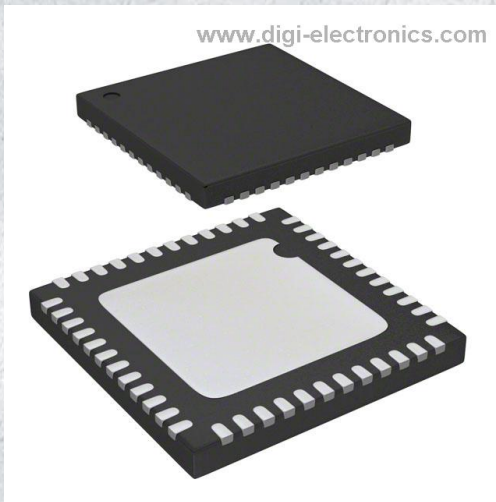


# EFM32PG12B500F1024IM48-C Datasheet



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DiGi Electronics Part Number	EFM32PG12B500F1024IM48-C-DG
Manufacturer	<a href="#">Silicon Labs</a>
Manufacturer Product Number	EFM32PG12B500F1024IM48-C
Description	IC MCU 32BIT 1MB FLASH 48QFN
Detailed Description	ARM® Cortex®-M4 Pearl Gecko Microcontroller IC 32-Bit Single-Core 40MHz 1MB (1M x 8) FLASH 48-QFN (7x7)

This model EFM32PG12B500F1024IM48-C is available at DiGi Electronics.

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## Purchase and inquiry

Manufacturer Product Number:

EFM32PG12B500F1024IM48-C

Series:

Pearl Gecko

DiGi-Electronics Programmable:

Not Verified

Core Size:

32-Bit Single-Core

Connectivity:

I2C, IrDA, LINbus, SmartCard, SPI, UART/USART

Number of I/O:

33

Program Memory Type:

FLASH

RAM Size:

256K x 8

Data Converters:

A/D - 12b SAR

Operating Temperature:

-40°C ~ 125°C (Tj)

Supplier Device Package:

48-QFN (7x7)

Base Product Number:

EFM32PG12B500

Manufacturer:

Silicon Labs

Product Status:

Active

Core Processor:

ARM® Cortex®-M4

Speed:

40MHz

Peripherals:

Brown-out Detect/Reset, DMA, I2S, POR, PWM, WDT

Program Memory Size:

1MB (1M x 8)

EEPROM Size:

-

Voltage - Supply (Vcc/Vdd):

1.8V ~ 3.8V

Oscillator Type:

Internal

Mounting Type:

Surface Mount

Package / Case:

48-VFQFN Exposed Pad

## Environmental & Export classification

RoHS Status:

ROHS3 Compliant

REACH Status:

REACH Unaffected

HTSUS:

8542.31.0001

Moisture Sensitivity Level (MSL):

2 (1 Year)

ECCN:

5A992C



# EFM32 Gecko Family

## EFM32PG12 Family Data Sheet



The EFM32 Gecko MCUs are the world’s most energy-friendly microcontrollers.

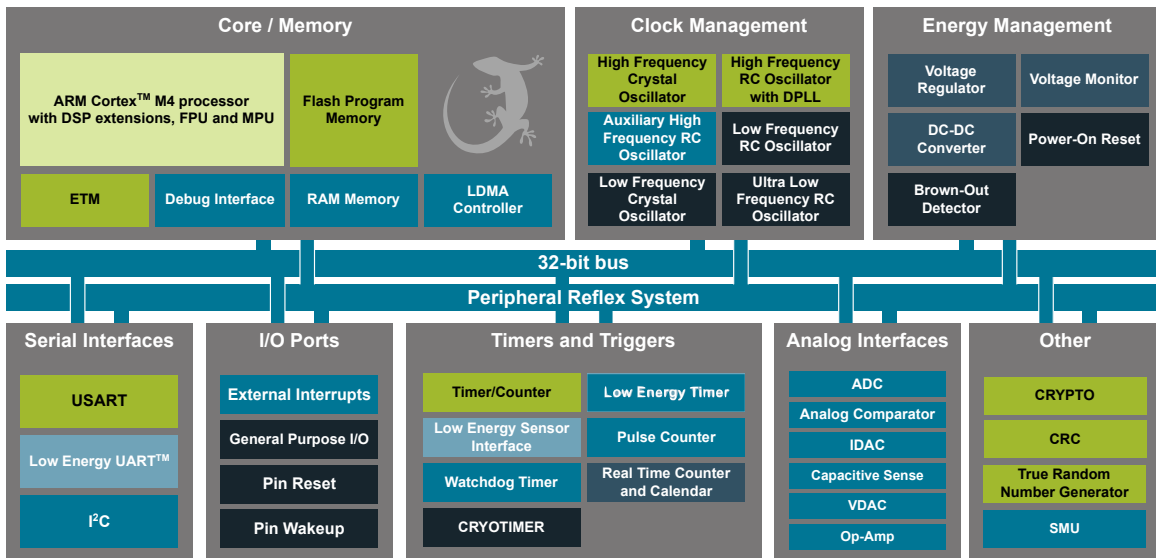
EFM32PG12 features a powerful 32-bit ARM® Cortex®-M4 and a wide selection of peripherals, including a unique cryptographic hardware engine and Security Management Unit, True Random Number Generator, and robust capacitive touch sense unit. These features, combined with ultra-low current active and sleep modes, make EFM32PG12 microcontrollers well suited for any battery-powered application, as well as other systems requiring high performance and low energy consumption.

Example applications:

- IoT devices and sensors
- Health and fitness
- Smart accessories
- Home automation and security
- Industrial and factory automation

**ENERGY FRIENDLY FEATURES**

- ARM Cortex-M4 at 40 MHz
- Ultra low energy operation:
  - 0.39 µA EM4H Hibernate current
  - 1.5 µA EM2 Deep Sleep current (RTCC running with state and RAM retention)
  - 64 µA/MHz EM0 Active current
- Hardware cryptographic engine (AES, ECC, and SHA) and TRNG
- Security Management Unit (SMU)
- Autonomous low energy sensor interface (LESENSE)
- Rich analog features including ADC, VDAC, OPAMPs, and capacitive sense
- Integrated DC-DC converter
- 5 V tolerant I/O



Lowest power mode with peripheral operational:



## 1. Feature List

The EFM32PG12 highlighted features are listed below.

