternate supply such as a battery, supercapacitor, or alternate voltage level (1.62V to 3.6V). The VBAT island includes the low-frequency clock system (LFOSC, LFXT), the real-time clock, the tamper detection, and timestamp logic, an independent watchdog timer, and a 32-byte backup memory. Up to five digital IOs are powered from the VBAT supply. A charging mode is provided to optionally trickle charge a supercapacitor on the VBAT pin from the primary (VDD) supply when VDD is greater than VBAT.

An ultra-low power segmented LCD controller (on MSPM0L2228 and MSPM0L2227 devices) supports driving LCD glass with up to 59 pins in a variety of mux and bias configurations, enabling low cost displays.

Flexible cybersecurity enablers can be used to support secure boot, secure in-field firmware updates, IP protection (execute-only memory), key storage, and more. Hardware acceleration is provided for a variety of AES symmetric cipher modes, as well as a TRNG entropy source. The cybersecurity architecture is Arm® [PSA Level 1 certified](#).

A set of high-performance analog modules is provided, including a 12-bit 1.68MSPS SAR ADC supporting up to 26 external channels. An analog comparator is provided to support low power or low latency monitoring of analog signals. An on-chip voltage reference (1.4V or 2.5V) can be used to provide a stable reference voltage to the ADC and comparator. Environmental monitoring of the die temperature using the internal temperature sensor, VDD voltage, and VBAT voltage is supported.

The TI MSPM0 family of low-power MCUs consists of devices with varying degrees of analog and digital integration allowing for customers find the MCU that meets their project's needs. The MSPM0 MCU platform combines the Arm Cortex-M0+ platform with a holistic ultra-low-power system architecture, allowing system designers to increase performance while reducing energy consumption.

MSPM0Lx22x MCUs are supported by an extensive hardware and software ecosystem with reference designs and code examples to get the design started quickly. Development kits include a [LaunchPad](#) available for purchase. TI also provides a free MSP Software Development Kit (SDK), which is available as a component of [Code Composer Studio™ IDE](#) desktop and cloud version within the [TI Resource Explorer](#). MSPM0 MCUs are also supported by extensive online collateral, training with [MSP Academy](#), and online support through the [TI E2E™ support forums](#).

For complete module descriptions, see the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

**CAUTION**

System-level ESD protection must be applied in compliance with the device-level ESD specification to prevent electrical overstress or disturbing of data or code memory. See [MSP430™ System-Level ESD Considerations](#) for more information. The principles in this application note are applicable to MSPM0 MCUs.

**Device Information**

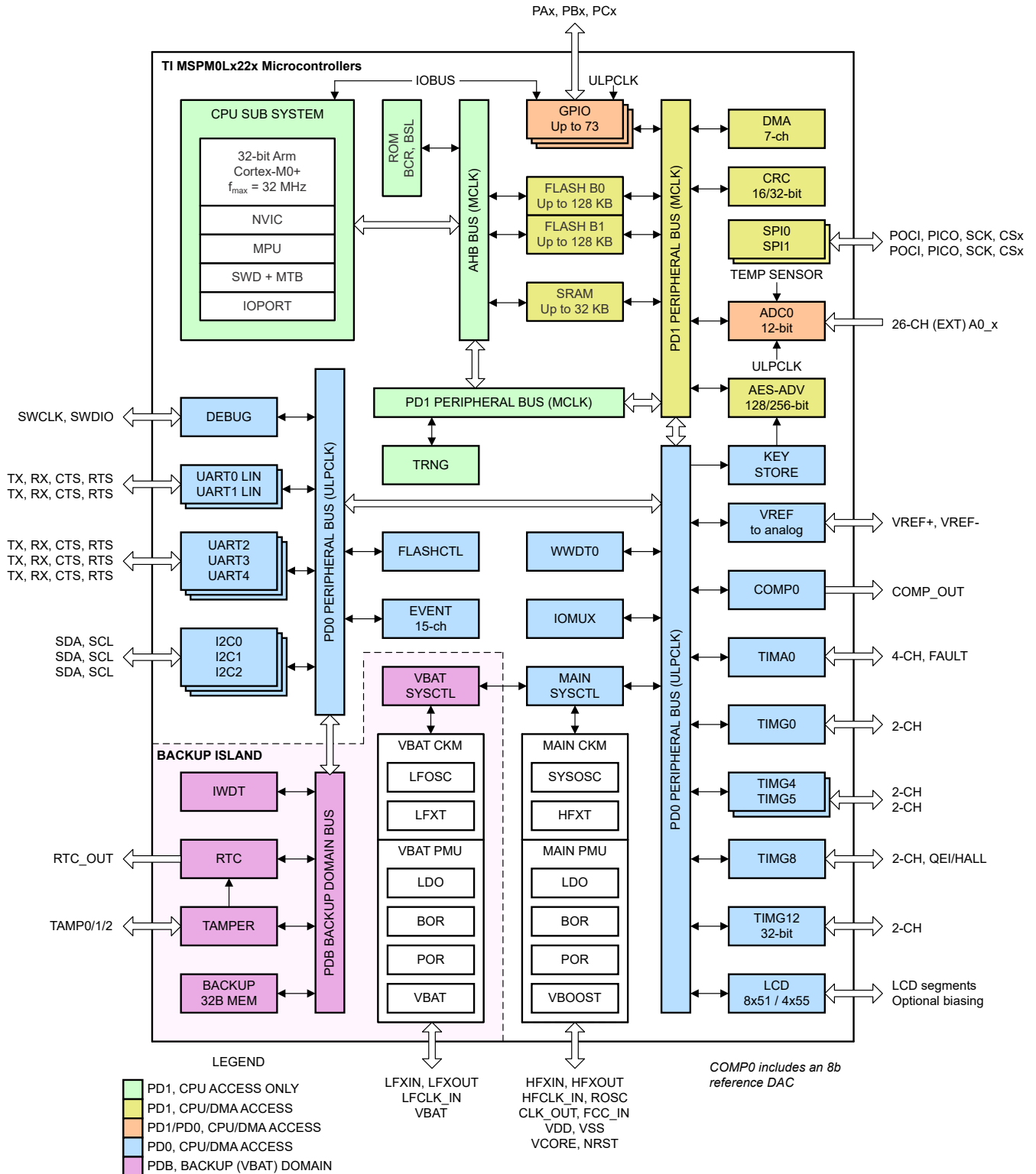
| PART NUMBER    | PACKAGE <sup>(1)</sup> | PACKAGE SIZE <sup>(2)</sup> |
|----------------|------------------------|-----------------------------|
| MSPM0L2228SPN  | PN (LQFP, 80)          | 14mm x 14mm                 |
| MSPM0L2227SPN  |                        |                             |
| MSPM0L1228SPN  |                        |                             |
| MSPM0L1227SPN  |                        |                             |
| MSPM0L2228SPM  | PM (LQFP, 64)          | 12 mm x 12 mm               |
| MSPM0L2227SPM  |                        |                             |
| MSPM0L1228SPM  |                        |                             |
| MSPM0L1227SPM  |                        |                             |
| MSPM0L2228SPT  | PT (LQFP, 48)          | 9mm x 9mm                   |
| MSPM0L2227SPT  |                        |                             |
| MSPM0L1228SPT  |                        |                             |
| MSPM0L1227SPT  |                        |                             |
| MSPM0L2228SRGZ | RGZ (VQFN, 48)         | 7mm x 7mm                   |
| MSPM0L2227SRGZ |                        |                             |
| MSPM0L1228SRGZ |                        |                             |
| MSPM0L1227SRGZ |                        |                             |
| MSPM0L1228SRHB | RHB (VQFN, 32)         | 5mm x 5mm                   |
| MSPM0L1227SRHB |                        |                             |
| MSPM0L1228SRGE | RGE (VQFN, 24)         | 4mm x 4mm                   |
| MSPM0L1227SRGE |                        |                             |

(1) For more information, see [Section 12](#).

(2) The package size (length x width) is a nominal value and includes pins, where applicable

## 4 Functional Block Diagram

Figure 4-1 shows the functional block diagram.



**Figure 4-1. MSPM0Lx22x Functional Block Diagram**

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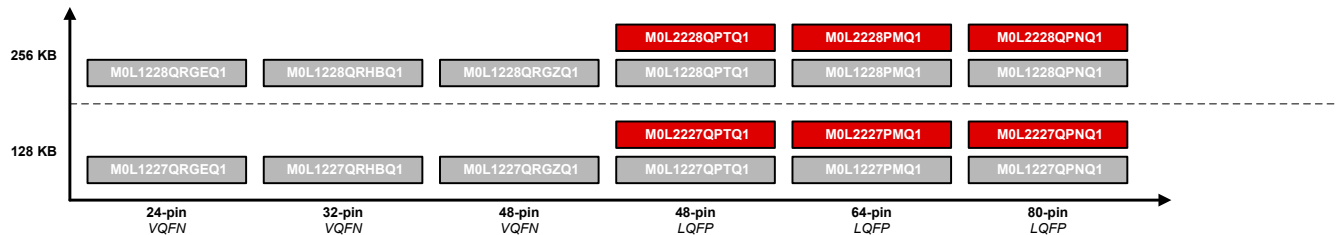
## 5 Device Comparison

**Table 5-1. Device Comparison Table**

| DEVICE NAME   | FLASH / SRAM (KB) | QUAL | LCD | UART/I2C/SPI | VBAT <sup>(1)</sup> | ADC CHANNEL | GPIO | PACKAGE                               |
|---------------|-------------------|------|-----|--------------|---------------------|-------------|------|---------------------------------------|
| M0L2228QPNQ1  | 256 / 32          | Q    | Yes | 5/3/2        | Yes                 | 26          | 73   | 80 LQFP<br>[14mm x 14mm]              |
| M0L2227QPNQ1  | 128 / 32          | Q    | Yes | 5/3/2        | Yes                 | 26          | 73   |                                       |
| M0L1228QPNQ1  | 256 / 32          | Q    | -   | 5/3/2        | Yes                 | 26          | 73   |                                       |
| M0L1227QPNQ1  | 128 / 32          | Q    | -   | 5/3/2        | Yes                 | 26          | 73   |                                       |
| M0L2228QPMQ1  | 256 / 32          | Q    | Yes | 5/3/2        | Yes                 | 26          | 59   | 64 LQFP<br>[12mm x 12mm]              |
| M0L2227QPMQ1  | 128 / 32          | Q    | Yes | 5/3/2        | Yes                 | 26          | 59   |                                       |
| M0L1228QPMQ1  | 256 / 32          | Q    | -   | 5/3/2        | Yes                 | 26          | 59   |                                       |
| M0L1227QPMQ1  | 128 / 32          | Q    | -   | 5/3/2        | Yes                 | 26          | 59   |                                       |
| M0L2228QPTQ1  | 256 / 32          | Q    | Yes | 5/3/2        | Yes                 | 21          | 43   | 48 LQFP<br>[9mm x 9mm]                |
| M0L2227QPTQ1  | 128 / 32          | Q    | Yes | 5/3/2        | Yes                 | 21          | 43   |                                       |
| M0L1228QPTQ1  | 256 / 32          | Q    | -   | 5/3/2        | Yes                 | 21          | 43   |                                       |
| M0L1227QPTQ1  | 128 / 32          | Q    | -   | 5/3/2        | Yes                 | 21          | 43   |                                       |
| M0L1228QRGZQ1 | 256 / 32          | Q    | -   | 5/3/2        | Yes                 | 21          | 43   | 48 VQFN<br>[7mm x 7mm] <sup>(2)</sup> |
| M0L1227QRGZQ1 | 128 / 32          | Q    | -   | 5/3/2        | Yes                 | 21          | 43   |                                       |
| M0L1228QRHBQ1 | 256 / 32          | Q    | -   | 4/3/2        | -                   | 13          | 28   | 32 VQFN<br>[5mm x 5mm] <sup>(2)</sup> |
| M0L1227QRHBQ1 | 128 / 32          | Q    | -   | 4/3/2        | -                   | 13          | 28   |                                       |
| M0L1228QRGEQ1 | 256 / 32          | Q    | -   | 4/3/2        | -                   | 9           | 20   | 24 VQFN<br>[4mm x 4mm] <sup>(2)</sup> |
| M0L1227QRGEQ1 | 128 / 32          | Q    | -   | 4/3/2        | -                   | 9           | 20   |                                       |

- (1) The VBAT pin for backup power domain is available in packages with 48 or more pins.  
(2) 24-pin, 32-pin, and 48-pin VQFN packages are available with wettable flanks.

### 5.1 Device Comparison Chart



**Figure 5-1. Device Comparison Chart**

## 6 Pin Configuration and Functions

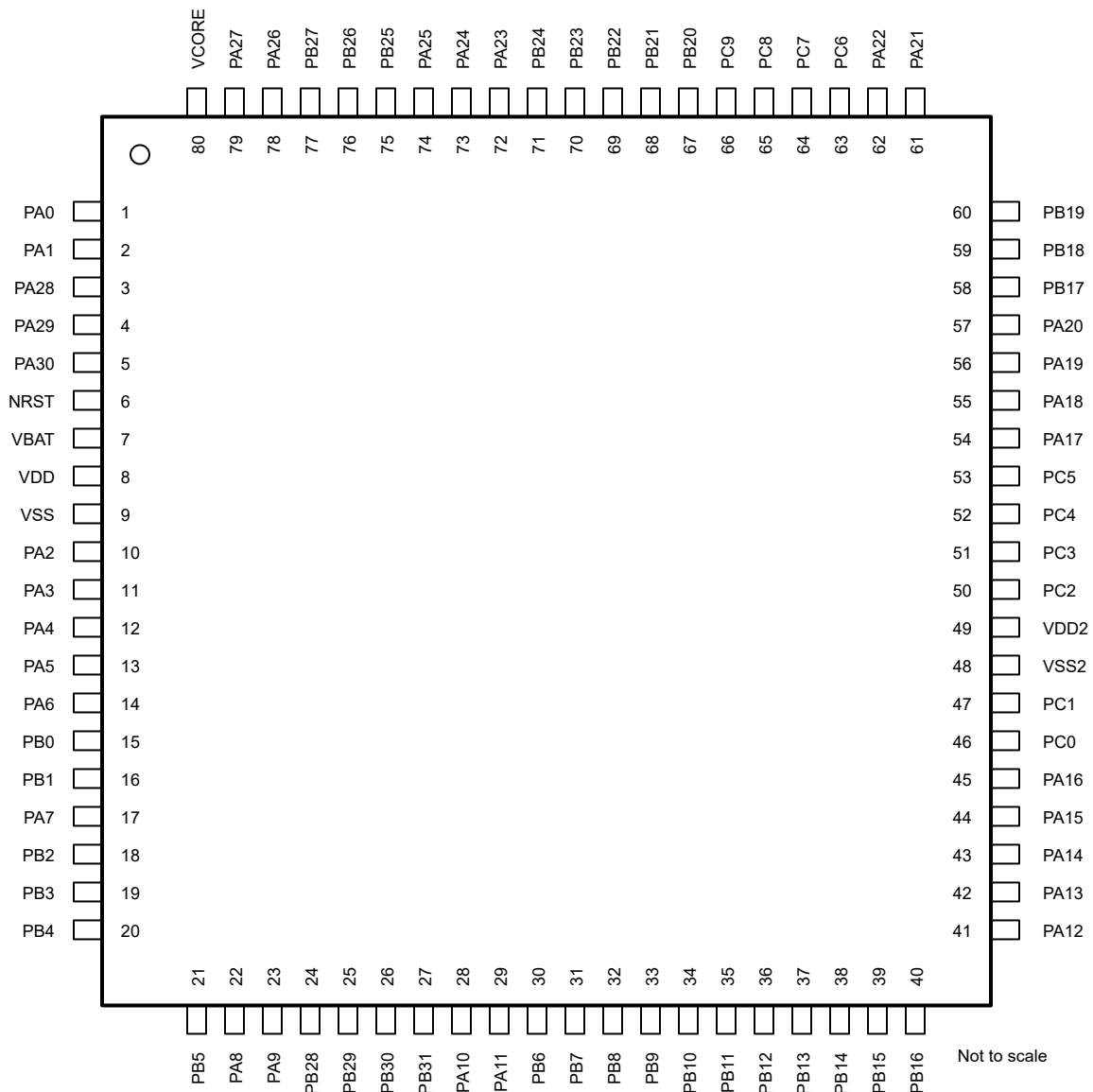
The [System Configuration tool](#) provides a graphical interface to enable, configurable, and generate initialization code for pin multiplexing and simplifying pin settings. The pin diagrams shown in the data sheet show the primary peripheral functions, some of the integrated device features, and available clock signals to simplify the device pinout.

For full descriptions of the pin functions, see the *Pin Attributes* and *Signal Descriptions* sections.

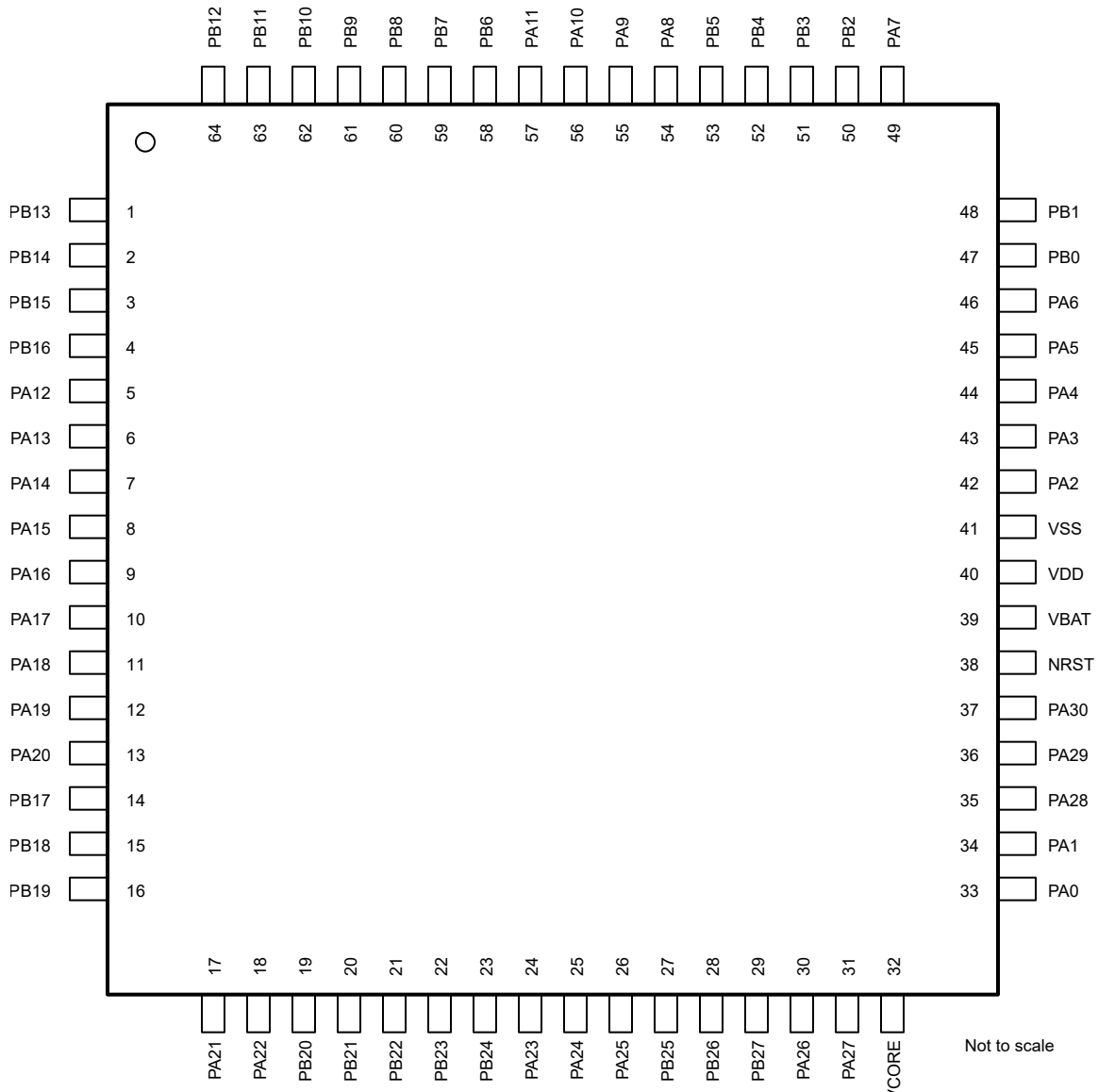
### 6.1 Pin Diagrams

#### Note

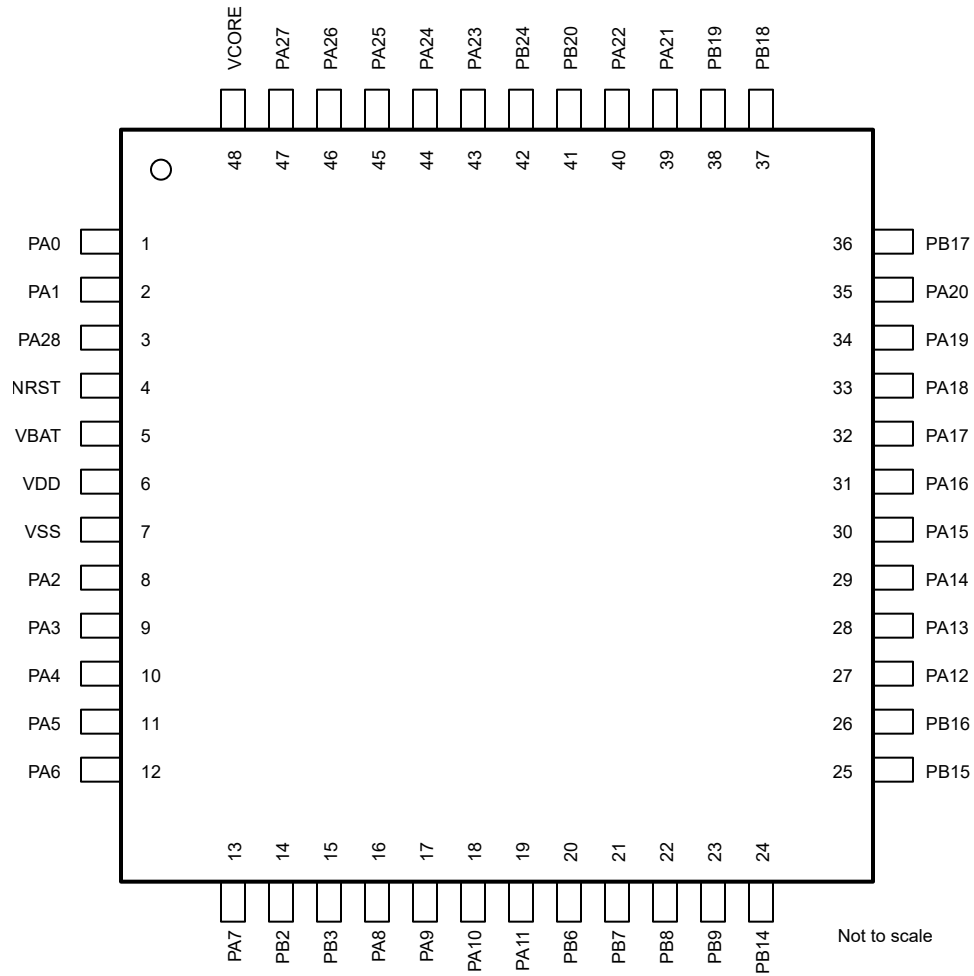
For full pin configuration and functions for each package option, refer to [Section 6.2.1](#) and [Signal Descriptions](#).



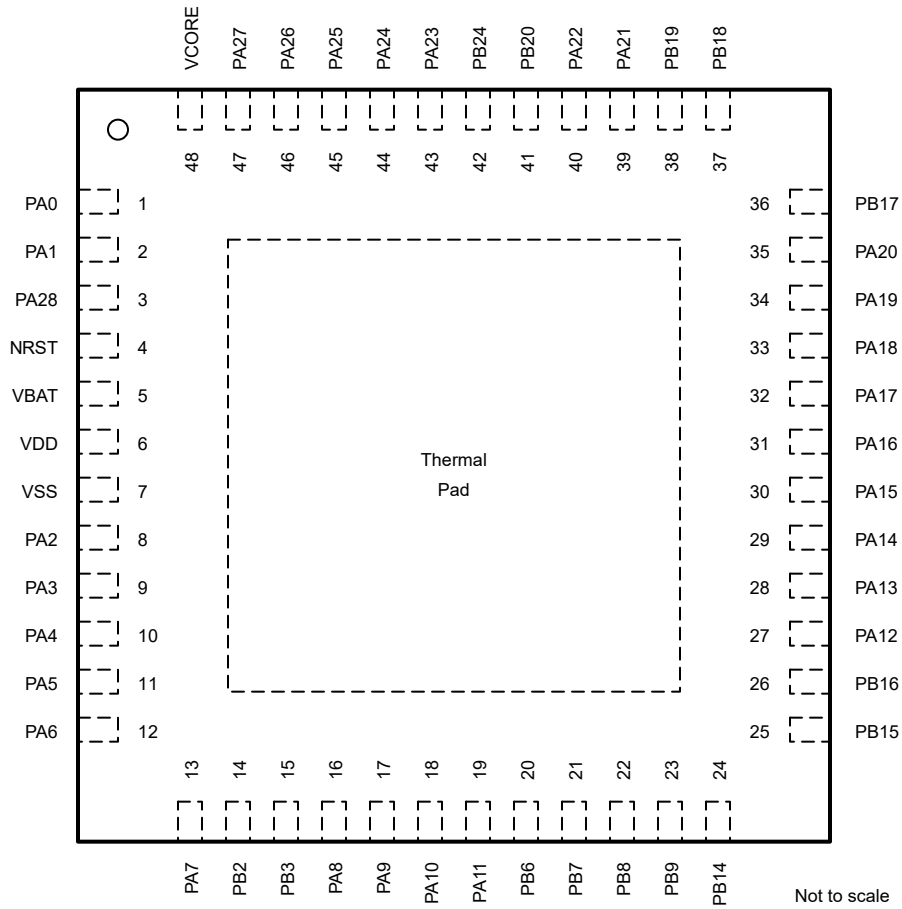
**Figure 6-1. 80-pin PN (0.5mm) (LQFP) Package**



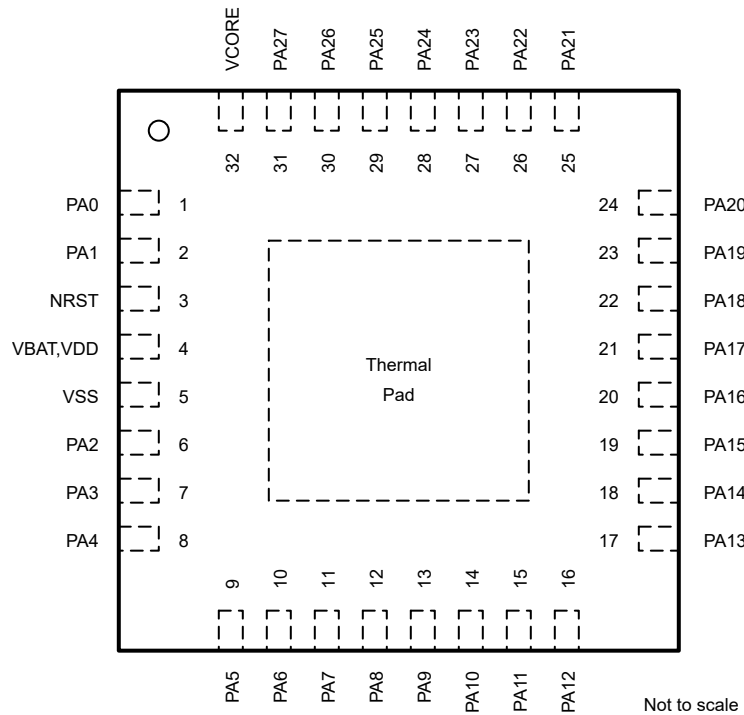
**Figure 6-2. 64-pin PM (LQFP) Package**



**Figure 6-3. 48-pin PT (LQFP) Package**

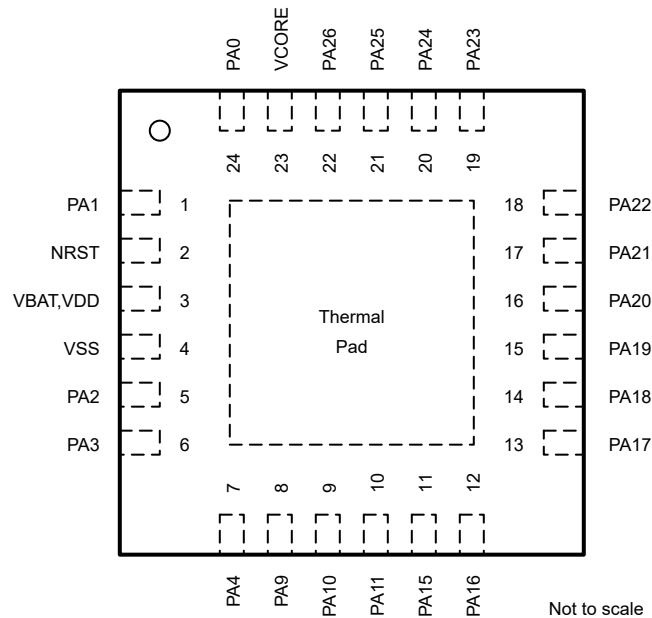


**Figure 6-4. 48-pin RGZ (VQFN) Package**



VBAT is internally shorted to VDD on 24 and 32 pin packages.

**Figure 6-5. 32-pin RHB (VQFN) Package**



VBAT is internally shorted to VDD on 24 and 32 pin packages.

**Figure 6-6. 24-pin RGE (VQFN) Package**

## 6.2 Pin Attributes

The following table describes the functions available on every pin for each device package.

### Note

Each digital I/O on a device is mapped to a specific Pin Control Management Register (PINCMx) that lets users configure the desired *Pin Function* using the PINCM.PF control bits.

Each digital I/O on a device is mapped to a specific Pin Control Management Register (PINCMx) which allows users to configure the desired Pin Function using the PINCM.PF control bits. The IOMUX only supports connecting one IOMUX-managed digital function to the pin at the same time. The PINCM.PF and PINCM.PC in **IOMUX** are recommended to be set to 0 when non-IOMUX managed functions (such as analog connections) are intended to be used on a pin. However, non-IOMUX managed signals (such as analog inputs and WAKE inputs) can be enabled on a pin at the same time that an IOMUX managed digital function is enabled on the pin, provided there is no contention between the functions. In this case, the designer must verify that no contention exists between the functions enabled on each pin.

**Table 6-1. Digital IO Features by IO Type**

| BUFFER TYPE                     | INVERSION CONTROL | DRIVE STRENGTH CONTROL | HYSTERESIS CONTROL | PULLUP RESISTOR | PULLDOWN RESISTOR | WAKEUP LOGIC | Power Domain |
|---------------------------------|-------------------|------------------------|--------------------|-----------------|-------------------|--------------|--------------|
| SDIO (standard drive)           | Y                 |                        |                    | Y               | Y                 |              | VDD          |
| SDIO (standard drive) with wake | Y                 |                        |                    | Y               | Y                 | Y            | VDD          |
| HDIO (High drive)               | Y                 | Y                      |                    | Y               | Y                 | Y            | VDD          |
| ODIO (5V-tolerant open drain)   | Y                 |                        | Y                  |                 | Y                 | Y            | VDD          |
| LFSSIO                          | Y                 |                        |                    | Y               | Y                 |              | VBAT         |

**Table 6-2. Pin Attributes (RGE, PM, PN, RHB, PT, RGZ Packages)**

| RGE PIN | RHB PIN         | RGZ PIN | PT PIN | PM PIN | PN PIN | PIN NAME/<br>IOMUX REG/<br>IOMUX ADDR | SIGNAL NAME | IOMUX PF        | SIGNAL TYPE | BUFFER TYPE     |
|---------|-----------------|---------|--------|--------|--------|---------------------------------------|-------------|-----------------|-------------|-----------------|
| 2       | 3               | 4       | 4      | 38     | 6      | NRST                                  | NRST        | (Non-IOMUX 1) 0 | I           | RESET           |
|         |                 |         |        |        |        |                                       | WAKE        | (Non-IOMUX 2) 0 | I           |                 |
| 24      | 1               | 1       | 1      | 33     | 1      | PA0<br>PINCM1<br>0x40428000           | PA0         | 1               | IO          | ODIO (5V-tol)   |
|         |                 |         |        |        |        |                                       | UART0_TX    | 2               | O           |                 |
|         |                 |         |        |        |        |                                       | I2C0_SDA    | 3               | IOD         |                 |
|         |                 |         |        |        |        |                                       | TIMA0_C0    | 4               | IO          |                 |
|         |                 |         |        |        |        |                                       | TIMA_FAL1   | 5               | I           |                 |
|         |                 |         |        |        |        |                                       | FCC_IN      | 6               | I           |                 |
|         |                 |         |        |        |        |                                       | TIMG8_C1    | 7               | IO          |                 |
|         |                 |         |        |        |        |                                       | TIMG12_C0   | 8               | IO          |                 |
|         |                 |         |        |        |        |                                       | TIMG0_C0    | 9               | IO          |                 |
|         |                 |         |        |        |        |                                       | BSLSDA      | (Non-IOMUX 1) 0 | IOD         |                 |
|         |                 |         |        |        |        |                                       | WAKE        | (Non-IOMUX 2) 0 | I           |                 |
| 1       | 2               | 2       | 2      | 34     | 2      | PA1<br>PINCM2<br>0x40428004           | PA1         | 1               | IO          | ODIO (5V-tol)   |
|         |                 |         |        |        |        |                                       | UART0_RX    | 2               | I           |                 |
|         |                 |         |        |        |        |                                       | I2C0_SCL    | 3               | IOD         |                 |
|         |                 |         |        |        |        |                                       | TIMA0_C1    | 4               | IO          |                 |
|         |                 |         |        |        |        |                                       | TIMA_FAL2   | 5               | I           |                 |
|         |                 |         |        |        |        |                                       | TIMG8_IDX   | 6               | I           |                 |
|         |                 |         |        |        |        |                                       | TIMG8_C0    | 7               | IO          |                 |
|         |                 |         |        |        |        |                                       | TIMG12_C1   | 8               | IO          |                 |
|         |                 |         |        |        |        |                                       | TIMG0_C1    | 9               | IO          |                 |
|         |                 |         |        |        |        |                                       | SPI0_CS3    | 10              | IO          |                 |
|         |                 |         |        |        |        |                                       | BSLSCL      | (Non-IOMUX 1) 0 | IOD         |                 |
| WAKE    | (Non-IOMUX 2) 0 | I       |        |        |        |                                       |             |                 |             |                 |
| 5       | 6               | 8       | 8      | 42     | 10     | PA2<br>PINCM7<br>0x40428018           | PA2         | 1               | IO          | SDIO (standard) |
|         |                 |         |        |        |        |                                       | TIMG8_C1    | 2               | IO          |                 |
|         |                 |         |        |        |        |                                       | SPI0_CS0    | 3               | IO          |                 |
|         |                 |         |        |        |        |                                       | TIMG5_C1    | 4               | IO          |                 |
|         |                 |         |        |        |        |                                       | SPI1_CS0    | 5               | IO          |                 |
|         |                 |         |        |        |        |                                       | TIMA0_C3N   | 6               | O           |                 |
|         |                 |         |        |        |        |                                       | TIMA0_C2N   | 7               | O           |                 |
|         |                 |         |        |        |        |                                       | TIMA_FAL0   | 8               | I           |                 |
|         |                 |         |        |        |        |                                       | TIMA_FAL1   | 9               | I           |                 |
|         |                 |         |        |        |        |                                       | UART4_CTS   | 10              | I           |                 |
|         |                 |         |        |        |        |                                       | TIMA0_C0    | 11              | IO          |                 |
| ROSC    | (Non-IOMUX 1) 0 | A       |        |        |        |                                       |             |                 |             |                 |

**Table 6-2. Pin Attributes (RGE, PM, PN, RHB, PT, RGZ Packages) (continued)**

| RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN | PIN NAME/<br>IOMUX REG/<br>IOMUX ADDR | SIGNAL NAME | IOMUX PF        | SIGNAL TYPE | BUFFER TYPE          |
|---------|---------|---------|--------|--------|--------|---------------------------------------|-------------|-----------------|-------------|----------------------|
| 6       | 7       | 9       | 9      | 43     | 11     | PA3<br>PINCM8<br>0x4042801c           | PA3         | 1               | IO          | LFSSIO<br>(standard) |
|         |         |         |        |        |        |                                       | TIMG8_C0    | 2               | IO          |                      |
|         |         |         |        |        |        |                                       | SPI0_CS1    | 3               | IO          |                      |
|         |         |         |        |        |        |                                       | I2C1_SDA    | 4               | IOD         |                      |
|         |         |         |        |        |        |                                       | TIMA0_C1    | 5               | IO          |                      |
|         |         |         |        |        |        |                                       | COMP0_OUT   | 6               | O           |                      |
|         |         |         |        |        |        |                                       | TIMG5_C0    | 7               | IO          |                      |
|         |         |         |        |        |        |                                       | TIMA0_C2    | 8               | IO          |                      |
|         |         |         |        |        |        |                                       | UART2_CTS   | 9               | I           |                      |
|         |         |         |        |        |        |                                       | UART1_TX    | 10              | O           |                      |
|         |         |         |        |        |        |                                       | SPI0_CS3    | 11              | IO          |                      |
|         |         |         |        |        |        |                                       | LFXIN       | (Non-IOMUX 1) 0 | A           |                      |
| 7       | 8       | 10      | 10     | 44     | 12     | PA4<br>PINCM9<br>0x40428020           | PA4         | 1               | IO          | LFSSIO<br>(standard) |
|         |         |         |        |        |        |                                       | TIMG8_C1    | 2               | IO          |                      |
|         |         |         |        |        |        |                                       | SPI0_POCI   | 3               | IO          |                      |
|         |         |         |        |        |        |                                       | I2C1_SCL    | 4               | IOD         |                      |
|         |         |         |        |        |        |                                       | TIMA0_C1N   | 5               | O           |                      |
|         |         |         |        |        |        |                                       | LFCLK_IN    | 6               | I           |                      |
|         |         |         |        |        |        |                                       | TIMG5_C1    | 7               | IO          |                      |
|         |         |         |        |        |        |                                       | TIMA0_C3    | 8               | IO          |                      |
|         |         |         |        |        |        |                                       | UART2_RTS   | 9               | O           |                      |
|         |         |         |        |        |        |                                       | UART1_RX    | 10              | I           |                      |
|         |         |         |        |        |        |                                       | SPI0_CS0    | 11              | IO          |                      |
|         |         |         |        |        |        |                                       | LFXOUT      | (Non-IOMUX 1) 0 | A           |                      |
|         | 9       | 11      | 11     | 45     | 13     | PA5<br>PINCM10<br>0x40428024          | PA5         | 1               | IO          | SDIO<br>(standard)   |
|         |         |         |        |        |        |                                       | TIMG8_C0    | 2               | IO          |                      |
|         |         |         |        |        |        |                                       | SPI0_PICO   | 3               | IO          |                      |
|         |         |         |        |        |        |                                       | I2C1_SDA    | 4               | IOD         |                      |
|         |         |         |        |        |        |                                       | TIMG0_C0    | 5               | IO          |                      |
|         |         |         |        |        |        |                                       | FCC_IN      | 6               | I           |                      |
|         |         |         |        |        |        |                                       | TIMG4_C0    | 7               | IO          |                      |
|         |         |         |        |        |        |                                       | TIMA_FAL1   | 8               | I           |                      |
|         |         |         |        |        |        |                                       | UART0_CTS   | 9               | I           |                      |
|         |         |         |        |        |        |                                       | UART4_RTS   | 10              | O           |                      |
|         |         |         |        |        |        |                                       | UART1_TX    | 11              | O           |                      |
|         |         |         |        |        |        |                                       | HFXIN       | (Non-IOMUX 1) 0 | A           |                      |
|         | 10      | 12      | 12     | 46     | 14     | PA6<br>PINCM11<br>0x40428028          | PA6         | 1               | IO          | SDIO<br>(standard)   |
|         |         |         |        |        |        |                                       | TIMG8_C1    | 2               | IO          |                      |
|         |         |         |        |        |        |                                       | SPI0_SCK    | 3               | IO          |                      |
|         |         |         |        |        |        |                                       | I2C1_SCL    | 4               | IOD         |                      |
|         |         |         |        |        |        |                                       | TIMG0_C1    | 5               | IO          |                      |
|         |         |         |        |        |        |                                       | HFCLK_IN    | 6               | I           |                      |
|         |         |         |        |        |        |                                       | TIMG4_C1    | 7               | IO          |                      |
|         |         |         |        |        |        |                                       | TIMA_FAL0   | 8               | I           |                      |
|         |         |         |        |        |        |                                       | UART0_RTS   | 9               | O           |                      |
|         |         |         |        |        |        |                                       | TIMA0_C2N   | 10              | O           |                      |
|         |         |         |        |        |        |                                       | UART1_RX    | 11              | I           |                      |
|         |         |         |        |        |        |                                       | HFXOUT      | (Non-IOMUX 1) 0 | A           |                      |

**Table 6-2. Pin Attributes (RGE, PM, PN, RHB, PT, RGZ Packages) (continued)**

| RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN | PIN NAME/<br>IOMUX REG/<br>IOMUX ADDR | SIGNAL NAME | IOMUX PF        | SIGNAL TYPE | BUFFER TYPE          |
|---------|---------|---------|--------|--------|--------|---------------------------------------|-------------|-----------------|-------------|----------------------|
| 11      | 13      | 13      | 13     | 49     | 17     | PA7<br>PINCM14<br>0x40428034          | PA7         | 1               | IO          | LFSSIO<br>(standard) |
|         |         |         |        |        |        |                                       | COMP0_OUT   | 2               | O           |                      |
|         |         |         |        |        |        |                                       | CLK_OUT     | 3               | O           |                      |
|         |         |         |        |        |        |                                       | TIMG8_C0    | 4               | IO          |                      |
|         |         |         |        |        |        |                                       | TIMA0_C2    | 5               | IO          |                      |
|         |         |         |        |        |        |                                       | TIMG8_IDX   | 6               | I           |                      |
|         |         |         |        |        |        |                                       | TIMG5_C1    | 7               | IO          |                      |
|         |         |         |        |        |        |                                       | TIMA0_C1    | 8               | IO          |                      |
|         |         |         |        |        |        |                                       | SPI0_CS2    | 9               | IO          |                      |
|         |         |         |        |        |        |                                       | FCC_IN      | 10              | I           |                      |
|         |         |         |        |        |        |                                       | SPI0_POCI   | 11              | IO          |                      |
|         |         |         |        |        |        |                                       | TIO0        | (Non-IOMUX 1) 0 | I           |                      |
| 12      | 16      | 16      | 16     | 54     | 22     | PA8<br>PINCM19<br>0x40428048          | PA8         | 1               | IO          | SDIO<br>(standard)   |
|         |         |         |        |        |        |                                       | UART1_TX    | 2               | O           |                      |
|         |         |         |        |        |        |                                       | SPI0_CS0    | 3               | IO          |                      |
|         |         |         |        |        |        |                                       | I2C0_SDA    | 4               | IOD         |                      |
|         |         |         |        |        |        |                                       | TIMA0_C0    | 5               | IO          |                      |
|         |         |         |        |        |        |                                       | TIMA_FAL2   | 6               | I           |                      |
|         |         |         |        |        |        |                                       | TIMA_FAL0   | 7               | I           |                      |
|         |         |         |        |        |        |                                       | SPI0_CS3    | 8               | IO          |                      |
|         |         |         |        |        |        |                                       | TIMG5_C1    | 9               | IO          |                      |
|         |         |         |        |        |        |                                       | HFCLK_IN    | 10              | I           |                      |
|         |         |         |        |        |        |                                       | UART0_RTS   | 11              | O           |                      |
|         |         |         |        |        |        |                                       | LCD0        | (Non-IOMUX 1) 0 | A           |                      |
| 8       | 13      | 17      | 17     | 55     | 23     | PA9<br>PINCM20<br>0x4042804c          | PA9         | 1               | IO          | SDIO<br>(standard)   |
|         |         |         |        |        |        |                                       | UART1_RX    | 2               | I           |                      |
|         |         |         |        |        |        |                                       | SPI0_PICO   | 3               | IO          |                      |
|         |         |         |        |        |        |                                       | I2C0_SCL    | 4               | IOD         |                      |
|         |         |         |        |        |        |                                       | TIMA0_CON   | 5               | O           |                      |
|         |         |         |        |        |        |                                       | CLK_OUT     | 6               | O           |                      |
|         |         |         |        |        |        |                                       | TIMA0_C1    | 7               | IO          |                      |
|         |         |         |        |        |        |                                       | RTC_OUT     | 8               | O           |                      |
|         |         |         |        |        |        |                                       | TIMG5_C0    | 9               | IO          |                      |
|         |         |         |        |        |        |                                       | UART4_RTS   | 10              | O           |                      |
|         |         |         |        |        |        |                                       | UART0_CTS   | 11              | I           |                      |
|         |         |         |        |        |        |                                       | LCD1        | (Non-IOMUX 1) 0 | A           |                      |

**Table 6-2. Pin Attributes (RGE, PM, PN, RHB, PT, RGZ Packages) (continued)**

| RGE PIN   | RHB PIN         | RGZ PIN | PT PIN | PM PIN | PN PIN                        | PIN NAME/<br>IOMUX REG/<br>IOMUX ADDR | SIGNAL NAME     | IOMUX PF        | SIGNAL TYPE | BUFFER TYPE       |
|-----------|-----------------|---------|--------|--------|-------------------------------|---------------------------------------|-----------------|-----------------|-------------|-------------------|
| 9         | 14              | 18      | 18     | 56     | 28                            | PA10<br>PINCM25<br>0x40428060         | PA10            | 1               | IO          | HDIO (high drive) |
|           |                 |         |        |        |                               |                                       | UART0_TX        | 2               | O           |                   |
|           |                 |         |        |        |                               |                                       | SPI0_POCI       | 3               | IO          |                   |
|           |                 |         |        |        |                               |                                       | I2C0_SDA        | 4               | IOD         |                   |
|           |                 |         |        |        |                               |                                       | TIMA0_C2        | 5               | IO          |                   |
|           |                 |         |        |        |                               |                                       | CLK_OUT         | 6               | O           |                   |
|           |                 |         |        |        |                               |                                       | TIMG0_C0        | 7               | IO          |                   |
|           |                 |         |        |        |                               |                                       | I2C1_SDA        | 8               | IOD         |                   |
|           |                 |         |        |        |                               |                                       | TIMG12_C0       | 9               | IO          |                   |
|           |                 |         |        |        |                               |                                       | TIMA_FAL1       | 10              | I           |                   |
|           |                 |         |        |        |                               |                                       | BSLTX           | (Non-IOMUX 1) 0 | O           |                   |
|           |                 |         |        |        |                               |                                       | WAKE            | (Non-IOMUX 2) 0 | I           |                   |
|           |                 |         |        |        |                               |                                       | LCD2            | (Non-IOMUX 3) 0 | A           |                   |
|           |                 |         |        |        |                               |                                       | 10              | 15              | 19          |                   |
| UART0_RX  | 2               | I       |        |        |                               |                                       |                 |                 |             |                   |
| SPI0_SCK  | 3               | IO      |        |        |                               |                                       |                 |                 |             |                   |
| I2C0_SCL  | 4               | IOD     |        |        |                               |                                       |                 |                 |             |                   |
| TIMA0_C2N | 5               | O       |        |        |                               |                                       |                 |                 |             |                   |
| COMP0_OUT | 6               | O       |        |        |                               |                                       |                 |                 |             |                   |
| TIMG0_C1  | 7               | IO      |        |        |                               |                                       |                 |                 |             |                   |
| I2C1_SCL  | 8               | IOD     |        |        |                               |                                       |                 |                 |             |                   |
| TIMG12_C1 | 9               | IO      |        |        |                               |                                       |                 |                 |             |                   |
| TIMA_FAL0 | 10              | I       |        |        |                               |                                       |                 |                 |             |                   |
| BSLRX     | (Non-IOMUX 1) 0 | I       |        |        |                               |                                       |                 |                 |             |                   |
| WAKE      | (Non-IOMUX 2) 0 | I       |        |        |                               |                                       |                 |                 |             |                   |
| LCD3      | (Non-IOMUX 3) 0 | A       |        |        |                               |                                       |                 |                 |             |                   |
| 16        | 27              | 27      | 5      | 41     | PA12<br>PINCM38<br>0x40428094 | PA12                                  |                 |                 |             | 1                 |
|           |                 |         |        |        |                               | UART3_CTS                             | 2               | I               |             |                   |
|           |                 |         |        |        |                               | SPI0_SCK                              | 3               | IO              |             |                   |
|           |                 |         |        |        |                               | COMP0_OUT                             | 4               | O               |             |                   |
|           |                 |         |        |        |                               | TIMA0_C3                              | 5               | IO              |             |                   |
|           |                 |         |        |        |                               | FCC_IN                                | 6               | I               |             |                   |
|           |                 |         |        |        |                               | TIMG0_C0                              | 7               | IO              |             |                   |
|           |                 |         |        |        |                               | SPI1_CS1                              | 8               | IO              |             |                   |
|           |                 |         |        |        |                               | SPI0_CS1                              | 9               | IO              |             |                   |
|           |                 |         |        |        |                               | UART2_CTS                             | 10              | I               |             |                   |
|           |                 |         |        |        |                               | UART1_CTS                             | 11              | I               |             |                   |
|           |                 |         |        |        |                               | LCD11                                 | (Non-IOMUX 1) 0 | A               |             |                   |
|           |                 |         |        |        |                               | R33                                   | (Non-IOMUX 2) 0 | A               |             |                   |
|           |                 |         |        |        |                               | A_18                                  | (Non-IOMUX 3) 0 | A               |             |                   |

**Table 6-2. Pin Attributes (RGE, PM, PN, RHB, PT, RGZ Packages) (continued)**

| RGE PIN    | RHB PIN         | RGZ PIN | PT PIN | PM PIN | PN PIN                        | PIN NAME/<br>IOMUX REG/<br>IOMUX ADDR | SIGNAL NAME     | IOMUX PF | SIGNAL TYPE        | BUFFER TYPE |
|------------|-----------------|---------|--------|--------|-------------------------------|---------------------------------------|-----------------|----------|--------------------|-------------|
| 17         | 28              | 28      | 6      | 42     | PA13<br>PINCM39<br>0x40428098 | PA13                                  | 1               | IO       | SDIO<br>(standard) |             |
|            |                 |         |        |        |                               | UART3_RTS                             | 2               | O        |                    |             |
|            |                 |         |        |        |                               | SPI0_POCI                             | 3               | IO       |                    |             |
|            |                 |         |        |        |                               | UART3_RX                              | 4               | I        |                    |             |
|            |                 |         |        |        |                               | TIMA0_C3N                             | 5               | O        |                    |             |
|            |                 |         |        |        |                               | RTC_OUT                               | 6               | O        |                    |             |
|            |                 |         |        |        |                               | TIMG0_C1                              | 7               | IO       |                    |             |
|            |                 |         |        |        |                               | SPI1_CS0                              | 8               | IO       |                    |             |
|            |                 |         |        |        |                               | SPI0_CS3                              | 9               | IO       |                    |             |
|            |                 |         |        |        |                               | UART2_TX                              | 10              | O        |                    |             |
|            |                 |         |        |        |                               | UART1_RTS                             | 11              | O        |                    |             |
|            |                 |         |        |        |                               | LCD12                                 | (Non-IOMUX 1) 0 | A        |                    |             |
|            |                 |         |        |        |                               | LCDCAP0                               | (Non-IOMUX 2) 0 | A        |                    |             |
|            |                 |         |        |        |                               | A_17                                  | (Non-IOMUX 3) 0 | A        |                    |             |
| COMP0_IN2- | (Non-IOMUX 4) 0 | A       |        |        |                               |                                       |                 |          |                    |             |
| 18         | 29              | 29      | 7      | 43     | PA14<br>PINCM40<br>0x4042809c | PA14                                  | 1               | IO       | SDIO<br>(standard) |             |
|            |                 |         |        |        |                               | UART0_CTS                             | 2               | I        |                    |             |
|            |                 |         |        |        |                               | SPI0_PICO                             | 3               | IO       |                    |             |
|            |                 |         |        |        |                               | UART3_TX                              | 4               | O        |                    |             |
|            |                 |         |        |        |                               | TIMG12_C0                             | 5               | IO       |                    |             |
|            |                 |         |        |        |                               | CLK_OUT                               | 6               | O        |                    |             |
|            |                 |         |        |        |                               | TIMG12_C1                             | 7               | IO       |                    |             |
|            |                 |         |        |        |                               | SPI1_CS2                              | 8               | IO       |                    |             |
|            |                 |         |        |        |                               | SPI0_CS2                              | 9               | IO       |                    |             |
|            |                 |         |        |        |                               | UART2_RX                              | 10              | I        |                    |             |
|            |                 |         |        |        |                               | LCD13                                 | (Non-IOMUX 1) 0 | A        |                    |             |
|            |                 |         |        |        |                               | LCDCAP1                               | (Non-IOMUX 2) 0 | A        |                    |             |
|            |                 |         |        |        |                               | A_16                                  | (Non-IOMUX 3) 0 | A        |                    |             |
|            |                 |         |        |        |                               | COMP0_IN2+                            | (Non-IOMUX 4) 0 | A        |                    |             |
| 11         | 30              | 30      | 8      | 44     | PA15<br>PINCM41<br>0x404280a0 | PA15                                  | 1               | IO       | SDIO<br>(standard) |             |
|            |                 |         |        |        |                               | UART0_RTS                             | 2               | O        |                    |             |
|            |                 |         |        |        |                               | SPI1_CS2                              | 3               | IO       |                    |             |
|            |                 |         |        |        |                               | I2C1_SCL                              | 4               | IOD      |                    |             |
|            |                 |         |        |        |                               | TIMA0_C2                              | 5               | IO       |                    |             |
|            |                 |         |        |        |                               | I2C2_SCL                              | 6               | IOD      |                    |             |
|            |                 |         |        |        |                               | TIMG8_IDX                             | 7               | I        |                    |             |
|            |                 |         |        |        |                               | TIMG12_C0                             | 8               | IO       |                    |             |
|            |                 |         |        |        |                               | LCDEN                                 | 9               | A        |                    |             |
|            |                 |         |        |        |                               | UART2_RTS                             | 10              | O        |                    |             |
|            |                 |         |        |        |                               | LCD14                                 | (Non-IOMUX 1) 0 | A        |                    |             |
|            |                 |         |        |        |                               | A_15                                  | (Non-IOMUX 2) 0 | A        |                    |             |
|            |                 |         |        |        |                               | COMP0_IN3+                            | (Non-IOMUX 3) 0 | A        |                    |             |

**Table 6-2. Pin Attributes (RGE, PM, PN, RHB, PT, RGZ Packages) (continued)**

| RGE PIN    | RHB PIN         | RGZ PIN | PT PIN | PM PIN | PN PIN | PIN NAME/<br>IOMUX REG/<br>IOMUX ADDR | SIGNAL NAME | IOMUX PF        | SIGNAL TYPE | BUFFER TYPE                     |
|------------|-----------------|---------|--------|--------|--------|---------------------------------------|-------------|-----------------|-------------|---------------------------------|
| 12         | 20              | 31      | 31     | 9      | 45     | PA16<br>PINCM42<br>0x404280a4         | PA16        | 1               | IO          | SDIO<br>(standard)              |
|            |                 |         |        |        |        |                                       | COMP0_OUT   | 2               | O           |                                 |
|            |                 |         |        |        |        |                                       | SPI1_POCI   | 3               | IO          |                                 |
|            |                 |         |        |        |        |                                       | I2C1_SDA    | 4               | IOD         |                                 |
|            |                 |         |        |        |        |                                       | TIMA0_C2N   | 5               | O           |                                 |
|            |                 |         |        |        |        |                                       | I2C2_SDA    | 6               | IOD         |                                 |
|            |                 |         |        |        |        |                                       | FCC_IN      | 7               | I           |                                 |
|            |                 |         |        |        |        |                                       | TIMG12_C1   | 8               | IO          |                                 |
|            |                 |         |        |        |        |                                       | LCDSON      | 9               | IO          |                                 |
|            |                 |         |        |        |        |                                       | UART2_CTS   | 10              | I           |                                 |
|            |                 |         |        |        |        |                                       | LCD15       | (Non-IOMUX 1) 0 | A           |                                 |
| A_14       | (Non-IOMUX 2) 0 | A       |        |        |        |                                       |             |                 |             |                                 |
| 13         | 21              | 32      | 32     | 10     | 54     | PA17<br>PINCM49<br>0x404280c0         | PA17        | 1               | IO          | SDIO<br>(standard<br>with wake) |
|            |                 |         |        |        |        |                                       | UART1_TX    | 2               | O           |                                 |
|            |                 |         |        |        |        |                                       | SPI1_SCK    | 3               | IO          |                                 |
|            |                 |         |        |        |        |                                       | I2C1_SCL    | 4               | IOD         |                                 |
|            |                 |         |        |        |        |                                       | TIMA0_C3    | 5               | IO          |                                 |
|            |                 |         |        |        |        |                                       | TIMG5_C0    | 6               | IO          |                                 |
|            |                 |         |        |        |        |                                       | TIMG8_C0    | 7               | IO          |                                 |
|            |                 |         |        |        |        |                                       | TIMG12_C0   | 8               | IO          |                                 |
|            |                 |         |        |        |        |                                       | SPI0_CS1    | 9               | IO          |                                 |
|            |                 |         |        |        |        |                                       | LCDLFCLK    | 10              | IO          |                                 |
|            |                 |         |        |        |        |                                       | WAKE        | (Non-IOMUX 1) 0 | I           |                                 |
|            |                 |         |        |        |        |                                       | LCD16       | (Non-IOMUX 2) 0 | A           |                                 |
|            |                 |         |        |        |        |                                       | A_13        | (Non-IOMUX 3) 0 | A           |                                 |
| COMP0_IN1- | (Non-IOMUX 4) 0 | A       |        |        |        |                                       |             |                 |             |                                 |
| 14         | 22              | 33      | 33     | 11     | 55     | PA18<br>PINCM50<br>0x404280c4         | PA18        | 1               | IO          | SDIO<br>(standard<br>with wake) |
|            |                 |         |        |        |        |                                       | UART1_RX    | 2               | I           |                                 |
|            |                 |         |        |        |        |                                       | SPI1_PICO   | 3               | IO          |                                 |
|            |                 |         |        |        |        |                                       | I2C1_SDA    | 4               | IOD         |                                 |
|            |                 |         |        |        |        |                                       | TIMA0_C3N   | 5               | O           |                                 |
|            |                 |         |        |        |        |                                       | TIMG5_C1    | 6               | IO          |                                 |
|            |                 |         |        |        |        |                                       | TIMG8_C1    | 7               | IO          |                                 |
|            |                 |         |        |        |        |                                       | TIMG12_C1   | 8               | IO          |                                 |
|            |                 |         |        |        |        |                                       | SPI0_CS0    | 9               | IO          |                                 |
|            |                 |         |        |        |        |                                       | LCDEN       | 10              | A           |                                 |
|            |                 |         |        |        |        |                                       | BSL_invoke  | (Non-IOMUX 1) 0 | I           |                                 |
|            |                 |         |        |        |        |                                       | WAKE        | (Non-IOMUX 2) 0 | I           |                                 |
|            |                 |         |        |        |        |                                       | LCD17       | (Non-IOMUX 3) 0 | A           |                                 |
|            |                 |         |        |        |        |                                       | A_12        | (Non-IOMUX 4) 0 | A           |                                 |
| COMP0_IN1+ | (Non-IOMUX 5) 0 | A       |        |        |        |                                       |             |                 |             |                                 |
| 15         | 23              | 34      | 34     | 12     | 56     | PA19<br>PINCM51<br>0x404280c8         | PA19        | 1               | IO          | SDIO<br>(standard)              |
|            |                 |         |        |        |        |                                       | SWDIO       | 2               | IO          |                                 |
|            |                 |         |        |        |        |                                       | SPI1_POCI   | 3               | IO          |                                 |
|            |                 |         |        |        |        |                                       | I2C1_SDA    | 4               | IOD         |                                 |
|            |                 |         |        |        |        |                                       | TIMA0_C2    | 5               | IO          |                                 |
|            |                 |         |        |        |        |                                       | TIMG0_C0    | 6               | IO          |                                 |

