

## MSPM0H321x Mixed-Signal Microcontrollers

#### 1 Features

#### Core

 Arm® 32-bit Cortex®-M0+ CPU, frequency up to 32MHz

## **Operating characteristics**

- Extended temperature: –40°C to 125°C
- Supply voltage range: 4.5V to 5.5V

#### **Memories**

- Up to 64KB of flash
- 8KB of SRAM

#### High-performance analog peripherals

- One analog-to-digital converter (ADC) with up to 27 total external channels, 1.6-Msps@12-bit
- 4.05V internal ADC voltage reference (VREF)
- Integrated temperature sensor
- Integrated supply monitor

### **Optimized low-power modes**

- RUN: 125µA/MHz (CoreMark)
- SLEEP: 2418uA at 32MHz
- STOP: 1429µA at 4MHz and 642uA at 32kHz
- STANDBY: 3.6µA with SRAM retention

#### Intelligent digital peripherals

- 3-channel DMA controller
- Five timers supporting up to 18 PWM channels
  - One 16-bit advanced timers with deadband support up to 8 PWM channels
  - One 16-bit general purpose timer with 4 capture/compares
  - Two 16-bit general purpose timers with 2 capture/compares
  - One 16-bit general purpose timer with 2 capture/compares and QEI
- Windowed watchdog timer (WWDT)
- Independent watch dog timer (IWDT)
- RTC with alarm and calendar mode
- BEEPER generating 1/2/4/8kHz square wave to drive an external beeper

#### **Enhanced communication interfaces**

- UART interfaces supporting low-power operation in STANDBY mode
  - One advanced UART instance supporting LIN, IrDA, DALI, Smart Card, & Manchester coding
- Two I<sup>2</sup>C interfaces supporting FM+ (1Mbit/s), SMBus/PMBus, and wakeup from STOP mode,
- One SPI supporting up to 16Mbit/s

#### Clock system

- Internal 32MHz oscillator with up to ±1.2% accuracy (SYSOSC)
- Internal 32kHz low-frequency oscillator (LFOSC)
- External 4MHz to 32MHz crystal oscillator
- External 32kHz crystal oscillator (LFXT)
- External Low Frequency (LF) and High Frequency (HF) digital clock inputs

### **Data integrity**

Cyclic redundancy checker (CRC-16)

#### Flexible I/O features

- Up to 45 GPIOs
- True 5V IOs

### **Development support**

2-pin serial wire debug (SWD)

### Package options 1

- 48-pin LQFP (PT), VQFN (RGZ)
- 44-pin LQFP (NNA)
- 32-pin VSSOP (DGS32), VQFN (RHB), LQFP (VFC)
- 28-pin VSSOP (DGS28)
- 24-pin VQFN (RGE)
- 20-pin VSSOP (DGS20), WQFN (RUK)

#### Family members (also see *Device Comparison*)

- MSPM0H3216: 64KB of flash, 8KB of RAM
- MSPM0H3215: 32KB of flash, 8KB of RAM
- **Development kits and software** (also see *Tools* and Software)
  - LP-MSPM0H3216 LaunchPad<sup>™</sup> development
  - MSP Software Development Kit (SDK)

### 2 Applications

- **Appliances**
- Battery charging and management
- Power supplies and power delivery
- Personal electronics
- Building security and fire safety
- Connected peripherals and printers
- **Factory Automation Control**
- Smart metering
- Communication modules
- Medical and healthcare
- Lighting

The LQFP-44 and LQFP-32 packages are preview



### 3 Description

MSPM0H321x microcontrollers (MCUs) are part of the MSP highly-integrated 5V power supply and 32-bit MCU family based on the enhanced Arm® Cortex®-M0+ core platform operating at up to 32MHz frequency. These cost-optimized MCUs offer high-performance analog peripheral integration, support extended temperature ranges from -40°C to 125°C, and operate with supply voltages from 4.5V.

The MSPM0H321x devices provide up to 64KB embedded flash program memory with 8KB SRAM. These MCUs incorporate a high-speed on-chip oscillator with an accuracy up to ±1.2%, eliminating the need for an external crystal. Additional features include a 3-channel DMA, CRC-16 accelerator, and a variety of high-performance analog peripherals such as one 12-bit 1.6Msps ADC with VDD as the voltage reference, and an on-chip temperature sensor. These devices offer intelligent digital peripherals such as one 16-bit advanced timer, four 16-bit general purpose timer, one windowed watchdog timer, one independent watchdog timer, and a real-time clock (RTC). These devices also offer a variety of communication peripherals including three UART, one SPI, and two I<sup>2</sup>C. These communication peripherals offer protocol support for LIN, IrDA, DALI, Manchester, smart card, SMBus, and PMBus.

The TI MSPM0 family of low-power MCUs consists of devices with varying degrees of analog and digital integration enabling customers to find the MCU that meets their project needs. The architecture combined with extensive low-power modes is optimized to achieve extended battery life in portable measurement applications.

MSPM0H321x 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<sup>™</sup> kit available for purchase and design files for a target-socket board. 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 MSPM0H-Series 32MHz Microcontrollers Technical Reference Manual.

**Table 3-1. Package Information** 

PART NUMBER (1) (3)	PACKAGE	PACKAGE SIZE(2)
MSPR5F100FESNNAR (4)	NNA (LQFP, 44)	10mm × 10mm
MSPR5F100FCSNNAR (4)	NNA (LQFP, 44)	10mm × 10mm
MSPR7F102GBESVFCR (4)	VFC (LQFP, 32)	7mm × 7mm
MSPR7F102GBCSVFCR (4)	VFC (LQFP, 32)	7mm × 7mm
MSPM0H3216SPTR	PT (LQFP, 48)	7mm × 7mm
MSPM0H3215SPTR	PT (LQFP, 48)	7mm × 7mm
MSPM0H3216SRGZR	RGZ (VQFN, 48)	7mm × 7mm
MSPM0H3215SRGZR	RGZ (VQFN, 48)	7mm × 7mm
MSPM0H3216SRHBR	RHB (VQFN, 32)	5mm × 5mm
MSPM0H3215SRHBR	RHB (VQFN, 32)	5mm x 5mm
MSPM0H3216SDGS32R	DGS32 (VSSOP, 32)	8.1mm × 4.9mm
MSPM0H3215SDGS32R	DGS32 (VSSOP, 32)	8.1mm × 4.9mm
MSPM0H3216SDGS28R	DGS28 (VSSOP, 28)	7.1mm × 4.9mm
MSPM0H3215SDGS28R	DGS28 (VSSOP, 28)	7.1mm × 4.9mm
MSPM0H3216SRGER	RGE (VQFN, 24)	4mm x 4mm
MSPM0H3215SRGER	RGE (VQFN, 24)	4mm x 4mm
MSPM0H3216SDGS20R	DGS20 (VSSOP, 20)	5.1mm × 4.9mm

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**Table 3-1. Package Information (continued)** 

PART NUMBER (1) (3)	PACKAGE	PACKAGE SIZE(2)
MSPM0H3215SDGS20R	DGS20 (VSSOP, 20)	5.1mm × 4.9mm
MSPM0H3216SRUKR	RUK (WQFN, 20)	3mm x 3mm
MSPM0H3215SRUKR	RUK (WQFN, 20)	3mm x 3mm

- 1. For the most current part, package, and ordering information for all available devices, see the *Package Option Addendum* in Section 12, or see the TI web site.
- 2. The package size (length × width) is a nominal value and includes pins, where applicable. For package dimensions with tolerances, see the *Mechanical Data* in Section 12.
- 3. For more information about the device name, see Section 10.1.
- 4. The LQFP-44 and LQFP-32 packages are preview

#### **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, as the principles in that application note also apply to MSPM0 MCUs.



## **4 Functional Block Diagram**

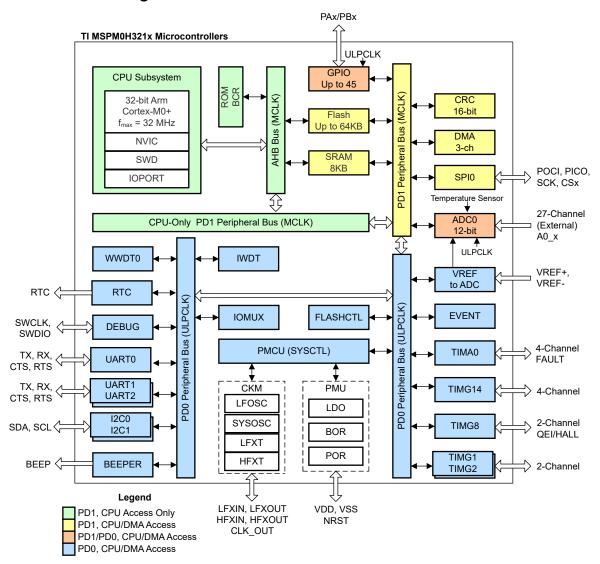


Figure 4-1. MSPM0H321x Functional Block Diagram



## **Table of Contents**

2 Applications       1       8.8 Memory         3 Description       2       8.9 Flash Memory         4 Functional Block Diagram       4       8.10 SRAM         5 Device Comparison       6       8.11 GPIO         6 Pin Configuration and Functions       7       8.12 IOMUX         6.1 Pin Diagrams       7       8.13 ADC         6.2 Signal Descriptions       27       8.14 Temperature Sensor         6.3 Connections for Unused Pins       36       8.15 VREF         7 Specifications       37       8.16 CRC         7.1 Absolute Maximum Ratings       37       8.18 SPI         7.2 ESD Ratings       37       8.18 SPI         7.3 Recommended Operating Conditions       37       8.19 I2C         7.4 Thermal Information       37       8.20 Low-Frequency Sub System (LFSS)         7.5 Supply Current Characteristics       39       8.21 RTC_B         7.6 Power Supply Sequencing       40       8.22 IWDT_B         7.7 Flash Memory Characteristics       42       8.23 WWDT         7.8 Timing Characteristics       42       8.24 Timers (TIMx)         7.9 Clock Specifications       42       8.25 Device Analog Connections         7.10 Lightal IO       44       8.28 Device Factory Constants	1 Features	1	8.7 Events	57
4 Functional Block Diagram       .4       8.10 SRAM         5 Device Comparison       .6       8.11 GPIO         6 Pin Configuration and Functions       .7       8.12 IOMUX         6.1 Pin Diagrams       .7       8.13 ADC       .6         6.2 Signal Descriptions       .27       8.14 Temperature Sensor       .6         6.3 Connections for Unused Pins       .36       8.15 VREF       .6         7 Specifications       .37       8.16 CRC       .6         7.1 Absolute Maximum Ratings       .37       8.17 UART       .6         7.2 ESD Ratings       .37       8.18 SPI       .7         7.3 Recommended Operating Conditions       .37       8.19 I2C       .6         7.4 Thermal Information       .37       8.20 Low-Frequency Sub System (LFSS)       .6         7.5 Supply Current Characteristics       .39       8.21 RTC B       .6         7.6 Power Supply Sequencing       .40       8.22 IWDT B       .6         7.7 Flash Memory Characteristics       .41       8.23 WWDT       .6         7.8 Timing Characteristics       .42       8.24 Timers (TIMx)       .6         7.10 Digital IO       .44       8.26 Input/Output Diagrams       .7         7.11 ADC       .45       8.27 Serial	2 Applications	1	8.8 Memory	58
5 Device Comparison         6           6 Pin Configuration and Functions         7           6.1 Pin Diagrams         .7           6.2 Signal Descriptions         .27           6.3 Connections for Unused Pins         .36           7 Specifications         .37           7.1 Absolute Maximum Ratings         .37           7.2 ESD Ratings         .37           7.3 Recommended Operating Conditions         .37           7.4 Thermal Information         .37           7.5 Supply Current Characteristics         .39           7.6 Power Supply Sequencing         .40           7.7 Flash Memory Characteristics         .41           7.9 Clock Specifications         .42           7.10 Digital IO         .44           7.11 ADC         .45           7.12 Temperature Sensor         .47           7.15 SPI         .48           7.16 UART         .9           7.17 TIMX         .50           7.19 Emulation and Debug         .50           8 Detailed Description         .50           8.10 Overview         .53	3 Description	<mark>2</mark>	8.9 Flash Memory	60
6 Pin Configuration and Functions       .7       8.12 IOMUX       6.1 Pin Diagrams       .7       8.13 ADC       .6       .6       .2 Signal Descriptions       .27       8.14 Temperature Sensor       .6       .6       .3 Connections for Unused Pins       .36       8.15 VREF       .6       .6       .7       .8       .14 Temperature Sensor       .6       .6       .6       .7       .8       .14 Temperature Sensor       .6       .6       .8       .5 VREF       .6       .6       .7       .8       .14 Temperature Sensor       .6       .6       .8       .15 VREF       .6       .6       .6       .7       .8       .14 Temperature Sensor       .6       .6       .8       .15 VREF       .6       .6       .6       .7       .8       .16 CRC       .6       .6       .7       .7       .8       .10 ART       .6       .7       .7       .8       .17 UART       .6       .7       .7       .8       .17 UART       .6       .7       .7       .8       .2       .8       .2       .8       .2       .8       .2       .8       .2       .8       .2       .8       .2       .2       .2       .2       .2       .2       .2       .2       .2       .2	4 Functional Block Diagram	4	8.10 SRAM	60
6.1 Pin Diagrams       7       8.13 ADC       6.2 Signal Descriptions       27       8.14 Temperature Sensor       6.3 Connections for Unused Pins       36       8.15 VREF       6       6.2 Signal Descriptions       6.3 Connections for Unused Pins       36       8.15 VREF       6       6.2 Connections for Unused Pins       6.3 End of the Maximum Ratings       37       8.16 CRC       6       6.2 Connections for Unused Pins       6.3 End of the Maximum Ratings       37       8.16 CRC       6        7       7       8       10       10       6       7       8       10       10       6        8       10       10       10       8       10       10       10       10       10       10       10       10       10       10       10       10       10	5 Device Comparison	6	8.11 GPIO	61
6.2 Signal Descriptions       27       8.14 Temperature Sensor       6         6.3 Connections for Unused Pins       36       8.15 VREF       6         7 Specifications       37       8.16 CRC       6         7.1 Absolute Maximum Ratings       37       8.17 UART       6         7.2 ESD Ratings       37       8.18 SPI       6         7.3 Recommended Operating Conditions       37       8.19 I2C       6         7.4 Thermal Information       37       8.20 Low-Frequency Sub System (LFSS)       6         7.5 Supply Current Characteristics       39       8.21 RTC_B       6         7.6 Power Supply Sequencing       40       8.21 WDT_B       6         7.7 Flash Memory Characteristics       41       8.23 WWDT       6         7.8 Timing Characteristics       42       8.24 Timers (TIMx)       6         7.9 Clock Specifications       42       8.25 Device Analog Connections       6         7.10 Digital IO       44       8.26 Input/Output Diagrams       6         7.11 ADC       45       8.27 Serial Wire Debug Interface       6         7.13 VREF       47       8.28 Device Factory Constants       6         7.15 SPI       9       Applications, Implementation, and Layout       9	6 Pin Configuration and Functions	7	8.12 IOMUX	61
6.3 Connections for Unused Pins	6.1 Pin Diagrams	<b>7</b>	8.13 ADC	61
6.3 Connections for Unused Pins	6.2 Signal Descriptions	<mark>27</mark>	8.14 Temperature Sensor	62
7.1 Absolute Maximum Ratings.       37       8.17 UART.       6         7.2 ESD Ratings.       37       8.18 SPl.       6         7.3 Recommended Operating Conditions.       37       8.19 I2C.       6         7.4 Thermal Information.       37       8.20 Low-Frequency Sub System (LFSS).       6         7.5 Supply Current Characteristics.       39       8.21 RTC_B.       6         7.6 Power Supply Sequencing.       40       8.22 IWDT_B.       6         7.7 Flash Memory Characteristics.       41       8.23 WWDT.       6         7.8 Timing Characteristics.       42       8.24 Timers (TIMx).       6         7.9 Clock Specifications.       42       8.25 Device Analog Connections.       6         7.10 Digital IO.       44       8.26 Input/Output Diagrams.       6         7.12 Temperature Sensor.       47       8.28 Device Factory Constants       6         7.13 VREF.       47       8.29 Identification.       6         7.14 I2C.       47       9 Applications, Implementation, and Layout.       9.1 Typical Application.       9.1 Typical Application.         7.17 TIMx.       50       10.1 Device Nomenclature.       10.2 Tools and Software.       7.19 Emulation and Debug.       50       10.3 Documentation Support.       10.4 Support Resources. <td></td> <td></td> <td>8.15 VREF</td> <td>62</td>			8.15 VREF	62
7.1 Absolute Maximum Ratings.       37       8.17 UART.       6         7.2 ESD Ratings.       37       8.18 SPl.       6         7.3 Recommended Operating Conditions.       37       8.19 I2C.       6         7.4 Thermal Information.       37       8.20 Low-Frequency Sub System (LFSS).       6         7.5 Supply Current Characteristics.       39       8.21 RTC_B.       6         7.6 Power Supply Sequencing.       40       8.22 IWDT_B.       6         7.7 Flash Memory Characteristics.       41       8.23 WWDT.       6         7.8 Timing Characteristics.       42       8.24 Timers (TIMx).       6         7.9 Clock Specifications.       42       8.25 Device Analog Connections.       6         7.10 Digital IO.       44       8.26 Input/Output Diagrams.       6         7.12 Temperature Sensor.       47       8.27 Serial Wire Debug Interface.       6         7.13 VREF.       47       8.29 Identification.       6         7.14 I2C.       47       8.29 Identification.       9         7.15 SPI.       48       9.1 Typical Application, and Layout.       9.1 Typical Application.       9.1 Typical Application.         7.18 Windowed Watchdog Characteristics.       50       10.2 Tools and Software.       7.0.2 Tools and Software. <td>7 Specifications</td> <td>37</td> <td>8.16 CRC</td> <td>62</td>	7 Specifications	37	8.16 CRC	62
7.2 ESD Ratings       37       8.18 SPI       6         7.3 Recommended Operating Conditions       37       8.19 I2C       6         7.4 Thermal Information       37       8.20 Low-Frequency Sub System (LFSS)       6         7.5 Supply Current Characteristics       39       8.21 RTC_B       6         7.6 Power Supply Sequencing       40       8.22 IWDT_B       6         7.7 Flash Memory Characteristics       41       8.23 IWDT       6         7.8 Timing Characteristics       42       8.24 Timers (TIMx)       6         7.9 Clock Specifications       42       8.25 Device Analog Connections       6         7.10 Digital IO       44       8.26 Input/Output Diagrams       6         7.11 ADC       45       8.27 Serial Wire Debug Interface       6         7.12 Temperature Sensor       47       8.28 Device Factory Constants       6         7.13 VREF       47       8.29 Identification       9         7.14 I2C       47       9 Applications, Implementation, and Layout       9.1 Typical Application         7.17 TIMx       50       10 Device and Documentation Support         7.18 Windowed Watchdog Characteristics       50       10.2 Tools and Software         7.19 Emulation and Debug       50       10.4 Support Res			8.17 UART	62
7.4 Thermal Information       37       8.20 Low-Frequency Sub System (LFSS)       6         7.5 Supply Current Characteristics       39       8.21 RTC_B       6         7.6 Power Supply Sequencing       40       8.22 IWDT_B       6         7.7 Flash Memory Characteristics       41       8.23 WWDT       6         7.8 Timing Characteristics       42       8.24 Timers (TIMx)       6         7.9 Clock Specifications       42       8.25 Device Analog Connections       6         7.10 Digital IO       44       8.26 Input/Output Diagrams       6         7.11 ADC       45       8.27 Serial Wire Debug Interface       6         7.12 Temperature Sensor       47       8.28 Device Factory Constants       6         7.13 VREF       47       8.29 Identification       6         7.14 I2C       47       9 Applications, Implementation, and Layout       9         7.15 SPI       48       9.1 Typical Application       10 Device and Documentation Support         7.17 TIMx       50       10.1 Device Nomenclature       10.2 Tools and Software         7.19 Emulation and Debug       50       10.3 Documentation Support       10.4 Support Resources         8.1 Overview       53       10.5 Trademarks			8.18 SPI	63
7.4 Thermal Information       37       8.20 Low-Frequency Sub System (LFSS)       6         7.5 Supply Current Characteristics       39       8.21 RTC_B       6         7.6 Power Supply Sequencing       40       8.22 IWDT_B       6         7.7 Flash Memory Characteristics       41       8.23 WWDT       6         7.8 Timing Characteristics       42       8.24 Timers (TIMx)       6         7.9 Clock Specifications       42       8.25 Device Analog Connections       6         7.10 Digital IO       44       8.26 Input/Output Diagrams       6         7.11 ADC       45       8.27 Serial Wire Debug Interface       6         7.12 Temperature Sensor       47       8.28 Device Factory Constants       6         7.13 VREF       47       8.29 Identification       6         7.14 I2C       47       9 Applications, Implementation, and Layout       9         7.15 SPI       48       9.1 Typical Application       10 Device and Documentation Support         7.17 TIMx       50       10.1 Device Nomenclature       10.2 Tools and Software         7.19 Emulation and Debug       50       10.3 Documentation Support       10.4 Support Resources         8.1 Overview       53       10.5 Trademarks	7.3 Recommended Operating Conditions	37	8.19 I2C	63
7.5 Supply Current Characteristics.       39       8.21 RTC_B.       6         7.6 Power Supply Sequencing.       40       8.22 IWDT_B.       6         7.7 Flash Memory Characteristics.       41       8.23 WWDT.       6         7.8 Timing Characteristics.       42       8.24 Timers (TIMx).       6         7.9 Clock Specifications.       42       8.25 Device Analog Connections.       6         7.10 Digital IO.       44       8.26 Input/Output Diagrams.       6         7.11 ADC.       45       8.27 Serial Wire Debug Interface.       6         7.12 Temperature Sensor.       47       8.28 Device Factory Constants.       6         7.13 VREF.       47       8.29 Identification.       6         7.15 SPI.       48       9.4 Applications, Implementation, and Layout.       9         7.17 TIMX.       50       9.1 Typical Application.       9         7.18 Windowed Watchdog Characteristics.       50       10.1 Device Nomenclature.       10.1 Device Nomenclature.       10.2 Tools and Software.       10.3 Documentation Support.         8 Detailed Description.       52       10.4 Support Resources.       10.4 Support Resources.         8.1 Overview.       53       10.5 Trademarks.	7.4 Thermal Information	37	8.20 Low-Frequency Sub System (LFSS)	64
7.7 Flash Memory Characteristics       41       8.23 WWDT       6         7.8 Timing Characteristics       42       8.24 Timers (TIMx)       6         7.9 Clock Specifications       42       8.25 Device Analog Connections       6         7.10 Digital IO       44       8.26 Input/Output Diagrams       6         7.11 ADC       45       8.27 Serial Wire Debug Interface       6         7.12 Temperature Sensor       47       8.28 Device Factory Constants       6         7.13 VREF       47       8.29 Identification       6         7.14 I2C       47       9 Applications, Implementation, and Layout       9         7.15 SPI       48       9.1 Typical Application       9         7.16 UART       50       10 Device and Documentation Support       10.1 Device Nomenclature         7.18 Windowed Watchdog Characteristics       50       10.2 Tools and Software       10.3 Documentation Support         8 Detailed Description       52       10.4 Support Resources         8.1 Overview       53       10.5 Trademarks	7.5 Supply Current Characteristics	39		
7.8 Timing Characteristics       42       8.24 Timers (TIMx)       6         7.9 Clock Specifications       42       8.25 Device Analog Connections       6         7.10 Digital IO       44       8.26 Input/Output Diagrams       6         7.11 ADC       45       8.27 Serial Wire Debug Interface       6         7.12 Temperature Sensor       47       8.28 Device Factory Constants       6         7.13 VREF       47       8.29 Identification       6         7.14 I2C       47       9 Applications, Implementation, and Layout       9         7.15 SPI       48       9.1 Typical Application       9         7.16 UART       50       10 Device and Documentation Support       10.1 Device Nomenclature       10.2 Tools and Software       10.2 Tools and Software       10.3 Documentation Support       10.3 Documentation Support       10.4 Support Resources       10.4 Support Resources       10.5 Trademarks	7.6 Power Supply Sequencing	40	8.22 IWDT B	65
7.9 Clock Specifications       42       8.25 Device Analog Connections       6         7.10 Digital IO       44       8.26 Input/Output Diagrams       6         7.11 ADC       45       8.27 Serial Wire Debug Interface       6         7.12 Temperature Sensor       47       8.28 Device Factory Constants       6         7.13 VREF       47       8.29 Identification       6         7.14 I2C       47       9 Applications, Implementation, and Layout       9         7.15 SPI       48       9.1 Typical Application       9         7.16 UART       50       10 Device and Documentation Support       10.1 Device Nomenclature         7.18 Windowed Watchdog Characteristics       50       10.2 Tools and Software       10.3 Documentation Support         7.19 Emulation and Debug       50       10.3 Documentation Support       10.4 Support Resources         8.1 Overview       53       10.5 Trademarks	7.7 Flash Memory Characteristics	41	8.23 WWDT	65
7.9 Clock Specifications       42       8.25 Device Analog Connections       6         7.10 Digital IO       44       8.26 Input/Output Diagrams       6         7.11 ADC       45       8.27 Serial Wire Debug Interface       6         7.12 Temperature Sensor       47       8.28 Device Factory Constants       6         7.13 VREF       47       8.29 Identification       6         7.14 I2C       47       9 Applications, Implementation, and Layout       9         7.15 SPI       48       9.1 Typical Application       9         7.16 UART       50       10 Device and Documentation Support       10.1 Device Nomenclature         7.18 Windowed Watchdog Characteristics       50       10.2 Tools and Software       10.3 Documentation Support         7.19 Emulation and Debug       50       10.3 Documentation Support       10.4 Support Resources         8.1 Overview       53       10.5 Trademarks	7.8 Timing Characteristics	42	8.24 Timers (TIMx)	65
7.10 Digital IO.       44       8.26 Input/Output Diagrams.       6         7.11 ADC.       45       8.27 Serial Wire Debug Interface.       6         7.12 Temperature Sensor.       47       8.28 Device Factory Constants       6         7.13 VREF.       47       8.29 Identification.       6         7.14 I2C.       47       9 Applications, Implementation, and Layout.       9         7.15 SPI.       48       9.1 Typical Application.       9         7.16 UART.       50       10 Device and Documentation Support.       10.1 Device Nomenclature.         7.18 Windowed Watchdog Characteristics.       50       10.2 Tools and Software.       10.3 Documentation Support.         7.19 Emulation and Debug.       50       10.3 Documentation Support.       10.4 Support Resources.         8.1 Overview.       53       10.5 Trademarks.			8.25 Device Analog Connections	67
7.12 Temperature Sensor.       47       8.28 Device Factory Constants       6         7.13 VREF.       47       8.29 Identification.       6         7.14 I2C.       47       9 Applications, Implementation, and Layout.       9         7.15 SPI.       48       9.1 Typical Application.       9         7.16 UART.       50       10 Device and Documentation Support.       10.1 Device Nomenclature.         7.17 TIMx.       50       10.2 Tools and Software.       10.2 Tools and Software.         7.19 Emulation and Debug.       50       10.3 Documentation Support.         8 Detailed Description       52       10.4 Support Resources.         8.1 Overview.       53       10.5 Trademarks.	7.10 Digital IO	44		
7.12 Temperature Sensor.       47       8.28 Device Factory Constants       6         7.13 VREF.       47       8.29 Identification.       6         7.14 I2C.       47       9 Applications, Implementation, and Layout.       9         7.15 SPI.       48       9.1 Typical Application.       9         7.16 UART.       50       10 Device and Documentation Support.       10.1 Device Nomenclature.         7.17 TIMx.       50       10.2 Tools and Software.       10.2 Tools and Software.         7.19 Emulation and Debug.       50       10.3 Documentation Support.         8 Detailed Description       52       10.4 Support Resources.         8.1 Overview.       53       10.5 Trademarks.			8.27 Serial Wire Debug Interface	68
7.14 I2C	7.12 Temperature Sensor	47		
7.15 SPI	7.13 VREF	47	8.29 Identification	69
7.15 SPI	7.14 I2C	47	9 Applications, Implementation, and Layout	70
7.17 TIMx5010.1 Device Nomenclature7.18 Windowed Watchdog Characteristics5010.2 Tools and Software7.19 Emulation and Debug5010.3 Documentation Support8 Detailed Description5210.4 Support Resources8.1 Overview5310.5 Trademarks	7.15 SPI	48		
7.18 Windowed Watchdog Characteristics	7.16 UART	50	10 Device and Documentation Support	71
7.19 Emulation and Debug	7.17 TIMx	50	10.1 Device Nomenclature	71
7.19 Emulation and Debug	7.18 Windowed Watchdog Characteristics	50	10.2 Tools and Software	72
8.1 Overview			10.3 Documentation Support	72
	8 Detailed Description	52	10.4 Support Resources	73
8.2 CPU53 10.6 Electrostatic Discharge Caution	8.1 Overview	53	10.5 Trademarks	73
	8.2 CPU	53	10.6 Electrostatic Discharge Caution	73
8.3 Operating Modes	8.3 Operating Modes	<u>53</u>		
8.4 Power Management Unit (PMU)55 11 Revision History	8.4 Power Management Unit (PMU)	<mark>55</mark>	11 Revision History	73
8.5 Clock Module (CKM)55 12 Mechanical, Packaging, and Orderable				
8.6 DMA_B	8.6 DMA_B	56	Information	74