- **ARM Cortex-M4 CPU platform**
  - High performance 32-bit processor @ up to 40 MHz
  - DSP instruction support and Floating Point Unit
  - Memory Protection Unit
  - Wake-up Interrupt Controller
- **Flexible Energy Management System**
  - 64  $\mu$ A/MHz in Active Mode (EM0)
  - 2.1  $\mu$ A EM2 Deep Sleep current (256 kB RAM retention and RTCC running from LFXO)
  - 1.5  $\mu$ A EM2 Deep Sleep current (16 kB RAM retention and RTCC running from LFRCO)
  - 1.81  $\mu$ A EM3 Stop current (State and 256 kB RAM retention, CRYOTIMER running from ULFRCO)
  - 0.39  $\mu$ A EM4H Hibernate Mode (128 byte RAM retention)
- **Up to 1024 kB flash program memory**
  - Dual-bank with read-while-write support
- **Up to 256 kB RAM data memory**
- **Up to 65 General Purpose I/O Pins**
  - Configurable push-pull, open-drain, pull-up/down, input filter, drive strength
  - Configurable peripheral I/O locations
  - Asynchronous external interrupts
  - Output state retention and wake-up from Shutoff Mode
- **Hardware Cryptography**
  - AES 128/256-bit keys
  - ECC B/K163, B/K233, P192, P224, P256
  - SHA-1 and SHA-2 (SHA-224 and SHA-256)
  - True random number generator (TRNG)
- **Security Management Unit (SMU)**
  - Fine-grained access control for on-chip peripherals
- **Timers/Counters**
  - 2  $\times$  16-bit Timer/Counter
    - 3 or 4 Compare/Capture/PWM channels
  - 2  $\times$  32-bit Timer/Counter
    - 3 or 4 Compare/Capture/PWM channels
  - 1  $\times$  32-bit Real Time Counter and Calendar
  - 1  $\times$  32-bit Ultra Low Energy CRYOTIMER for periodic wake-up from any Energy Mode
  - 16-bit Low Energy Timer for waveform generation
  - 3  $\times$  16-bit Pulse Counter with asynchronous operation
  - 2  $\times$  Watchdog Timer with dedicated RC oscillator
- **8 Channel DMA Controller**
- **12 Channel Peripheral Reflex System (PRS) for autonomous inter-peripheral signaling**
- **Communication Interfaces**
  - 4  $\times$  Universal Synchronous/Asynchronous Receiver/ Transmitter
    - UART/SPI/SmartCard (ISO 7816)/IrDA/I2S/LIN
    - Triple buffered full/half-duplex operation with flow control
  - Low Energy UART
    - Autonomous operation with DMA in Deep Sleep Mode
  - 2  $\times$  I<sup>2</sup>C Interface with SMBus support
    - Address recognition in EM3 Stop Mode
- **Ultra Low-Power Precision Analog Peripherals**
  - 12-bit 1 Msps SAR Analog to Digital Converter (ADC)
  - 2  $\times$  Analog Comparator (ACMP)
  - 2  $\times$  12-bit 500 ksps Digital to Analog Converter (VDAC)
  - 3  $\times$  Operational Amplifier (OPAMP)
  - Digital to Analog Current Converter (IDAC)
  - Multi-channel Capacitive Sense Interface (CSEN)
  - Up to 54 pins connected to analog channels (APORT) shared between analog peripherals
- **Low-Energy Sensor Interface (LESENSE)**
  - Autonomous sensor monitoring in deep sleep mode
  - Wide range of supported sensors, including LC sensors and capacitive touch switches
  - Up to 16 channels
- **Ultra efficient Power-on Reset and Brown-Out Detector**
- **Debug Interface**
  - 2-pin Serial Wire Debug interface
  - 1-pin Serial Wire Viewer
  - JTAG (programming only)
  - Embedded Trace Macrocell (ETM)
- **Wide Operating Range**
  - 1.8 V to 3.8 V single power supply
  - Integrated DC-DC, down to 1.8 V output with up to 200 mA load current for system
  - Standard (-40  $^{\circ}$ C to 85  $^{\circ}$ C T<sub>AMB</sub>) and Extended (-40  $^{\circ}$ C to 125  $^{\circ}$ C T<sub>J</sub>) temperature grades available
- **Packages**
  - 7 mm  $\times$  7 mm QFN48
  - 7 mm  $\times$  7 mm BGA125
- **Pre-Programmed UART Bootloader**
- **Full Software Support**
  - CMSIS register definitions
  - Low-power Hardware Abstraction Layer (HAL)
  - Portable software components
  - Third-party middleware
  - Free and available example code

## 2. Ordering Information

Table 2.1. Ordering Information

Ordering Code	Flash (kB)	RAM (kB)	DC-DC Converter	GPIO	Package	Temp Range
EFM32PG12B500F1024GL125-C	1024	256	Yes	65	BGA125	-40 to +85°C
EFM32PG12B500F1024IL125-C	1024	256	Yes	65	BGA125	-40 to +125°C
EFM32PG12B500F1024GM48-C	1024	256	Yes	33	QFN48	-40 to +85°C
EFM32PG12B500F1024IM48-C	1024	256	Yes	33	QFN48	-40 to +125°C