**Table 6-2. Pin Attributes (RGE, PM, PN, RHB, PT, RGZ Packages) (continued)**

| RGE PIN | RHB PIN         | RGZ PIN | PT PIN | PM PIN | PN PIN | PIN NAME/<br>IOMUX REG/<br>IOMUX ADDR | SIGNAL NAME | IOMUX PF        | SIGNAL TYPE | BUFFER TYPE        |
|---------|-----------------|---------|--------|--------|--------|---------------------------------------|-------------|-----------------|-------------|--------------------|
| 16      | 24              | 35      | 35     | 13     | 57     | PA20<br>PINCM52<br>0x404280cc         | PA20        | 1               | IO          | SDIO<br>(standard) |
|         |                 |         |        |        |        |                                       | SWCLK       | 2               | I           |                    |
|         |                 |         |        |        |        |                                       | SPI1_SCK    | 3               | IO          |                    |
|         |                 |         |        |        |        |                                       | I2C1_SCL    | 4               | IOD         |                    |
|         |                 |         |        |        |        |                                       | TIMA0_C2N   | 5               | O           |                    |
|         |                 |         |        |        |        |                                       | TIMG0_C1    | 6               | IO          |                    |
| 17      | 25              | 39      | 39     | 17     | 61     | PA21<br>PINCM56<br>0x404280dc         | PA21        | 1               | IO          | SDIO<br>(standard) |
|         |                 |         |        |        |        |                                       | UART2_TX    | 2               | O           |                    |
|         |                 |         |        |        |        |                                       | SPI0_CS3    | 3               | IO          |                    |
|         |                 |         |        |        |        |                                       | UART1_CTS   | 4               | I           |                    |
|         |                 |         |        |        |        |                                       | TIMA0_C0    | 5               | IO          |                    |
|         |                 |         |        |        |        |                                       | TIMG4_C0    | 6               | IO          |                    |
|         |                 |         |        |        |        |                                       | SPI1_CS1    | 7               | IO          |                    |
|         |                 |         |        |        |        |                                       | UART2_CTS   | 8               | I           |                    |
|         |                 |         |        |        |        |                                       | UART4_RTS   | 9               | O           |                    |
|         |                 |         |        |        |        |                                       | TIMG8_C0    | 10              | IO          |                    |
|         |                 |         |        |        |        |                                       | LCD21       | (Non-IOMUX 1) 0 | A           |                    |
|         |                 |         |        |        |        |                                       | A_8         | (Non-IOMUX 2) 0 | A           |                    |
| VREF-   | (Non-IOMUX 3) 0 | A       |        |        |        |                                       |             |                 |             |                    |
| 18      | 26              | 40      | 40     | 18     | 62     | PA22<br>PINCM57<br>0x404280e0         | PA22        | 1               | IO          | SDIO<br>(standard) |
|         |                 |         |        |        |        |                                       | UART2_RX    | 2               | I           |                    |
|         |                 |         |        |        |        |                                       | SPI0_CS2    | 3               | IO          |                    |
|         |                 |         |        |        |        |                                       | UART1_RTS   | 4               | O           |                    |
|         |                 |         |        |        |        |                                       | TIMA0_C0N   | 5               | O           |                    |
|         |                 |         |        |        |        |                                       | TIMG4_C1    | 6               | IO          |                    |
|         |                 |         |        |        |        |                                       | TIMA0_C1    | 7               | IO          |                    |
|         |                 |         |        |        |        |                                       | CLK_OUT     | 8               | O           |                    |
|         |                 |         |        |        |        |                                       | I2C0_SCL    | 9               | IOD         |                    |
|         |                 |         |        |        |        |                                       | TIMG8_C1    | 10              | IO          |                    |
|         |                 |         |        |        |        |                                       | LCD22       | (Non-IOMUX 1) 0 | A           |                    |
|         |                 |         |        |        |        |                                       | A_7         | (Non-IOMUX 2) 0 | A           |                    |
| 19      | 27              | 43      | 43     | 24     | 72     | PA23<br>PINCM67<br>0x40428108         | PA23        | 1               | IO          | SDIO<br>(standard) |
|         |                 |         |        |        |        |                                       | UART2_TX    | 2               | O           |                    |
|         |                 |         |        |        |        |                                       | SPI0_CS3    | 3               | IO          |                    |
|         |                 |         |        |        |        |                                       | I2C2_SCL    | 4               | IOD         |                    |
|         |                 |         |        |        |        |                                       | TIMA0_C3    | 5               | IO          |                    |
|         |                 |         |        |        |        |                                       | TIMG8_C0    | 6               | IO          |                    |
|         |                 |         |        |        |        |                                       | TIMG5_C0    | 7               | IO          |                    |
|         |                 |         |        |        |        |                                       | UART3_CTS   | 8               | I           |                    |
|         |                 |         |        |        |        |                                       | TIMG0_C0    | 9               | IO          |                    |
|         |                 |         |        |        |        |                                       | SPI1_CS1    | 10              | IO          |                    |
|         |                 |         |        |        |        |                                       | LCD25       | (Non-IOMUX 1) 0 | A           |                    |
|         |                 |         |        |        |        |                                       | VREF+       | (Non-IOMUX 2) 0 | A           |                    |

**Table 6-2. Pin Attributes (RGE, PM, PN, RHB, PT, RGZ Packages) (continued)**

| RGE PIN    | RHB PIN         | RGZ PIN | PT PIN | PM PIN | PN PIN | PIN NAME/<br>IOMUX REG/<br>IOMUX ADDR | SIGNAL NAME | IOMUX PF        | SIGNAL TYPE | BUFFER TYPE        |
|------------|-----------------|---------|--------|--------|--------|---------------------------------------|-------------|-----------------|-------------|--------------------|
| 20         | 28              | 44      | 44     | 25     | 73     | PA24<br>PINCM68<br>0x4042810c         | PA24        | 1               | IO          | SDIO<br>(standard) |
|            |                 |         |        |        |        |                                       | UART2_RX    | 2               | I           |                    |
|            |                 |         |        |        |        |                                       | SPI0_CS2    | 3               | IO          |                    |
|            |                 |         |        |        |        |                                       | I2C2_SDA    | 4               | IOD         |                    |
|            |                 |         |        |        |        |                                       | TIMA0_C3N   | 5               | O           |                    |
|            |                 |         |        |        |        |                                       | TIMG8_C1    | 6               | IO          |                    |
|            |                 |         |        |        |        |                                       | TIMG5_C1    | 7               | IO          |                    |
|            |                 |         |        |        |        |                                       | UART3_RTS   | 8               | O           |                    |
|            |                 |         |        |        |        |                                       | TIMG0_C1    | 9               | IO          |                    |
|            |                 |         |        |        |        |                                       | SPI1_CS2    | 10              | IO          |                    |
|            |                 |         |        |        |        |                                       | LCD26       | (Non-IOMUX 1) 0 | A           |                    |
|            |                 |         |        |        |        |                                       | A_3         | (Non-IOMUX 2) 0 | A           |                    |
| 21         | 29              | 45      | 45     | 26     | 74     | PA25<br>PINCM69<br>0x40428110         | PA25        | 1               | IO          | SDIO<br>(standard) |
|            |                 |         |        |        |        |                                       | UART3_RX    | 2               | I           |                    |
|            |                 |         |        |        |        |                                       | SPI1_CS3    | 3               | IO          |                    |
|            |                 |         |        |        |        |                                       | TIMG12_C1   | 4               | IO          |                    |
|            |                 |         |        |        |        |                                       | TIMA0_C3    | 5               | IO          |                    |
|            |                 |         |        |        |        |                                       | TIMA0_C1N   | 6               | O           |                    |
|            |                 |         |        |        |        |                                       | COMP0_OUT   | 7               | O           |                    |
|            |                 |         |        |        |        |                                       | UART2_CTS   | 8               | I           |                    |
|            |                 |         |        |        |        |                                       | UART3_TX    | 9               | O           |                    |
|            |                 |         |        |        |        |                                       | TIMG4_C0    | 10              | IO          |                    |
|            |                 |         |        |        |        |                                       | LCD27       | (Non-IOMUX 1) 0 | A           |                    |
|            |                 |         |        |        |        |                                       | A_2         | (Non-IOMUX 2) 0 | A           |                    |
| 22         | 30              | 46      | 46     | 30     | 78     | PA26<br>PINCM73<br>0x40428120         | PA26        | 1               | IO          | SDIO<br>(standard) |
|            |                 |         |        |        |        |                                       | UART3_TX    | 2               | O           |                    |
|            |                 |         |        |        |        |                                       | SPI1_CS0    | 3               | IO          |                    |
|            |                 |         |        |        |        |                                       | TIMG8_C0    | 4               | IO          |                    |
|            |                 |         |        |        |        |                                       | TIMA_FAL0   | 5               | I           |                    |
|            |                 |         |        |        |        |                                       | TIMA0_C3N   | 6               | O           |                    |
|            |                 |         |        |        |        |                                       | TIMG5_C0    | 7               | IO          |                    |
|            |                 |         |        |        |        |                                       | UART2_RTS   | 8               | O           |                    |
|            |                 |         |        |        |        |                                       | UART3_RX    | 9               | I           |                    |
|            |                 |         |        |        |        |                                       | TIMG4_C1    | 10              | IO          |                    |
|            |                 |         |        |        |        |                                       | LCD28       | (Non-IOMUX 1) 0 | A           |                    |
|            |                 |         |        |        |        |                                       | A_1         | (Non-IOMUX 2) 0 | A           |                    |
| COMP0_IN0+ | (Non-IOMUX 3) 0 | A       |        |        |        |                                       |             |                 |             |                    |

**Table 6-2. Pin Attributes (RGE, PM, PN, RHB, PT, RGZ Packages) (continued)**

| RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN | PIN NAME/<br>IOMUX REG/<br>IOMUX ADDR | SIGNAL NAME | IOMUX PF        | SIGNAL TYPE | BUFFER TYPE          |
|---------|---------|---------|--------|--------|--------|---------------------------------------|-------------|-----------------|-------------|----------------------|
|         | 31      | 47      | 47     | 31     | 79     | PA27<br>PINCM74<br>0x40428124         | PA27        | 1               | IO          | SDIO<br>(standard)   |
|         |         |         |        |        |        |                                       | UART3_RX    | 2               | I           |                      |
|         |         |         |        |        |        |                                       | SPI1_CS1    | 3               | IO          |                      |
|         |         |         |        |        |        |                                       | TIMG8_C1    | 4               | IO          |                      |
|         |         |         |        |        |        |                                       | TIMA_FAL2   | 5               | I           |                      |
|         |         |         |        |        |        |                                       | CLK_OUT     | 6               | O           |                      |
|         |         |         |        |        |        |                                       | TIMG5_C1    | 7               | IO          |                      |
|         |         |         |        |        |        |                                       | RTC_OUT     | 8               | O           |                      |
|         |         |         |        |        |        |                                       | COMP0_OUT   | 9               | O           |                      |
|         |         |         |        |        |        |                                       | LCD29       | (Non-IOMUX 1) 0 | A           |                      |
|         |         |         |        |        |        |                                       | A_0         | (Non-IOMUX 2) 0 | A           |                      |
|         |         |         |        |        |        |                                       | COMP0_IN0-  | (Non-IOMUX 3) 0 | A           |                      |
|         |         | 3       | 3      | 35     | 3      | PA28<br>PINCM3<br>0x40428008          | PA28        | 1               | IO          | HDIO (high<br>drive) |
|         |         |         |        |        |        |                                       | UART0_TX    | 2               | O           |                      |
|         |         |         |        |        |        |                                       | I2C0_SDA    | 3               | IOD         |                      |
|         |         |         |        |        |        |                                       | TIMA0_C3    | 4               | IO          |                      |
|         |         |         |        |        |        |                                       | TIMA_FAL0   | 5               | I           |                      |
|         |         |         |        |        |        |                                       | TIMG5_C0    | 6               | IO          |                      |
|         |         |         |        |        |        |                                       | TIMA0_C1    | 7               | IO          |                      |
|         |         |         |        |        |        |                                       | WAKE        | (Non-IOMUX 1) 0 | I           |                      |
|         |         |         |        |        |        |                                       | LCD30       | (Non-IOMUX 2) 0 | A           |                      |
|         |         |         |        | 36     | 4      | PA29<br>PINCM4<br>0x4042800c          | PA29        | 1               | IO          | SDIO<br>(standard)   |
|         |         |         |        |        |        |                                       | I2C1_SCL    | 2               | IOD         |                      |
|         |         |         |        |        |        |                                       | UART2_RTS   | 3               | O           |                      |
|         |         |         |        |        |        |                                       | TIMG8_C0    | 4               | IO          |                      |
|         |         |         |        |        |        |                                       | TIMG4_C0    | 5               | IO          |                      |
|         |         |         |        |        |        |                                       | I2C2_SCL    | 6               | IOD         |                      |
|         |         |         |        |        |        |                                       | UART0_CTS   | 7               | I           |                      |
|         |         |         |        |        |        |                                       | SPI0_CS3    | 8               | IO          |                      |
|         |         |         |        |        |        |                                       | LCD31       | (Non-IOMUX 1) 0 | A           |                      |
|         |         |         |        | 37     | 5      | PA30<br>PINCM5<br>0x40428010          | PA30        | 1               | IO          | SDIO<br>(standard)   |
|         |         |         |        |        |        |                                       | I2C1_SDA    | 2               | IOD         |                      |
|         |         |         |        |        |        |                                       | UART2_CTS   | 3               | I           |                      |
|         |         |         |        |        |        |                                       | TIMG8_C1    | 4               | IO          |                      |
|         |         |         |        |        |        |                                       | TIMG4_C1    | 5               | IO          |                      |
|         |         |         |        |        |        |                                       | I2C2_SDA    | 6               | IOD         |                      |
|         |         |         |        |        |        |                                       | UART0_RTS   | 7               | O           |                      |
|         |         |         |        |        |        |                                       | SPI0_CS2    | 8               | IO          |                      |
|         |         |         |        |        |        |                                       | LCD32       | (Non-IOMUX 1) 0 | A           |                      |
|         |         |         |        | 47     | 15     | PB0<br>PINCM12<br>0x4042802c          | PB0         | 1               | IO          | SDIO<br>(standard)   |
|         |         |         |        |        |        |                                       | UART0_TX    | 2               | O           |                      |
|         |         |         |        |        |        |                                       | SPI1_CS2    | 3               | IO          |                      |
|         |         |         |        |        |        |                                       | I2C0_SCL    | 4               | IOD         |                      |
|         |         |         |        |        |        |                                       | TIMA0_C2    | 5               | IO          |                      |
|         |         |         |        |        |        |                                       | TIMG0_C0    | 6               | IO          |                      |
|         |         |         |        |        |        |                                       | SPI0_CS3    | 7               | IO          |                      |

**Table 6-2. Pin Attributes (RGE, PM, PN, RHB, PT, RGZ Packages) (continued)**

| RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN | PIN NAME/<br>IOMUX REG/<br>IOMUX ADDR | SIGNAL NAME     | IOMUX PF        | SIGNAL TYPE | BUFFER TYPE          |
|---------|---------|---------|--------|--------|--------|---------------------------------------|-----------------|-----------------|-------------|----------------------|
|         |         |         |        | 48     | 16     | PB1<br>PINCM13<br>0x40428030          | PB1             | 1               | IO          | SDIO<br>(standard)   |
|         |         |         |        |        |        |                                       | UART0_RX        | 2               | I           |                      |
|         |         |         |        |        |        |                                       | SPI1_CS3        | 3               | IO          |                      |
|         |         |         |        |        |        |                                       | I2C0_SDA        | 4               | IOD         |                      |
|         |         |         |        |        |        |                                       | TIMA0_C2N       | 5               | O           |                      |
|         |         |         |        |        |        |                                       | TIMG0_C1        | 6               | IO          |                      |
|         |         |         |        |        |        |                                       | SPI0_CS2        | 7               | IO          |                      |
|         |         | 14      | 14     | 50     | 18     | PB2<br>PINCM15<br>0x40428038          | PB2             | 1               | IO          | LFSSIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART3_TX        | 2               | O           |                      |
|         |         |         |        |        |        |                                       | UART2_CTS       | 3               | I           |                      |
|         |         |         |        |        |        |                                       | I2C1_SCL        | 4               | IOD         |                      |
|         |         |         |        |        |        |                                       | TIMA0_C3        | 5               | IO          |                      |
|         |         |         |        |        |        |                                       | UART1_CTS       | 6               | I           |                      |
|         |         |         |        |        |        |                                       | TIMG4_C0        | 7               | IO          |                      |
|         |         |         |        |        |        |                                       | UART2_TX        | 8               | O           |                      |
|         |         |         |        |        |        |                                       | TIMG12_C0       | 9               | IO          |                      |
|         |         |         |        |        |        |                                       | HFCLK_IN        | 10              | I           |                      |
|         |         |         |        |        |        |                                       | SPI0_PICO       | 11              | IO          |                      |
|         |         |         |        |        |        | TIO1                                  | (Non-IOMUX 1) 0 | I               |             |                      |
|         |         | 15      | 15     | 51     | 19     | PB3<br>PINCM16<br>0x4042803c          | PB3             | 1               | IO          | LFSSIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART3_RX        | 2               | I           |                      |
|         |         |         |        |        |        |                                       | UART2_RTS       | 3               | O           |                      |
|         |         |         |        |        |        |                                       | I2C1_SDA        | 4               | IOD         |                      |
|         |         |         |        |        |        |                                       | TIMA0_C3N       | 5               | O           |                      |
|         |         |         |        |        |        |                                       | UART1_RTS       | 6               | O           |                      |
|         |         |         |        |        |        |                                       | TIMG4_C1        | 7               | IO          |                      |
|         |         |         |        |        |        |                                       | UART2_RX        | 8               | I           |                      |
|         |         |         |        |        |        |                                       | TIMG12_C1       | 9               | IO          |                      |
|         |         |         |        |        |        |                                       | TIMA0_C0        | 10              | IO          |                      |
|         |         |         |        |        |        |                                       | SPI0_SCK        | 11              | IO          |                      |
|         |         |         |        |        |        | TIO2                                  | (Non-IOMUX 1) 0 | I               |             |                      |
|         |         |         |        | 52     | 20     | PB4<br>PINCM17<br>0x40428040          | PB4             | 1               | IO          | SDIO<br>(standard)   |
|         |         |         |        |        |        |                                       | UART1_TX        | 2               | O           |                      |
|         |         |         |        |        |        |                                       | UART3_CTS       | 3               | I           |                      |
|         |         |         |        |        |        |                                       | TIMA0_C1        | 4               | IO          |                      |
|         |         |         |        |        |        |                                       | TIMA0_C2        | 5               | IO          |                      |
|         |         |         |        |        |        |                                       | TIMG0_C0        | 6               | IO          |                      |
|         |         |         |        |        |        |                                       | TIMG4_C0        | 7               | IO          |                      |
|         |         |         |        |        |        |                                       | LCD33           | (Non-IOMUX 1) 0 | A           |                      |
|         |         |         |        | 53     | 21     | PB5<br>PINCM18<br>0x40428044          | PB5             | 1               | IO          | SDIO<br>(standard)   |
|         |         |         |        |        |        |                                       | UART1_RX        | 2               | I           |                      |
|         |         |         |        |        |        |                                       | UART3_RTS       | 3               | O           |                      |
|         |         |         |        |        |        |                                       | TIMA0_C1N       | 4               | O           |                      |
|         |         |         |        |        |        |                                       | TIMA0_C2N       | 5               | O           |                      |
|         |         |         |        |        |        |                                       | TIMG0_C1        | 6               | IO          |                      |
|         |         |         |        |        |        |                                       | TIMG4_C1        | 7               | IO          |                      |
|         |         |         |        |        |        |                                       | LCD34           | (Non-IOMUX 1) 0 | A           |                      |

**Table 6-2. Pin Attributes (RGE, PM, PN, RHB, PT, RGZ Packages) (continued)**

| RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN | PIN NAME/<br>IOMUX REG/<br>IOMUX ADDR | SIGNAL NAME     | IOMUX PF        | SIGNAL TYPE | BUFFER TYPE        |
|---------|---------|---------|--------|--------|--------|---------------------------------------|-----------------|-----------------|-------------|--------------------|
|         |         | 20      | 20     | 58     | 30     | PB6<br>PINCM27<br>0x40428068          | PB6             | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART1_TX        | 2               | O           |                    |
|         |         |         |        |        |        |                                       | SPI1_CS0        | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | I2C2_SCL        | 4               | IOD         |                    |
|         |         |         |        |        |        |                                       | TIMG8_C0        | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | UART2_CTS       | 6               | I           |                    |
|         |         |         |        |        |        |                                       | TIMG4_C0        | 7               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA_FAL2       | 8               | I           |                    |
|         |         |         |        |        |        |                                       | SPI0_CS1        | 9               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG12_C0       | 10              | IO          |                    |
|         |         |         |        |        |        |                                       | LCD4            | (Non-IOMUX 1) 0 | A           |                    |
|         |         | 21      | 21     | 59     | 31     | PB7<br>PINCM28<br>0x4042806c          | PB7             | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART1_RX        | 2               | I           |                    |
|         |         |         |        |        |        |                                       | SPI1_POCI       | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | I2C2_SDA        | 4               | IOD         |                    |
|         |         |         |        |        |        |                                       | TIMG8_C1        | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | UART2_RTS       | 6               | O           |                    |
|         |         |         |        |        |        |                                       | TIMG4_C1        | 7               | IO          |                    |
|         |         |         |        |        |        |                                       | LCDLFCLK        | 8               | IO          |                    |
|         |         |         |        |        |        |                                       | SPI0_CS2        | 9               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG12_C1       | 10              | IO          |                    |
|         |         |         |        |        |        |                                       | LCD5            | (Non-IOMUX 1) 0 | A           |                    |
|         |         | 22      | 22     | 60     | 32     | PB8<br>PINCM29<br>0x40428070          | PB8             | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART1_CTS       | 2               | I           |                    |
|         |         |         |        |        |        |                                       | SPI1_PICO       | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | I2C2_SCL        | 4               | IOD         |                    |
|         |         |         |        |        |        |                                       | TIMA0_C0        | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | COMP0_OUT       | 6               | O           |                    |
|         |         |         |        |        |        |                                       | TIMG4_C0        | 7               | IO          |                    |
|         |         |         |        |        |        |                                       | LCDSON          | 8               | IO          |                    |
|         |         |         |        |        |        |                                       | LCD6            | (Non-IOMUX 1) 0 | A           |                    |
|         |         | 23      | 23     | 61     | 33     | PB9<br>PINCM30<br>0x40428074          | PB9             | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART1_RTS       | 2               | O           |                    |
|         |         |         |        |        |        |                                       | SPI1_SCK        | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | I2C2_SDA        | 4               | IOD         |                    |
|         |         |         |        |        |        |                                       | TIMA0_CON       | 5               | O           |                    |
|         |         |         |        |        |        |                                       | TIMA0_C1        | 6               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG4_C1        | 7               | IO          |                    |
|         |         |         |        |        |        |                                       | LCDEN           | 8               | A           |                    |
|         |         |         |        |        |        | LCD7                                  | (Non-IOMUX 1) 0 | A               |             |                    |
|         |         |         |        | 62     | 34     | PB10<br>PINCM31<br>0x40428078         | PB10            | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | TIMG0_C0        | 2               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG8_C0        | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | COMP0_OUT       | 4               | O           |                    |
|         |         |         |        |        |        |                                       | TIMG4_C0        | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | UART4_TX        | 6               | O           |                    |
|         |         |         |        |        |        |                                       | SPI1_CS3        | 7               | IO          |                    |
|         |         |         |        |        |        |                                       | LCD35           | (Non-IOMUX 1) 0 | A           |                    |

**Table 6-2. Pin Attributes (RGE, PM, PN, RHB, PT, RGZ Packages) (continued)**

| RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN | PIN NAME/<br>IOMUX REG/<br>IOMUX ADDR | SIGNAL NAME     | IOMUX PF        | SIGNAL TYPE | BUFFER TYPE        |
|---------|---------|---------|--------|--------|--------|---------------------------------------|-----------------|-----------------|-------------|--------------------|
|         |         |         |        | 63     | 35     | PB11<br>PINCM32<br>0x4042807c         | PB11            | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | TIMG0_C1        | 2               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG8_C1        | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | CLK_OUT         | 4               | O           |                    |
|         |         |         |        |        |        |                                       | TIMG4_C1        | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | UART4_RX        | 6               | I           |                    |
|         |         |         |        |        |        |                                       | SPI1_CS2        | 7               | IO          |                    |
|         |         |         |        |        |        |                                       | LCD36           | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        | 64     | 36     | PB12<br>PINCM33<br>0x40428080         | PB12            | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART3_TX        | 2               | O           |                    |
|         |         |         |        |        |        |                                       | TIMA0_C2        | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA_FAL1       | 4               | I           |                    |
|         |         |         |        |        |        |                                       | TIMA0_C1        | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | UART4_CTS       | 6               | I           |                    |
|         |         |         |        |        |        |                                       | SPI1_CS1        | 7               | IO          |                    |
|         |         |         |        |        |        |                                       | LCD37           | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        | 1      | 37     | PB13<br>PINCM34<br>0x40428084         | PB13            | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART3_RX        | 2               | I           |                    |
|         |         |         |        |        |        |                                       | TIMA0_C3        | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG12_C0       | 4               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA0_C1N       | 5               | O           |                    |
|         |         |         |        |        |        |                                       | UART4_RTS       | 6               | O           |                    |
|         |         |         |        |        |        |                                       | SPI1_CS0        | 7               | IO          |                    |
|         |         |         |        |        |        |                                       | LCD38           | (Non-IOMUX 1) 0 | A           |                    |
|         |         | 24      | 24     | 2      | 38     | PB14<br>PINCM35<br>0x40428088         | PB14            | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | SPI1_CS3        | 2               | IO          |                    |
|         |         |         |        |        |        |                                       | SPI1_POCI       | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG12_C1       | 4               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA0_C0        | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG8_IDX       | 6               | I           |                    |
|         |         |         |        |        |        |                                       | SPIO_CS3        | 7               | IO          |                    |
|         |         |         |        |        |        |                                       | LCD8            | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        |        |        |                                       | R13             | (Non-IOMUX 2) 0 | A           |                    |
|         |         |         |        |        |        | A_21                                  | (Non-IOMUX 3) 0 | A               |             |                    |
|         |         | 25      | 25     | 3      | 39     | PB15<br>PINCM36<br>0x4042808c         | PB15            | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART2_TX        | 2               | O           |                    |
|         |         |         |        |        |        |                                       | SPI1_PICO       | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | UART3_CTS       | 4               | I           |                    |
|         |         |         |        |        |        |                                       | TIMG8_C0        | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG5_C0        | 6               | IO          |                    |
|         |         |         |        |        |        |                                       | I2C2_SCL        | 7               | IOD         |                    |
|         |         |         |        |        |        |                                       | LCD9            | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        |        |        |                                       | R24             | (Non-IOMUX 2) 0 | A           |                    |
|         |         |         |        |        |        |                                       | A_20            | (Non-IOMUX 3) 0 | A           |                    |

**Table 6-2. Pin Attributes (RGE, PM, PN, RHB, PT, RGZ Packages) (continued)**

| RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN | PIN NAME/<br>IOMUX REG/<br>IOMUX ADDR | SIGNAL NAME     | IOMUX PF        | SIGNAL TYPE | BUFFER TYPE        |
|---------|---------|---------|--------|--------|--------|---------------------------------------|-----------------|-----------------|-------------|--------------------|
|         |         | 26      | 26     | 4      | 40     | PB16<br>PINCM37<br>0x40428090         | PB16            | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART2_RX        | 2               | I           |                    |
|         |         |         |        |        |        |                                       | SPI1_SCK        | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | UART3_RTS       | 4               | O           |                    |
|         |         |         |        |        |        |                                       | TIMG8_C1        | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG5_C1        | 6               | IO          |                    |
|         |         |         |        |        |        |                                       | I2C2_SDA        | 7               | IOD         |                    |
|         |         |         |        |        |        |                                       | LCD10           | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        |        |        |                                       | R23             | (Non-IOMUX 2) 0 | A           |                    |
|         |         |         |        |        |        |                                       | A_19            | (Non-IOMUX 3) 0 | A           |                    |
|         |         | 36      | 36     | 14     | 58     | PB17<br>PINCM53<br>0x404280d0         | PB17            | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART2_TX        | 2               | O           |                    |
|         |         |         |        |        |        |                                       | SPI0_PICO       | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | I2C0_SCL        | 4               | IOD         |                    |
|         |         |         |        |        |        |                                       | TIMA0_C2        | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG0_C0        | 6               | IO          |                    |
|         |         |         |        |        |        |                                       | SPI1_CS1        | 7               | IO          |                    |
|         |         |         |        |        |        |                                       | UART4_TX        | 8               | O           |                    |
|         |         |         |        |        |        |                                       | TIMG4_C0        | 9               | IO          |                    |
|         |         |         |        |        |        |                                       | LCDSON          | 10              | IO          |                    |
|         |         |         |        |        |        |                                       | LCD18           | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        |        |        |                                       | A_11            | (Non-IOMUX 2) 0 | A           |                    |
|         |         | 37      | 37     | 15     | 59     | PB18<br>PINCM54<br>0x404280d4         | PB18            | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART2_RX        | 2               | I           |                    |
|         |         |         |        |        |        |                                       | SPI0_SCK        | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | I2C0_SDA        | 4               | IOD         |                    |
|         |         |         |        |        |        |                                       | TIMA0_C2N       | 5               | O           |                    |
|         |         |         |        |        |        |                                       | TIMG0_C1        | 6               | IO          |                    |
|         |         |         |        |        |        |                                       | SPI1_CS2        | 7               | IO          |                    |
|         |         |         |        |        |        |                                       | UART4_RX        | 8               | I           |                    |
|         |         |         |        |        |        |                                       | TIMG4_C1        | 9               | IO          |                    |
|         |         |         |        |        |        |                                       | LCDLFCLK        | 10              | IO          |                    |
|         |         |         |        |        |        |                                       | LCD19           | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        |        |        | A_10                                  | (Non-IOMUX 2) 0 | A               |             |                    |
|         |         | 38      | 38     | 16     | 60     | PB19<br>PINCM55<br>0x404280d8         | PB19            | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | COMP0_OUT       | 2               | O           |                    |
|         |         |         |        |        |        |                                       | SPI0_POCI       | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG8_C1        | 4               | IO          |                    |
|         |         |         |        |        |        |                                       | UART0_CTS       | 5               | I           |                    |
|         |         |         |        |        |        |                                       | TIMG5_C1        | 6               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG8_IDX       | 7               | I           |                    |
|         |         |         |        |        |        |                                       | UART2_CTS       | 8               | I           |                    |
|         |         |         |        |        |        |                                       | UART4_CTS       | 9               | I           |                    |
|         |         |         |        |        |        |                                       | SPI1_CS3        | 10              | IO          |                    |
|         |         |         |        |        |        |                                       | LCD20           | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        |        |        |                                       | A_9             | (Non-IOMUX 2) 0 | A           |                    |

**Table 6-2. Pin Attributes (RGE, PM, PN, RHB, PT, RGZ Packages) (continued)**

| RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN | PIN NAME/<br>IOMUX REG/<br>IOMUX ADDR | SIGNAL NAME     | IOMUX PF        | SIGNAL TYPE | BUFFER TYPE        |
|---------|---------|---------|--------|--------|--------|---------------------------------------|-----------------|-----------------|-------------|--------------------|
|         |         | 41      | 41     | 19     | 67     | PB20<br>PINCM62<br>0x404280f4         | PB20            | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | SPI0_CS2        | 2               | IO          |                    |
|         |         |         |        |        |        |                                       | SPI1_CS0        | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG12_C0       | 4               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA0_C2        | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA_FAL1       | 6               | I           |                    |
|         |         |         |        |        |        |                                       | TIMA0_C1        | 7               | IO          |                    |
|         |         |         |        |        |        |                                       | UART2_RTS       | 8               | O           |                    |
|         |         |         |        |        |        |                                       | I2C0_SDA        | 9               | IOD         |                    |
|         |         |         |        |        |        |                                       | LCD23           | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        |        |        | A_6                                   | (Non-IOMUX 2) 0 | A               |             |                    |
|         |         |         |        | 20     | 68     | PB21<br>PINCM63<br>0x404280f8         | PB21            | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART4_TX        | 2               | O           |                    |
|         |         |         |        |        |        |                                       | SPI1_POCI       | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | I2C0_SCL        | 4               | IOD         |                    |
|         |         |         |        |        |        |                                       | TIMG8_C0        | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | UART1_TX        | 6               | O           |                    |
|         |         |         |        |        |        |                                       | LCD39           | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        |        |        | A_25                                  | (Non-IOMUX 2) 0 | A               |             |                    |
|         |         |         |        | 21     | 69     | PB22<br>PINCM64<br>0x404280fc         | PB22            | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART4_RX        | 2               | I           |                    |
|         |         |         |        |        |        |                                       | SPI1_PICO       | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | I2C0_SDA        | 4               | IOD         |                    |
|         |         |         |        |        |        |                                       | TIMG8_C1        | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | UART1_RX        | 6               | I           |                    |
|         |         |         |        |        |        |                                       | LCD40           | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        |        |        | A_24                                  | (Non-IOMUX 2) 0 | A               |             |                    |
|         |         |         |        | 22     | 70     | PB23<br>PINCM65<br>0x40428100         | PB23            | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART1_CTS       | 2               | I           |                    |
|         |         |         |        |        |        |                                       | SPI1_SCK        | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA_FAL0       | 4               | I           |                    |
|         |         |         |        |        |        |                                       | COMP0_OUT       | 5               | O           |                    |
|         |         |         |        |        |        | LCD41                                 | (Non-IOMUX 1) 0 | A               |             |                    |
|         |         | 42      | 42     | 23     | 71     | PB24<br>PINCM66<br>0x40428104         | PB24            | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | SPI0_CS3        | 2               | IO          |                    |
|         |         |         |        |        |        |                                       | SPI0_CS1        | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG12_C1       | 4               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA0_C3        | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA0_C1N       | 6               | O           |                    |
|         |         |         |        |        |        |                                       | SPI1_CS1        | 7               | IO          |                    |
|         |         |         |        |        |        |                                       | UART2_RTS       | 8               | O           |                    |
|         |         |         |        |        |        |                                       | LCD24           | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        |        |        | A_5                                   | (Non-IOMUX 2) 0 | A               |             |                    |

**Table 6-2. Pin Attributes (RGE, PM, PN, RHB, PT, RGZ Packages) (continued)**

| RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN | PIN NAME/<br>IOMUX REG/<br>IOMUX ADDR | SIGNAL NAME | IOMUX PF        | SIGNAL TYPE | BUFFER TYPE        |
|---------|---------|---------|--------|--------|--------|---------------------------------------|-------------|-----------------|-------------|--------------------|
|         |         |         |        | 27     | 75     | PB25<br>PINCM70<br>0x40428114         | PB25        | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART0_CTS   | 2               | I           |                    |
|         |         |         |        |        |        |                                       | SPI0_CS0    | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA_FAL0   | 4               | I           |                    |
|         |         |         |        |        |        |                                       | TIMA_FAL1   | 5               | I           |                    |
|         |         |         |        |        |        |                                       | TIMA_FAL2   | 6               | I           |                    |
|         |         |         |        |        |        |                                       | COMP0_OUT   | 7               | O           |                    |
|         |         |         |        |        |        |                                       | FCC_IN      | 8               | I           |                    |
|         |         |         |        |        |        |                                       | LCD42       | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        |        |        |                                       | A_4         | (Non-IOMUX 2) 0 | A           |                    |
|         |         |         |        | 28     | 76     | PB26<br>PINCM71<br>0x40428118         | PB26        | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART0_RTS   | 2               | O           |                    |
|         |         |         |        |        |        |                                       | SPI0_CS1    | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA0_C0    | 4               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA0_C3    | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG4_C0    | 6               | IO          |                    |
|         |         |         |        |        |        |                                       | COMP0_OUT   | 7               | O           |                    |
|         |         |         |        |        |        |                                       | FCC_IN      | 8               | I           |                    |
|         |         |         |        |        |        |                                       | LCD43       | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        |        |        |                                       | A_23        | (Non-IOMUX 2) 0 | A           |                    |
|         |         |         |        | 29     | 77     | PB27<br>PINCM72<br>0x4042811c         | PB27        | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | COMP0_OUT   | 2               | O           |                    |
|         |         |         |        |        |        |                                       | SPI1_CS1    | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA0_C0N   | 4               | O           |                    |
|         |         |         |        |        |        |                                       | TIMA0_C3N   | 5               | O           |                    |
|         |         |         |        |        |        |                                       | TIMG4_C1    | 6               | IO          |                    |
|         |         |         |        |        |        |                                       | LCD44       | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        |        |        |                                       | A_22        | (Non-IOMUX 2) 0 | A           |                    |
|         |         |         |        | 24     | 24     | PB28<br>PINCM21<br>0x40428050         | PB28        | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | I2C2_SCL    | 2               | IOD         |                    |
|         |         |         |        |        |        |                                       | SPI1_CS0    | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA_FAL0   | 4               | I           |                    |
|         |         |         |        |        |        |                                       | TIMA0_C0    | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG0_C0    | 6               | IO          |                    |
|         |         |         |        |        |        |                                       | LCD45       | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        | 25     | 25     | PB29<br>PINCM22<br>0x40428054         | PB29        | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | I2C2_SDA    | 2               | IOD         |                    |
|         |         |         |        |        |        |                                       | SPI1_POCI   | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA_FAL1   | 4               | I           |                    |
|         |         |         |        |        |        |                                       | TIMA0_C0N   | 5               | O           |                    |
|         |         |         |        |        |        |                                       | TIMG0_C1    | 6               | IO          |                    |
|         |         |         |        |        |        |                                       | LCD46       | (Non-IOMUX 1) 0 | A           |                    |

**Table 6-2. Pin Attributes (RGE, PM, PN, RHB, PT, RGZ Packages) (continued)**

| RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN | PIN NAME/<br>IOMUX REG/<br>IOMUX ADDR | SIGNAL NAME     | IOMUX PF        | SIGNAL TYPE | BUFFER TYPE        |
|---------|---------|---------|--------|--------|--------|---------------------------------------|-----------------|-----------------|-------------|--------------------|
|         |         |         |        |        | 26     | PB30<br>PINCM23<br>0x40428058         | PB30            | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART1_CTS       | 2               | I           |                    |
|         |         |         |        |        |        |                                       | SPI1_PICO       | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA_FAL2       | 4               | I           |                    |
|         |         |         |        |        |        |                                       | TIMA0_C1        | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG4_C0        | 6               | IO          |                    |
|         |         |         |        |        |        | LCD47                                 | (Non-IOMUX 1) 0 | A               |             |                    |
|         |         |         |        |        | 27     | PB31<br>PINCM24<br>0x4042805c         | PB31            | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART1_RTS       | 2               | O           |                    |
|         |         |         |        |        |        |                                       | SPI1_SCK        | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG8_IDX       | 4               | I           |                    |
|         |         |         |        |        |        |                                       | TIMA0_C1N       | 5               | O           |                    |
|         |         |         |        |        |        |                                       | TIMG4_C1        | 6               | IO          |                    |
|         |         |         |        |        |        | LCD48                                 | (Non-IOMUX 1) 0 | A               |             |                    |
|         |         |         |        |        | 46     | PC0<br>PINCM43<br>0x404280a8          | PC0             | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART1_TX        | 2               | O           |                    |
|         |         |         |        |        |        |                                       | SPI1_CS3        | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG8_C0        | 4               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA0_C2        | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | LCD49           | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        |        | 47     | PC1<br>PINCM44<br>0x404280ac          | PC1             | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART1_RX        | 2               | I           |                    |
|         |         |         |        |        |        |                                       | SPI1_CS2        | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG8_C1        | 4               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA0_C2N       | 5               | O           |                    |
|         |         |         |        |        |        |                                       | LCD50           | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        |        | 50     | PC2<br>PINCM45<br>0x404280b0          | PC2             | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | I2C2_SCL        | 2               | IOD         |                    |
|         |         |         |        |        |        |                                       | SPI1_CS0        | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA_FAL0       | 4               | I           |                    |
|         |         |         |        |        |        |                                       | TIMA0_C0        | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG0_C0        | 6               | IO          |                    |
|         |         |         |        |        |        | LCD51                                 | (Non-IOMUX 1) 0 | A               |             |                    |
|         |         |         |        |        | 51     | PC3<br>PINCM46<br>0x404280b4          | PC3             | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | I2C2_SDA        | 2               | IOD         |                    |
|         |         |         |        |        |        |                                       | SPI1_CS1        | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA_FAL1       | 4               | I           |                    |
|         |         |         |        |        |        |                                       | TIMA0_C0N       | 5               | O           |                    |
|         |         |         |        |        |        |                                       | TIMG0_C1        | 6               | IO          |                    |
|         |         |         |        |        |        | LCD52                                 | (Non-IOMUX 1) 0 | A               |             |                    |
|         |         |         |        |        | 52     | PC4<br>PINCM47<br>0x404280b8          | PC4             | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART3_CTS       | 2               | I           |                    |
|         |         |         |        |        |        |                                       | SPI1_CS2        | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA_FAL2       | 4               | I           |                    |
|         |         |         |        |        |        |                                       | TIMA0_C1        | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG4_C0        | 6               | IO          |                    |
|         |         |         |        |        |        | LCD53                                 | (Non-IOMUX 1) 0 | A               |             |                    |

**Table 6-2. Pin Attributes (RGE, PM, PN, RHB, PT, RGZ Packages) (continued)**

| RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN | PIN NAME/<br>IOMUX REG/<br>IOMUX ADDR | SIGNAL NAME | IOMUX PF        | SIGNAL TYPE | BUFFER TYPE        |
|---------|---------|---------|--------|--------|--------|---------------------------------------|-------------|-----------------|-------------|--------------------|
|         |         |         |        |        | 53     | PC5<br>PINCM48<br>0x404280bc          | PC5         | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART3_RTS   | 2               | O           |                    |
|         |         |         |        |        |        |                                       | SPI1_CS3    | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG8_IDX   | 4               | I           |                    |
|         |         |         |        |        |        |                                       | TIMA0_C1N   | 5               | O           |                    |
|         |         |         |        |        |        |                                       | TIMG4_C1    | 6               | IO          |                    |
|         |         |         |        |        |        |                                       | LCD54       | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        |        | 63     | PC6<br>PINCM58<br>0x404280e4          | PC6         | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART3_TX    | 2               | O           |                    |
|         |         |         |        |        |        |                                       | SPI0_CS1    | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG8_C0    | 4               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA0_C0    | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | LCD55       | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        |        | 64     | PC7<br>PINCM59<br>0x404280e8          | PC7         | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART3_RX    | 2               | I           |                    |
|         |         |         |        |        |        |                                       | SPI0_CS0    | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG8_C1    | 4               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA0_CON   | 5               | O           |                    |
|         |         |         |        |        |        |                                       | LCD56       | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        |        | 65     | PC8<br>PINCM60<br>0x404280ec          | PC8         | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART3_CTS   | 2               | I           |                    |
|         |         |         |        |        |        |                                       | SPI1_CS2    | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG5_C0    | 4               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA0_C1    | 5               | IO          |                    |
|         |         |         |        |        |        |                                       | LCD57       | (Non-IOMUX 1) 0 | A           |                    |
|         |         |         |        |        | 66     | PC9<br>PINCM61<br>0x404280f0          | PC9         | 1               | IO          | SDIO<br>(standard) |
|         |         |         |        |        |        |                                       | UART3_RTS   | 2               | O           |                    |
|         |         |         |        |        |        |                                       | SPI1_CS1    | 3               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMG5_C1    | 4               | IO          |                    |
|         |         |         |        |        |        |                                       | TIMA0_C1N   | 5               | O           |                    |
|         |         |         |        |        |        |                                       | LCD58       | (Non-IOMUX 1) 0 | A           |                    |
| 3       | 4       | 5       | 5      | 39     | 7      | VBAT                                  | VBAT        | (Non-IOMUX 1) 0 | PWR         | PWR                |
| 23      | 32      | 48      | 48     | 32     | 80     | VCORE                                 | VCORE       | (Non-IOMUX 1) 0 | PWR         | PWR                |
| 3       | 4       | 6       | 6      | 40     | 8      | VDD                                   | VDD         | (Non-IOMUX 1) 0 | PWR         | PWR                |
|         |         |         |        |        | 49     | VDD2                                  | VDD2        | (Non-IOMUX 1) 0 | PWR         | PWR                |
| 4       | 5       | 7       | 7      | 41     | 9      | VSS                                   | VSS         | (Non-IOMUX 1) 0 | PWR         | PWR                |
|         |         |         |        |        | 48     | VSS2                                  | VSS2        | (Non-IOMUX 1) 0 | PWR         | PWR                |

### 6.3 Signal Descriptions

Many MSPM0 signals are made available on multiple device pins. The following list describes the column headers:

- SIGNAL NAME:** The name of the signal which can be connected to one of the specified pins.
- PIN TYPE:** The signal direction and signal type:
  - I = Input
  - O = Output
  - IO = Input, output, or simultaneous input and output
  - ID = Input with open-drain behavior

- OD = Output with open-drain behavior
  - IOD = Input, output, or simultaneous input and output with open-drain behavior
  - A = Analog
  - PWR = Power function
3. **DESCRIPTION:** A description of the signal.
  4. **PIN:** Associated pin number.

For additional information on the pin multiplexing scheme, refer to the IOMUX chapter of the .

**Note**

The IOMUX only supports connecting one IOMUX-managed digital function to the pin at the same time. However, non-IOMUX managed signals (such as analog inputs and WAKE inputs) can be enabled on a pin at the same time that an IOMUX managed digital function is enabled on the pin. In this case, the designer must verify that no contention exists between the functions enabled on each pin.

**Table 6-3. Analog to Digital Converter (ADC) Signal Descriptions**

| SIGNAL NAME | PIN TYPE | DESCRIPTION                 | RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN |
|-------------|----------|-----------------------------|---------|---------|---------|--------|--------|--------|
| A_0         | A        | ADC analog input channel 0  |         | 31      | 47      | 47     | 31     | 79     |
| A_1         | A        | ADC analog input channel 1  | 22      | 30      | 46      | 46     | 30     | 78     |
| A_2         | A        | ADC analog input channel 2  | 21      | 29      | 45      | 45     | 26     | 74     |
| A_3         | A        | ADC analog input channel 3  | 20      | 28      | 44      | 44     | 25     | 73     |
| A_4         | A        | ADC analog input channel 4  |         |         |         |        | 27     | 75     |
| A_5         | A        | ADC analog input channel 5  |         |         | 42      | 42     | 23     | 71     |
| A_6         | A        | ADC analog input channel 6  |         |         | 41      | 41     | 19     | 67     |
| A_7         | A        | ADC analog input channel 7  | 18      | 26      | 40      | 40     | 18     | 62     |
| A_8         | A        | ADC analog input channel 8  | 17      | 25      | 39      | 39     | 17     | 61     |
| A_9         | A        | ADC analog input channel 9  |         |         | 38      | 38     | 16     | 60     |
| A_10        | A        | ADC analog input channel 10 |         |         | 37      | 37     | 15     | 59     |
| A_11        | A        | ADC analog input channel 11 |         |         | 36      | 36     | 14     | 58     |
| A_12        | A        | ADC analog input channel 12 | 14      | 22      | 33      | 33     | 11     | 55     |
| A_13        | A        | ADC analog input channel 13 | 13      | 21      | 32      | 32     | 10     | 54     |
| A_14        | A        | ADC analog input channel 14 | 12      | 20      | 31      | 31     | 9      | 45     |
| A_15        | A        | ADC analog input channel 15 | 11      | 19      | 30      | 30     | 8      | 44     |
| A_16        | A        | ADC analog input channel 16 |         | 18      | 29      | 29     | 7      | 43     |
| A_17        | A        | ADC analog input channel 17 |         | 17      | 28      | 28     | 6      | 42     |
| A_18        | A        | ADC analog input channel 18 |         | 16      | 27      | 27     | 5      | 41     |
| A_19        | A        | ADC analog input channel 19 |         |         | 26      | 26     | 4      | 40     |
| A_20        | A        | ADC analog input channel 20 |         |         | 25      | 25     | 3      | 39     |
| A_21        | A        | ADC analog input channel 21 |         |         | 24      | 24     | 2      | 38     |
| A_22        | A        | ADC analog input channel 22 |         |         |         |        | 29     | 77     |
| A_23        | A        | ADC analog input channel 23 |         |         |         |        | 28     | 76     |
| A_24        | A        | ADC analog input channel 24 |         |         |         |        | 21     | 69     |
| A_25        | A        | ADC analog input channel 25 |         |         |         |        | 20     | 68     |

**Table 6-4. Bootstrap Loader (BSL) Signal Descriptions**

| SIGNAL NAME | PIN TYPE | DESCRIPTION                   | RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN |
|-------------|----------|-------------------------------|---------|---------|---------|--------|--------|--------|
| BSLRX       | I        | BSL UART receive signal (RXD) | 10      | 15      | 19      | 19     | 57     | 29     |

**Table 6-4. Bootstrap Loader (BSL) Signal Descriptions (continued)**

| SIGNAL NAME | PIN TYPE | DESCRIPTION   | RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN |
|-------------|----------|---|---------|---------|---------|--------|--------|--------|
| BSLSCL      | IOD      | BSL I2C clock signal (SCL)  | 1       | 2       | 2       | 2      | 34     | 2      |
| BSLSDA      | IOD      | BSL I2C data signal (SDA)   | 24      | 1       | 1       | 1      | 33     | 1      |
| BSLTX       | O        | BSL UART transmit signal (TXD)  | 9       | 14      | 18      | 18     | 56     | 28     |
| BSL_invoke  | I        | BSL invoke signal (if BSL is enabled, must be HIGH during BOOTRST for a BSL entry, and LOW during BOOTRST to prevent BSL entry) | 14      | 22      | 33      | 33     | 11     | 55     |

**Table 6-5. Clock Module (CKM) Signal Descriptions**

| SIGNAL NAME | PIN TYPE | DESCRIPTION   | RGE PIN  | RHB PIN                | RGZ PIN                | PT PIN                 | PM PIN                    | PN PIN                     |
|-------------|----------|---|----------|------------------------|------------------------|------------------------|---------------------------|----------------------------|
| CLK_OUT     | O        | CLK_OUT digital clock output from the PMCU                      | 18, 8, 9 | 11, 13, 14, 18, 26, 31 | 13, 17, 18, 29, 40, 47 | 13, 17, 18, 29, 40, 47 | 18, 31, 49, 55, 56, 63, 7 | 17, 23, 28, 35, 43, 62, 79 |
| FCC_IN      | I        | Frequency clock counter (FCC) input signal                      | 12, 24   | 1, 11, 16, 20, 9       | 1, 11, 13, 27, 31      | 1, 11, 13, 27, 31      | 27, 28, 33, 45, 49, 5, 9  | 1, 13, 17, 41, 45, 75, 76  |
| HFCLK_IN    | I        | High frequency clock digital clock input signal                 |          | 10, 12                 | 12, 14, 16             | 12, 14, 16             | 46, 50, 54                | 14, 18, 22                 |
| HFXIN       | A        | High frequency crystal oscillator (HFXT) signal                 |          | 9                      | 11                     | 11                     | 45                        | 13                         |
| HFXOUT      | A        | High frequency crystal oscillator (HFXT) signal                 |          | 10                     | 12                     | 12                     | 46                        | 14                         |
| LFCLK_IN    | I        | Low frequency clock digital clock input signal                  | 7        | 8                      | 10                     | 10                     | 44                        | 12                         |
| LFXIN       | A        | Low frequency crystal oscillator (LFXT) signal                  | 6        | 7                      | 9                      | 9                      | 43                        | 11                         |
| LFXOUT      | A        | Low frequency crystal oscillator (LFXT) signal                  | 7        | 8                      | 10                     | 10                     | 44                        | 12                         |
| ROSC        | A        | SYSOSC frequency correction loop (FCL) external resistor signal | 5        | 6                      | 8                      | 8                      | 42                        | 10                         |

**Table 6-6. Comparator (COMP) Signal Descriptions**

| SIGNAL NAME | PIN TYPE | DESCRIPTION                         | RGE PIN       | RHB PIN                   | RGZ PIN                           | PT PIN                            | PM PIN   | PN PIN   | PNA PIN  |
|-------------|----------|-------------------------------------|---------------|---------------------------|-----------------------------------|-----------------------------------|--|--|--|
| COMP0_OUT   | O        | COMP0 digital output signal         | 10, 12, 21, 6 | 11, 15, 16, 20, 29, 31, 7 | 13, 19, 22, 27, 31, 38, 45, 47, 9 | 13, 19, 22, 27, 31, 38, 45, 47, 9 | 16, 22, 26, 27, 28, 29, 31, 43, 49, 5, 57, 60, 62, 9 | 11, 17, 29, 32, 34, 41, 45, 60, 70, 74, 75, 76, 77, 79 | 11, 17, 29, 32, 34, 41, 45, 60, 70, 74, 75, 76, 77, 79 |
| COMP0_IN0+  | A        | COMP0 non-inverting input channel 0 | 22            | 30                        | 46                                | 46                                | 30   | 78   | 78   |
| COMP0_IN0-  | A        | COMP0 inverting input channel 0     |               | 31                        | 47                                | 47                                | 31   | 79   | 79   |
| COMP0_IN1+  | A        | COMP0 non-inverting input channel 1 | 14            | 22                        | 33                                | 33                                | 11   | 55   | 55   |
| COMP0_IN1-  | A        | COMP0 inverting input channel 1     | 13            | 21                        | 32                                | 32                                | 10   | 54   | 54   |
| COMP0_IN2+  | A        | COMP0 non-inverting input channel 2 |               | 18                        | 29                                | 29                                | 7  | 43   | 43   |
| COMP0_IN2-  | A        | COMP0 inverting input channel 2     |               | 17                        | 28                                | 28                                | 6  | 42   | 42   |

**Table 6-6. Comparator (COMP) Signal Descriptions (continued)**

| SIGNAL NAME | PIN TYPE | DESCRIPTION                         | RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN | PNA PIN |
|-------------|----------|-------------------------------------|---------|---------|---------|--------|--------|--------|---------|
| COMP0_IN3+  | A        | COMP0 non-inverting input channel 3 | 11      | 19      | 30      | 30     | 8      | 44     | 44      |