## **5 Device Comparison**

**Table 5-1. Device Comparison** 

DEVICE NAME (1) (3)	FLASH / SRAM (KB)	ADC CHANNELS	UART / I2C / SPI	TIMG	TIMA	GPIOs	PACKAGE (PACKAGE SIZE) <sup>(2)</sup>
MSPR5F100FESNNAR (4)	64 / 8	24	3/2/1	4	1	41	44 LQFP
MSPR5F100FCSNNAR <sup>(4)</sup>	32 / 8	24	3/2/1	4	<b>!</b>	41	(10mm × 10mm)
MSPR7F102GBESVFCR <sup>(4)</sup>	64 / 8	18	3/2/1	4	1	29	32 LQFP
MSPR7F102GBCSVFCR <sup>(4)</sup>	32 / 8	10	3/2/1	4	ļ !	29	(7mm × 7mm)
MSPM0H3216SPTR	64 / 8	27	3/2/1	4	1	45	48 LQFP
MSPM0H3215SPTR	32 / 8	21	3/2/1	4	<b>!</b>	45	(7mm × 7mm)
MSPM0H3216SRGZR	64 / 8	27	3/2/1	4	1	45	48 VQFN
MSPM0H3215SRGZR	32 / 8	21	3/2/1	4	<b>!</b>	45	(7mm × 7mm)
MSPM0H3216SRHBR	64 / 8	18	3/2/1	4	1	29	32 VQFN
MSPM0H3215SRHBR	32 / 8	10	3/2/1	4	<b>!</b>	29	(5mm × 5mm)
MSPM0H3216SDGS32R	64 / 8	18	3/2/1	4	1	29	32 VSSOP
MSPM0H3215SDGS32R	32 / 8	10	3/2/1	4	'	29	(8.1mm × 4.9mm)
MSPM0H3216SDGS28R	64 / 8	15	3/2/1	4	1	25	28 VSSOP
MSPM0H3215SDGS28R	32 / 8	15	3/2/1	4	ļ !	25	(7.1mm × 4.9mm)
MSPM0H3216SRGER	64 / 8	13	3/2/1	4	1	21	24 VQFN
MSPM0H3215SRGER	32 / 8	13	3/2/1	4	<b>!</b>	21	(4mm × 4mm)
MSPM0H3216SDGS20R	64 / 8	12	3/2/1	4	1	17	20 VSSOP
MSPM0H3215SDGS20R	32 / 8	12	3/2/1	4	'	17	(5.1mm × 4.9mm)
MSPM0H3216SRUKR	64 / 8	12	3/2/1	4	4	17	20 WQFN
MSPM0H3215SRUKR	32 / 8	12	3/2/1	4	1	17	(3mm × 3mm)

<sup>(1)</sup> For the most current part, package, and ordering information for all available devices, see the *Package Option Addendum* in Section 12, or see the TI web site.

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<sup>(2)</sup> The package size (length × width) is a nominal value and includes pins, where applicable. For package dimensions with tolerances, see the *Mechanical Data* in Section 12.

<sup>(3)</sup> For more information about the device name, see Section 10.1.

<sup>(4)</sup> The LQFP-44 and LQFP-32 packages are preview



## **6 Pin Configuration and Functions**

## **6.1 Pin Diagrams**

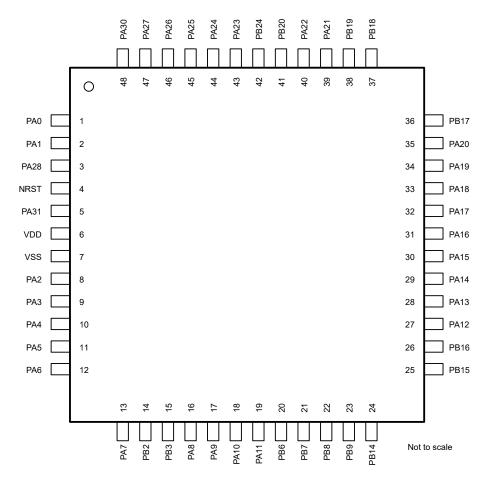


Figure 6-1. 48-Pin PT (LQFP) (Top View)



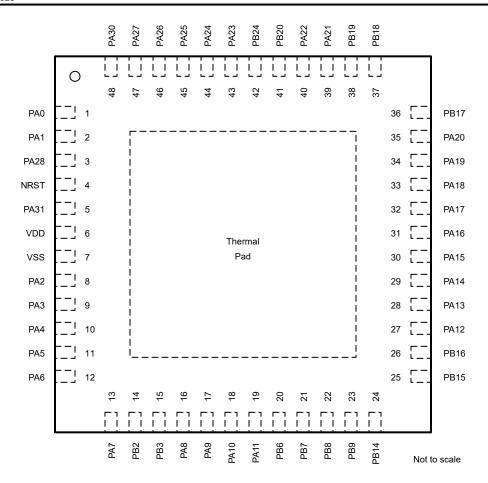


Figure 6-2. 48-Pin RGZ (VQFN) (Top View)

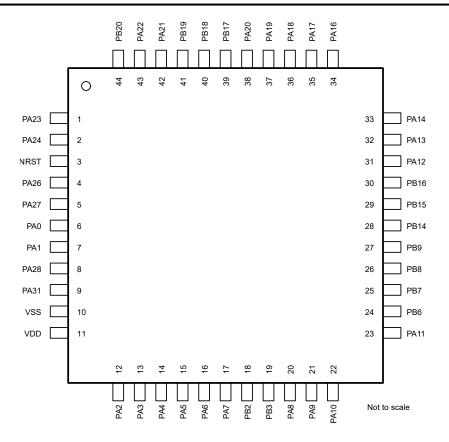


Figure 6-3. 44-Pin NNA (LQFP) (Top View)



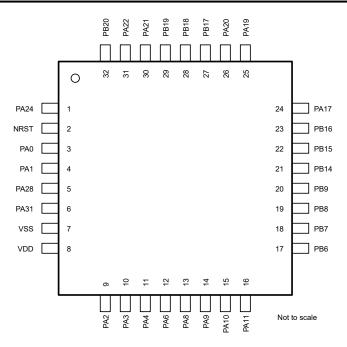


Figure 6-4. 32-Pin VFC (LQFP) (Top View)

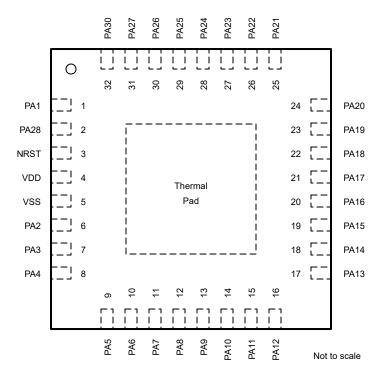


Figure 6-5. 32-Pin RHB (VQFN) (Top View)



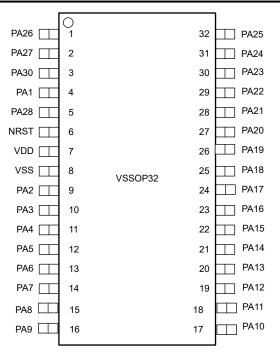


Figure 6-6. 32-Pin DGS32 (VSSOP) (Top View)

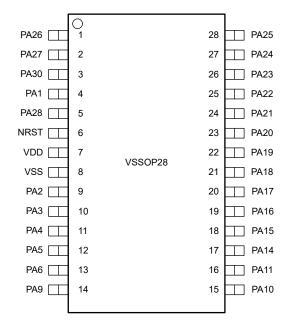


Figure 6-7. 28-Pin DGS28 (VSSOP) (Top View)



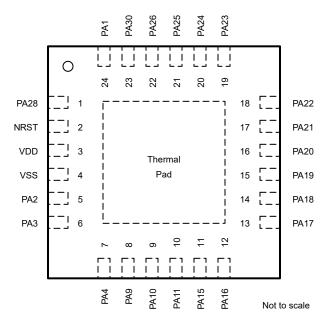


Figure 6-8. 24-Pin RGE (VQFN) (Top View)

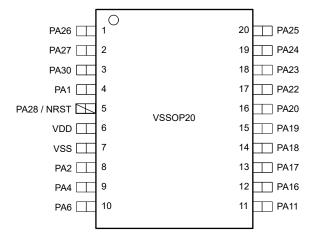


Figure 6-9. 20-Pin DGS20 (VSSOP) (Top View)



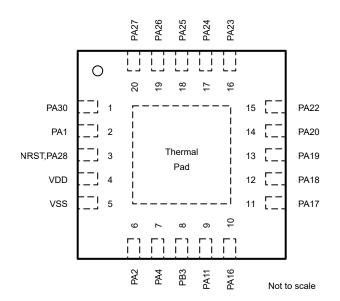


Figure 6-10. 20-Pin RUK (WQFN) (Top View)

Table 6-1. Pin Attributes (PT, RUK, RGZ, NNA, VFC, RHB, DGS32, DGS28, RGE, DGS20 Packages)

PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN	PIN NAME/ IOMUX REG/ IOMUX ADDR	SIGNAL NAME	IOMUX PF	SIGNAL TYPE	BUFFER TYPE	
4	3	4	3	2	3	6	6	2	5	NRST	NRST	(Non-IOMUX 1) 0	RESET	RESET	
											PA0	1	10		
											UART0_TX	2	0		
											I2C0_SDA	3	IOD		
											TIMA0_C0	4	10		
										PA0	TIMA_FAL1	5	I	SDIO	
1		1	6	3						PINCM1	FCC_IN	6	I	(standar	
										0x40428000	TIMG8_C1	7	10	d)	
												BEEP	8	0	]
											TIMG14_C0	9	10	]	
											SPI0_CS1	10	10		
											RTC_OUT	12	0		



PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN	PIN NAME/ IOMUX REG/ IOMUX ADDR	SIGNAL NAME	IOMUX PF	SIGNAL TYPE	BUFFER TYPE
											PA1	1	Ю	
											UART0_RX	2	Ю	
											I2C0_SCL	3	IOD	
											TIMA0_C1	4	Ю	
											TIMA_FAL2	5	I	
											TIMG8_IDX	6	I	
										PA1	TIMG8_C0	7	Ю	SDIO
2	2	2	7	4	1	4	4	24	4	PINCM2	TIMG14_C1	9	Ю	(standar d)
										0.40438004	SPI0_CS3	10	Ю	u)
											HFCLKIN	11	1	
											UART0_TX	12	0	
											UART1_RTS	13	0	
											I2C0_SDA	14	IOD	
											HFXOUT	(Non-IOMUX 1)	Α	
											PA2	1	Ю	
											TIMG8_C1	2	Ю	
											SPI0_CS0	3	Ю	
											TIMG2_C1	4	Ю	
										PA2	TIMG8_IDX	5	1	HSIO
8	6	8	12	9	6	9	9	5	5 8	PINCM5	TIMA0_C3N	6	0	(high-
										0x40428010	TIMA0_C2N	7	0	speed)
											TIMA_FAL0	8	1	
											TIMA_FAL1	9	I	
											TIMA0_C0	11	Ю	
											I2C0_SCL	12	IOD	
											PA3	1	Ю	
											TIMG8_C0	2	Ю	
											SPI0_CS1	3	Ю	
											I2C1_SDA	4	IOD	
											TIMA0_C1	5	Ю	
							10 10			PA3	TIMG2_C0	7	Ю	HSIO
9		9	13	10	7	10		6		PINCM6	TIMA0_C2	8	Ю	(high- speed)
										0x40428014	UART2_CTS	9	I	Speeu)
										UART1_TX	10	0	$\exists$	
											SPI0_CS3	11	Ю	
											I2C0_SDA	12	IOD	
											LFXIN (1)	(Non-IOMUX 1)	А	

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						DGS3	DGS2		DGS2	PIN NAME/				
PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	2 PIN	8 PIN	RGE PIN	0 PIN	IOMUX REG/	SIGNAL NAME	IOMUX PF	SIGNAL	BUFFER TYPE
											PA4	1	Ю	
											TIMG8_C1	2	Ю	
											SPI0_POCI	3	Ю	
											I2C1_SCL	4	IOD	
											TIMA0_C1N	5	0	
										DA4	TIMG2_C1	7	Ю	
10	7	10	14	11	8	11	11	7	9	PA4 PINCM7	TIMA0_C3	8	10	HSIO (high-
										0x40428018	UART2_RTS	9	0	speed)
											UART1_RX	10	I	
											SPI0_CS0	11	Ю	
											TIMA0_C0N	12	0	
											HFCLKIN	13	I	
											LFXOUT (1)	(Non-IOMUX 1)	А	
											PA5	1	Ю	
											TIMG8_C0	2	Ю	
											SPI0_PICO	3	10	
	11 11										I2C1_SDA	4	IOD	
										PA5	TIMG14_C0	5	Ю	HSIO
11		11	15		9	12	12			PINCM8	FCC_IN	6	I	(high-
										0x4042801c	TIMG1_C0	7	Ю	speed)
											TIMA_FAL1	8	I	
											UART0_CTS	9	I	
											UART1_TX	11	0	
											TIMA0_C1	12	Ю	
											PA6	1	Ю	
											TIMG8_C1	2	Ю	
											SPI0_SCLK	3	IOD	
											I2C1_SCL	4	IOD	
											TIMG14_C1	5	Ю	
											HFCLKIN	6	I	
12		12	16	12	10	13	13		10	PA6	TIMG1_C1	7	Ю	HSIO (bigb
12	12 12	12	10	12	10	13	13		10	PINCM9 0x40428020	TIMA_FAL0	8	I	(high- speed)
											UART0_RTS	9	0	
											TIMA0_C2N	10	0	
											UART1_RX	11	I	
											TIMA0_C2	12	Ю	
											I2C0_SDA	13	IOD	
											BEEP	14	0	



PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN	PIN NAME/ IOMUX REG/ IOMUX ADDR	SIGNAL NAME	IOMUX PF	SIGNAL TYPE	BUFFER TYPE			
											PA7	1	Ю				
											CLK_OUT	2	0	-			
											TIMG8_C0	3	Ю				
											TIMA0_C2	4	Ю				
											TIMG8_IDX	5	1	]			
										PA7	TIMG2_C1	6	Ю	HSIO			
13		13	17		11	14				PINCM10	TIMA0_C1	7	Ю	(high-			
										0x40428024	SPI0_CS2	8	Ю	speed)			
											FCC_IN	9	I				
											SPI0_POCI	10	Ю				
											SPI0_PICO	11	Ю				
											UART1_TX	12	0				
											TIMG1_C0	13	Ю				
											PA8	1	Ю				
											UART1_TX	2	0				
											SPI0_CS0	3	Ю				
	16 16 20 13								I2C0_SDA	4	IOD						
										TIMA0_C0	5	Ю					
		20			0.5	00							DAG	TIMA_FAL2	6	I	
16			13	12	15				PA8	TIMA_FAL0	7	I	HSIO (high-				
10		10	20	13	12					PINCM13 0x40428030	SPI0_CS3	8	Ю	speed)			
											TIMG2_C1	9	Ю				
											HFCLKIN	10	I				
											UART0_RTS	11	0				
											SPI0_SCLK	12	IOD				
											UART1_RX	13	1				
											TIMA0_C3N	14	0				
											PA9	1	Ю				
											UART1_RX	2	1				
											SPI0_PICO	3	Ю				
											I2C0_SCL	4	IOD				
											TIMA0_C0N	5	0				
	17 21 14 1						PA9	CLK_OUT	6	0	HSIO						
17		13	16	14	8		PINCM14	TIMA0_C1	7	Ю	(high- speed)						
							0x40428034	RTC_OUT	8	0	apeeu)						
												TIMG2_C0	9	Ю			
										SPI0_POCI	10	Ю					
									UARTO_CTS	11	I						
									TIMA_FAL1	12	I						
											TIMG1_C1	13	IO				

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		1						(001	itinue					1	
PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN	PIN NAME/ IOMUX REG/ IOMUX ADDR	SIGNAL NAME	IOMUX PF	SIGNAL TYPE	BUFFER TYPE	
											PA10	1	10		
											UART0_TX	2	0		
											SPI0_POCI	3	Ю		
											I2C0_SDA	4	IOD		
											TIMA0_C2	5	10		
18		18	22	15	14	17	15	9		PA10	CLK_OUT	6	0	SDIO (standar	
10		10	22	15	14	''	15	9		PINCM15 0x40428038	TIMG14_C0	7	Ю	d)	
											I2C1_SDA	8	IOD		
											TIMA_FAL1	10	I		
											TIMA0_C1N	12	0		
											TIMG8_C1	13	10		
											SPI0_PICO	14	10		
											PA11	1	10		
											UART0_RX	2	Ю		
											SPI0_SCLK	3	IOD		
	19 9 19 23 16 15									I2C0_SCL	4	IOD			
										PA11	TIMA0_C2N	5	0	l	
19		18	16	10	11	PINCM16	UART1_RX	6	I	HSIO (high-					
						18			''	0x4042803c	TIMG14_C1	7	10	speed)	
											I2C1_SCL	8	IOD		
											TIMA_FAL0	10	I		
											SPI0_CS0	12	Ю		
											ADC0_25	(Non-IOMUX 1)	Α		
											PA12	1	Ю		
											SPI0_SCLK	2	IOD		
												TIMA0_C3	4	10	
											FCC_IN	5	I		
											TIMG14_C0	6	10		
										PA12	SPI0_CS1	8	Ю	SDIO	
27		27	31		16	19				PINCM24	UART2_CTS	9	ı	(standar	
								0x4042805c	UART1_CTS	10	ı	d)			
									TIMA0_C3N	11	0	]			
											I2C1_SCL	12	IOD	1	
										TIMG2_C1	13	IO	1		
											ADC0_18	(Non-IOMUX 1)	А		



Table 6-1. Pin Attributes (PT, RUK, RGZ, NNA, VFC, RHB, DGS32, DGS28, RGE, DGS20 Packages) (continued)

								(001	tinue					
PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN	PIN NAME/ IOMUX REG/ IOMUX ADDR	SIGNAL NAME	IOMUX PF	SIGNAL TYPE	BUFFER TYPE
											PA13	1	Ю	
											SPI0_POCI	3	Ю	
											TIMA0_C2N	4	0	
											TIMA0_C3N	5	0	
											RTC_OUT	6	0	
											TIMG14_C1	7	Ю	
										PA13	TIMG14_C3	8	Ю	SDIO
28		28	32		17	20				PINCM25	SPI0_CS3	9	Ю	(standar d)
										0x40428060	UART2_TX	10	0	u)
											UART1_RTS	11	0	
											SPI0_CS0	12	Ю	
											TIMG8_C1	13	Ю	
											TIMA0_C1	14	Ю	
											ADC0_17	(Non-IOMUX 1) 0	А	
											PA14	1	Ю	
											UART0_CTS	2	1	
											SPI0_PICO	3	Ю	
											TIMG1_C0	4	Ю	
	9 29 3									DA 14	CLK_OUT	6	0	
29		33		18	21	17			PA14	SPI0_CS2	9	Ю	SDIO (standar	
					10					PINCM26 0x40428064	UART2_RX	10	I	d)
											I2C0_SCL	12	IOD	
											UART0_TX	13	0	
											TIMA0_C2	14	Ю	
											ADC0_16	(Non-IOMUX 1) 0	Α	
											PA15	1	Ю	
											UART0_RTS	2	0	
											SPI0_CS2	3	Ю	
										PA15	I2C1_SCL	4	IOD	SDIO
30		30			19	22	18	11		PINCM27	TIMA0_C2	5	Ю	(standar d)
										0x40428068	TIMG8_IDX	7	I	] u)
											UART2_RTS	10	0	
							ADC0_15	(Non-IOMUX 1) 0	Α					
						-				PA16	1	Ю		
		10 31 34 20 23 19 12				SPI0_POCI	3	Ю						
						I2C1_SDA	4	IOD						
					PA16	TIMA0_C2N	5	0	SDIO					
31	10		12	12	PINCM28	FCC_IN	7	I	(standar d)					
				0x4042806c	UART2_CTS	10	I	_ u,						
						TIMG14_C2	12	Ю						
								ADC0_14	(Non-IOMUX 1) 0	Α				

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			1	1				(COI	tinue	u,				
PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN	PIN NAME/ IOMUX REG/ IOMUX ADDR	SIGNAL NAME	IOMUX PF	SIGNAL TYPE	BUFFER TYPE
											PA17	1	IO	
											UART1_TX	2	0	
											TIMA0_C2	3	Ю	
											I2C1_SCL	4	IOD	
											TIMA0_C3	5	Ю	
										PA17	TIMG2_C0	6	IO	HSIO
32	11	32	35	24	21	24	20	13	13	PINCM29	TIMG8_C0	7	Ю	(high-
										0x40428070	TIMA0_C0N	8	0	speed)
											SPI0_CS1	9	Ю	1
											SPI0_SCLK	10	IOD	1
											UART0_RX	12	Ю	1
											ADC0_13	(Non-IOMUX 1)	Α	
											PA18	1	Ю	
											UART1_RX	2	1	1
											UART1_RTS	3	0	1
											I2C1_SDA	4	IOD	1
	33 12 33										TIMA0_C3N	5	0	1
											TIMG2_C1	6	Ю	1
										DA40	TIMG8_C1	7	Ю	1
33		33	36		22	25	21	14	14	PA18 PINCM30	SPI0_PICO	8	Ю	SDIO (standar
00	'-									0x40428074	SPI0_CS0	9	Ю	d)
											UART0_CTS	10	1	
											TIMA0_C0	11	Ю	
											SPI0_POCI	12	Ю	
											TIMA_FAL2	13	Ţ	
											CLK_OUT	14	0	
											ADC0_12	(Non-IOMUX 1)	Α	
											PA19	1	Ю	
											SWDIO	2	Ю	
											SPI0_SCLK	3	IOD	
											I2C1_SDA	4	IOD	
										PA19	TIMA0_C2	5	Ю	]
34	34 13	34	37	25	23	26	22	15	15	PINCM31	TIMG14_C0	6	Ю	HSIO (high-
	-						_			0x40428078	SPI0_POCI	7	Ю	speed)
											UART0_CTS	8	I	]
											UART0_RTS	12	0	]
											SPI0_PICO	13	Ю	]
										ADC0_22	(Non-IOMUX 1)	Α		



					1			,00.	unue	۳,		1			
PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN	PIN NAME/ IOMUX REG/ IOMUX ADDR	SIGNAL NAME	IOMUX PF	SIGNAL TYPE	BUFFER TYPE	
											PA20	1	10		
											SWCLK	2	ı		
											TIMA_FAL1	3	I		
											I2C1_SCL	4	IOD		
										DAGG	TIMA0_C2N	5	0		
35	14	35	38	26	24	27	23	16	16	PA20 PINCM32	TIMG14_C1	6	10	HSIO (high-	
00										0x4042807c	SPI0_PICO	7	10	speed)	
												TIMA0_C0	8	10	
											UART0_RTS	9	0		
											UART1_RX	13	I		
											ADC0_4	(Non-IOMUX 1)	А		
											PA21	1	10		
											UART2_TX	2	0		
											SPI0_CS3	3	10		
											UART1_CTS	4	I		
										PA21	TIMA0_C0	5	10	]	
39	39 39 42	42	30	25	28	24	17		PINCM36	TIMG1_C0	6	10	SDIO (standar		
								0x4042808c	UART2_CTS	8	I	d)			
											TIMG8_C0	10	10		
											TIMA0_C0N	12	0		
											UART2_RX	13	I		
											ADC0_8	(Non-IOMUX 1)	А		
											PA22	1	10		
											UART2_RX	2	I		
											SPI0_CS2	3	10		
											UART1_RTS	4	0		
											TIMA0_C0N	5	0		
											TIMG1_C1	6	10		
											TIMA0_C1	7	10		
40	15	40	42	24	26	20	25	40	17	PA22	CLK_OUT	8	0	SDIO	
40	15	40	43	31	26	29	25	18	17	PINCM37 0x40428090	I2C0_SCL	9	IOD	(standar d)	
								TIMG8_C1	10	10					
							UART1_RX	11	I						
								SPI0_POCI	12	10					
								UART2_TX	13	0					
								ADC0_7	(Non-IOMUX 1) 0	А					
											ADC0_VREF-	(Non-IOMUX 2)	А		