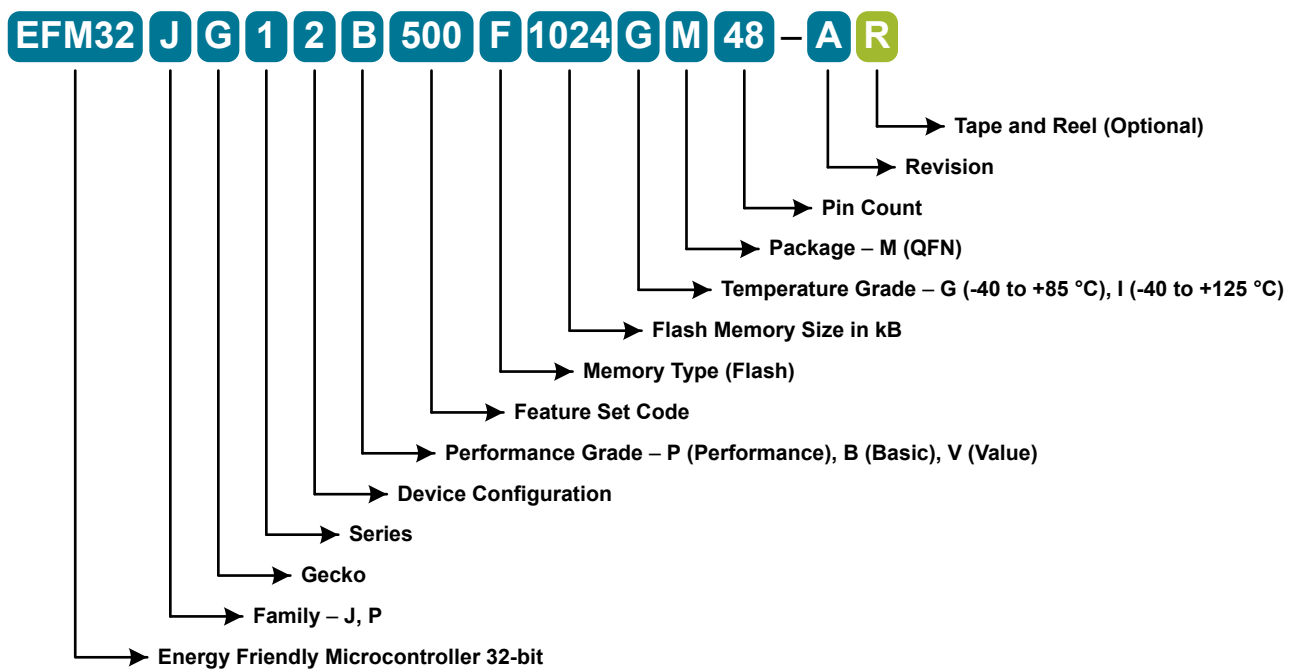


Figure 2.1. Ordering Code Key

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### 3. System Overview

#### 3.1 Introduction

The EFM32PG12 product family is well suited for any battery operated application as well as other systems requiring high performance and low energy consumption. This section gives a short introduction to the MCU system. The detailed functional description can be found in the EFM32PG12 Reference Manual.

A block diagram of the EFM32PG12 family is shown in [Figure 3.1 Detailed EFM32PG12 Block Diagram on page 7](#). The diagram shows a superset of features available on the family, which vary by OPN. For more information about specific device features, consult [Ordering Information](#).

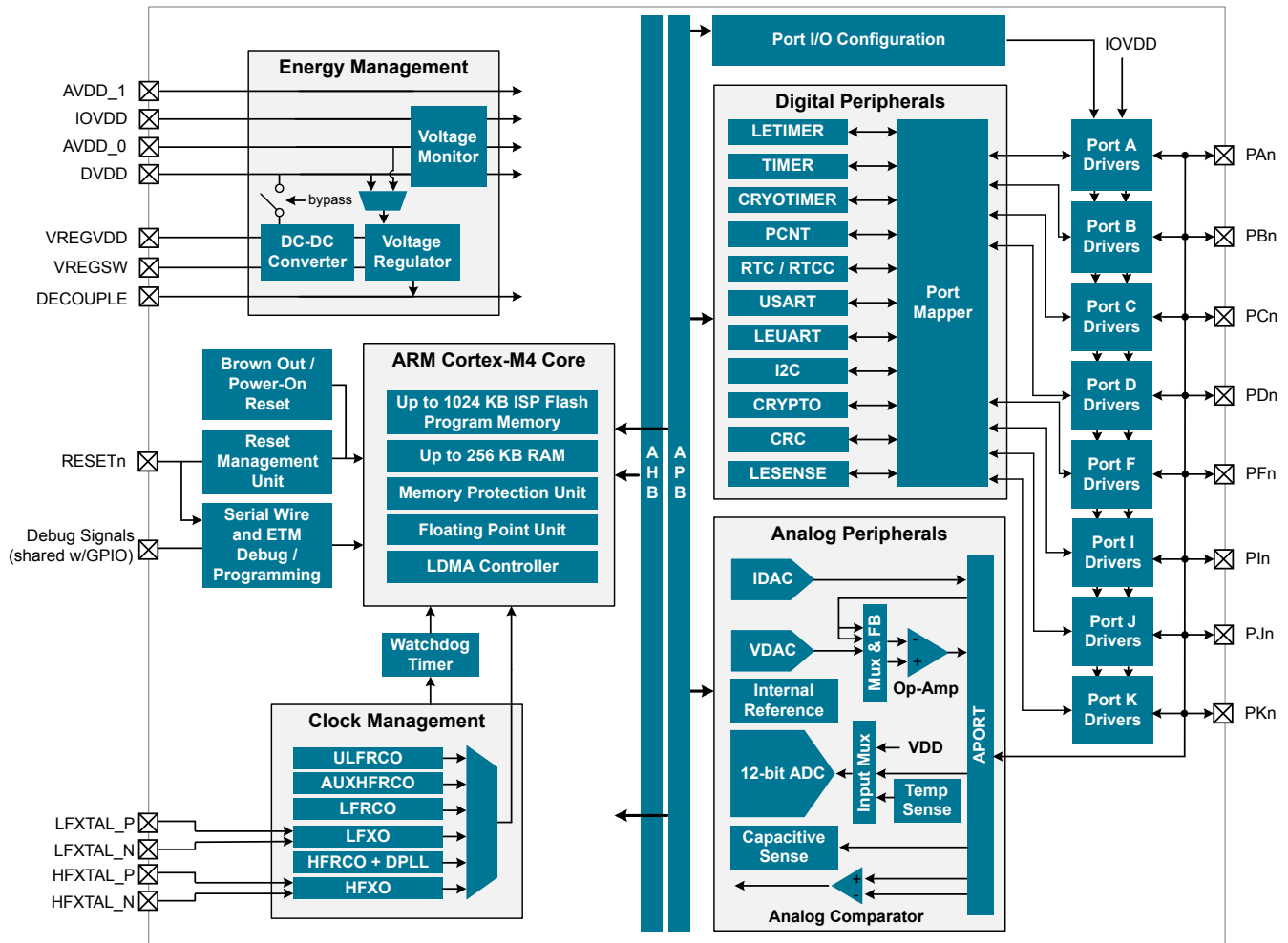


Figure 3.1. Detailed EFM32PG12 Block Diagram

## 3.2 Power

The EFM32PG12 has an Energy Management Unit (EMU) and efficient integrated regulators to generate internal supply voltages. Only a single external supply voltage is required, from which all internal voltages are created. An optional integrated DC-DC buck regulator can be utilized to further reduce the current consumption. The DC-DC regulator requires one external inductor and one external capacitor.

The EFM32PG12 device family includes support for internal supply voltage scaling, as well as two different power domains groups for peripherals. These enhancements allow for further supply current reductions and lower overall power consumption.

AVDD and VREGVDD need to be 1.8 V or higher for the MCU to operate across all conditions; however the rest of the system will operate down to 1.62 V, including the digital supply and I/O. This means that the device is fully compatible with 1.8 V components. Running from a sufficiently high supply, the device can use the DC-DC to regulate voltage not only for itself, but also for other PCB components, supplying up to a total of 200 mA.