**Table 6-7. General Purpose Input Output Module Signal Descriptions**

| SIGNAL NAME | PIN TYPE | DESCRIPTION                 | RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN |
|-------------|----------|-----------------------------|---------|---------|---------|--------|--------|--------|
| PA0         | IO       | GPIO port A input/output 0  | 24      | 1       | 1       | 1      | 33     | 1      |
| PA1         | IO       | GPIO port A input/output 1  | 1       | 2       | 2       | 2      | 34     | 2      |
| PA2         | IO       | GPIO port A input/output 2  | 5       | 6       | 8       | 8      | 42     | 10     |
| PA3         | IO       | GPIO port A input/output 3  | 6       | 7       | 9       | 9      | 43     | 11     |
| PA4         | IO       | GPIO port A input/output 4  | 7       | 8       | 10      | 10     | 44     | 12     |
| PA5         | IO       | GPIO port A input/output 5  |         | 9       | 11      | 11     | 45     | 13     |
| PA6         | IO       | GPIO port A input/output 6  |         | 10      | 12      | 12     | 46     | 14     |
| PA7         | IO       | GPIO port A input/output 7  |         | 11      | 13      | 13     | 49     | 17     |
| PA8         | IO       | GPIO port A input/output 8  |         | 12      | 16      | 16     | 54     | 22     |
| PA9         | IO       | GPIO port A input/output 9  | 8       | 13      | 17      | 17     | 55     | 23     |
| PA10        | IO       | GPIO port A input/output 10 | 9       | 14      | 18      | 18     | 56     | 28     |
| PA11        | IO       | GPIO port A input/output 11 | 10      | 15      | 19      | 19     | 57     | 29     |
| PA12        | IO       | GPIO port A input/output 12 |         | 16      | 27      | 27     | 5      | 41     |
| PA13        | IO       | GPIO port A input/output 13 |         | 17      | 28      | 28     | 6      | 42     |
| PA14        | IO       | GPIO port A input/output 14 |         | 18      | 29      | 29     | 7      | 43     |
| PA15        | IO       | GPIO port A input/output 15 | 11      | 19      | 30      | 30     | 8      | 44     |
| PA16        | IO       | GPIO port A input/output 16 | 12      | 20      | 31      | 31     | 9      | 45     |
| PA17        | IO       | GPIO port A input/output 17 | 13      | 21      | 32      | 32     | 10     | 54     |
| PA18        | IO       | GPIO port A input/output 18 | 14      | 22      | 33      | 33     | 11     | 55     |
| PA19        | IO       | GPIO port A input/output 19 | 15      | 23      | 34      | 34     | 12     | 56     |
| PA20        | IO       | GPIO port A input/output 20 | 16      | 24      | 35      | 35     | 13     | 57     |
| PA21        | IO       | GPIO port A input/output 21 | 17      | 25      | 39      | 39     | 17     | 61     |
| PA22        | IO       | GPIO port A input/output 22 | 18      | 26      | 40      | 40     | 18     | 62     |
| PA23        | IO       | GPIO port A input/output 23 | 19      | 27      | 43      | 43     | 24     | 72     |
| PA24        | IO       | GPIO port A input/output 24 | 20      | 28      | 44      | 44     | 25     | 73     |
| PA25        | IO       | GPIO port A input/output 25 | 21      | 29      | 45      | 45     | 26     | 74     |
| PA26        | IO       | GPIO port A input/output 26 | 22      | 30      | 46      | 46     | 30     | 78     |
| PA27        | IO       | GPIO port A input/output 27 |         | 31      | 47      | 47     | 31     | 79     |
| PA28        | IO       | GPIO port A input/output 28 |         |         | 3       | 3      | 35     | 3      |
| PA29        | IO       | GPIO port A input/output 29 |         |         |         |        | 36     | 4      |
| PA30        | IO       | GPIO port A input/output 30 |         |         |         |        | 37     | 5      |
| PB0         | IO       | GPIO port B input/output 0  |         |         |         |        | 47     | 15     |
| PB1         | IO       | GPIO port B input/output 1  |         |         |         |        | 48     | 16     |
| PB2         | IO       | GPIO port B input/output 2  |         |         | 14      | 14     | 50     | 18     |
| PB3         | IO       | GPIO port B input/output 3  |         |         | 15      | 15     | 51     | 19     |
| PB4         | IO       | GPIO port B input/output 4  |         |         |         |        | 52     | 20     |
| PB5         | IO       | GPIO port B input/output 5  |         |         |         |        | 53     | 21     |
| PB6         | IO       | GPIO port B input/output 6  |         |         | 20      | 20     | 58     | 30     |
| PB7         | IO       | GPIO port B input/output 7  |         |         | 21      | 21     | 59     | 31     |

**Table 6-7. General Purpose Input Output Module Signal Descriptions (continued)**

| SIGNAL NAME | PIN TYPE | DESCRIPTION                 | RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN |
|-------------|----------|-----------------------------|---------|---------|---------|--------|--------|--------|
| PB8         | IO       | GPIO port B input/output 8  |         |         | 22      | 22     | 60     | 32     |
| PB9         | IO       | GPIO port B input/output 9  |         |         | 23      | 23     | 61     | 33     |
| PB10        | IO       | GPIO port B input/output 10 |         |         |         |        | 62     | 34     |
| PB11        | IO       | GPIO port B input/output 11 |         |         |         |        | 63     | 35     |
| PB12        | IO       | GPIO port B input/output 12 |         |         |         |        | 64     | 36     |
| PB13        | IO       | GPIO port B input/output 13 |         |         |         |        | 1      | 37     |
| PB14        | IO       | GPIO port B input/output 14 |         |         | 24      | 24     | 2      | 38     |
| PB15        | IO       | GPIO port B input/output 15 |         |         | 25      | 25     | 3      | 39     |
| PB16        | IO       | GPIO port B input/output 16 |         |         | 26      | 26     | 4      | 40     |
| PB17        | IO       | GPIO port B input/output 17 |         |         | 36      | 36     | 14     | 58     |
| PB18        | IO       | GPIO port B input/output 18 |         |         | 37      | 37     | 15     | 59     |
| PB19        | IO       | GPIO port B input/output 19 |         |         | 38      | 38     | 16     | 60     |
| PB20        | IO       | GPIO port B input/output 20 |         |         | 41      | 41     | 19     | 67     |
| PB21        | IO       | GPIO port B input/output 21 |         |         |         |        | 20     | 68     |
| PB22        | IO       | GPIO port B input/output 22 |         |         |         |        | 21     | 69     |
| PB23        | IO       | GPIO port B input/output 23 |         |         |         |        | 22     | 70     |
| PB24        | IO       | GPIO port B input/output 24 |         |         | 42      | 42     | 23     | 71     |
| PB25        | IO       | GPIO port B input/output 25 |         |         |         |        | 27     | 75     |
| PB26        | IO       | GPIO port B input/output 26 |         |         |         |        | 28     | 76     |
| PB27        | IO       | GPIO port B input/output 27 |         |         |         |        | 29     | 77     |
| PB28        | IO       | GPIO port B input/output 28 |         |         |         |        |        | 24     |
| PB29        | IO       | GPIO port B input/output 29 |         |         |         |        |        | 25     |
| PB30        | IO       | GPIO port B input/output 30 |         |         |         |        |        | 26     |
| PB31        | IO       | GPIO port B input/output 31 |         |         |         |        |        | 27     |
| PC0         | IO       | GPIO port C input/output 0  |         |         |         |        |        | 46     |
| PC1         | IO       | GPIO port C input/output 1  |         |         |         |        |        | 47     |
| PC2         | IO       | GPIO port C input/output 2  |         |         |         |        |        | 50     |
| PC3         | IO       | GPIO port C input/output 3  |         |         |         |        |        | 51     |
| PC4         | IO       | GPIO port C input/output 4  |         |         |         |        |        | 52     |
| PC5         | IO       | GPIO port C input/output 5  |         |         |         |        |        | 53     |
| PC6         | IO       | GPIO port C input/output 6  |         |         |         |        |        | 63     |
| PC7         | IO       | GPIO port C input/output 7  |         |         |         |        |        | 64     |
| PC8         | IO       | GPIO port C input/output 8  |         |         |         |        |        | 65     |
| PC9         | IO       | GPIO port C input/output 9  |         |         |         |        |        | 66     |

**Table 6-8. I2C Signal Descriptions**

| SIGNAL NAME | PIN TYPE | DESCRIPTION                    | RGE PIN      | RHB PIN       | RGZ PIN              | PT PIN               | PM PIN                     | PN PIN                   |
|-------------|----------|--------------------------------|--------------|---------------|----------------------|----------------------|----------------------------|--------------------------|
| I2C0_SCL    | IOD      | I2C0 serial clock signal (SCL) | 1, 10, 18, 8 | 13, 15, 2, 26 | 17, 19, 2, 36, 40    | 17, 19, 2, 36, 40    | 14, 18, 34, 47, 55, 57     | 15, 2, 23, 29, 58, 62    |
| I2C0_SDA    | IOD      | I2C0 serial data signal (SDA)  | 24, 9        | 1, 12, 14     | 1, 16, 18, 3, 37, 41 | 1, 16, 18, 3, 37, 41 | 15, 19, 33, 35, 48, 54, 56 | 1, 16, 22, 28, 3, 59, 67 |

**Table 6-8. I2C Signal Descriptions (continued)**

| SIGNAL NAME | PIN TYPE | DESCRIPTION                    | RGE PIN           | RHB PIN               | RGZ PIN                    | PT PIN                     | PM PIN                        | PN PIN                        |
|-------------|----------|--------------------------------|-------------------|-----------------------|----------------------------|----------------------------|-------------------------------|-------------------------------|
| I2C1_SCL    | IOD      | I2C1 serial clock signal (SCL) | 10, 11, 13, 16, 7 | 10, 15, 19, 21, 24, 8 | 10, 12, 14, 19, 30, 32, 35 | 10, 12, 14, 19, 30, 32, 35 | 10, 13, 36, 44, 50, 57, 8     | 12, 18, 29, 4, 44, 54, 57     |
| I2C1_SDA    | IOD      | I2C1 serial data signal (SDA)  | 12, 14, 15, 6, 9  | 14, 20, 22, 23, 7, 9  | 11, 15, 18, 31, 33, 34, 9  | 11, 15, 18, 31, 33, 34, 9  | 11, 12, 37, 43, 45, 51, 56, 9 | 11, 13, 19, 28, 45, 5, 55, 56 |
| I2C2_SCL    | IOD      | I2C2 serial clock signal (SCL) | 11, 19            | 19, 27                | 20, 22, 25, 30, 43         | 20, 22, 25, 30, 43         | 24, 3, 36, 58, 60, 8          | 24, 30, 32, 39, 4, 44, 50, 72 |
| I2C2_SDA    | IOD      | I2C2 serial data signal (SDA)  | 12, 20            | 20, 28                | 21, 23, 26, 31, 44         | 21, 23, 26, 31, 44         | 25, 37, 4, 59, 61, 9          | 25, 31, 33, 40, 45, 5, 51, 73 |

**Table 6-9. IOMUX Signal Descriptions**

| SIGNAL NAME | PIN TYPE | DESCRIPTION  | RGE PIN                 | RHB PIN                 | RGZ PIN                    | PT PIN                     | PM PIN                         | PN PIN                     |
|-------------|----------|--|-------------------------|-------------------------|----------------------------|----------------------------|--------------------------------|----------------------------|
| WAKE        | I        | Input signal to wake the device from SHUTDOWN mode | 1, 10, 13, 14, 2, 24, 9 | 1, 14, 15, 2, 21, 22, 3 | 1, 18, 19, 2, 3, 32, 33, 4 | 1, 18, 19, 2, 3, 32, 33, 4 | 10, 11, 33, 34, 35, 38, 56, 57 | 1, 2, 28, 29, 3, 54, 55, 6 |

**Table 6-10. Liquid Crystal Display (LCD) Signal Descriptions**

| SIGNAL NAME | PIN TYPE | DESCRIPTION    | RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN |
|-------------|----------|----------------|---------|---------|---------|--------|--------|--------|
| LCD0        | A        | LCD segment 0  |         | 12      | 16      | 16     | 54     | 22     |
| LCD1        | A        | LCD segment 1  | 8       | 13      | 17      | 17     | 55     | 23     |
| LCD2        | A        | LCD segment 2  | 9       | 14      | 18      | 18     | 56     | 28     |
| LCD3        | A        | LCD segment 3  | 10      | 15      | 19      | 19     | 57     | 29     |
| LCD4        | A        | LCD segment 4  |         |         | 20      | 20     | 58     | 30     |
| LCD5        | A        | LCD segment 5  |         |         | 21      | 21     | 59     | 31     |
| LCD6        | A        | LCD segment 6  |         |         | 22      | 22     | 60     | 32     |
| LCD7        | A        | LCD segment 7  |         |         | 23      | 23     | 61     | 33     |
| LCD8        | A        | LCD segment 8  |         |         | 24      | 24     | 2      | 38     |
| LCD9        | A        | LCD segment 9  |         |         | 25      | 25     | 3      | 39     |
| LCD10       | A        | LCD segment 10 |         |         | 26      | 26     | 4      | 40     |
| LCD11       | A        | LCD segment 11 |         | 16      | 27      | 27     | 5      | 41     |
| LCD12       | A        | LCD segment 12 |         | 17      | 28      | 28     | 6      | 42     |
| LCD13       | A        | LCD segment 13 |         | 18      | 29      | 29     | 7      | 43     |
| LCD14       | A        | LCD segment 14 | 11      | 19      | 30      | 30     | 8      | 44     |
| LCD15       | A        | LCD segment 15 | 12      | 20      | 31      | 31     | 9      | 45     |
| LCD16       | A        | LCD segment 16 | 13      | 21      | 32      | 32     | 10     | 54     |
| LCD17       | A        | LCD segment 17 | 14      | 22      | 33      | 33     | 11     | 55     |
| LCD18       | A        | LCD segment 18 |         |         | 36      | 36     | 14     | 58     |
| LCD19       | A        | LCD segment 19 |         |         | 37      | 37     | 15     | 59     |
| LCD20       | A        | LCD segment 20 |         |         | 38      | 38     | 16     | 60     |
| LCD21       | A        | LCD segment 21 | 17      | 25      | 39      | 39     | 17     | 61     |

**Table 6-10. Liquid Crystal Display (LCD) Signal Descriptions (continued)**

| SIGNAL NAME | PIN TYPE | DESCRIPTION         | RGE PIN | RHB PIN | RGZ PIN    | PT PIN     | PM PIN     | PN PIN     |
|-------------|----------|---------------------|---------|---------|------------|------------|------------|------------|
| LCD22       | A        | LCD segment 22      | 18      | 26      | 40         | 40         | 18         | 62         |
| LCD23       | A        | LCD segment 23      |         |         | 41         | 41         | 19         | 67         |
| LCD24       | A        | LCD segment 24      |         |         | 42         | 42         | 23         | 71         |
| LCD25       | A        | LCD segment 25      | 19      | 27      | 43         | 43         | 24         | 72         |
| LCD26       | A        | LCD segment 26      | 20      | 28      | 44         | 44         | 25         | 73         |
| LCD27       | A        | LCD segment 27      | 21      | 29      | 45         | 45         | 26         | 74         |
| LCD28       | A        | LCD segment 28      | 22      | 30      | 46         | 46         | 30         | 78         |
| LCD29       | A        | LCD segment 29      |         | 31      | 47         | 47         | 31         | 79         |
| LCD30       | A        | LCD segment 30      |         |         | 3          | 3          | 35         | 3          |
| LCD31       | A        | LCD segment 31      |         |         |            |            | 36         | 4          |
| LCD32       | A        | LCD segment 32      |         |         |            |            | 37         | 5          |
| LCD33       | A        | LCD segment 33      |         |         |            |            | 52         | 20         |
| LCD34       | A        | LCD segment 34      |         |         |            |            | 53         | 21         |
| LCD35       | A        | LCD segment 35      |         |         |            |            | 62         | 34         |
| LCD36       | A        | LCD segment 36      |         |         |            |            | 63         | 35         |
| LCD37       | A        | LCD segment 37      |         |         |            |            | 64         | 36         |
| LCD38       | A        | LCD segment 38      |         |         |            |            | 1          | 37         |
| LCD39       | A        | LCD segment 39      |         |         |            |            | 20         | 68         |
| LCD40       | A        | LCD segment 40      |         |         |            |            | 21         | 69         |
| LCD41       | A        | LCD segment 41      |         |         |            |            | 22         | 70         |
| LCD42       | A        | LCD segment 42      |         |         |            |            | 27         | 75         |
| LCD43       | A        | LCD segment 43      |         |         |            |            | 28         | 76         |
| LCD44       | A        | LCD segment 44      |         |         |            |            | 29         | 77         |
| LCD45       | A        | LCD segment 45      |         |         |            |            |            | 24         |
| LCD46       | A        | LCD segment 46      |         |         |            |            |            | 25         |
| LCD47       | A        | LCD segment 47      |         |         |            |            |            | 26         |
| LCD48       | A        | LCD segment 48      |         |         |            |            |            | 27         |
| LCD49       | A        | LCD segment 49      |         |         |            |            |            | 46         |
| LCD50       | A        | LCD segment 50      |         |         |            |            |            | 47         |
| LCD51       | A        | LCD segment 51      |         |         |            |            |            | 50         |
| LCD52       | A        | LCD segment 52      |         |         |            |            |            | 51         |
| LCD53       | A        | LCD segment 53      |         |         |            |            |            | 52         |
| LCD54       | A        | LCD segment 54      |         |         |            |            |            | 53         |
| LCD55       | A        | LCD segment 55      |         |         |            |            |            | 63         |
| LCD56       | A        | LCD segment 56      |         |         |            |            |            | 64         |
| LCD57       | A        | LCD segment 57      |         |         |            |            |            | 65         |
| LCD58       | A        | LCD segment 58      |         |         |            |            |            | 66         |
| LCDCAP0     | A        | LCD capacitor pin 0 |         | 17      | 28         | 28         | 6          | 42         |
| LCDCAP1     | A        | LCD capacitor pin 1 |         | 18      | 29         | 29         | 7          | 43         |
| LCDEN       | A        | LCD enable pin      | 11, 14  | 19, 22  | 23, 30, 33 | 23, 30, 33 | 11, 61, 8  | 33, 44, 55 |
| LCDFCLK     | IO       | LCD LFCLK signal    | 13      | 21      | 21, 32, 37 | 21, 32, 37 | 10, 15, 59 | 31, 54, 59 |
| LCDSON      | IO       | LCD SON signal      | 12      | 20      | 22, 31, 36 | 22, 31, 36 | 14, 60, 9  | 32, 45, 58 |

**Table 6-10. Liquid Crystal Display (LCD) Signal Descriptions (continued)**

| SIGNAL NAME | PIN TYPE | DESCRIPTION    | RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN |
|-------------|----------|----------------|---------|---------|---------|--------|--------|--------|
| R13         | A        | LCD R13 signal |         |         | 24      | 24     | 2      | 38     |
| R23         | A        | LCD R23 signal |         |         | 26      | 26     | 4      | 40     |
| R24         | A        | LCD R24 signal |         |         | 25      | 25     | 3      | 39     |
| R33         | A        | LCD R33 signal |         | 16      | 27      | 27     | 5      | 41     |

**Table 6-11. Power Management Unit (PMU) Signal Descriptions**

| SIGNAL NAME | PIN TYPE | DESCRIPTION                 | RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN |
|-------------|----------|-----------------------------|---------|---------|---------|--------|--------|--------|
| VBAT        | PWR      | VBAT (backup island) supply | 3       | 4       | 5       | 5      | 39     | 7      |
| VCORE       | PWR      | VCORE capacitor connection  | 23      | 32      | 48      | 48     | 32     | 80     |
| VDD         | PWR      | VDD supply                  | 3       | 4       | 6       | 6      | 40     | 8      |
| VDD2        | PWR      | VDD2 supply                 |         |         |         |        |        | 49     |
| VSS         | PWR      | VSS (ground)                | 4       | 5       | 7       | 7      | 41     | 9      |
| VSS2        | PWR      | VSS (ground)                |         |         |         |        |        | 48     |

**Table 6-12. Real-time Clock (RTC) Signal Descriptions**

| SIGNAL NAME | PIN TYPE | DESCRIPTION                   | RGE PIN | RHB PIN    | RGZ PIN    | PT PIN     | PM PIN    | PN PIN     |
|-------------|----------|-------------------------------|---------|------------|------------|------------|-----------|------------|
| RTC_OUT     | O        | Real-time clock output signal | 8       | 13, 17, 31 | 17, 28, 47 | 17, 28, 47 | 31, 55, 6 | 23, 42, 79 |

**Table 6-13. Serial Peripheral Interface (SPI) Signal Descriptions**

| SIGNAL NAME | PIN TYPE | DESCRIPTION                              | RGE PIN  | RHB PIN       | RGZ PIN            | PT PIN             | PM PIN                | PN PIN                     |
|-------------|----------|--|----------|---------------|--------------------|--------------------|-----------------------|----------------------------|
| SPI0_PICO   | IO       | SPI0 peripheral in controller out signal | 8        | 13, 18, 9     | 11, 14, 17, 29, 36 | 11, 14, 17, 29, 36 | 14, 45, 50, 55, 7     | 13, 18, 23, 43, 58         |
| SPI0_POCI   | IO       | SPI0 peripheral out controller in signal | 7, 9     | 11, 14, 17, 8 | 10, 13, 18, 28, 38 | 10, 13, 18, 28, 38 | 16, 44, 49, 56, 6     | 12, 17, 28, 42, 60         |
| SPI0_SCK    | IO       | SPI0 serial clock                        | 10       | 10, 15, 16    | 12, 15, 19, 27, 37 | 12, 15, 19, 27, 37 | 15, 46, 5, 51, 57     | 14, 19, 29, 41, 59         |
| SPI1_PICO   | IO       | SPI1 peripheral in controller out signal | 14       | 22            | 22, 25, 33         | 22, 25, 33         | 11, 21, 3, 60         | 26, 32, 39, 55, 69         |
| SPI1_POCI   | IO       | SPI1 peripheral out controller in signal | 12, 15   | 20, 23        | 21, 24, 31, 34     | 21, 24, 31, 34     | 12, 2, 20, 59, 9      | 25, 31, 38, 45, 56, 68     |
| SPI1_SCK    | IO       | SPI1 serial clock                        | 13, 16   | 21, 24        | 23, 26, 32, 35     | 23, 26, 32, 35     | 10, 13, 22, 4, 61     | 27, 33, 40, 54, 57, 70     |
| SPI0_CS0    | IO       | SPI0 chip select 0 signal                | 14, 5, 7 | 12, 22, 6, 8  | 10, 16, 33, 8      | 10, 16, 33, 8      | 11, 27, 42, 44, 54    | 10, 12, 22, 55, 64, 75     |
| SPI0_CS1    | IO       | SPI0 chip select 1 signal                | 13, 6    | 16, 21, 7     | 20, 27, 32, 42, 9  | 20, 27, 32, 42, 9  | 10, 23, 28, 43, 5, 58 | 11, 30, 41, 54, 63, 71, 76 |

**Table 6-13. Serial Peripheral Interface (SPI) Signal Descriptions (continued)**

| SIGNAL NAME | PIN TYPE | DESCRIPTION               | RGE PIN      | RHB PIN              | RGZ PIN                      | PT PIN                       | PM PIN                               | PN PIN                                 |
|-------------|----------|---------------------------|--------------|----------------------|------------------------------|------------------------------|--------------------------------------|--|
| SPI0_CS2    | IO       | SPI0 chip select 2 signal | 18, 20       | 11, 18, 26, 28       | 13, 21, 29, 40, 41, 44       | 13, 21, 29, 40, 41, 44       | 18, 19, 25, 37, 48, 49, 59, 7        | 16, 17, 31, 43, 5, 62, 67, 73          |
| SPI0_CS3    | IO       | SPI0 chip select 3 signal | 1, 17, 19, 6 | 12, 17, 2, 25, 27, 7 | 16, 2, 24, 28, 39, 42, 43, 9 | 16, 2, 24, 28, 39, 42, 43, 9 | 17, 2, 23, 24, 34, 36, 43, 47, 54, 6 | 11, 15, 2, 22, 38, 4, 42, 61, 71, 72   |
| SPI1_CS0    | IO       | SPI1 chip select 0 signal | 22, 5        | 17, 30, 6            | 20, 28, 41, 46, 8            | 20, 28, 41, 46, 8            | 1, 19, 30, 42, 58, 6                 | 10, 24, 30, 37, 42, 50, 67, 78         |
| SPI1_CS1    | IO       | SPI1 chip select 1 signal | 17, 19       | 16, 25, 27, 31       | 27, 36, 39, 42, 43, 47       | 27, 36, 39, 42, 43, 47       | 14, 17, 23, 24, 29, 31, 5, 64        | 36, 41, 51, 58, 61, 66, 71, 72, 77, 79 |
| SPI1_CS2    | IO       | SPI1 chip select 2 signal | 11, 20       | 18, 19, 28           | 29, 30, 37, 44               | 29, 30, 37, 44               | 15, 25, 47, 63, 7, 8                 | 15, 35, 43, 44, 47, 52, 59, 65, 73     |
| SPI1_CS3    | IO       | SPI1 chip select 3 signal | 21           | 29                   | 24, 38, 45                   | 24, 38, 45                   | 16, 2, 26, 48, 62                    | 16, 34, 38, 46, 53, 60, 74             |

**Table 6-14. Serial Wire Debug (SWD) Signal Descriptions**

| SIGNAL NAME | PIN TYPE | DESCRIPTION  | RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN |
|-------------|----------|--|---------|---------|---------|--------|--------|--------|
| SWCLK       | I        | Serial wire debug interface clock input signal       | 16      | 24      | 35      | 35     | 13     | 57     |
| SWDIO       | IO       | Serial wire debug interface data input/output signal | 15      | 23      | 34      | 34     | 12     | 56     |

**Table 6-15. System Controller (SYSCTL) Signal Descriptions**

| SIGNAL NAME | PIN TYPE | DESCRIPTION  | RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN |
|-------------|----------|--|---------|---------|---------|--------|--------|--------|
| NRST        | I        | Active-low reset signal (must be logic high for the device to start) | 2       | 3       | 4       | 4      | 38     | 6      |

**Table 6-16. Tamper IO (TIO) Signal Descriptions**

| SIGNAL NAME | PIN TYPE | DESCRIPTION                       | RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN |
|-------------|----------|-----------------------------------|---------|---------|---------|--------|--------|--------|
| TIO0        | I        | Passive tamper detection signal 0 |         | 11      | 13      | 13     | 49     | 17     |
| TIO1        | I        | Passive tamper detection signal 1 |         |         | 14      | 14     | 50     | 18     |
| TIO2        | I        | Passive tamper detection signal 2 |         |         | 15      | 15     | 51     | 19     |

**Table 6-17. Timer (TIMx) Signal Descriptions**

| SIGNAL NAME | PIN TYPE | DESCRIPTION                                  | RGE PIN       | RHB PIN           | RGZ PIN                       | PT PIN                        | PM PIN                                 | PN PIN   |
|-------------|----------|--|---------------|-------------------|-------------------------------|-------------------------------|--|--|
| TIMA0_C0    | IO       | TIMA0 capture/compare 0 signal               | 17, 24, 5     | 1, 12, 25, 6      | 1, 15, 16, 22, 24, 39, 8      | 1, 15, 16, 22, 24, 39, 8      | 17, 2, 28, 33, 42, 51, 54, 60          | 1, 10, 19, 22, 24, 32, 38, 50, 61, 63, 76        |
| TIMA0_C1    | IO       | TIMA0 capture/compare 1 signal               | 1, 18, 6, 8   | 11, 13, 2, 26, 7  | 13, 17, 2, 23, 3, 40, 41, 9   | 13, 17, 2, 23, 3, 40, 41, 9   | 18, 19, 34, 35, 43, 49, 52, 55, 61, 64 | 11, 17, 2, 20, 23, 26, 3, 33, 36, 52, 62, 65, 67 |
| TIMA0_C2    | IO       | TIMA0 capture/compare 2 signal               | 11, 15, 6, 9  | 11, 14, 19, 23, 7 | 13, 18, 30, 34, 36, 41, 9     | 13, 18, 30, 34, 36, 41, 9     | 12, 14, 19, 43, 47, 49, 52, 56, 64, 8  | 11, 15, 17, 20, 28, 36, 44, 46, 56, 58, 67       |
| TIMA0_C3    | IO       | TIMA0 capture/compare 3 signal               | 13, 19, 21, 7 | 16, 21, 27, 29, 8 | 10, 14, 27, 3, 32, 42, 43, 45 | 10, 14, 27, 3, 32, 42, 43, 45 | 1, 10, 23, 24, 26, 28, 35, 44, 5, 50   | 12, 18, 3, 37, 41, 54, 71, 72, 74, 76            |
| TIMA0_C0N   | O        | TIMA0 capture/compare 0 complementary output | 18, 8         | 13, 26            | 17, 23, 40                    | 17, 23, 40                    | 18, 29, 55, 61                         | 23, 25, 33, 51, 62, 64, 77                       |
| TIMA0_C1N   | O        | TIMA0 capture/compare 1 complementary output | 21, 7         | 29, 8             | 10, 42, 45                    | 10, 42, 45                    | 1, 23, 26, 44, 53                      | 12, 21, 27, 37, 53, 66, 71, 74                   |
| TIMA0_C2N   | O        | TIMA0 capture/compare 2 complementary output | 10, 12, 16, 5 | 10, 15, 20, 24, 6 | 12, 19, 31, 35, 37, 8         | 12, 19, 31, 35, 37, 8         | 13, 15, 42, 46, 48, 53, 57, 9          | 10, 14, 16, 21, 29, 45, 47, 57, 59               |
| TIMA0_C3N   | O        | TIMA0 capture/compare 3 complementary output | 14, 20, 22, 5 | 17, 22, 28, 30, 6 | 15, 28, 33, 44, 46, 8         | 15, 28, 33, 44, 46, 8         | 11, 25, 29, 30, 42, 51, 6              | 10, 19, 42, 55, 73, 77, 78                       |
| TIMA_FAL0   | I        | Timer fault input 0                          | 10, 22, 5     | 10, 12, 15, 30, 6 | 12, 16, 19, 3, 46, 8          | 12, 16, 19, 3, 46, 8          | 22, 27, 30, 35, 42, 46, 54, 57         | 10, 14, 22, 24, 29, 3, 50, 70, 75, 78            |
| TIMA_FAL1   | I        | Timer fault input 1                          | 24, 5, 9      | 1, 14, 6, 9       | 1, 11, 18, 41, 8              | 1, 11, 18, 41, 8              | 19, 27, 33, 42, 45, 56, 64             | 1, 10, 13, 25, 28, 36, 51, 67, 75                |
| TIMA_FAL2   | I        | Timer fault input 2                          | 1             | 12, 2, 31         | 16, 2, 20, 47                 | 16, 2, 20, 47                 | 27, 31, 34, 54, 58                     | 2, 22, 26, 30, 52, 75, 79                        |
| TIMG8_IDX   | I        | TIMG8 quadrature encoder index pulse signal  | 1, 11         | 11, 19, 2         | 13, 2, 24, 30, 38             | 13, 2, 24, 30, 38             | 16, 2, 34, 49, 8                       | 17, 2, 27, 38, 44, 53, 60                        |

**Table 6-17. Timer (TIMx) Signal Descriptions (continued)**

| SIGNAL NAME | PIN TYPE | DESCRIPTION                     | RGE PIN              | RHB PIN                     | RGZ PIN                               | PT PIN                                | PM PIN  | PN PIN   |
|-------------|----------|---------------------------------|----------------------|-----------------------------|---------------------------------------|---------------------------------------|---|--|
| TIMG0_C0    | IO       | TIMG0 capture/compare 0 signal  | 15, 19, 24, 9        | 1, 14, 16, 23, 27, 9        | 1, 11, 18, 27, 34, 36, 43             | 1, 11, 18, 27, 34, 36, 43             | 12, 14, 24, 33, 45, 47, 5, 52, 56, 62             | 1, 13, 15, 20, 24, 28, 34, 41, 50, 56, 58, 72            |
| TIMG0_C1    | IO       | TIMG0 capture/compare 1 signal  | 1, 10, 16, 20        | 10, 15, 17, 2, 24, 28       | 12, 19, 2, 28, 35, 37, 44             | 12, 19, 2, 28, 35, 37, 44             | 13, 15, 25, 34, 46, 48, 53, 57, 6, 63             | 14, 16, 2, 21, 25, 29, 35, 42, 51, 57, 59, 73            |
| TIMG12_C0   | IO       | TIMG12 capture/compare 0 signal | 11, 13, 24, 9        | 1, 14, 18, 19, 21           | 1, 14, 18, 20, 29, 30, 32, 41         | 1, 14, 18, 20, 29, 30, 32, 41         | 1, 10, 19, 33, 50, 56, 58, 7, 8                   | 1, 18, 28, 30, 37, 43, 44, 54, 67                        |
| TIMG12_C1   | IO       | TIMG12 capture/compare 1 signal | 1, 10, 12, 14, 21    | 15, 18, 2, 20, 22, 29       | 15, 19, 2, 21, 24, 29, 31, 33, 42, 45 | 15, 19, 2, 21, 24, 29, 31, 33, 42, 45 | 11, 2, 23, 26, 34, 51, 57, 59, 7, 9               | 19, 2, 29, 31, 38, 43, 45, 55, 71, 74                    |
| TIMG4_C0    | IO       | TIMG4 capture/compare 0 signal  | 17, 21               | 25, 29, 9                   | 11, 14, 20, 22, 36, 39, 45            | 11, 14, 20, 22, 36, 39, 45            | 14, 17, 26, 28, 36, 45, 50, 52, 58, 60, 62        | 13, 18, 20, 26, 30, 32, 34, 4, 52, 58, 61, 74, 76        |
| TIMG4_C1    | IO       | TIMG4 capture/compare 1 signal  | 18, 22               | 10, 26, 30                  | 12, 15, 21, 23, 37, 40, 46            | 12, 15, 21, 23, 37, 40, 46            | 15, 18, 29, 30, 37, 46, 51, 53, 59, 61, 63        | 14, 19, 21, 27, 31, 33, 35, 5, 53, 59, 62, 77, 78        |
| TIMG5_C0    | IO       | TIMG5 capture/compare 0 signal  | 13, 19, 22, 6, 8     | 13, 21, 27, 30, 7           | 17, 25, 3, 32, 43, 46, 9              | 17, 25, 3, 32, 43, 46, 9              | 10, 24, 3, 30, 35, 43, 55                         | 11, 23, 3, 39, 54, 65, 72, 78                            |
| TIMG5_C1    | IO       | TIMG5 capture/compare 1 signal  | 14, 20, 5, 7         | 11, 12, 22, 28, 31, 6, 8    | 10, 13, 16, 26, 33, 38, 44, 47, 8     | 10, 13, 16, 26, 33, 38, 44, 47, 8     | 11, 16, 25, 31, 4, 42, 44, 49, 54                 | 10, 12, 17, 22, 40, 55, 60, 66, 73, 79                   |
| TIMG8_C0    | IO       | TIMG8 capture/compare 0 signal  | 1, 13, 17, 19, 22, 6 | 11, 2, 21, 25, 27, 30, 7, 9 | 11, 13, 2, 20, 25, 32, 39, 43, 46, 9  | 11, 13, 2, 20, 25, 32, 39, 43, 46, 9  | 10, 17, 20, 24, 3, 30, 34, 36, 43, 45, 49, 58, 62 | 11, 13, 17, 2, 30, 34, 39, 4, 46, 54, 61, 63, 68, 72, 78 |

**Table 6-17. Timer (TIMx) Signal Descriptions (continued)**

| SIGNAL NAME | PIN TYPE | DESCRIPTION                    | RGE PIN              | RHB PIN                     | RGZ PIN                                  | PT PIN                                   | PM PIN  | PN PIN   |
|-------------|----------|--------------------------------|----------------------|-----------------------------|--|--|---|--|
| TIMG8_C1    | IO       | TIMG8 capture/compare 1 signal | 14, 18, 20, 24, 5, 7 | 1, 10, 22, 26, 28, 31, 6, 8 | 1, 10, 12, 21, 26, 33, 38, 40, 44, 47, 8 | 1, 10, 12, 21, 26, 33, 38, 40, 44, 47, 8 | 11, 16, 18, 21, 25, 31, 33, 37, 4, 42, 44, 46, 59, 63 | 1, 10, 12, 14, 31, 35, 40, 47, 5, 55, 60, 62, 64, 69, 73, 79 |

**Table 6-18. Universal Asynchronous Receiver Transmitter (UART) Signal Descriptions**

| SIGNAL NAME | PIN TYPE | DESCRIPTION                 | RGE PIN       | RHB PIN           | RGZ PIN                       | PT PIN                        | PM PIN                           | PN PIN                            |
|-------------|----------|-----------------------------|---------------|-------------------|-------------------------------|-------------------------------|----------------------------------|-----------------------------------|
| UART0_CTS   | I        | UART0 clear to send signal  | 8             | 13, 18, 9         | 11, 17, 29, 38                | 11, 17, 29, 38                | 16, 27, 36, 45, 55, 7            | 13, 23, 4, 43, 60, 75             |
| UART0_RTS   | O        | UART0 ready to send signal  | 11            | 10, 12, 19        | 12, 16, 30                    | 12, 16, 30                    | 28, 37, 46, 54, 8                | 14, 22, 44, 5, 76                 |
| UART0_RX    | I        | UART0 receive signal (RXD)  | 1, 10         | 15, 2             | 19, 2                         | 19, 2                         | 34, 48, 57                       | 16, 2, 29                         |
| UART0_TX    | O        | UART0 transmit signal (TXD) | 24, 9         | 1, 14             | 1, 18, 3                      | 1, 18, 3                      | 33, 35, 47, 56                   | 1, 15, 28, 3                      |
| UART1_CTS   | I        | UART1 clear to send signal  | 17            | 16, 25            | 14, 22, 27, 39                | 14, 22, 27, 39                | 17, 22, 5, 50, 60                | 18, 26, 32, 41, 61, 70            |
| UART1_RTS   | O        | UART1 ready to send signal  | 18            | 17, 26            | 15, 23, 28, 40                | 15, 23, 28, 40                | 18, 51, 6, 61                    | 19, 27, 33, 42, 62                |
| UART1_RX    | I        | UART1 receive signal (RXD)  | 14, 7, 8      | 10, 13, 22, 8     | 10, 12, 17, 21, 33            | 10, 12, 17, 21, 33            | 11, 21, 44, 46, 53, 55, 59       | 12, 14, 21, 23, 31, 47, 55, 69    |
| UART1_TX    | O        | UART1 transmit signal (TXD) | 13, 6         | 12, 21, 7, 9      | 11, 16, 20, 32, 9             | 11, 16, 20, 32, 9             | 10, 20, 43, 45, 52, 54, 58       | 11, 13, 20, 22, 30, 46, 54, 68    |
| UART2_CTS   | I        | UART2 clear to send signal  | 12, 17, 21, 6 | 16, 20, 25, 29, 7 | 14, 20, 27, 31, 38, 39, 45, 9 | 14, 20, 27, 31, 38, 39, 45, 9 | 16, 17, 26, 37, 43, 5, 50, 58, 9 | 11, 18, 30, 41, 45, 5, 60, 61, 74 |
| UART2_RTS   | O        | UART2 ready to send signal  | 11, 22, 7     | 19, 30, 8         | 10, 15, 21, 30, 41, 42, 46    | 10, 15, 21, 30, 41, 42, 46    | 19, 23, 30, 36, 44, 51, 59, 8    | 12, 19, 31, 4, 44, 67, 71, 78     |
| UART2_RX    | I        | UART2 receive signal (RXD)  | 18, 20        | 18, 26, 28        | 15, 26, 29, 37, 40, 44        | 15, 26, 29, 37, 40, 44        | 15, 18, 25, 4, 51, 7             | 19, 40, 43, 59, 62, 73            |
| UART2_TX    | O        | UART2 transmit signal (TXD) | 17, 19        | 17, 25, 27        | 14, 25, 28, 36, 39, 43        | 14, 25, 28, 36, 39, 43        | 14, 17, 24, 3, 50, 6             | 18, 39, 42, 58, 61, 72            |
| UART3_CTS   | I        | UART3 clear to send signal  | 19            | 16, 27            | 25, 27, 43                    | 25, 27, 43                    | 24, 3, 5, 52                     | 20, 39, 41, 52, 65, 72            |
| UART3_RTS   | O        | UART3 ready to send signal  | 20            | 17, 28            | 26, 28, 44                    | 26, 28, 44                    | 25, 4, 53, 6                     | 21, 40, 42, 53, 66, 73            |

**Table 6-18. Universal Asynchronous Receiver Transmitter (UART) Signal Descriptions (continued)**

| SIGNAL NAME | PIN TYPE | DESCRIPTION                 | RGE PIN | RHB PIN        | RGZ PIN            | PT PIN             | PM PIN               | PN PIN                     |
|-------------|----------|-----------------------------|---------|----------------|--------------------|--------------------|----------------------|----------------------------|
| UART3_RX    | I        | UART3 receive signal (RXD)  | 21, 22  | 17, 29, 30, 31 | 15, 28, 45, 46, 47 | 15, 28, 45, 46, 47 | 1, 26, 30, 31, 51, 6 | 19, 37, 42, 64, 74, 78, 79 |
| UART3_TX    | O        | UART3 transmit signal (TXD) | 21, 22  | 18, 29, 30     | 14, 29, 45, 46     | 14, 29, 45, 46     | 26, 30, 50, 64, 7    | 18, 36, 43, 63, 74, 78     |
| UART4_CTS   | I        | UART4 clear to send signal  | 5       | 6              | 38, 8              | 38, 8              | 16, 42, 64           | 10, 36, 60                 |
| UART4_RTS   | O        | UART4 ready to send signal  | 17, 8   | 13, 25, 9      | 11, 17, 39         | 11, 17, 39         | 1, 17, 45, 55        | 13, 23, 37, 61             |
| UART4_RX    | I        | UART4 receive signal (RXD)  |         |                | 37                 | 37                 | 15, 21, 63           | 35, 59, 69                 |
| UART4_TX    | O        | UART4 transmit signal (TXD) |         |                | 36                 | 36                 | 14, 20, 62           | 34, 58, 68                 |

**Table 6-19. Voltage Reference Signal Descriptions**

| SIGNAL NAME | PIN TYPE | DESCRIPTION                      | RGE PIN | RHB PIN | RGZ PIN | PT PIN | PM PIN | PN PIN |
|-------------|----------|----------------------------------|---------|---------|---------|--------|--------|--------|
| VREF+       | A        | Voltage reference positive input | 19      | 27      | 43      | 43     | 24     | 72     |
| VREF-       | A        | Voltage reference negative input | 17      | 25      | 39      | 39     | 17     | 61     |

## 6.4 Connections for Unused Pins

Table 6-20 lists the correct termination of unused pins.

**Table 6-20. Connection of Unused Pins**

| PIN <sup>(1)</sup> | POTENTIAL | COMMENT   |
|--------------------|-----------|---|
| PAx , PBx, and PCx | Open      | Set corresponding pin functions to GPIO (PINCMx.PF = 0x1) and configure unused pins to output low or input with internal pullup/pulldown resistor.        |
| NRST               | VCC       | NRST is an active-low reset signal; it must be pulled high to VCC or the device will not start, for more information refer to <a href="#">Section 9.1</a> |

(1) Any unused pin with a function that is shared with general-purpose I/O should follow the "PAx, PBx, and PCx" unused pin connection guidelines.

## 7 Specifications

### 7.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

|                   |                         |  | MIN  | MAX                                | UNIT |
|-------------------|-------------------------|--|------|------------------------------------|------|
| VDD               | Supply voltage          | At VDD pin   | -0.3 | 4.1                                | V    |
| VBAT              | Battery Backup Supply   | At VBAT pin, with respect to VSS   | -0.3 | 4.1                                | V    |
| V <sub>I</sub>    | Input voltage           | Applied to any 5-V tolerant open-drain pins                                | -0.3 | 5.5                                | V    |
| V <sub>I</sub>    | Input voltage           | Applied to any common tolerance pins                                       | -0.3 | V <sub>DD</sub> + 0.3<br>(4.1 MAX) | V    |
| I <sub>VDD</sub>  | Current of VDD pin      | Current into VDD pin (source), VDD >= 2.7V                                 |      | 80                                 | mA   |
| I <sub>VBAT</sub> | Current of VBAT pin     | Current into VBAT pin (source), VBAT >= 2.7V                               |      | 20                                 | mA   |
| I <sub>VSS</sub>  | Current of VSS pin      | Current out of VSS pin (sink), VDD, VBAT >= 2.7V                           |      | 80                                 | mA   |
| I <sub>IO</sub>   | Current of SD IO pin    | Current sunk or sourced by SD IO pin, VDD >= 2.7V                          |      | 6                                  | mA   |
| I <sub>IO</sub>   | Current of HS IO pin    | Current sunk or sourced by HS IO pin, VDD >= 2.7V                          |      | 6                                  | mA   |
| I <sub>IO</sub>   | Current of HD IO pin    | Current sunk or sourced by HD IO pin                                       |      | 20                                 | mA   |
| I <sub>IO</sub>   | Current of OD IO pin    | Current sunk by OD IO pin  |      | 20                                 | mA   |
| I <sub>D</sub>    | Supported diode current | Diode current on pin supporting LCD function                               | -2   | 0.4                                | mA   |
| I <sub>D</sub>    | Supported diode current | Diode current on pin not supporting LCD function (excluding Open Drain IO) | -2   | 0.05                               | mA   |
| T <sub>J</sub>    |                         | Junction temperature   | -40  | 130                                | °C   |
| T <sub>stg</sub>  |                         | Storage temperature  | -40  | 150                                | °C   |

- (1) Operation outside the Absolute Maximum Ratings may cause permanent device damage. Absolute Maximum Ratings do not imply functional operation of the device at these or any other conditions beyond those listed under Recommended Operating Conditions. If used outside the Recommended Operating Conditions but within the Absolute Maximum Ratings, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.

### 7.2 ESD Ratings

|                    |                         |  | VALUE | UNIT |
|--------------------|-------------------------|--|-------|------|
| V <sub>(ESD)</sub> | Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/ JEDEC JS-001, all pins <sup>(1)</sup>             | ±2000 | V    |
|                    |                         | Charged device model (CDM), per JEDEC specification JESD22-C101, all pins <sup>(2)</sup> | ±500  |      |

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.  
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

### 7.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

|                               |  | MIN                 | NOM  | MAX | UNIT |
|-------------------------------|--|---------------------|------|-----|------|
| VDD <sup>(4)</sup>            | Supply voltage   | 1.62 <sup>(5)</sup> |      | 3.6 | V    |
| VBAT                          | At VBAT pin, with respect to VSS   | 1.62 <sup>(5)</sup> |      | 3.6 | V    |
| V <sub>CORE</sub>             | Voltage on V <sub>CORE</sub> pin <sup>(2)</sup>                          |                     | 1.35 |     | V    |
| C <sub>VDD</sub>              | Capacitor connected between VDD and VSS <sup>(1)</sup>                   |                     | 10   |     | uF   |
| C <sub>VBAT</sub>             | Capacitor connected between VBAT and VSS                                 |                     | 1    |     | µF   |
| C <sub>V<sub>CORE</sub></sub> | Capacitor connected between V <sub>CORE</sub> and VSS <sup>(1) (2)</sup> |                     | 470  |     | nF   |
| T <sub>A</sub>                | Ambient temperature  | -40                 |      | 125 | °C   |
| T <sub>J</sub>                | Max junction temperature   |                     |      | 130 | °C   |

### 7.3 Recommended Operating Conditions (continued)

over operating free-air temperature range (unless otherwise noted)

|                   |  | MIN | NOM | MAX | UNIT |
|-------------------|--|-----|-----|-----|------|
| f <sub>MCLK</sub> | MCLK, CPUCLK, ULPCLK frequency with 1 flash wait state <sup>(3)</sup>  |     |     | 32  | MHz  |
|                   | MCLK, CPUCLK, ULPCLK frequency with 0 flash wait states <sup>(3)</sup> |     |     | 24  |      |

- (1) Connect C<sub>VDD</sub>, C<sub>VBAT</sub> and C<sub>VCORE</sub> between VDD/VSS, VBAT/VSS and V<sub>CORE</sub>/VSS, respectively, as close to the device pins as possible. A low-ESR capacitor with at least the specified value and tolerance of ±20% or better is required for C<sub>VDD</sub>, C<sub>VBAT</sub> and C<sub>VCORE</sub>.
- (2) The V<sub>CORE</sub> pin must only be connected to C<sub>VCORE</sub>. Do not supply any voltage or apply any external load to the V<sub>CORE</sub> pin.
- (3) Wait states are managed automatically by the system controller (SYSCTL), and do not need to be configured by application software unless MCLK is sourced from a high speed clock source (HSCLK sourced from HFCLK)
- (4) There is no dependency on MCLK frequency with respect to VDD recommended operating range.
- (5) Functionality is guaranteed down to V<sub>BOR0-(min)</sub>.

### 7.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> |  | PACKAGE       | VALUE | UNIT |
|-------------------------------|--|---------------|-------|------|
| R <sub>θJA</sub>              | Junction-to-ambient thermal resistance       | LQFP-80 (PN)  | 59.6  | °C/W |
| R <sub>θJC(top)</sub>         | Junction-to-case (top) thermal resistance    |               | 19.8  | °C/W |
| R <sub>θJB</sub>              | Junction-to-board thermal resistance         |               | 39.5  | °C/W |
| Ψ <sub>JT</sub>               | Junction-to-top characterization parameter   |               | 1.0   | °C/W |
| Ψ <sub>JB</sub>               | Junction-to-board characterization parameter |               | 38.9  | °C/W |
| R <sub>θJC(bot)</sub>         | Junction-to-case (bottom) thermal resistance |               | N/A   | °C/W |
| R <sub>θJA</sub>              | Junction-to-ambient thermal resistance       | LQFP-64 (PM)  | 63.1  | °C/W |
| R <sub>θJC(top)</sub>         | Junction-to-case (top) thermal resistance    |               | 22.7  | °C/W |
| R <sub>θJB</sub>              | Junction-to-board thermal resistance         |               | 40.2  | °C/W |
| Ψ <sub>JT</sub>               | Junction-to-top characterization parameter   |               | 1.1   | °C/W |
| Ψ <sub>JB</sub>               | Junction-to-board characterization parameter |               | 39.7  | °C/W |
| R <sub>θJC(bot)</sub>         | Junction-to-case (bottom) thermal resistance |               | N/A   | °C/W |
| R <sub>θJA</sub>              | Junction-to-ambient thermal resistance       | VQFN-48 (RGZ) | 29.3  | °C/W |
| R <sub>θJC(top)</sub>         | Junction-to-case (top) thermal resistance    |               | 20.1  | °C/W |
| R <sub>θJB</sub>              | Junction-to-board thermal resistance         |               | 11.7  | °C/W |
| Ψ <sub>JT</sub>               | Junction-to-top characterization parameter   |               | 0.3   | °C/W |
| Ψ <sub>JB</sub>               | Junction-to-board characterization parameter |               | 11.7  | °C/W |
| R <sub>θJC(bot)</sub>         | Junction-to-case (bottom) thermal resistance |               | 3.5   | °C/W |
| R <sub>θJA</sub>              | Junction-to-ambient thermal resistance       | LQFP-48 (PT)  | 72.5  | °C/W |
| R <sub>θJC(top)</sub>         | Junction-to-case (top) thermal resistance    |               | 28.5  | °C/W |
| R <sub>θJB</sub>              | Junction-to-board thermal resistance         |               | 44.5  | °C/W |
| Ψ <sub>JT</sub>               | Junction-to-top characterization parameter   |               | 1.6   | °C/W |
| Ψ <sub>JB</sub>               | Junction-to-board characterization parameter |               | 44.0  | °C/W |
| R <sub>θJC(bot)</sub>         | Junction-to-case (bottom) thermal resistance |               | N/A   | °C/W |
| R <sub>θJA</sub>              | Junction-to-ambient thermal resistance       | VQFN-32 (RHB) | 33.1  | °C/W |
| R <sub>θJC(top)</sub>         | Junction-to-case (top) thermal resistance    |               | 24.2  | °C/W |
| R <sub>θJB</sub>              | Junction-to-board thermal resistance         |               | 13.3  | °C/W |
| Ψ <sub>JT</sub>               | Junction-to-top characterization parameter   |               | 0.3   | °C/W |
| Ψ <sub>JB</sub>               | Junction-to-board characterization parameter |               | 13.3  | °C/W |
| R <sub>θJC(bot)</sub>         | Junction-to-case (bottom) thermal resistance |               | 3.5   | °C/W |

## 7.4 Thermal Information (continued)

| THERMAL METRIC <sup>(1)</sup> |  | PACKAGE       | VALUE | UNIT |
|-------------------------------|--|---------------|-------|------|
| R <sub>θJA</sub>              | Junction-to-ambient thermal resistance       | VQFN-24 (RGE) | 40.7  | °C/W |
| R <sub>θJC(top)</sub>         | Junction-to-case (top) thermal resistance    |               | 32.3  | °C/W |
| R <sub>θJB</sub>              | Junction-to-board thermal resistance         |               | 18.1  | °C/W |
| Ψ <sub>JT</sub>               | Junction-to-top characterization parameter   |               | 0.5   | °C/W |
| Ψ <sub>JB</sub>               | Junction-to-board characterization parameter |               | 18.0  | °C/W |
| R <sub>θJC(bot)</sub>         | Junction-to-case (bottom) thermal resistance |               | 3.6   | °C/W |

- (1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.

## 7.5 Supply Current Characteristics

### 7.5.1 RUN/SLEEP Modes

VDD=3.3V. All inputs tied to 0V or VDD. Outputs do not source or sink any current. All peripherals are disabled.

| PARAMETER                    |   | MCLK  | -40°C |      | 25°C |      | 85°C |      | 105°C |      | 125°C |      | UNIT   |
|------------------------------|---|-------|-------|------|------|------|------|------|-------|------|-------|------|--------|
|                              |   |       | TYP   | MAX  | TYP  | MAX  | TYP  | MAX  | TYP   | MAX  | TYP   | MAX  |        |
| <b>RUN Mode</b>              |   |       |       |      |      |      |      |      |       |      |       |      |        |
| IDD <sub>RUN</sub>           | MCLK=SYSOSC, CoreMark, execute from flash | 32MHz | 3.3   |      | 3.4  |      | 3.4  |      | 3.5   |      | 3.5   |      | mA     |
|                              |   | 4MHz  | 0.6   |      | 0.7  |      | 0.7  |      | 0.8   |      | 0.8   |      |        |
|                              | MCLK=SYSOSC, CoreMark, execute from SRAM  | 32MHz | 2.9   |      | 3.0  |      | 3.0  |      | 3.1   |      | 3.1   |      |        |
|                              |   | 4MHz  | 0.6   |      | 0.6  |      | 0.7  |      | 0.7   |      | 0.7   |      |        |
| IDD <sub>RUN</sub> , per MHz | MCLK=SYSOSC, While(1), execute from flash | 32MHz | 57    | 62   | 57   | 65   | 58   | 68   | 60    | 70   | 61    | 75   | uA/MHz |
|                              | MCLK=SYSOSC, CoreMark, execute from flash | 32MHz | 103   |      | 106  |      | 106  |      | 109   |      | 109   |      |        |
|                              | MCLK=SYSOSC, CoreMark, execute from flash | 4MHz  | 150   |      | 175  |      | 175  |      | 200   |      | 200   |      |        |
| <b>SLEEP Mode</b>            |   |       |       |      |      |      |      |      |       |      |       |      |        |
| IDD <sub>SLEEP</sub>         | MCLK=LFCLK, CPU is halted                 | 32KHz | 252   | 310  | 259  | 320  | 284  | 370  | 317   | 585  | 370   | 800  | uA     |
| IDD <sub>SLEEP</sub>         | MCLK=SYSOSC, CPU is halted                | 32MHz | 1240  | 1312 | 1255 | 1328 | 1275 | 1405 | 1305  | 1552 | 1350  | 1699 | uA     |
|                              |   | 4MHz  | 408   | 461  | 416  | 474  | 438  | 589  | 477   | 737  | 517   | 885  |        |

### 7.5.2 STOP/STANDBY Modes

VDD=3.3V, VBAT=3.3V. All inputs in VDD Island tied to 0V or VDD, All inputs in VBAT Island tied to 0V or VBAT. Outputs do not source or sink any current. All peripherals not noted are disabled.

| PARAMETER                           |  | ULPCLK | -40°C |     | 25°C |     | 85°C |     | 105°C |     | 125°C |     | UNIT |
|-------------------------------------|--|--------|-------|-----|------|-----|------|-----|-------|-----|-------|-----|------|
|                                     |  |        | TYP   | MAX | TYP  | MAX | TYP  | MAX | TYP   | MAX | TYP   | MAX |      |
| <b>STOP Mode</b>                    |  |        |       |     |      |     |      |     |       |     |       |     |      |
| IDD <sub>STOP0</sub>                | SYSOSC=32MHz, USE4MHZSTOP=0, DISABLESTOP=0       | 4MHz   | 342   | 359 | 347  | 362 | 352  | 367 | 361   | 380 | 369   | 392 | uA   |
| IDD <sub>STOP1</sub>                | SYSOSC=4MHz, USE4MHZSTOP=1, DISABLESTOP=0        |        | 180   | 192 | 186  | 197 | 191  | 203 | 200   | 217 | 209   | 230 |      |
| IDD <sub>STOP2</sub>                | SYSOSC off, DISABLESTOP=1, ULPCLK=LFCLK          | 32kHz  | 51    | 55  | 54   | 58  | 58   | 64  | 66    | 79  | 74    | 93  |      |
| <b>STANDBY Mode</b>                 |  |        |       |     |      |     |      |     |       |     |       |     |      |
| VDD Island<br>IDD <sub>STBY0</sub>  | STOPCLKSTBY=0, TIMG0 enabled                     | 32kHz  | 1.5   | 2.2 | 1.6  | 2.3 | 4.0  | 7   | 12    | 22  | 20    | 36  | uA   |
| VDD Island<br>IDD <sub>STBY1</sub>  | STOPCLKSTBY=1, TIMG0 enabled                     |        | 1     | 2   | 1.2  | 2   | 3.5  | 6.5 | 11    | 21  | 19    | 35  |      |
| VDD Island<br>IDD <sub>STBY1</sub>  | STOPCLKSTBY=1, GPIOA enabled                     |        | 1     | 2   | 1.2  | 2   | 3.5  | 6.5 | 11    | 21  | 19    | 35  |      |
| VBAT Island<br>IDD <sub>STBY1</sub> | LF-XT and RTC is running                         | 32kHz  | 1.1   | 1.6 | 1.1  | 1.7 | 1.2  | 1.8 | 1.8   | 2.7 | 2.0   | 3.6 | uA   |
| VBAT Island<br>IDD <sub>STBY1</sub> | LFOSC and IWDG is running                        |        | 1.1   | 1.6 | 1.1  | 1.7 | 1.2  | 1.8 | 1.8   | 2.7 | 2.0   | 3.6 |      |
| IDD <sub>STBY0</sub>                | Idd <sub>Q</sub> (VBAT) + Idd <sub>Q</sub> (SoC) |        | 2.6   | 3.8 | 2.7  | 4   | 5.2  | 9   | 14    | 25  | 22    | 40  |      |

### 7.5.3 SHUTDOWN Mode

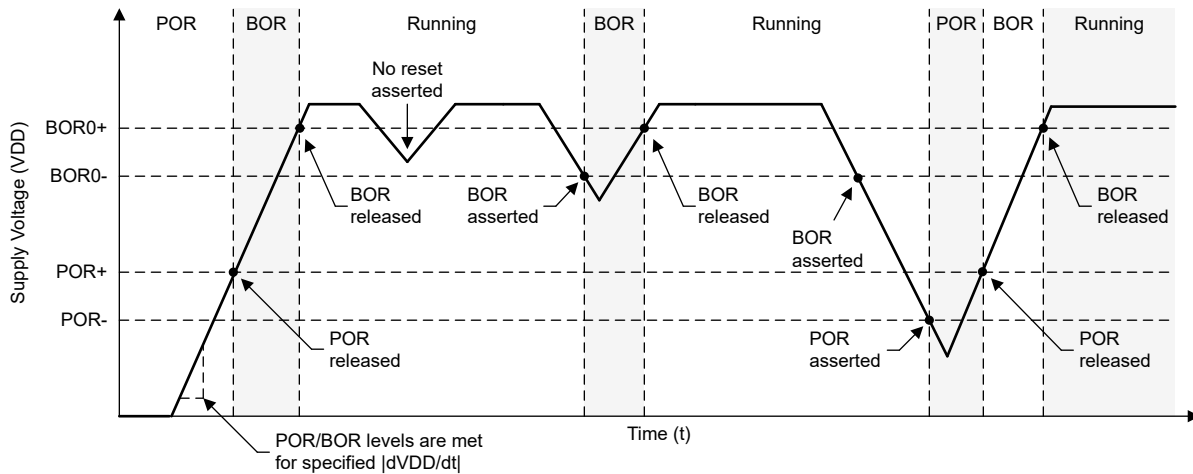
VDD=3.3V, VBAT=3.3V. All inputs in VDD Island tied to 0V or VDD, All inputs in VBAT Island tied to 0V or VBAT. Outputs do not source or sink any current. Core regulator is powered down.

| PARAMETER                             |                                 | VDD  | -40°C |     | 25°C |     | 85°C |     | 105°C |     | 125°C |     | UNIT |
|---------------------------------------|---------------------------------|------|-------|-----|------|-----|------|-----|-------|-----|-------|-----|------|
|                                       |                                 |      | TYP   | MAX | TYP  | MAX | TYP  | MAX | TYP   | MAX | TYP   | MAX |      |
| VDD Island<br>IDD <sub>SHDN</sub>     | Supply current in SHUTDOWN mode | 3.3V | 40    |     | 80   |     | 700  |     | 2600  |     | 4500  |     | nA   |
| VBAT<br>Island<br>IDD <sub>SHDN</sub> | Supply current in SHUTDOWN mode | 3.3V | 1.1   | 1.6 | 1.1  | 1.7 | 1.2  | 1.8 | 1.8   | 2.7 | 2.0   | 3.6 | uA   |

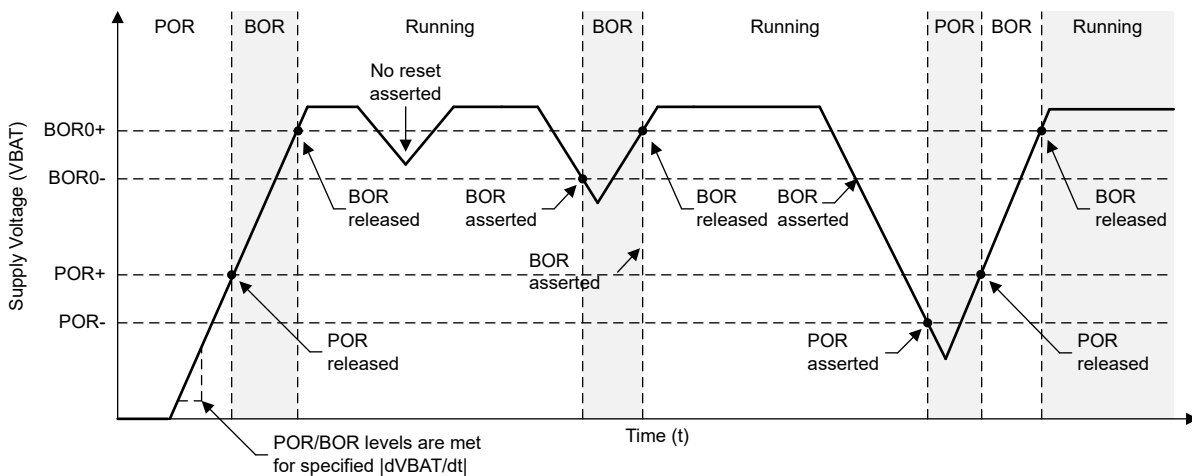
## 7.6 Power Supply Sequencing

### 7.6.1 Power Supply Ramp

Figure 7-1 gives the relationship of POR-, POR+, BOR0-, and BOR0+ during power-up and power-down.