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								(COII	tinue	u)				
PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN	PIN NAME/ IOMUX REG/ IOMUX ADDR	SIGNAL NAME	IOMUX PF	SIGNAL TYPE	BUFFER TYPE
											PA23	1	10	
											UART2_TX	2	0	
											SPI0_CS3	3	10	
											TIMA0_C3	5	10	
											TIMG8_C0	6	10	
										PA23	TIMG2_C0	7	10	
43	16	43	1		27	30	26	19	18	PINCM40	UART0_TX	8	0	HSIO (high-
										0x4042809c	TIMG14_C0	9	10	speed)
											SPI0_POCI	12	10	
											UART0_CTS	13	I	
											ADC0_26	(Non-IOMUX 1)	А	
											ADC0_VREF+	(Non-IOMUX 2) 0	А	
											PA24	1	10	
											UART2_RX	2	I	
											SPI0_CS2	3	10	
											UART0_RTS	4	0	
											TIMA0_C3N	5	0	1
										PA24	TIMG8_C1	6	10	SDIO
44	17	44	2	1	28	31	27	20	19	PINCM41	TIMG2_C1	7	10	(standar
										0x404280a0	UART1_RX	8	I	d)
											TIMG14_C1	9	10	
											SPI0_PICO	12	10	
											I2C0_SDA	13	IOD	
											ADC0_3	(Non-IOMUX 1) 0	А	
											PA25	1	10	
											SPI0_PICO	2	10	
											SPI0_POCI	3	10	
											SPI0_SCLK	4	IOD	
											TIMA0_C3	5	10	
											TIMA0_C1N	6	0	
										DAGE	TIMA0_C2	7	Ю	
45	18	45			29	32	28	21	20	PA25 PINCM42	UART2_CTS	8	I	SDIO (standar
10		10			20	02				0x404280a4	TIMG14_C0	9	10	d)
											TIMG1_C0	10	Ю	]
											I2C0_SDA	11	IOD	]
											UART0_TX	12	0	]
											UARTO_RTS	13	0	]
											I2C0_SCL	14	IOD	1
											ADC0_2	(Non-IOMUX 1)	А	



								(COI	tinue	u)				
PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN	PIN NAME/ IOMUX REG/ IOMUX ADDR	SIGNAL NAME	IOMUX PF	SIGNAL TYPE	BUFFER TYPE
											PA26	1	Ю	
											BEEP	2	0	
											SPI0_POCI	3	IO	
											TIMG8_C0	4	IO	
											TIMA_FAL0	5	1	
											TIMA0_C3N	6	0	
											TIMG2_C0	7	Ю	
										PA26	UART2_RTS	8	0	HSIO
46	19	46	4		30	1	1	22	1	PINCM43	I2C0_SCL	9	IOD	(high-
										0x404280a8	TIMG1_C1	10	Ю	speed)
											UART0_RX	11	Ю	
											TIMA0_C0	12	Ю	
											I2C0_SDA	13	IOD	
											UART1_CTS	14	I	
											ADC0_1	(Non-IOMUX 1)	А	
											LFXOUT (2)	(Non-IOMUX 2)	Α	
											PA27	1	Ю	
											SPI0_CS3	2	Ю	
											TIMA0_C0N	3	0	
											TIMG8_C1	4	Ю	
											TIMA_FAL2	5	1	
											CLK_OUT	6	0	
											TIMG2_C1	7	Ю	
										PA27	RTC_OUT	8	0	HSIO
47	20	47	5		31	2	2		2	PINCM44	UART1_CTS	9	ı	(high- speed)
										0x404280ac	I2C0_SCL	10	IOD	, speed,
											UART0_TX	11	0	
											SPI0_POCI	12	Ю	
											LFCLKIN	14	Ţ	
											ADC0_0	(Non-IOMUX 1)	А	
											LFXIN (2)	(Non-IOMUX 2)	Α	
											PA28	1	Ю	
											UART0_TX	2	0	1
											I2C0_SDA	3	IOD	]
										PA28	TIMA0_C3	4	Ю	SDIO
3	3	3	8	5	2	5	5	1	5	PINCM3	TIMA_FAL0	5	I	(standar
										0x40428008	TIMG2_C0	6	Ю	- d)
											TIMA0_C1	7	Ю	1
											HFXIN	(Non-IOMUX 1)	А	

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								(001	tinue					
PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN	PIN NAME/ IOMUX REG/ IOMUX ADDR	SIGNAL NAME	IOMUX PF	SIGNAL TYPE	BUFFER TYPE
											PA30	1	10	
											UART0_RX	4	Ю	1
											TIMG8_IDX	5	1	1
40		48			20			23		PA30	TIMA0_C0	6	Ю	SDIO
48	1	40			32	3	3	23	3	PINCM45 0x404280b0	UART1_RTS	9	0	(standar d)
											TIMG2_C1	10	Ю	
											TIMG14_C2	11	Ю	
											I2C0_SDA	12	IOD	
											PA31	1	Ю	
										PA31	UART0_RX	2	Ю	SDIO
5		5	9	6						PINCM4	I2C0_SCL	3	IOD	(standar
										0x4042800c	TIMA0_C3N	4	0	d)
											CLK_OUT	6	0	
											PB2	1	Ю	
											UART2_CTS	3	I	
											I2C1_SCL	4	IOD	
											TIMA0_C3	5	Ю	
										PB2	UART1_CTS	6	I	HSIO
14		14	18							PINCM11	TIMG1_C0	7	Ю	(high-
										0x40428028	UART2_TX	8	0	speed)
											HFCLKIN	10	I	
											SPI0_PICO	11	Ю	
											UART1_RX	12	I	
											TIMA0_C1N	13	0	
											PB3	1	Ю	
											TIMA_FAL0	2	I	
											UART2_RTS	3	0	
											I2C1_SDA	4	IOD	
											TIMA0_C3N	5	0	
											UART1_RTS	6	0	
15	8	15	19							PB3	TIMG1_C1	7	Ю	HSIO high-
13	0	13	15							PINCM12 0x4042802c	UART2_RX	8	I	speed)
											TIMG2_C1	9	Ю	
											TIMA0_C0	10	Ю	]
											SPI0_SCLK	11	IOD	
											SPI0_CS0	12	Ю	
											UART1_TX	13	0	
											RTC_OUT	14	0	



PT	RUK	RGZ	NNA	VFC	RHB	DGS3	DGS2	RGE	DGS2	PIN NAME/	SIGNAL	IOMUX	SIGNAL	BUFFER
PIN	PIN	PIN	PIN	PIN	PIN	2 PIN	8 PIN	PIN	0 PIN	IOMUX REG/ IOMUX ADDR	NAME	PF	TYPE	TYPE
											PB6	1	10	
											UART1_TX	2	0	
											TIMG8_C0	5	10	
											UART2_CTS	6	I	
											TIMG1_C0	7	10	
00		00	0.4	47						PB6	TIMA_FAL2	8	I	SDIO
20		20	24	17						PINCM17 0x40428040	SPI0_CS1	9	10	(standar d)
										0.00.1200.10	TIMA0_C3N	11	0	
											TIMG8_C1	12	10	
											TIMA0_C2N	13	0	_
											UART0_TX	14	0	_
											ADC0_24	(Non-IOMUX 1) 0	А	
											PB7	1	10	
											UART1_RX	2	I	
											TIMG8_C1	5	10	
											UART2_RTS	6	0	
			0.5							PB7	TIMG1_C1	7	10	SDIO
21		21	25	18						PINCM18 0x40428044	SPI0_CS2	9	10	(standar d)
										0.40420044	BEEP	12	0	_ ′
											SPI0_SCLK	13	IOD	_
											UART0_RX	14	10	_
											ADC0_23	(Non-IOMUX 1) 0	Α	
											PB8	1	10	
											UART1_CTS	2	I	
											TIMA0_C0	5	10	
										PB8	TIMG1_C0	7	10	
22		22	26	19						PINCM19	SPI0_SCLK	9	IOD	SDIO (standar
										0x40428048	BEEP	10	0	` d)
											TIMG8_C0	11	10	
											UART0_RX	12	10	
											SPI0_POCI	13	10	
											I2C0_SCL	14	IOD	
											PB9	1	IO	
											UART1_RTS	2	0	
											TIMA0_C0N	5	0	
											TIMA0_C1	6	IO	
25										PB9	TIMG1_C1	7	10	SDIO
23		23	27	20						PINCM20 0x4042804c	TIMG2_C0	8	10	(standar d)
										UX4U420U4U	SPI0_POCI	10	10	, -7
											UARTO_RX	11	10	
											I2C0_SCL	12	IOD	
											UART0_TX	13	0	
											I2C0_SDA	14	IOD	

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PT	RUK	RGZ	NNA	VFC	RHB	DGS3	DGS2	RGE	DGS2	PIN NAME/	SIGNAL	IOMUX	SIGNAL	BUFFER
PIN	PIN	PIN	PIN	PIN	PIN	2 PIN	8 PIN	PIN	0 PIN	IOMUX REG/ IOMUX ADDR	NAME	PF	TYPE	TYPE
											PB14	1	Ю	
											TIMA0_C0	5	Ю	
											TIMG8_IDX	6	I	
											SPI0_CS3	7	Ю	
											TIMG2_C1	8	Ю	
										PB14	I2C0_SDA	9	IOD	SDIO
24		24	28	21						PINCM21	SPI0_PICO	10	Ю	(standar d)
										0x40428050	UART0_TX	11	0	
											TIMA_FAL2	12	I	
											TIMA_FAL0	13	I	
											TIMG14_C2	14	Ю	
											ADC0_21	(Non-IOMUX 1) 0	Α	
											PB15	1	Ю	
											UART2_TX	2	0	1
											TIMG8_C0	5	Ю	1
										PB15	TIMG2_C0	6	Ю	SDIO
25		25	29	22						PINCM22 0x40428054	TIMA0_C1N	12	0	(standar
										0x40428054	UART1_TX	13	0	- d)
											TIMG2_C1	14	Ю	
											ADC0_20	(Non-IOMUX 1)	А	
											PB16	1	Ю	
											UART2_RX	2	I	
											TIMG8_C1	5	Ю	
										PB16	TIMG2_C1	6	Ю	SDIO
26		26	30	23						PINCM23	TIMA0_C2N	12	0	(standar
										0x40428058	UART1_RX	13	I	- d)
											I2C1_SDA	14	IOD	1
											ADC0_19	(Non-IOMUX 1)	А	
											PB17	1	Ю	
											UART2_TX	2	0	1
											SPI0_PICO	3	Ю	1
											I2C0_SCL	4	IOD	1
											TIMA0_C2	5	Ю	1
										PB17	TIMG14_C0	6	Ю	SDIO
36		36	39	27						PINCM33	TIMG1_C0	9	Ю	(standar d)
										0x40428080	SPI0_CS0	10	Ю	] ""
											UART1_RX	11	Į	
											UART1_TX	13	0	1
											UART0_RTS	14	0	1
											ADC0_11	(Non-IOMUX 1)	Α	



								(COI	itinue	u)				
PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN	PIN NAME/ IOMUX REG/ IOMUX ADDR	SIGNAL NAME	IOMUX PF	SIGNAL TYPE	BUFFER TYPE
											PB18	1	Ю	
											UART2_RX	2	I	
											SPI0_SCLK	3	IOD	
											I2C0_SDA	4	IOD	
										DD40	TIMA0_C2N	5	0	
37		37	40	28						PB18 PINCM34	TIMG14_C1	6	Ю	SDIO (standar
0,			10							0x40428084	SPI0_CS0	7	Ю	d)
											TIMG1_C1	9	Ю	
											TIMA0_C1	12	Ю	
											UART0_RTS	13	0	
											ADC0_10	(Non-IOMUX 1) 0	Α	
											PB19	1	Ю	
											SPI0_POCI	3	Ю	
											TIMG8_C1	4	Ю	
											UART0_CTS	5	1	
										PB19	TIMG2_C1	6	Ю	SDIO
38		38	41	29						PINCM35	TIMG8_IDX	7	1	(standar
										0x40428088	UART2_CTS	8	I	- d)
											TIMA0_C1N	12	0	
											UART2_RX	13	1	
											ADC0_9	(Non-IOMUX 1)	А	
											PB20	1	Ю	
											SPI0_CS2	2	Ю	
											TIMA0_C2	5	Ю	
											TIMA_FAL1	6	I	
										PB20	TIMA0_C1	7	Ю	]
41		41	44	32						PINCM38	UART2_RTS	8	0	SDIO (standar
				02						0x40428094	I2C0_SDA	9	IOD	d)
											UART1_CTS	12	I	
											TIMA0_C2N	13	0	
											TIMG8_C1	14	Ю	
											ADC0_6	(Non-IOMUX 1) 0	Α	
											PB24	1	Ю	
											SPI0_CS3	2	Ю	
											SPI0_CS1	3	Ю	
											TIMA0_C3	5	Ю	
										PB24	TIMA0_C1N	6	0	SDIO
42		42								PINCM39	UART2_RTS	8	0	(standar d)
										0x40428098	SPI0_SCLK	12	IOD	] ",
											TIMG14_C2	13	Ю	
											UARTO_RTS	14	0	
											ADC0_5	(Non-IOMUX 1) 0	А	
6	4	6	11	8	4	7	7	3	6	VDD	VDD	(Non-IOMUX 1) 0	PWR	PWR

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PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN	PIN NAME/ IOMUX REG/ IOMUX ADDR	SIGNAL NAME	IOMUX PF	SIGNAL TYPE	BUFFER TYPE
7	5	7	10	7	5	8	8	4	7	vss	VSS	(Non-IOMUX 1) 0	PWR	PWR

- RUK, DGS20, VFC, and NNA do not support LFXIN/LFXOUT on pins PA3/PA4 respectively. DGS28, DGS32, RGE, RHB, VFC, RGZ, and PT do not support LFXOUT/LFXIN on pins PA26/PA27 respectively.

### 6.2 Signal Descriptions

Table 6-2. Analog to Digital Converter (ADC) Signal Descriptions

SIGNAL NAME	PIN TYPE	DESCRIPTION	PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN
ADC0_VREF+	А	ADC0 voltage reference (VREF) power supply	43	16	43	1		27	30	26	19	18
ADC0_VREF-	А	ADC0 voltage reference (VREF) ground supply	40	15	40	43	31	26	29	25	18	17
ADC0_0	Α	ADC0 analog input channel 0	47	20	47	5		31	2	2		2
ADC0_1	Α	ADC0 analog input channel 1	46	19	46	4		30	1	1	22	1
ADC0_2	А	ADC0 analog input channel 2	45	18	45			29	32	28	21	20
ADC0_3	Α	ADC0 analog input channel 3	44	17	44	2	1	28	31	27	20	19
ADC0_4	А	ADC0 analog input channel 4	35	14	35	38	26	24	27	23	16	16
ADC0_5	А	ADC0 analog input channel 5	42		42							
ADC0_6	А	ADC0 analog input channel 6	41		41	44	32					
ADC0_7	А	ADC0 analog input channel 7	40	15	40	43	31	26	29	25	18	17
ADC0_8	Α	ADC0 analog input channel 8	39		39	42	30	25	28	24	17	
ADC0_9	А	ADC0 analog input channel 9	38		38	41	29					
ADC0_10	Α	ADC0 analog input channel 10	37		37	40	28					
ADC0_11	Α	ADC0 analog input channel 11	36		36	39	27					
ADC0_12	А	ADC0 analog input channel 12	33	12	33	36		22	25	21	14	14
ADC0_13	Α	ADC0 analog input channel 13	32	11	32	35	24	21	24	20	13	13
ADC0_14	А	ADC0 analog input channel 14	31	10	31	34		20	23	19	12	12
ADC0_15	А	ADC0 analog input channel 15	30		30			19	22	18	11	
ADC0_16	А	ADC0 analog input channel 16	29		29	33		18	21	17		
ADC0_17	А	ADC0 analog input channel 17	28		28	32		17	20			
ADC0_18	Α	ADC0 analog input channel 18	27		27	31		16	19			
ADC0_19	А	ADC0 analog input channel 19	26		26	30	23					
ADC0_20	Α	ADC0 analog input channel 20	25		25	29	22					
ADC0_21	Α	ADC0 analog input channel 21	24		24	28	21					
ADC0_22	Α	ADC0 analog input channel 22	34	13	34	37	25	23	26	22	15	15
ADC0_23	Α	ADC0 analog input channel 23	21		21	25	18					
ADC0_24	Α	ADC0 analog input channel 24	20		20	24	17					
ADC0_25	Α	ADC0 analog input channel 25	19	9	19	23	16	15	18	16	10	11
ADC0_26	А	ADC0 analog input channel 26	43	16	43	1		27	30	26	19	18



Table 6-3. Clock Module (CKM) Signal Descriptions

SIGNAL NAME	PIN TYPE	DESCRIPTION	PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN
CLK_OUT	0	CLK_OUT digital clock output from the PMCU	13, 17, 18, 29, 33, 40, 47, 5	12, 15, 20	13, 17, 18, 29, 33, 40, 47, 5	17, 21, 22, 33, 36, 43, 5, 9	14, 15, 31, 6	11, 13, 14, 18, 22, 26, 31	14, 16, 17, 2, 21, 25, 29	14, 15, 17, 2, 21, 25		14, 17, 2
FCC_IN	I	Frequency clock counter (FCC) input signal	1, 11, 13, 27, 31	10	1, 11, 13, 27, 31	15, 17, 31, 34, 6	3	11, 16, 20, 9	12, 14, 19, 23	12, 19	12	12
HFCLKIN	I	High frequency clock digital clock input signal	10, 12, 14, 16, 2	2, 7	10, 12, 14, 16, 2	14, 16, 18, 20, 7	11, 12, 13, 4	1, 10, 12, 8	11, 13, 15, 4	11, 13, 4	24, 7	10, 4,
HFXIN	А	High frequency crystal oscillator (HFXT) signal	3	3	3	8	5	2	5	5	1	5
HFXOUT	А	High frequency crystal oscillator (HFXT) signal	2	2	2	7	4	1	4	4	24	4
LFCLKIN	I	Low frequency clock digital clock input signal	47	20	47	5		31	2	2		2
LFXIN	А	Low frequency crystal oscillator (LFXT) signal	47, 9	20	47, 9	13, 5	10	31, 7	10, 2	10, 2	6	2
LFXOUT	А	Low frequency crystal oscillator (LFXT) signal	10, 46	19, 7	10, 46	14, 4	11	30, 8	1, 11	1, 11	22, 7	1, 9

Table 6-4. General Purpose Input Output Module Signal Descriptions

SIGNAL NAME	PIN TYPE	DESCRIPTION	PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN
PA0	Ю	GPIO port A input/output 0	1		1	6	3					
PA1	Ю	GPIO port A input/output 1	2	2	2	7	4	1	4	4	24	4
PA2	Ю	GPIO port A input/output 2	8	6	8	12	9	6	9	9	5	8
PA3	Ю	GPIO port A input/output 3	9		9	13	10	7	10	10	6	
PA4	Ю	GPIO port A input/output 4	10	7	10	14	11	8	11	11	7	9
PA5	Ю	GPIO port A input/output 5	11		11	15		9	12	12		
PA6	Ю	GPIO port A input/output 6	12		12	16	12	10	13	13		10
PA7	Ю	GPIO port A input/output 7	13		13	17		11	14			
PA8	Ю	GPIO port A input/output 8	16		16	20	13	12	15			
PA9	Ю	GPIO port A input/output 9	17		17	21	14	13	16	14	8	
PA10	Ю	GPIO port A input/output 10	18		18	22	15	14	17	15	9	
PA11	Ю	GPIO port A input/output 11	19	9	19	23	16	15	18	16	10	11
PA12	Ю	GPIO port A input/output 12	27		27	31		16	19			
PA13	Ю	GPIO port A input/output 13	28		28	32		17	20			
PA14	Ю	GPIO port A input/output 14	29		29	33		18	21	17		
PA15	Ю	GPIO port A input/output 15	30		30			19	22	18	11	
PA16	Ю	GPIO port A input/output 16	31	10	31	34		20	23	19	12	12
PA17	Ю	GPIO port A input/output 17	32	11	32	35	24	21	24	20	13	13
PA18	Ю	GPIO port A input/output 18	33	12	33	36		22	25	21	14	14
PA19	Ю	GPIO port A input/output 19	34	13	34	37	25	23	26	22	15	15
PA20	Ю	GPIO port A input/output 20	35	14	35	38	26	24	27	23	16	16

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**Table 6-4. General Purpose Input Output Module Signal Descriptions (continued)** 

SIGNAL NAME	PIN TYPE	DESCRIPTION	PT	RUK	RGZ PIN	NNA PIN	VFC PIN	RHB	DGS3 2 PIN		RGE PIN	DGS2 0 PIN
PA21	10	GPIO port A input/output 21	39	1 114	39	42	30	25	28	24	17	01111
PA22	IO	GPIO port A input/output 22	40	15	40	43	31	26	29	25	18	17
PA23	IO	GPIO port A input/output 23	43	16	43	1		27	30	26	19	18
PA24	10	GPIO port A input/output 24	44	17	44	2	1	28	31	27	20	19
PA25	10	· · · · · · · · · · · · · · · · · · ·	45	18	45			29	32	28	21	20
		GPIO port A input/output 25			_				-	-	22	
PA26	IO	GPIO port A input/output 26	46	19	46	4		30	1	1	22	1
PA27	10	GPIO port A input/output 27	47	20	47	5		31	2	2		2
PA28	Ю	GPIO port A input/output 28	3	3	3	8	5	2	5	5	1	5
PA30	Ю	GPIO port A input/output 30	48	1	48			32	3	3	23	3
PA31	Ю	GPIO port A input/output 31	5		5	9	6					
PB2	Ю	GPIO port B input/output 2	14		14	18						
PB3	Ю	GPIO port B input/output 3	15	8	15	19						
PB6	Ю	GPIO port B input/output 6	20		20	24	17					
PB7	Ю	GPIO port B input/output 7	21		21	25	18					
PB8	Ю	GPIO port B input/output 8	22		22	26	19					
PB9	Ю	GPIO port B input/output 9	23		23	27	20					
PB14	Ю	GPIO port B input/output 14	24		24	28	21					
PB15	Ю	GPIO port B input/output 15	25		25	29	22					
PB16	Ю	GPIO port B input/output 16	26		26	30	23					
PB17	Ю	GPIO port B input/output 17	36		36	39	27					
PB18	Ю	GPIO port B input/output 18	37		37	40	28					
PB19	Ю	GPIO port B input/output 19	38		38	41	29					
PB20	Ю	GPIO port B input/output 20	41		41	44	32					
PB24	Ю	GPIO port B input/output 24	42		42							

### Table 6-5. I2C Signal Descriptions

SIGNAL NAME	PIN TYPE	DESCRIPTION	PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN
12C0_SCL	IOD	I2C0 serial clock signal (SCL)	17, 19, 2, 22, 23, 29, 36, 40, 45, 46, 47, 5,	15, 18, 19, 2, 20, 6, 9	17, 19, 2, 22, 23, 29, 36, 40, 45, 46, 47, 5, 8	12, 21, 23, 26, 27, 33, 39, 4, 43, 5, 7, 9	14, 16, 19, 20, 27, 31, 4, 6, 9	1, 13, 15, 18, 26, 29, 30, 31, 6	1, 16, 18, 2, 21, 29, 32, 4, 9	1, 14, 16, 17, 2, 25, 28, 4, 9	10, 18, 21, 22, 24, 5, 8	1, 11, 17, 2, 20, 4, 8
I2C0_SDA	IOD	I2C0 serial data signal (SDA)	1, 12, 16, 18, 2, 23, 24, 3, 37, 41, 44, 45, 46, 48, 9	1, 17, 18, 19, 2, 3	1, 12, 16, 18, 2, 23, 24, 3, 37, 41, 44, 45, 46, 48, 9	13, 16, 2, 20, 22, 27, 28, 4, 40, 44, 6, 7, 8	1, 10, 12, 13, 15, 20, 21, 28, 3, 32, 4, 5	1, 10, 12, 14, 2, 28, 29, 30, 32, 7	1, 10, 13, 15, 17, 3, 31, 32, 4, 5	1, 10, 13, 15, 27, 28, 3, 4, 5	1, 20, 21, 22, 23, 24, 6, 9	1, 10, 19, 20, 3, 4, 5



**Table 6-5. I2C Signal Descriptions (continued)** 

	SIGNAL DIN DI DIN DE DEL DES													
SIGNAL NAME	PIN TYPE	DESCRIPTION	PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN		
I2C1_SCL	IOD	I2C1 serial clock signal (SCL)	10, 12, 14, 19, 27, 30, 32, 35	11, 14, 7, 9	10, 12, 14, 19, 27, 30, 32, 35	14, 16, 18, 23, 31, 35, 38	11, 12, 16, 24, 26	10, 15, 16, 19, 21, 24, 8	11, 13, 18, 19, 22, 24, 27	11, 13, 16, 18, 20, 23	10, 11, 13, 16, 7	10, 11, 13, 16, 9		
I2C1_SDA	IOD	I2C1 serial data signal (SDA)	11, 15, 18, 26, 31, 33, 34, 9	10, 12, 13, 8	11, 15, 18, 26, 31, 33, 34, 9	13, 15, 19, 22, 30, 34, 36, 37	10, 15, 23, 25	14, 20, 22, 23, 7, 9	10, 12, 17, 23, 25, 26	10, 12, 15, 19, 21, 22	12, 14, 15, 6, 9	12, 14, 15		

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

SIGNAL NAME	PIN TYPE	DESCRIPTION	PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN		RGE PIN	DGS2 0 PIN
RTC_OUT	0	Real-time clock output signal	1, 15, 17, 28, 47	20, 8	1, 15, 17, 28, 47	19, 21, 32, 5, 6	14, 3	13, 17, 31	-, ,	14, 2	8	2