### 3.2.1 Energy Management Unit (EMU)

The Energy Management Unit manages transitions of energy modes in the device. Each energy mode defines which peripherals and features are available and the amount of current the device consumes. The EMU can also be used to turn off the power to unused RAM blocks, and it contains control registers for the DC-DC regulator and the Voltage Monitor (VMON). The VMON is used to monitor multiple supply voltages. It has multiple channels which can be programmed individually by the user to determine if a sensed supply has fallen below a chosen threshold.

### 3.2.2 DC-DC Converter

The DC-DC buck converter covers a wide range of load currents and provides up to 90% efficiency in energy modes EM0, EM1, EM2 and EM3, and can supply up to 200 mA to the device and surrounding PCB components. Protection features include programmable current limiting, short-circuit protection, and dead-time protection. The DC-DC converter may also enter bypass mode when the input voltage is too low for efficient operation. In bypass mode, the DC-DC input supply is internally connected directly to its output through a low resistance switch. Bypass mode also supports in-rush current limiting to prevent input supply voltage droops due to excessive output current transients.

### 3.2.3 Power Domains

The EFM32PG12 has two peripheral power domains for operation in EM2 and lower. If all of the peripherals in a peripheral power domain are configured as unused, the power domain for that group will be powered off in the low-power mode, reducing the overall current consumption of the device.

**Table 3.1. Peripheral Power Subdomains**

Peripheral Power Domain 1	Peripheral Power Domain 2
ACMP0	ACMP1
PCNT0	PCNT1
ADC0	PCNT2
LETIMER0	CSEN
LESENSE	DAC0
APOINT	LEUART0
-	I2C0
-	I2C1
-	IDAC

### 3.3 General Purpose Input/Output (GPIO)

EFM32PG12 has up to 65 General Purpose Input/Output pins. Each GPIO pin can be individually configured as either an output or input. More advanced configurations including open-drain, open-source, and glitch-filtering can be configured for each individual GPIO pin. The GPIO pins can be overridden by peripheral connections, like SPI communication. Each peripheral connection can be routed to several GPIO pins on the device. The input value of a GPIO pin can be routed through the Peripheral Reflex System to other peripherals. The GPIO subsystem supports asynchronous external pin interrupts.

### 3.4 Clocking

#### 3.4.1 Clock Management Unit (CMU)

The Clock Management Unit controls oscillators and clocks in the EFM32PG12. Individual enabling and disabling of clocks to all peripherals is performed by the CMU. The CMU also controls enabling and configuration of the oscillators. A high degree of flexibility allows software to optimize energy consumption in any specific application by minimizing power dissipation in unused peripherals and oscillators.

#### 3.4.2 Internal and External Oscillators

The EFM32PG12 supports two crystal oscillators and fully integrates four RC oscillators, listed below.

- A high frequency crystal oscillator (HFXO) with integrated load capacitors, tunable in small steps, provides a precise timing reference for the MCU. Crystal frequencies in the range from 38 to 40 MHz are supported. An external clock source such as a TCXO can also be applied to the HFXO input for improved accuracy over temperature.
- A 32.768 kHz crystal oscillator (LFXO) provides an accurate timing reference for low energy modes.
- An integrated high frequency RC oscillator (HFRCO) is available for the MCU system. The HFRCO employs fast startup at minimal energy consumption combined with a wide frequency range. When crystal accuracy is not required, it can be operated in free-running mode at a number of factory-calibrated frequencies. A digital phase-locked loop (DPLL) feature allows the HFRCO to achieve higher accuracy and stability by referencing other available clock sources such as LFXO and HFXO.
- An integrated auxiliary high frequency RC oscillator (AUXHFRCO) is available for timing the general-purpose ADC and the Serial Wire Viewer port with a wide frequency range.
- An integrated low frequency 32.768 kHz RC oscillator (LFRCO) can be used as a timing reference in low energy modes, when crystal accuracy is not required.
- An integrated ultra-low frequency 1 kHz RC oscillator (ULFRCO) is available to provide a timing reference at the lowest energy consumption in low energy modes.

### 3.5 Counters/Timers and PWM

#### 3.5.1 Timer/Counter (TIMER)

TIMER peripherals keep track of timing, count events, generate PWM outputs and trigger timed actions in other peripherals through the PRS system. The core of each TIMER is a 16-bit counter with up to 4 compare/capture channels. Each channel is configurable in one of three modes. In capture mode, the counter state is stored in a buffer at a selected input event. In compare mode, the channel output reflects the comparison of the counter to a programmed threshold value. In PWM mode, the TIMER supports generation of pulse-width modulation (PWM) outputs of arbitrary waveforms defined by the sequence of values written to the compare registers, with optional dead-time insertion available in timer unit TIMER\_0 only.

#### 3.5.2 Wide Timer/Counter (WTIMER)

WTIMER peripherals function just as TIMER peripherals, but are 32 bits wide. They keep track of timing, count events, generate PWM outputs and trigger timed actions in other peripherals through the PRS system. The core of each WTIMER is a 32-bit counter with up to 4 compare/capture channels. Each channel is configurable in one of three modes. In capture mode, the counter state is stored in a buffer at a selected input event. In compare mode, the channel output reflects the comparison of the counter to a programmed threshold value. In PWM mode, the WTIMER supports generation of pulse-width modulation (PWM) outputs of arbitrary waveforms defined by the sequence of values written to the compare registers, with optional dead-time insertion available in timer unit WTIMER\_0 only.

#### 3.5.3 Real Time Counter and Calendar (RTCC)

The Real Time Counter and Calendar (RTCC) is a 32-bit counter providing timekeeping in all energy modes. The RTCC includes a Binary Coded Decimal (BCD) calendar mode for easy time and date keeping. The RTCC can be clocked by any of the on-board oscillators with the exception of the AUXHFRCO, and it is capable of providing system wake-up at user defined instances. The RTCC includes 128 bytes of general purpose data retention, allowing easy and convenient data storage in all energy modes down to EM4H.

### 3.5.4 Low Energy Timer (LETIMER)

The unique LETIMER is a 16-bit timer that is available in energy mode EM0 Active, EM1 Sleep, EM2 Deep Sleep, and EM3 Stop. This allows it to be used for timing and output generation when most of the device is powered down, allowing simple tasks to be performed while the power consumption of the system is kept at an absolute minimum. The LETIMER can be used to output a variety of waveforms with minimal software intervention. The LETIMER is connected to the Real Time Counter and Calendar (RTCC), and can be configured to start counting on compare matches from the RTCC.