**Figure 7-1. Power Cycle POR/BOR Conditions - VDD**



**Figure 7-2. Power Cycle POR/BOR Conditions - VBAT**

## 7.6.2 POR and BOR

over operating free-air temperature range (unless otherwise noted)

| PARAMETER                |   | TEST CONDITIONS  | MIN  | TYP  | MAX  | UNIT |
|--------------------------|---|--|------|------|------|------|
| VDD                      | Power supply range                              |  | 1.62 |      | 3.6  | V    |
| dVDD/dt                  | VDD (supply voltage) slew rate                  | Rising   |      |      | 0.1  | V/us |
| dVDD/dt                  | VDD (supply voltage) slew rate                  | Falling <sup>(2)</sup>   |      |      | 0.01 | V/us |
| dVDD/dt                  | VDD (supply voltage) slew rate                  | Falling, STANDBY   |      |      | 0.1  | V/ms |
| V <sub>POR+</sub>        | Power-on reset voltage level                    | Rising <sup>(1)</sup>  | 0.95 | 1.30 | 1.56 | V    |
| V <sub>POR-</sub>        | Power-on reset voltage level                    | Falling <sup>(1)</sup>   | 0.9  | 1.25 | 1.53 | V    |
| V <sub>HYS, POR</sub>    | POR hysteresis                                  |  | 25   | 45   | 70   | mV   |
| V <sub>BOR0+, COLD</sub> | Brown-out reset voltage level 0 (default level) | -40°C ≤ T <sub>j</sub> ≤ 30°C<br>Cold start, rising <sup>(1)</sup> | 1.45 | 1.54 | 1.62 | V    |
| V <sub>BOR0+, COLD</sub> |   | 30°C ≤ T <sub>j</sub> ≤ 85°C<br>Cold start, rising <sup>(1)</sup>  | 1.48 | 1.56 | 1.64 | V    |
| V <sub>BOR0+, COLD</sub> |   | 85°C ≤ T <sub>j</sub> ≤ 130°C<br>Cold start, rising <sup>(1)</sup> | 1.48 | 1.57 | 1.66 | V    |
| V <sub>BOR0+</sub>       | Brown-out reset voltage level 0 (default level) | Rising <sup>(1) (2)</sup>  | 1.56 | 1.59 | 1.62 | V    |
| V <sub>BOR0-</sub>       | Brown-out reset voltage level 0 (default level) | Falling <sup>(1) (2)</sup>   | 1.55 | 1.58 | 1.61 | V    |
| V <sub>BOR0, STBY</sub>  | Brown-out reset voltage level 0 (default level) | STANDBY mode <sup>(1)</sup>  | 1.51 | 1.56 | 1.61 | V    |
| V <sub>BOR1+</sub>       | Brown-out-reset voltage level 1                 | Rising <sup>(1) (2)</sup>  | 2.13 | 2.17 | 2.21 | V    |
| V <sub>BOR1-</sub>       | Brown-out-reset voltage level 1                 | Falling <sup>(1) (2)</sup>   | 2.10 | 2.14 | 2.18 | V    |
| V <sub>BOR1, STBY</sub>  | Brown-out-reset voltage level 1                 | STANDBY mode <sup>(1)</sup>  | 2.06 | 2.13 | 2.20 | V    |
| V <sub>BOR2+</sub>       | Brown-out-reset voltage level 2                 | Rising <sup>(1) (2)</sup>  | 2.73 | 2.77 | 2.82 | V    |
| V <sub>BOR2-</sub>       | Brown-out-reset voltage level 2                 | Falling <sup>(1) (2)</sup>   | 2.7  | 2.74 | 2.79 | V    |
| V <sub>BOR2, STBY</sub>  | Brown-out-reset voltage level 2                 | STANDBY mode <sup>(1)</sup>  | 2.62 | 2.71 | 2.8  | V    |
| V <sub>BOR3+</sub>       | Brown-out-reset voltage level 3                 | Rising <sup>(1) (2)</sup>  | 2.88 | 2.96 | 3.04 | V    |
| V <sub>BOR3-</sub>       | Brown-out-reset voltage level 3                 | Falling <sup>(1) (2)</sup>   | 2.85 | 2.93 | 3.01 | V    |
| V <sub>BOR3, STBY</sub>  | Brown-out-reset voltage level 3                 | STANDBY mode <sup>(1)</sup>  | 2.82 | 2.92 | 3.02 | V    |
| V <sub>HYS, BOR</sub>    | Brown-out reset hysteresis                      | Level 0 <sup>(1)</sup>   |      | 15   | 21   | mV   |
| V <sub>HYS, BOR</sub>    | Brown-out reset hysteresis                      | Levels 1-3 <sup>(1)</sup>  |      | 34   | 40   | mV   |
| T <sub>PD, BOR</sub>     | BOR propagation delay                           | RUN/SLEEP/STOP mode  |      |      | 10   | us   |
| T <sub>PD, BOR</sub>     | BOR propagation delay                           | STANDBY mode   |      |      | 100  | us   |

(1) |dVDD/dt| ≤ 3V/s

(2) Device operating in RUN, SLEEP, or STOP mode.

## 7.7 VBat Characteristics

over operating free-air temperature range (unless otherwise noted)

| PARAMETER                   |                                 | TEST CONDITIONS        | MIN  | TYP  | MAX  | UNIT |
|-----------------------------|---------------------------------|------------------------|------|------|------|------|
| VBAT                        | Power supply range              |                        | 1.62 |      | 3.6  | V    |
| dVBAT/dt                    | VBAT (supply voltage) slew rate | Rising                 |      |      | 0.1  | V/us |
| dVBAT/dt                    | VBAT (supply voltage) slew rate | Falling, standby       |      |      | 0.1  | V/ms |
| V <sub>POR+ (VBAT)</sub>    | Power-on reset voltage level    | Rising <sup>(1)</sup>  | 0.95 | 1.3  | 1.55 | V    |
| V <sub>POR- (VBAT)</sub>    | Power-on reset voltage level    | Falling <sup>(1)</sup> | 0.9  | 1.25 | 1.52 | V    |
| V <sub>HYS, POR(VBAT)</sub> | POR hysteresis                  |                        | 25   | 45   | 70   | mV   |

## 7.7 VBat Characteristics (continued)

over operating free-air temperature range (unless otherwise noted)

| PARAMETER                          |  | TEST CONDITIONS                   | MIN  | TYP  | MAX  | UNIT |
|------------------------------------|--|-----------------------------------|------|------|------|------|
| V <sub>BOR0+</sub> ,<br>COLD(VBAT) | Brown-out reset voltage level  | Cold start, rising <sup>(1)</sup> | 1.48 | 1.54 | 1.62 | V    |
| V <sub>BOR0+</sub><br>(VBAT)       | Brown-out reset voltage level  | Rising <sup>(1)</sup>             | 1.56 | 1.58 | 1.62 | V    |
| V <sub>BOR0-</sub><br>(VBAT)       | Brown-out reset voltage level  | Falling <sup>(1)</sup>            | 1.51 | 1.56 | 1.61 | V    |
| T <sub>PU</sub> (VBAT)             | Cold power up time   |                                   |      | 1.2  |      | ms   |
| I <sub>charge</sub>                | Charging peak current  | VDD=3.3, VBAT=0V                  |      | 1.7  |      | mA   |
| R <sub>switch</sub>                | Internal switch resistance between VBAT and VDD                                |                                   | 0.9  | 1.4  | 2.7  | kΩ   |
| I <sub>(trip)</sub>                | Min current for internal comparator to detect reverse current from VBAT to VDD | VDD sinking , 1.6<VBAT<3.3        | 100  |      |      | μA   |
| VBAT <sub>HYS</sub> ,<br>BOR       | Brown-out reset hysteresis   | Level 0 <sup>(1)</sup>            |      | 15   | 21   | mV   |

(1) |dVBAT/dt| ≤ 3V/s

## 7.8 Flash Memory Characteristics

over operating free-air temperature range (unless otherwise noted)

| PARAMETER                       |  | TEST CONDITIONS           | MIN  | TYP | MAX | UNIT                |
|---------------------------------|--|---------------------------|------|-----|-----|---------------------|
| <b>Supply</b>                   |  |                           |      |     |     |                     |
| VDD <sub>PGM/ERASE</sub>        | Program and erase supply voltage   |                           | 1.62 |     | 3.6 | V                   |
| IDDERASE                        | Supply current from VDD during erase operation                                 | Supply current delta      |      |     | 10  | mA                  |
| IDDPGM                          | Supply current from VDD during program operation                               | Supply current delta      |      |     | 10  | mA                  |
| <b>Endurance</b>                |  |                           |      |     |     |                     |
| NWEC(HI_ENDURANCE)              | Erase/program cycle endurance for any 32 sectors of flash <sup>(1)</sup>       |                           | 100  |     |     | k cycles per sector |
| NWEC(NORMAL_ENDURANCE)          | Erase/program cycle endurance (Flash not used for HI_ENDURANCE) <sup>(1)</sup> |                           | 10   |     |     | k cycles per sector |
| NE <sub>(MAX)</sub>             | Total erase operations before failure <sup>(2)</sup>                           |                           | 802  |     |     | k erase operations  |
| NW <sub>(MAX)</sub>             | Write operations per word line before sector erase <sup>(3)</sup>              |                           |      |     | 83  | write operations    |
| <b>Retention</b>                |  |                           |      |     |     |                     |
| t <sub>RET_85</sub>             | Flash memory data retention  | -40°C ≤ Tj ≤ 85°C         | 60   |     |     | years               |
| t <sub>RET_105</sub>            | Flash memory data retention  | -40°C ≤ Tj ≤ 105°C        | 11.4 |     |     | years               |
| <b>Program and Erase Timing</b> |  |                           |      |     |     |                     |
| t <sub>PROG</sub> (WORD, 64)    | Program time for flash word <sup>(4)</sup> <sup>(6)</sup>                      |                           |      | 50  | 275 | μs                  |
| t <sub>PROG</sub> (SEC, 64)     | Program time for 1kB sector <sup>(5)</sup> <sup>(6)</sup>                      |                           |      | 6.4 |     | ms                  |
| t <sub>ERASE</sub> (SEC)        | Sector erase time  | <10k erase/program cycles |      | 20  | 200 | ms                  |
| t <sub>ERASE</sub> (BANK)       | Bank erase time  | <10k erase/program cycles |      | 22  | 220 | ms                  |

- Up to 32 application-chosen sectors from the main flash bank(s) or data bank can be used as high endurance sectors. This enables applications that frequently update flash data such as EEPROM emulation.
- Total number of cumulative erase operations supported by the flash before failure. A sector erase or bank erase operation is considered to be one erase operation.
- Maximum number of write operations allowed per word line before the word line must be erased. If additional writes to the same word line are required, a sector erase is required once the maximum number of write operations per word line is reached.

- (4) Program time is defined as the time from when the program command is triggered until the command completion interrupt flag is set in the flash controller.
- (5) Sector program time is defined as the time from when the first word program command is triggered until the final word program command completes and the interrupt flag is set in the flash controller. This time includes the time needed for software to load each flash word (after the first flash word) into the flash controller during programming of the sector.
- (6) Flash word size is 64 data bits (8 bytes). On devices with ECC, the total flash word size is 72 bits (64 data bits plus 8 ECC bits).

## 7.9 Timing Characteristics

VDD=3.3V, T<sub>a</sub>=25°C (unless otherwise noted)

| PARAMETER                                     |   | TEST CONDITIONS    | MIN | TYP  | MAX | UNIT |
|---|---|--------------------|-----|------|-----|------|
| <b>Wakeup Timing</b>                          |   |                    |     |      |     |      |
| t <sub>WAKE, SLEEP</sub>                      | Wakeup time from SLEEP0 to RUN <sup>(1)</sup>                         |                    |     | 1.5  |     | us   |
|   | Wakeup time from SLEEP1 to RUN <sup>(1)</sup>                         |                    |     | 2.1  |     |      |
|   | Wakeup time from SLEEP2 to RUN <sup>(1)</sup>                         |                    |     | 2.5  |     |      |
| t <sub>WAKE, STOP</sub>                       | Wakeup time from STOP0 to RUN (SYSOSC enabled) <sup>(1)</sup>         |                    |     | 12.5 |     | us   |
|   | Wakeup time from STOP1 to RUN (SYSOSC enabled) <sup>(1)</sup>         |                    |     | 14.6 |     |      |
|   | Wakeup time from STOP2 to RUN (SYSOSC disabled) <sup>(1)</sup>        |                    |     | 13.5 |     |      |
| t <sub>WAKE, STBY</sub>                       | Wakeup time from STANDBY0 to RUN <sup>(1)</sup>                       |                    |     | 15.7 |     | us   |
|   | Wakeup time from STANDBY1 to RUN <sup>(1)</sup>                       |                    |     | 15.7 |     |      |
| t <sub>WAKEUP, SHDN</sub>                     | Wakeup time from SHUTDOWN to RUN <sup>(2)</sup>                       | Fast boot enabled  |     | 300  |     | us   |
|   |   | Fast boot disabled |     | 322  |     | us   |
| <b>Asynchronous Fast Clock Request Timing</b> |   |                    |     |      |     |      |
| t <sub>DELAY</sub>                            | Delay time from edge of asynchronous request to first 32MHz MCLK edge | Mode is SLEEP2     |     | 0.9  |     | us   |
|   |   | Mode is STOP1      |     | 2.4  |     |      |
|   |   | Mode is STOP2      |     | 0.9  |     |      |
|   |   | Mode is STANDBY1   |     | 3.2  |     |      |
| <b>Startup Timing</b>                         |   |                    |     |      |     |      |
| t <sub>START, RESET</sub>                     | Device cold startup time from reset/power-up <sup>(3)</sup>           | Fast boot enabled  |     | 304  |     | us   |
|   |   | Fast boot disabled |     | 370  |     |      |
| <b>NRST Timing</b>                            |   |                    |     |      |     |      |
| t <sub>RST, BOOTRST</sub>                     | Pulse length on NRST pin to generate BOOTRST                          | ULPCLK≥4MHz        |     | 1.5  |     | us   |
|   |   | ULPCLK=32kHz       |     | 80   |     |      |
| t <sub>RST, POR</sub>                         | Pulse length on NRST pin to generate POR                              |                    |     | 1    |     | s    |

- (1) The wake-up time is measured from the edge of an external wake-up signal (GPIO wake-up event) to the time that the first instruction of the user program is executed, with glitch filter disabled (FILTEREN=0x0) and fast wake enabled (FASTWAKEONLY=1).
- (2) The wake-up time is measured from the edge of an external wake-up signal (IOMUX wake-up event) to the time that first instruction of the user program is executed.
- (3) The start-up time is measured from the time that VDD crosses VBOR0- (cold start-up) to the time that the first instruction of the user program is executed.

## 7.10 Clock Specifications

### 7.10.1 System Oscillator (SYSOSC)

over operating free-air temperature range (unless otherwise noted)

| PARAMETER                  |  | TEST CONDITIONS  | MIN   | TYP | MAX  | UNIT |
|----------------------------|--|--|-------|-----|------|------|
| f <sub>SYSOSC</sub>        | Factory trimmed SYSOSC frequency   | SYSOSCCFG.FREQ=00 (BASE)   |       | 32  |      | MHz  |
|                            |  | SYSOSCCFG.FREQ=01  |       | 4   |      |      |
| f <sub>SYSOSC</sub>        | User trimmed SYSOSC frequency  | SYSOSCCFG.FREQ=10,<br>SYSOSCSTRIMUSER.FREQ=10                                |       | 24  |      |      |
|                            |  | SYSOSCCFG.FREQ=10,<br>SYSOSCSTRIMUSER.FREQ=01                                |       | 16  |      |      |
| f <sub>SYSOSC</sub>        | SYSOSC frequency accuracy when frequency correction loop (FCL) is enabled and an ideal ROOSC resistor is assumed <sup>(1)</sup> <sup>(2)</sup>       | SETUSEFCL=1, T <sub>a</sub> = 25 °C  | -0.41 |     | 0.58 | %    |
|                            |  | SETUSEFCL=1, -40 °C ≤ T <sub>a</sub> ≤ 85 °C                                 | -0.8  |     | 0.93 |      |
|                            |  | SETUSEFCL=1, -40 °C ≤ T <sub>a</sub> ≤ 105 °C                                | -0.8  |     | 1.1  |      |
|                            |  | SETUSEFCL=1, -40 °C ≤ T <sub>a</sub> ≤ 125 °C                                | -0.8  |     | 1.3  |      |
| f <sub>SYSOSC</sub>        | SYSOSC accuracy when frequency correction loop (FCL) is enabled with ROOSC resistor put at ROOSC pin, for factory trimmed frequencies <sup>(1)</sup> | SETUSEFCL=1, ±0.1% 25ppm R <sub>Osc</sub> ,<br>T <sub>a</sub> = 25 °C        | -0.5  |     | 0.7  | %    |
|                            |  | SETUSEFCL=1, ±0.1% 25ppm R <sub>Osc</sub> , -40 °C ≤ T <sub>a</sub> ≤ 85 °C  | -1.1  |     | 1.2  |      |
|                            |  | SETUSEFCL=1, ±0.1% 25ppm R <sub>Osc</sub> , -40 °C ≤ T <sub>a</sub> ≤ 105 °C | -1.1  |     | 1.4  |      |
|                            |  | SETUSEFCL=1, ±0.1% 25ppm R <sub>Osc</sub> , -40 °C ≤ T <sub>a</sub> ≤ 125 °C | -1.5  |     | 1.4  |      |
| f <sub>SYSOSC</sub>        | SYSOSC frequency accuracy when frequency correction loop (FCL) is enabled when the internal ROOSC resistor is used <sup>(4)</sup>                    | SETUSEFCL=1 -40 °C ≤ T <sub>a</sub> ≤ 125 °C                                 | -2    |     | 1.4  | %    |
| f <sub>SYSOSC</sub>        | SYSOSC raw accuracy with FCL disabled, 32MHz   | SETUSEFCL=0,SYSOSCCFG.FREQ=00<br>-40 °C ≤ T <sub>a</sub> ≤ 125 °C            | -2.6  |     | 1.8  | %    |
| f <sub>SYSOSC</sub>        | SYSOSC raw accuracy with FCL disabled, 4MHz  | SETUSEFCL=0,SYSOSCCFG.FREQ=01<br>-40 °C ≤ T <sub>a</sub> ≤ 125 °C            | -2.7  |     | 2.3  | %    |
| R <sub>Osc</sub>           | External resistor between ROOSC pin and VSS <sup>(1)</sup>   | SETUSEFCL=1  |       | 100 |      | kΩ   |
| t <sub>settle,SYSOSC</sub> | Settling time to target accuracy <sup>(3)</sup>  | SETUSEFCL=1, ±0.1% 25ppm R <sub>Osc</sub> <sup>(1)</sup>                     |       |     | 30   | us   |
| f <sub>settle,SYSOSC</sub> | f <sub>SYSOSC</sub> accuracy during t <sub>settle</sub> <sup>(3)</sup>   | SETUSEFCL=1 <sup>(1)</sup> , ±0.1% 25ppm R <sub>Osc</sub>                    | -11   |     |      | %    |

- (1) The SYSOSC frequency correction loop (FCL) enables high SYSOSC accuracy via an external reference resistor (ROOSC) which must be connected between the device ROOSC pin and VSS when using the FCL. Accuracies are shown for a ±0.1% ±25ppm ROOSC; relaxed tolerance resistors may also be used (with reduced SYSOSC accuracy). See the SYSOSC section of the technical reference manual for details on computing SYSOSC accuracy for various ROOSC accuracies. ROOSC does not need to be populated if the FCL is not enabled.
- (2) Represents the device accuracy only. The tolerance and temperature drift of the ROOSC resistor used must be combined with this spec to determine final accuracy. Performance for a ±0.1% ±25ppm ROOSC is given as a reference point.
- (3) When SYSOSC is waking up (for example, when exiting a low power mode) and FCL is enabled, the SYSOSC will initially undershoot the target frequency f<sub>SYSOSC</sub> by an additional error of up to f<sub>settle,SYSOSC</sub> for the time t<sub>settle,SYSOSC</sub>, after which the target accuracy is achieved.
- (4) The SYSOSC frequency correction loop (FCL) enables high SYSOSC accuracy via an internal reference resistor when using the FCL. See the SYSOSC section of the technical reference manual for details on computing SYSOSC accuracy.

### 7.10.2 Low Frequency Oscillator (LFOOSC)

over operating free-air temperature range (unless otherwise noted)

| PARAMETER           |                  | TEST CONDITIONS                  | MIN | TYP   | MAX | UNIT |
|---------------------|------------------|----------------------------------|-----|-------|-----|------|
| f <sub>LFOOSC</sub> | LFOOSC frequency |                                  |     | 32768 |     | Hz   |
|                     | LFOOSC accuracy  | -40 °C ≤ T <sub>a</sub> ≤ 125 °C | -5  |       | 5   | %    |
|                     |                  | -40 °C ≤ T <sub>a</sub> ≤ 85 °C  | -3  |       | 3   | %    |

### 7.10.2 Low Frequency Oscillator (LFOSC) (continued)

over operating free-air temperature range (unless otherwise noted)

| PARAMETER          |                           | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--------------------|---------------------------|-----------------|-----|-----|-----|------|
| $I_{LFOSC}$        | LFOSC current consumption |                 |     | 300 |     | nA   |
| $t_{start, LFOSC}$ | LFOSC start-up time       |                 |     | 1.7 |     | ms   |

### 7.10.3 Low Frequency Crystal/Clock

over operating free-air temperature range (unless otherwise noted)

| PARAMETER   |  | TEST CONDITIONS      | MIN   | TYP   | MAX   | UNIT       |
|---|--|----------------------|-------|-------|-------|------------|
| <b>Low frequency crystal oscillator (LFXT)</b>      |  |                      |       |       |       |            |
| $f_{LFXT}$  | LFXT frequency                                       |                      |       | 32768 |       | Hz         |
| $DC_{LFXT}$   | LFXT duty cycle                                      |                      | 30    |       | 70    | %          |
| $OA_{LFXT}$   | LFXT crystal oscillation allowance                   |                      |       | 419   |       | k $\Omega$ |
| $C_{L, eff}$  | Integrated effective load capacitance <sup>(1)</sup> |                      |       | 1     |       | pF         |
| $t_{start, LFXT}$                                   | LFXT start-up time                                   |                      |       | 483   | 640   | ms         |
| $I_{LFXT}$  | LFXT current consumption                             | XT1DRIVE=0, LOWCAP=1 |       | 200   |       | nA         |
| <b>Low frequency digital clock input (LFCLK_IN)</b> |  |                      |       |       |       |            |
| $f_{LFIN}$  | LFCLK_IN frequency <sup>(2)</sup>                    | SETUSEEXLF=1         | 29491 | 32768 | 36045 | Hz         |
| $DC_{LFIN}$   | LFCLK_IN duty cycle <sup>(2)</sup>                   | SETUSEEXLF=1         | 40    |       | 60    | %          |
| <b>LFCLK Monitor</b>                                |  |                      |       |       |       |            |
| $f_{FAULTLF}$                                       | LFCLK monitor fault frequency <sup>(3)</sup>         | MONITOR=1            | 2800  | 4200  | 8400  | Hz         |

- (1) This includes parasitic bond and package capacitance ( $\approx 2$ pF per pin), calculated as  $C_{LFXIN} \times C_{LFXOUT} / (C_{LFXIN} + C_{LFXOUT})$ , where  $C_{LFXIN}$  and  $C_{LFXOUT}$  are the total capacitance at LFXIN and LFXOUT, respectively.
- (2) The digital clock input (LFCLK\_IN) accepts a logic level square wave clock.
- (3) The LFCLK monitor may be used to monitor the LFXT or LFCLK\_IN. It will always fault below the MIN fault frequency, and will never fault above the MAX fault frequency.

### 7.10.4 High Frequency Crystal/Clock

over operating free-air temperature range (unless otherwise noted)

| PARAMETER  |  | TEST CONDITIONS   | MIN   | TYP | MAX | UNIT       |
|--|--|---|-------|-----|-----|------------|
| <b>High frequency crystal oscillator (HFXT)</b>      |  |   |       |     |     |            |
| $f_{HFXT}$   | HFXT frequency                                       | HFXTTRSEL=00  | 4     |     | 8   | MHz        |
|  |  | HFXTTRSEL=01  | 8.01  |     | 16  |            |
|  |  | HFXTTRSEL=10  | 16.01 |     | 32  |            |
| $DC_{HFXT}$  | HFXT duty cycle                                      | HFXTTRSEL=00  | 40    |     | 65  | %          |
|  |  | HFXTTRSEL=01  | 40    |     | 60  |            |
|  |  | HFXTTRSEL=10  | 40    |     | 60  |            |
|  |  | HFXTTRSEL=11  | 40    |     | 60  |            |
| $OA_{HFXT}$  | HFXT crystal oscillation allowance                   | HFXTTRSEL=00 (4 to 8MHz range)  |       | 2   |     | k $\Omega$ |
| $C_{L, eff}$   | Integrated effective load capacitance <sup>(1)</sup> |   |       | 1   |     | pF         |
| $t_{start, HFXT}$                                    | HFXT start-up time <sup>(2)</sup>                    | HFXTTRSEL=11, 32MHz crystal   |       | 0.5 |     | ms         |
| $I_{HFXT}$   | HFXT current consumption                             | $f_{HFXT}=4$ MHz, $R_m=300\Omega$ , $C_L=12$ pF                               |       | 100 |     | uA         |
|  |  | $f_{HFXT}=32$ MHz, $R_m=30\Omega$ , $C_L=12$ pF, $C_m=6.26$ fF, $L_m=1.76$ mH |       | 600 |     |            |
| <b>High frequency digital clock input (HFCLK_IN)</b> |  |   |       |     |     |            |
| $f_{HFIN}$   | HFCLK_IN frequency <sup>(3)</sup>                    | USEEXTHFCLK=1   | 4     |     | 32  | MHz        |

### 7.10.4 High Frequency Crystal/Clock (continued)

over operating free-air temperature range (unless otherwise noted)

| PARAMETER          |                                    | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--------------------|------------------------------------|-----------------|-----|-----|-----|------|
| DC <sub>HFIN</sub> | HFCLK_IN duty cycle <sup>(3)</sup> | USEEXTHFCLK=1   | 40  |     | 60  | %    |

- (1) This includes parasitic bond and package capacitance ( $\approx 2\text{pF}$  per pin), calculated as  $C_{\text{HFXIN}} \times C_{\text{HFXOUT}} / (C_{\text{HFXIN}} + C_{\text{HFXOUT}})$ , where  $C_{\text{HFXIN}}$  and  $C_{\text{HFXOUT}}$  are the total capacitance at HFXIN and HFXOUT, respectively.
- (2) The HFXT startup time ( $t_{\text{start, HFXT}}$ ) is measured from the time the HFXT is enabled until stable oscillation for a typical crystal. Start-up time is dependent upon crystal frequency and crystal specifications. Refer to the HFXT section of the [MSPM0 G-Series 80-MHz Microcontrollers Technical Reference Manual](#).
- (3) The digital clock input (HFCLK\_IN) accepts a logic level square wave clock.

## 7.11 Digital IO

### 7.11.1 Electrical Characteristics

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted). All specifications for SDIO in VDD Power Domain are also applicable to LFSSIO in the VBAT Power Domain.

| PARAMETER        |                           | TEST CONDITIONS                                  |  | MIN      | TYP | MAX     | UNIT       |
|------------------|---------------------------|--|--|----------|-----|---------|------------|
| V <sub>IH</sub>  | High level input voltage  | ODIO <sup>(1)</sup>                              | VDD $\geq$ 1.62V   | 0.7*VDD  |     | 5.5     | V          |
|                  |                           |  | VDD $\geq$ 2.7V  | 2        |     | 5.5     | V          |
|                  |                           | All I/O except ODIO & Reset                      | VDD $\geq$ 1.62V   | 0.7*VDD  |     | VDD+0.3 | V          |
| V <sub>IL</sub>  | Low level input voltage   | ODIO   | VDD $\geq$ 1.62V   | -0.3     |     | 0.3*VDD | V          |
|                  |                           |  | VDD $\geq$ 2.7V  | -0.3     |     | 0.8     | V          |
|                  |                           | All I/O except ODIO & Reset                      | VDD $\geq$ 1.62V   | -0.3     |     | 0.3*VDD | V          |
| V <sub>HYS</sub> | Hysteresis                | ODIO   |  | 0.05*VDD |     |         | V          |
|                  |                           | All I/O except ODIO                              |  | 0.1*VDD  |     |         | V          |
| I <sub>Ikg</sub> | High-Z leakage current    | non-LCD pins SDIO <sup>(2) (3)</sup>             |  |          |     | 50      | nA         |
| I <sub>Ikg</sub> | High-Z leakage current    | All LCD pins except PA12 SDIO <sup>(2) (3)</sup> |  |          |     | 100     | nA         |
| I <sub>Ikg</sub> | High-Z leakage current    | PA12 LCD pin SDIO <sup>(2) (3)</sup>             |  |          |     | 300     | nA         |
| R <sub>PU</sub>  | Pull up resistance        | All I/O except ODIO                              |  |          | 40  |         | k $\Omega$ |
| R <sub>PD</sub>  | Pull down resistance      |  |  |          | 40  |         | k $\Omega$ |
| C <sub>I</sub>   | Input capacitance         |  |  |          | 5   |         | pF         |
| V <sub>OH</sub>  | High level output voltage | SDIO   | VDD $\geq$ 2.7V,  I <sub>IO</sub>   <sub>max</sub> =6mA<br>VDD $\geq$ 1.71V,  I <sub>IO</sub>   <sub>max</sub> =2mA<br>T <sub>j</sub> $\leq$ 85 °C | VDD-0.4  |     |         | V          |
|                  |                           |  | VDD $\geq$ 2.7V,  I <sub>IO</sub>   <sub>max</sub> =6mA<br>VDD $\geq$ 1.71V,  I <sub>IO</sub>   <sub>max</sub> =2mA<br>T <sub>j</sub> $>$ 85 °C    | VDD-0.45 |     |         | V          |
|                  |                           | HDIO   | VDD $\geq$ 2.7V, DRV=1,  I <sub>IO</sub>   <sub>max</sub> =20mA<br>VDD $\geq$ 1.71V, DRV=1,  I <sub>IO</sub>   <sub>max</sub> =10mA                | VDD-0.4  |     |         | V          |
|                  |                           |  | VDD $\geq$ 2.7V, DRV=0,  I <sub>IO</sub>   <sub>max</sub> =6mA<br>VDD $\geq$ 1.71V, DRV=0,  I <sub>IO</sub>   <sub>max</sub> =2mA                  | VDD-0.45 |     |         | V          |

### 7.11.1 Electrical Characteristics (continued)

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted). All specifications for SDIO in VDD Power Domain are also applicable to LFSSIO in the VBAT Power Domain.

| PARAMETER       |                          | TEST CONDITIONS |  | MIN | TYP | MAX  | UNIT |
|-----------------|--------------------------|-----------------|--|-----|-----|------|------|
| V <sub>OL</sub> | Low level output voltage | SDIO            | VDD ≥ 2.7V,  I <sub>IO</sub>   <sub>max</sub> = 6mA<br>VDD ≥ 1.71V,  I <sub>IO</sub>   <sub>max</sub> = 2mA<br>T <sub>j</sub> ≤ 85 °C  |     |     | 0.4  | V    |
|                 |                          |                 | VDD ≥ 2.7V,  I <sub>IO</sub>   <sub>max</sub> = 6mA<br>VDD ≥ 1.71V,  I <sub>IO</sub>   <sub>max</sub> = 2mA<br>T <sub>j</sub> > 85 °C  |     |     | 0.45 |      |
|                 |                          | HDIO            | VDD ≥ 2.7V, DRV = 1,  I <sub>IO</sub>   <sub>max</sub> = 20mA<br>VDD ≥ 1.71V, DRV = 1,  I <sub>IO</sub>   <sub>max</sub> = 10mA<br>VDD ≥ 2.7V, DRV = 0,  I <sub>IO</sub>   <sub>max</sub> = 6mA<br>VDD ≥ 1.71V, DRV = 0,  I <sub>IO</sub>   <sub>max</sub> = 2mA<br>T <sub>j</sub> ≤ 85 °C |     |     | 0.4  |      |
|                 |                          |                 | VDD ≥ 2.7V, DRV = 1,  I <sub>IO</sub>   <sub>max</sub> = 20mA<br>VDD ≥ 1.71V, DRV = 1,  I <sub>IO</sub>   <sub>max</sub> = 10mA<br>VDD ≥ 2.7V, DRV = 0,  I <sub>IO</sub>   <sub>max</sub> = 6mA<br>VDD ≥ 1.71V, DRV = 0,  I <sub>IO</sub>   <sub>max</sub> = 2mA<br>T <sub>j</sub> > 85 °C |     |     | 0.45 |      |
|                 |                          | ODIO            | VDD ≥ 2.7V, I <sub>OL</sub> = 8mA<br>VDD ≥ 1.71V, I <sub>OL</sub> = 4mA<br>T <sub>j</sub> ≤ 85 °C  |     |     | 0.4  |      |
|                 |                          |                 | VDD ≥ 2.7V, I <sub>OL</sub> = 8mA<br>VDD ≥ 1.71V, I <sub>OL</sub> = 4mA<br>T <sub>j</sub> > 85 °C  |     |     | 0.45 |      |

- (1) I/O Types: ODIO = 5V Tolerant Open-Drain , SDIO = Standard-Drive , HDIO = High-Drive
- (2) The leakage current is measured with VSS or VDD applied to the corresponding pin(s), unless otherwise noted.
- (3) The leakage of the digital port pins is measured individually. The port pin is selected for input and the pullup/pulldown resistor is disabled.

### 7.11.2 Switching Characteristics

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted). All specifications for SDIO in VDD Power Domain are also applicable to LFSSIO in the VBAT Power Domain.

| PARAMETER                       |                       | TEST CONDITIONS              |  | MIN        | TYP | MAX                  | UNIT |
|---------------------------------|-----------------------|------------------------------|--|------------|-----|----------------------|------|
| f <sub>max</sub>                | Port output frequency | SDIO (1)                     | VDD ≥ 1.71V, C <sub>L</sub> = 20pF                           |            |     | 16                   | MHz  |
| f <sub>max</sub>                | Port output frequency | SDIO (1)                     | VDD ≥ 2.7V, C <sub>L</sub> = 20pF                            |            |     | 32                   |      |
| f <sub>max</sub>                | Port output frequency | ODIO                         | VDD ≥ 1.71V, FM <sup>+</sup> , C <sub>L</sub> = 20pF - 100pF |            |     | 1                    |      |
| t <sub>r</sub> , t <sub>f</sub> | Output rise/fall time | All output ports except ODIO | VDD ≥ 1.71V  |            |     | 0.3*f <sub>max</sub> | s    |
| t <sub>f</sub>                  | Output fall time      | ODIO                         | VDD ≥ 1.71V, FM <sup>+</sup> , C <sub>L</sub> = 20pF-100pF   | 20*VDD/5.5 |     | 120                  | ns   |

- (1) I/O Types: ODIO = 5V Tolerant Open-Drain , SDIO = Standard-Drive , HSIO = High-Speed , HDIO = High-Drive

### 7.12 Analog Mux VBOOST

over operating free-air temperature range (unless otherwise noted)

| PARAMETER               |                      | TEST CONDITIONS                                    |  | MIN | TYP  | MAX | UNIT |
|-------------------------|----------------------|--|--|-----|------|-----|------|
| I <sub>VBST</sub>       | VBOOST current adder | MCLK/ULPCLK is LFCLK                               |  |     | 0.8  |     | uA   |
| I <sub>VBST</sub>       | VBOOST current adder | MCLK/ULPCLK is not LFCLK, SYSOSC frequency is 4MHz |  |     | 10.6 |     | uA   |
| t <sub>START,VBST</sub> | VBOOST startup time  |  |  |     | 12   | 20  | us   |

## 7.13 ADC

### 7.13.1 Electrical Characteristics

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted), all TYP values are measured at 25°C and all accuracy parameters are measured using 12-bit resolution mode (unless otherwise noted)

| PARAMETER                         |  | TEST CONDITIONS   | MIN  | TYP  | MAX  | UNIT |
|-----------------------------------|--|---|------|------|------|------|
| V <sub>in(ADC)</sub>              | Analog input voltage range <sup>(1)</sup>          | Applies to all ADC analog input pins  | 0    |      | VDD  | V    |
| V <sub>R+</sub>                   | Positive ADC reference voltage                     | V <sub>R+</sub> sourced from VDD  |      | VDD  |      | V    |
|                                   |  | V <sub>R+</sub> sourced from external reference pin (VREF+)   | 1.4  |      | VDD  | V    |
|                                   |  | V <sub>R+</sub> sourced from internal reference (VREF)  |      | VREF |      | V    |
| V <sub>R-</sub>                   | Negative ADC reference voltage                     |   | 0    |      | V    |      |
| F <sub>S</sub>                    | ADC sampling frequency                             | RES = 0x0 (12-bit mode), External Reference   |      |      | 1.68 | Msps |
| F <sub>S</sub>                    | ADC sampling frequency                             | RES = 0x0 (12-bit mode), Internal Reference   |      |      | 200  | ksps |
| I <sub>(ADC)</sub> <sup>(2)</sup> | Operating supply current into VDD terminal         | F <sub>S</sub> = 1.68MSPS, Internal reference OFF, V <sub>R+</sub> = VDD                                |      | 570  |      | μA   |
|                                   |  | F <sub>S</sub> = 200ksps, Internal reference ON, V <sub>R+</sub> = VREF = 2.5V                          |      | 320  | 435  |      |
| R <sub>in</sub>                   | ADC input resistance                               |   |      | 0.5  |      | kΩ   |
| C <sub>S/H</sub>                  | ADC sample-and-hold capacitance                    |   |      | 4.3  |      | pF   |
| ENOB                              | Effective number of bits                           | Fin = 10kHz, External reference <sup>(3)</sup>  | 11.0 | 11.1 |      | bit  |
|                                   |  | Fin = 10kHz, Internal reference, V <sub>R+</sub> = VREF = 2.5V  | 10   | 10.2 |      |      |
| SNR                               | Signal-to-noise ratio                              | Fin = 10kHz, External reference <sup>(3)</sup>  | 68   | 71   |      | dB   |
|                                   |  | Fin = 10kHz, Internal reference, V <sub>R+</sub> = VREF = 2.5V  | 63   | 65   |      |      |
| PSRR <sub>DC</sub>                | Power supply rejection ratio, DC                   | External reference <sup>(3)</sup> , VDD = VDD <sub>(min)</sub> to VDD <sub>(max)</sub>                  | 63   | 68   |      | dB   |
|                                   |  | VDD = VDD <sub>(min)</sub> to VDD <sub>(max)</sub><br>Internal reference, V <sub>R+</sub> = VREF = 2.5V | 50   | 68   |      |      |
| PSRR <sub>AC</sub>                | Power supply rejection ratio, AC                   | External reference <sup>(3)</sup> , ΔVDD = 0.1 V at 1 kHz   |      | 61   |      | dB   |
|                                   |  | ΔVDD = 0.1 V at 1 kHz<br>Internal reference, V <sub>R+</sub> = VREF = 2.5V                              |      | 55   |      |      |
| T <sub>wakeup</sub>               | ADC Wakeup Time                                    | Assumes internal reference is active  |      |      | 5    | us   |
| V <sub>SupplyMon</sub>            | Supply Monitor voltage divider (VDD/3) accuracy    | ADC input channel: Supply Monitor <sup>(4)</sup>  | -1.5 |      | +1.5 | %    |
| I <sub>SupplyMon</sub>            | Supply Monitor voltage divider current consumption | ADC input channel: Supply Monitor   |      | 10   |      | uA   |
| V <sub>VBATmon</sub>              | VBAT Monitor voltage divider (VBAT/3) accuracy     | ADC input channel: VBAT Monitor <sup>(4)</sup>  | -1.5 |      | +1.5 | %    |
| I <sub>VBATmon</sub>              | VBAT Monitor voltage divider current consumption   | ADC input channel: VBAT Monitor   |      | 10   |      | uA   |

(1) The analog input voltage range must be within the selected ADC reference voltage range V<sub>R+</sub> to V<sub>R-</sub> for valid conversion results.

(2) The internal reference (VREF) supply current is not included in current consumption parameter I<sub>(ADC)</sub>.

(3) All external reference specifications are measured with V<sub>R+</sub> = VREF+ = VDD = 3.3V and V<sub>R-</sub> = VREF- = VSS = 0V and external 1uF cap on VREF+ pin

(4) Analog power supply monitor. Analog input on channel 31 for VDD monitor and channel 30 for VBAT monitor is disconnected and is internally connected to the voltage divider which is VDD/3. Both the supply monitors are measured with external reference

### 7.13.2 Switching Characteristics

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

| PARAMETER                          |  | TEST CONDITIONS   | MIN | TYP | MAX | UNIT          |
|------------------------------------|--|---|-----|-----|-----|---------------|
| f <sub>ADCCLK</sub>                | ADC clock frequency                                    |   | 4   |     | 32  | MHz           |
| t <sub>ADC trigger</sub>           | Software trigger minimum width                         |   | 3   |     |     | ADCCLK cycles |
| t <sub>Sample</sub>                | Sampling time  | 12-bit mode, R <sub>S</sub> = 50Ω, C <sub>pext</sub> = 10pF | 156 |     |     | ns            |
| t <sub>Sample_VREF</sub>           | Sample time with VREF                                  | ADC Channel = 28, 12-bit mode, VDD as reference             | 4   |     |     | μs            |
| t <sub>Sample_SupplyMon(VDD)</sub> | Sample time with Supply Monitor (VDD/3) <sup>(1)</sup> |   | 5   |     |     | μs            |

### 7.13.2 Switching Characteristics (continued)

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

| PARAMETER                            |   | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--------------------------------------|---|-----------------|-----|-----|-----|------|
| $t_{\text{Sample\_SupplyMon(VBAT)}}$ | Sample time with Supply Monitor (VBAT/3) <sup>(1)</sup> |                 | 5   |     |     | μs   |

- (1) Analog power supply monitor. Analog input on channel 31 for VDD monitor and channel 30 for VBAT monitor is disconnected and is internally connected to the voltage divider which is VDD/3.

### 7.13.3 Linearity Parameters

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted), all TYP values are measured at 25°C and all linearity parameters are measured using 12-bit resolution mode (unless otherwise noted) <sup>(1)</sup>

| PARAMETER      |   | TEST CONDITIONS                   |                                   | MIN  | TYP | MAX  | UNIT |
|----------------|---|-----------------------------------|-----------------------------------|------|-----|------|------|
| E <sub>J</sub> | Integral linearity error (INL)                                    | External reference <sup>(2)</sup> | External reference <sup>(2)</sup> | -2.0 |     | +2.0 | LSB  |
| E <sub>K</sub> | Differential linearity error (DNL)<br>Guaranteed no missing codes | External reference <sup>(2)</sup> | External reference <sup>(2)</sup> | -1.0 |     | +1.0 | LSB  |
| E <sub>O</sub> | Offset error  | External reference <sup>(2)</sup> |                                   | -3.5 |     | 3.5  | mV   |
| E <sub>G</sub> | Gain error  | External reference <sup>(2)</sup> |                                   | -4   |     | 4    | LSB  |

- (1) Total Unadjusted Error (TUE) can be calculated from E<sub>J</sub>, E<sub>O</sub>, and E<sub>G</sub> using the following formula:  $TUE = \sqrt{E_J^2 + |E_O|^2 + E_G^2}$   
Note: You must convert all of the errors into the same unit, usually LSB, for the above equation to be accurate
- (2) All external reference specifications are measured with V<sub>R+</sub> = VREF+ = VDD and V<sub>R-</sub> = VSS = 0V, external 1uF cap on VREF+ Pin and HW Averaging feature will only be supported since PG2.0.

### 7.13.4 Typical Connection Diagram

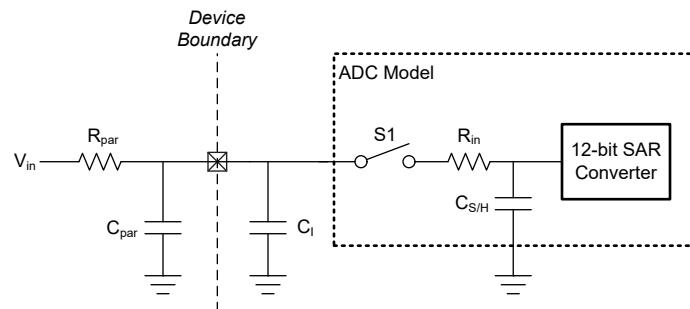


Figure 7-3. ADC Input Network

1. Refer to [ADC Electrical Characteristics](#) for the values of R<sub>in</sub> and C<sub>S/H</sub>
2. Refer to [Digital IO Electrical Characteristics](#) for the value of C<sub>I</sub>
3. C<sub>par</sub> and R<sub>par</sub> represent the parasitic capacitance and resistance of the external ADC input circuitry

Use the following equations to solve for the minimum sampling time (T) required for an ADC conversion:

1.  $\tau = (R_{\text{par}} + R_{\text{in}}) * C_{\text{S/H}} + R_{\text{par}} * (C_{\text{par}} + C_{\text{I}})$
2.  $K = \ln(2^n / \text{Settling error}) - \ln((C_{\text{par}} + C_{\text{I}}) / C_{\text{S/H}})$
3. T (Min sampling time) = K \* Tau

### 7.14 Temperature Sensor

over operating free-air temperature range (unless otherwise noted)

| PARAMETER          |   | TEST CONDITIONS  | MIN  | TYP  | MAX  | UNIT  |
|--------------------|---|--|------|------|------|-------|
| TS <sub>TRIM</sub> | Factory trim temperature <sup>(1)</sup> | ADC and VREF configuration: RES=0 (12-bit mode), VRSEL= 2h (VREF = 1.4V), ADC t <sub>sample</sub> = 12.5uS | 27   | 30   | 33   | °C    |
| TS <sub>C</sub>    | Temperature coefficient                 | -40°C ≤ T <sub>J</sub> ≤ 130°C   | -1.9 | -1.8 | -1.7 | mV/°C |

## 7.14 Temperature Sensor (continued)

over operating free-air temperature range (unless otherwise noted)

| PARAMETER            |   | TEST CONDITIONS   | MIN | TYP | MAX  | UNIT |
|----------------------|---|---|-----|-----|------|------|
| t <sub>SET, TS</sub> | Temperature sensor settling time <sup>(2)</sup> | ADC and VREF configuration: RES=0 (12-bit mode), VRSEL=2h (VREF=1.4V), ADC CHANNEL=29 |     |     | 12.5 | us   |

- (1) Higher absolute accuracy may be achieved through user calibration. Please refer to temperature sensor chapter in detailed description section.
- (2) This is the minimum required ADC sampling time when measuring the temperature sensor.

## 7.15 VREF

### 7.15.1 Electrical Characteristics ADC

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

| PARAMETER     |  | TEST CONDITIONS                                 |   | MIN | TYP | MAX | UNIT       |
|---------------|--|---|---|-----|-----|-----|------------|
| $I_{VREF}$    | VREF operating supply current                | BUFCONFIG = {0, 1}, No load                     | BUFCONFIG = {0, 1}, No load                     |     | 80  | 100 | $\mu$ A    |
| $TC_{VREF}$   | Temperature coefficient of VREF (1)          | BUFCONFIG = {0, 1}                              | BUFCONFIG = {0, 1}                              |     |     | 75  | ppm/°C     |
| $TC_{drift}$  | Long term VREF drift                         | Time = 1000 hours, BUFCONFIG = {0, 1}, T = 25°C | Time = 1000 hours, BUFCONFIG = {0, 1}, T = 25°C |     |     | 300 | ppm        |
| $PSRR_{DC}$   | VREF Power supply rejection ratio, DC        | VDD = 1.7 V to VDDmax, BUFCONFIG = 1            | VDD = 1.7 V to VDDmax, BUFCONFIG = 1            | 60  | 70  |     | dB         |
| $PSRR_{DC}$   | VREF Power supply rejection ratio, DC        | VDD = 2.7 V to VDDmax, BUFCONFIG = 0            | VDD = 2.7 V to VDDmax, BUFCONFIG = 0            | 50  | 60  |     | dB         |
| $V_{noise}$   | RMS noise at VREF output (0.1 Hz to 100 MHz) | BUFFCONFIG = 1                                  | BUFFCONFIG = 1                                  |     | 500 |     | $\mu$ Vrms |
| $V_{noise}$   | RMS noise at VREF output (0.1 Hz to 100 MHz) | BUFFCONFIG = 0                                  | BUFFCONFIG = 0                                  |     | 750 |     | $\mu$ Vrms |
| ADC $F_S$     | Max supported ADC sampling frequency         | Using VREF as ADC reference                     | Using VREF as ADC reference                     |     |     | 200 | ksps       |
| $T_{startup}$ | VREF startup time                            | BUFCONFIG = {0, 1}, VDD = 2.8 V                 | BUFCONFIG = {0, 1}, VDD = 2.8 V                 |     |     | 15  | us         |

(1) The temperature coefficient of the VREF output is the sum of  $TC_{VRBUF}$  and the temperature coefficient of the internal bandgap reference.

### 7.15.2 Electrical Characteristics (Comparator)

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

| PARAMETER    |  | TEST CONDITIONS                                 |   | MIN | TYP | MAX | UNIT       |
|--------------|--|---|---|-----|-----|-----|------------|
| $I_{VREF}$   | VREF operating supply current                | BUFCONFIG = {0, 1}, No load                     | BUFCONFIG = {0, 1}, No load                     |     | 80  | 100 | $\mu$ A    |
| $TC_{VREF}$  | Temperature coefficient of VREF (1)          | BUFCONFIG = {0, 1}                              | BUFCONFIG = {0, 1}                              |     |     | 75  | ppm/°C     |
| $TC_{drift}$ | Long term VREF drift                         | Time = 1000 hours, BUFCONFIG = {0, 1}, T = 25°C | Time = 1000 hours, BUFCONFIG = {0, 1}, T = 25°C |     |     | 300 | ppm        |
| $PSRR_{DC}$  | VREF Power supply rejection ratio, DC        | VDD = 1.7 V to VDDmax, BUFCONFIG = 1            | VDD = 1.7 V to VDDmax, BUFCONFIG = 1            |     | 69  |     | dB         |
| $PSRR_{DC}$  | VREF Power supply rejection ratio, DC        | VDD = 2.7 V to VDDmax, BUFCONFIG = 0            | VDD = 2.7 V to VDDmax, BUFCONFIG = 0            |     | 60  |     | dB         |
| $V_{noise}$  | RMS noise at VREF output (0.1 Hz to 100 MHz) | BUFFCONFIG = 1                                  | BUFFCONFIG = 1                                  |     | 500 |     | $\mu$ Vrms |
| $V_{noise}$  | RMS noise at VREF output (0.1 Hz to 100 MHz) | BUFFCONFIG = 0                                  | BUFFCONFIG = 0                                  |     | 750 |     | $\mu$ Vrms |

### 7.15.2 Electrical Characteristics (Comparator) (continued)

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

| PARAMETER            |                   | TEST CONDITIONS                 | MIN | TYP | MAX | UNIT |
|----------------------|-------------------|---------------------------------|-----|-----|-----|------|
| $T_{\text{startup}}$ | VREF startup time | BUFCONFIG = {0, 1}, VDD = 2.8 V |     |     | 15  | us   |

(1) The temperature coefficient of the VREF output is the sum of  $TC_{V_{\text{RBUF}}}$  and the temperature coefficient of the internal bandgap reference.