### Table 6-7. Serial Peripheral Interface (SPI) Signal Descriptions

SIGNAL NAME	PIN TYPE	DESCRIPTION	PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN
SPI0_PICO	Ю	SPI0 peripheral in controller out signal	11, 13, 14, 17, 18, 24, 29, 33, 34, 35, 36, 44, 45	12, 13, 14, 17, 18	11, 13, 14, 17, 18, 24, 29, 33, 34, 35, 36, 44, 45	15, 17, 18, 2, 21, 22, 28, 33, 36, 37, 38, 39	1, 14, 15, 21, 25, 26, 27	11, 13, 14, 18, 22, 23, 24, 28, 29, 9	12, 14, 16, 17, 21, 25, 26, 27, 31, 32	12, 14, 15, 17, 21, 22, 23, 27, 28	14, 15, 16, 20, 21, 8, 9	14, 15, 16, 19, 20
SPI0_POCI	Ю	SPI0 peripheral out controller in signal	10, 13, 17, 18, 22, 23, 28, 31, 33, 34, 38, 40, 43, 45, 46, 47	10, 12, 13, 15, 16, 18, 19, 20, 7	10, 13, 17, 18, 22, 23, 28, 31, 33, 34, 38, 40, 43, 45, 46, 47	1, 14, 17, 21, 22, 26, 27, 32, 34, 36, 37, 4, 41, 43, 5	11, 14, 15, 19, 20, 25, 29, 31	11, 13, 14, 17, 20, 22, 23, 26, 27, 29, 30, 31, 8	1, 11, 14, 16, 17, 2, 20, 23, 25, 26, 29, 30, 32	1, 11, 14, 15, 19, 2, 21, 22, 25, 26, 28	12, 14, 15, 18, 19, 21, 22, 7, 8, 9	1, 12, 14, 15, 17, 18, 2, 20, 9

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Table 6-7. Serial Peripheral Interface (SPI) Signal Descriptions (continued)

	Table 6-	7. Serial Peripheral Interf	ace (S	PI) Si	gnai L	Jescri	ptions	s (con	tinue	<b>1</b> )		
SIGNAL NAME	PIN TYPE	DESCRIPTION	PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN
SPI0_SCLK	IOD	SPI0 serial clock	12, 15, 16, 19, 21, 22, 27, 32, 34, 37, 42, 45	11, 13, 18, 8, 9	12, 15, 16, 19, 21, 22, 27, 32, 34, 37, 42, 45	16, 19, 20, 23, 25, 26, 31, 35, 37, 40	12, 13, 16, 18, 19, 24, 25, 28	10, 12, 15, 16, 21, 23, 29	13, 15, 18, 19, 24, 26, 32	13, 16, 20, 22, 28	10, 13, 15, 21	10, 11, 13, 15, 20
SPI0_CS0	IO	SPI0 chip-select 0 signal	10, 15, 16, 19, 28, 33, 36, 37, 8	12, 6, 7, 8, 9	10, 15, 16, 19, 28, 33, 36, 37, 8	12, 14, 19, 20, 23, 32, 36, 39, 40	11, 13, 16, 27, 28, 9	12, 15, 17, 22, 6, 8	11, 15, 18, 20, 25, 9	11, 16, 21, 9	10, 14, 5, 7	11, 14, 8, 9
SPI0_CS1	Ю	SPI0 chip-select 1 signal	1, 20, 27, 32, 42, 9	11	1, 20, 27, 32, 42, 9	13, 24, 31, 35, 6	10, 17, 24, 3	16, 21, 7	10, 19, 24	10, 20	13, 6	13
SPI0_CS2	Ю	SPI0 chip-select 2 signal	13, 21, 29, 30, 40, 41, 44	15, 17	13, 21, 29, 30, 40, 41, 44	17, 2, 25, 33, 43, 44	1, 18, 31, 32	19,	14, 21, 22, 29, 31	17, 18, 25, 27	11, 18, 20	17, 19
SPI0_CS3	Ю	SPI0 chip-select 3 signal	16, 2, 24, 28, 39, 42, 43, 47, 9	16, 2, 20	16, 2, 24, 28, 39, 42, 43, 47, 9	1, 13, 20, 28, 32, 42, 5, 7	10, 13, 21, 30, 4	1, 12, 17, 25, 27, 31, 7	10, 15, 2, 20, 28, 30, 4	10, 2, 24, 26, 4	17, 19, 24, 6	18, 2, 4

### Table 6-8. Serial Wire Debug (SWD) Signal Descriptions

			· · · · · · · · · · · · · · · · · · ·	( )								
SIGNAL NAME	PIN TYPE	DESCRIPTION	PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN		RGE PIN	DGS2 0 PIN
SWCLK	I	Serial wire debug interface clock input signal	35	14	35	38	26	24	27	23	16	16
SWDIO	Ю	Serial wire debug interface data input/output signal	34	13	34	37	25	23	26	22	15	15

### Table 6-9. System Controller (SYSCTL) Signal Descriptions

					<i>,</i> - 5	-						
SIGNAL NAME	PIN TYPE	DESCRIPTION	PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN
ВЕЕР	0	Beep output	1, 12, 21, 22, 46	19	1, 12, 21, 22, 46	16, 25, 26, 4, 6	12, 18, 19, 3	10, 30	1, 13	1, 13	22	1, 10
NRST	RESET	Active-low reset signal (must be logic high for the device to start)	4	3	4	3	2	3	6	6	2	5
VDD	PWR	VDD supply	6	4	6	11	8	4	7	7	3	6



### Table 6-9. System Controller (SYSCTL) Signal Descriptions (continued)

SIGNAL NAME	PIN TYPE	DESCRIPTION	PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN
VSS	PWR	VSS (ground)	7	5	7	10	7	5	8	8	4	7

### Table 6-10. Timer (TIMx) Signal Descriptions

		Table 6-10. Timer	( I IIVIX	Sign	ai Des	scripti	ons					
SIGNAL NAME	PIN TYPE	DESCRIPTION	PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN
TIMA0_C0	Ю	TIMA0 capture/compare 0 signal	1, 15, 16, 22, 24, 33, 35, 39, 46, 48, 8	1, 12, 14, 19, 6, 8	1, 15, 16, 22, 24, 33, 35, 39, 46, 48, 8	12, 19, 20, 26, 28, 36, 38, 4, 42, 6	13, 19, 21, 26, 3, 30, 9	12, 22, 24, 25, 30, 32, 6	1, 15, 25, 27, 28, 3, 9	1, 21, 23, 24, 3, 9	14, 16, 17, 22, 23, 5	1, 14, 16, 3, 8
TIMA0_C1	Ю	TIMA0 capture/compare 1 signal	11, 13, 17, 2, 23, 28, 3, 37, 40, 41, 9	15, 2, 3	11, 13, 17, 2, 23, 28, 3, 37, 40, 41, 9	13, 15, 17, 21, 27, 32, 40, 43, 44, 7, 8	10, 14, 20, 28, 31, 32, 4, 5	1, 11, 13, 17, 2, 26, 7, 9	10, 12, 14, 16, 20, 29, 4, 5	10, 12, 14, 25, 4, 5	1, 18, 24, 6, 8	17, 4, 5
TIMA0_C2	Ю	TIMA0 capture/compare 2 signal	12, 13, 18, 29, 30, 32, 34, 36, 41, 45, 9	11, 13, 18	12, 13, 18, 29, 30, 32, 34, 36, 41, 45, 9	13, 16, 17, 22, 33, 35, 37, 39, 44	10, 12, 15, 24, 25, 27, 32	10, 11, 14, 18, 19, 21, 23, 29, 7	10, 13, 14, 17, 21, 22, 24, 26, 32	10, 13, 15, 17, 18, 20, 22, 28	11, 13, 15, 21, 6, 9	10, 13, 15, 20
TIMA0_C3	Ю	TIMA0 capture/compare 3 signal	10, 14, 27, 3, 32, 42, 43, 45	11, 16, 18, 3, 7	10, 14, 27, 3, 32, 42, 43, 45	1, 14, 18, 31, 35, 8	11, 24, 5	16, 2, 21, 27, 29, 8	11, 19, 24, 30, 32, 5	11, 20, 26, 28, 5	1, 13, 19, 21, 7	13, 18, 20, 5, 9
TIMA0_C0N	0	TIMA0 capture/compare 0 complementary output	10, 17, 23, 32, 39, 40, 47	11, 15, 20, 7	10, 17, 23, 32, 39, 40, 47	14, 21, 27, 35, 42, 43, 5	11, 14, 20, 24, 30, 31	13, 21, 25, 26, 31, 8	11, 16, 2, 24, 28, 29	11, 14, 2, 20, 24, 25	13, 17, 18, 7, 8	13, 17, 2, 9
TIMA0_C1N	0	TIMA0 capture/compare 1 complementary output	10, 14, 18, 25, 38, 42, 45	18, 7	10, 14, 18, 25, 38, 42, 45	14, 18, 22, 29, 41	11, 15, 22, 29	14, 29, 8	11, 17, 32	11, 15, 28	21, 7, 9	20, 9

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Table 6-10. Timer (TIMx) Signal Descriptions (continued)

SIGNAL	PIN	PERCENTION	PT	RUK	RGZ	NNA	VFC	RHB	DGS3	DGS2	RGE	DGS2
NAME	TYPE	DESCRIPTION	PIN	PIN	PIN	PIN	PIN	PIN	2 PIN	8 PIN	PIN	0 PIN
TIMA0_C2N	0	TIMA0 capture/compare 2 complementary output	12, 19, 20, 26, 28, 31, 35, 37, 41, 8	10, 14, 6, 9	12, 19, 20, 26, 28, 31, 35, 37, 41, 8	12, 16, 23, 24, 30, 32, 34, 38, 40, 44	12, 16, 17, 23, 26, 28, 32, 9	10, 15, 17, 20, 24, 6	13, 18, 20, 23, 27, 9	13, 16, 19, 23, 9	10, 12, 16, 5	10, 11, 12, 16, 8
TIMA0_C3N	0	TIMA0 capture/compare 3 complementary output	15, 16, 20, 27, 28, 33, 44, 46, 5,	12, 17, 19, 6, 8	15, 16, 20, 27, 28, 33, 44, 46, 5,	12, 19, 2, 20, 24, 31, 32, 36, 4, 9	1, 13, 17, 6, 9	12, 16, 17, 22, 28, 30, 6	1, 15, 19, 20, 25, 31, 9	1, 21, 27, 9	14, 20, 22, 5	1, 14, 19, 8
TIMA_FAL0	I	TIMA fault input 0	12, 15, 16, 19, 24, 3, 46, 8	19, 3, 6, 8, 9	12, 15, 16, 19, 24, 3, 46, 8	12, 16, 19, 20, 23, 28, 4, 8	12, 13, 16, 21, 5, 9	10, 12, 15, 2, 30, 6	1, 13, 15, 18, 5, 9	1, 13, 16, 5, 9	1, 10, 22, 5	1, 10, 11, 5, 8
TIMA_FAL1	ı	TIMA fault input 1	1, 11, 17, 18, 35, 41, 8	14, 6	1, 11, 17, 18, 35, 41, 8	12, 15, 21, 22, 38, 44, 6	14, 15, 26, 3, 32, 9	13, 14, 24, 6, 9	12, 16, 17, 27, 9	12, 14, 15, 23, 9	16, 5, 8, 9	16, 8
TIMA_FAL2	ı	TIMA fault input 2	16, 2, 20, 24, 33, 47	12, 2, 20	16, 2, 20, 24, 33, 47	20, 24, 28, 36, 5, 7	13, 17, 21, 4	1, 12, 22, 31		2, 21,	14, 24	14, 2, 4
TIMG8_IDX	ı	TIMG8 quadrature encoder index pulse signal	13, 2, 24, 30, 38, 48, 8	1, 2, 6	13, 2, 24, 30, 38, 48, 8	12, 17, 28, 41, 7	21, 29, 4, 9	1, 11, 19, 32, 6	14, 22, 3, 4, 9	18, 3, 4, 9	11, 23, 24, 5	3, 4, 8
TIMG14_C0	Ю	TIMG14 capture/compare 0 signal	1, 11, 18, 27, 34, 36, 43, 45	13, 16, 18	1, 11, 18, 27, 34, 36, 43, 45	1, 15, 22, 31, 37, 39, 6	15, 25, 27, 3	14, 16, 23, 27, 29, 9	12, 17, 19, 26, 30, 32	12, 15, 22, 26, 28	15, 19, 21, 9	15, 18, 20
TIMG14_C1	Ю	TIMG14 capture/compare 1 signal	12, 19, 2, 28, 35, 37, 44	14, 17, 2, 9	12, 19, 2, 28, 35, 37, 44	16, 2, 23, 32, 38, 40, 7	1, 12, 16, 26, 28, 4	1, 10, 15, 17, 24, 28	13, 18, 20, 27, 31, 4	13, 16, 23, 27, 4	10, 16, 20, 24	10, 11, 16, 19, 4
TIMG14_C2	Ю	TIMG14 capture/compare 2 signal	24, 31, 42, 48	1, 10	24, 31, 42, 48	28, 34	21	20, 32	23, 3	19, 3	12, 23	12, 3
TIMG14_C3	Ю	TIMG14 capture/compare 3 signal	28		28	32		17	20			



Table 6-10 Timer (TIMy) Signal Descriptions (continued)

		Table 6-10. Timer (TIMx										
SIGNAL NAME	PIN TYPE	DESCRIPTION	PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN
TIMG1_C0	Ю	TIMG1 capture/compare 0 signal	11, 13, 14, 20, 22, 29, 36, 39, 45	18	11, 13, 14, 20, 22, 29, 36, 39, 45	15, 17, 18, 24, 26, 33, 39, 42	17, 19, 27, 30	11, 18, 25, 29, 9	12, 14, 21, 28, 32	12, 17, 24, 28	17, 21	20
TIMG1_C1	10	TIMG1 capture/compare 1 signal	12, 15, 17, 21, 23, 37, 40, 46	15, 19, 8	12, 15, 17, 21, 23, 37, 40, 46	16, 19, 21, 25, 27, 4, 40, 43	12, 14, 18, 20, 28, 31	10, 13, 26, 30	1, 13, 16, 29	1, 13, 14, 25	18, 22, 8	1, 10, 17
TIMG2_C0	IO	TIMG2 capture/compare 0 signal	17, 23, 25, 3, 32, 43, 46, 9	11, 16, 19, 3	17, 23, 25, 3, 32, 43, 46, 9	1, 13, 21, 27, 29, 35, 4, 8	10, 14, 20, 22, 24, 5	13, 2, 21, 27, 30, 7	1, 10, 16, 24, 30, 5	1, 10, 14, 20, 26, 5	1, 13, 19, 22, 6, 8	1, 13, 18, 5
TIMG2_C1	Ю	TIMG2 capture/compare 1 signal	10, 13, 15, 16, 24, 25, 26, 27, 33, 38, 44, 47, 48, 8	1, 12, 17, 20, 6, 7, 8	10, 13, 15, 16, 24, 25, 26, 27, 33, 38, 44, 47, 48, 8	12, 14, 17, 19, 2, 20, 28, 29, 30, 31, 36, 41, 5	1, 11, 13, 21, 22, 23, 29, 9	11, 12, 16, 22, 28, 31, 32, 6, 8	11, 14, 15, 19, 2, 25, 3, 31, 9	11, 2, 21, 27, 3, 9	14, 20, 23, 5, 7	14, 19, 2, 3, 8, 9
TIMG8_C0	Ю	TIMG8 capture/compare 0 signal	11, 13, 2, 20, 22, 25, 32, 39, 43, 46, 9	11, 16, 19, 2	11, 13, 2, 20, 22, 25, 32, 39, 43, 46, 9	1, 13, 15, 17, 24, 26, 29, 35, 4, 42, 7	10, 17, 19, 22, 24, 30, 4	1, 11, 21, 25, 27, 30, 7, 9	1, 10, 12, 14, 24, 28, 30, 4	1, 10, 12, 20, 24, 26, 4	13, 17, 19, 22, 24, 6	1, 13, 18, 4
TIMG8_C1	Ю	TIMG8 capture/compare 1 signal	1, 10, 12, 18, 20, 21, 26, 28, 33, 38, 40, 41, 44, 47, 8	12, 15, 17, 20, 6, 7	1, 10, 12, 18, 20, 21, 26, 28, 33, 38, 40, 41, 44, 47, 8	12, 14, 16, 2, 22, 24, 25, 30, 32, 36, 41, 43, 44, 5,	1, 11, 12, 15, 17, 18, 23, 29, 3, 31, 32, 9	10, 14, 17, 22, 26, 28, 31, 6, 8	11, 13, 17, 2, 20, 25, 29, 31, 9	11, 13, 15, 2, 21, 25, 27, 9	14, 18, 20, 5, 7, 9	10, 14, 17, 19, 2, 8, 9



Table 6-11. Universal Asynchronous Receiver Transmitter (UART) Signal Descriptions

Table	0-11. UII	iversai Asynchronous R	eceive	i iiai	15111111	ei (Ur	KKI) S	nyman	Desci	iptioi	15	
SIGNAL NAME	PIN TYPE	DESCRIPTION	PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN
UARTO_CTS	I	UART0 clear to send signal	11, 17, 29, 33, 34, 38, 43	12, 13, 16	11, 17, 29, 33, 34, 38, 43	1, 15, 21, 33, 36, 37, 41	14, 25, 29	13, 18, 22, 23, 27, 9	12, 16, 21, 25, 26, 30	12, 14, 17, 21, 22, 26	14, 15, 19, 8	14, 15, 18
UART0_RTS	0	UART0 ready to send signal	12, 16, 30, 34, 35, 36, 37, 42, 44, 45	13, 14, 17, 18	12, 16, 30, 34, 35, 36, 37, 42, 44, 45		1, 12, 13, 25, 26, 27, 28		13, 15, 22, 26, 27, 31, 32	13, 18, 22, 23, 27, 28	11, 15, 16, 20, 21	10, 15, 16, 19, 20
UART0_RX	Ю	UART0 receive signal (RXD)	19, 2, 21, 22, 23, 32, 46, 48, 5	1, 11, 19, 2, 9	19, 2, 21, 22, 23, 32, 46, 48, 5	23, 25, 26, 27, 35, 4, 7, 9	16, 18, 19, 20, 24, 4, 6	1, 15, 21, 30, 32	24, 3,	1, 16, 20, 3, 4	10, 13, 22, 23, 24	1, 11, 13, 3, 4
UART0_TX	0	UART0 transmit signal (TXD)	1, 18, 2, 20, 23, 24, 29, 3, 43, 45, 47	16, 18, 2, 20, 3	1, 18, 2, 20, 23, 24, 29, 3, 43, 45, 47	1, 22, 24, 27, 28, 33, 5, 6, 7, 8	15, 17, 20, 21, 3, 4, 5	1, 14, 18, 2, 27, 29, 31	17, 2, 21, 30, 32, 4, 5	15, 17, 2, 26, 28, 4, 5	1, 19, 21, 24, 9	18, 2, 20, 4, 5
UART1_CTS	I	UART1 clear to send signal	14, 22, 27, 39, 41, 46, 47	19, 20	14, 22, 27, 39, 41, 46, 47	18, 26, 31, 4, 42, 44, 5	19, 30, 32	16, 25, 30, 31	1, 19, 2, 28	1, 2, 24	17, 22	1, 2
UART1_RTS	0	UART1 ready to send signal	15, 2, 23, 28, 33, 40, 48	1, 12, 15, 2, 8	15, 2, 23, 28, 33, 40, 48	19, 27, 32, 36, 43, 7	20, 31, 4	1, 17, 22, 26, 32	20, 25, 29, 3, 4	21, 25, 3, 4	14, 18, 23, 24	14, 17, 3, 4
UART1_RX	I	UART1 receive signal (RXD)	10, 12, 14, 16, 17, 19, 21, 26, 33, 35, 36, 40, 44	12, 14, 15, 17, 7, 9	10, 12, 14, 16, 17, 19, 21, 26, 33, 35, 36, 40, 44	14, 16, 18, 2, 20, 21, 23, 25, 30, 36, 38, 39, 43	1, 11, 12, 13, 14, 16, 18, 23, 26, 27, 31	10, 12, 13, 15, 22, 24, 26, 28, 8	11, 13, 15, 16, 18, 25, 27, 29, 31	11, 13, 14, 16, 21, 23, 25, 27	10, 14, 16, 18, 20, 7, 8	10, 11, 14, 16, 17, 19, 9
UART1_TX	0	UART1 transmit signal (TXD)	11, 13, 15, 16, 20, 25, 32, 36, 9	11, 8	11, 13, 15, 16, 20, 25, 32, 36, 9	13, 15, 17, 19, 20, 24, 29, 35, 39	10, 13, 17, 22, 24, 27	11, 12, 21, 7, 9	10, 12, 14, 15, 24	10, 12, 20	13, 6	13



Table 6-11. Universal Asynchronous Receiver Transmitter (UART) Signal Descriptions (continued)

SIGNAL NAME	PIN TYPE	DESCRIPTION	PT PIN	RUK PIN	RGZ PIN	NNA PIN	VFC PIN	RHB PIN	DGS3 2 PIN	DGS2 8 PIN	RGE PIN	DGS2 0 PIN
UART2_CTS	I	UART2 clear to send signal	14, 20, 27, 31, 38, 39, 45, 9	10, 18	14, 20, 27, 31, 38, 39, 45, 9	13, 18, 24, 31, 34, 41, 42	10, 17, 29, 30	16, 20, 25, 29, 7	10, 19, 23, 28, 32	10, 19, 24, 28	12, 17, 21, 6	12, 20
UART2_RTS	0	UART2 ready to send signal	10, 15, 21, 30, 41, 42, 46	19, 7,	10, 15, 21, 30, 41, 42, 46	14, 19, 25, 4, 44	11, 18, 32	19, 30, 8	1, 11, 22	1, 11, 18	11, 22, 7	1, 9
UART2_RX	I	UART2 receive signal (RXD)	15, 26, 29, 37, 38, 39, 40, 44	15, 17, 8	15, 26, 29, 37, 38, 39, 40, 44	19, 2, 30, 33, 40, 41, 42, 43	1, 23, 28, 29, 30, 31	18, 25, 26, 28	21, 28, 29, 31	17, 24, 25, 27	17, 18, 20	17, 19
UART2_TX	0	UART2 transmit signal (TXD)	14, 25, 28, 36, 39, 40, 43	15, 16	14, 25, 28, 36, 39, 40, 43	1, 18, 29, 32, 39, 42, 43	22, 27, 30, 31	17, 25, 26, 27	20, 28, 29, 30	24, 25, 26	17, 18, 19	17, 18

### **6.3 Connections for Unused Pins**

Table 6-12 lists the correct termination of unused pins.

Table 6-12. Connection of Unused Pins

PIN <sup>(1)</sup>	POTENTIAL	COMMENT
PAx		Set corresponding pin functions to GPIO (PINCMx.PF = 0x1) and configure unused pins to output low or input with internal pullup or pulldown resistor.
NRST	1 (/(:(:	NRST is an active-low reset signal. Pull high to VCC or the device cannot start. For more information, see Section 9.1.

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

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# 7 Specifications

# 7.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)

			MIN	MAX	UNIT
VDD	Supply voltage	At VDD pin	-0.3	6.5	V
VI	Input voltage	Applied to any common tolerance pins	-0.3	$V_{DD}$	V
I <sub>VDD</sub>	Current of VDD pin	Current into VDD pin (source)		80	mA
I <sub>VSS</sub>	Current of VSS pin	Current out of VSS pin (sink)		80	mA
I <sub>IO</sub>	Current for SDIO pin	Current sunk or sourced by SDIO pin		6	mA
I <sub>D</sub>	Supported diode current	Diode current at any device pin		±2	mA
T <sub>stg</sub>		Storage temperature	-40	150	°C

<sup>(1)</sup> Stresses beyond those listed under Absolute Maximum Rating may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Condition. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

# 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
V <sub>(ESD)</sub>	Electrostatic discharge	Charged device model (CDM), per JEDEC specification JESD22-C101, all pins <sup>(2)</sup>	±500	V

- (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	Supply voltage <sup>(2)</sup>	4.5 (4)		5.5	V
C <sub>VDD</sub>	Capacitor placed between VDD and VSS (1)		10		uF
T <sub>A</sub>	Ambient temperature	-40		125	°C
TJ	Max junction temperature			130	°C
f <sub>MCLK</sub>	MCLK, CPUCLK, ULPCLK frequency with 1 flash wait state (3)			32	MHz

- (1) Connect C<sub>VDD</sub> between VDD/VSS, 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>.
- (2) There is no dependency on MCLK frequency with respect to VDD recommended operating range.
- (3) Wait states are managed automatically by the system controller (SYSCTL) and do not need to be configured by application software.
- (4) Functionality is designed down to VBOR0-(min).