### 3.5.5 Ultra Low Power Wake-up Timer (CRYOTIMER)

The CRYOTIMER is a 32-bit counter that is capable of running in all energy modes. It can be clocked by either the 32.768 kHz crystal oscillator (LFXO), the 32.768 kHz RC oscillator (LFRCO), or the 1 kHz RC oscillator (ULFRCO). It can provide periodic Wakeup events and PRS signals which can be used to wake up peripherals from any energy mode. The CRYOTIMER provides a wide range of interrupt periods, facilitating flexible ultra-low energy operation.

### 3.5.6 Pulse Counter (PCNT)

The Pulse Counter (PCNT) peripheral can be used for counting pulses on a single input or to decode quadrature encoded inputs. The clock for PCNT is selectable from either an external source on pin PCTNn\_S0IN or from an internal timing reference, selectable from among any of the internal oscillators, except the AUXHFRCO. The peripheral may operate in energy mode EM0 Active, EM1 Sleep, EM2 Deep Sleep, and EM3 Stop.

### 3.5.7 Watchdog Timer (WDOG)

The watchdog timer can act both as an independent watchdog or as a watchdog synchronous with the CPU clock. It has windowed monitoring capabilities, and can generate a reset or different interrupts depending on the failure mode of the system. The watchdog can also monitor autonomous systems driven by PRS.

## 3.6 Communications and Other Digital Peripherals

### 3.6.1 Universal Synchronous/Asynchronous Receiver/Transmitter (USART)

The Universal Synchronous/Asynchronous Receiver/Transmitter is a flexible serial I/O interface. It supports full duplex asynchronous UART communication with hardware flow control as well as RS-485, SPI, MicroWire and 3-wire. It can also interface with devices supporting:

- ISO7816 SmartCards
- IrDA
- I<sup>2</sup>S

### 3.6.2 Low Energy Universal Asynchronous Receiver/Transmitter (LEUART)

The unique LEUART<sup>TM</sup> provides two-way UART communication on a strict power budget. Only a 32.768 kHz clock is needed to allow UART communication up to 9600 baud. The LEUART includes all necessary hardware to make asynchronous serial communication possible with a minimum of software intervention and energy consumption.

### 3.6.3 Inter-Integrated Circuit Interface (I<sup>2</sup>C)

The I<sup>2</sup>C interface enables communication between the MCU and a serial I<sup>2</sup>C bus. It is capable of acting as both a master and a slave and supports multi-master buses. Standard-mode, fast-mode and fast-mode plus speeds are supported, allowing transmission rates from 10 kbit/s up to 1 Mbit/s. Slave arbitration and timeouts are also available, allowing implementation of an SMBus-compliant system. The interface provided to software by the I<sup>2</sup>C peripheral allows precise timing control of the transmission process and highly automated transfers. Automatic recognition of slave addresses is provided in active and low energy modes.

### 3.6.4 Peripheral Reflex System (PRS)

The Peripheral Reflex System provides a communication network between different peripherals without software involvement. Peripherals producing Reflex signals are called producers. The PRS routes Reflex signals from producers to consumer peripherals, which in turn perform actions in response. Edge triggers and other functionality such as simple logic operations (AND, OR, NOT) can be applied by the PRS to the signals. The PRS allows peripheral to act autonomously without waking the MCU core, saving power.

### 3.6.5 Low Energy Sensor Interface (LESENSE)

The Low Energy Sensor Interface LESENSE™ is a highly configurable sensor interface with support for up to 16 individually configurable sensors. By controlling the analog comparators, ADC, and DAC, LESENSE is capable of supporting a wide range of sensors and measurement schemes, and can for instance measure LC sensors, resistive sensors and capacitive sensors. LESENSE also includes a programmable finite state machine which enables simple processing of measurement results without CPU intervention. LESENSE is available in energy mode EM2, in addition to EM0 and EM1, making it ideal for sensor monitoring in applications with a strict energy budget.

## 3.7 Security Features

### 3.7.1 General Purpose Cyclic Redundancy Check (GPCRC)

The GPCRC block implements a Cyclic Redundancy Check (CRC) function. It supports both 32-bit and 16-bit polynomials. The supported 32-bit polynomial is 0x04C11DB7 (IEEE 802.3), while the 16-bit polynomial can be programmed to any value, depending on the needs of the application.

### 3.7.2 Crypto Accelerator (CRYPTO)

The Crypto Accelerator is a fast and energy-efficient autonomous hardware encryption and decryption accelerator. EFM32PG12 devices support AES encryption and decryption with 128- or 256-bit keys, ECC over both GF(P) and GF(2<sup>m</sup>), and SHA-1 and SHA-2 (SHA-224 and SHA-256).

Supported block cipher modes of operation for AES include: ECB, CTR, CBC, PCBC, CFB, OFB, GCM, CBC-MAC, GMAC and CCM.

Supported ECC NIST recommended curves include P-192, P-224, P-256, K-163, K-233, B-163 and B-233.

The CRYPTO peripheral allows fast processing of GCM (AES), ECC and SHA with little CPU intervention. CRYPTO also provides trigger signals for DMA read and write operations.

### 3.7.3 True Random Number Generator (TRNG)

The TRNG is a non-deterministic random number generator based on a full hardware solution. The TRNG is validated with NIST800-22 and AIS-31 test suites as well as being suitable for FIPS 140-2 certification (for the purposes of cryptographic key generation).

**Note:** TRNG operation is only supported at VSCALE2. TRNG cannot be used at VSCALE0.

### 3.7.4 Security Management Unit (SMU)

The Security Management Unit (SMU) allows software to set up fine-grained security for peripheral access, which is not possible in the Memory Protection Unit (MPU). Peripherals may be secured by hardware on an individual basis, such that only privileged accesses to the peripheral's register interface will be allowed. When an access fault occurs, the SMU reports the specific peripheral involved and can optionally generate an interrupt.

## 3.8 Analog

### 3.8.1 Analog Port (APORT)

The Analog Port (APORT) is an analog interconnect matrix allowing access to many analog peripherals on a flexible selection of pins. Each APORT bus consists of analog switches connected to a common wire. Since many clients can operate differentially, buses are grouped by X/Y pairs.

### 3.8.2 Analog Comparator (ACMP)

The Analog Comparator is used to compare the voltage of two analog inputs, with a digital output indicating which input voltage is higher. Inputs are selected from among internal references and external pins. The tradeoff between response time and current consumption is configurable by software. Two 6-bit reference dividers allow for a wide range of internally-programmable reference sources. The ACMP can also be used to monitor the supply voltage. An interrupt can be generated when the supply falls below or rises above the programmable threshold.