### 7.15.3 Voltage Characteristics (ADC)

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

| PARAMETER                    |  | TEST CONDITIONS | MIN  | TYP | MAX  | UNIT |
|------------------------------|--|-----------------|------|-----|------|------|
| $V_{\text{DD}_{\text{min}}}$ | Minimum supply voltage needed for VREF operation | BUFCONFIG = 0   | 2.7  |     |      | V    |
| $V_{\text{DD}_{\text{min}}}$ | Minimum supply voltage needed for VREF operation | BUFCONFIG = 1   | 1.62 |     |      | V    |
| VREF                         | Voltage reference output voltage                 | BUFCONFIG = 0   | 2.46 | 2.5 | 2.54 | V    |
| VREF                         | Voltage reference output voltage                 | BUFCONFIG = 1   | 1.38 | 1.4 | 1.42 | V    |

### 7.15.4 Voltage Characteristics (Comparator)

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

| PARAMETER                    |  | TEST CONDITIONS | MIN  | TYP | MAX  | UNIT |
|------------------------------|--|-----------------|------|-----|------|------|
| $V_{\text{DD}_{\text{min}}}$ | Minimum supply voltage needed for VREF operation | BUFCONFIG = 0   | 2.7  |     |      | V    |
| $V_{\text{DD}_{\text{min}}}$ | Minimum supply voltage needed for VREF operation | BUFCONFIG = 1   | 1.62 |     |      | V    |
| VREF                         | Voltage reference output voltage                 | BUFCONFIG = 0   | 2.46 | 2.5 | 2.54 | V    |
| VREF                         | Voltage reference output voltage                 | BUFCONFIG = 1   | 1.38 | 1.4 | 1.42 | V    |

## 7.16 Comparator (COMP)

### 7.16.1 Comparator Electrical Characteristics

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

| PARAMETER                                    |                                  | TEST CONDITIONS  | MIN | TYP | MAX | UNIT |
|--|----------------------------------|--|-----|-----|-----|------|
| <b>Comparator Electrical Characteristics</b> |                                  |  |     |     |     |      |
| $V_{\text{cm}}$                              | Common mode input range          |  | 0   |     | VDD | V    |
| $V_{\text{offset}}$                          | Input offset voltage             |  |     |     | ±20 | mV   |
| $V_{\text{hys}}$                             | DC input hysteresis              | HYST = 00h   |     | 0.4 |     | mV   |
|  |                                  | HYST = 01h   |     | 10  |     |      |
|  |                                  | HYST = 02h   |     | 20  |     |      |
|  |                                  | HYST = 03h   |     | 30  |     |      |
| $t_{\text{PD}_{\text{ls}}}$                  | Propagation delay, response time | Output Filter off, Overdrive = 100 mV, High Speed Mode                 |     | 32  | 50  | ns   |
|  |                                  | Output Filter off, Overdrive = 100 mV, Low Power Mode                  |     | 1.2 | 4   | μs   |
| $t_{\text{en}}$                              | Comparator enable time           | Startup time to reach propagation delay specification, High Speed Mode |     |     | 5   | μs   |
|  |                                  | Startup time to reach propagation delay specification, Low Power Mode  |     |     | 10  | μs   |

### 7.16.1 Comparator Electrical Characteristics (continued)

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

| PARAMETER                                   |   | TEST CONDITIONS   | MIN | TYP                         | MAX | UNIT     |
|---|---|---|-----|-----------------------------|-----|----------|
| I <sub>comp</sub>                           | Comparator current consumption.                   | V <sub>cm</sub> = VDD/2, 100mV overdrive, DAC output as a voltage reference, VDD is reference for DAC, High Speed Mode          |     | 130                         | 200 | μA       |
|   |   | V <sub>cm</sub> = VDD/2, 100mV overdrive, DAC output as a voltage reference, VDD is reference for DAC, Low Power Mode           |     | 0.85                        | 2.7 | μA       |
|   |   | V <sub>cm</sub> = VDD/2, 100mV overdrive, comparator only, High Speed Mode  |     | 120                         | 180 | μA       |
|   |   | V <sub>cm</sub> = VDD/2, 100mV overdrive, comparator only, Low Power Mode   |     | 0.7                         | 2.1 | μA       |
| I <sub>comp</sub>                           | Comparator +VREF current consumption in low power | V <sub>cm</sub> = VDD/2, 100mV overdrive, DAC output as a voltage reference, Internal VREF is reference for DAC, Low Power Mode |     | 1.5                         |     | μA       |
| <b>8-bit DAC Electrical Characteristics</b> |   |   |     |                             |     |          |
| V <sub>dac</sub>                            | DAC output range                                  |   | 0   |                             | VDD | V        |
| V <sub>dac-code</sub>                       | 8-bit DAC output voltage for a given code         | V <sub>IN</sub> = reference voltage into 8-bit DAC, code n = 0 to 255   |     | $V_{IN} \times (n+1) / 256$ |     | V        |
| INL   | Integral nonlinearity of 8-bit DAC                |   | -1  |                             | 1   | LSB      |
| DNL   | Differential nonlinearity of 8-bit DAC            |   | -1  |                             | 1   | LSB      |
| Gain error                                  | Gain error of 8-bit DAC                           | Reference voltage = VDD   | -2  |                             | 2   | % of FSR |
| Offset error                                | Offset error of 8-bit DAC                         |   | -5  |                             | 5   | mV       |
| t <sub>dac_settle</sub>                     | 8-bit DAC settling time in static mode            | DACCODE0 = 0 → 255, DAC output accurate to 1 LSB  |     | 1.5                         |     | μs       |

### 7.17 LCD

over operating free-air temperature range (unless otherwise noted)

| PARAMETERS                            |  | TEST CONDITIONS  | MIN  | TYP  | MAX | UNIT |
|---------------------------------------|--|--|------|------|-----|------|
| <b>LCD Electrical Characteristics</b> |  |  |      |      |     |      |
| V <sub>CC, LCD, CP en, 3.6</sub>      | Supply voltage range, charge pump enabled, V <sub>LCD</sub> ≤ 3.6 V                | LCDCPEN = 1, 0000 < VLCDx ≤ 1111, LCDREFEN = 1 (charge pump enabled, VLCD ≤ 3.6 V) | 1.62 |      | 3.6 | V    |
| Delta VLCD                            | 1/4 bias mode  | LCDCPEN = 1, 0000 < VLCDx ≤ 1111, LCDREFEN = 1 (charge pump enabled, VLCD ≤ 3.6 V) |      | 60   |     | mV   |
| Delta VLCD                            | 1/3 bias mode  | LCDCPEN = 1, 0000 < VLCDx ≤ 1111, LCDREFEN = 1 (charge pump enabled, VLCD ≤ 3.6 V) |      | 75   |     | mV   |
| V <sub>CC, LCD, ext. bias</sub>       | Supply voltage range, external biasing, charge pump enabled                        | LCDCPEN = 1, LCDREFEN = 0  | 1.62 |      | 3.6 | V    |
| V <sub>CC, LCD, VLCDEXT</sub>         | Supply voltage range, external LCD voltage, external biasing, charge pump disabled | LCDCPEN = 0, LCDSELVDD = 0   | 1.62 |      | 3.6 | V    |
| V <sub>R33</sub>                      | External LCD voltage at R33, external biasing, charge pump disabled                | LCDCPEN = 0, LCDSELVDD = 0   | 1.62 |      | 3.6 | V    |
| V <sub>R33</sub>                      | LCD voltage at R33, internal biasing, charge pump enabled                          | LCDCPEN=1, LCDSELVDD=0, LCDREFEN=1   | 2.4  |      | 3.8 | V    |
| C <sub>LCDCAP</sub>                   |  | +/-20% tolerance is recommended, ceramic caps X5R (Between LCDCAP0 and LCDCAP1)    |      | 0.47 |     | μF   |
| C <sub>R33</sub>                      |  | +/-20% tolerance is recommended, ceramic caps X5R                                  |      | 0.47 |     | μF   |

## 7.17 LCD (continued)

over operating free-air temperature range (unless otherwise noted)

| PARAMETERS                |   | TEST CONDITIONS  | MIN | TYP    | MAX | UNIT  |
|---------------------------|---|--|-----|--------|-----|-------|
| C <sub>R23</sub>          |   | +/-20% tolerance is recommended, ceramic caps X5R  |     | 0.47   |     | μF    |
| C <sub>R24</sub>          |   | +/-20% tolerance is recommended, ceramic caps X5R  |     | 0.47   |     | μF    |
| C <sub>R13</sub>          |   | +/-20% tolerance is recommended, ceramic caps X5R  |     | 0.47   |     | μF    |
| f <sub>Frame</sub>        | LCD frame frequency range   | f <sub>LCD</sub> = 2 × mux × f <sub>FRAME</sub> with mux = 1 (static), 2, 3, 4, 8  | 16  | 32     | 64  | Hz    |
| f <sub>LFCLK, in</sub>    | LFCLK input frequency range   | +/-10% accurate  |     | 32.768 |     | kHz   |
| C <sub>Panel</sub>        | Panel capacitance   | 32-Hz frame frequency  |     |        | 20  | nF    |
| V <sub>R33</sub>          | Analog input voltage at R33   | LCDCPEN = 0, LCDSELVDD = 0, LCDREFEN = 0   | 1.6 |        | 3.6 | V     |
| V <sub>R23, 1/3bias</sub> | Analog input voltage at R23 with 1/3 biasing  | LCDCPEN = 0, LCDSELVDD = 0, LCDREFEN = 0   | 1.1 |        | 2.4 | V     |
| V <sub>R23, 1/4bias</sub> | Analog input voltage at R23 with 1/4 biasing  | LCDCPEN = 0, LCDSELVDD = 0, LCDREFEN = 0   | 1.2 |        | 2.7 | V     |
| V <sub>R24, 1/4bias</sub> | Analog input voltage at R24 with 1/4 biasing  | LCDCPEN = 0, LCDSELVDD = 0, LCDREFEN = 0   | 0.8 |        | 1.8 | V     |
| V <sub>R13, 1/3bias</sub> | Analog input voltage at R13 with 1/3 biasing  | LCDCPEN = 0, LCDSELVDD = 0, LCDREFEN = 0   | 0   |        | 1.2 | V     |
| V <sub>R14, 1/4bias</sub> | Analog input voltage at R14 with 1/4 biasing  | LCDCPEN = 0, LCDSELVDD = 0, LCDREFEN = 0   | 0   |        | 0.9 | V     |
| V <sub>LCDREF/R13</sub>   | External LCD reference voltage applied at LCDREF/R13 for 1/4 bias mode  | LCDCPEN = 1, LCDSELVDD = 0, LCDREFEN = 0   | 0.6 |        | 0.9 | V     |
| V <sub>LCDREF/R13</sub>   | External LCD reference voltage applied at LCDREF/R13 for 1/3 bias mode  | LCDCPEN = 1, LCDSELVDD = 0, LCDREFEN = 0   | 0.8 |        | 1.2 | V     |
| Tamb                      | Operating Temperature Range   |  | -40 | 25     | 125 | deg C |
| IDD LCD                   | Stand by power - External Biasing (Mode 0), Vboost = OFF. External resistor ladder. 5% matched tolerance and less than 1% individual tolerance  | Vdd>=2.4V,LCDCPEN =0, LCDSELVDD=0,LCDSEL_VDD_R33=0,LCDINTBIASEN=0,LVDVERFEN=0, Vboost=OFF, External Supply on                        |     | 100    |     | nA    |
| IDD LCD                   | Stand by power - External Biasing (Mode 0), Vboost = ON, External resistor ladder. Current through resistor ladder is not accounted in spec. 5% matched tolerance and less than 1% individual tolerance | Vdd<2.4V,LCDCPEN =0, LCDSELVDD=0,LCDSEL_VDD_R33=0,LCDINTBIASEN=0,LVDVERFEN=0, Vboost=ON, External Supply on                          |     | 150    |     | nA    |
| IDD LCD                   | Stand by power - Internal Biasing (Mode 1). Enable VDD connection to R33 pin and add external resistor ladder. Current through resistor ladder is not accounted in spec                                 | LCDCPEN =0, LCDSELVDD=1,LCDSEL_VDD_R33=0,LCDINTBIASEN=0, LCDVREFEN =0( Internal reference disabled),Vboost= OFF, External Supply Off |     | 54     |     | uA    |
| IDD LCD                   | Stand by power - External Biasing (Mode 2). Check for LCD_HP_LP=0/1 and LCDBIASSEL=0/1  | LCDCPEN =0, LCDSELVDD=0,LCDSEL_VDD_R33=0,LCDINTBIASEN=1, LCDVREFEN =0( Internal reference disabled),Vboost= OFF, External Supply on  |     | 100    |     | nA    |

## 7.17 LCD (continued)

over operating free-air temperature range (unless otherwise noted)

| PARAMETERS |  | TEST CONDITIONS  | MIN | TYP | MAX | UNIT |
|------------|--|--|-----|-----|-----|------|
| IDD LCD    | Stand by power - Internal Biasing (Mode 3). Check for LCD_HP_LP=0/1 and LCDBIASSEL=0/1. AVDD connected to internal ladder used to generate voltages          | LCDCPEN =0, LCDSELVDD=0, LCDSEL_VDD_R33=1, LCDINTBIASEN=1, LCDVREFEN =0( Internal reference disabled), Vboost= OFF, External Supply off                |     | 57  |     | uA   |
| IDD LCD    | Stand by power - External Biasing (Mode 4). Check for LCDBIASSEL=0/1. Vext connected to R33. CP used to generate voltage fractions                           | LCDCPEN =1, LCDSELVDD=0, LCDSEL_VDD_R33=0, LCDINTBIASEN=0, LCDVREFEN =0( Internal reference disabled), Vboost= OFF, External Supply on                 |     | 200 |     | nA   |
| IDD LCD    | Stand by power - Internal Biasing (Mode 5). Check for LCDBIASSEL=0/1. AVDD connected to R33. CP used to generate voltage fractions. LOADCAP0/1 are connected | LCDCPEN =1, LCDCPFSELx=0x2 LCDSELVDD=1, LCDSEL_VDD_R33=1, LCDINTBIASEN=0, LCDVREFEN =0( Internal reference disabled), Vboost= OFF, External Supply off |     | 300 |     | nA   |
| IDD LCD    | Stand by power - External Biasing (Mode 6). CP used to generate 1/3 and 1/4 voltage fractions. Vext connected to R13. LOADCAP0/1 are connected               | LCDCPEN =1, LCDSELVDD=0, LCDSEL_VDD_R33=1, LCDINTBIASEN=0, LCDVREFEN =0( Internal reference disabled), Vboost= OFF, External Supply on                 |     | 200 |     | nA   |
| IDD LCD    | Stand by power - Internal Biasing (Mode 7). CP used to generate 1/3 and 1/4 voltage fractions. LOADCAP0/1 are connected. Vboost = OFF                        | LCDCPEN =1, LCDCPFSELx=0x2, VLCDx=3V LCDSELVDD=0, LCDSEL_VDD_R33=1, LCDINTBIASEN=0, LCDVREFEN =1( Internal reference enabled), LCDREFMODE =0/1         |     | 1.2 |     | μA   |
| IDD LCD    | Stand by power - Internal Biasing (Mode 7). CP used to generate 1/3 and 1/4 voltage fractions. LOADCAP0/1 are connected. Vboost = ON                         | LCDCPEN =1, LCDCPFSELx=0x2, VLCDx=3V LCDSELVDD=0, LCDSEL_VDD_R33=1, LCDINTBIASEN=0, LCDVREFEN =1( Internal reference enabled), LCDREFMODE =0/1         |     | 1.5 |     | μA   |

## 7.18 I2C

### 7.18.1 I2C Characteristics

over operating free-air temperature range (unless otherwise noted)

| PARAMETERS          |  | TEST CONDITIONS | Standard mode |      | Fast mode |     | Fast mode plus |      | UNIT |
|---------------------|--|-----------------|---------------|------|-----------|-----|----------------|------|------|
|                     |  |                 | MIN           | MAX  | MIN       | MAX | MIN            | MAX  |      |
| f <sub>I2C</sub>    | I2C input clock frequency                        |                 | 2             | 32   | 8         | 32  | 20             | 32   | MHz  |
| f <sub>SCL</sub>    | SCL clock frequency                              |                 | 0.025         | 0.1  |           | 0.4 |                | 1    | MHz  |
| t <sub>HD,STA</sub> | Hold time (repeated) START                       |                 | 4             |      | 0.6       |     | 0.26           |      | us   |
| t <sub>LOW</sub>    | LOW period of the SCL clock                      |                 | 4.7           |      | 1.3       |     | 0.5            |      | us   |
| t <sub>HIGH</sub>   | High period of the SCL clock                     |                 | 4             |      | 0.6       |     | 0.26           |      | us   |
| t <sub>SU,STA</sub> | Setup time for a repeated START                  |                 | 4.7           |      | 0.6       |     | 0.26           |      | us   |
| t <sub>HD,DAT</sub> | Data hold time                                   |                 | 0             |      | 0         |     | 0              |      | ns   |
| t <sub>SU,DAT</sub> | Data setup time                                  |                 | 250           |      | 100       |     | 50             |      | ns   |
| t <sub>SU,STO</sub> | Setup time for STOP                              |                 | 4             |      | 0.6       |     | 0.26           |      | us   |
| t <sub>BUF</sub>    | bus free time between a STOP and START condition |                 | 4.7           |      | 1.3       |     | 0.5            |      | us   |
| t <sub>VD,DAT</sub> | data valid time                                  |                 |               | 3.45 |           | 0.9 |                | 0.45 | us   |

### 7.18.1 I2C Characteristics (continued)

over operating free-air temperature range (unless otherwise noted)

| PARAMETERS   |                             | TEST CONDITIONS | Standard mode |     | Fast mode |     | Fast mode plus |     | UNIT |
|--------------|-----------------------------|-----------------|---------------|-----|-----------|-----|----------------|-----|------|
|              |                             |                 | MIN           | MAX | MIN       | MAX | MIN            | MAX |      |
| $t_{VD,ACK}$ | data valid acknowledge time |                 | 3.45          |     | 0.9       |     | 0.45           |     | us   |

### 7.18.2 I2C Filter

over operating free-air temperature range (unless otherwise noted)

| PARAMETERS |   | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|------------|---|-----------------|-----|-----|-----|------|
| $f_{SP}$   | Pulse duration of spikes suppressed by input filter | AGFSELx = 0     |     | 6   |     | ns   |
|            |   | AGFSELx = 1     |     | 14  | 35  | ns   |
|            |   | AGFSELx = 2     |     | 22  | 60  | ns   |
|            |   | AGFSELx = 3     |     | 35  | 90  | ns   |

### 7.18.3 I<sup>2</sup>C Timing Diagram

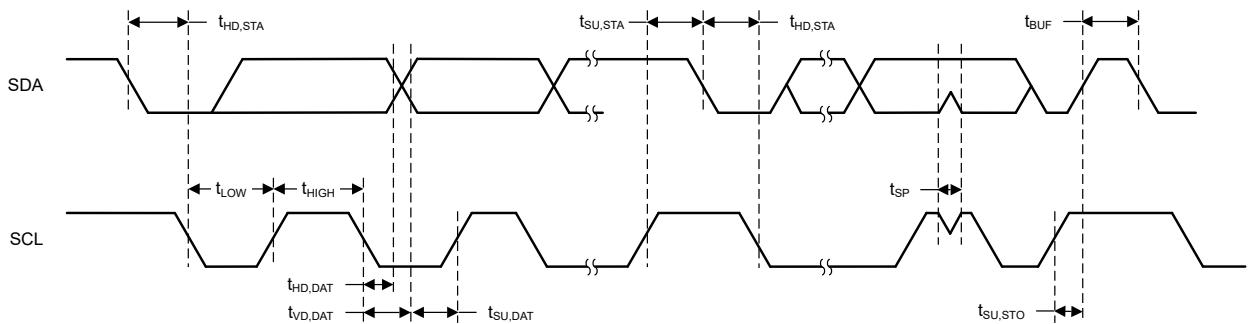


Figure 7-4. I2C Timing Diagram

## 7.19 SPI

### 7.19.1 SPI

over operating free-air temperature range (unless otherwise noted)

| PARAMETERS        |  | TEST CONDITIONS   | MIN               | TYP           | MAX               | UNIT |
|-------------------|--|---|-------------------|---------------|-------------------|------|
| <b>SPI</b>        |  |   |                   |               |                   |      |
| $f_{SPI}$         | SPI clock frequency                        | Clock max speed = 32MHz<br>1.62 < VDD < 3.6V<br>Controller mode |                   |               | 16                | MHz  |
| $f_{SPI}$         | SPI clock frequency                        | Clock max speed = 32MHz<br>1.62 < VDD < 3.6V<br>Peripheral mode |                   |               | 16                | MHz  |
| $DC_{SCK}$        | SCK Duty Cycle                             |   | 40                | 50            | 60                | %    |
| <b>Controller</b> |  |   |                   |               |                   |      |
| $t_{SCLK\_H/L}$   | SCLK High or Low time                      |   | $(t_{SPI}/2) - 1$ | $t_{SPI} / 2$ | $(t_{SPI}/2) + 1$ | ns   |
| $t_{CS.LEAD}$     | CS lead-time, CS active to clock           | SPH=0   | 1 SPI<br>Clock    |               |                   | ns   |
| $t_{CS.LEAD}$     | CS lead-time, CS active to clock           | SPH=1   | 1/2 SPI<br>Clock  |               |                   | ns   |
| $t_{CS.LAG}$      | CS lag time, Last clock to CS inactive     |   | 1 SPI<br>Clock    |               |                   | ns   |
| $t_{CS.ACC}$      | CS access time, CS active to PICO data out |   |                   |               | 1/2 SPI<br>Clock  | ns   |

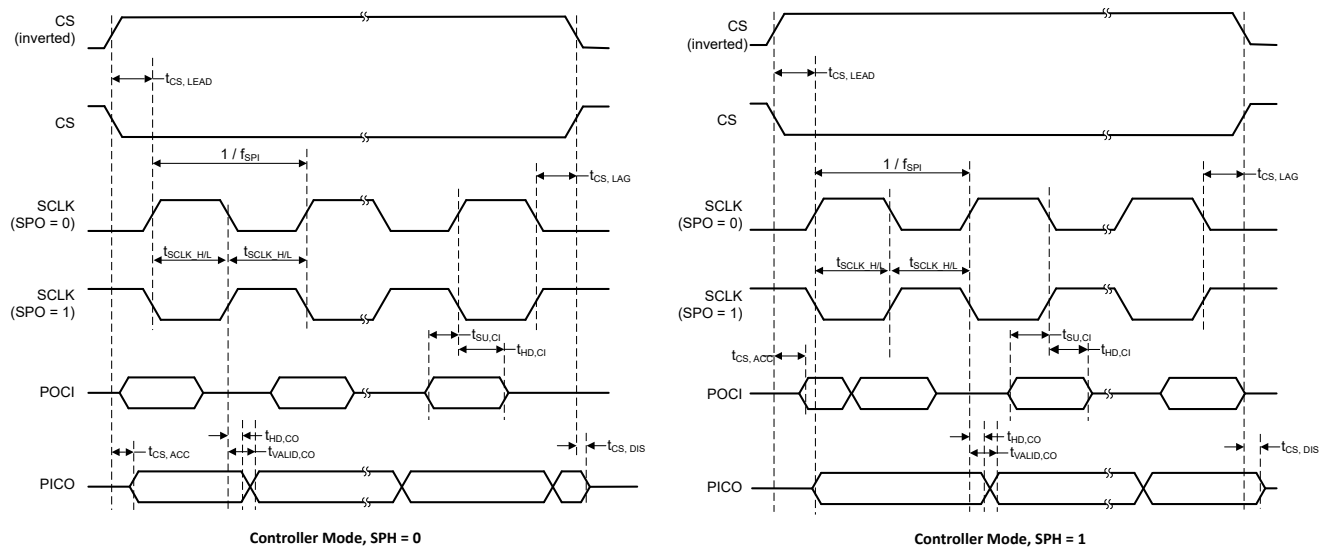
### 7.19.1 SPI (continued)

over operating free-air temperature range (unless otherwise noted)

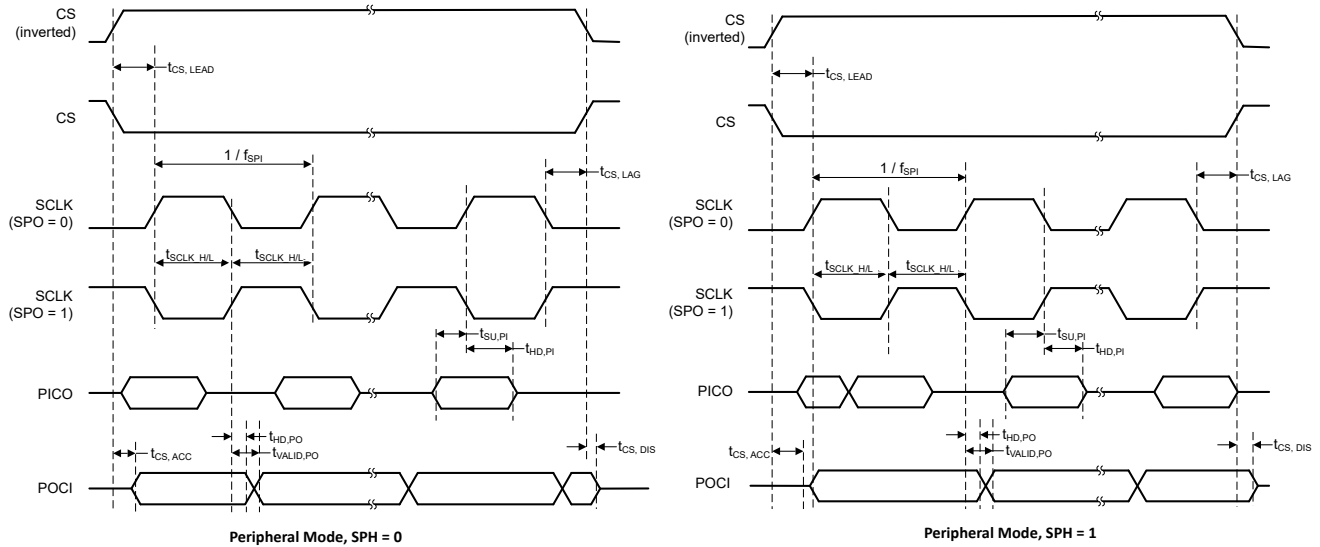
| PARAMETERS        |   | TEST CONDITIONS                             | MIN | TYP | MAX         | UNIT |
|-------------------|---|---|-----|-----|-------------|------|
| $t_{CS.DIS}$      | CS disable time, CS inactive to PICO high impedance |   |     |     | 1 SPI Clock | ns   |
| $t_{SU,CI}$       | POCI input data setup time (1)                      | 2.7 < VDD < 3.6V, delayed sampling enabled  | 1   |     |             | ns   |
| $t_{SU,CI}$       | POCI input data setup time (1)                      | 1.62 < VDD < 2.7V, delayed sampling enabled | 1   |     |             | ns   |
| $t_{SU,CI}$       | POCI input data setup time (1)                      | 2.7 < VDD < 3.6V, no delayed sampling       | 29  |     |             | ns   |
| $t_{SU,CI}$       | POCI input data setup time (1)                      | 1.62 < VDD < 2.7V, no delayed sampling      | 37  |     |             | ns   |
| $t_{HD,CI}$       | POCI input data hold time                           | delayed sampling enabled                    | 24  |     |             | ns   |
| $t_{HD,CI}$       | POCI input data hold time                           | no delayed sampling enabled                 | 0   |     |             | ns   |
| $t_{VALID,CO}$    | PICO output data valid time (2)                     |   |     |     | 10          | ns   |
| $t_{HD,CO}$       | PICO output data hold time (3)                      |   | 6   |     |             | ns   |
| <b>Peripheral</b> |   |   |     |     |             |      |
| $t_{CS.LEAD}$     | CS lead-time, CS active to clock                    |   | 11  |     |             | ns   |
| $t_{CS.LAG}$      | CS lag time, Last clock to CS inactive              |   | 1   |     |             | ns   |
| $t_{CS.ACC}$      | CS access time, CS active to POCI data out          |   |     |     | 26          | ns   |
| $t_{CS.DIS}$      | CS disable time, CS inactive to POCI high impedance |   |     |     | 26          | ns   |
| $t_{SU,PI}$       | PICO input data setup time                          |   | 7   |     |             | ns   |
| $t_{HD,PI}$       | PICO input data hold time                           |   | 0   |     |             | ns   |
| $t_{VALID,PO}$    | POCI output data valid time(2)                      | 2.7 < VDD < 3.6V                            |     |     | 25          | ns   |
| $t_{VALID,PO}$    | POCI output data valid time(2)                      | 1.62 < VDD < 2.7V                           |     |     | 31          | ns   |
| $t_{HD,PO}$       | POCI output data hold time(3)                       |   | 5   |     |             | ns   |

- (1) The POCI input data setup time can be fully compensated when delayed sampling feature is enabled.
- (2) Specifies the time to drive the next valid data to the output after the output changing SCLK clock edge
- (3) Specifies how long data on the output is valid after the output changing SCLK clock edge

### 7.19.2 SPI Timing Diagram



**Figure 7-5. SPI Timing Diagram - Controller Mode**



**Figure 7-6. SPI Timing Diagram - Peripheral Mode**

## 7.20 UART

over operating free-air temperature range (unless otherwise noted)

| PARAMETERS          |   | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---------------------|---|-----------------|-----|-----|-----|------|
| $f_{\text{UART}}$   | UART input clock frequency                          |                 |     |     | 32  | MHz  |
| $f_{\text{BITCLK}}$ | BITCLK clock frequency (equals baud rate in MBaud)  |                 |     |     | 4   | MHz  |
| $t_{\text{SP}}$     | Pulse duration of spikes suppressed by input filter | AGFSELx = 0     |     | 6   |     | ns   |
| $t_{\text{SP}}$     | Pulse duration of spikes suppressed by input filter | AGFSELx = 1     |     | 14  | 35  | ns   |
| $t_{\text{SP}}$     | Pulse duration of spikes suppressed by input filter | AGFSELx = 2     |     | 22  | 60  | ns   |
| $t_{\text{SP}}$     | Pulse duration of spikes suppressed by input filter | AGFSELx = 3     |     | 35  | 90  | ns   |

## 7.21 TIMx

over operating free-air temperature range (unless otherwise noted)

| PARAMETERS           |                             | TEST CONDITIONS                     | MIN     | TYP | MAX            | UNIT                 |
|----------------------|-----------------------------|-------------------------------------|---------|-----|----------------|----------------------|
| $t_{\text{res}}$     | Timer resolution time       | $f_{\text{TIMxCLK}} = 32\text{MHz}$ | 31.25   |     |                | ns                   |
|                      |                             |                                     | 1       |     |                | $t_{\text{TIMxCLK}}$ |
| $t_{\text{res}}$     | Timer resolution time       | TIMx with 16bit counter             |         |     | 16             | bit                  |
| $t_{\text{res}}$     | Timer resolution time       | TIMx with 32bit counter             |         |     | 32             | bit                  |
| $t_{\text{COUNTER}}$ | 32-bit counter clock period | $f_{\text{TIMxCLK}} = 32\text{MHz}$ | 0.03125 |     | 134.21         | s                    |
|                      |                             |                                     | 1       |     | 42949672<br>96 | $t_{\text{TIMxCLK}}$ |
| $t_{\text{COUNTER}}$ | 16-bit counter clock period | $f_{\text{TIMxCLK}} = 32\text{MHz}$ | 0.03125 |     | 2048           | us                   |
|                      |                             |                                     | 1       |     | 65536          | $t_{\text{TIMxCLK}}$ |

## 7.22 TRNG

### 7.22.1 TRNG Electrical Characteristics

over operating free-air temperature range (unless otherwise noted)

| PARAMETER             |                     | TEST CONDITIONS    | MIN | TYP | MAX | UNIT |
|-----------------------|---------------------|--------------------|-----|-----|-----|------|
| TRNG <sub>I</sub> ACT | TRNG active current | TRNG clock = 20MHz |     | 115 |     | μA   |

### 7.22.2 TRNG Switching Characteristics

over operating free-air temperature range (unless otherwise noted)

| PARAMETER               |                                     | TEST CONDITIONS                          | MIN | TYP  | MAX | UNIT |
|-------------------------|-------------------------------------|--|-----|------|-----|------|
| TRNGCLK <sub>F</sub>    | TRNG input clock frequency          |  | 9.5 | 10   | 25  | MHz  |
| TRNG <sub>STARTUP</sub> | TRNG startup time                   |  |     | 520  |     | μs   |
| TRNG <sub>LAT32</sub>   | Latency to generate 32 random bits  | Decimation ratio = 4, TRNG clock = 20MHz |     | 6.4  |     | μs   |
| TRNG <sub>LAT256</sub>  | Latency to generate 256 random bits | Decimation ratio = 4, TRNG clock = 20MHz |     | 51.2 |     | μs   |

## 7.23 Emulation and Debug

### 7.23.1 SWD Timing

over operating free-air temperature range (unless otherwise noted)

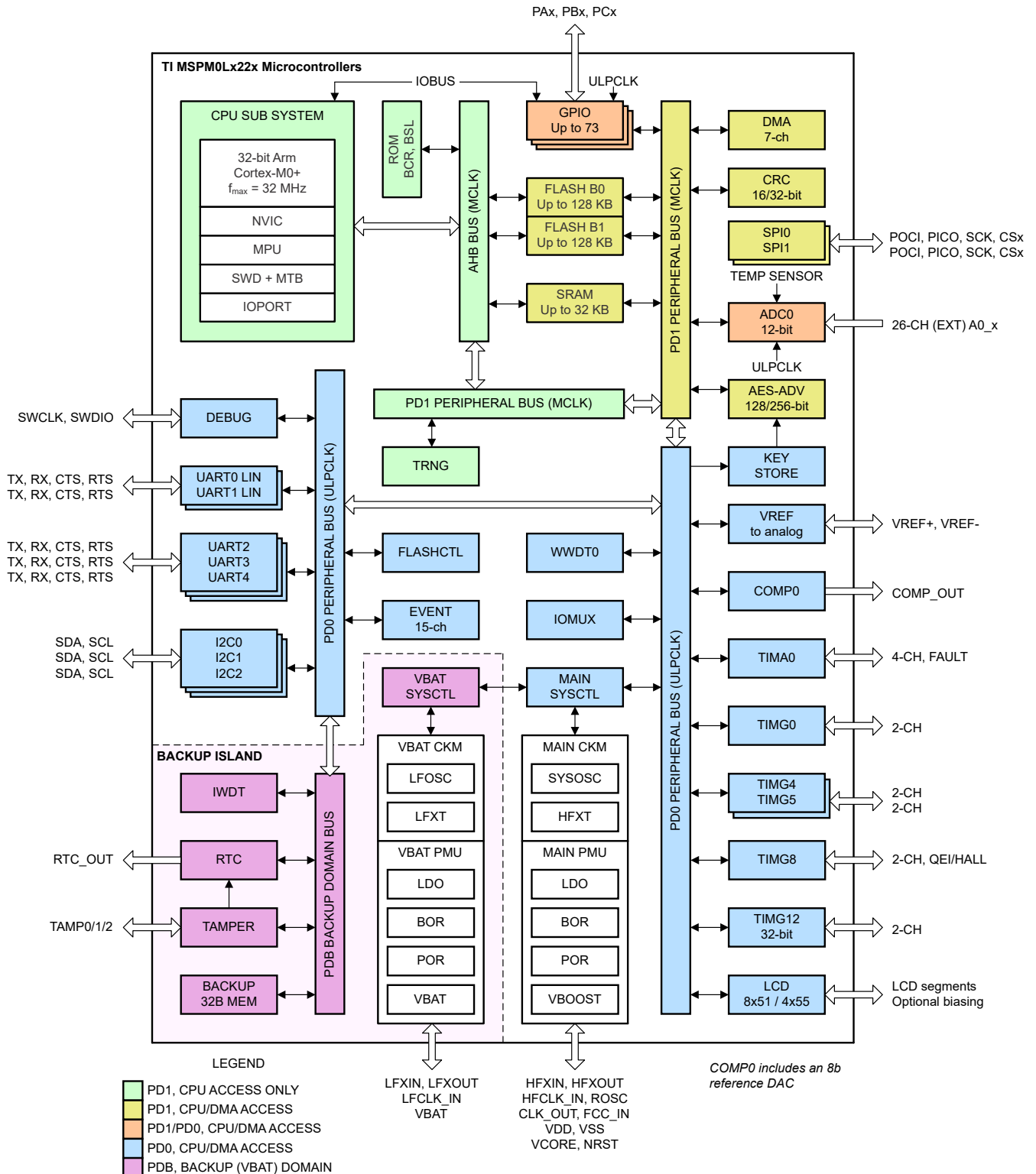
| PARAMETER        |               | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|------------------|---------------|-----------------|-----|-----|-----|------|
| f <sub>SWD</sub> | SWD frequency |                 |     |     | 10  | MHz  |

## 8 Detailed Description

The following sections describe all of the components that make up the devices in this data sheet. The peripherals integrated into these devices are configured by software through Memory Mapped Registers (MMRs). For more details, see the corresponding chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

### 8.1 Functional Block Diagram

[Figure 8-1](#) shows the functional block diagram.



**Figure 8-1. MSPM0Lx22x Functional Block Diagram**

## 8.2 CPU

The CPU subsystem (MCPUSS) implements an Arm Cortex-M0+ CPU, an instruction pre-fetch/cache, a system timer, a memory protection unit, and interrupt management features. The Arm Cortex-M0+ is a cost-optimized,

32-bit CPU which delivers high performance and low power to embedded applications. Key features of the CPU Sub System include:

- Arm Cortex-M0+ CPU supporting clock frequencies up to 32kHz
  - ARMv6-M Thumb instruction set (little endian) with single-cycle 32×32 multiply instruction
  - Single-cycle access to GPIO registers through Arm single-cycle IO port
- Pre-fetch logic to improve sequential code execution, and I-cache with four 64-bit cache lines
- System timer (SysTick) with 24-bit down counter and automatic reload
- Memory protection unit (MPU) with 8 programmable regions
- Nested vectored interrupt controller (NVIC) with 4 programmable priority levels and tail-chaining
- Interrupt groups for expanding the total interrupt sources, with jump index for low interrupt latency

### 8.3 Operating Modes

MSPM0 MCUs provide five main operating modes (power modes) to allow for optimization of the device power consumption based on application requirements. In order of decreasing power, the modes are: RUN, SLEEP, STOP, STANDBY, and SHUTDOWN. The CPU is active executing code in RUN mode. Peripheral interrupt events can wake the device from SLEEP, STOP, or STANDBY mode to the RUN mode. SHUTDOWN mode completely disables the internal core regulator to minimize power consumption, and wake is only possible via NRST, SWD, or a logic level match on certain IOs. RUN, SLEEP, STOP, and STANDBY modes also include several configurable policy options (for example, RUN.x) for balancing performance with power consumption.

To further balance performance and power consumption, MSPM0 devices implement two power domains: **PD1** (for the CPU, memories, and high performance peripherals), and **PD0** (for low speed, low power peripherals).

- **PD1** is always powered in RUN and SLEEP modes, but is disabled in all other modes.
- **PD0** is always powered in RUN, SLEEP, STOP, and STANDBY modes.
- PD1 and PD0 are both disabled in SHUTDOWN mode.
- PDB ( for VBAT island) is operational irrespective of mode.

#### 8.3.1 Functionality by Operating Mode (MSPM0Lx22x)

Supported functionality in each operating mode is given in [Table 8-1](#).

Functional key:

- **EN**: The function is enabled in the specified mode.
  - **DIS**: The function is disabled (either clock or power gated) in the specified mode, but the function's configuration is retained.
  - **OPT**: The function is optional in the specified mode, and remains enabled if configured to be enabled.
  - **NS**: The function is not automatically disabled in the specified mode but is not supported.
  - **OFF**: The function is fully powered off in the specified mode, and no configuration information is retained.
- When waking up from an OFF state, all module registers must be re-configured to the desired settings by application software.

**Table 8-1. Supported Functionality by Operating Mode**

| OPERATING MODE |               | RUN                |      |      | SLEEP  |        |        | STOP               |       |       | STANDBY  |          | SHUTDOWN |
|----------------|---------------|--------------------|------|------|--------|--------|--------|--------------------|-------|-------|----------|----------|----------|
|                |               | RUN0               | RUN1 | RUN2 | SLEEP0 | SLEEP1 | SLEEP2 | STOP0              | STOP1 | STOP2 | STANDBY0 | STANDBY1 |          |
| Oscillators    | SYSOSC        | EN                 | EN   | DIS  | EN     | EN     | DIS    | OPT <sup>(1)</sup> | EN    | DIS   | DIS      | DIS      | OFF      |
|                | LFOSC or LFXT | EN (LFOSC or LFXT) |      |      |        |        |        |                    |       |       |          |          | EN       |
|                | HFXT          | OPT                | DIS  | DIS  | OPT    | DIS    | DIS    | DIS                | DIS   | DIS   | DIS      | DIS      | DIS      |

**Table 8-1. Supported Functionality by Operating Mode (continued)**

| OPERATING MODE  |   | RUN        |       |       | SLEEP  |        |                          | STOP                |       |           | STANDBY  |          | SHUTDOWN |
|-----------------|---|------------|-------|-------|--------|--------|--------------------------|---------------------|-------|-----------|----------|----------|----------|
|                 |   | RUN0       | RUN1  | RUN2  | SLEEP0 | SLEEP1 | SLEEP2                   | STOP0               | STOP1 | STOP2     | STANDBY0 | STANDBY1 |          |
| Clocks          | CPUCLK  | 32MHz      | 32kHz | 32kHz | DIS    |        |                          |                     |       |           |          |          | OFF      |
|                 | MCLK to PD1   | 32MHz      | 32kHz | 32kHz | 32MHz  | 32kHz  | 32kHz                    | DIS                 |       |           |          |          | OFF      |
|                 | ULPCLK to PD0                                       | 32MHz      | 32kHz | 32kHz | 32MHz  | 32kHz  | 32kHz                    | 4MHz <sup>(1)</sup> | 4MHz  | 32kHz     | DIS      | OFF      |          |
|                 | ULPCLK to TIMG0, TIMG4, TIMG5, TIMG8, TIMG12, TIMA0 | 32MHz      | 32kHz | 32kHz | 32MHz  | 32kHz  | 32kHz                    | 4MHz <sup>(1)</sup> | 4MHz  | 32kHz     |          | OFF      |          |
|                 | MFCLK   | OPT        | DIS   |       | OPT    | DIS    |                          | OPT                 |       | DIS       |          | OFF      |          |
|                 | MFPCLK  | OPT        | DIS   |       | OPT    | DIS    |                          | OPT                 |       | DIS       |          | OFF      |          |
|                 | LFCLK   | 32kHz      |       |       |        |        |                          |                     |       |           |          | DIS      | OFF      |
|                 | LFCLK to TIMG0, TIMG4, TIMG5, TIMG8, TIMG12, TIMA0  | 32kHz      |       |       |        |        |                          |                     |       |           |          | OFF      |          |
|                 | LFCLK Monitor                                       | OPT        |       |       |        |        |                          |                     |       |           |          | OFF      |          |
|                 | MCLK Monitor  | OPT        |       |       |        |        |                          |                     |       |           |          | DIS      | OFF      |
| PMU             | POR monitor   | EN         |       |       |        |        |                          |                     |       |           |          |          |          |
|                 | BOR monitor   | EN         |       |       |        |        |                          |                     |       |           |          | OFF      |          |
|                 | Core regulator                                      | FULL DRIVE |       |       |        |        | REDUCED DRIVE            |                     |       | LOW DRIVE |          | OFF      |          |
| VBAT            | POR monitor   | EN         |       |       |        |        |                          |                     |       |           |          |          |          |
|                 | BOR monitor   | EN         |       |       |        |        |                          |                     |       |           |          |          |          |
|                 | Core regulator                                      | EN         |       |       |        |        |                          |                     |       |           |          |          |          |
| Core Functions  | CPU   | EN         |       |       | DIS    |        |                          |                     |       |           |          |          | OFF      |
|                 | DMA   | OPT        |       |       |        |        | DIS (triggers supported) |                     |       |           |          |          | OFF      |
|                 | Flash   | EN         |       |       |        |        | DIS                      |                     |       |           |          |          | OFF      |
|                 | SRAM  | EN         |       |       |        |        | DIS                      |                     |       |           |          |          | OFF      |
| PD1 Peripherals | CRC   | OPT        |       |       |        |        |                          |                     |       |           |          | OFF      |          |
|                 | SPI0, SPI1  | OPT        |       |       |        |        |                          |                     |       |           |          | OFF      |          |
|                 | AESADV  | OPT        |       |       |        |        |                          |                     |       |           |          | OFF      |          |

**Table 8-1. Supported Functionality by Operating Mode (continued)**

| OPERATING MODE      |  | RUN  |           |      | SLEEP     |        |           | STOP                    |       |       | STANDBY            |                        | SHUTDOWN |
|---------------------|--|------|-----------|------|-----------|--------|-----------|-------------------------|-------|-------|--------------------|------------------------|----------|
|                     |  | RUN0 | RUN1      | RUN2 | SLEEP0    | SLEEP1 | SLEEP2    | STOP0                   | STOP1 | STOP2 | STANDBY0           | STANDBY1               |          |
| PD0<br>Peripherals  | Keystore                                       | OPT  |           |      |           |        |           |                         |       |       |                    | OFF                    |          |
|                     | UART0,<br>UART1,<br>UART2,<br>UART3,<br>UART4  | OPT  |           |      |           |        |           |                         |       |       | OPT <sup>(2)</sup> | OFF                    |          |
|                     | I2C0, I2C1                                     | OPT  |           |      |           |        |           |                         |       |       | OPT <sup>(2)</sup> | OFF                    |          |
|                     | TIMG0,<br>TIMG4,<br>TIMG5,<br>TIMG8,<br>TIMG12 | OPT  |           |      |           |        |           |                         |       |       |                    | OFF                    |          |
|                     | TIMA0  | OPT  |           |      |           |        |           |                         |       |       |                    | OFF                    |          |
|                     | COMP0  | OPT  |           |      |           |        |           |                         |       |       |                    | OFF                    |          |
|                     | LCD  | OPT  |           |      |           |        |           |                         |       |       |                    | OFF                    |          |
|                     | GPIOA,<br>GPIOB,<br>GPIOC <sup>(3)</sup>       | OPT  |           |      |           |        |           |                         |       |       | OPT <sup>(2)</sup> | OFF                    |          |
|                     | WWDTO  | OPT  |           |      |           |        |           |                         |       |       | DIS                | OFF                    |          |
| LFSS<br>Peripherals | IWDT   | OPT  |           |      |           |        |           |                         |       |       |                    | OPT                    |          |
|                     | RTC_A  | OPT  |           |      |           |        |           |                         |       |       |                    | OPT                    |          |
|                     | Tamper I/O,<br>SPM                             | OPT  |           |      |           |        |           |                         |       |       |                    | OPT                    |          |
| Analog              | TRNG   | OPT  |           |      |           |        |           |                         |       |       |                    | OFF                    |          |
|                     | ADC0 <sup>(3)</sup>                            | OPT  |           |      |           |        |           | NS (triggers supported) |       |       |                    | OFF                    |          |
|                     | COMP0  | OPT  | OPT (ULP) | OPT  | OPT (ULP) | OPT    | OPT (ULP) |                         |       |       | OFF                |                        |          |
|                     | Temperature<br>Sensor                          | OPT  |           |      |           |        |           |                         |       |       | OFF                | OFF                    |          |
| IOMUX and IO Wakeup |  | EN   |           |      |           |        |           |                         |       |       |                    | DIS w/<br>WAKE         |          |
| Wake Sources        |  | N/A  |           |      | ANY IRQ   |        |           | PD0 IRQ                 |       |       |                    | IOMUX,<br>NRST,<br>SWD |          |

- (1) If STOP0 is entered from RUN1 (SYSOSC enabled but MCLK sourced from LFCLK), SYSOSC remains enabled as in RUN1, and ULPClk remains at 32kHz as in RUN1. If STOP0 is entered from RUN2 (SYSOSC was disabled and MCLK was sourced from LFCLK), SYSOSC remains disabled as in RUN2, and ULPClk remains at 32kHz as in RUN2.
- (2) When using the STANDBY1 policy for STANDBY, all TIMx instances and the RTC are clocked. Other PD0 peripherals can generate an asynchronous fast clock request upon external activity but are not actively clocked.
- (3) For ADCx and GPIO Ports A, B and C, the digital logic is in PD0 and the register interface is in PD1. These peripherals support fast single-cycle register access when PD1 is active and also support basic operation down to STANDBY mode where PD0 is still active.

## 8.4 Security

This [PSA-L1 certified](#) device offers several security features, including:

- Debug security
- Device identify
- Crypto acceleration
- True random number generation
- Flash write-erase protection
- Flash read-execute protection
- Flash IP protection
- SRAM write-execute mutual exclusion
- Secure boot
- Secure firmware update

- Secure key storage
- Customer secure code
- Hardware monotonic counter

For more details, see the Security chapter of the .

## 8.5 Power Management Unit (PMU)

The power management unit (PMU) generates the internally regulated core supplies for the device and provides supervision of the external supply (VDD). The PMU also contains the bandgap voltage reference used by the PMU itself as well as analog peripherals. Key features of the PMU include:

- Power-on reset (POR) supply monitor
- Brown-out reset (BOR) supply monitor with early warning capability using three programmable thresholds
- Core regulator with support for RUN, SLEEP, STOP, and STANDBY mode to dynamically balance performance with power consumption
- Parity-protected trim to immediately generate a power-on reset (POR) in the event that a power management trim is corrupted

For more details, see the PMU chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

## 8.6 Clock Module (CKM)

The clock module provides the following oscillators:

- **LFOSC**: Internal low-frequency oscillator (32kHz)
- **SYSCOSC**: Internal high-frequency oscillator (4MHz or 32MHz with factory trim, 16MHz or 24MHz with user trim)
- **LFXT/LFCKIN** : low-frequency external crystal oscillator or digital clock input (32kHz)
- **HFXT/HFCKIN**: high-frequency external crystal oscillator or digital clock input (4MHz to 32MHz)

The following clocks are distributed by the clock module for use by the processor, bus, and peripherals:

- **MCLK**: Main system clock for PD1 peripherals, derived from SYSCOSC, LFCLK, or HSCLK, active in RUN and SLEEP modes
- **CPUCLK**: Clock for the processor (derived from MCLK), active in RUN mode
- **ULPCLK**: Ultra-low power clock for PD0 peripherals, active in RUN, SLEEP, STOP, and STANDBY modes
- **MFCLK**: 4MHz fixed mid-frequency clock for peripherals, available in RUN, SLEEP, and STOP modes
- **MFPCCLK**: 4MHz fixed mid-frequency precision clock, available in RUN, SLEEP, and STOP modes
- **LFCLK**: 32kHz fixed low-frequency clock for peripherals or MCLK, active in RUN, SLEEP, STOP, and STANDBY modes
- **ADCCLK**: ADC clock, available in RUN, SLEEP and STOP modes
- **CLK\_OUT**: Used to output a clock externally, available in RUN, SLEEP, STOP, and STANDBY modes
- **HFCLK**: High frequency clock derived from HFXT or HFCLK\_IN, available in RUN and SLEEP mode
- **HSCLK**: High speed clock derived from HFCLK or the SYSPLL, available in RUN and SLEEP mode

For more details, see the CKM chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

## 8.7 DMA

The direct memory access (DMA) controller allows movement of data from one memory address to another without CPU intervention. For example, the DMA can be used to move data from ADC conversion memory to SRAM. The DMA reduces system power consumption by allowing the CPU to remain in low power mode, without having to awaken to move data to or from a peripheral.

The DMA in these devices support the following key features:

- 7 independent DMA transfer channels
- Configurable DMA channel priorities

- Byte (8-bit), short word (16-bit), word (32-bit) and long word (64-bit) or mixed byte and word transfer capability
- Transfer counter block size supports up to 64k transfers of any data type
- Configurable DMA transfer trigger selection
- Active channel interruption to service other channels
- Early interrupt generation for ping-pong buffer architecture
- Cascading channels upon completion of activity on another channel
- Stride mode to support data re-organization, such as 3-phase metering applications

Table 8-2 lists the available triggers for the DMA which are configured using the DMACTL.DMATSEL control bits in the DMA memory mapped registers.

**Table 8-2. DMA Trigger Mapping**

| DMACTL.DMATSEL | TRIGGER SOURCE                | DMACTL.DMATSEL | TRIGGER SOURCE    |
|----------------|-------------------------------|----------------|-------------------|
| 0              | Software                      | 13             | SPI1 Publisher 1  |
| 1              | Generic Subscriber 0 (FSUB_0) | 14             | SPI1 Publisher 2  |
| 2              | Generic Subscriber 0 (FSUB_1) | 15             | UART0 Publisher 1 |
| 3              | AES Publisher 1               | 16             | UART0 Publisher 2 |
| 4              | AES Publisher 1               | 17             | UART1 Publisher 1 |
| 5              | I2C0 Publisher 1              | 18             | UART1 Publisher 2 |
| 6              | I2C0 Publisher 2              | 19             | UART2 Publisher 1 |
| 7              | I2C1 Publisher 1              | 20             | UART2 Publisher 2 |
| 8              | I2C1 Publisher 2              | 21             | UART3 Publisher 1 |
| 9              | I2C2 Publisher 1              | 22             | UART3 Publisher 2 |
| 10             | I2C2 Publisher 2              | 23             | UART4 Publisher 1 |
| 11             | SPI0 Publisher 1              | 24             | UART4 Publisher 2 |
| 12             | SPI1 Publisher 2              | 25             | ADC0 Publisher 2  |

For more details, see the DMA chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

## 8.8 Events

The event manager transfers digital events from one entity (for example, a peripheral) to another (for example, a second peripheral, the DMA, or the CPU). The event manager implements event transfer through a defined set of event publishers (generators) and subscribers (receivers) which are interconnected through an event fabric containing a combination of static and programmable routes.

Events which are transferred by the event manager include:

- Peripheral event transferred to the CPU as an interrupt request (IRQ) (Static Event)
  - Example: RTC interrupt is sent to the CPU
- Peripheral event transferred to the DMA as a DMA trigger (DMA Event)
  - Example: UART data receive trigger to DMA to request a DMA transfer
- Peripheral event transferred to another peripheral to directly trigger an action in hardware (Generic Event)
  - Example: TIMx timer peripheral publishes a periodic event to the ADC subscriber port, and the ADC uses the event to trigger start-of-sampling

For more details, see the EVENT chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

**Table 8-3. Generic Event Channels**

A generic route is either a point-to-point (1:1) route or a point-to-two (1:2) splitter route in which the peripheral publishing the event is configured to use one of several available generic route channels to publish its event to another entity (or entities, in the case of a splitter route), where an entity may be another peripheral, a generic DMA trigger event, or a generic CPU event.

| CHANID | Generic Route Channel Selection   | Channel Type     |
|--------|-----------------------------------|------------------|
| 0      | No generic event channel selected | N/A              |
| 1      | Generic event channel 1 selected  | 1 : 1            |
| 2      | Generic event channel 2 selected  | 1 : 1            |
| 3      | Generic event channel 3 selected  | 1 : 1            |
| 4      | Generic event channel 4 selected  | 1 : 1            |
| 5      | Generic event channel 5 selected  | 1 : 1            |
| 6      | Generic event channel 6 selected  | 1 : 1            |
| 7      | Generic event channel 7 selected  | 1 : 1            |
| 8      | Generic event channel 8 selected  | 1 : 1            |
| 9      | Generic event channel 9 selected  | 1 : 1            |
| 10     | Generic event channel 10 selected | 1 : 1            |
| 11     | Generic event channel 11 selected | 1 : 1            |
| 12     | Generic event channel 12 selected | 1 : 2 (splitter) |
| 13     | Generic event channel 13 selected | 1 : 2 (splitter) |
| 14     | Generic event channel 14 selected | 1 : 2 (splitter) |
| 15     | Generic event channel 15 selected | 1 : 2 (splitter) |

## 8.9 Memory

### 8.9.1 Memory Organization

Table 8-4 summarizes the memory map of the devices. For more information about the memory region detail, see the *Platform Memory Map* section in the [MSPM0 Lx22x-Series 32MHz Microcontrollers Technical Reference Manual](#).

**Table 8-4. Memory Organization**

| MEMORY REGION       | SUBREGION            | MSPM0L1227, MSPM0L2227                            | MSPM0L1228, MSPM0L2228                             |
|---------------------|----------------------|---|--|
| Code (Flash Bank 0) | MAIN ECC Corrected   | 64KB <sup>(1)</sup><br>0x0000.0000 to 0x0000.FFFF | 128KB <sup>(1)</sup><br>0x0000.0000 to 0x0001.FFFF |
|                     | MAIN ECC Uncorrected | 0x0040.0000 to 0x0040.FFFF                        | 0x0040.0000 to 0x0041.FFFF                         |
|                     | Flash ECC code       | 0x0080.0000 to 0x0080.FFFF                        | 0x0080.0000 to 0x0081.FFFF                         |
| Code (Flash Bank 1) | MAIN ECC Corrected   | 64KB <sup>(1)</sup><br>0x0001.0000 to 0x0001.FFFF | 128KB <sup>(1)</sup><br>0x0002.0000 to 0x0003.FFFF |
|                     | MAIN ECC Uncorrected | 0x0041.0000 to 0x0041.FFFF                        | 0x0042.0000 to 0x0043.FFFF                         |
|                     | Flash ECC code       | 0x0081.0000 to 0x0081.FFFF                        | 0x0082.0000 to 0x0083.FFFF                         |
| SRAM (SRAM)         | SRAM "ECC Checked"   | 32KB<br>0x2000.0000 to 0x2000.7FFF                | 32KB<br>0x2000.0000 to 0x2000.7FFF                 |
|                     | Parity checked       | 0x2010.0000 to 0x2010.7FFF                        | 0x2010.0000 to 0x2010.7FFF                         |
|                     | Un-checked           | 0x2020.0000 to 0x2020.7FFF                        | 0x2020.0000 to 0x2020.7FFF                         |
|                     | ECC/parity code      | 0x2030.0000 to 0x2030.7FFF                        | 0x2030.0000 to 0x2030.7FFF                         |

**Table 8-4. Memory Organization (continued)**

| MEMORY REGION | SUBREGION                               | MSP0L1227, MSP0L2227       | MSPM0L1228, MSPM0L2228     |
|---------------|---|----------------------------|----------------------------|
| Peripheral    | Peripherals                             | 0x4000.4000 to 0x4087.1FFF | 0x4000.4000 to 0x4087.1FFF |
|               | Configuration NVM (NONMAIN) Corrected   | 0x41C0.0000 to 0x41C0.03FF | 0x41C0.0000 to 0x41C0.03FF |
|               | Configuration NVM (NONMAIN) Uncorrected | 0x41C1.0000 to 0x41C1.03FF | 0x41C1.0000 to 0x41C1.03FF |
|               | Configuration NVM (NONMAIN) ECC code    | 0x41C2.0000 to 0x41C2.03FF | 0x41C2.0000 to 0x41C2.03FF |
|               | FACTORY Corrected                       | 0x41C4.0000 to 0x41C4.01FF | 0x41C4.0000 to 0x41C4.01FF |
|               | FACTORY Uncorrected                     | 0x41C5.0000 to 0x41C5.01FF | 0x41C5.0000 to 0x41C5.01FF |
|               | FACTORY ECC code                        | 0x41C6.0000 to 0x41C6.01FF | 0x41C6.0000 to 0x41C6.01FF |
| Subsystem     |   | 0x6000.0000 to 0x7FFF.FFFF | 0x6000.0000 to 0x7FFF.FFFF |
| System PPB    |   | 0xE000.0000 to 0xE00F.FFFF | 0xE000.0000 to 0xE00F.FFFF |

(1) First 32KB flash memory (address 0x0000.0000 to 0x0000.8000) has up to 100000 program/erase cycles.