#### 7.4 Thermal Information

	THERMAL METRIC(1)	PACKAGE	VALUE	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance		77.8	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance		34.2	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	LQFP-48 (PT)	49.8	°C/W
$\Psi_{JT}$	Junction-to-top characterization parameter	LQ(F-40 (F1)	3.1	°C/W
$\Psi_{JB}$	Junction-to-board characterization parameter		49.2	°C/W
R <sub>0JC(bot)</sub>	Junction-to-case (bottom) thermal resistance		N/A	°C/W



	THERMAL METRIC(1)	PACKAGE	VALUE	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance		TBD	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance		TBD	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	) (OFN 40 (DOZ)	TBD	°C/W
$\Psi_{JT}$	Junction-to-top characterization parameter	VQFN-48 (RGZ)	TBD	°C/W
$\Psi_{JB}$	Junction-to-board characterization parameter		TBD	°C/W
R <sub>0JC(bot)</sub>	Junction-to-case (bottom) thermal resistance		TBD	°C/W
R <sub>θJA</sub>	Junction-to-ambient thermal resistance		90.1	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance		33.7	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance		67.9	°C/W
$\Psi_{JT}$	Junction-to-top characterization parameter	LQFP-44 (NNA)	3.1	°C/W
Ψ <sub>JB</sub>	Junction-to-board characterization parameter		66.8	°C/W
R <sub>0JC(bot)</sub>	Junction-to-case (bottom) thermal resistance		N/A	°C/W
R <sub>θJA</sub>	Junction-to-ambient thermal resistance		68.8	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance		27.7	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance		42.3	°C/W
$\Psi_{JT}$	Junction-to-top characterization parameter	LQFP-32 (VFC)	2.4	°C/W
Ψ <sub>JB</sub>	Junction-to-board characterization parameter		41.7	°C/W
R <sub>0JC(bot)</sub>	Junction-to-case (bottom) thermal resistance		N/A	°C/W
$R_{\theta JA}$	Junction-to-ambient thermal resistance		72.9	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance		28.6	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	\(\(\text{1000D}\) \(\text{1000D}\)	36.9	°C/W
$\Psi_{JT}$	Junction-to-top characterization parameter	VSSOP-32 (DGS32)	0.9	°C/W
$\Psi_{JB}$	Junction-to-board characterization parameter		36.6	°C/W
R <sub>0JC(bot)</sub>	Junction-to-case (bottom) thermal resistance		N/A	°C/W
$R_{\theta JA}$	Junction-to-ambient thermal resistance		TBD	°C/W
R <sub>0JC(top)</sub>	Junction-to-case (top) thermal resistance		TBD	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	\(OEN 22 (DUD)	TBD	°C/W
$\Psi_{JT}$	Junction-to-top characterization parameter	VQFN-32 (RHB)	TBD	°C/W
$\Psi_{JB}$	Junction-to-board characterization parameter		TBD	°C/W
R <sub>0JC(bot)</sub>	Junction-to-case (bottom) thermal resistance		TBD	°C/W
$R_{\theta JA}$	Junction-to-ambient thermal resistance		79.4	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance		38.9	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	VSSOP-28 (DGS28)	41.2	°C/W
$\Psi_{JT}$	Junction-to-top characterization parameter	V330F-26 (DG326)	3.1	°C/W
$\Psi_{JB}$	Junction-to-board characterization parameter		40.7	°C/W
R <sub>0JC(bot)</sub>	Junction-to-case (bottom) thermal resistance		N/A	°C/W
$R_{\theta JA}$	Junction-to-ambient thermal resistance		TBD	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance		TBD	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	VOEN 24 (BOE)	TBD	°C/W
$\Psi_{JT}$	Junction-to-top characterization parameter	VQFN-24 (RGE)	TBD	°C/W
$\Psi_{JB}$	Junction-to-board characterization parameter		TBD	°C/W
R <sub>0JC(bot)</sub>	Junction-to-case (bottom) thermal resistance		TBD	°C/W

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	THERMAL METRIC <sup>(1)</sup>	PACKAGE	VALUE	UNIT
R <sub>θJA</sub>	Junction-to-ambient thermal resistance		91.6	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance		34.4	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	VSSOP-20 (DGS20)	48.3	°C/W
$\Psi_{JT}$	Junction-to-top characterization parameter	V330F-20 (DG320)	1.2	°C/W
$\Psi_{JB}$	Junction-to-board characterization parameter		47.8	°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		TBD	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance		TBD	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	WOEN 20 (DUIZ)	TBD	°C/W
$\Psi_{JT}$	Junction-to-top characterization parameter	WQFN-20 (RUK)	TBD	°C/W
$\Psi_{JB}$	Junction-to-board characterization parameter		TBD	°C/W
R <sub>θJC(bot)</sub>	Junction-to-case (bottom) thermal resistance		TBD	°C/W

<sup>(1)</sup> 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=5V. 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	5°C	125	5°C	UNIT
	FARAINE LEK		TYP	MAX	UNII								
RUN Mode													
IDD	MCLK=SYSOSC, CoreMark, execute from flash	32MHz	4	TBD	4	TBD	4	TBD	4	TBD	4.1	TBD	mA
IDD <sub>RUN</sub>	MCLK=SYSOSC, While(1), execute from flash	32MHz	2.8	TBD	2.9	TBD	2.9	TBD	2.9	TBD	2.9	TBD	mA
IDD <sub>RUN</sub> ,	MCLK=SYSOSC, CoreMark, execute from flash	32MHz	124	TBD	125	TBD	126	TBD	126	TBD	127	TBD	
per MHz	MCLK=SYSOSC, While(1), execute from flash	32MHz	88	TBD	89	TBD	90	TBD	90	TBD	91	TBD	uA/Mhz
SLEEP Mo	de												
IDD <sub>SLEEP</sub>	MCLK=SYSOSC, CPU is halted	32MHz	2369	TBD	2418	TBD	2449	TBD	2462	TBD	2489	TBD	uA

## 7.5.2 STOP/STANDBY Modes

VDD=5V unless otherwise noted. All inputs tied to 0V or VDD. Outputs do not source or sink any current. All peripherals not noted are disabled.

	PARAMETER		-40°C		25°C		85°C		105°C		125°C		UNIT
	FARAMETER	ULPCLK	TYP	MAX	TYP	MAX	TYP	MAX	TYP	MAX	TYP	MAX	UNII
STOP Mod	е		•										
IDD <sub>STOP0</sub>	SYSOSC=32MHz, DISABLESTOP=0	4MHz	1384	TBD	1429	TBD	1461	TBD	1475	TBD	1498	TBD	
IDD <sub>STOP2</sub>	SYSOSC off, DISABLESTOP=1, ULPCLK=LFCLK	32kHz	603	TBD	642	TBD	675	TBD	689	TBD	714	TBD	uA
STANDBY	Mode	·	•				•						



VDD=5V unless otherwise noted. All inputs tied to 0V or VDD. Outputs do not source or sink any current. All peripherals not noted are disabled.

	PARAMETER		-40	°C	25	°C	85	°C	105	5°C	125	5°C	UNIT
			TYP	MAX	TYP	MAX	TYP	MAX	TYP	MAX	TYP	MAX	UNII
IDD <sub>STBY0</sub>	LFCLK=LFOSC, STOPCLKSTBY=0, TIMG8 enabled		3.9	TBD	4.1	TBD	5.9	TBD	8.9	TBD	19.1	TBD	
IDD <sub>STBY1</sub>	LFCLK=LFOSC, STOPCLKSTBY=1, TIMG8 enabled		3.5	TBD	3.6	TBD	5.5	TBD	8.5	TBD	18.6	TBD	
IDD <sub>STBY1</sub>	LFCLK=LFOSC, STOPCLKSTBY=1, GPIOA enabled	32kHz	3.5	TBD	3.6	TBD	5.5	TBD	8.5	TBD	18.6	TBD	uA
IDD <sub>STBY0</sub>	LFCLK=LFXT, STOPCLKSTBY=0, TIMG8 enabled	JZKI IZ	TBD	TBD	uA								
IDD <sub>STBY1</sub>	LFCLK=LFXT, STOPCLKSTBY=1, TIMG8 enabled		TBD	TBD									
IDD <sub>STBY1</sub>	LFCLK=LFXT, STOPCLKSTBY=1, GPIOA enabled		TBD	TBD									

# 7.6 Power Supply Sequencing

## 7.6.1 POR and BOR

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

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
		Rising			0.1	V/us
dVDD/dt	VDD (supply voltage) slew rate	Falling (1)			0.01	v/uS
		Falling, STANDBY			0.1	V/ms
V <sub>POR+</sub>	Dower on recet voltage level	Rising	2.5	3.33	4.2	V
V <sub>POR-</sub>	Power-on reset voltage level	Falling	2.4	3.25	4.1	V
V <sub>HYS, POR</sub>	POR hysteresis		10	80	150	mV
V <sub>BOR0+</sub> ,		Cold start, rising	3.9	4.2	4.5	
V <sub>BOR0+</sub>	Brown-out reset voltage level 0 (default level)	Rising (2)	4.26	4.4	4.5	V
V <sub>BOR0</sub> -		Falling (2)	4.24	4.38	4.48	
V <sub>BOR0, STBY</sub>	Brown-out reset voltage level 0 (default level)	STANDBY mode	4	4.27	4.5	V
V <sub>HYS,BOR</sub>	Brown-out reset hysteresis	Level 0		14	18	mV
T <sub>PD, BOR</sub>	BOR propagation delay	RUN/SLEEP/STOP mode			10	us
		STANDBY mode			100	us

<sup>(1)</sup> Device operating in RUN, SLEEP, or STOP mode.

# 7.6.2 Power Supply Ramp

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

Product Folder Links: MSPM0H3216



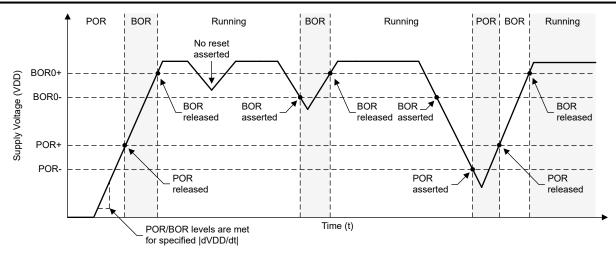


Figure 7-1. Power Cycle POR/BOR Conditions

# 7.7 Flash Memory Characteristics

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

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Supply						
VDD <sub>PGM/ERASE</sub>	Program and erase supply voltage		4.5		5.5	V
IDD <sub>ERASE</sub>	Supply current from VDD during erase operation	Supply current delta		2		mA
IDD <sub>PGM</sub>	Supply current from VDD during program operation	Supply current delta		2.5		mA
Endurance						
NWEC(HI_ENDU RANCE)	Erase/program cycle endurance for chosen 32 sectors of flash <sup>(1)</sup>		100			k cycles
NWEC (NORMAL_ENDU RANCE)	Erase/program cycle endurance (Flash not used for HI_ENDURANCE) <sup>(1)</sup>		10			k cycles
NE <sub>(MAX)</sub>	Total erase operations before failure (2)		802			k erase operations
NW <sub>(MAX)</sub>	Write operations per word line before sector erase (2)				83	write operations
Retention						
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
t <sub>RET_130</sub>	Flash memory data retention	-40°C <= Tj <= 130°C	2.4			years
Program and Eras	e Timing					
t <sub>PROG (WORD, 64)</sub>	Program time for flash word (3)			40		μs
t <sub>PROG (SEC, 64)</sub>	Program time for 1kB sector			5.1		ms
t <sub>ERASE (SEC)</sub>	Sector erase time	<10k erase/program cycles		20	200	ms
t <sub>ERASE (BANK)</sub>	Bank erase time	<10k erase/program cycles		22	220	ms

<sup>(1)</sup> 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.

<sup>(2)</sup> 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.

<sup>(3)</sup> 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.



## 7.8 Timing Characteristics

VDD=5V, T<sub>a</sub>=25 °C (unless otherwise noted)

	PARAMETER	TEST CONDITIONS	MIN TYP	MAX UNIT
Wakeup	Timing			
t <sub>WAKE</sub> ,	Wakeup time from SLEEP to RUN		2	cycles
t <sub>WAKE</sub> ,	Wakeup time from STOP0 to RUN (SYSOSC enabled)		14	us
STOP	Wakeup time from STOP2 to RUN (SYSOSC disabled)		15	us
t <sub>WAKE</sub> , STBY	Wakeup time from STANDBY to RUN		20	us
Asynchr	onous Fast Clock Request Timing			
		Mode is SLEEP2	2	us
t <sub>DELAY</sub>	Delay time from edge of asynchronous request to first 32MHz MCLK edge	Mode is STOP2	2	us
	request to met ozim iz mezit euge	Mode is STANDBY	5	us
Startup 7	Timing		-	'
t <sub>START,</sub> RESET	Device cold start-up time from reset/ power-up (1)		370	us
NRST Ti	ming			
t <sub>RST,</sub>	Pulse length on NRST pin to generate	ULPCLK=SYSOSC	2	us
BOOTRST	BOOTRST	ULPCLK=LFOSC	100	us
t <sub>RST, POR</sub>	Pulse length on NRST pin to generate POR		1	s

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.

## 7.9 Clock Specifications

# 7.9.1 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
	SYSOSC frequency accuracy when	SETUSEFCL=1, T <sub>a</sub> = 25 °C	-1.2		1.2	
f <sub>SYSOSC</sub>	frequency correction loop (FCL) is enabled when the internal ROSC resistor is used <sup>(1)</sup>	SETUSEFCL=1 -40 °C ≤ T <sub>a</sub> ≤ 125 °C	-2.1		1.6	%
f <sub>sysosc</sub>	SYSOSC accuracy when frequency correction loop (FCL) is disabled, 32MHz	SETUSEFCL=0, SYSOSCCFG.FREQ=00, -40 °C $\leq$ T <sub>a</sub> $\leq$ 125 °C	-2.5		2.5	%
t <sub>settle,</sub>	Settling time to target accuracy (2)	SETUSEFCL=1			36	us
f <sub>settle,</sub>	f <sub>SYSOSC</sub> accuracy during t <sub>settle</sub> (2)	SETUSEFCL=1	-16		1.3	%

The SYSOSC frequency correction loop (FCL) enables high SYSOSC accuracy via an internal reference resistor when using the (1) FCL. See the SYSOSC section of the technical reference manual for details on computing SYSOSC accuracy.

Product Folder Links: MSPM0H3216

When SYSOSC is enabled from a disabled state, the SYSOSC output will be released to the device within the time specified by t<sub>start, SYSOSC</sub>. Once the output is released, the SYSOSC worst-case accuracy is specified by f<sub>settle</sub>, SYSOSC. After the time specified by  $t_{\text{settle. SYSSOSC}}$ , the SYSOSC will have settled to the target  $f_{\text{SYSOSC}}$  accuracy.



# 7.9.2 Low Frequency Oscillator (LFOSC)

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

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
f <sub>LFOSC</sub>	LFOSC frequency			32768		Hz
f <sub>LFOSC</sub>	LFOSC accuracy	-40 °C ≤ T <sub>a</sub> ≤ 125 °C	-5		5	%
f <sub>LFOSC</sub>	LFOSC accuracy	-40 °C ≤ T <sub>a</sub> ≤ 85 °C	-3		3	%
I <sub>LFOSC</sub>	LFOSC current consumption			300		nA
t <sub>start,</sub> LFOSC	LFOSC start-up time			1		ms

## 7.9.3 High Frequency Crystal/Clock

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

	PARAMETER	TEST CONDITIONS	MIN	TYP MAX	UNIT
High frequer	ncy crystal oscillator (HFXT)				
VDD	Power supply range		4.5	5.5	V
f <sub>HFXT</sub>	HFXT frequency	HFXTRSEL=00	4	8	MHz
f <sub>HFXT</sub>	HFXT frequency	HFXTRSEL=01	8.01	16	MHz
f <sub>HFXT</sub>	HFXT frequency	HFXTRSEL=10	16.01	32	MHz
DC <sub>HFXT</sub>	HFXT duty cycle	HFXTRSEL=00	40	65	%
DC <sub>HFXT</sub>	HFXT duty cycle	HFXTRSEL=01	40	60	%
DC <sub>HFXT</sub>	HFXT duty cycle	HFXTRSEL=10	40	60	%
OA <sub>HFXT</sub>	HFXT crystal oscillation allowance	HFXTRSEL=00 (4 to 8MHz range)		2	kΩ
C <sub>L, eff</sub>	Integrated effective load capacitance (1)			1	pF
t <sub>start, HFXT</sub>	HFXT start-up time <sup>(2)</sup>	HFXTRSEL=11, 32MHz crystal		0.5	ms
I <sub>HFXT</sub>	HFXT current consumption <sup>(2)</sup>	$\begin{array}{c} f_{HFXT}\text{=}4MHz, \\ R_m\text{=}300\Omega, \\ C_L\text{=}12pF \end{array}$		75	uA
I <sub>HFXT</sub>	HFXT current consumption <sup>(2)</sup>	$\begin{array}{l} f_{HFXT}{=}32MHz,\\ R_{m}{=}30\Omega,\\ C_{L}{=}12pF,\\ C_{m}{=}6.26fF,\\ L_{m}{=}1.76mH \end{array}$		600	uA
High frequer	ncy digital clock input (HFCLK_IN)	- '			
f <sub>HFIN</sub>	HFCLK_IN frequency (3)	USEEXTHFCLK =1	4	32	MHz
DC <sub>HFIN</sub>	HFCLK_IN duty cycle (3)	USEEXTHFCLK =1	40	60	%

- (1) This includes parasitic bond and package capacitance (≈2pF per pin), calculated as C<sub>HFXIN</sub>×C<sub>HFXOUT</sub>/(C<sub>HFXIN</sub>+C<sub>HFXOUT</sub>), where C<sub>HFXIN</sub> and C<sub>HFXOUT</sub> are the total capacitance at HFXIN and HFXOUT, respectively.
- (2) The HFXT startup time (t<sub>start, HFXT</sub>) 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 H-Series 32-MHz Microcontrollers Technical Reference Manual Current consumption increases with higher RSEL and start up time is decreases with higher RSEL.
- (3) The digital clock input (HFCLK\_IN) accepts a logic level square wave clock.



## 7.9.4 Low Frequency Crystal/Clock

over operating free-air temperature range (unless otherwise noted)(1)

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Low frequen	cy crystal oscillator (LFXT)					
VDD	Power supply range for low-frequency crystal operation		4.5		5.5	V
f <sub>LFXT</sub>	LFXT frequency		32768			Hz
DC <sub>LFXT</sub>	LFXT duty cycle		30		70	%
OA <sub>LFXT</sub>	LFXT crystal oscillation allowance			419		kΩ
C <sub>L, eff</sub>	Integrated effective load capacitance <sup>(2)</sup>			1		pF
t <sub>start, LFXT</sub>	LFXT start-up time			300		ms
I <sub>LFXT</sub>	LFXT current consumption	XT1DRIVE=0, LOWCAP=1		300		nA
Low frequen	cy digital clock input (LFCLK_IN)				•	
f <sub>LFIN</sub>	LFCLK_IN frequency (3)	SETUSEEXLF=1	29491	32768	36045	Hz
DC <sub>LFIN</sub>	LFCLK_IN duty cycle (3)	SETUSEEXLF=1	40		60	%
LFCLK Moni	FCLK Monitor					
f <sub>FAULTLF</sub>	LFCLK monitor fault frequency (4)	MONITOR=1	2800	4200	8400	Hz

- The LQFP44 (NNA) package is limited to a max operating free-air temperature of 105°C for proper LFXT operation.
- This includes parasitic bond and package capacitance ( $\approx$ 2pF per pin), calculated as  $C_{LFXIN} \times C_{LFXOUT}/(C_{LFXIN} + C_{LFXOUT})$ , where  $C_{LFXIN} \times C_{LFXIN} \times C_{LFX$ (2) and C<sub>LFXOUT</sub> are the total capacitance at LFXIN and LFXOUT, respectively.
- 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 Digital IO

#### 7.10.1 Electrical Characteristics

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

	PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V <sub>IH</sub>	High level input voltage		VDD≥4.5V	0.7*VDD		VDD	V
V <sub>IL</sub>	Low level input voltage		VDD≥4.5V	-0.3		0.3*VDD	V
V <sub>HYS</sub>	Hysteresis			0.1*VDD			V
	Lligh 7 lookaga surrant	HSIO	VDD = 5.5V			0.79	uA
I <sub>lkg</sub>  H	High-Z leakage current	SDIO <sup>(1)</sup> (2)	VDD = 5.5V			0.42	uA
R <sub>PU</sub>	Pull up resistance		VIN = VSS		40		kΩ
Cı	Input capacitance		VDD = 5V		20		pF
V <sub>OH</sub>	High level output voltage	HSIO	VDD≥4.5V,  I <sub>IO</sub>   <sub>,max</sub> =6mA	VDD-0.4			V
V <sub>OL</sub>	Low level output voltage	HSIO	VDD≥4.5V,  I <sub>IO</sub>   <sub>,max</sub> =6mA			0.4	V
V <sub>OH</sub>	High level output voltage	SDIO	VDD ≥ 4.5V, I <sub>OH,max</sub> = 3mA	VDD-0.4			V
V <sub>OL</sub>	Low level output voltage	SDIO	VDD ≥ 4.5V, I <sub>OH,max</sub> = 3mA			0.4	V

- The leakage current is measured with VSS or VDD applied to the corresponding pin(s), unless otherwise noted. (1)
- (2) The leakage of the digital port pins is measured individually. The port pin is selected for input and the pullup/pulldown resistor is disabled.

## 7.10.2 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>max</sub>	Port output frequency	SDIO (1)	VDD ≥ 4.5V, C <sub>L</sub> = 20pF			8	MHz
f <sub>max</sub>	Port output frequency	HSIO	VDD ≥ 4.5V, C <sub>L</sub> = 20pF			16	MHz

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

		PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
-	t <sub>r</sub> ,t <sub>f</sub>	Output rise/fall time	All output ports	VDD ≥ 4.5V			0.2*f <sub>max</sub>	s

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

## 7.11 ADC

#### 7.11.1 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
Vin <sub>(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
VR+	Fositive ADC reference voltage	V <sub>R+</sub> sourced from internal reference (VREF)		4.05		V
V <sub>R-</sub>	Negative ADC reference voltage			0		V
		RES = 0x0 (12-bit mode), External Reference			1.6	
Fs	ADC sampling frequency	RES = 0x1 (10-bit mode), External Reference			1.77	Msps
		RES = 0x2 (8-bit mode), External Reference			2	
		RES = 0x0 (12-bit mode), Internal Reference			0.9	
F <sub>S</sub>	ADC sampling frequency	RES = 0x1 (10-bit mode), Internal Reference			1	Msps
		RES = 0x2 (8-bit mode), Internal Reference			1.2	
	0 " 1 1	$F_S = 1.6MSPS, V_{R+} = VDD$	,	350		
I <sub>(ADC)</sub>	Operating supply current into VDD terminal	$F_S = 0.9$ MSPS, $V_{R+} = V$ REF = 4.05 $V$ (VREF power consumption included)		400		μΑ
C <sub>S/H</sub>	ADC sample-and-hold capacitance			0.22		pF
Rin	ADC switch resistance			15		kΩ
ENOB <sub>DC</sub>	Effective number of bits, DC	External reference (2)		11		bit
ENOB <sub>DC</sub>	Effective number of bits, DC	External reference with over sampling		12.4		bit
ENOB <sub>DC</sub>	Effective number of bits, DC	Internal reference, V <sub>R+</sub> = VREF = 4.05V		10.3		bit
ENOBAC	Effective number of bits, AC	External reference with over sampling, f <sub>in</sub> = 1kHz		11.4		bit
ENOBAC	Effective number of bits, AC	External reference <sup>(2)</sup> , f <sub>in</sub> = 5kHz		10.7		bit
ENOBAC	Effective number of bits, AC	Internal reference, V <sub>R+</sub> = VREF = 4.05V, f <sub>in</sub> = 5kHz		10.2		bit
		External reference (2)		68		
SNR	Signal-to-noise ratio	External reference with over sampling		74		dB
		Internal reference, V <sub>R+</sub> = VREF = 4.05V		64		
PSRR <sub>DC</sub>	Power supply rejection ratio, DC	VDD = VDD <sub>(min)</sub> to VDD <sub>(max)</sub> Internal reference, $V_{R+}$ = VREF = 4.05V		61		dB
PSRR <sub>DC</sub>	Power supply rejection ratio, DC	External reference (4), VDD = VDD <sub>(min)</sub> to VDD <sub>(max)</sub>		61		dB
PSRR <sub>AC</sub>	Power supply rejection ratio, AC	$\Delta$ VDD = 0.1 V at 1 kHz Internal reference, V <sub>R+</sub> = VREF = 4.05V		48.6		dB
PSRR <sub>AC</sub>	Power supply rejection ratio, AC	$\Delta$ VDD = 0.1 V at 1 kHz External reference, V <sub>R+</sub> = VREF = 4.05V		61		dB
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 (3)	-1.5		+1.5	%
I <sub>SupplyMon</sub>	Supply Monitor voltage divider current consumption	ADC input channel: Supply Monitor		16		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) All external reference specifications are measured with V<sub>R+</sub> = VREF+ = VDD = 5V and V<sub>R-</sub> = VREF- = VSS = 0V and external 1uF cap on VREF+ pin
- (3) Analog power supply monitor. Analog input on channel 15 is disconnected and is internally connected to the voltage divider which is VDD/3.



#### 7.11.2 Switching Characteristics

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

	PARAMETER	T	EST 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_step</sub>	Sampling time for step input	12-bit mode, $R_S = 50\Omega$ , $C_{pext} = 10pF$ , $V_{step}=4V$		0.188			μs
t <sub>Sample_step</sub>	Sampling time for step input	12-bit mode, $R_S$ = $50\Omega$ , $C_{pext}$ = $10pF$ , $V_{step}$ = $5V$	12-bit mode, $R_S = 50\Omega$ , $C_{pext} = 10pF$ , $V_{step}=5V$	0.400			μs
t <sub>Sample_VREF</sub>	Sample time with internal VREF input		ADC CHANNEL=29,12-bit mode, VDD as reference	10			μs
t <sub>Sample_SupplyMon</sub>	Sample time with Supply Monitor (VDD/3)			3			μs

#### 7.11.3 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) (1)

	PARAMETER	TEST CONDIT	IONS	MIN	TYP	TYP MAX	
Eı	Integral linearity error (INL)	External reference, 12-bit (2)	<u> </u>			+2.5	LSB
E <sub>D</sub>	Differential linearity error (DNL)	xternal reference, 12-bit (2)		-1		+1.5	LSB
E <sub>D</sub>	Differential linearity error (DNL)	External reference, 10-bit (2)	External reference, 10-bit (2)	-1		+0.4	LSB
Eo	Offset error	External reference, 12-bit (2)		-5		5	mV
Eo	Offset error	Internal reference, 12-bit		-5		5	mV
E <sub>G</sub>	Gain error	External reference, 12-bit (2)		-6		6	mV

- Total Unadjusted Error (TUE) can be calculated from E<sub>I</sub>, E<sub>O</sub>, and E<sub>G</sub> using the following formula: TUE =  $\sqrt{(E_1^2 + |E_O|^2 + E_G^2)}$ Note: You must convert all of the errors into the same unit, usually LSB, for the above equation to be accurate
- All external reference specifications are measured with V<sub>R+</sub> = VREF+ = VDD = 5V and V<sub>R-</sub> = VREF- = VSS = 0V and external 1uF cap on VREF+ pin

## 7.11.4 Typical Connection Diagram

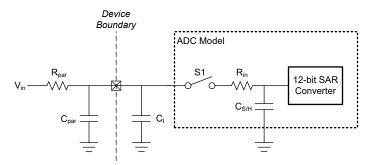


Figure 7-2. ADC Input Network

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- 1. Refer to Electrical Characteristics for the values of Rin and CS/H
- Refer to Electrical Characteristics for the value of C<sub>I</sub>
- $C_{\text{par}}$  and  $R_{\text{par}}$  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:

- $\begin{aligned} &\text{Tau} = (\mathsf{R}_{\mathsf{par}} + \mathsf{R}_{\mathsf{in}}) \times \mathsf{C}_{\mathsf{S}/\mathsf{H}} + \mathsf{R}_{\mathsf{par}} \times (\mathsf{C}_{\mathsf{par}} + \mathsf{C}_{\mathsf{I}}) \\ &\mathsf{K} = \mathsf{In}(2^{\mathsf{n}}/\mathsf{Settling}\;\mathsf{error}) \mathsf{In}((\mathsf{C}_{\mathsf{par}} + \mathsf{C}_{\mathsf{I}})/\mathsf{C}_{\mathsf{S}/\mathsf{H}}) \end{aligned}$
- T (minimum sampling time) = K × Tau

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## 7.12 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 (1)		27	30	33	°C
TS <sub>c</sub>	Temperature coefficient		-1.84	-1.75	-1.66	mV/°C
t <sub>SET, TS</sub>	Temperature sensor settling time (2)	ADC and VREF configuration: RES=0 (12-bit mode), VRSEL=4h (VREF+=4.05V,VREF-=0), ADC CHANNEL=28		5	10	us

- (1) Higher absolute accuracy may be achieved through user calibration.
- (2) This is the minimum required ADC sampling time when measuring the temperature sensor.