### 3.8.3 Analog to Digital Converter (ADC)

The ADC is a Successive Approximation Register (SAR) architecture, with a resolution of up to 12 bits at up to 1 Msps. The output sample resolution is configurable and additional resolution is possible using integrated hardware for averaging over multiple samples. The ADC includes integrated voltage references and an integrated temperature sensor. Inputs are selectable from a wide range of sources, including pins configurable as either single-ended or differential.

### 3.8.4 Capacitive Sense (CSEN)

The CSEN peripheral is a dedicated Capacitive Sensing block for implementing touch-sensitive user interface elements such as switches and sliders. The CSEN peripheral uses a charge ramping measurement technique, which provides robust sensing even in adverse conditions including radiated noise and moisture. The peripheral can be configured to take measurements on a single port pin or scan through multiple pins and store results to memory through DMA. Several channels can also be shorted together to measure the combined capacitance or implement wake-on-touch from very low energy modes. Hardware includes a digital accumulator and an averaging filter, as well as digital threshold comparators to reduce software overhead.

### 3.8.5 Digital to Analog Current Converter (IDAC)

The IDAC can source or sink a configurable constant current. This current can be driven on an output pin or routed to the selected ADC input pin for capacitive sensing. The full-scale current is programmable between 0.05  $\mu\text{A}$  and 64  $\mu\text{A}$  with several ranges consisting of various step sizes.

### 3.8.6 Digital to Analog Converter (VDAC)

The Digital to Analog Converter (VDAC) can convert a digital value to an analog output voltage. The VDAC is a fully differential, 500 kbps, 12-bit converter. The opamps are used in conjunction with the VDAC, to provide output buffering. One opamp is used per single-ended channel, or two opamps are used to provide differential outputs. The VDAC may be used for a number of different applications such as sensor interfaces or sound output. The VDAC can generate high-resolution analog signals while the MCU is operating at low frequencies and with low total power consumption. Using DMA and a timer, the VDAC can be used to generate waveforms without any CPU intervention. The VDAC is available in all energy modes down to and including EM3.

### 3.8.7 Operational Amplifiers

The opamps are low power amplifiers with a high degree of flexibility targeting a wide variety of standard opamp application areas, and are available down to EM3. With flexible built-in programming for gain and interconnection they can be configured to support multiple common opamp functions. All pins are also available externally for filter configurations. Each opamp has a rail to rail input and a rail to rail output. They can be used in conjunction with the VDAC peripheral or in stand-alone configurations. The opamps save energy, PCB space, and cost as compared with standalone opamps because they are integrated on-chip.

## 3.9 Reset Management Unit (RMU)

The RMU is responsible for handling reset of the EFM32PG12. A wide range of reset sources are available, including several power supply monitors, pin reset, software controlled reset, core lockup reset, and watchdog reset.

## 3.10 Core and Memory

### 3.10.1 Processor Core

The ARM Cortex-M processor includes a 32-bit RISC processor integrating the following features and tasks in the system:

- ARM Cortex-M4 RISC processor with FPU achieving 1.25 Dhrystone MIPS/MHz
- Memory Protection Unit (MPU) supporting up to 8 memory segments
- Embedded Trace Macrocell (ETM) for real-time trace and debug
- Up to 1024 kB flash program memory
  - Dual-bank memory with read-while-write support
- Up to 256 kB RAM data memory
- Configuration and event handling of all modules
- 2-pin Serial-Wire or 4-pin JTAG debug interface

### 3.10.2 Memory System Controller (MSC)

The Memory System Controller (MSC) is the program memory unit of the microcontroller. The flash memory is readable and writable from both the Cortex-M and DMA. The flash memory is divided into two blocks; the main block and the information block. Program code is normally written to the main block, whereas the information block is available for special user data and flash lock bits. There is also a read-only page in the information block containing system and device calibration data. Read and write operations are supported in energy modes EM0 Active and EM1 Sleep.

### 3.10.3 Linked Direct Memory Access Controller (LDMA)

The Linked Direct Memory Access (LDMA) controller allows the system to perform memory operations independently of software. This reduces both energy consumption and software workload. The LDMA allows operations to be linked together and staged, enabling sophisticated operations to be implemented.

### 3.10.4 Bootloader

All devices come pre-programmed with a UART bootloader. This bootloader resides in flash and can be erased if it is not needed. More information about the bootloader protocol and usage can be found in *AN0003: UART Bootloader*. Application notes can be found on the Silicon Labs website ([www.silabs.com/32bit-appnotes](http://www.silabs.com/32bit-appnotes)) or within Simplicity Studio in the **[Documentation]** area.

### 3.11 Memory Map

The EFM32PG12 memory map is shown in the figures below. RAM and flash sizes are for the largest memory configuration.