### 8.9.2 Peripheral File Map

Table 8-5 lists the available peripherals and the register base address for each.

**Table 8-5. Peripherals Summary**

| PERIPHERAL NAME              | BASE ADDRESS | SIZE   |
|------------------------------|--------------|--------|
| ADC0                         | 0x40004000   | 0x2000 |
| COMP0                        | 0x40008000   | 0x2000 |
| VREF                         | 0x40030000   | 0x2000 |
| LCD                          | 0x40070000   | 0x2000 |
| WWDT0                        | 0x40080000   | 0x2000 |
| TIMG0                        | 0x40084000   | 0x2000 |
| TIMG4                        | 0x4008C000   | 0x2000 |
| TIMG5                        | 0x4008E000   | 0x2000 |
| TIMG8                        | 0x40090000   | 0x2000 |
| LFSS (RTC_A, TIO, IWDT, SPM) | 0x40094000   | 0x2000 |
| RTC_A                        | 0x40095100   | 0x100  |
| TIO                          | 0x40095200   | 0x100  |
| IWDT                         | 0x40095300   | 0x100  |
| SPM                          | 0x040095400  | 0x100  |
| GPIOA                        | 0x400A0000   | 0x2000 |
| GPIOB                        | 0x400A2000   | 0x2000 |
| GPIOC                        | 0x400A4000   | 0x2000 |
| KEYSTORE                     | 0x400AC000   | 0x2000 |
| SYSCTL                       | 0x400AF000   | 0x4000 |
| DEBUGSS                      | 0x400C7000   | 0x2000 |
| EVENT                        | 0x400C9000   | 0x3000 |
| NVM                          | 0x400CD000   | 0x2000 |
| I2C0                         | 0x400F0000   | 0x2000 |
| I2C1                         | 0x400F2000   | 0x2000 |
| I2C2                         | 0x400F4000   | 0x2000 |
| UART2                        | 0x40100000   | 0x2000 |
| UART3                        | 0x40102000   | 0x2000 |
| UART4                        | 0x40104000   | 0x2000 |

**Table 8-5. Peripherals Summary (continued)**

| PERIPHERAL NAME     | BASE ADDRESS | SIZE   |
|---------------------|--------------|--------|
| UART0               | 0x40108000   | 0x2000 |
| UART1               | 0x4010A000   | 0x2000 |
| MCPUSS              | 0x40400000   | 0x2000 |
| WUC                 | 0x40424000   | 0x2000 |
| IOMUX               | 0x40428000   | 0x2000 |
| DMA                 | 0x4042A000   | 0x2000 |
| CRC                 | 0x40440000   | 0x2000 |
| AESADV              | 0x40442000   | 0x2000 |
| TRNG                | 0x40444000   | 0x2000 |
| SPI0                | 0x40468000   | 0x2000 |
| SPI1                | 0x4046A000   | 0x2000 |
| ADC0 <sup>(1)</sup> | 0x4055A000   | 0x2000 |
| TIMA0               | 0x40860000   | 0x2000 |
| TIMG12              | 0x40870000   | 0x2000 |

### 8.9.3 Peripheral Interrupt Vector

Table 8-6 shows the IRQ number and the interrupt group number for each peripheral in this device.

**Table 8-6. Interrupt vector number**

| Peripheral Name  | NVIC IRQ | Group IIDX |
|------------------|----------|------------|
| WWDT0            | 0        | 0          |
| DEBUGSS          | 0        | 2          |
| FLASHCTL         | 0        | 3          |
| EVENT SUB PORT 0 | 0        | 4          |
| EVENT SUB PORT 1 | 0        | 5          |
| SYSCTL           | 0        | 6          |
| GPIOA            | 1        | 0          |
| GPIOB            | 1        | 1          |
| COMP0            | 1        | 2          |
| TRNG             | 1        | 5          |
| GPIOC            | 1        | 6          |
| TIMG12           | 2        | -          |
| UART4            | 3        | -          |
| ADC0             | 4        | -          |
| SPI0             | 9        | -          |
| SPI1             | 10       | -          |
| UART2            | 13       | -          |
| UART3            | 14       | -          |
| UART0            | 15       | -          |
| UART1            | 16       | -          |
| TIMA0            | 18       | -          |
| TIMG8            | 20       | -          |
| TIMG0            | 21       | -          |
| TIMG4            | 22       | -          |
| TIMG5            | 23       | -          |
| I2C0             | 24       | -          |
| I2C1             | 25       | -          |
| I2C2             | 26       | -          |
| AESADV           | 28       | -          |
| LCD0             | 29       | -          |
| LFSS             | 30       | -          |
| DMA0             | 31       | -          |

### 8.10 Flash Memory

A dual bank of nonvolatile flash memory (up to 128KB or 256KB total) is provided for storing executable program code and application data.

Key features of the flash include:

- Hardware ECC protection (encode and decode) with single bit error correction and double-bit error detection
- In-circuit program and erase operations supported across the entire recommended supply range
- Small 1KB sector sizes (minimum erase resolution of 1KB)

- Up to 100,000 program/erase cycles on the 32 selected sectors of the flash memory, with up to 10,000 program/erase cycles on the remaining flash memory (devices with 32kB support 100,000 cycles on the entire flash memory)

For more details, see the NVM chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

## 8.11 SRAM

MSPM0 MCUs include a low power, high performance SRAM memory with zero wait state access across the supported CPU frequency range of the device. MSPM0 MCUs also provide up to 128KB of ECC protected SRAM with hardware parity. SRAM memory may be used for storing volatile information such as the call stack, heap, global data, and code. The SRAM memory content is fully retained in RUN, SLEEP, STOP, and STANDBY modes and is lost in shutdown mode.

A write-execute mutual exclusion mechanism is provided to allow the application to partition the SRAM into two sections: a read-write (RW) partition and a read-execute (RX) partition. The RX partition occupies the upper portion of the SRAM address space. Write protection is useful when placing executable code into SRAM as it provides a level of protection against unintentional overwrites of code by either the CPU or DMA. Placing code in SRAM can improve performance of critical loops by enabling zero wait state operation and lower power consumption.

## 8.12 GPIO

The general purpose input/output (GPIO) peripheral provides the user with a means to write data out and read data in to and from the device pins. Through the use of the Port A, Port B and Port C GPIO peripherals, these devices support up to 60 GPIO pins.

The key features of the GPIO module include:

- 0 wait state MMR access from CPU
- Set/Clear/Toggle multiple bits without the need of a read-modify-write construct in software
- GPIOs with "Standard with Wake" drive functionality able to wake the device from SHUTDOWN mode
- "FastWake" feature enables low-power wakeup from STOP and STANDBY modes for any GPIO port
- User controlled input filtering

For more details, see the GPIO chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

## 8.13 IOMUX

The IOMUX peripheral enables IO pad configuration and controls digital data flow to and from the device pins. The key features of the IOMUX include:

- IO Pad configuration registers allow for programmable drive strength, speed, pullup-down, and more
- Digital pin muxing allows for multiple peripheral signals to be routed to the same IO pad
- Pin functions and capabilities are user-configured using the PINCM register

For more details, see the IOMUX chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

## 8.14 ADC

The 12-bit analog-to-digital converter (ADC) module in these devices support fast 12-bit conversions with single-ended inputs.

ADC features include:

- 12-bit output resolution at up to 1.68Msps with greater than 11-bit ENOB
- Hardware averaging enables 14-bit conversion resolution at 105ksps
- Up to 26 external input channels
- Internal channels for temperature sensing, supply monitoring, and analog signal chain
- Software selectable reference:

- Configurable internal dedicated ADC reference voltage of 1.4V and 2.5V (VREF)
- MCU supply voltage (VDD)
- External reference supplied to the ADC through the VREF+ and VREF- pins
- Operates in RUN, SLEEP, and STOP modes and supports triggers from STANDBY mode

**Table 8-7. ADC Channel Mapping**

| Channel [0:15] | Signal Name (ADC0) <sup>(1) (2)</sup> | Channel [16:31] | Signal Name (ADC0) <sup>(1) (2)</sup> |
|----------------|---------------------------------------|-----------------|---------------------------------------|
| 0              | A0_0                                  | 16              | A0_16                                 |
| 1              | A0_1                                  | 17              | A0_17                                 |
| 2              | A0_2                                  | 18              | A0_18                                 |
| 3              | A0_3                                  | 19              | A0_19                                 |
| 4              | A0_4                                  | 20              | A0_20                                 |
| 5              | A0_5                                  | 21              | A0_21                                 |
| 6              | A0_6                                  | 22              | A0_22                                 |
| 7              | A0_7                                  | 23              | A0_23                                 |
| 8              | A0_8                                  | 24              | A0_24                                 |
| 9              | A0_9                                  | 25              | A0_25                                 |
| 10             | A0_10                                 | 26              | -                                     |
| 11             | A0_11                                 | 27              | -                                     |
| 12             | A0_12                                 | 28              | VREF                                  |
| 13             | A0_13                                 | 29              | <i>Temperature Sensor</i>             |
| 14             | A0_14                                 | 30              | <i>VBAT Monitor</i>                   |
| 15             | A0_15                                 | 31              | <i>Supply/Battery Monitor</i>         |

(1) *Italicized* signal names are purely internal to the device. These signals are used for internal peripheral interconnections.

(2) For more information about device analog connections, refer to [Section 8.31](#)

For more details, see the ADC chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

## 8.15 Temperature Sensor

The temperature sensor provides a voltage output that changes linearly with device temperature. The temperature sensor output is internally connected to one of ADC input channels to enable a temperature-to-digital conversion.

A unit-specific single-point calibration value for the temperature sensor is provided in the factory constants memory region. This calibration value represents the ADC conversion result (in ADC code format) corresponding to the temperature sensor being measured in 12-bit mode with the 1.4V internal VREF at the factory trim temperature (TS<sub>TRIM</sub>). This calibration value can be used with the temperature sensor temperature coefficient (TS<sub>C</sub>) to estimate the device temperature. See the temperature sensor section of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#) for guidance on estimating the device temperature with the factory trim value.

## 8.16 LFSS

The Low-Frequency Subsystem (LFSS) combines several functional peripherals under one shared subsystem. These peripherals are clocked by the low-frequency clock (LFCLK) or need to be active during low-power modes. In this device, LFSS is powered by a separate battery backup domain called VBAT. The low-frequency clock has a typical frequency of 32kHz and is mainly intended for long-term timekeeping.

LFSS in this device contains following components:

- A dedicated battery backup domain supply and dedicated pin (VBAT)
- [Real-time clock \(RTC\\_A\)](#) with additional prescaler extension and timestamp captures
- An asynchronous [Independent Watchdog Timer \(IWDT\)](#)
- Tamper detection input / output (TIO) module

- Tamper detection with timestamp
- A small scratchpad memory storage (SPM)
- Heartbeat generator

For more details, see the LFSS chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

## 8.17 VREF

### VREF for ADC

The voltage reference module (VREF) contains a configurable voltage reference buffer dedicated for the on-board ADC. The devices also support connection of an external reference for applications in which higher accuracy is required.

VREF features include:

- 1.4V and 2.5V user-selectable internal references. Same reference voltage will be selected for ADC and COMP
- Internal reference supports ADC operation at 200ksps
- Support for bringing in an external reference on VREF+ and VREF- device pins
- Requires a decoupling capacitor placed on VREF+ pin and VREF- pins for proper operation. See [VREF specification section](#) for more details

### VREF for COMP

The voltage reference module (VREF) contains a configurable voltage reference buffer dedicated for the on-board COMP. The devices also support connection of an external reference for applications in which higher accuracy is required.

VREF features include:

- 1.4V and 2.5V user-selectable internal reference for COMP. Same reference voltage will be selected for ADC and COMP.
- Supports low power mode operation of COMP+VREF in standby mode.
- Support for bringing in an external reference on VREF+ and VREF- device pins.
- Requires a decoupling capacitor placed on VREF+ pin and VREF- pins for proper operation. See [VREF specification section](#) for more details.

For more details, see the VREF chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

## 8.18 COMP

The comparator peripheral in the device compares the voltage levels on two inputs terminals and provides a digital output based on this comparison. It supports the following key features:

- Programmable hysteresis
- Programmable reference voltage:
  - External reference voltage (VREF IO)
  - Dedicated Internal reference voltage (1.4V, 2.5V) available in RUN/SLEEP/STOP/STANDBY modes.
  - Integrated 8-bit reference DAC
- Configurable operation modes:
  - High speed mode
  - Lower power mode
- Programmable output glitch filter delay
- Support output wake up device from all low power modes
- Output connected to advanced timer fault handling mechanism
- The IPSEL and IMSEL bits in comparator registers can be used to select the comparator channel inputs from device pins or from internal analog modules.

**Table 8-8. COMP0 Input Channel Selection**

| IPSEL / IMSEL BITS | POSITIVE TERMINAL INPUT | NEGATIVE TERMINAL INPUT |
|--------------------|-------------------------|-------------------------|
| 0x0                | COMP0_IN0+              | COMP0_IN0-              |
| 0x1                | COMP0_IN1+              | COMP0_IN1-              |
| 0x2                | COMP0_IN2+              | COMP0_IN2-              |
| 0x3                | COMP0_IN3+              | -                       |
| 0x5                | -                       | Temp Sensor output      |

For more information about device analog connections, refer to [Section 8.31](#).

For more details, see the COMP chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

### 8.19 TRNG

The true random number generator (TRNG) utilizes an internal circuit to generate 32-bit random numbers. The TRNG is intended to be used as a source to a deterministic random number generator (DRNG) to build a FIPS-140-2 compliant system. Key features of the TRNG include:

- Generation of 32-bit random numbers
- A new 32-bit number can be generated every  $32 \times 4 = 128$  TRNG clock cycles
- Built-in health tests
- Available in RUN and SLEEP modes

For more details, see the TRNG chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

### 8.20 AESADV

The AES advanced (AESADV) accelerator module performs encryption and decryption of 128-bit data blocks with a 128-bit or 256-bit key in hardware according to the advanced encryption standard (AES). AES is a symmetric-key block cipher algorithm specified in FIPS PUB 197.

The AESADV accelerator features include:

- AES operation with 128-bit and 256-bit keys
- Key scheduling in hardware
- Enc/decrypt only modes: CBC, CFB-1, CFB-8, CFB-128, OFB-128, CTR/ICM
- Authentication only modes: CBC-MAC, CMAC
- AES-CCM
- AES-GCM
- AES-CCM and AES-GCM modes support continuation with hold/resume of payload data
- 32-bit word access to provide key data, input data, and output data
- AESADV ready interrupt
- DMA triggers for input/output data
- Supported in RUN and SLEEP (see the *Operating Modes* section of the device technical reference manual)

For more details, see the AESADV chapter of the .

### 8.21 Keystore

The Keystore controller provides secure management of the Advanced Encryption Engine (AES) keys. The use-model of the keystore controller is to securely deposit keys into it during the execution of customer secure code, and have the AES engine access them subsequently in a secure manner without leaking any key data to observers. Both 128 and 256-bit keys can be stored in the keystore's key slots. The keystore and its interaction with the AES engine are designed for secure operation including thwarting partial key modification attacks.

For more details, see the KEYSTORE chapter of the .

## 8.22 CRC

The cyclical redundancy check (CRC) module provides a signature for an input data sequence. Key features of the CRC module include:

- Support for 16-bit CRC based on CRC16-CCITT
- Support for 32-bit CRC based on CRC32-ISO3309
- Support for bit reversal
- Support for custom polynomials

For more details, see the CRC chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

## 8.23 UART

The UART peripherals (UART0, UART1, UART2, UART3, UART4) provide the following key features:

- Standard asynchronous communication bits for start, stop, and parity
- Fully programmable serial interface
  - 5, 6, 7 or 8 data bits
  - Even, odd, stick, or no-parity bit generation and detection
  - 1 or 2 stop bit generation
  - Line-break detection
  - Glitch filter on the input signals
  - Programmable baud rate generation with oversampling by 16, 8 or 3
  - Local Interconnect Network (LIN) mode support
- Separated transmit and receive FIFOs support DMA data transfer
- Support transmit and receive loopback mode operation
- See [Table 8-9](#) for detail information on supported protocols.

**Table 8-9. UART Features**

| UART Features                       | UART0, UART1 (Extend) | UART2, UART3, UART4 (Main) |
|-------------------------------------|-----------------------|----------------------------|
| Active in Stop and Standby Mode     | Yes                   | Yes                        |
| Separate transmit and receive FIFOs | Yes                   | Yes                        |
| Support hardware flow control       | Yes                   | Yes                        |
| Support 9-bit configuration         | Yes                   | Yes                        |
| Support LIN mode                    | Yes                   | -                          |
| Support DALI                        | Yes                   | -                          |
| Support IrDA                        | Yes                   | -                          |
| Support ISO7816 Smart Card          | Yes                   | -                          |
| Support Manchester coding           | Yes                   | -                          |

For more details, see the UART chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

## 8.24 I2C

The inter-integrated circuit interface (I<sup>2</sup>C) peripherals in these devices provide bidirectional data transfer with other I2C devices on the bus and support the following key features:

- 7-bit and 10-bit addressing mode with multiple 7-bit target addresses
- Multiple-controller transmitter or receiver mode
- Target receiver or transmitter mode with configurable clock stretching
- Support Standard-mode (Sm), with a bit rate up to 100kbps
- Support Fast-mode (Fm), with a bit rate up to 400kbps
- Support Fast-mode Plus (Fm+), with a bit rate up to 1Mbps
- Separated transmit and receive FIFOs support DMA data transfer
- Support SMBus 3.0 with PEC, ARP, timeout detection and host support

- Wakeup from low power mode on address match
- Support analog and digital glitch filter for input signal glitch suppression

For more details, see the I2C chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

## 8.25 SPI

The serial peripheral interface (SPI) peripherals in these devices support the following key features:

- Support ULPCLK/2 bit rate and up to Mb/s in both controller and peripheral mode
- Configurable as a controller or a peripheral
- Configurable chip select for both controller and peripheral
- Programmable clock prescaler and bit rate
- Programmable data frame size from 4 bits to 16 bits (controller mode)
- Programmable data frame size from 7 bits to 16 bits (peripheral mode)
- Separated transmit and receive FIFOs support DMA data transfer
- Supports TI mode, Motorola mode, and National Microwire format

For more details, see the SPI chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

## 8.26 IWDT

The independent watchdog timer (IWDT) in the LFSS is a device-independent supervisor which monitors code execution and overall hang up scenarios of the device. Due to the nature of LFSS, this IWDT has its own system independent power and clock source. If the application software does not successfully reset the watchdog within the programmed time, the watchdog generates a POR reset to the device.

Key features of the IWDT include:

- A 25-bit counter
- Counter driven from LFOSC (fixed 32kHz clock path) with a programmable clock divider
- Eight selectable watchdog timer periods (2ms to 2hr)

For more details, see the IWDT chapter of the .

## 8.27 WWDT

The windowed watchdog timer (WWDT) can be used to supervise the operation of the device, specifically code execution. The WWDT can be used to generate a reset or an interrupt if the application software does not successfully reset the watchdog within a specified window of time. Key features of the WWDT include:

- 25-bit counter
- Programmable clock divider
- Eight software selectable watchdog timer periods
- Eight software selectable window sizes
- Support for stopping the WWDT automatically when entering a sleep mode
- Interval timer mode for applications which do not require watchdog functionality

For more details, see the WWDT chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

## 8.28 RTC\_A

The RTC\_A instance of the real-time clock operates off of a 32kHz input clock source (typically a low frequency crystal) and provides a time base to the application with multiple options for interrupts to the CPU. RTC\_A provides common key features in relation to the Low-Frequency Subsystem (LFSS).

Common key features of RTC\_A include:

- Counters for seconds, minutes, hours, day of the week, day of the month, month, and year
- Binary or BCD format

- Leap-year handling
- One customizable alarm interrupt based on minute, hour, day of the week, and day of the month
- Interval alarm interrupt to wake every minute, every hour, at midnight, or at noon
- Interval alarm interrupt providing periodic wake-up at 4096, 2048, 1024, 512, 256, or 128Hz
- Interval alarm interrupt providing periodic wake-up at 64, 32, 16, 8, 4, 2, 1, and 0.5Hz
- Calibration for crystal offset error (up to  $\pm 240$ ppm)
- Compensation for temperature drift (up to  $\pm 240$ ppm)
- RTC clock output to pin for calibration
- Three bit prescaler for heartbeat function with interrupt generation
- RTC external clock selection of untrimmed 32kHz, trimmed 512Hz, 256Hz, or 1Hz
- RTC time stamp capture upon detection of a timer stamp event, including tamper (TIO) event and VDD fail event
- RTC counter lock function

Table 8-10 shows the RTC features supported in this device.

**Table 8-10. RTC Instances and Key Features**

| RTC Features   | RTC_A |
|--|-------|
| Power enable register  | -     |
| Real-time clock and calendar mode providing seconds, minutes, hours, day of week, day of month, and year   | Yes   |
| Selectable binary or binary-coded decimal (BCD) format   | Yes   |
| Leap-year correction (valid for year 1901 through 2099)  | Yes   |
| Two customizable calendar alarm interrupts based on minute, hour, day of the week, and day of the month  | Yes   |
| Interval alarm interrupt to wake every minute, every hour, at midnight, or at noon   | Yes   |
| Periodic interrupt to wake at 4096, 2048, 1024, 512, 256, or 128Hz   | Yes   |
| Periodic interrupt to wake at 64, 32, 16, 8, 4, 2, 1, and 0.5Hz  | Yes   |
| Interrupt capability down to STANDBY mode with STOPCLKSTBY   | Yes   |
| Calibration for crystal offset error and crystal temperature drift (up to $\pm 240$ ppm total)   | Yes   |
| RTC clock output to pin for calibration (GPIO)   | Yes   |
| RTC clock output to pin for calibration (TIO)  | Yes   |
| Three bit prescaler for heartbeat function with interrupt generation   | Yes   |
| RTC external clock selection of untrimmed 32kHz, trimmed 512Hz, 256Hz or 1Hz   | Yes   |
| RTC time stamp capture upon detection of a timer stamp event, including: <ul style="list-style-type: none"> <li>• TIO event</li> <li>• VDD fail event</li> </ul> | Yes   |
| RTC counter lock function  | Yes   |

For more details, see the RTC chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

## 8.29 Timers (TIMx)

There are two timer peripherals in these devices support that following key features: TIMGx (general-purpose timer) and TIMAx (advanced timer). TIMGx is a subset of TIMAx, which means these timers share many common features that are compatible in software. For specific configuration, see [Table 8-11](#):

Specific features for the general-purpose timer (**TIMGx**) include:

- 16-bit and 32-bit timers with up, down or up-down counting modes, with repeat-reload mode
- Selectable and configurable clock source
- 8-bit programmable prescaler to divide the counter clock frequency
- Two independent CC channels for
  - Output compare
  - Input capture

- PWM output
- One-shot mode
- Support quadrature encoder interface (QEI) for positioning and movement sensing available in TIMG8
- Support synchronization and cross trigger among different TIMx instances in the same power domain
- Support interrupt/DMA trigger generation and cross peripherals (such as ADC) trigger capability
- Cross trigger event logic for Hall sensor inputs (TIMG8)

Specific features for the advanced timer (**TIMAx**) include:

- 16-bit timer with up, down or up-down counting modes, with repeat-reload mode
- Selectable and configurable clock source
- 8-bit programmable prescaler to divide the counter clock frequency
- Repeat counter to generate an interrupt or event only after a given number of cycles of the counter
- Up to four independent CC channels for
  - Output compare
  - Input capture
  - PWM output
  - One-shot mode
- Two additional capture/compare channels for internal events (CC4/CC5)
- Shadow register for load and CC register available in TIMA0
- Complementary output PWM
- Asymmetric PWM with programmable dead band insertion
- Fault handling mechanism to ensure the output signals in a safe user-defined state when a fault condition is encountered
- Support synchronization and cross trigger among different TIMx instances in the same power domain
- Support interrupt and DMA trigger generation and cross peripherals (such as ADC) trigger capability
- Two additional capture/compare channels for internal events

**Table 8-11. TIMx Instance Configuration**

| Instance | Power Domain | Counter Resolution | Prescaler | Repeat Counter | CCP Channels (External/Internal) | External PWM Channels | Phase Load | Shadow Load | Shadow CCs | Deadband | Fault Handler | QEI / Hall Input Mode |
|----------|--------------|--------------------|-----------|----------------|----------------------------------|-----------------------|------------|-------------|------------|----------|---------------|-----------------------|
| TIMG0    | PD0          | 16-bit             | 8-bit     | -              | 2                                | 2                     | -          | -           | -          | -        | -             | -                     |
| TIMG4    | PD0          | 16-bit             | 8-bit     | -              | 2                                | 2                     | -          | Yes         | Yes        | -        | -             | -                     |
| TIMG5    | PD0          | 16-bit             | 8-bit     | -              | 2                                | 2                     | -          | Yes         | Yes        | -        | -             | -                     |
| TIMG8    | PD0          | 16-bit             | 8-bit     | -              | 2                                | 2                     | -          | -           | -          | -        | -             | Yes                   |
| TIMG12   | PD0          | 32-bit             | -         | -              | 2                                | 2                     | -          | -           | Yes        | -        | -             | -                     |
| TIMA0    | PD0          | 16-bit             | 8-bit     | Yes            | 4/2                              | 8                     | Yes        | Yes         | Yes        | Yes      | Yes           | -                     |

**Table 8-12. TIMx Cross Trigger Map (PD0)**

| TSEL.ETSEL Selection | TIMA0                           | TIMG0        | TIMG4        | TIMG5        | TIMG8        | TIMG12       |
|----------------------|---------------------------------|--------------|--------------|--------------|--------------|--------------|
| 0                    | TIMA0.TRIGO                     | TIMA0.TRIGO  | TIMA0.TRIGO  | TIMA0.TRIGO  | TIMA0.TRIGO  | TIMA0.TRIGO  |
| 1                    | TIMG0.TRIGO                     | TIMG0.TRIGO  | TIMG0.TRIGO  | TIMG0.TRIGO  | TIMG0.TRIGO  | TIMG0.TRIGO  |
| 2                    | TIMG4.TRIGO                     | TIMG4.TRIGO  | TIMG4.TRIGO  | TIMG4.TRIGO  | TIMG4.TRIGO  | TIMG4.TRIGO  |
| 3                    | TIMG5.TRIGO                     | TIMG5.TRIGO  | TIMG5.TRIGO  | TIMG5.TRIGO  | TIMG5.TRIGO  | TIMG5.TRIGO  |
| 4                    | TIMG8.TRIGO                     | TIMG8.TRIGO  | TIMG8.TRIGO  | TIMG8.TRIGO  | TIMG8.TRIGO  | TIMG8.TRIGO  |
| 5                    | TIMG12.TRIGO                    | TIMG12.TRIGO | TIMG12.TRIGO | TIMG12.TRIGO | TIMG12.TRIGO | TIMG12.TRIGO |
| 6 to 15              | Reserved                        |              |              |              |              |              |
| 16                   | Event Subscriber Port 0 (FSUB0) |              |              |              |              |              |
| 17                   | Event Subscriber Port 1 (FSUB1) |              |              |              |              |              |
| 18-31                | Reserved                        |              |              |              |              |              |

The following tests can be applied as functional safety mechanisms for this module (to provide diagnostic coverage on a specific function):

**Table 8-13. Timers Safety Mechanisms**

| Safety Mechanism                    | Description  | Faults/Failure modes  |
|-------------------------------------|--|---|
| <i>TIM1</i>                         | Test for PWM generation  | Targeted towards PWM generation logic, including the counters, compare registers, clocking logic, output generation logic etc.  |
| <i>TIM2</i>                         | Periodic Software Read Back of IP Static Configuration Registers | Targets the static configuration registers in Timer.  |
| <i>TIM3</i> (latent fault coverage) | Test for fault generation  | This test is a test for diagnostic, which checks the functioning of fault detection logic in timer.<br><br><b>Note</b><br><br>This test is applicable only to TIMAx.  |
| <i>TIM4</i>                         | Fault detection to take the PWMs to safe state                   | This safety mechanism can be used to detect faults which result in system level failures like over/under voltages/currents. The external faults can be monitored using the fault pins or the analog comparators. The faults which can be covered include the faults in the PWM generation logic, faults in external drivers etc.<br><br><b>Note</b><br><br>This test is applicable only to TIMAx. |
| <i>TIM5</i>                         | Input capture on two or more timer instances                     | This test is used to cover the faults in the capture mode logic. The faults could be in clocking, capture logic, counter logic etc.   |
| <i>TIM6</i>                         | Timer period monitoring.   | This test is a run time check in which the duration between two interrupts can be measured (using another timer). This is useful in detecting faults which result in the counter taking more or less time than expected and can also cover the clocking related faults.   |
| <i>WDT</i>                          | Windowed watchdog event  | Targeted towards faults which result in missing interrupts (periodic interrupts) affecting the program sequence of the CPU. These could be faults in the interrupt logic or the logic which sets the interrupt flags or the logic which generated hardware triggers for other IPs (ADC for example) etc.  |

### 8.30 LCD

The Liquid Crystal Display (LCD) controller directly drives LCD displays through the segment (SEG) and common (COM) voltage signals. The controller can support 2-mux to 8-mux LCD glasses. The main features of the LCD controller are:

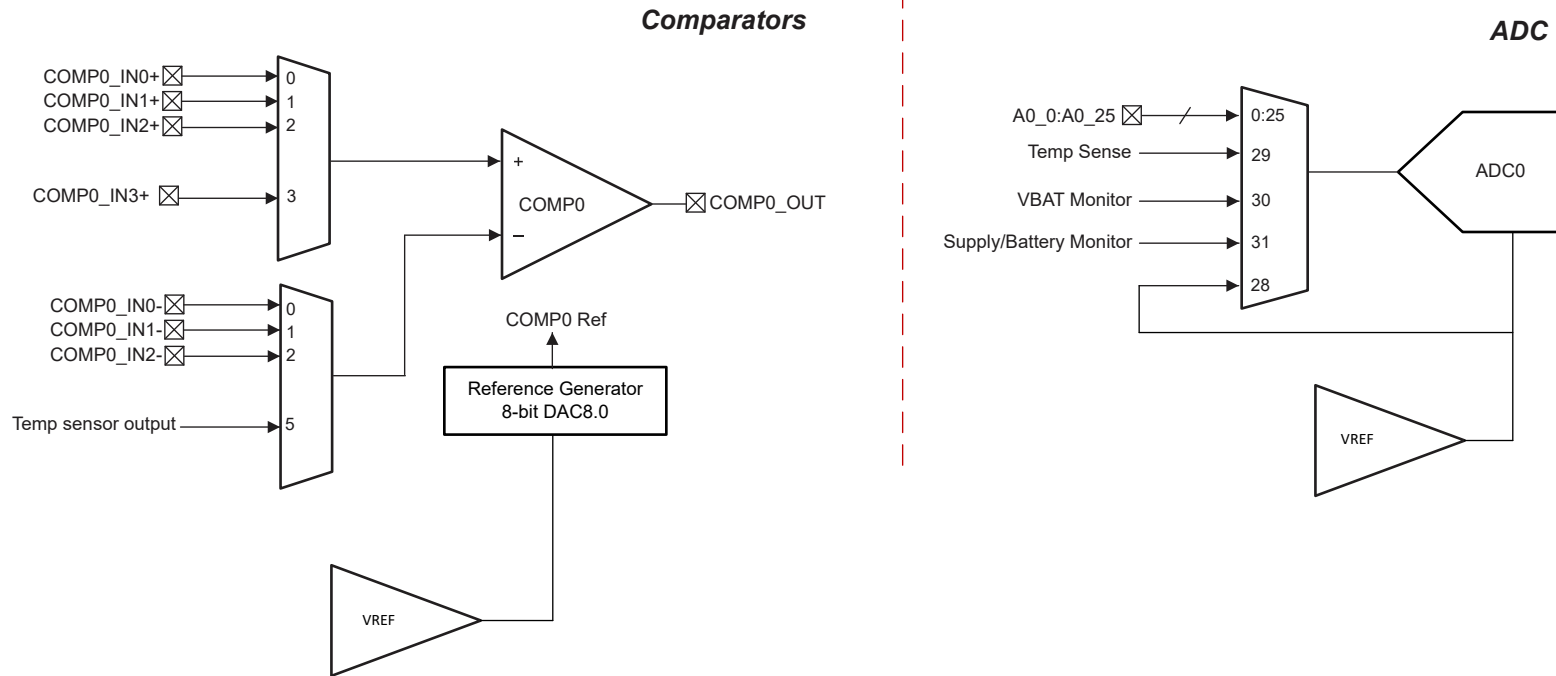
- Display memory

- Standby mode support
- Configurable SEG and COM pins
- Automatic signal generation
- Configurable frame frequency
- Blinking of individual segments with separate blinking memory for static and 2-4 mux LCD
- Blinking of complete display for 5-8 mux LCDs
- Regulated charge pump up to 3.6V (typical)
- Internal resistor divider for generating bias voltages
- Internal charge pump for generating bias voltages
- Contrast control by software
- Ability to use LCD IOs as GPIOs or analog signals when pins are not used for LCD operation
- Supports static, 1/3 and 1/4 bias modes. 1/2 bias mode is not supported.

For more details, see the LCD chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

### 8.31 Device Analog Connections

Figure 8-2 shows the internal analog connection of the device.

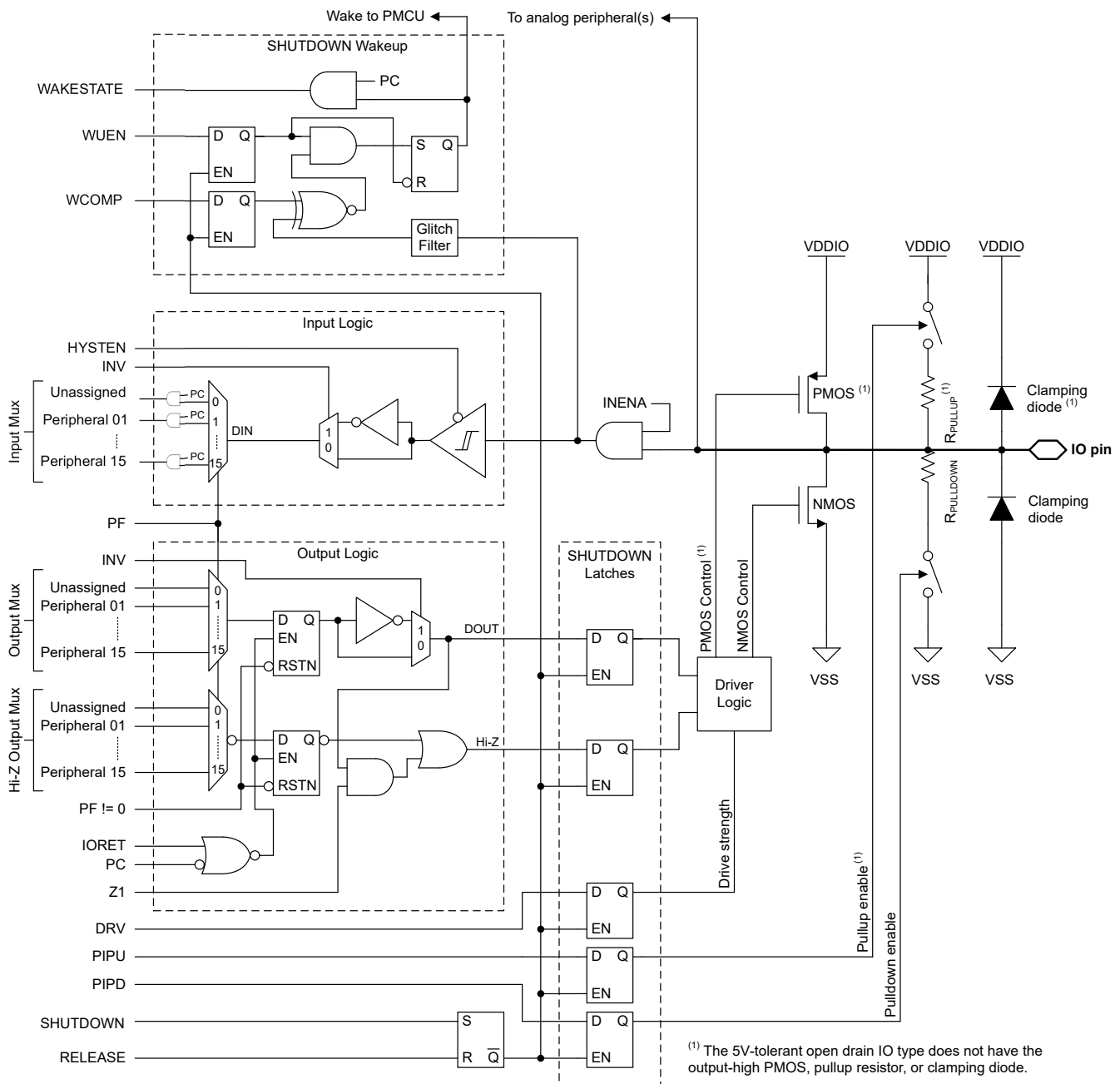


**Figure 8-2. Device Analog Connection**

## 8.32 Input/Output Diagrams

The IOMUX manages the selection of which peripheral function is to be used on a digital IO. It also provides the controls for the output driver, input path, and the wake-up logic for wakeup from SHUTDOWN mode. For more information, refer to the IOMUX section of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

The mixed-signal IO pin slice diagram for a full featured IO pin is shown in [Figure 8-3](#). Not all pins will have analog functions, wake-up logic, drive strength control, and pullup or pulldown resistors available. See the device-specific data sheet for detailed information on what features are supported for a specific pin.



**Figure 8-3. Superset Input/Output Diagram**

### 8.33 Serial Wire Debug Interface

A serial wire debug (SWD) two-wire interface is provided via an Arm compatible serial wire debug port (SW-DP) to enable access to multiple debug functions within the device.

**Table 8-14. Serial Wire Debug Pin Requirements and Functions**

| DEVICE SIGNAL | DIRECTION    | SWD FUNCTION                             |
|---------------|--------------|--|
| SWCLK         | Input        | Serial wire clock from debug probe       |
| SWDIO         | Input/Output | Bi-directional (shared) serial wire data |

For a complete description of the debug functionality offered on MSPM0 devices, see the Debug chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#).

### 8.34 Bootstrap Loader (BSL)

The bootstrap loader (BSL) enables configuration of the device as well as programming of the device memory through a UART or I2C serial interface. Access to the device memory and configuration through the BSL is protected by a 256-bit user-defined password, and it is possible to completely disable the BSL in the device configuration, if desired. The BSL is enabled by default from TI to support use of the BSL for production programming.

A minimum of two pins are required to use the BSL: the BSLRX and BSLTX signals (for UART), or the BSLSCL and BSLSDA signals (for I2C). Additionally, one or two additional pins (BSL\_invoke and NRST) may be used for controlled invocation of the bootloader by an external host.

If enabled, the BSL may be invoked (started) in the following ways:

- The BSL is invoked during the boot process if the BSL\_invoke pin state matches the defined BSL\_invoke logic level. If the device fast boot mode is enabled, this invocation check is skipped. An external host can force the device into the BSL by asserting the invoke condition and applying a reset pulse to the NRST pin to trigger a BOOTRST, after which the device will verify the invoke condition during the reboot process and start the BSL if the invoke condition matches the expected logic level.
- The BSL is automatically invoked during the boot process if the reset vector and stack pointer are left unprogrammed. As a result, a blank device from TI will invoke the BSL during the boot process without any need to provide a hardware invoke condition on the BSL\_invoke pin. This enables production programming using just the serial interface signals.
- The BSL may be invoked at runtime from application software by issuing a SYSRST with BSL entry command.

**Table 8-15. BSL Pin Requirements and Functions**

| DEVICE SIGNAL | CONNECTION        | BSL FUNCTION  |
|---------------|-------------------|---|
| BSLRX         | Required for UART | UART receive signal (RXD), an input   |
| BSLTX         | Required for UART | UART transmit signal (TXD) an output  |
| BSLSCL        | Required for I2C  | I2C BSL clock signal (SCL)  |
| BSLSDA        | Required for I2C  | I2C BSL data signal (SDA)   |
| BSL_invoke    | Optional          | Active-high digital input used to start the BSL during boot   |
| NRST          | Optional          | Active-low reset pin used to trigger a reset and subsequent check of the invoke signal (BSL_invoke) |

For a complete description of the BSL functionality and command set, see the MSPM0 boot strap loader user's guide.

### 8.35 Device Factory Constants

All devices include a memory-mapped FACTORY region which provides read-only data describing the capabilities of a device as well as any factory-provided trim information for use by application software. Please

refer to Factory Constants chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#) for more information.

**Table 8-16. DEVICEID**

DEVICEID address is 0x41C4.0004, PARTNUM is bit 12 to 27, MANUFACTURER is bit 1 to 11.

| Device                 | PARTNUM | MANUFACTURER |
|------------------------|---------|--------------|
| MSPM0L1227, MSPM0L2227 | 0xBB9F  | 0x17         |
| MSPM0L1228, MSPM0L2228 | 0xBB9F  | 0x17         |

**Table 8-17. USERID**

USERID address is 0x41C4.0008, PART is bit 0 to 15, VARIANT is bit 16 to 23

| Device         | Part   | Variant |
|----------------|--------|---------|
| M0L1227QRGERQ1 | 0xDDE7 | 0x1B    |
| M0L1227QRHBRQ1 | 0xDDE7 | 0xF2    |
| M0L1227QRGZRQ1 | 0xDDE7 | 0x86    |
| M0L1227QPTRQ1  | 0xDDE7 | 0x78    |
| M0L1227QPMRQ1  | 0xDDE7 | 0x2     |
| M0L1227QPNRQ1  | 0xDDE7 | 0xD1    |
| M0L1228QRGERQ1 | 0xB371 | 0x50    |
| M0L1228QRHBRQ1 | 0xB371 | 0x9C    |
| M0L1228QRGZRQ1 | 0xB371 | 0x19    |
| M0L1228QPTRQ1  | 0xB371 | 0xF1    |
| M0L1228QPMRQ1  | 0xB371 | 0xE9    |
| M0L1228QPNRQ1  | 0xB371 | 0xB2    |
| M0L2227QPTRQ1  | 0x6BC  | 0xD1    |
| M0L2227QPMRQ1  | 0x6BC  | 0x87    |
| M0L2227QPNRQ1  | 0x6BC  | 0xFF    |
| M0L2228QPTRQ1  | 0xBE7B | 0x3E    |
| M0L2228QPMRQ1  | 0xBE7B | 0xFD    |
| M0L2228QPNRQ1  | 0xBE7B | 0xFC    |

## 8.36 Identification

### Revision and Device Identification

The hardware revision and device identification values are stored in the memory-mapped FACTORY region, refer to Device Factory Constants section, which provides read-only data describing the capabilities of a device as well as any factory-provided trim information for use by application software. Refer to the Factory Constants chapter of the [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#) for more information.

The device revision and identification information are also included as part of the top-side marking on the device package. The device-specific errata sheet describes these markings (see [Section 10.4](#)).

## 9 Applications, Implementation, and Layout

### 9.1 Typical Application

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#### Note

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation to confirm system functionality.

---

#### 9.1.1 Schematic

TI recommends connecting a combination of a 10 $\mu$ F and a 0.1 $\mu$ F low-ESR ceramic decoupling capacitor to the VDD and VSS pins. Higher-value capacitors may be used but can impact supply rail ramp-up time. Decoupling capacitors must be placed as close as possible to the pins that they decouple (within a few millimeters).

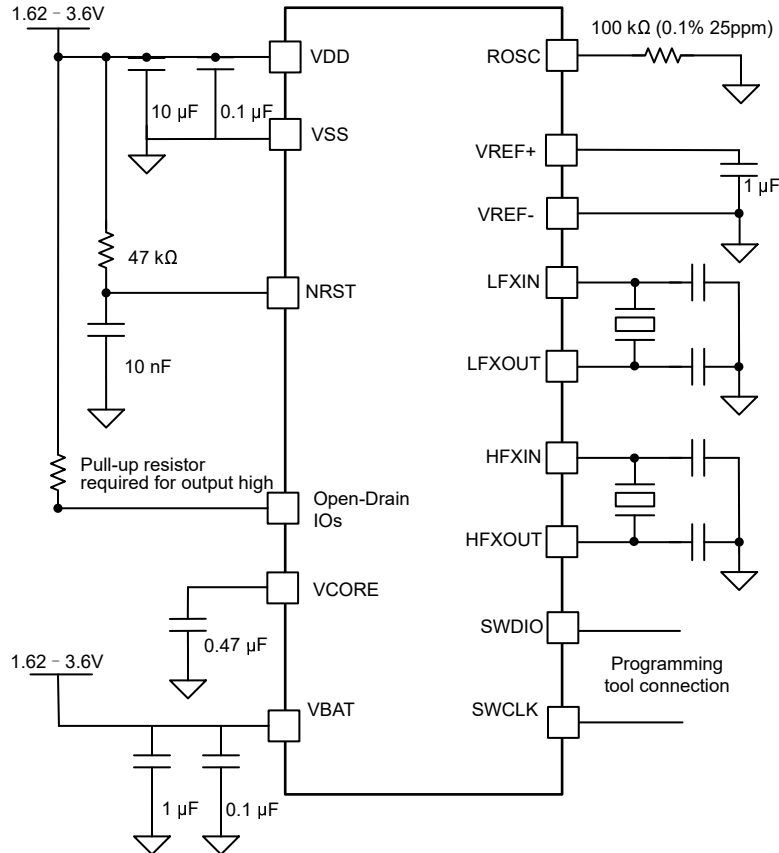
The NRST reset pin is required to connect an external 47k $\Omega$  pullup resistor with a 10nF pulldown capacitor.

The SYSOSC frequency correction loop (FCL) circuit utilizes an external 100k $\Omega$  resistor, populated between the ROSC pin and VSS, to stabilize the SYSOSC frequency by providing a precision reference current for the SYSOSC. This resistor needs to be 0.1% accurate and is not required if the SYSOSC FCL is not enabled.

For devices supporting external crystals, external bypass capacitors for the crystal oscillator pins are required. Refer to [MSPM0 L-Series 32MHz Microcontrollers Technical Reference Manual](#) which explains how to calculate the capacitor value.

A 0.47 $\mu$ F tank capacitor is required for the VCORE pin and needs to be placed close to the device with minimum distance to the device ground.

For 5V-tolerant open drain IOs (ODIO), a pullup resistor is required to output a logic high signal. This is required for I<sup>2</sup>C and UART functions if the ODIO are used.



**Figure 9-1. Typical Application Schematic**

## 10 Device and Documentation Support

TI offers an extensive line of development tools. Tools and software to evaluate the performance of the device, generate code, and develop solutions are listed below.

### 10.1 Getting Started and Next Steps

For more information on the MSP low-power microcontrollers and the tools and libraries that are available to help with development, visit the Texas Instruments [Arm Cortex-M0+ MCUs](#) page.

### 10.2 Device Nomenclature

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

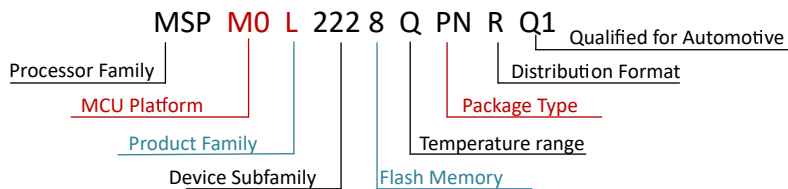
**X** – Experimental device that is not necessarily representative of the final device's electrical specifications

**MSP** – Fully qualified production device

**X** devices 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 (X) 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. [Figure 10-1](#) provides a legend for reading the complete device name.



**Figure 10-1. Device Nomenclature**

**Table 10-1. Device Nomenclature**

|                            |  |
|----------------------------|--|
| <b>Processor Family</b>    | MSP = Mixed-signal processor<br>X= Experimental silicon  |
| <b>MCU Platform</b>        | M0 = Arm based 32-bit M0+  |
| <b>Product Family</b>      | L = 32MHz frequency  |
| <b>Device Subfamily</b>    | 1227 = ADC, CMP, VBAT<br>222x = ADC, CMP, VBAT, LCD  |
| <b>Flash Memory</b>        | 7 = 128KB<br>8 = 256KB   |
| <b>Temperature Range</b>   | Q = -40°C to 125°C, AEC-Q100 qualified   |
| <b>Package Type</b>        | See the <i>Device Comparison</i> section and <a href="https://www.ti.com/packaging">https://www.ti.com/packaging</a> |
| <b>Distribution Format</b> | R = Large reel<br>No marking = Tube or tray  |

For orderable part numbers of MSP devices in different package types, see the Package Option Addendum of this document, [ti.com](http://ti.com), or contact your TI sales representative.

## 10.3 Tools and Software

### Design Kits and Evaluation Modules

#### [MSPM0 LaunchPad \(LP\) Boards: LP-MSPM0L2228](#)

Empowers you to immediately start developing on the industry's best integrated analog and most cost-optimized general purpose MSPM0 MCU family. Exposes all device pins and functionality; includes some built-in circuitry, out-of-box software demos, and on-board XDS110 debug probe for programming/debugging/EnergyTrace. The LP ecosystem includes dozens of [BoosterPack](#) stackable plug-in modules to extend functionality.

### Embedded Software

#### [MSPM0 Software Development Kit \(SDK\)](#)

Contains software drivers, middleware libraries, documentation, tools, and code examples that create a familiar and easy user experience for all MSPM0 devices.

### Software Development Tools

#### [TI Cloud Tools](#)

Start your evaluation and development on a web browser without any installation. Cloud tools also have a downloadable, offline version.

#### [TI Resource Explorer SysConfig](#)

Online portal to TI SDKs. Accessible in CCS IDE or in TI Cloud Tools.

Intuitive GUI to configure device and peripherals, resolve system conflicts, generate configuration code, and automate pin mux settings. Accessible in CCS IDE or in TI Cloud Tools. ([offline version](#))

#### [MSP Academy](#)

Great starting point for all developers to learn about the MSPM0 MCU Platform with training modules that span a wide range of topics. Part of TIRex.

#### [GUI Composer](#)

GUIs that simplify evaluation of certain MSPM0 features, such as configuring and monitoring a fully integrated analog signal chain without any code needed.

### IDE & compiler toolchains

#### [Code Composer Studio™ \(CCS\)](#)

Includes [TI Arm-Clang](#) compiler. Supports all TI Arm Cortex MCUs and boasts competitive code size performance advantages, fast compile time, code coverage support, safety certification support, and completely free to use.

#### [IAR Embedded Workbench® IDE](#)

#### [Keil® MDK IDE](#)

#### [GNU Arm Embedded Toolchain](#)

## 10.4 Documentation Support

To receive notification of documentation updates, navigate to the device product folder on [ti.com](http://ti.com). Click on *Subscribe to updates* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

The following documents describe the MSPM0 MCUs. Copies of these documents are available on the Internet at [www.ti.com](http://www.ti.com).

### Technical Reference Manual

#### [MSPM0 L-Series 32MHz Microcontrollers](#)

This manual describes the modules and peripherals of the family of devices. Each description presents the module or peripheral in a general sense. Not all features

[Technical Reference Manual](#)

and functions of all modules or peripherals are present on all devices. In addition, modules or peripherals can differ in their exact implementation on different devices. Pin functions, internal signal connections, and operational parameters differ from device to device. See the device-specific data sheet for these details.

### 10.5 Support Resources

[TI E2E™ support forums](#) are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

### 10.6 Trademarks

LaunchPad™, Code Composer Studio™, and TI E2E™ are trademarks of Texas Instruments. Arm® and Cortex® are registered trademarks of Arm Limited. All trademarks are the property of their respective owners.

### 10.7 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

### 10.8 Glossary

[TI Glossary](#) This glossary lists and explains terms, acronyms, and definitions.