#### **7.13 VREF**

## 7.13.1 Voltage Characteristics

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

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
VDD <sub>min</sub>	Minimum supply voltage needed for VREF operation		4.5	5	5.5	V
VREF	Voltage reference output voltage		3.98	4.05	4.12	V

#### 7.13.2 Electrical Characteristics

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

	PARAMETER	1	TEST CONDITIONS	MIN	TYP	MAX	UNIT
I <sub>VREF</sub>	VREF operating supply current(this spec is an estimation and will be more reliable once the IP is further in the design phase)	No load	No load.		150	200	μΑ
TC <sub>VREF</sub>	Temperature coefficient of VREF (1)					80	ppm/°C
TC <sub>drift</sub>	Long term VREF drift	Time = 1000 hours, T = 25°C	Time = 1000 hours, T = 25°C			300	ppm
T <sub>startup</sub>	VREF startup time	VDD = 5 V	VDD = 5 V			30	us

<sup>(1)</sup> The temperature coefficient of the VREF output is the sum of TC<sub>VRBUF</sub> and the temperature coefficient of the internal bandgap reference.

## 7.14 I2C

#### 7.14.1 I2C Characteristics

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

	PARAMETERS	TEST CONDITIONS	Standard	Standard mode		ode	Fast mode plus		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
f <sub>I2C</sub>	I2C input clock frequency	I2C in Power Domain0		32		32		32	MHz
f <sub>SCL</sub>	SCL clock frequency			100		400		1000	kHz
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



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 <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
t <sub>VD;ACK</sub>	data valid acknowledge time			3.45		0.9		0.45	us

# 7.14.2 I2C Filter

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

	PARAMETERS	TEST CONDITIONS	MIN	TYP	MAX	UNIT
		AGFSELx = 0		6		ns
f <sub>SP</sub> Pulse duration of spil	Pulse duration of spikes suppressed by	AGFSELx = 1		14	35	ns
	input filter	AGFSELx = 2		22	60	ns
		AGFSELx = 3		35	90	ns

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

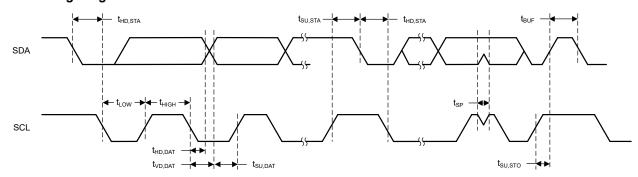


Figure 7-3. I2C Timing Diagram

# 7.15 SPI

# 7.15.1 SPI

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

	PARAMETERS	TEST CONDITIONS	MIN	TYP	MAX	UNIT
SPI			,			
f <sub>SPI</sub>	SPI clock frequency	MCLK = 32MHz 4.5 < VDD < 5.5V Controller mode			16	MHz
f <sub>SPI</sub>	SPI clock frequency	MCLK = 32MHz 4.5 < VDD < 5.5V Peripheral mode			16	MHz
DC <sub>SCK</sub>	SCK Duty Cycle		40	50	60	%
Controller					,	
t <sub>SCLK_H/L</sub>	SCLK High or Low time		(tSPI/2) - 1	tSPI / 2	(tSPI/2) + 1	ns
t <sub>CS.LEAD</sub>	CS lead-time, CS active to clock	SPH=0	1			ns
t <sub>CS.LAG</sub>	CS lag time, Last clock to CS inactive	SPH=0	11			ns
t <sub>CS.ACC</sub>	CS access time, CS active to PICO data out				10	ns

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

	PARAMETERS	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t <sub>CS.DIS</sub>	CS disable time, CS inactive to PICO high impedance				10	ns
t <sub>SU.CI</sub>	POCI input data setup time (1)	delayed sampling enabled	3			ns
t <sub>SU.CI</sub>	POCI input data setup time (1)	no delayed sampling	33			ns
t <sub>HD.CI</sub>	POCI input data hold time	delayed sampling enabled	23			ns
t <sub>HD.CI</sub>	POCI input data hold time	no delayed sampling	0			ns
t <sub>VALID.CO</sub>	PICO output data valid time (2)				10	ns
t <sub>HD.CO</sub>	PICO output data hold time (3)		0			ns
Peripheral	1					
t <sub>CS.LEAD</sub>	CS lead-time, CS active to clock		15			ns
t <sub>CS.LAG</sub>	CS lag time, Last clock to CS inactive		1			ns
t <sub>CS.ACC</sub>	CS access time, CS active to POCI data out				45	ns
t <sub>CS.DIS</sub>	CS disable time, CS inactive to POCI high impedance				45	ns
t <sub>SU.PI</sub>	PICO input data setup time		15			ns
t <sub>HD.PI</sub>	PICO input data hold time		31.25			ns
t <sub>VALID.PO</sub>	POCI output data valid time <sup>(2)</sup>				33	ns
t <sub>HD.PO</sub>	POCI output data hold time <sup>(3)</sup>		7			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

## 7.15.2 SPI Timing Diagram

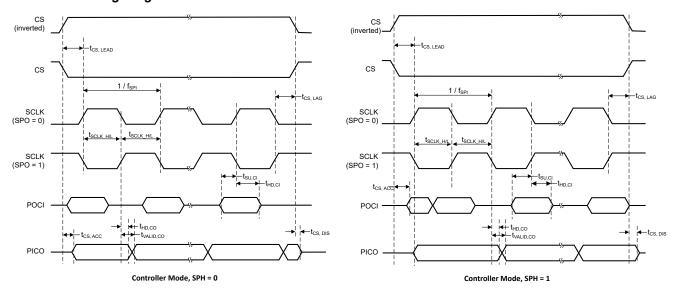


Figure 7-4. SPI timing diagram - Controller Mode



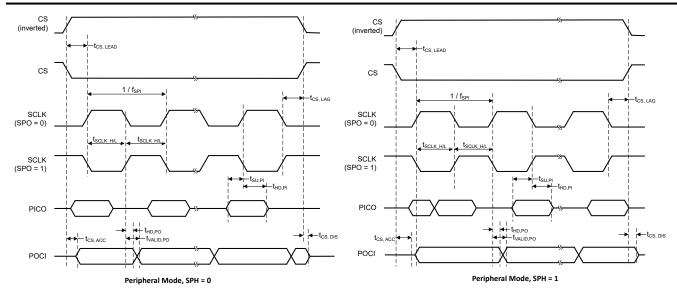


Figure 7-5. SPI timing diagram - Peripheral Mode

# **7.16 UART**

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

	PARAMETERS	TEST CONDITIONS	MIN	TYP	MAX	UNIT
f <sub>UART</sub>	UART input clock frequency				32	MHz
IDITOLIC	BITCLK clock frequency(equals baud rate in MBaud)				4	MHz

# 7.17 TIMx

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

	PARAMETERS	TEST CONDITIONS	MIN	TYP MAX	UNIT
t <sub>res</sub>	Timer resolution time	f <sub>TIMxCLK</sub> = 64MHz <sup>(1)</sup>	15.625		ns
<b>.</b>	Timer resolution time	f <sub>TIMxCLK</sub> = 32MHz	31.25		ns
l <sub>res</sub>	Timer resolution time		1		t <sub>TIMxCLK</sub>
t <sub>COUNTER</sub>	16-bit counter clock period	$f_{TIMxCLK} = 64MHz^{(1)}$	0.01563	2048	us
<b>.</b>	16-bit counter clock period	f <sub>TIMxCLK</sub> = 32MHz	0.03125	1024	us
tCOUNTER	To-bit counter clock period		1	65536	t <sub>TIMxCLK</sub>

<sup>(1)</sup> f<sub>TIMxCLK</sub> = 64MHz only applies to TIMA0 with clock doubler configured

# 7.18 Windowed Watchdog Characteristics

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

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
WWDT <sub>FREQ</sub>	WWDT operating frequency			32.768		kHz
WWDT <sub>Tstart</sub>	WWDT counter start time	Write to WWDTCTL0 until WWDT counter starts (WWDT <sub>FREQ</sub> = 32.768kHz)			30.5	μs
WWDT <sub>Trestart</sub>	WWDT counter restart time	Write to WWDTCNTRST until WWDT counter restarts (WWDT <sub>FREQ</sub> = 32.768kHz)			30.5	μs

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# 7.19 Emulation and Debug

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# **7.19.1 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 MSPMO H-Series 32MHz Microcontrollers Technical Reference Manual.

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#### 8.1 Overview

MSPM0H321x microcontrollers (MCUs) are part of the MSP highly-integrated 5V power supply and 32-bit MCU family based on the enhanced Arm® Cortex®-M0+ core platform operating at up to 32MHz frequency. These cost-optimized MCUs offer high-performance analog peripheral integration, support extended temperature ranges from -40°C to 125°C, and operate with supply voltages from 4.5V.

The MSPM0H321x devices provide up to 64KB embedded flash program memory with 8KB SRAM. These MCUs incorporate a high-speed on-chip oscillator with an accuracy up to ±1.2%, eliminating the need for an external crystal. Additional features include a 3-channel DMA, CRC-16 accelerator, and a variety of high-performance analog peripherals such as one 12-bit 1.6-Msps ADC with VDD as the voltage reference, and an on-chip temperature sensor. These devices also offer intelligent digital peripherals such as one 16-bit advanced timer, four 16-bit general purpose timer, one windowed watchdog timer, one independent watchdog timer, a real-time clock (RTC) and a variety of communication peripherals including three UART, one SPI, and two I<sup>2</sup>C. These communication peripherals offer protocol support for LIN, IrDA, DALI, Manchester, smart card, SMBus, and PMBus.

The TI MSPM0 family of low-power MCUs consists of devices with varying degrees of analog and digital integration enabling customers to find the MCU that meets their project needs. The architecture combined with extensive low-power modes is optimized to achieve extended battery life in portable measurement applications.

MSPM0H321x 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<sup>™</sup> kit available for purchase and design files for a target-socket board. 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 MSPM0H-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, as the principles in that application note also apply to MSPM0 MCUs.

#### 8.2 CPU

The CPU subsystem (MCPUSS) implements an Arm Cortex-M0+ CPU, a system timer, and interrupt management features. The Arm Cortex-M0+ is a cost-optimized 32-bit CPU that delivers high performance and low power to embedded applications. Key features of the CPU Sub System include:

- Arm Cortex-M0+ CPU supports clock frequencies from 32kHz to 32MHz
  - ARMv6-M Thumb instruction set (little endian) with 32-cycle 32x32 fast multiply instruction
- Prefetch logic to improve sequential code execution, and I-cache with 2 64-bit cache lines
- System timer (SysTick) with 24-bit down counter and automatic reload
- Nested vectored interrupt controller (NVIC) with 4 programmable priority levels and tail chaining

#### 8.3 Operating Modes

MSPM0H MCUs provide four 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 and STANDBY. 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.



To further balance performance and power consumption, MSPM0H 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.

# 8.3.1 Functionality by Operating Mode (MSPM0H321x)

Table 8-1 lists the supported functionality in each operating mode.

#### 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 it is not supported.
- **OFF**: The function is fully powered off in the specified mode, and no configuration information is retained.

Table 8-1. Supported Functionality by Operating Mode

	RUN SLEEP STOP STANDBY										
			RUN			SLEEP		ST	OP		NDBY
Operati	ing Mode	RUNO	RUN1	RUN2	SLEEP0	SLEEP1	SLEEP2	STOP0	STOP2	STANDBY0	STANDBY1
On sillata na	SYSOSC	EN	EN	DIS	EN	EN	DIS	OPT <sup>(1)</sup>	DIS	DIS	DIS
Oscillators	LFOSC			•		E	N				
	CPUCLK	32M	32k	32k				DIS			
	MCLK to PD1	32M	M 32k 32k 32M 32k 32k DIS								
	ULPCLK to PD0	32M	M 32k 32k 32M 32k 32k 4M <sup>(1)</sup> 32k						DIS		
	ULPCLK to TIMG14, TIMG8	32M	32M 32k 32M 32k 32k 4M <sup>(1)</sup> 32k								
	MFCLK	OPT	D	IS	OPT	D	IS	OPT		DIS	
Clocks	LFCLK		32k								
	LFCLK to TIMG14, TIMG1,TIMG2,TI MG8, TIMA0					3	2k				
	MCLK Monitor					OPT					DIS
	LFCLK Monitor					0	PT				
	POR Monitor					E	N				
PMU	BOR Monitor					Е	N				
	Core Regulator				Full	drive				Low	drive
	CPU	EN DIS									
Core Functions	DMA			OI	PT			N	S (triggers	supporte	d)
Core Functions	Flash			Е	:N			OI	PT	D	IS
	SRAM			Е	:N			OI	PT	D	IS
PD1 Peripherals	SPI0			OI	PT				D	IS	
FD1 Feliplierals	CRC			OI	PT				D	IS	

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

			RUN			SLEEP			ОР	STAI	NDBY
Operati	ing Mode	RUNO	RUN1	RUN2	SLEEPO	SLEEP1	SLEEP2	STOP0	STOP2	STANDBY0	STANDBY1
	TIMG14					OI	PT				
	TIMG1					OPT					DIS
	TIMG2					OPT					DIS
	TIMG8					OPT					DIS
	TIMA0					OPT					DIS
	UART0		OPT								DIS
PD0 Peripherals	UART1					OPT					DIS
	UART2					OPT					DIS
	I2C0					OPT					DIS
	I2C1					OPT					DIS
	GPIOA					OPT					OPT <sup>(2)</sup>
	GPIOB					OPT					OPT <sup>(2)</sup>
	WWDT0					OPT					OPT <sup>(2)</sup>
	ADC0	OPT NS (triggers supp						ported)			
Analog	VREF				OPT					NS	
, manag	Temperature Sensor				С	)PT				0	FF
IOMUX and IO Wa	IOMUX and IO Wakeup			EN							
Wake Sources N/A ANY IRQ PD0 IRQ											

<sup>(1)</sup> If STOP0 is entered from RUN1 (SYSOSC enabled but MCLK sourced from LFCLK), SYSOSC remains enabled as it was in RUN1, and ULPCLK remains at 32kHz as it was in RUN1. If STOP0 is entered from RUN2 (SYSOSC was disabled and MCLK was sourced from LFCLK), SYSOSC remains disabled as it was in RUN2, and ULPCLK remains at 32kHz as it was in RUN2.

#### 8.4 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
- Core regulator with support for RUN, SLEEP, STOP, and STANDBY operating modes 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 H-Series 32MHz Microcontrollers Technical Reference Manual.

## 8.5 Clock Module (CKM)

The clock module provides the following oscillators:

- LFOSC: Internal low-frequency oscillator (32kHz)
- SYSOSC: Internal high-frequency oscillator (32MHz)
- LFXT: Low frequency, low power crystal oscillator (32kHz typical frequency)
- HFXT: High frequency crystal oscillator (4-32MHz typical frequency)

<sup>(2)</sup> When using the STANDBY1 policy for STANDBY, only TIMG14 is clocked. These PD0 peripherals can generate an asynchronous fast clock request upon external activity but are not actively clocked.



- **LFCKIN**: low-frequency digital clock input (32KHz)
- **HFCKIN**: high-frequency digital clock input (4 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 SYSOSC or LFCLK, active in RUN and SLEEP modes
- CPUCLK: Clock for the processor (derived from MCLK), active in RUN mode
- **HFCLK**: High frequency external clock
- 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
- 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
- RTCCLK: Fixed 32kHz clock direct to RTC
- CLK OUT: Used to output a clock externally, available in RUN, SLEEP, STOP, and STANDBY modes

For more details, see the CKM chapter of the MSPM0 H-Series 32MHz Microcontrollers Technical Reference Manual.

## 8.6 DMA B

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 B in these devices support the following key features:

- 3 DMA transfer channel
  - 2 full-feature channels, supporting repeated transfer modes
  - 1 basic channel, supporting single transfer mode
- Configurable DMA channel priorities
- Direct peripheral to DMA trigger is supported from ADC, UART, SPI or timer triggers.
- Byte (8-bit), short word (16-bit) and word (32-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
- Gather mode

DMA B Channel Features shows the DMA features that are supported and the corresponding DMA channel numbers.

Table 8-2. DMA B Channel Features

DMA Feature	DMA_B	
DINA Feature	Full-Feature Channel	Basic Channel
Channel Number	0, 1	2
Repeated mode	✓	_
Table & fill mode	✓	_
Gather mode	✓	_
Early IRQ notification	✓	_
Auto enable	✓	✓
Long long (128-bit) transfer	✓	✓
Stride mode	✓	✓

Product Folder Links: MSPM0H3216



## Table 8-2. DMA\_B Channel Features (continued)

DMA Feature	DMA_B	
	Full-Feature Channel	Basic Channel
Cascading channel support	✓	✓

DMA Trigger Mapping lists the available triggers for the DMA which are configured using the DMATCTL.DMATSEL control bits in the DMA memory mapped registers.

**Table 8-3. DMA Trigger Mapping** 

Software
Generic Subscriber 0 (FSUB_0)
Generic Subscriber 0 (FSUB_1)
UARTO PUBLISHER 1
UARTO PUBLISHER 2
UART2 PUBLISHER 1
UART2 PUBLISHER 2
SPI0 PUBLISHER 1
SPI0 PUBLISHER 2
I2C1 PUBLISHER 1
I2C1 PUBLISHER 2
I2C0 PUBLISHER 1
I2C0 PUBLISHER 2
ADC0 EVT g
UART1 PUBLISHER 1
UART1 PUBLISHER 2

#### 8.7 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) that are interconnected through an event fabric containing a combination of static and programmable routes.

Events that are transferred by the event manager include:

- · Peripheral event transferred to the CPU as an interrupt request (IRQ) (Static Event)
  - Example: GPIO interrupt is sent to the CPU
- Peripheral event transferred to the DMA as a DMA trigger (DMA Event)
  - Example: ADC 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 H-Series 32MHz Microcontrollers Technical Reference Manual.

## **Table 8-4. 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 the event to another entity (or entities, in the case of a splitter route). An entity can 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



## Table 8-4. Generic Event Channels (continued)

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 the event to another entity (or entities, in the case of a splitter route). An entity can be another peripheral, a generic DMA trigger event, or a generic CPU event.

CHANID	Generic Route Channel Selection	Channel Type
2	Generic event channel 2 selected	1:1
3	Generic event channel 3 selected	1 : 2 (splitter)

# 8.8 Memory

## 8.8.1 Memory Organization

Table 8-5 summarizes the memory map of the devices. For more information about the memory region detail, see the Platform Memory Map section in the MSPM0 H-Series 32MHz Microcontrollers Technical Reference Manual.

Table 8-5. Memory Organization Summary

Memory Region	Subregion	MSPM0H3216, MSPM0H3215
SRAM (SRAM)	SRAM	8KBn0x20000000 to 0x20001FFF
Peripheral	Peripherals	0x40004000 to 0x40871FFF
Subsystem	Subsystem	0x60000000 to 0x7FFFFFF
System PPB	System PPB	0xE0000000 to 0xE00FFFF

# 8.8.2 Peripheral File Map

Table 8-6 lists the available peripherals and the register base address for each.

## **Table 8-6. Peripherals Summary**

Table 6-6. I criphorals duminary				
Peripheral name	Base Address	Size		
VREF	0x40030000	0x00001F00		
WWDT0	0x40080000	0x00001500		
TIMG14	0x40084000	0x00001F00		
TIMG1	0x40086000	0x00001F00		
TIMG2	0x40088000	0x00001F00		
TIMG8	0x40090000	0x00001F00		
LFSS	0x40094000	0x00001600		
RTC_B	0x40094000	0x00001600		
IWDT	0x40094000	0x00001600		
GPIOA	0x400A0000	0x00001F00		
GPIOB	0x400A2000	0x00001F00		
SYSCTL	0x400AF000	0x00003100		
DEBUGSS	0x400C7000	0x00001F00		
EVENTLP	0x400C9000	0x00003000		
FLASHCTL	0x400CD000	0x00002000		
I2C0	0x400F0000	0x00001F00		
I2C1	0x400F2000	0x00001F00		
UART1	0x40100000	0x00001F00		
UART2	0x40102000	0x00001F00		
UART0	0x40108000	0x00001F00		
CPUSS	0x40400000	0x00001F00		
WUC	0x40424000	0x00000500		
IOMUX	0x40428000	0x00002000		

Product Folder Links: MSPM0H3216



DMA	0x4042A000	0x00001F00
CRC	0x40440000	0x00002000
SPI0	0x40468000	0x00001F00
ADC0	0x4055A000	0x00001000
TIMA0	0x40860000	0x00001F00



#### 8.8.3 Peripheral Interrupt Vector

Interrupt Vector Number shows the IRQ number for each peripheral.

**Table 8-7. Interrupt Vector Number** 

Peripheral name	NVIC IRQ
SYSCTL	0
DEBUGSS	1
TIMG8	2
UART1	3
ADC0	4
UART2	8
SPI0	9
UART0	15
TIMG14	16
TIMG2	17
TIMA0	18
TIMG1	19
GPIOA	22
GPIOB	23
12C0	24
I2C1	25
FLASHCTL	27
WWDT0	29
LFSS	30
RTC_B	30
IWDT	30
DMA	31

# 8.9 Flash Memory

A single bank of nonvolatile flash memory is provided for storing executable program code and application data.

Key features of the flash include:

- 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 a complete description of the flash memory, see the NVM chapter of the MSPM0 H-Series 32MHz Microcontrollers Technical Reference Manual.

#### 8.10 SRAM

MSPM0Hxx MCUs include a low-power high-performance SRAM memory with zero wait state access across the supported CPU frequency range of the device. SRAM memory can 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 operating modes. A write protection mechanism is provided to allow the application to dynamically write protect the SRAM memory with 1KB resolution. Write protection is useful when placing executable code into SRAM to provide 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.

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#### 8.11 **GPIO**

The general purpose input/output (GPIO) peripheral lets the application write data out and read data in through the device pins. Through the use of the Port A and Port B GPIO peripheral, these devices support up to 45 GPIO pins.

The key features of the GPIO module include:

- · 0 wait state MMR access from CPU
- · Set, clear, or toggle multiple bits without the need of a read-modify-write construct in software
- "FastWake" feature enables low-power wakeup from STOP and STANDBY modes for any GPIO port
- User controlled input filtering

#### **8.12 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, 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 H-Series 32MHz Microcontrollers Technical Reference Manual.

#### 8.13 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 1.6-Msps with greater than 10-bit ENOB
- Up to 27 external input channels
- Internal channels for temperature sensing, supply monitoring, and analog signal chain
- · Software selectable reference:
  - Configurable internal dedicated ADC reference voltage of 4.05V (VREF)
  - MCU supply voltage (VDD)
  - Support for bringing in an external reference on VREF+/- device pins
- Operates in RUN, SLEEP, and STOP modes and supports triggers from STANDBY mode

**Table 8-8. ADC0 Channel Mapping** 

CHANNEL[0:7]	SIGNAL NAME	CHANNEL[8:15]	SIGNAL NAME
0	A0	16	A16
1	A1	17	A17
2	A2	18	A18
3	A3	19	A19
4	A4	20	A20
5	A5	21	A21
6	A6	22	A22
7	A7	23	A23
8	A8	24	A24
9	A9	25	A25
10	A10	26	A26
11	A11	27	Reserved



Table 8-8. ADC0 Channel Mapping (continued)

CHANNEL[0:7]	SIGNAL NAME	CHANNEL[8:15]	SIGNAL NAME
12	A12	28	Temperature Sensor
13	A13	29	VREF
14	A14	30	Reserved
15	A15	31	Supply/Battery Monitor

Italicized signal names are internal to the SoC. These signals are used for internal peripheral interconnections.

For more details, see the ADC chapter of the MSPM0 H-Series 32MHz Microcontrollers Technical Reference Manual.

#### 8.14 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-todigital 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 4.05V 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 H-Series 32MHz Microcontrollers Technical Reference Manual for guidance on estimating the device temperature with the factory trim value.

#### 8.15 VREF

The voltage reference module (VREF) in these devices contains a configurable voltage reference buffer dedicated for the on-board ADC.

VREF features include:

- 4.05V internal reference
- Internal reference supports ADC operation up to 0.9Msps at 12-bit mode

For more details, see the VREF chapter of the MSPM0 H-Series 32MHz Microcontrollers Technical Reference Manual.

## 8.16 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 bit reversal

For more details, see the CRC chapter of the MSPM0 H-Series 32MHz Microcontrollers Technical Reference Manual.

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#### 8.17 **UART**

The UART peripherals 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 transmit and receive loopback mode operation
- See Table 8-9 for detail information on supported protocols

Table 8-9. UART Features

Table 6 6. GART I catales					
UART FEATURES	UART0 (ADV)	UART1 (MAIN)	UART2 (MAIN)		
Active in stop and standby modes	Yes	Yes	Yes		
Separate transmit and receive FIFOs	Yes	Yes	Yes		
Support hardware flow control	Yes	Yes	Yes		
Support 9-bit configuration	Yes	Yes	Yes		
Support LIN mode	Yes	No	No		
Support DALI	Yes	No	No		
Support IrDA	Yes	No	No		
Support ISO7816 Smart Card	Yes	No	No		
Support Manchester coding	Yes	No	No		

For more details, see the UART chapter of the MSPM0 H-Series 32MHz Microcontrollers Technical Reference Manual.

#### 8.18 SPI

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

- Support ULPCLK/2 bit rate and up to 16 Mbits/s in both controller and peripheral modes
- 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
- Supports TI mode, Motorola mode, and National Microwire format

For more details, see the SPI chapter of the MSPM0 H-Series 32MHz Microcontrollers Technical Reference Manual.

## 8.19 I2C

The inter-integrated circuit interface ( $I^2C$ ) 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 100 kbit/s
- Support Fast-mode (Fm), with a bit rate up to 400 kbit/s
- Support Fast-mode Plus (Fm+), with a bit rate up to 1 Mbit/s
- Separated transmit and receive FIFOs
- Support SMBus 3.0 with PEC, ARP, timeout detection, and host support



· Support analog and digital glitch filter for input signal glitch suppression

For more details, see the I2C chapter of the MSPM0 H-Series 32MHz Microcontrollers Technical Reference Manual.

## 8.20 Low-Frequency Sub System (LFSS)

The Low-Frequency Sub-System (LFSS) is a sub-system which 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. The LFCLK has a typical frequency of 32kHz and is mainly intended for long-term timekeeping.

LFSS in this device contains following components:

- Real Time Clock with additional prescalar extension and timestamp captures
- An asynchronous Independent Watchdog Timer

For more details, see the LFSS chapter of the MSPM0 H-Series 32MHz Microcontrollers Technical Reference Manual.

## 8.21 RTC\_B

The RTC\_B 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. The RTC\_B provides common key features in relation to the Low-Frequency Sub System (LFSS).