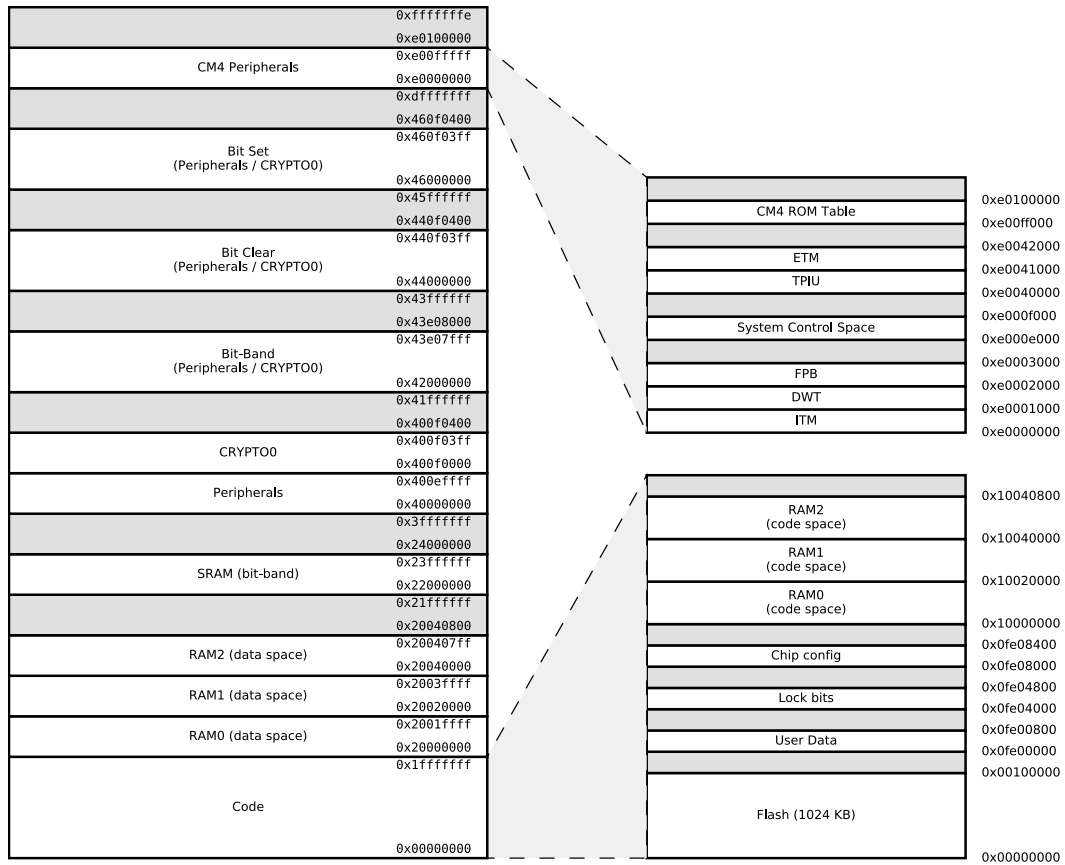


Figure 3.2. EFM32PG12 Memory Map — Core Peripherals and Code Space

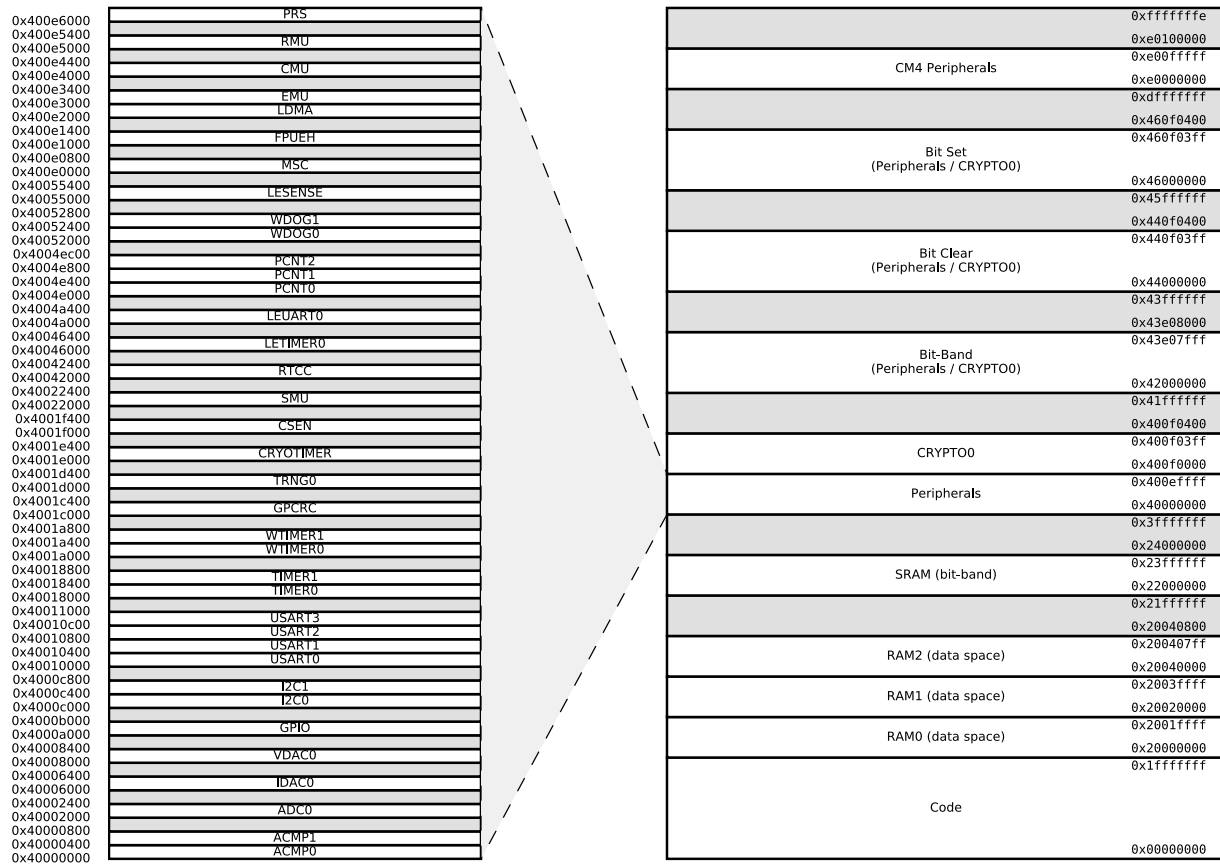


Figure 3.3. EFM32PG12 Memory Map — Peripherals

### 3.12 Configuration Summary

The features of the EFM32PG12 are a subset of the feature set described in the device reference manual. The table below describes device specific implementation of the features. Remaining modules support full configuration.

**Table 3.2. Configuration Summary**

Module	Configuration	Pin Connections
USART0	IrDA SmartCard	US0_TX, US0_RX, US0_CLK, US0_CS
USART1	I <sup>2</sup> S SmartCard	US1_TX, US1_RX, US1_CLK, US1_CS
USART2	IrDA SmartCard	US2_TX, US2_RX, US2_CLK, US2_CS
USART3	I <sup>2</sup> S SmartCard	US3_TX, US3_RX, US3_CLK, US3_CS
TIMER0	with DTI	TIM0_CC[2:0], TIM0_CDTI[2:0]
TIMER1	-	TIM1_CC[3:0]
WTIMER0	with DTI	WTIM0_CC[2:0], WTIM0_CDTI[2:0]
WTIMER1	-	WTIM1_CC[3:0]

## 4. Electrical Specifications

### 4.1 Electrical Characteristics

All electrical parameters in all tables are specified under the following conditions, unless stated otherwise:

- Typical values are based on  $T_{AMB}=25\text{ }^{\circ}\text{C}$  and  $V_{DD}=3.3\text{ V}$ , by production test and/or technology characterization.
- Minimum and maximum values represent the worst conditions across supply voltage, process variation, and operating temperature, unless stated otherwise.

Refer to [4.1.2.1 General Operating Conditions](#) for more details about operational supply and temperature limits.

#### 4.1.1 Absolute Maximum Ratings

Stresses above those listed below may cause permanent damage to the device. This is a stress rating only and functional operation of the devices at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability. For more information on the available quality and reliability data, see the Quality and Reliability Monitor Report at <http://www.silabs.com/support/quality/pages/default.aspx>.