## 11 Revision History

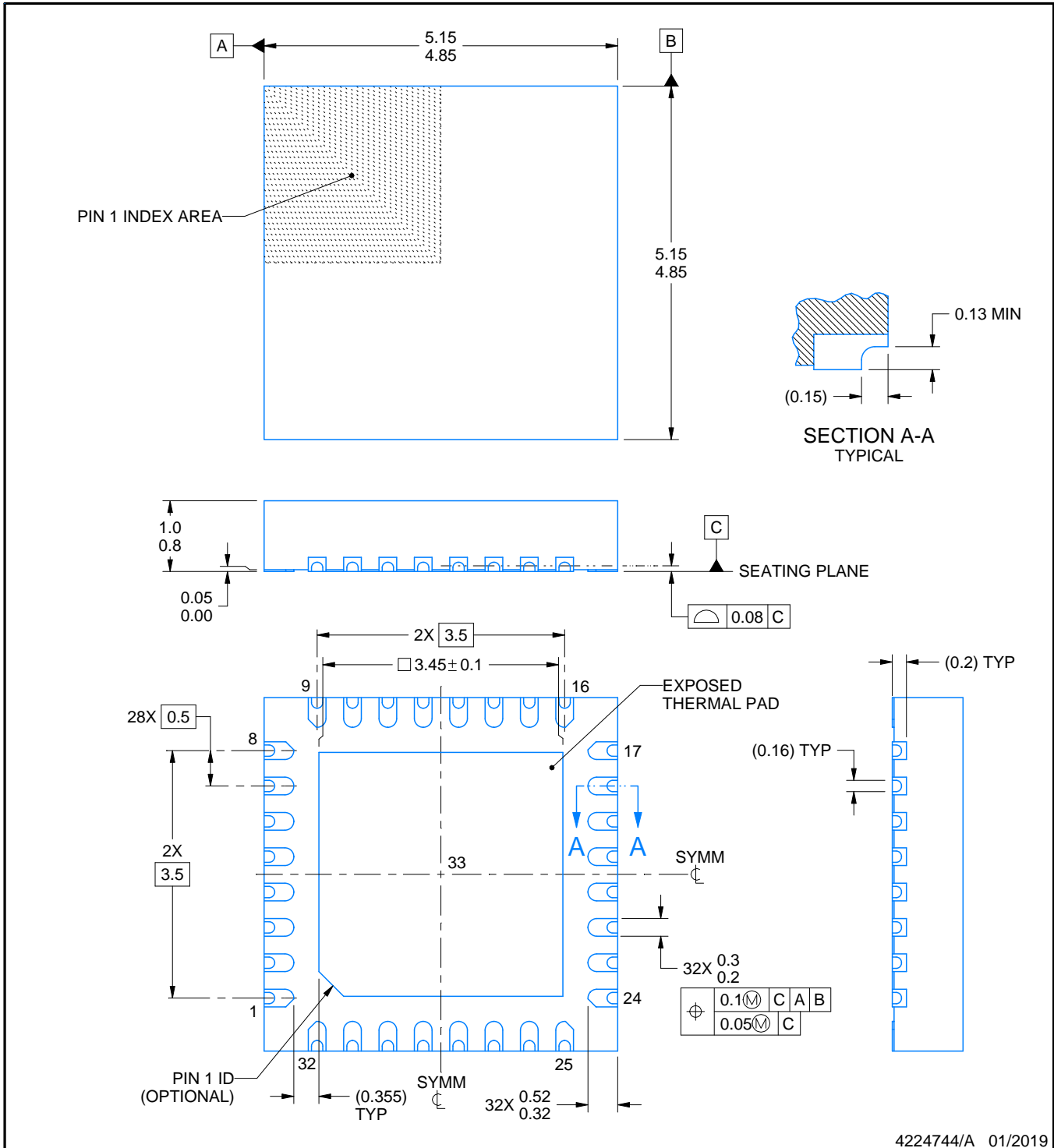
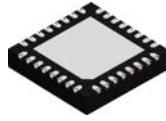
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

### Changes from May 20, 2024 to November 30, 2024 (from Revision \* (May 2024) to Revision A (November2024))

|  | Page |
|--|------|
| • Added column to specify number of communications interfaces for each part number.....                      | 6    |
| • Removed unavailable OPNs.....  | 6    |
| • Corrected pin attributes and descriptions.....   | 7    |
| • Added VBAT specifications for SHUTDOWN mode.....   | 46   |
| • Updated NWECS specification name to reflect what type of endurance is being defined.....                   | 48   |
| • Changed specification to reflect that the user can choose up to 32 sectors from any area of the flash..... | 48   |
| • Updated endurance specification units to indicate number of cycles per sector.....                         | 48   |
| • Updated NWECS specification name to reflect what type of endurance is being defined.....                   | 48   |
| • Updated endurance specification units to indicate number of cycles per sector.....                         | 48   |
| • Updated current from 75uA to 100uA.....  | 51   |
| • Updated spec from 460uA to 570uA, and removed max spec.....  | 54   |
| • Changed sample-and-hold capacitance from 3.3pF to 4.3pF.....   | 54   |
| • Changed DC PSRR from 60 to 68.....   | 54   |
| • Changed AC PSRR from 49 to 55.....   | 54   |
| • Removed I2C PD0 test condition because I2C is only in PD0.....   | 61   |
| • Split out register base addresses for TIO and SPM, and made corrections to the sizes.....                  | 73   |
| • Added "Support for custom polynomials" to CRC feature list.....  | 81   |

## 12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.



NOTES:

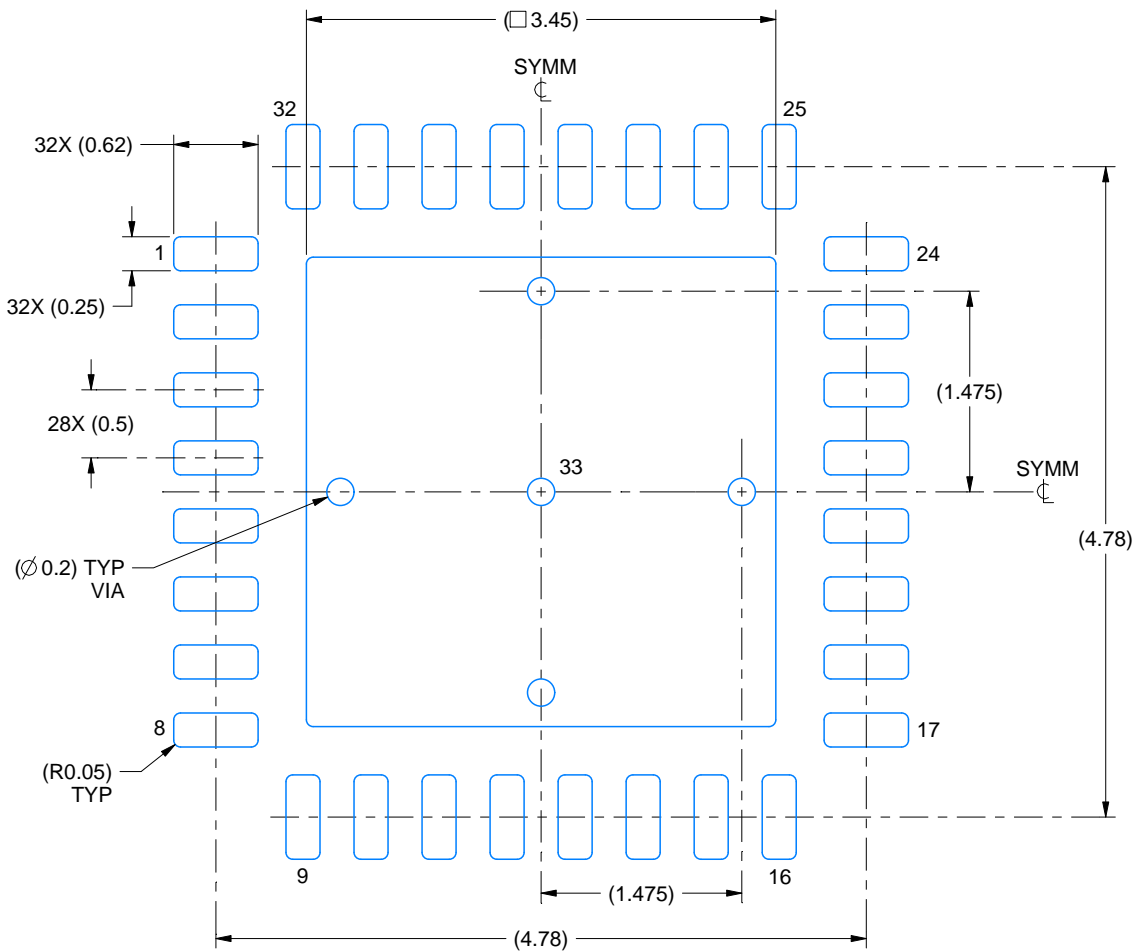
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

# EXAMPLE BOARD LAYOUT

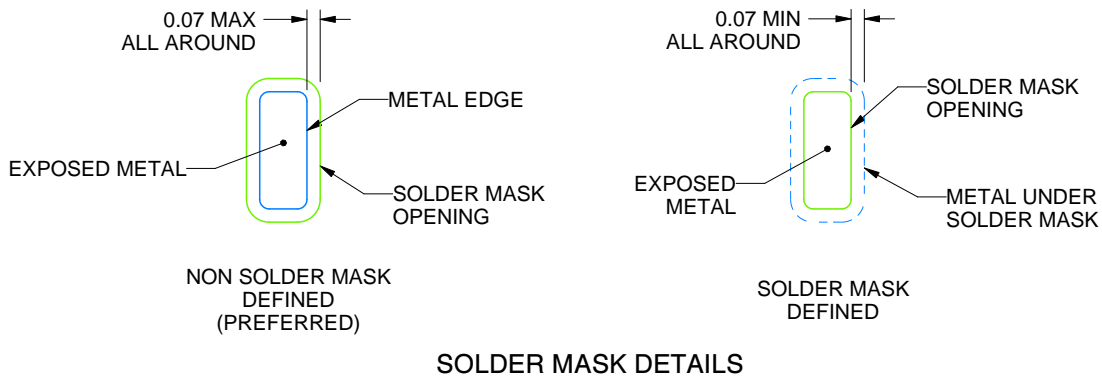
RHB0032T

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:18X



SOLDER MASK DETAILS

4224744/A 01/2019

NOTES: (continued)

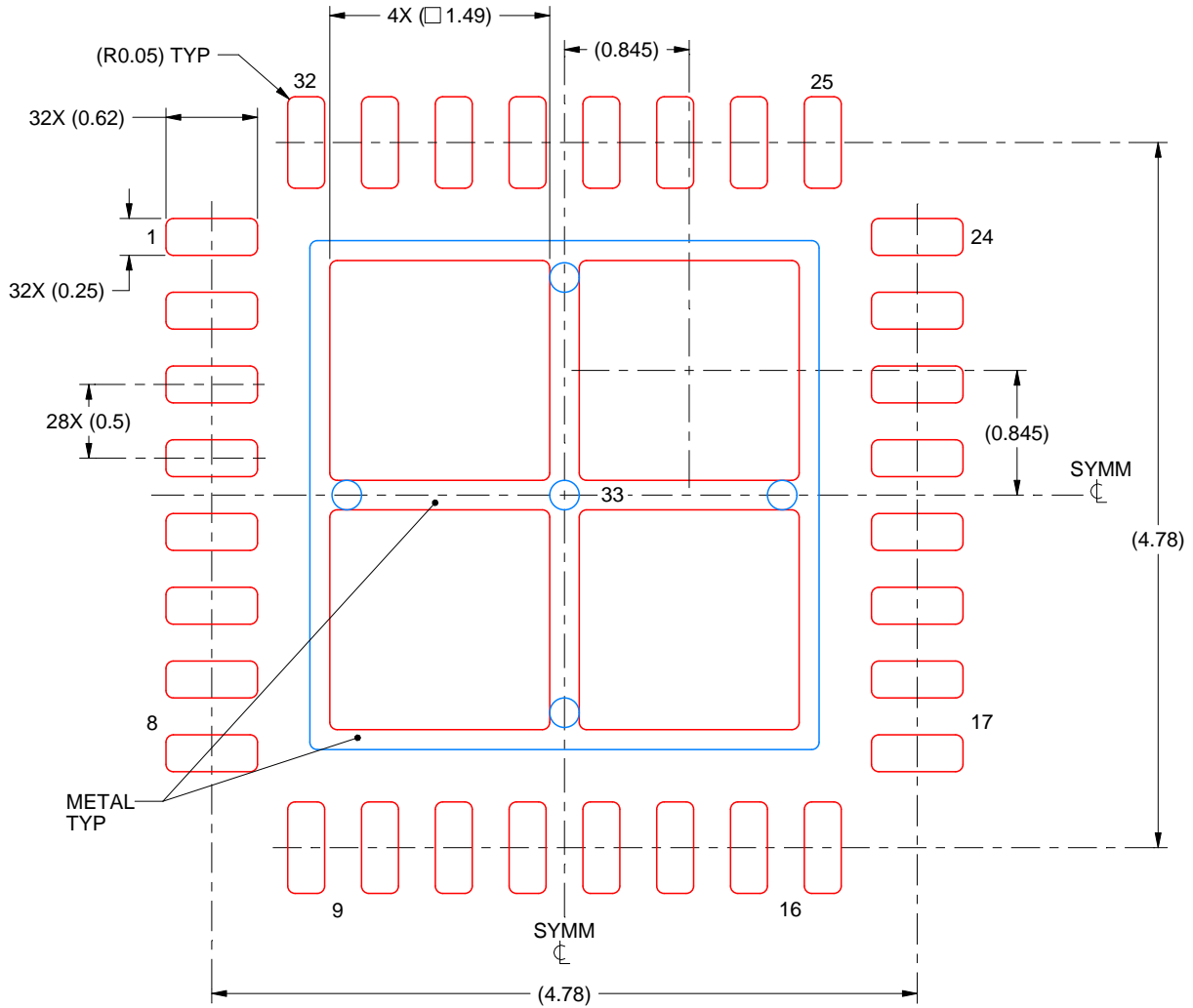
- This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/sluea271](http://www.ti.com/lit/sluea271)).
- Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

# EXAMPLE STENCIL DESIGN

RHB0032T

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



**SOLDER PASTE EXAMPLE**  
 BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 33:  
 75% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE  
 SCALE:20X

4224744/A 01/2019

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

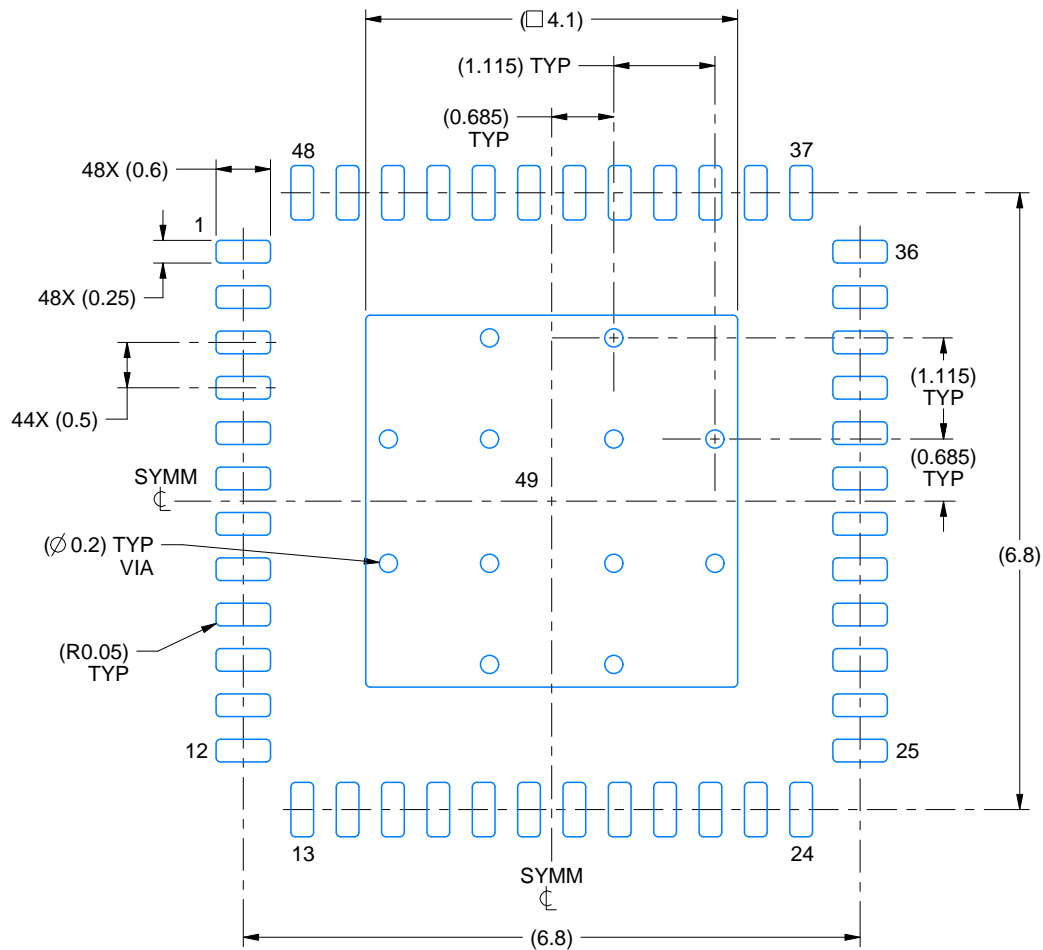


# EXAMPLE BOARD LAYOUT

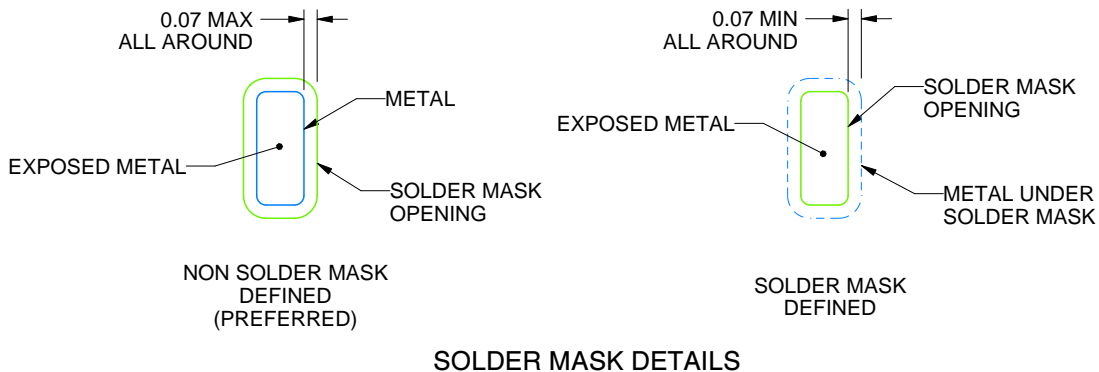
**RGZ0048F**

**VQFN - 1 mm max height**

PLASTIC QUAD FLATPACK - NO LEAD



**LAND PATTERN EXAMPLE**  
EXPOSED METAL SHOWN  
SCALE:12X



**SOLDER MASK DETAILS**

4229427/A 02/2023

NOTES: (continued)

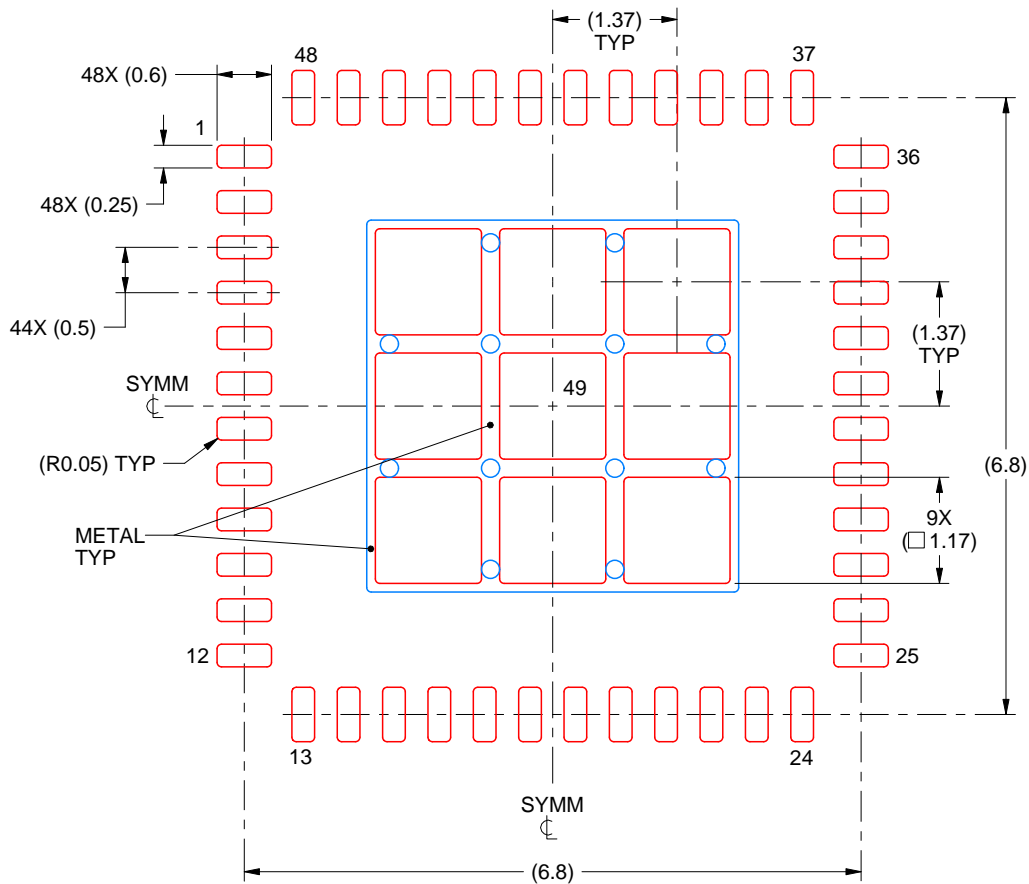
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/slua271](http://www.ti.com/lit/slua271)).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

# EXAMPLE STENCIL DESIGN

RGZ0048F

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



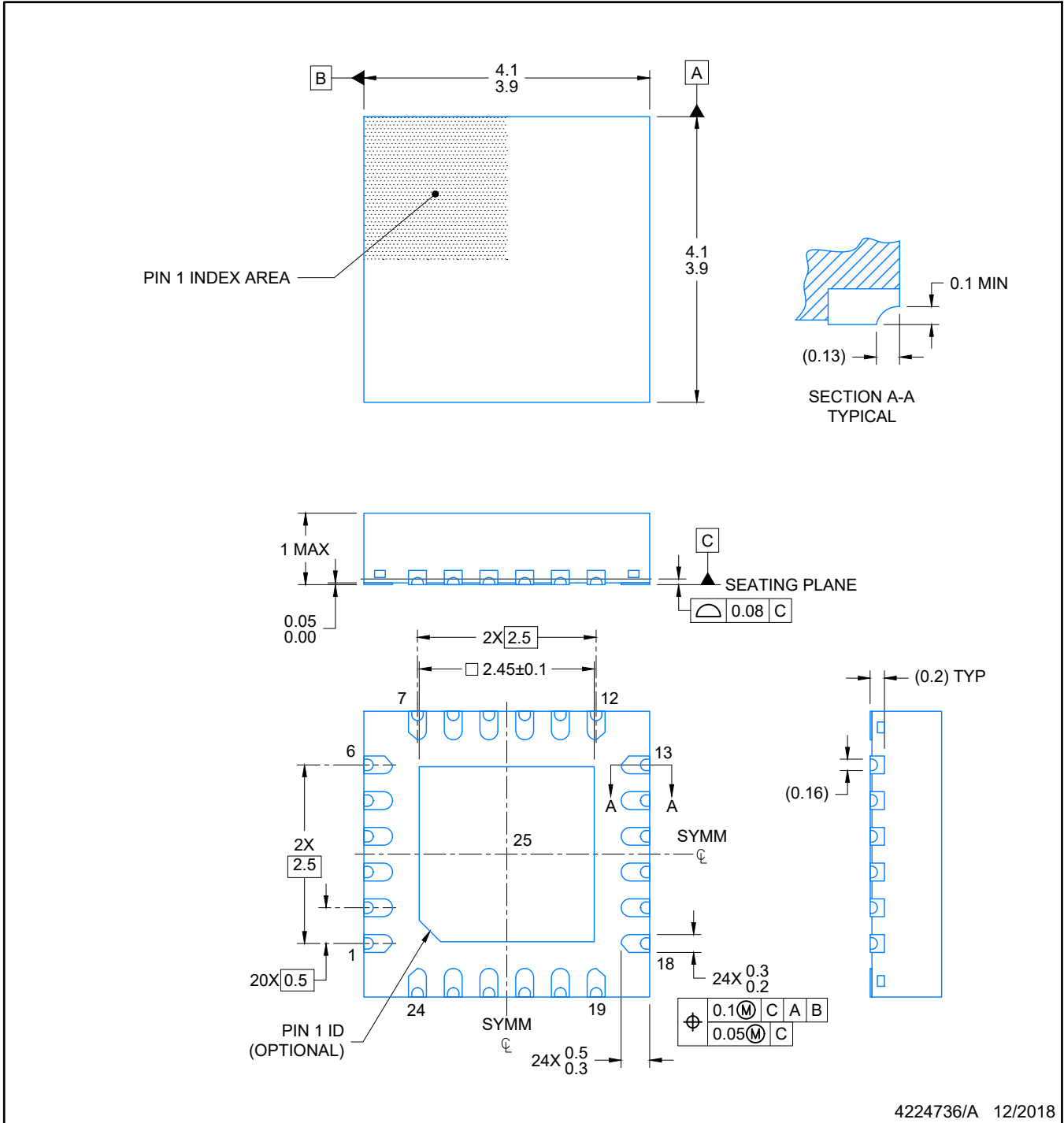
## SOLDER PASTE EXAMPLE BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 49  
73% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE  
SCALE:12X

4229427/A 02/2023

NOTES: (continued)

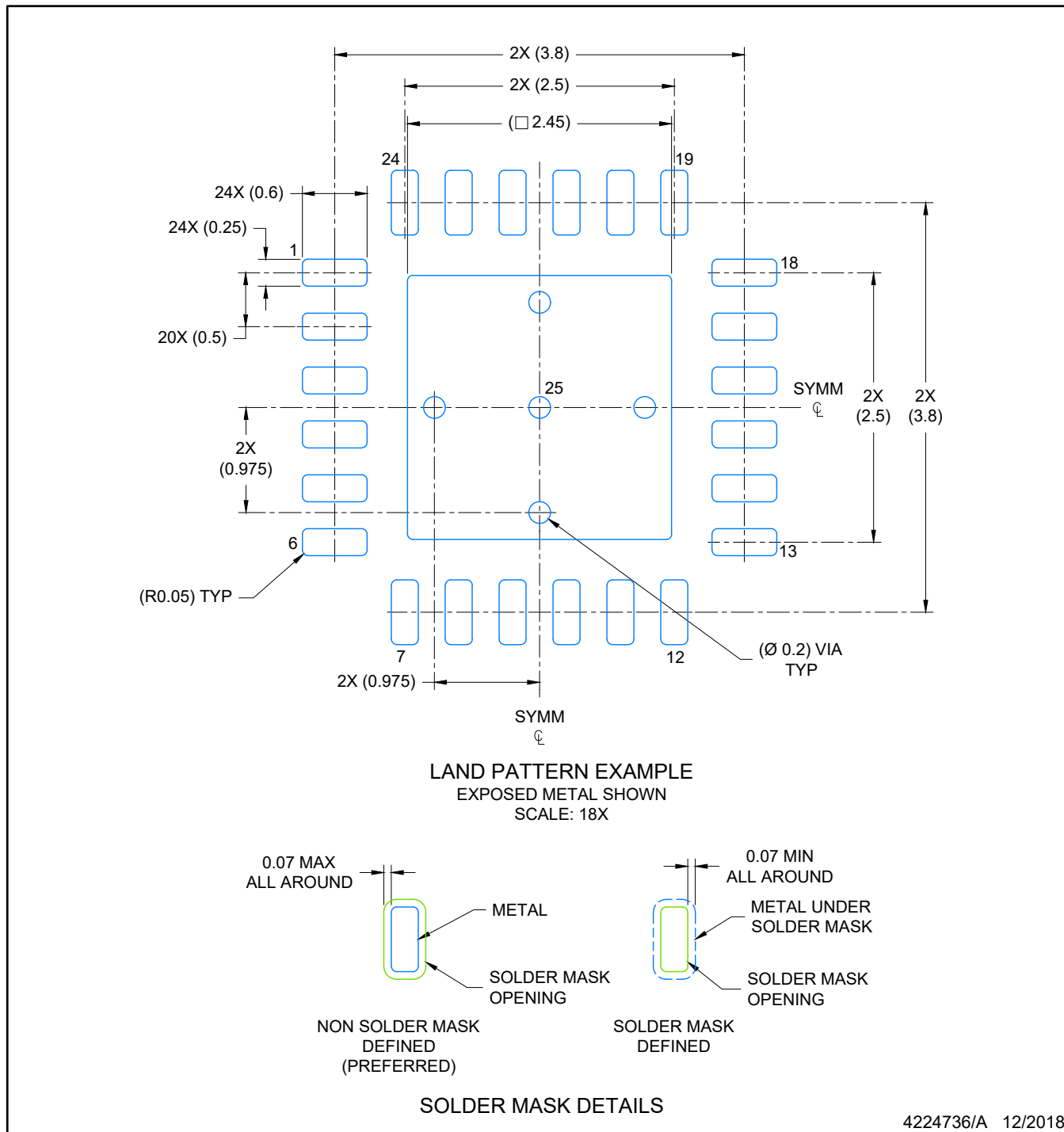
6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.



4224736/A 12/2018

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for optimal thermal and mechanical performance.



NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/sluea271](http://www.ti.com/lit/sluea271)).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.



**PACKAGING INFORMATION**

| Orderable part number          | Status<br>(1) | Material type<br>(2) | Package   Pins  | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|--------------------------------|---------------|----------------------|-----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| <a href="#">M0L1227QPMRQ1</a>  | Active        | Production           | LQFP (PM)   64  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L1227Q            |
| M0L1227QPMRQ1.A                | Active        | Production           | LQFP (PM)   64  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L1227Q            |
| M0L1227QPMRQ1.B                | Active        | Production           | LQFP (PM)   64  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L1227Q            |
| <a href="#">M0L1227QPNRQ1</a>  | Active        | Production           | LQFP (PN)   80  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-3-260C-168 HR               | -40 to 125   | M0L1227Q            |
| M0L1227QPNRQ1.A                | Active        | Production           | LQFP (PN)   80  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-3-260C-168 HR               | -40 to 125   | M0L1227Q            |
| M0L1227QPNRQ1.B                | Active        | Production           | LQFP (PN)   80  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-3-260C-168 HR               | -40 to 125   | M0L1227Q            |
| <a href="#">M0L1227QPTRQ1</a>  | Active        | Production           | LQFP (PT)   48  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L1227Q            |
| M0L1227QPTRQ1.A                | Active        | Production           | LQFP (PT)   48  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L1227Q            |
| M0L1227QPTRQ1.B                | Active        | Production           | LQFP (PT)   48  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L1227Q            |
| <a href="#">M0L1227QRGERQ1</a> | Active        | Production           | VQFN (RGE)   24 | 5000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | MSPM0<br>L1227Q     |
| M0L1227QRGERQ1.A               | Active        | Production           | VQFN (RGE)   24 | 5000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | MSPM0<br>L1227Q     |
| M0L1227QRGERQ1.B               | Active        | Production           | VQFN (RGE)   24 | 5000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | MSPM0<br>L1227Q     |
| <a href="#">M0L1227QRGZRQ1</a> | Active        | Production           | VQFN (RGZ)   48 | 4000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | MSPM0<br>L1227Q     |
| M0L1227QRGZRQ1.A               | Active        | Production           | VQFN (RGZ)   48 | 4000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | MSPM0<br>L1227Q     |
| M0L1227QRGZRQ1.B               | Active        | Production           | VQFN (RGZ)   48 | 4000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | MSPM0<br>L1227Q     |
| <a href="#">M0L1227QRHBRQ1</a> | Active        | Production           | VQFN (RHB)   32 | 5000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | MSPM0<br>L1227Q     |
| M0L1227QRHBRQ1.A               | Active        | Production           | VQFN (RHB)   32 | 5000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | MSPM0<br>L1227Q     |
| M0L1227QRHBRQ1.B               | Active        | Production           | VQFN (RHB)   32 | 5000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | MSPM0<br>L1227Q     |
| <a href="#">M0L1228QPMRQ1</a>  | Active        | Production           | LQFP (PM)   64  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L1228Q            |
| M0L1228QPMRQ1.A                | Active        | Production           | LQFP (PM)   64  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L1228Q            |
| M0L1228QPMRQ1.B                | Active        | Production           | LQFP (PM)   64  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L1228Q            |
| <a href="#">M0L1228QPNRQ1</a>  | Active        | Production           | LQFP (PN)   80  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-3-260C-168 HR               | -40 to 125   | M0L1228Q            |

| Orderable part number          | Status<br>(1) | Material type<br>(2) | Package   Pins  | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|--------------------------------|---------------|----------------------|-----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| M0L1228QPNRQ1.A                | Active        | Production           | LQFP (PN)   80  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-3-260C-168 HR               | -40 to 125   | M0L1228Q            |
| M0L1228QPNRQ1.B                | Active        | Production           | LQFP (PN)   80  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-3-260C-168 HR               | -40 to 125   | M0L1228Q            |
| <a href="#">M0L1228QPTRQ1</a>  | Active        | Production           | LQFP (PT)   48  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L1228Q            |
| M0L1228QPTRQ1.A                | Active        | Production           | LQFP (PT)   48  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L1228Q            |
| M0L1228QPTRQ1.B                | Active        | Production           | LQFP (PT)   48  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L1228Q            |
| <a href="#">M0L1228QRGERQ1</a> | Active        | Production           | VQFN (RGE)   24 | 5000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | MSPM0<br>L1228Q     |
| M0L1228QRGERQ1.A               | Active        | Production           | VQFN (RGE)   24 | 5000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | MSPM0<br>L1228Q     |
| M0L1228QRGERQ1.B               | Active        | Production           | VQFN (RGE)   24 | 5000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | MSPM0<br>L1228Q     |
| <a href="#">M0L1228QRGZRQ1</a> | Active        | Production           | VQFN (RGZ)   48 | 4000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | MSPM0<br>L1228Q     |
| M0L1228QRGZRQ1.A               | Active        | Production           | VQFN (RGZ)   48 | 4000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | MSPM0<br>L1228Q     |
| M0L1228QRGZRQ1.B               | Active        | Production           | VQFN (RGZ)   48 | 4000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | MSPM0<br>L1228Q     |
| <a href="#">M0L1228QRHBRQ1</a> | Active        | Production           | VQFN (RHB)   32 | 5000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | MSPM0<br>L1228Q     |
| M0L1228QRHBRQ1.A               | Active        | Production           | VQFN (RHB)   32 | 5000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | MSPM0<br>L1228Q     |
| M0L1228QRHBRQ1.B               | Active        | Production           | VQFN (RHB)   32 | 5000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | MSPM0<br>L1228Q     |
| <a href="#">M0L2227QPMRQ1</a>  | Active        | Production           | LQFP (PM)   64  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L2227Q            |
| M0L2227QPMRQ1.A                | Active        | Production           | LQFP (PM)   64  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L2227Q            |
| M0L2227QPMRQ1.B                | Active        | Production           | LQFP (PM)   64  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L2227Q            |
| <a href="#">M0L2227QPNRQ1</a>  | Active        | Production           | LQFP (PN)   80  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-3-260C-168 HR               | -40 to 125   | M0L2227Q            |
| M0L2227QPNRQ1.A                | Active        | Production           | LQFP (PN)   80  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-3-260C-168 HR               | -40 to 125   | M0L2227Q            |
| M0L2227QPNRQ1.B                | Active        | Production           | LQFP (PN)   80  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-3-260C-168 HR               | -40 to 125   | M0L2227Q            |
| <a href="#">M0L2227QPTRQ1</a>  | Active        | Production           | LQFP (PT)   48  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L2227Q            |
| M0L2227QPTRQ1.A                | Active        | Production           | LQFP (PT)   48  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L2227Q            |
| M0L2227QPTRQ1.B                | Active        | Production           | LQFP (PT)   48  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L2227Q            |
| <a href="#">M0L2228QPMRQ1</a>  | Active        | Production           | LQFP (PM)   64  | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L2228Q            |

| Orderable part number         | Status<br>(1) | Material type<br>(2) | Package   Pins | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|-------------------------------|---------------|----------------------|----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| M0L2228QPMRQ1.A               | Active        | Production           | LQFP (PM)   64 | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L2228Q            |
| M0L2228QPMRQ1.B               | Active        | Production           | LQFP (PM)   64 | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L2228Q            |
| <a href="#">M0L2228QPNRQ1</a> | Active        | Production           | LQFP (PN)   80 | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-3-260C-168 HR               | -40 to 125   | M0L2228Q            |
| M0L2228QPNRQ1.A               | Active        | Production           | LQFP (PN)   80 | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-3-260C-168 HR               | -40 to 125   | M0L2228Q            |
| M0L2228QPNRQ1.B               | Active        | Production           | LQFP (PN)   80 | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-3-260C-168 HR               | -40 to 125   | M0L2228Q            |
| <a href="#">M0L2228QPTRQ1</a> | Active        | Production           | LQFP (PT)   48 | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L2228Q            |
| M0L2228QPTRQ1.A               | Active        | Production           | LQFP (PT)   48 | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L2228Q            |
| M0L2228QPTRQ1.B               | Active        | Production           | LQFP (PT)   48 | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | M0L2228Q            |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "-" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

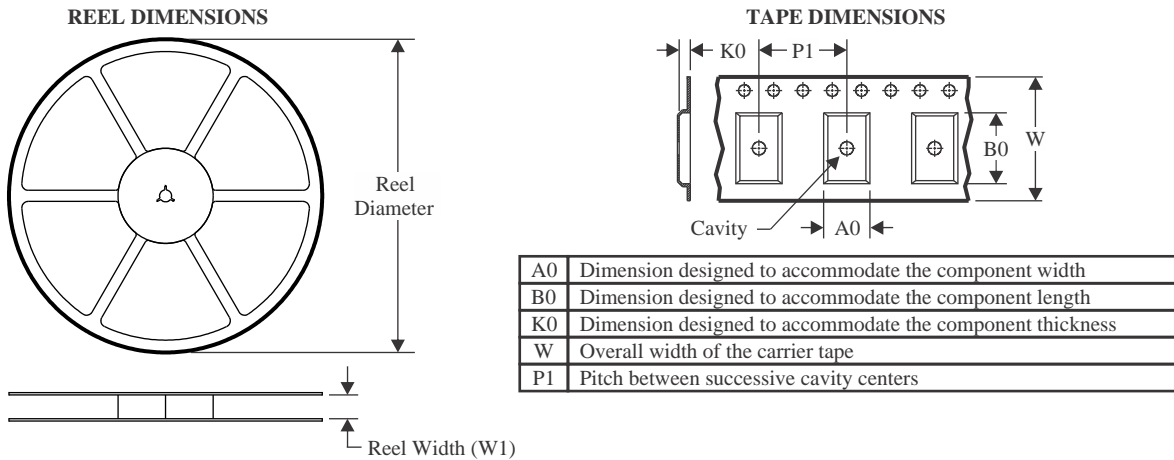
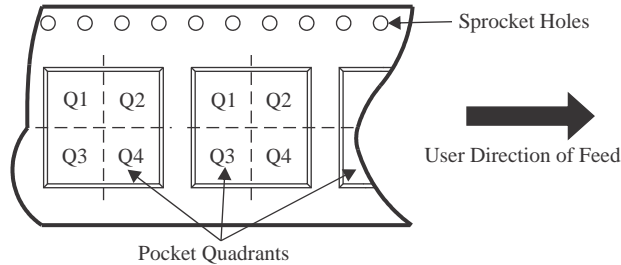
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF MSPM0L1227-Q1, MSPM0L1228-Q1, MSPM0L2227-Q1, MSPM0L2228-Q1 :**

- Catalog : [MSPM0L1227](#), [MSPM0L1228](#), [MSPM0L2227](#), [MSPM0L2228](#)

## NOTE: Qualified Version Definitions:

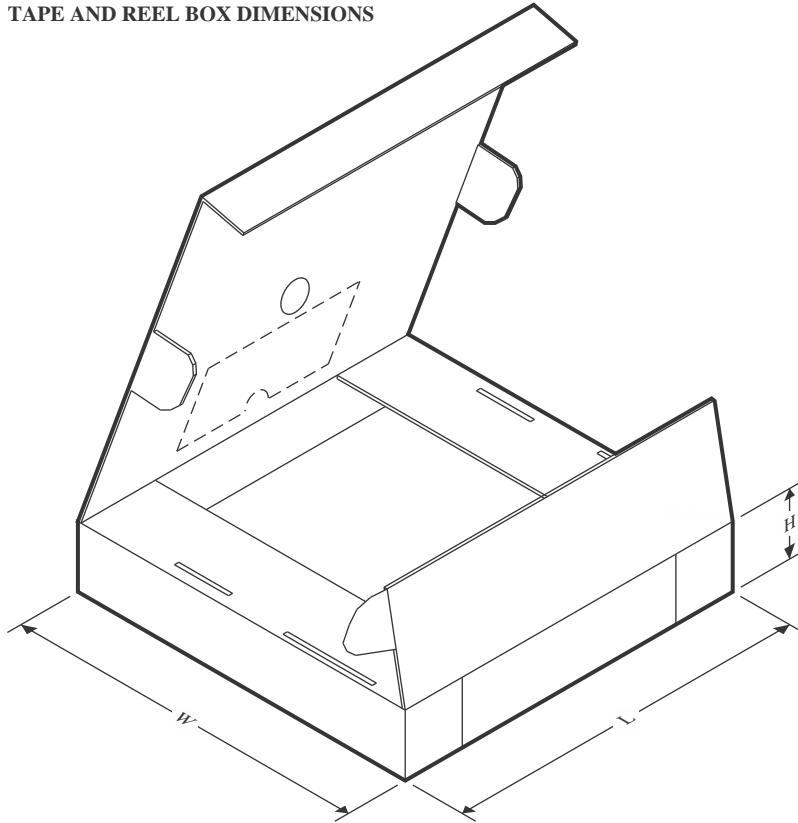
- Catalog - TI's standard catalog product

**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


\*All dimensions are nominal

| Device         | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| M0L1227QPMRQ1  | LQFP         | PM              | 64   | 1000 | 330.0              | 24.4               | 12.5    | 12.5    | 2.2     | 16.0    | 24.0   | Q2            |
| M0L1227QPNRQ1  | LQFP         | PN              | 80   | 1000 | 330.0              | 24.4               | 16.0    | 16.0    | 2.0     | 24.0    | 24.0   | Q2            |
| M0L1227QPTRQ1  | LQFP         | PT              | 48   | 1000 | 330.0              | 16.4               | 9.6     | 9.6     | 1.9     | 12.0    | 16.0   | Q2            |
| M0L1227QRGERQ1 | VQFN         | RGE             | 24   | 5000 | 330.0              | 12.4               | 4.25    | 4.25    | 1.15    | 8.0     | 12.0   | Q2            |
| M0L1227QRGZRQ1 | VQFN         | RGZ             | 48   | 4000 | 330.0              | 16.4               | 7.3     | 7.3     | 1.1     | 12.0    | 16.0   | Q2            |
| M0L1227QRHBRQ1 | VQFN         | RHB             | 32   | 5000 | 330.0              | 12.4               | 5.3     | 5.3     | 1.1     | 8.0     | 12.0   | Q2            |
| M0L1228QPMRQ1  | LQFP         | PM              | 64   | 1000 | 330.0              | 24.4               | 12.5    | 12.5    | 2.2     | 16.0    | 24.0   | Q2            |
| M0L1228QPNRQ1  | LQFP         | PN              | 80   | 1000 | 330.0              | 24.4               | 16.0    | 16.0    | 2.0     | 24.0    | 24.0   | Q2            |
| M0L1228QPTRQ1  | LQFP         | PT              | 48   | 1000 | 330.0              | 16.4               | 9.6     | 9.6     | 1.9     | 12.0    | 16.0   | Q2            |
| M0L1228QRGERQ1 | VQFN         | RGE             | 24   | 5000 | 330.0              | 12.4               | 4.25    | 4.25    | 1.15    | 8.0     | 12.0   | Q2            |
| M0L1228QRGZRQ1 | VQFN         | RGZ             | 48   | 4000 | 330.0              | 16.4               | 7.3     | 7.3     | 1.1     | 12.0    | 16.0   | Q2            |
| M0L1228QRHBRQ1 | VQFN         | RHB             | 32   | 5000 | 330.0              | 12.4               | 5.3     | 5.3     | 1.1     | 8.0     | 12.0   | Q2            |
| M0L2227QPMRQ1  | LQFP         | PM              | 64   | 1000 | 330.0              | 24.4               | 12.5    | 12.5    | 2.2     | 16.0    | 24.0   | Q2            |
| M0L2227QPNRQ1  | LQFP         | PN              | 80   | 1000 | 330.0              | 24.4               | 16.0    | 16.0    | 2.0     | 24.0    | 24.0   | Q2            |
| M0L2227QPTRQ1  | LQFP         | PT              | 48   | 1000 | 330.0              | 16.4               | 9.6     | 9.6     | 1.9     | 12.0    | 16.0   | Q2            |
| M0L2228QPMRQ1  | LQFP         | PM              | 64   | 1000 | 330.0              | 24.4               | 12.5    | 12.5    | 2.2     | 16.0    | 24.0   | Q2            |

| Device        | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| M0L2228QPNRQ1 | LQFP         | PN              | 80   | 1000 | 330.0              | 24.4               | 16.0    | 16.0    | 2.0     | 24.0    | 24.0   | Q2            |
| M0L2228QPTRQ1 | LQFP         | PT              | 48   | 1000 | 330.0              | 16.4               | 9.6     | 9.6     | 1.9     | 12.0    | 16.0   | Q2            |

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

| Device         | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| M0L1227QPMRQ1  | LQFP         | PM              | 64   | 1000 | 336.6       | 336.6      | 41.3        |
| M0L1227QPNRQ1  | LQFP         | PN              | 80   | 1000 | 367.0       | 367.0      | 55.0        |
| M0L1227QPTRQ1  | LQFP         | PT              | 48   | 1000 | 336.6       | 336.6      | 31.8        |
| M0L1227QRGERQ1 | VQFN         | RGE             | 24   | 5000 | 367.0       | 367.0      | 35.0        |
| M0L1227QRGZRQ1 | VQFN         | RGZ             | 48   | 4000 | 367.0       | 367.0      | 35.0        |
| M0L1227QRHBRQ1 | VQFN         | RHB             | 32   | 5000 | 367.0       | 367.0      | 35.0        |
| M0L1228QPMRQ1  | LQFP         | PM              | 64   | 1000 | 336.6       | 336.6      | 41.3        |
| M0L1228QPNRQ1  | LQFP         | PN              | 80   | 1000 | 367.0       | 367.0      | 55.0        |
| M0L1228QPTRQ1  | LQFP         | PT              | 48   | 1000 | 336.6       | 336.6      | 31.8        |
| M0L1228QRGERQ1 | VQFN         | RGE             | 24   | 5000 | 367.0       | 367.0      | 35.0        |
| M0L1228QRGZRQ1 | VQFN         | RGZ             | 48   | 4000 | 367.0       | 367.0      | 35.0        |
| M0L1228QRHBRQ1 | VQFN         | RHB             | 32   | 5000 | 367.0       | 367.0      | 35.0        |
| M0L2227QPMRQ1  | LQFP         | PM              | 64   | 1000 | 336.6       | 336.6      | 41.3        |
| M0L2227QPNRQ1  | LQFP         | PN              | 80   | 1000 | 367.0       | 367.0      | 55.0        |
| M0L2227QPTRQ1  | LQFP         | PT              | 48   | 1000 | 336.6       | 336.6      | 31.8        |
| M0L2228QPMRQ1  | LQFP         | PM              | 64   | 1000 | 336.6       | 336.6      | 41.3        |
| M0L2228QPNRQ1  | LQFP         | PN              | 80   | 1000 | 367.0       | 367.0      | 55.0        |
| M0L2228QPTRQ1  | LQFP         | PT              | 48   | 1000 | 336.6       | 336.6      | 31.8        |

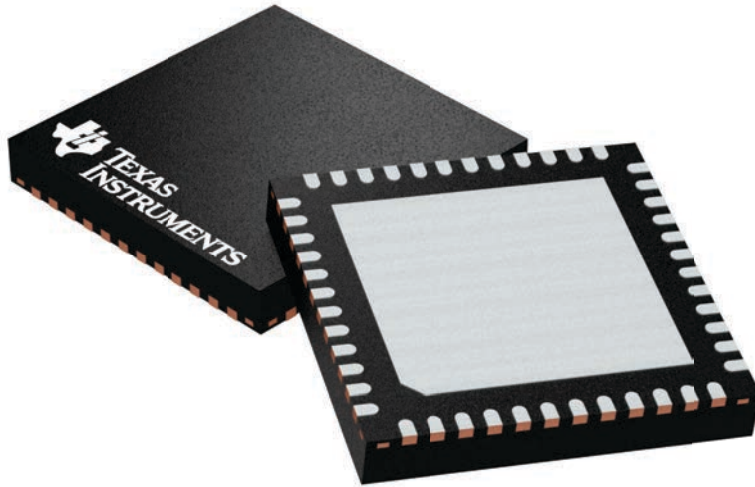
## GENERIC PACKAGE VIEW

**RGZ 48**

**VQFN - 1 mm max height**

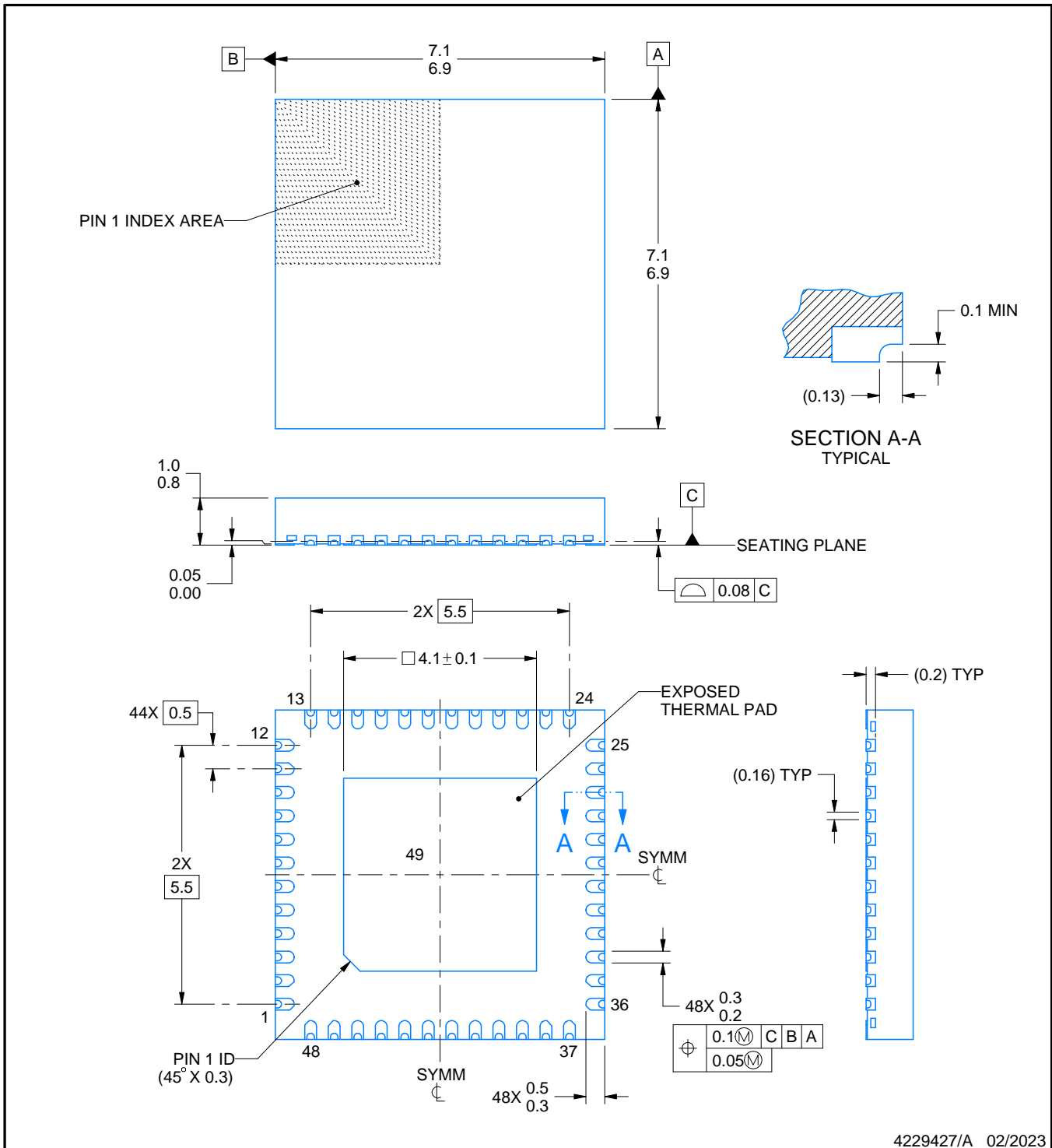
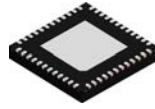
7 x 7, 0.5 mm pitch

PLASTIC QUADFLAT PACK- NO LEAD



Images above are just a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.

4224671/A



4229427/A 02/2023

NOTES:

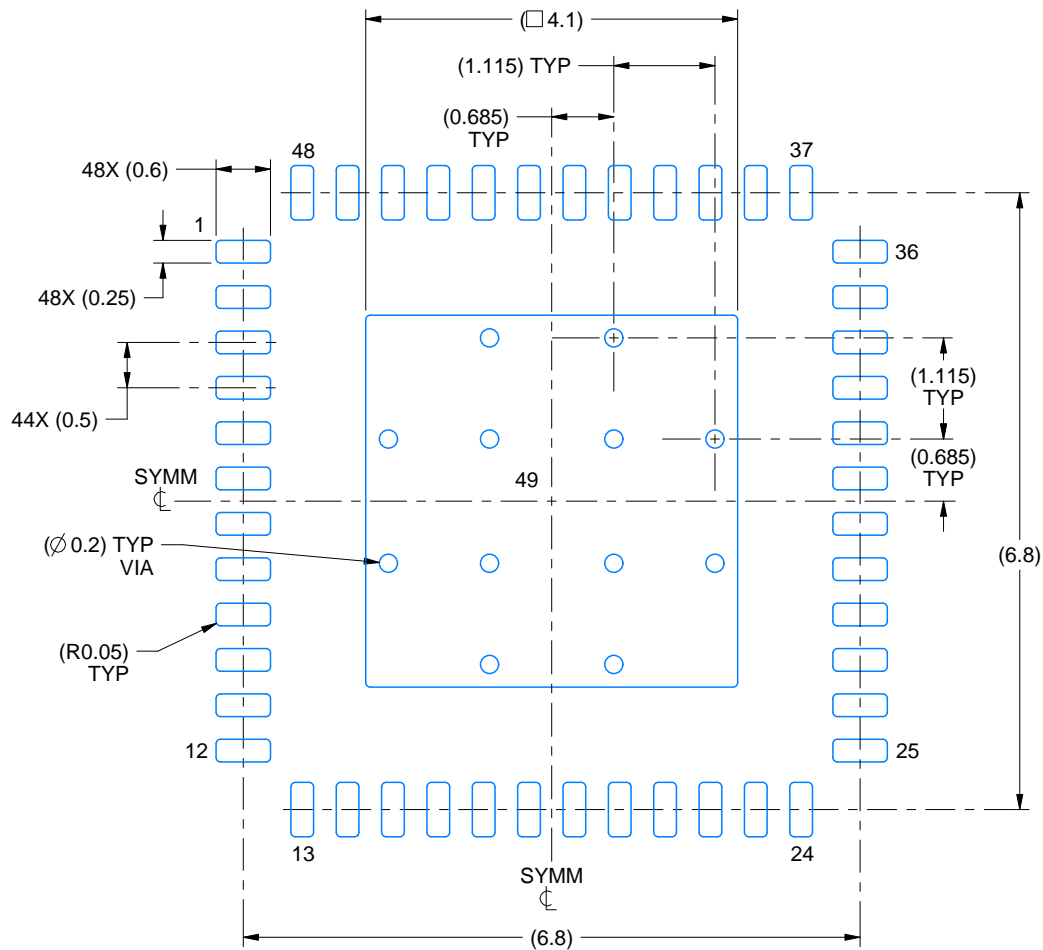
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

# EXAMPLE BOARD LAYOUT

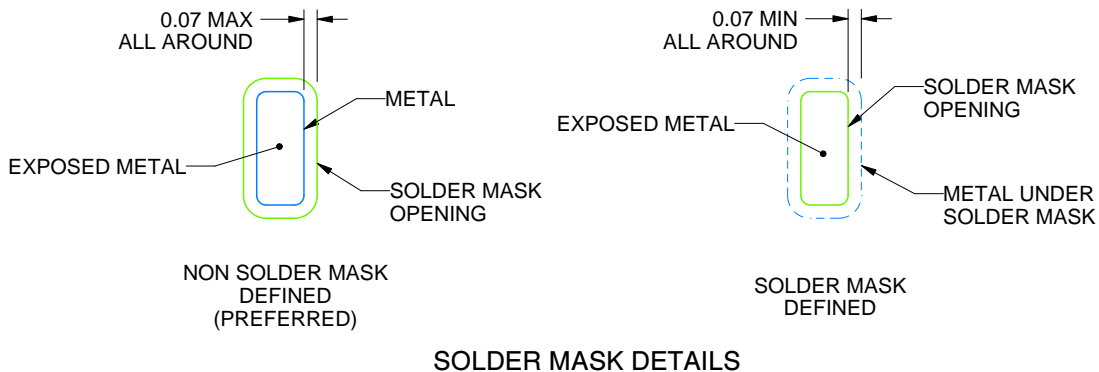
RGZ0048F

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:12X



SOLDER MASK DETAILS

4229427/A 02/2023

NOTES: (continued)

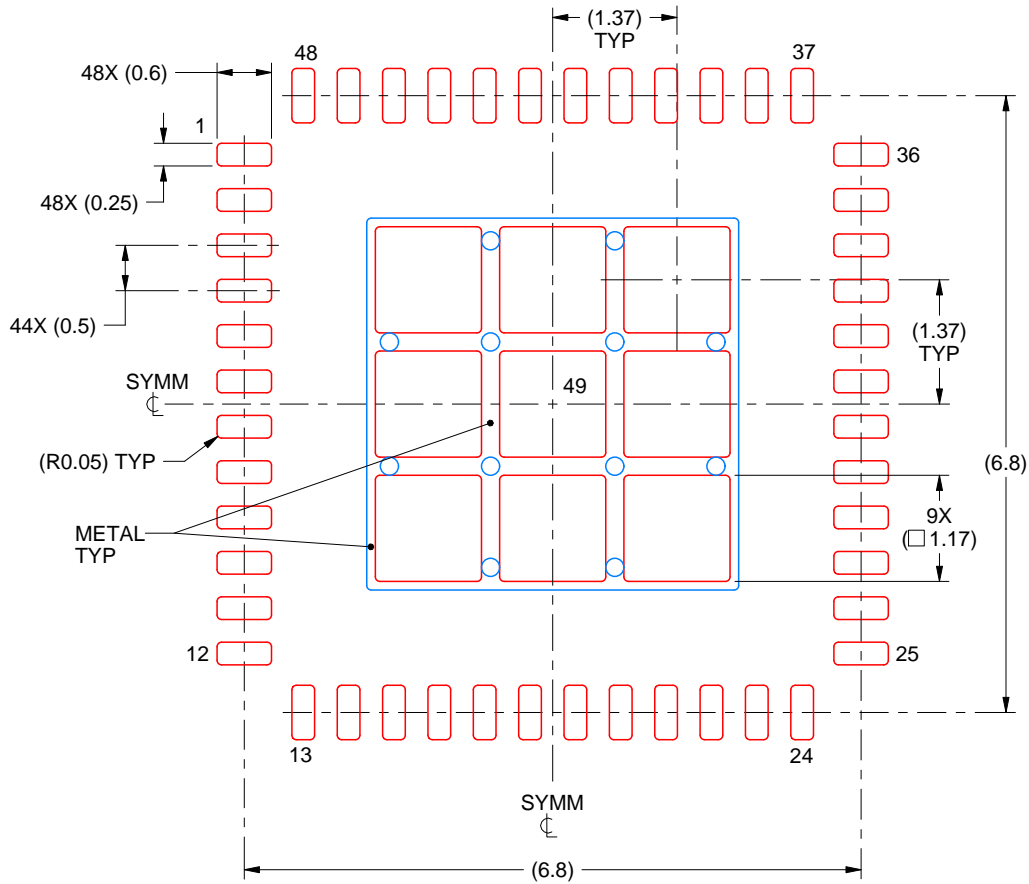
- This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/slua271](http://www.ti.com/lit/slua271)).
- Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

# EXAMPLE STENCIL DESIGN

RGZ0048F

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



**SOLDER PASTE EXAMPLE**  
 BASED ON 0.125 mm THICK STENCIL

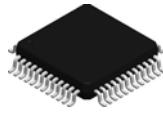
EXPOSED PAD 49  
 73% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE  
 SCALE:12X

4229427/A 02/2023

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

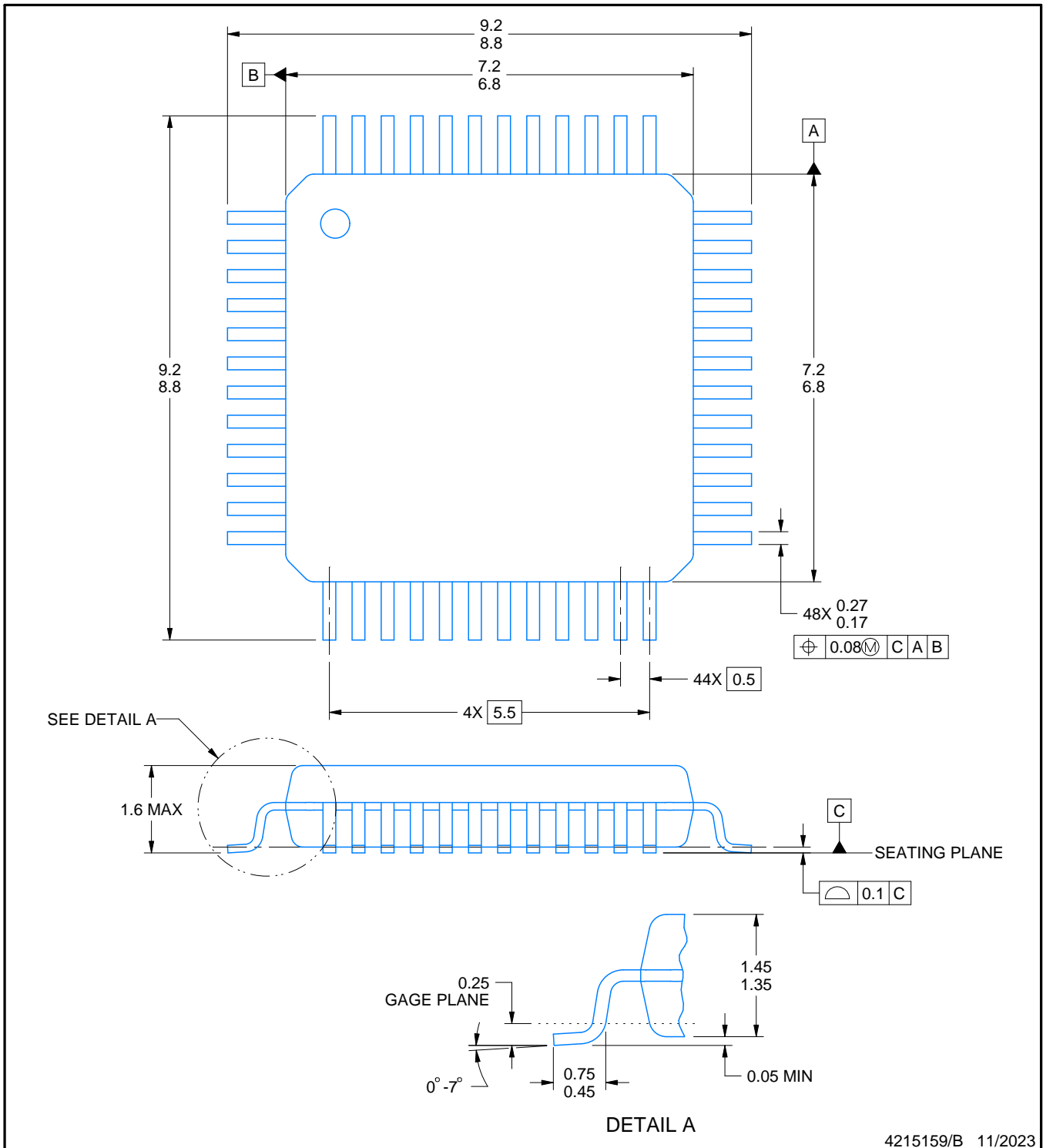
PT0048A



# PACKAGE OUTLINE

LQFP - 1.6 mm max height

LOW PROFILE QUAD FLATPACK



4215159/B 11/2023

NOTES:

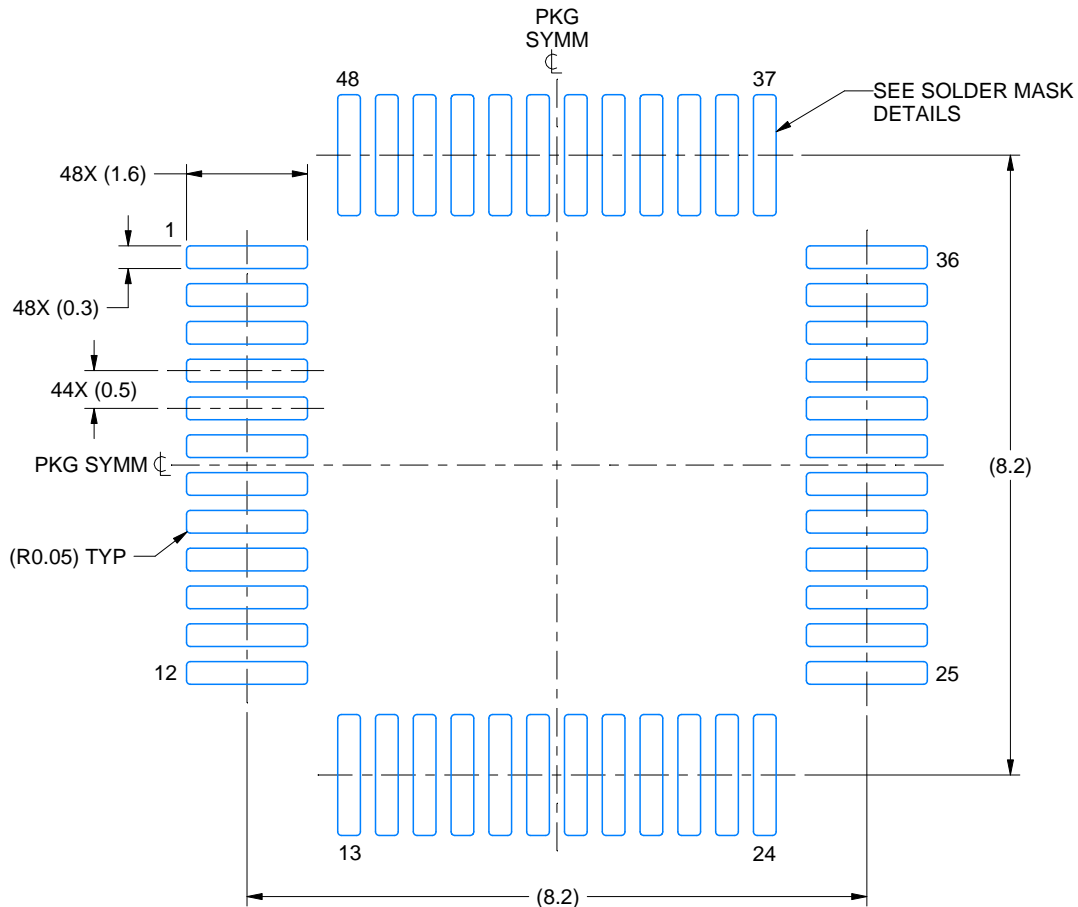
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC registration MS-026.
4. This may also be a thermally enhanced plastic package with leads connected to the die pads.