Common key features of the RTC B 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 128 Hz
- Interval alarm interrupt providing periodic wake-up at 64, 32, 16, 8, 4, 2, 1, and 0.5 Hz
- Calibration for crystal offset error (up to +/- 240ppm)
- Compensation for temperature drift (up to +/- 240ppm)
- RTC clock output to pin for calibration

RTC B Key Features #none# shows the RTC features supported in this device.

#### Table 8-10. RTC B Key Features

RTC Features	RTC_B
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 ±240 ppm total)	Yes

Product Folder Links: MSPM0H3216



Table 8-10. RTC\_B Key Features (continued)

RTC Features	RTC_B
RTC clock output to pin for calibration (GPIO)	Yes
RTC clock output to pin for calibration (TIO)	-
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:  TIO event  VDD fail event	-
RTC counter lock function	-

For more details, see the RTC chapter of the MSPM0 H-Series 32MHz Microcontrollers Technical Reference Manual.

## 8.22 **IWDT\_B**

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 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 MSPM0 H-Series 32MHz Microcontrollers Technical Reference Manual.

## 8.23 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 H-Series 32MHz Microcontrollers Technical Reference Manual

## 8.24 Timers (TIMx)

The timer peripherals in these devices support the following key features. For specific configuration, see Table 8-11.

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

- 16-bit down, up/down, or up counter with repeat-reload mode
- · Selectable and configurable clock source
- 8-bit programmable prescaler to divide the counter clock frequency



- Up to four independent CC channels for
  - Output compare
  - Input capture
  - PWM output
  - One-shot mode
- Support quadrature encoder interface (QEI) for positioning and movement sensing
- Support synchronization and cross trigger among different TIMx instances in the same power domain
- Support interrupt trigger generation and cross peripherals (such as ADC) trigger capability
- Cross-trigger event logic for Hall sensor inputs

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

- 16-bit down or up-down counter, with repeat-reload mode
- · Selectable and configurable clock source
- 8-bit programmable prescaler to divide the counter clock frequency
- Clock doubler to provide 2x clock source for improved timer resolution
- · 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
- · Shadow register for load and CC register available
- · Complementary output PWM
- Asymmetric PWM with programmable dead band insertion
- Fault handling mechanism to keep 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 trigger generation and cross peripherals (such as ADC) trigger capability
- Two additional capture/compare channels for internal events

# Table 8-11. TIMx Configurations

TIMER NAME	POWER DOMAIN	RESOLUTION	PRESCALER	REPEAT COUNTER	CAPTURE / COMPARE CHANNELS	PHASE	SHADOW	SHADOW	DEAD- BAND	FAULT	QEI
TIMG14	PD0	16 bit	8 bit	-	4	-	-	-	-	-	-
TIMG1	PD0	16 bit	8 bit	-	2	-	-	-	_	-	-
TIMG2	PD0	16 bit	8 bit	-	2	-	-	-	-	-	-
TIMG8	PD0	16 bit	8 bit	-	2	-	-	-	-	-	Yes
TIMA0	PD0	16 bit	8 bit	8-bit	4	Yes	Yes	Yes	Yes	Yes	-

For more details, see the timer chapters of the MSPM0 H-Series 32MHz Microcontrollers Technical Reference Manual.

Product Folder Links: MSPM0H3216



# **8.25 Device Analog Connections**

Figure 8-1 shows the internal analog connection of the device.

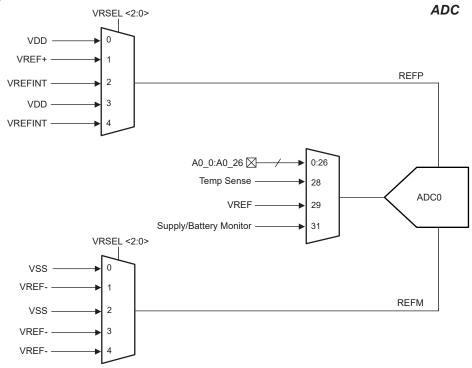


Figure 8-1. Analog Connections



## 8.26 Input/Output Diagrams

The IOMUX manages the selection of which peripheral function is to be used on a digital IO and provides the controls for the output driver and input path. For more information, see the IOMUX section of the MSPMO H-Series 32MHz Microcontrollers Technical Reference Manual.

The mixed-signal IO pin slice diagram for a full featured IO pin is shown in Figure 8-2. Not all pins have analog functions, drive strength control, and pullup resistors available. See Pin Attributes (PT, RUK, RGZ, NNA, VFC, RHB, DGS32, DGS28, RGE, DGS20 Packages) for detailed information on the features that are supported for a specific pin.

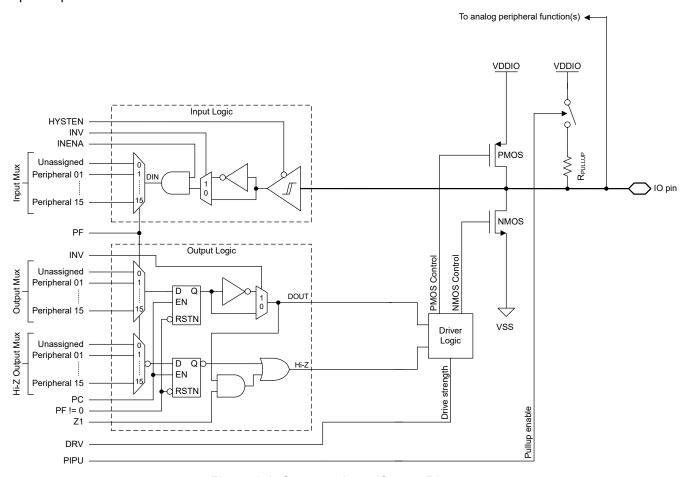


Figure 8-2. Superset Input/Output Diagram

## 8.27 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. For a complete description of the debug functionality offered on MSPM0 devices, see the debug chapter of the technical reference manual.

Table 8-12. 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

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## 8.28 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. See the *Factory Constants* section of the MSPM0 H-Series 32MHz Microcontrollers Technical Reference Manual.

#### Table 8-13. DEVICEID

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

Device	DEVICEID.PARTNUM	DEVICEID.MANUFACTURER
MSPM0H3215	0x0BBA	0x17
MSPM0H3216	0x0BBA	0x17

#### Table 8-14. USERID

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

Device	PART	VARIANT	Device	PART	VARIANT
M0H3216QPTRQ1	4840	24	M0H3215QPTRQ1	AA69	2C
M0H3216QRGZRQ1	4840	25	M0H3215QRGZRQ 1	AA69	2D
M0H3216QDGS32Q1	4840	26	M0H3215QDGS32 RQ1	AA69	2E
M0H3216QDGS28RQ1	4840	27	M0H3215QDGS28 RQ1	AA69	2F
M0H3216QDGS20RQ1	4840	28	M0H3215QDGS20 RQ1	AA69	30
M0H3216QRHBRQ1	4840	29	M0H3215QRHBRQ 1	AA69	31
M0H3216QRGERQ1	4840	2A	M0H3215QRGERQ 1	AA69	32
M0H3216QRUKRQ1	4840	2B	M0H3215QRUKRQ 1	AA69	33

#### 8.29 Identification

## **Revision and Device Identification**

The hardware revision and device identification values are stored in the memory-mapped FACTORY region (see the 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. For more information, see the Factory Constants chapter of the MSPMO H-Series 32MHz Microcontrollers Technical Reference Manual.

The device revision and identification information are also included as part of the top-side marking on the device package. The device-specific errata describes these markings.



# 9 Applications, Implementation, and Layout

#### **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 Typical Application

## 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 can be used but can affect the supply rail ramp-up time. Decoupling capacitors must be placed as close as possible to the pins (within a few millimeters).

The NRST reset pin must connect an external 47-kΩ pullup resistor with a 10-nF pulldown capacitor.

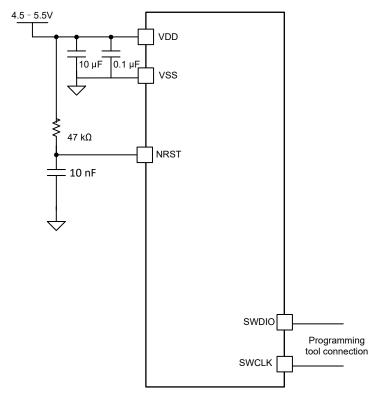


Figure 9-1. Typical Application Schematic

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# 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 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. Tl's standard warranty applies. Predictions show that prototype devices (X) have a greater failure rate than the standard production devices. Tl 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.

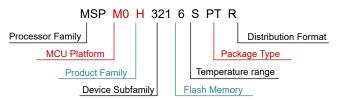


Figure 10-1. Device Nomenclature

**Table 10-1. Device Nomenclature** 

Processor Family	MSP = Mixed-signal processor X= Experimental silicon		
MCU Platform	10 = Arm-based 32-bit M0+		
Product Family	H = 5V		
Device Subfamily	321 = 32MHz frequency, ADC, RTC		
Flash Memory 5 = 32KB 6 = 64KB			
Temperature Range	S = -40°C to 125°C		
Package Type	See Table 5-1 and www.ti.com/packaging		
T = Small reel R = Large reel 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, or contact your TI sales representative.



#### 10.2 Tools and Software

#### **Design Kits and Evaluation Modules**

MSPM0 LaunchPad (LP) Boards: LP-MSPM0H3216 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, and EnergyTrace™ technology.

The LP ecosystem includes dozens of BoosterPack<sup>™</sup> 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.

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

TI Resource Explorer

SysConfig

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 tool chains

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 Tool Chain

# 10.3 Documentation Support

To receive notification of documentation updates, navigate to the device product folder on 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.

#### **Technical Reference Manual**

MSPM0 H-Series 32-MHz Microcontrollers Technical Reference Manual

This manual describes the modules and peripherals of the MSPM0H family of devices. Each description presents the module or peripheral in a general sense. Not all features 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

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devices. Pin functions, internal signal connections, and operational parameters differ from device to device. See the device-specific data sheet for these details.

#### **Errata**

MSPM0H321x Mixed-Signal Microcontrollers Errata

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

## 10.4 Support Resources

TI E2E<sup>™</sup> 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.

#### 10.5 Trademarks

LaunchPad<sup>™</sup>, Code Composer Studio<sup>™</sup>, TI E2E<sup>™</sup>, EnergyTrace<sup>™</sup>, and BoosterPack<sup>™</sup> are trademarks of Texas Instruments.

Arm® and Cortex® are registered trademarks of Arm Limited.

All trademarks are the property of their respective owners.

#### 10.6 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.

#### 10.7 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.

DATE	REVISION	NOTES		
June 2025	*	Initial Release		



# 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.

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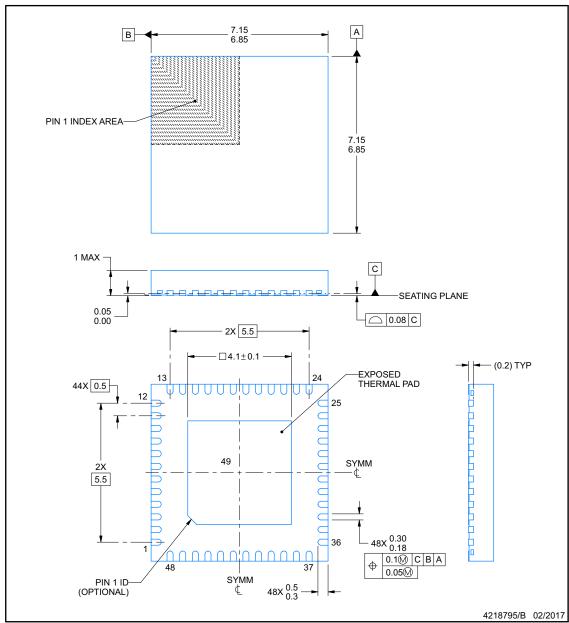
# **RGZ0048B**



## **PACKAGE OUTLINE**

#### VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



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

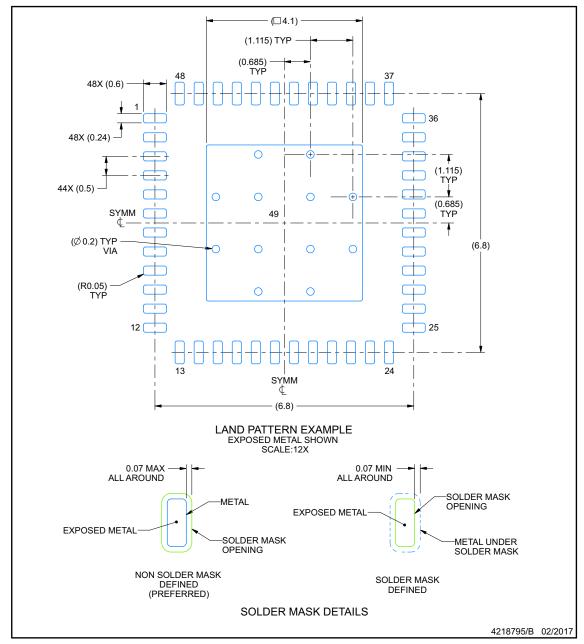




# **RGZ0048B**

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



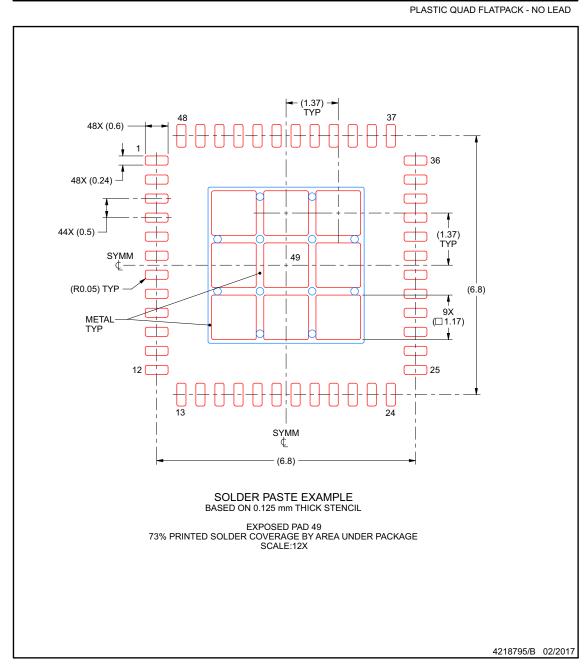
- 4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
- 5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations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





# **RGZ0048B**

VQFN - 1 mm max height



NOTES: (continued)

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





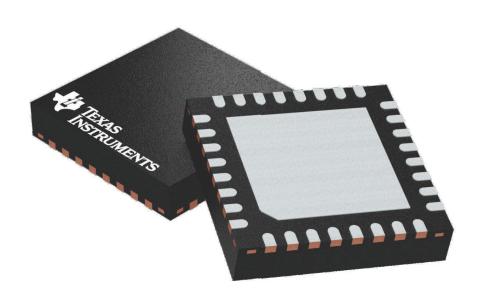
# **GENERIC PACKAGE VIEW**

**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



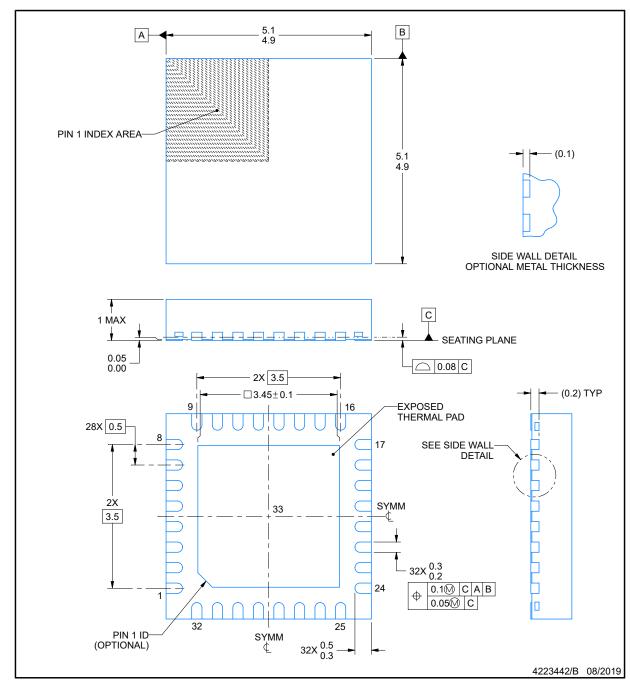
# **RHB0032E**



# PACKAGE OUTLINE

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



- 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.

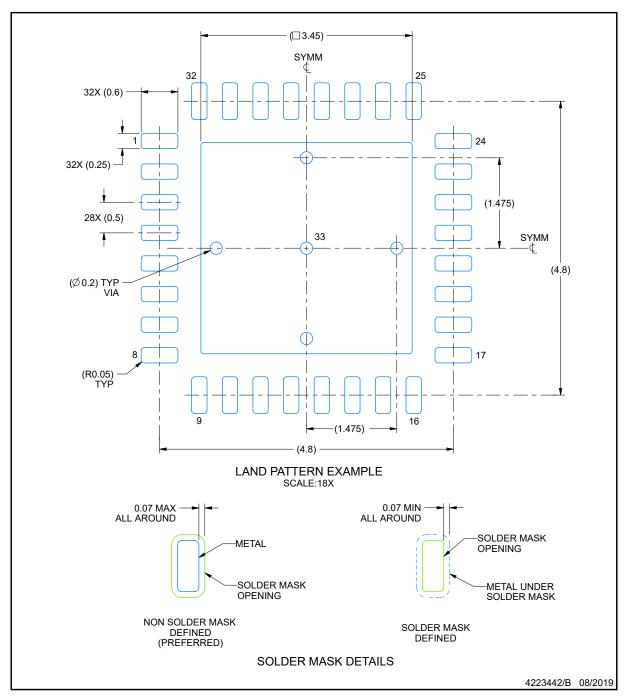
  3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.



# **RHB0032E**

# VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD

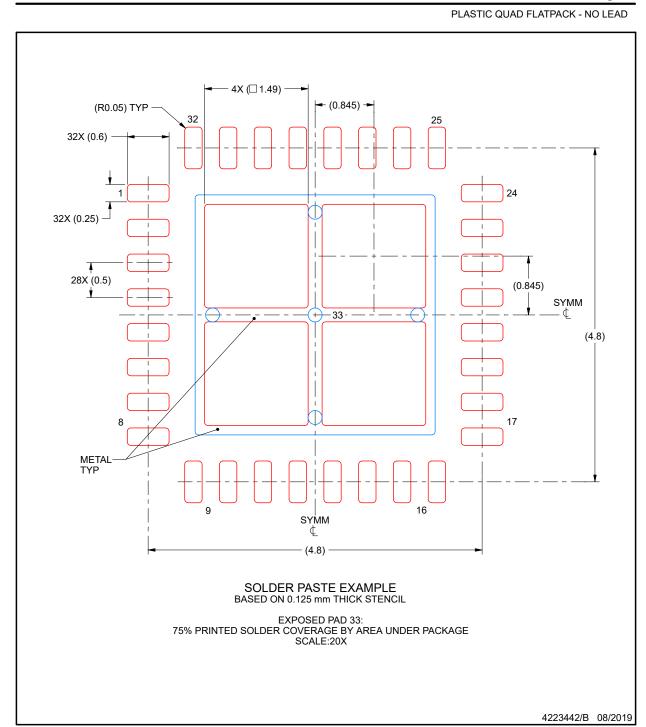


- 4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
- 5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations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



# **RHB0032E**

VQFN - 1 mm max height



NOTES: (continued)

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



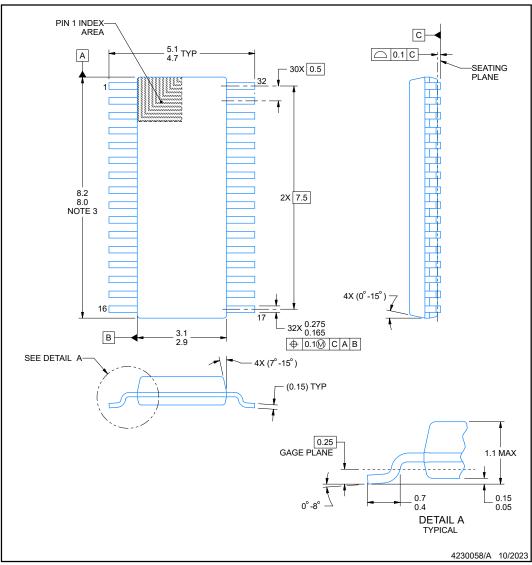
# **DGS0032A**



## **PACKAGE OUTLINE**

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



#### NOTES:

PowerPAD is a trademark of Texas Instruments.

- 1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing
- per ASME Y14.5M.
  This drawing is subject to change without notice.
  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. No JEDEC registration as of September 2020.5. Features may differ or may not be present.

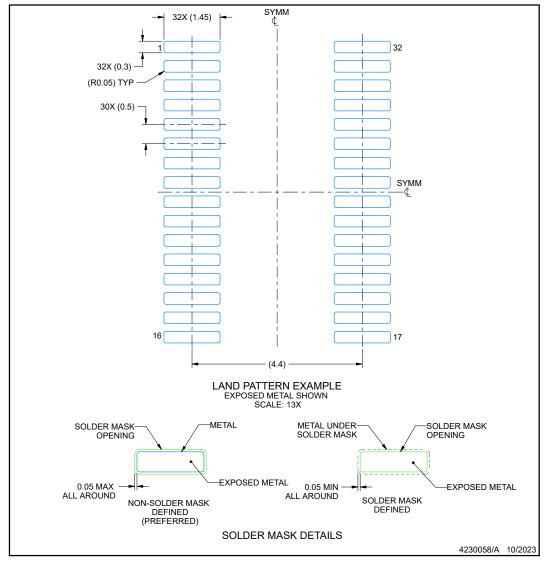




## **DGS0032A**

## VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



- 6. Publication IPC-7351 may have alternate designs.7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
- 8. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature numbers SLMA002 (www.ti.com/lit/slma002) and SLMA004 (www.ti.com/lit/slma004).
- 9. Size of metal pad may vary due to creepage requirement.
  10. Vias are optional depending on application, refer to device data sheet. It is recommended that vias under paste be filled, plugged.

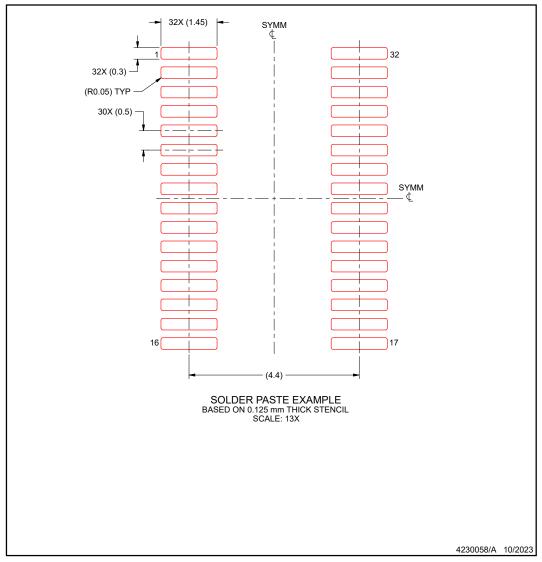




# **DGS0032A**

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



- 11. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.12. Board assembly site may have different recommendations for stencil design.



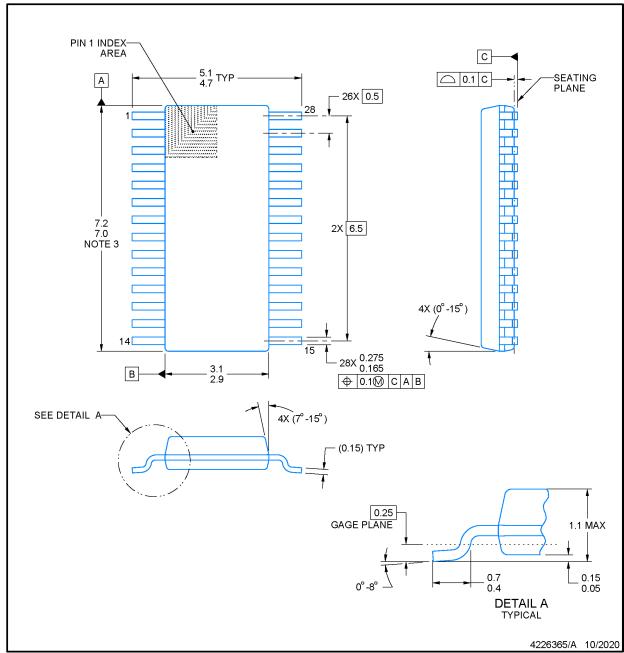


**DGS0028A** 

# **PACKAGE OUTLINE**

# VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



PowerPAD is a trademark of Texas Instruments.

- 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.

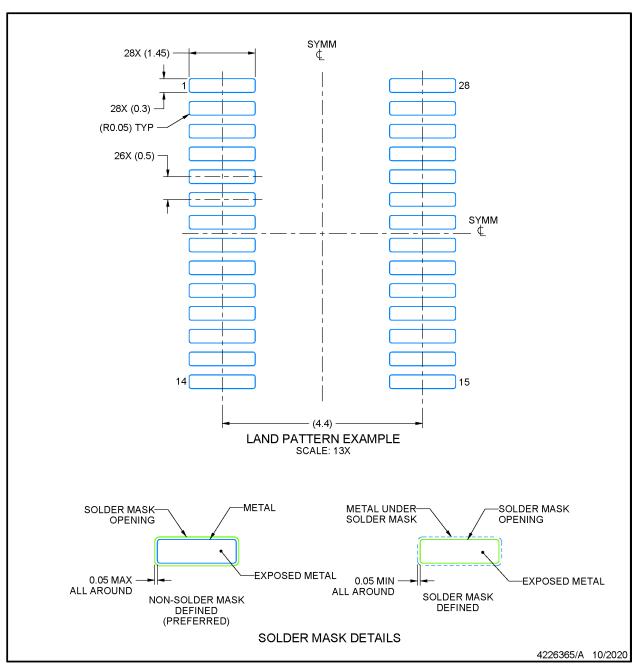
  3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not
- exceed 0.15 mm per side.
- 4. No JEDEC registration as of September 2020.
- 5. Features may differ or may not be present.



# **DGS0028A**

# VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



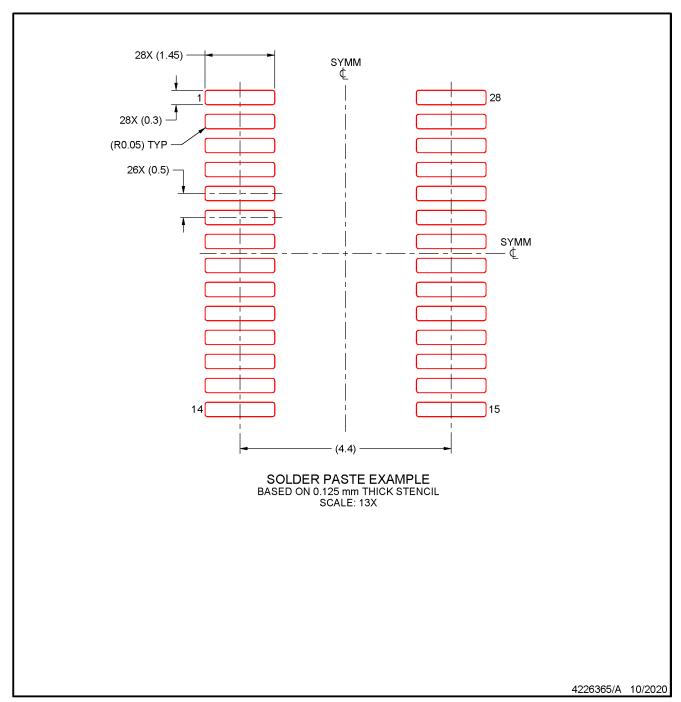
- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
- 8. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature numbers SLMA002 (www.ti.com/lit/slma002) and SLMA004 (www.ti.com/lit/slma004).
- 9. Size of metal pad may vary due to creepage requirement.
- 10. Vias are optional depending on application, refer to device data sheet. It is recommended that vias under paste be filled, plugged or tented.



# **DGS0028A**

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



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

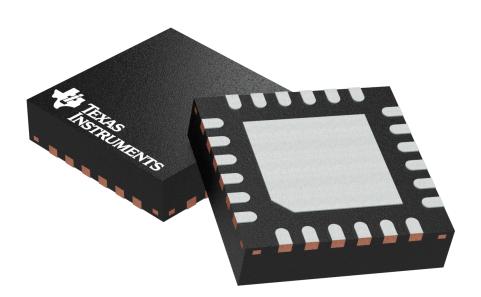
**RGE 24** 

# **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



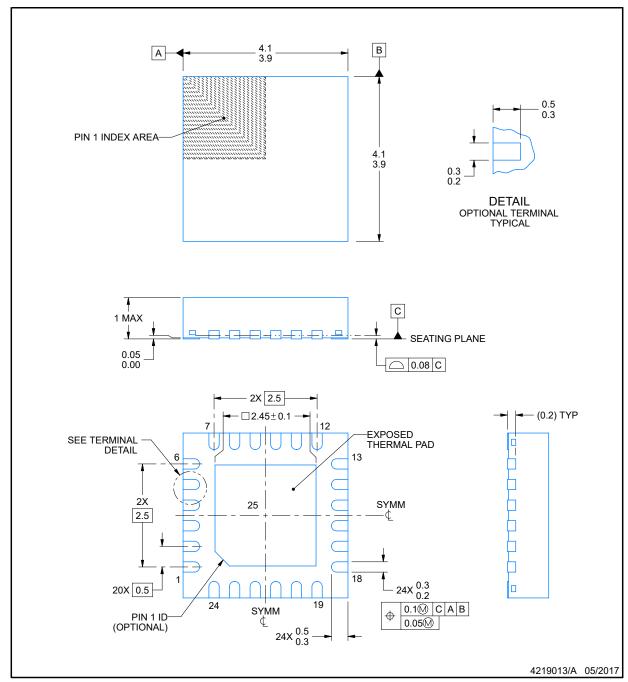
# **RGE0024B**



## **PACKAGE OUTLINE**

# VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



- 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.

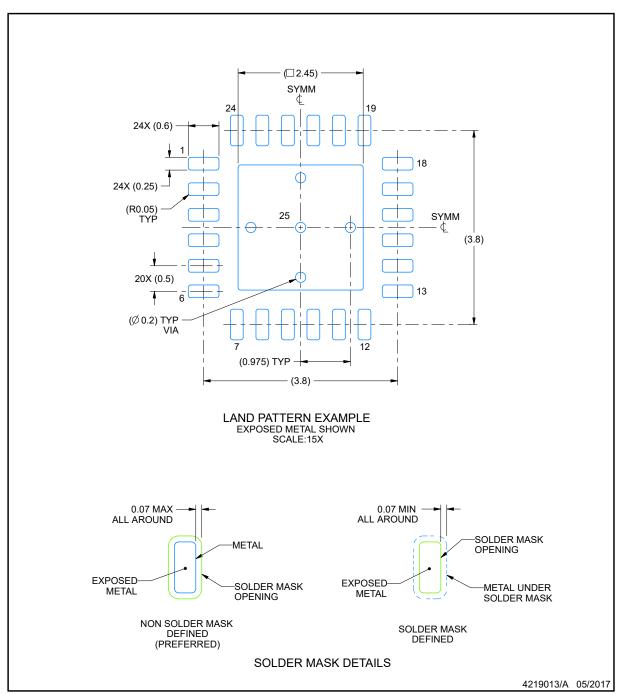
  3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.



# **RGE0024B**

# VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



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).
- 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.

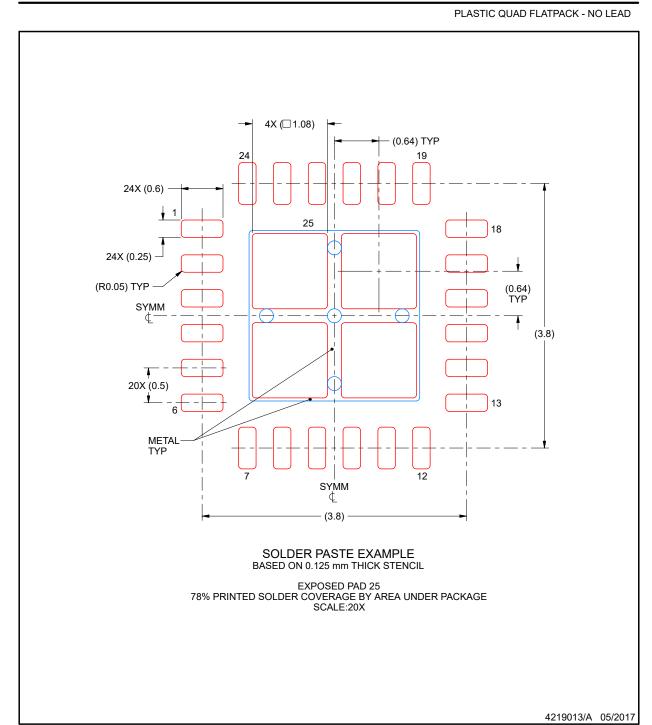
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# **RGE0024B**

VQFN - 1 mm max height



NOTES: (continued)

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

**DGS0020A** 

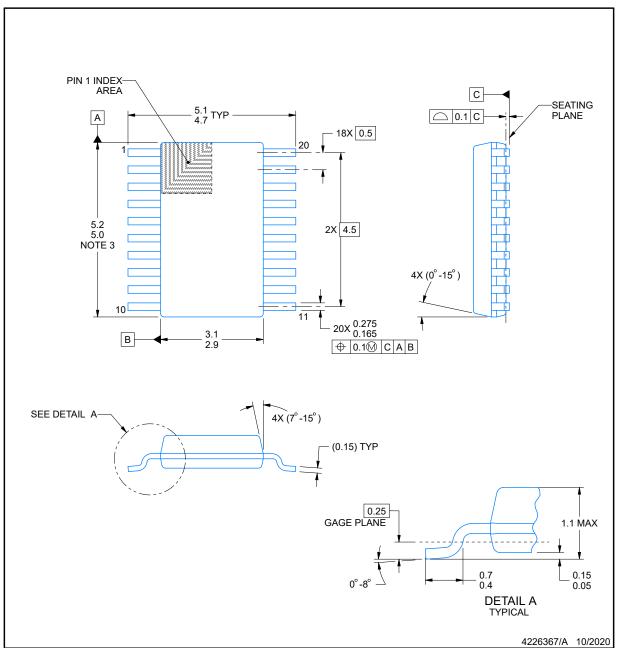




# **PACKAGE OUTLINE**

# VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



PowerPAD is a trademark of Texas Instruments.

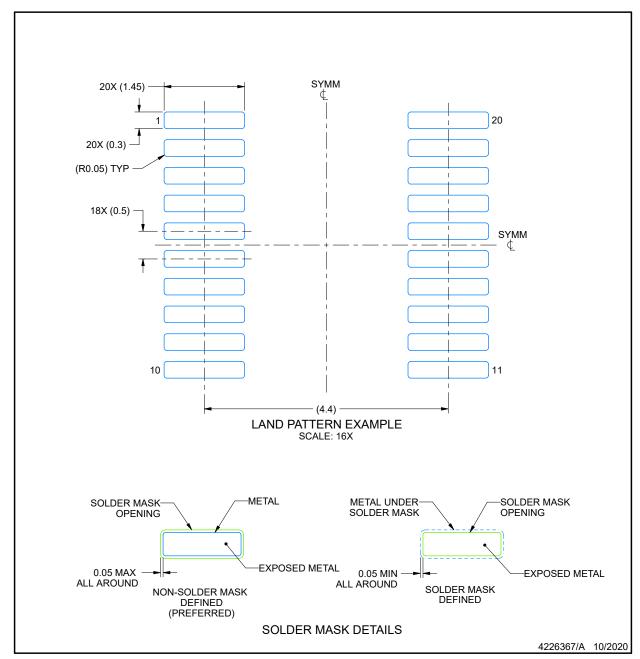
- 1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
  2. This drawing is subject to change without notice.
- 3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
- 4. No JEDEC registration as of September 2020.
- 5. Features may differ or may not be present.



# **DGS0020A**

# **VSSOP - 1.1 mm max height**

SMALL OUTLINE PACKAGE



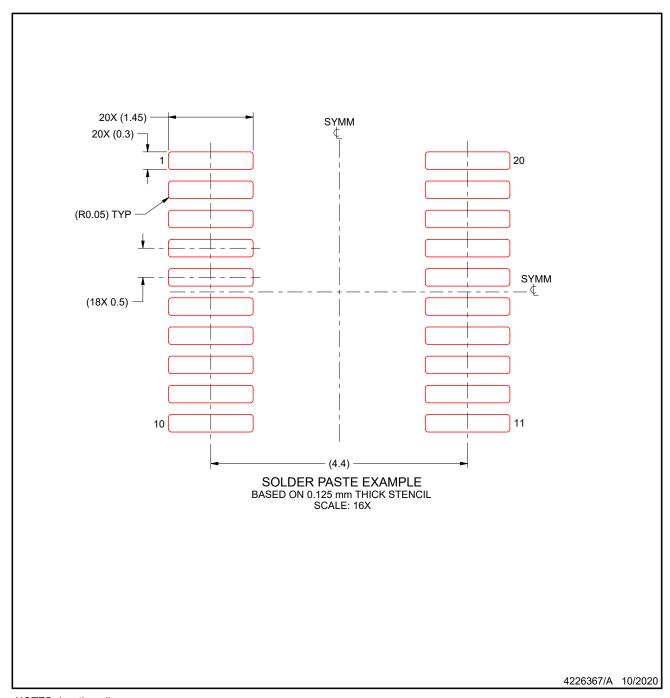
- 6. Publication IPC-7351 may have alternate designs.
- Solder mask tolerances between and around signal pads can vary based on board fabrication site.
   This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature numbers SLMA002 (www.ti.com/lit/slma002) and SLMA004 (www.ti.com/lit/slma004).
- 9. Size of metal pad may vary due to creepage requirement.
- 10. Vias are optional depending on application, refer to device data sheet. It is recommended that vias under paste be filled, plugged or tented.



# **DGS0020A**

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



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

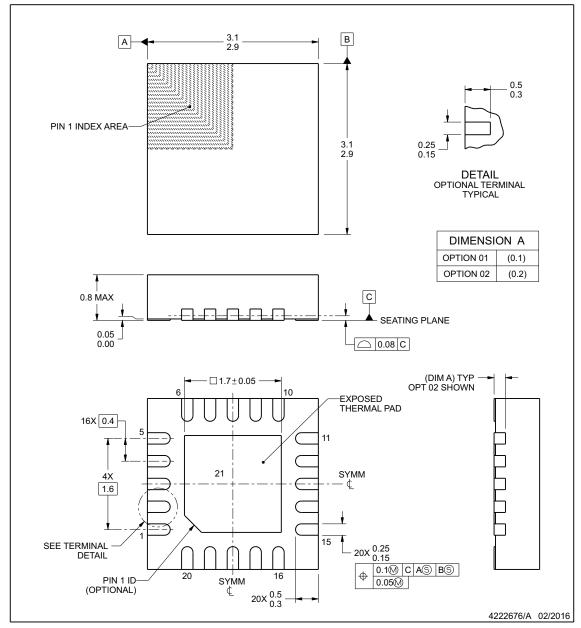


**RUK0020B** 

## **PACKAGE OUTLINE**

# WQFN - 0.8 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



#### 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.

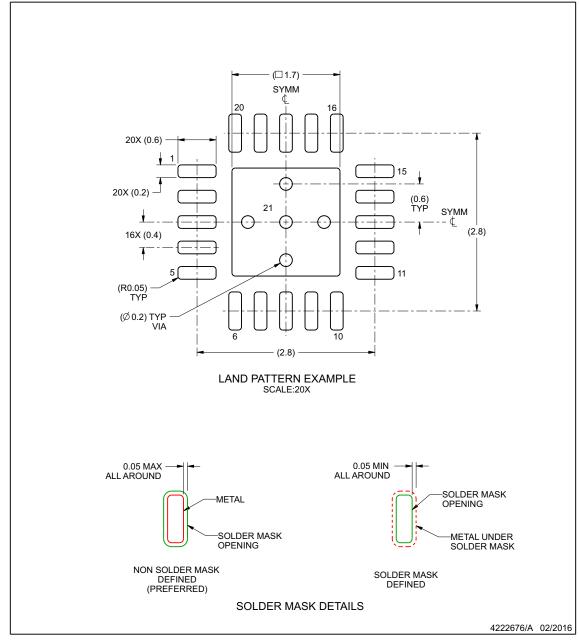
www.ti.com



# **RUK0020B**

WQFN - 0.8 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



NOTES: (continued)

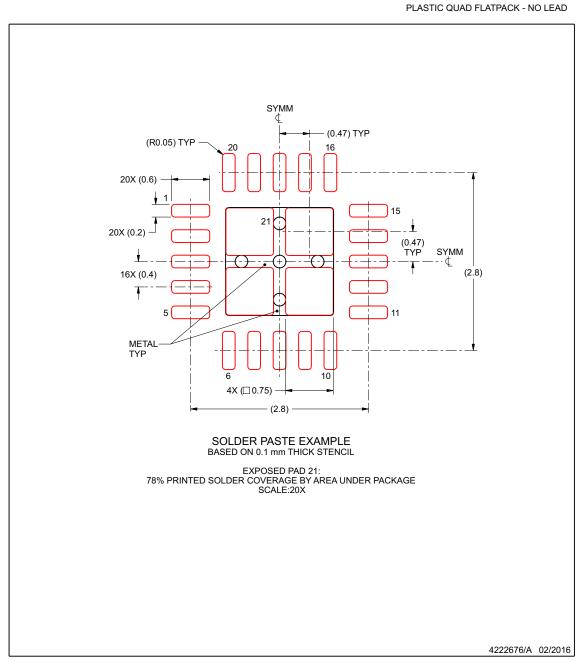
- 4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
- 5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations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

www.ti.com



# **RUK0020B**

WQFN - 0.8 mm max height



NOTES: (continued)

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

www.ti.com

www.ti.com 7-Nov-2025

#### PACKAGING INFORMATION

Orderable part number	Status	Material type	Package   Pins	Package qty   Carrier	RoHS	Lead finish/ Ball material	MSL rating/ Peak reflow	Op temp (°C)	Part marking (6)
						(4)	(5)		
XMSPM0H3216SPTR	Active	Preproduction	LQFP (PT)   48	1   LARGE T&R	-	Call TI	Call TI	-40 to 125	

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

- (3) RoHS values: Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.
- (4) 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.
- (5) 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.
- (6) 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.

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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 MSPM0H3216:

Automotive : MSPM0H3216-Q1

NOTE: Qualified Version Definitions:

<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.

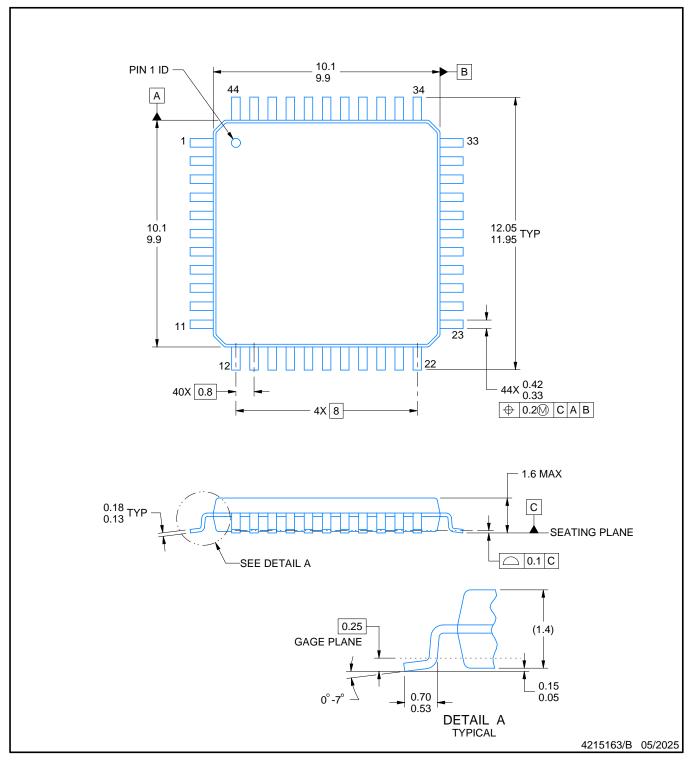
# **PACKAGE OPTION ADDENDUM**

www.ti.com 7-Nov-2025

• Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects



PLASTIC QUAD FLATPACK



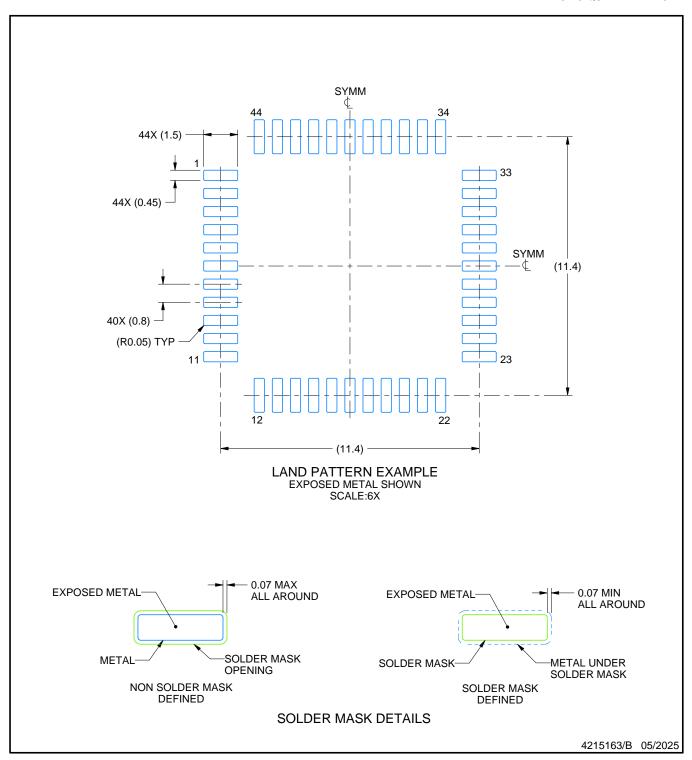
- 1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.

  2. This drawing is subject to change without notice.

  3. Reference JEDEC registration MS-026.



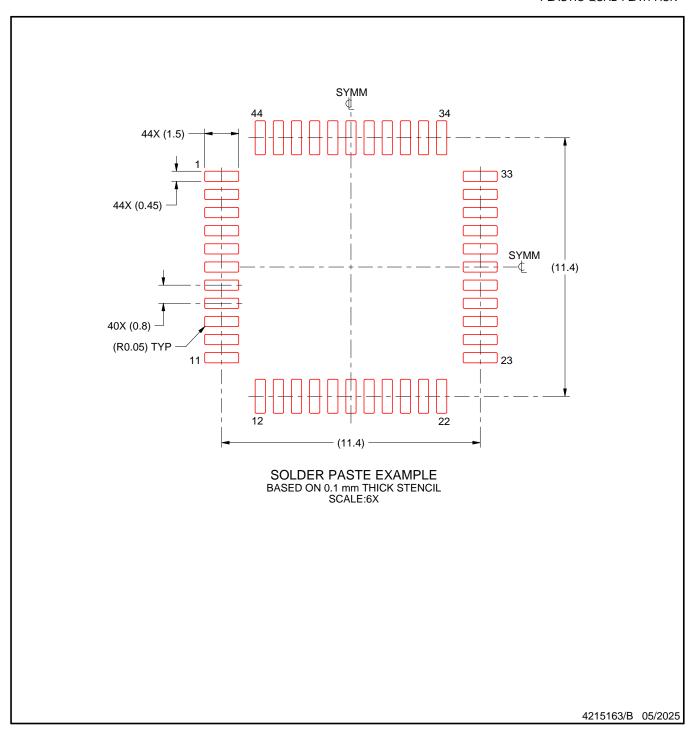
PLASTIC QUAD FLATPACK



- 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).



PLASTIC QUAD FLATPACK



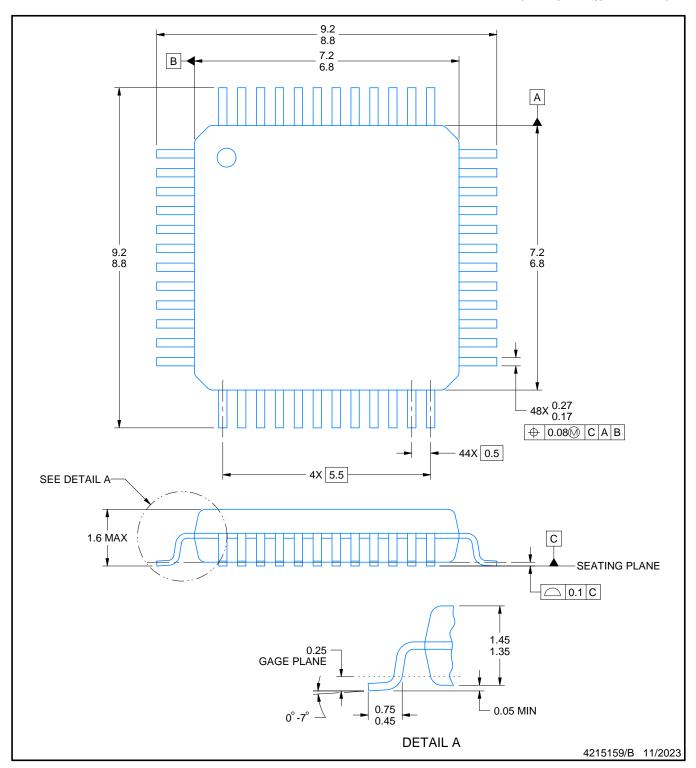


<sup>7.</sup> Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

<sup>8.</sup> Board assembly site may have different recommendations for stencil design.



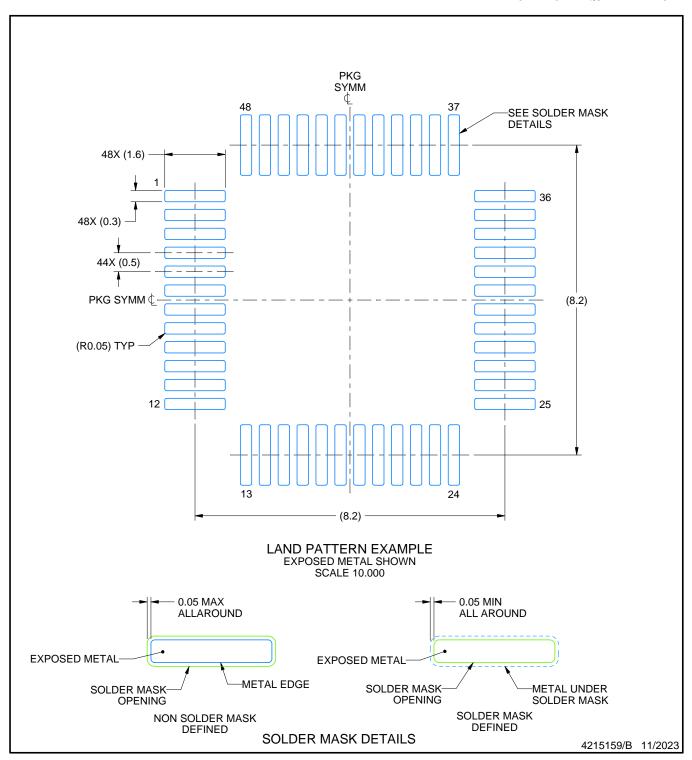
LOW PROFILE QUAD FLATPACK



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



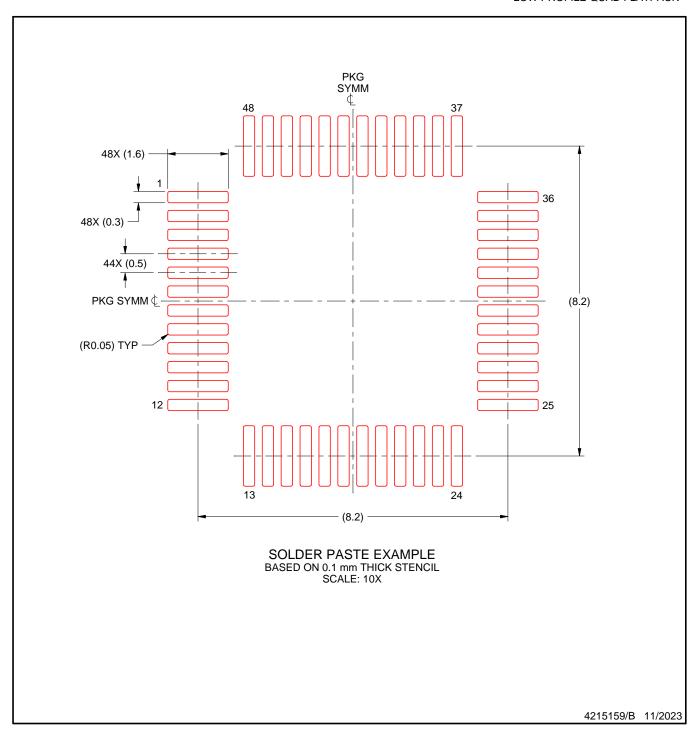
LOW PROFILE QUAD FLATPACK



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



LOW PROFILE QUAD FLATPACK



- 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.



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