# EXAMPLE BOARD LAYOUT

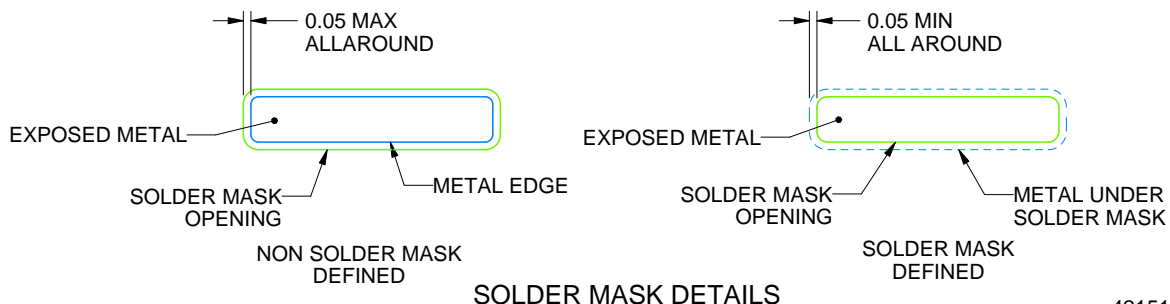
PT0048A

LQFP - 1.6 mm max height

LOW PROFILE QUAD FLATPACK



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE 10.000



SOLDER MASK DETAILS

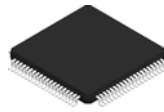
4215159/B 11/2023

NOTES: (continued)

- 5. Publication IPC-7351 may have alternate designs.
- 6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



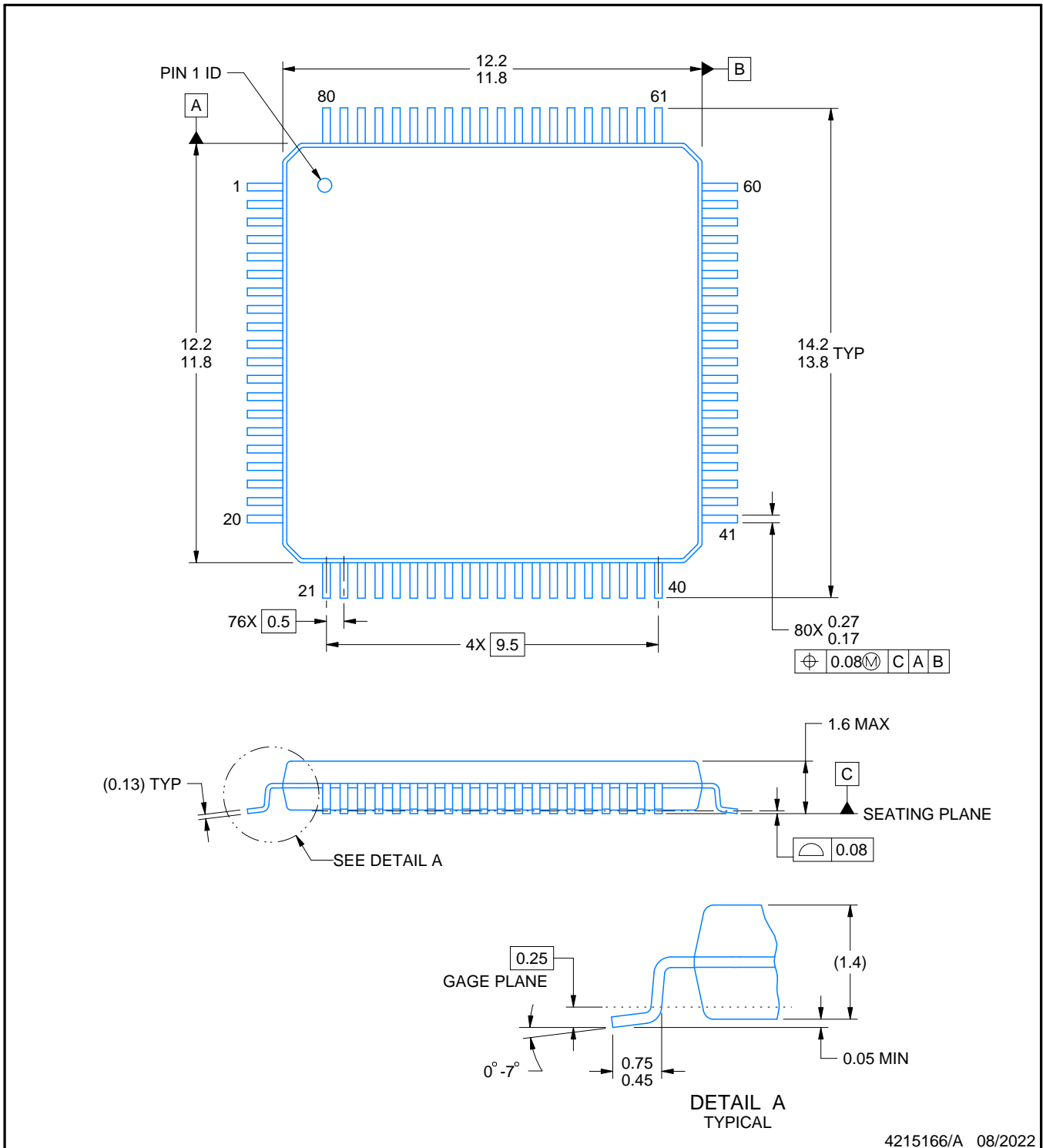
# PN0080A



# PACKAGE OUTLINE

LQFP - 1.6 mm max height

PLASTIC QUAD FLATPACK



**NOTES:**

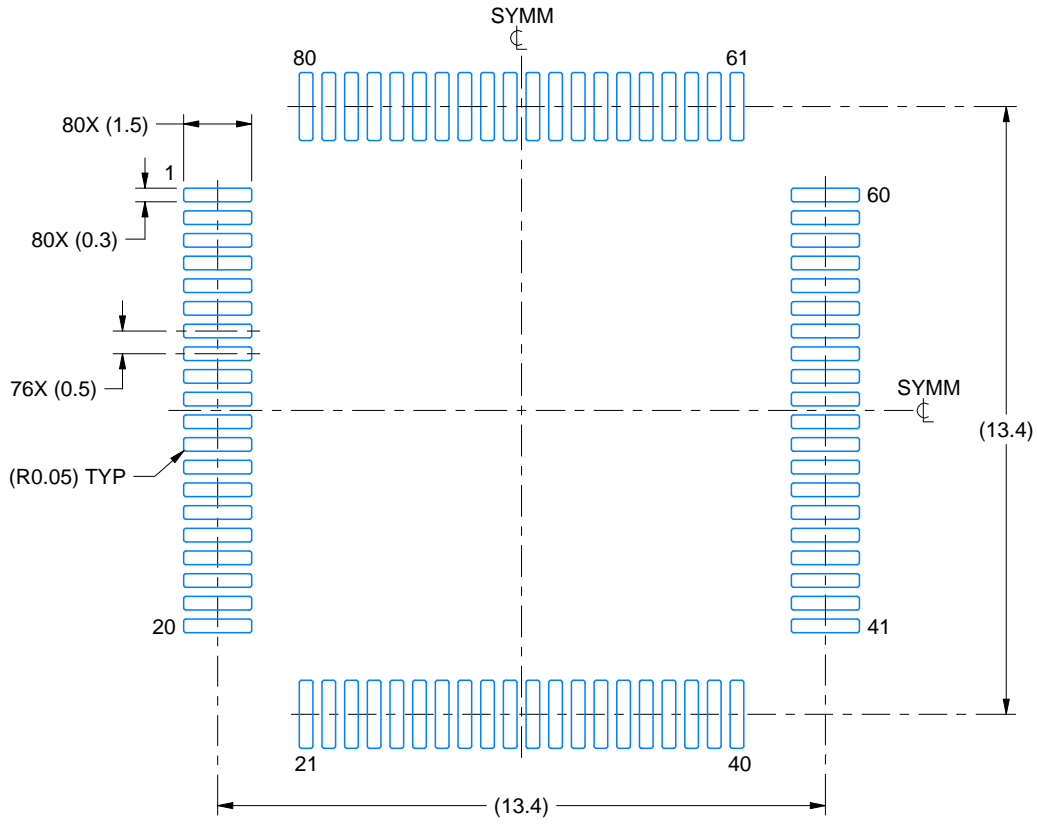
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC registration MS-026.

# EXAMPLE BOARD LAYOUT

PN0080A

LQFP - 1.6 mm max height

PLASTIC QUAD FLATPACK



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:6X



SOLDER MASK DETAILS

4215166/A 08/2022

NOTES: (continued)

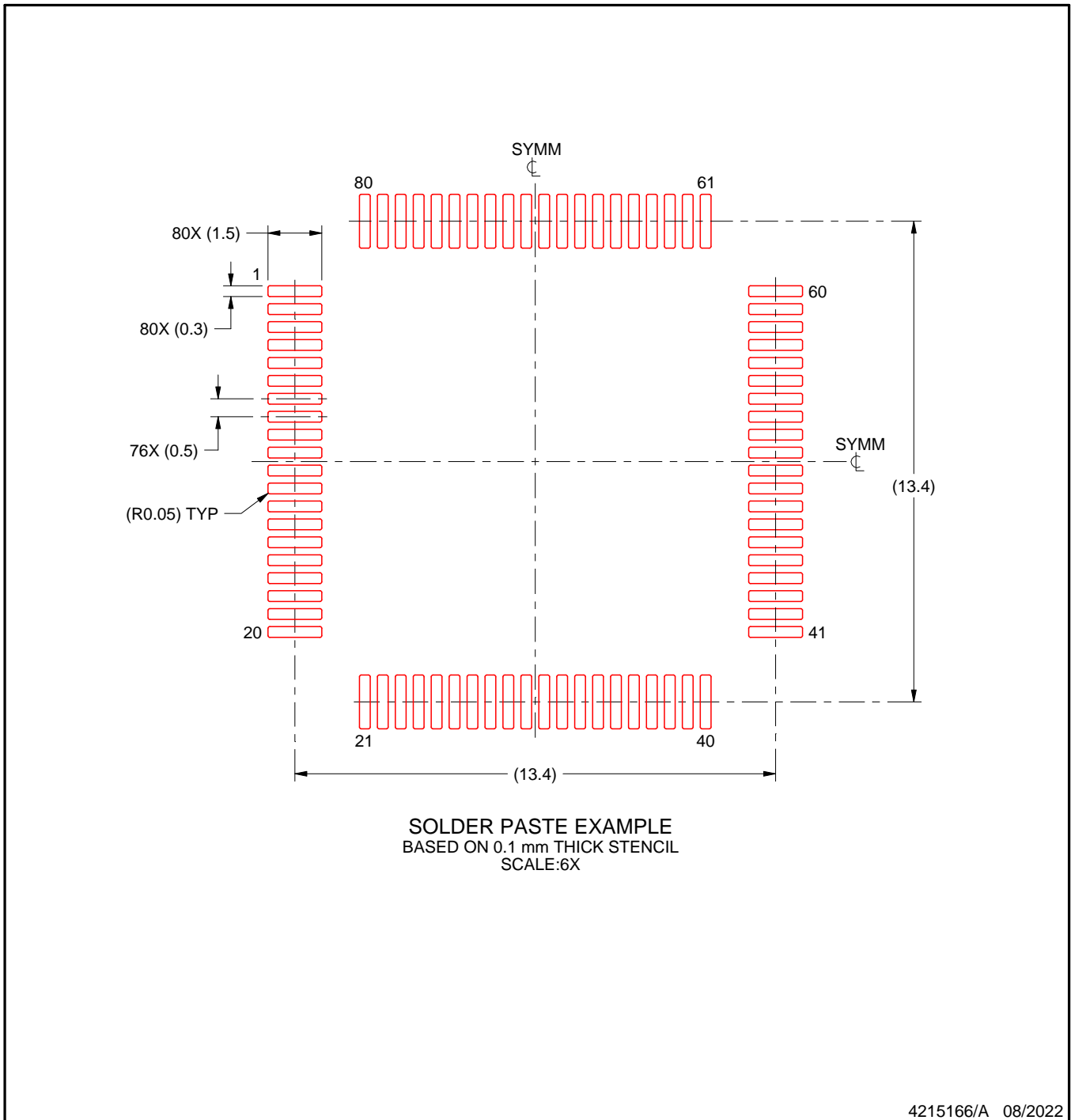
- 4. Publication IPC-7351 may have alternate designs.
- 5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
- 6. For more information, see Texas Instruments literature number SLMA004 ([www.ti.com/lit/slma004](http://www.ti.com/lit/slma004)).

# EXAMPLE STENCIL DESIGN

PN0080A

LQFP - 1.6 mm max height

PLASTIC QUAD FLATPACK



NOTES: (continued)

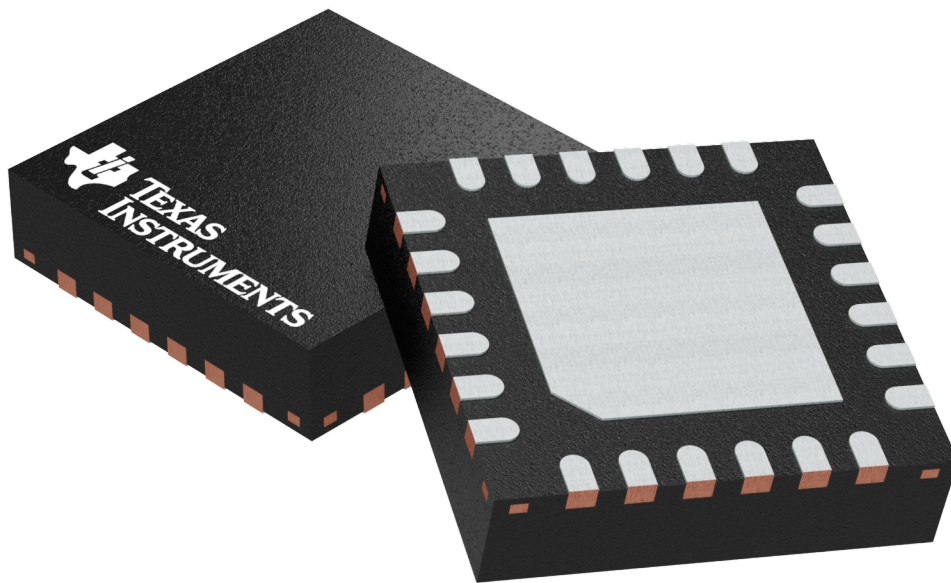
7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

**RGE 24**

**GENERIC PACKAGE VIEW**

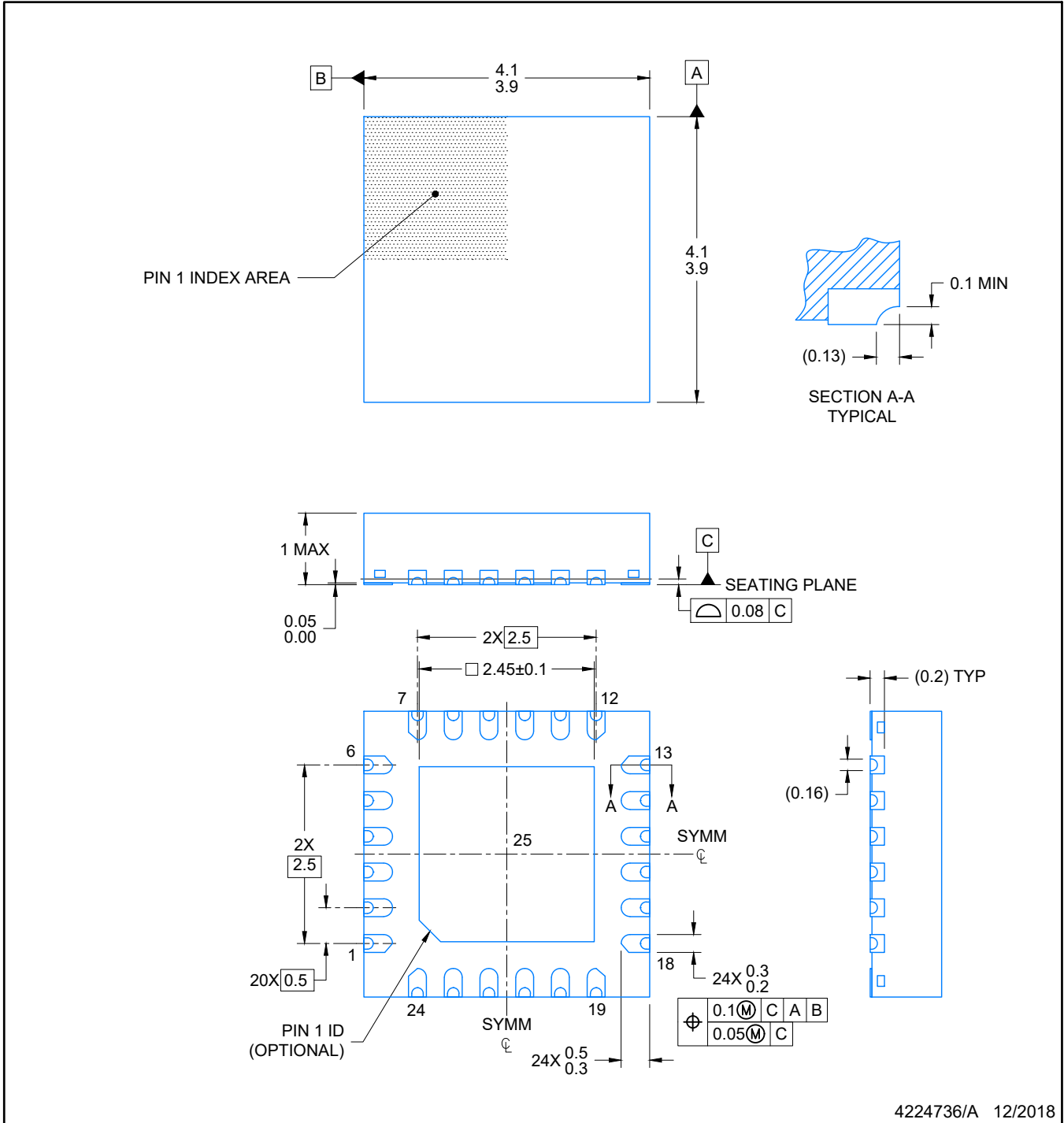
**VQFN - 1 mm max height**

PLASTIC QUAD FLATPACK - NO LEAD



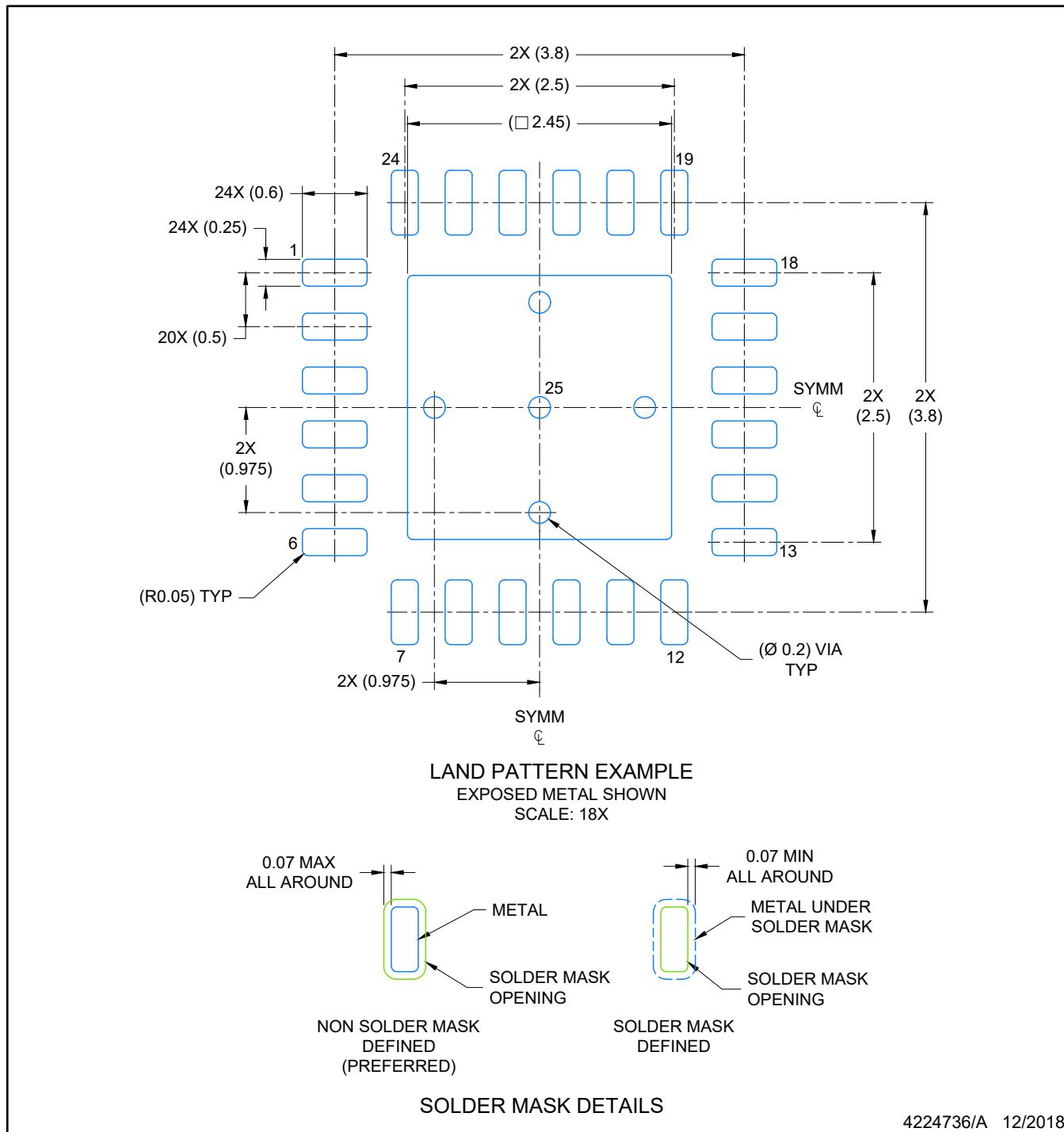
Images above are just a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.

4204104/H



NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for optimal thermal and mechanical performance.



NOTES: (continued)

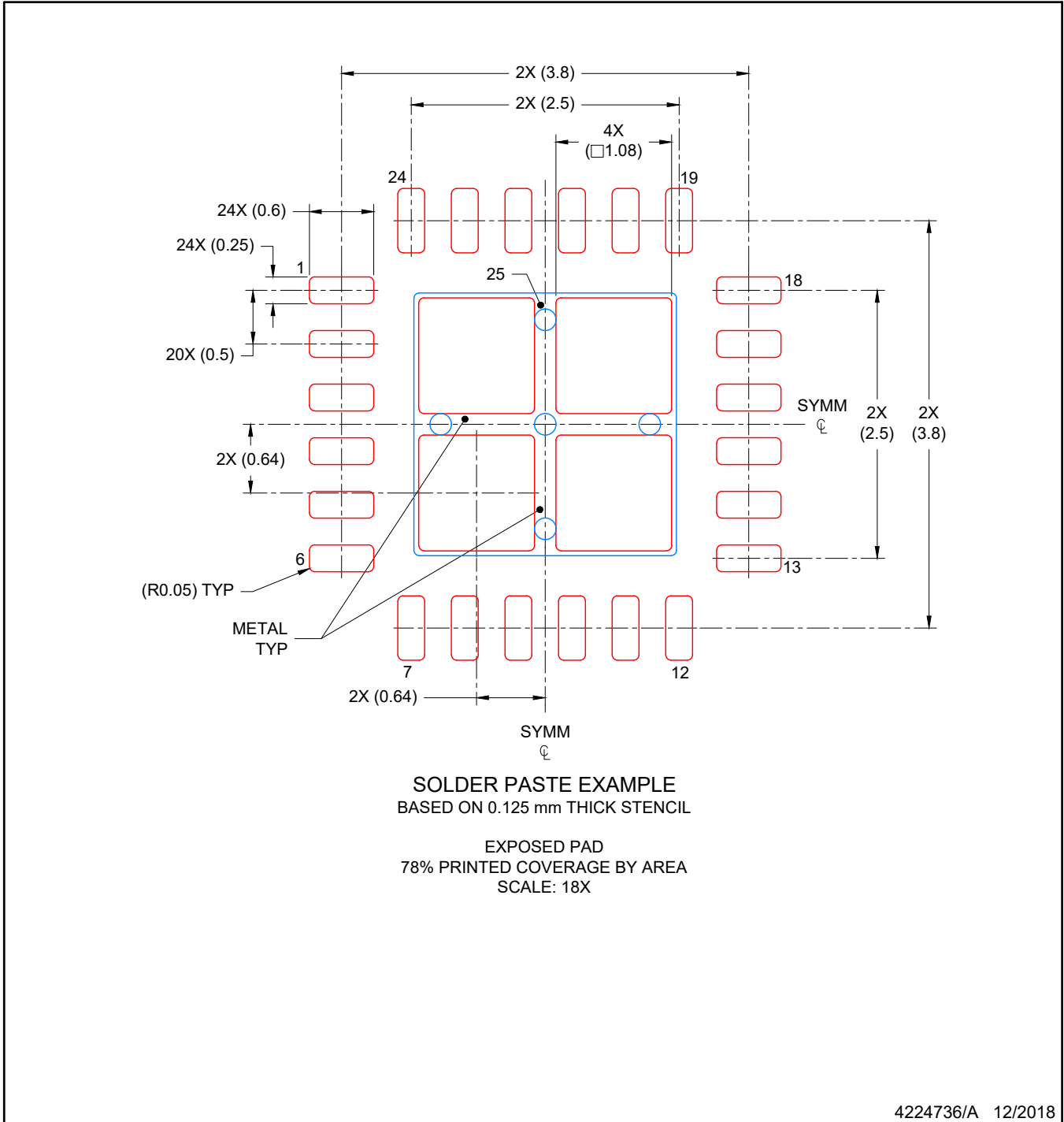
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/sluea271](http://www.ti.com/lit/sluea271)).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

# EXAMPLE STENCIL DESIGN

RGE0024N

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK-NO LEAD



NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

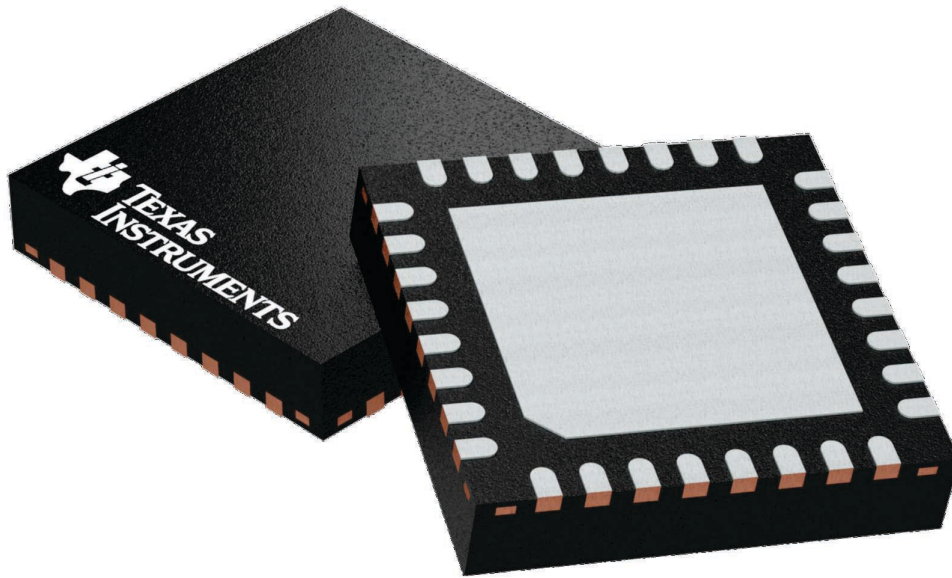
## GENERIC PACKAGE VIEW

**RHB 32**

**VQFN - 1 mm max height**

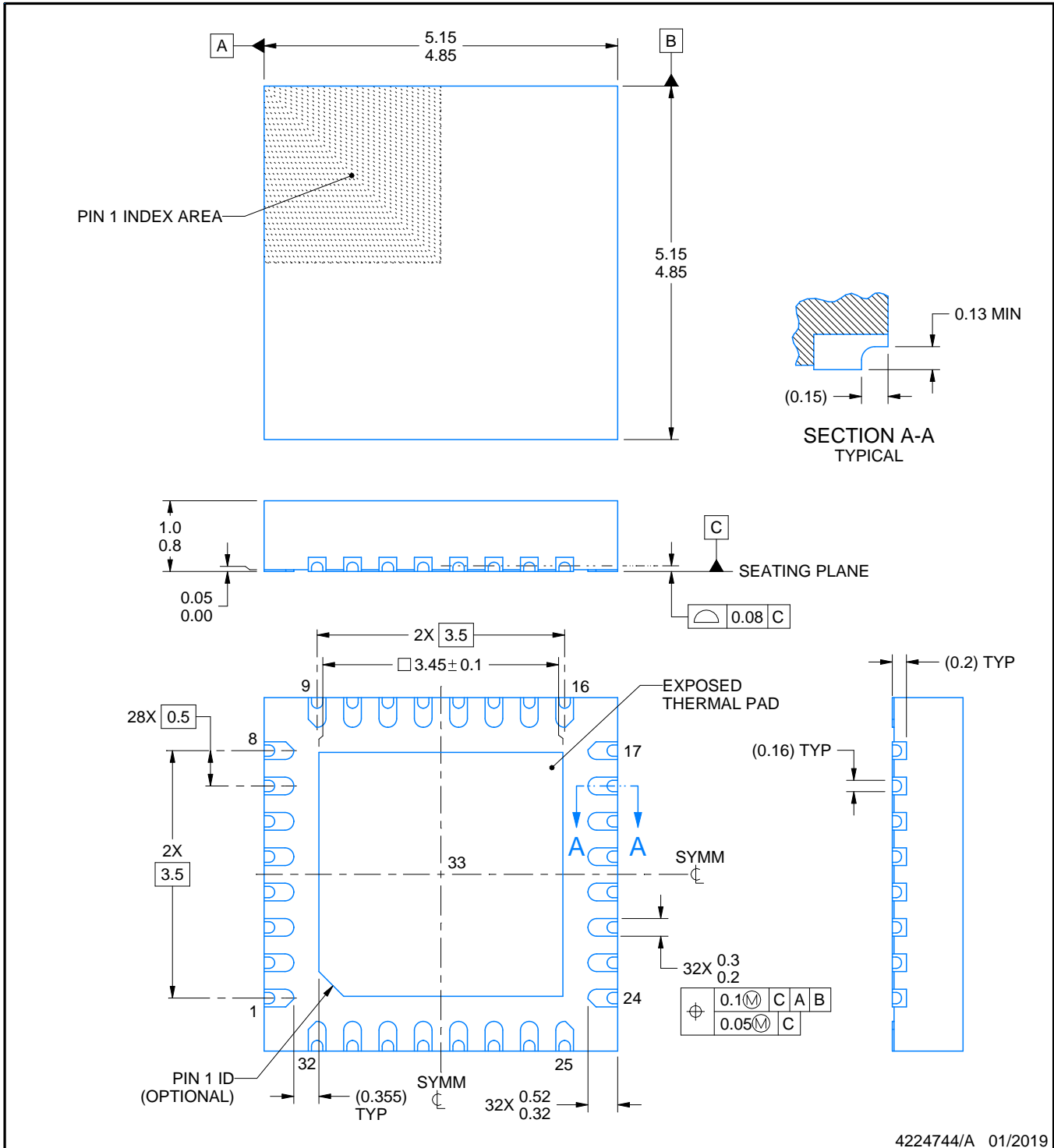
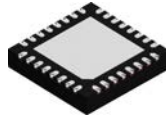
5 x 5, 0.5 mm pitch

PLASTIC QUAD FLATPACK - NO LEAD



Images above are just a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.

4224745/A



4224744/A 01/2019

NOTES:

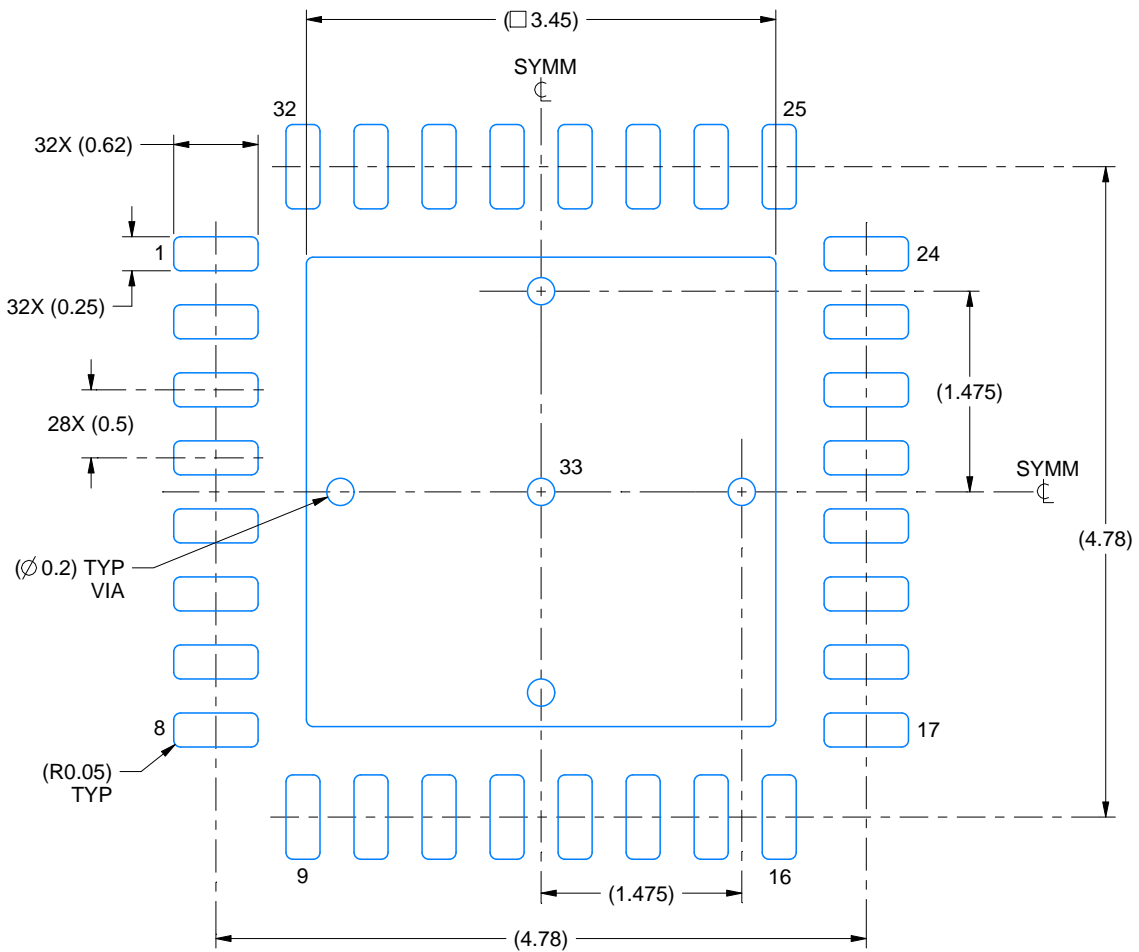
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

# EXAMPLE BOARD LAYOUT

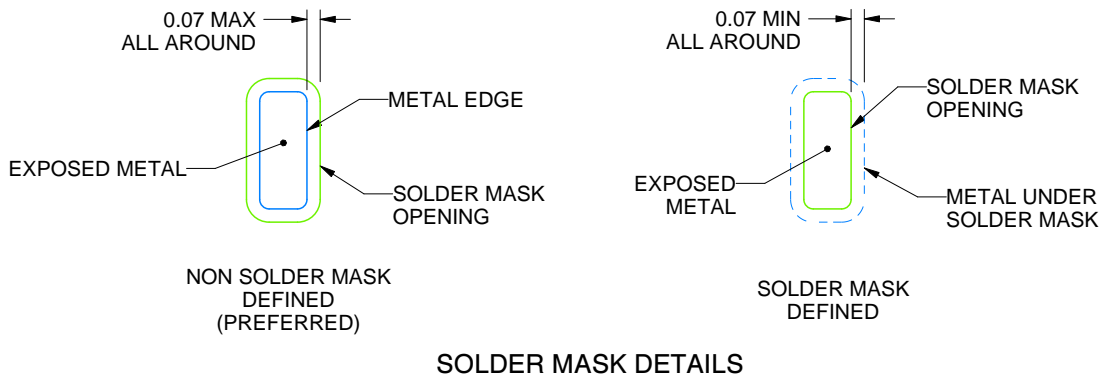
RHB0032T

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:18X



SOLDER MASK DETAILS

4224744/A 01/2019

NOTES: (continued)

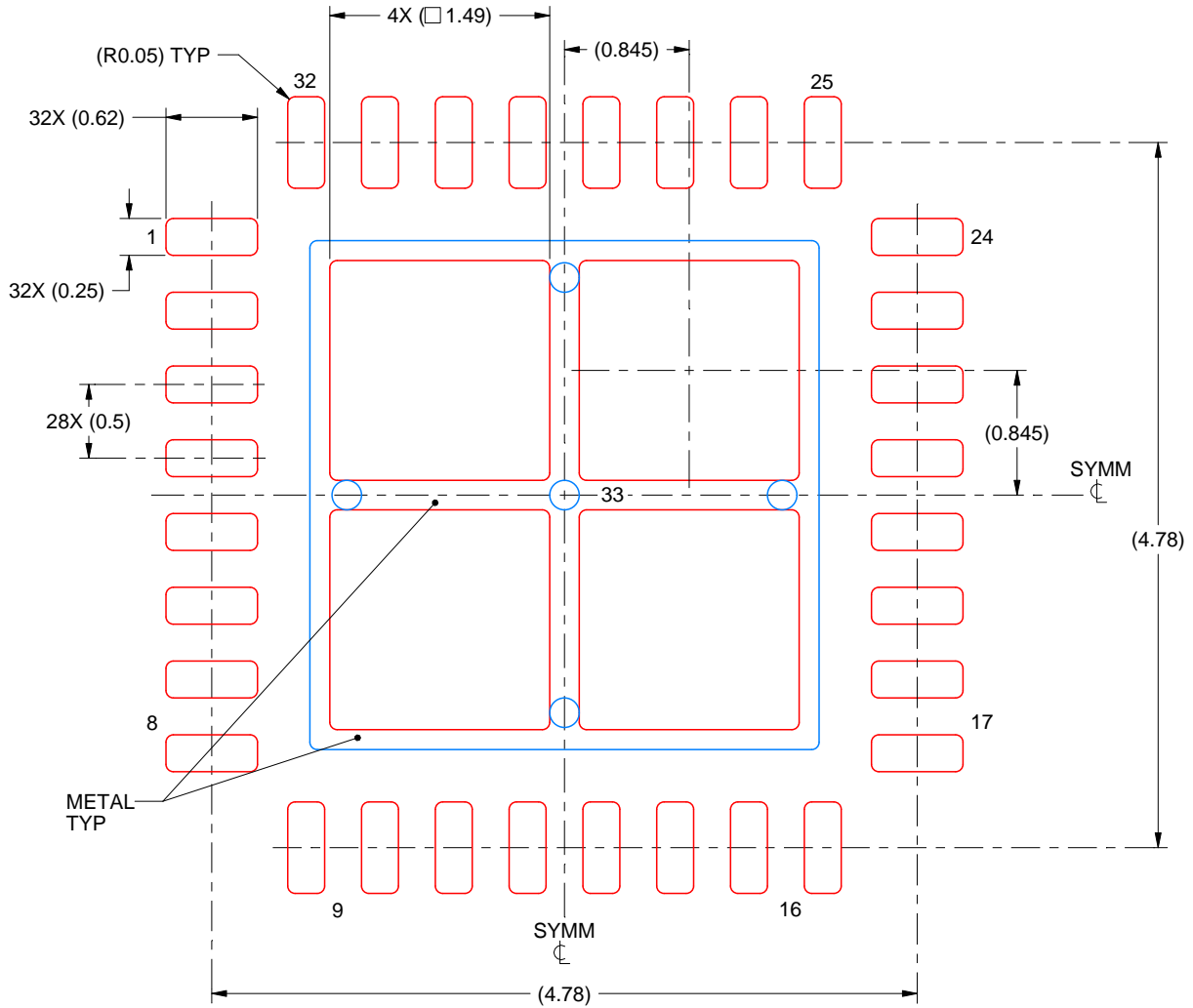
- This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/sluea271](http://www.ti.com/lit/sluea271)).
- Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

# EXAMPLE STENCIL DESIGN

RHB0032T

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



**SOLDER PASTE EXAMPLE**  
 BASED ON 0.125 mm THICK STENCIL

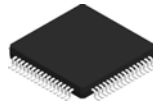
EXPOSED PAD 33:  
 75% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE  
 SCALE:20X

4224744/A 01/2019

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

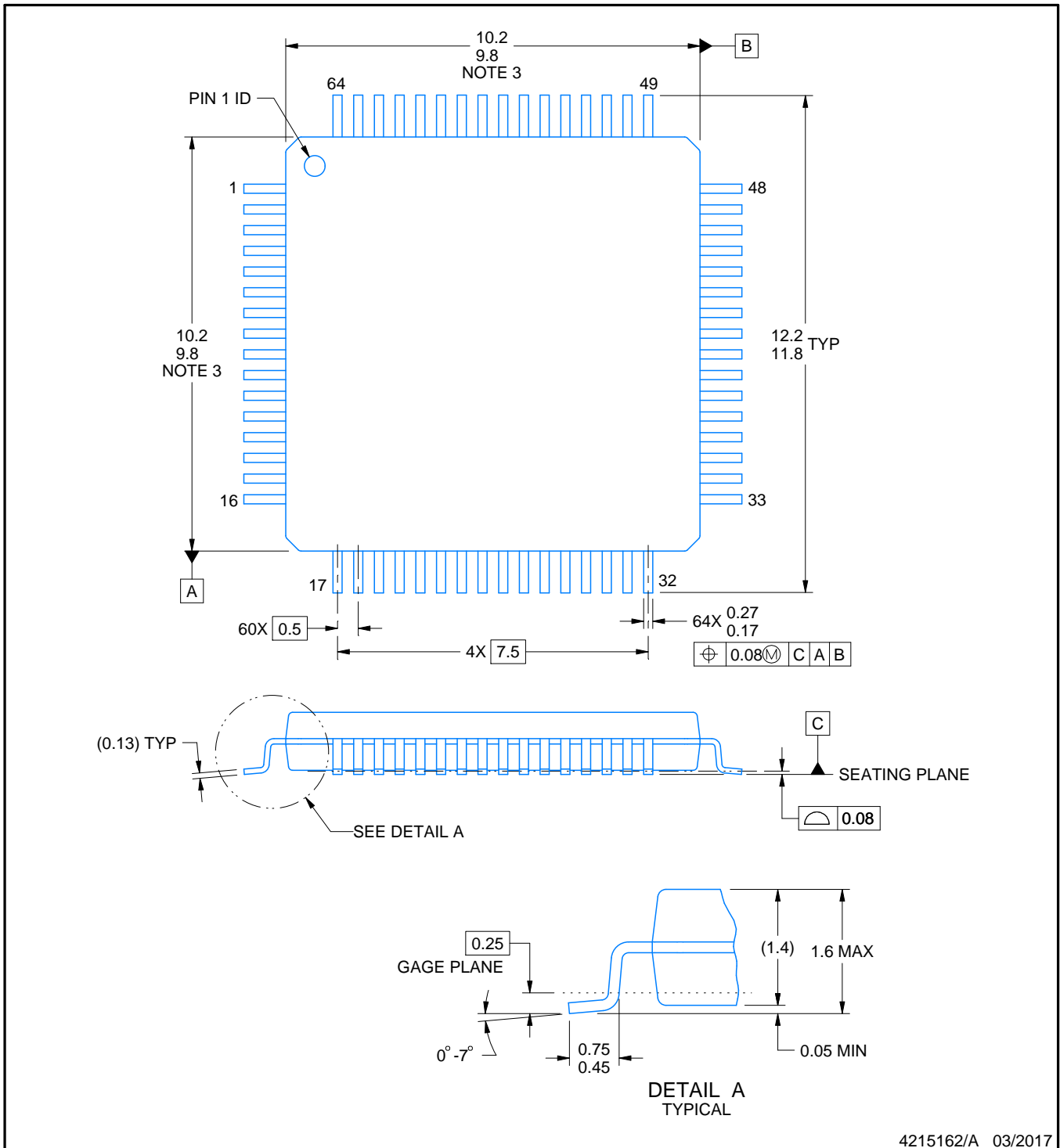
# PM0064A



# PACKAGE OUTLINE

LQFP - 1.6 mm max height

PLASTIC QUAD FLATPACK



4215162/A 03/2017

**NOTES:**

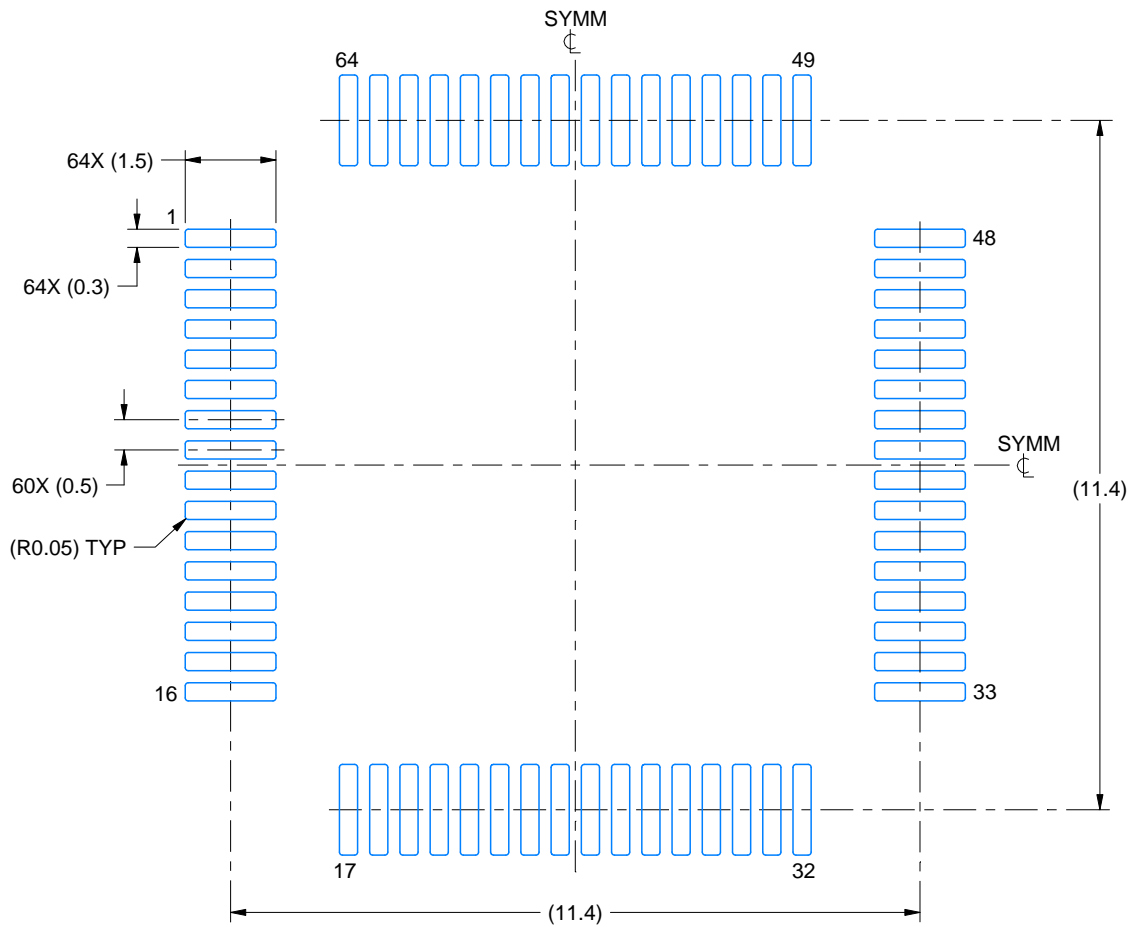
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MS-026.

# EXAMPLE BOARD LAYOUT

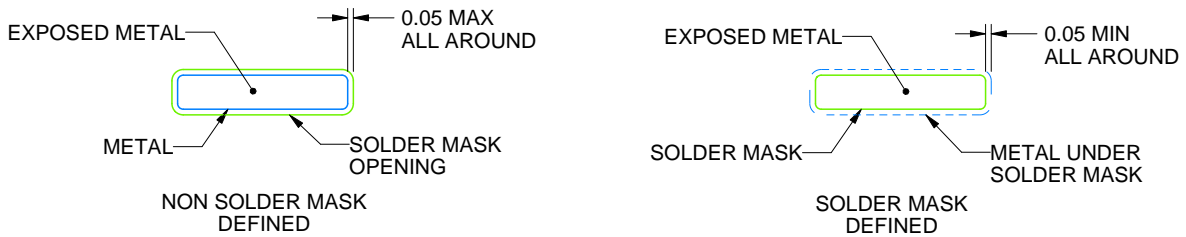
PM0064A

LQFP - 1.6 mm max height

PLASTIC QUAD FLATPACK



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:8X



SOLDER MASK DETAILS

4215162/A 03/2017

NOTES: (continued)

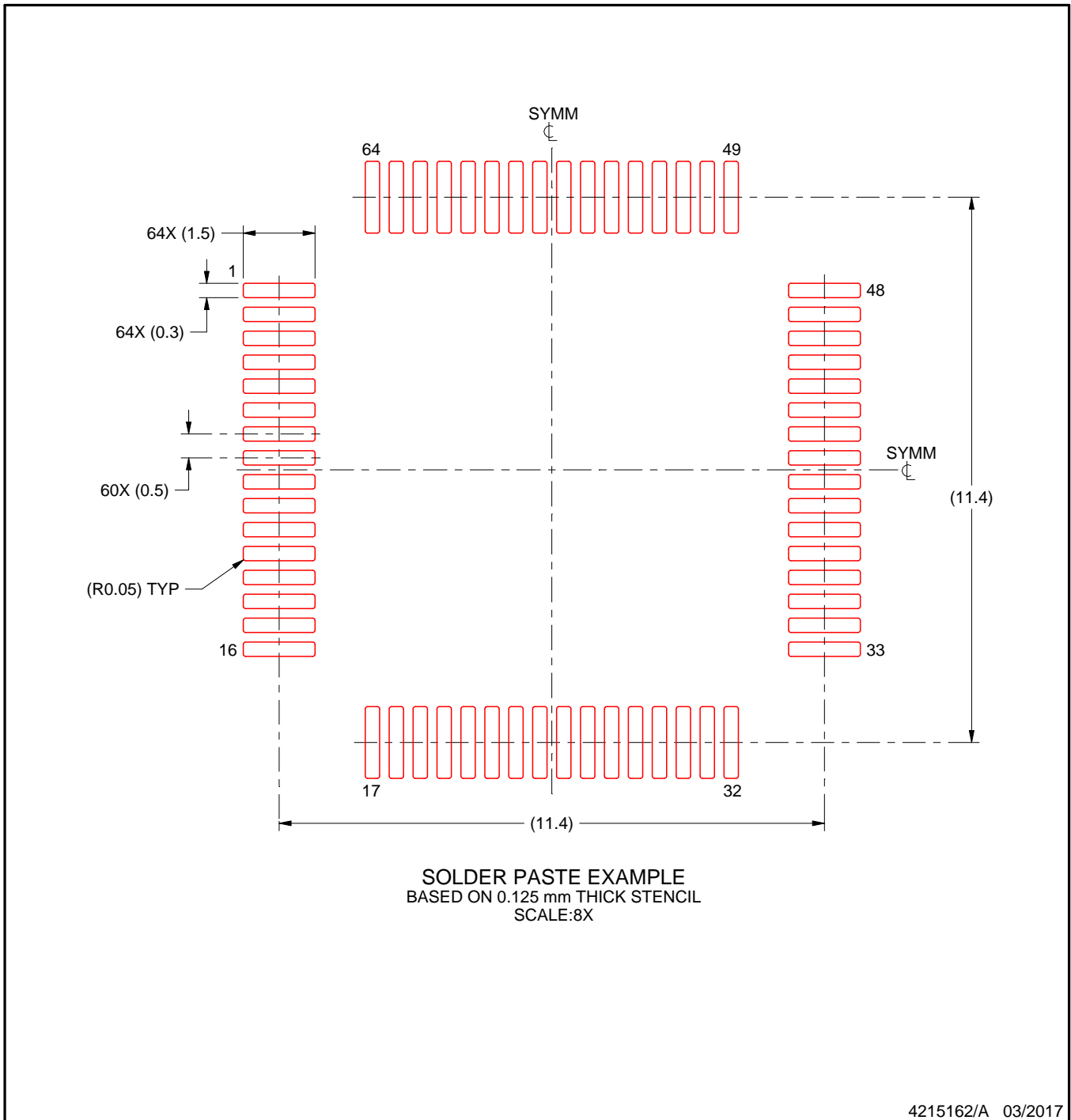
5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
7. For more information, see Texas Instruments literature number SLMA004 ([www.ti.com/lit/slma004](http://www.ti.com/lit/slma004)).

# EXAMPLE STENCIL DESIGN

PM0064A

LQFP - 1.6 mm max height

PLASTIC QUAD FLATPACK



NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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