**Table 4.1. Absolute Maximum Ratings**

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Storage temperature range	$T_{STG}$		-50	—	150	$^{\circ}\text{C}$
Voltage on any supply pin	$V_{DDMAX}$		-0.3	—	3.8	V
Voltage ramp rate on any supply pin	$V_{DDRAMPMAX}$		—	—	1	V / $\mu\text{s}$
DC voltage on any GPIO pin	$V_{DIGPIN}$	5V tolerant GPIO pins <sup>1 2 3</sup>	-0.3	—	Min of 5.25 and IOVDD +2	V
		Standard GPIO pins	-0.3	—	IOVDD+0.3	V
Voltage on HFXO pins	$V_{HFXOPIN}$		-0.3	—	1.4	V
Total current into VDD power lines	$I_{VDDMAX}$	Source	—	—	200	mA
Total current into VSS ground lines	$I_{VSSMAX}$	Sink	—	—	200	mA
Current per I/O pin	$I_{IOMAX}$	Sink	—	—	50	mA
		Source	—	—	50	mA
Current for all I/O pins	$I_{IOALLMAX}$	Sink	—	—	200	mA
		Source	—	—	200	mA
Junction temperature	$T_J$	-G grade devices	-40	—	105	$^{\circ}\text{C}$
		-I grade devices	-40	—	125	$^{\circ}\text{C}$

**Note:**

1. When a GPIO pin is routed to the analog module through the APORT, the maximum voltage = IOVDD.
2. Valid for IOVDD in valid operating range or when IOVDD is undriven (high-Z). If IOVDD is connected to a low-impedance source below the valid operating range (e.g. IOVDD shorted to VSS), the pin voltage maximum is IOVDD + 0.3 V, to avoid exceeding the maximum IO current specifications.
3. To operate above the IOVDD supply rail, over-voltage tolerance must be enabled according to the GPIO\_Px\_OVTDIS register. Pins with over-voltage tolerance disabled have the same limits as Standard GPIO.

#### 4.1.2 Operating Conditions

When assigning supply sources, the following requirements must be observed:

- VREGVDD must be greater than or equal to AVDD, DVDD and all IOVDD supplies.
- VREGVDD = AVDD
- DVDD  $\leq$  AVDD
- IOVDD  $\leq$  AVDD

## 4.1.2.1 General Operating Conditions

Table 4.2. General Operating Conditions

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Operating ambient temperature range <sup>6</sup>	T <sub>A</sub>	-G temperature grade	-40	25	85	°C
		-I temperature grade	-40	25	125	°C
AVDD supply voltage <sup>2</sup>	V <sub>AVDD</sub>		1.8	3.3	3.8	V
VREGVDD operating supply voltage <sup>2 1</sup>	V <sub>VREGVDD</sub>	DCDC in regulation	2.4	3.3	3.8	V
		DCDC in bypass, 50mA load	1.8	3.3	3.8	V
		DCDC not in use. DVDD externally shorted to VREGVDD	1.8	3.3	3.8	V
VREGVDD current	I <sub>VREGVDD</sub>	DCDC in bypass, T ≤ 85 °C	—	—	200	mA
		DCDC in bypass, T > 85 °C	—	—	100	mA
DVDD operating supply voltage	V <sub>DVDD</sub>		1.62	—	V <sub>VREGVDD</sub>	V
IOVDD operating supply voltage	V <sub>IOVDD</sub>	All IOVDD pins <sup>5</sup>	1.62	—	V <sub>VREGVDD</sub>	V
DECOUPLE output capacitor <sup>3 4</sup>	C <sub>DECOUPLE</sub>		0.75	1.0	2.75	μF
Difference between AVDD and VREGVDD, ABS(AVDD-VREGVDD) <sup>2</sup>	dV <sub>DD</sub>		—	—	0.1	V
HFCORECLK frequency	f <sub>CORE</sub>	VSCALE2, MODE = WS1	—	—	40	MHz
		VSCALE0, MODE = WS0	—	—	20	MHz
HFCLK frequency	f <sub>HFCLK</sub>	VSCALE2	—	—	40	MHz
		VSCALE0	—	—	20	MHz
HFSRCCLK frequency	f <sub>HFSRCCLK</sub>	VSCALE2	—	—	40	MHz
		VSCALE0	—	—	20	MHz

**Note:**

- The minimum voltage required in bypass mode is calculated using R<sub>BYP</sub> from the DCDC specification table. Requirements for other loads can be calculated as V<sub>DVDD\_min</sub> + I<sub>LOAD</sub> \* R<sub>BYP\_max</sub>.
- VREGVDD must be tied to AVDD. Both VREGVDD and AVDD minimum voltages must be satisfied for the part to operate.
- The system designer should consult the characteristic specs of the capacitor used on DECOUPLE to ensure its capacitance value stays within the specified bounds across temperature and DC bias.
- VSCALE0 to VSCALE2 voltage change transitions occur at a rate of 10 mV / usec for approximately 20 usec. During this transition, peak currents will be dependent on the value of the DECOUPLE output capacitor, from 35 mA (with a 1 μF capacitor) to 70 mA (with a 2.7 μF capacitor).
- When the CSEN peripheral is used with chopping enabled (CSEN\_CTRL\_CHOPEN = ENABLE), IOVDD must be equal to AVDD.
- The maximum limit on T<sub>A</sub> may be lower due to device self-heating, which depends on the power dissipation of the specific application. T<sub>A</sub> (max) = T<sub>J</sub> (max) - (THETA<sub>JA</sub> x PowerDissipation). Refer to the Absolute Maximum Ratings table and the Thermal Characteristics table for T<sub>J</sub> and THETA<sub>JA</sub>.

## 4.1.3 Thermal Characteristics

Table 4.3. Thermal Characteristics

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Thermal Resistance	THETA <sub>JA</sub>	QFN48 Package, 2-Layer PCB, Air velocity = 0 m/s	—	75.7	—	°C/W
		QFN48 Package, 2-Layer PCB, Air velocity = 1 m/s	—	61.5	—	°C/W
		QFN48 Package, 2-Layer PCB, Air velocity = 2 m/s	—	55.4	—	°C/W
		QFN48 Package, 4-Layer PCB, Air velocity = 0 m/s	—	30.2	—	°C/W
		QFN48 Package, 4-Layer PCB, Air velocity = 1 m/s	—	26.3	—	°C/W
		QFN48 Package, 4-Layer PCB, Air velocity = 2 m/s	—	24.9	—	°C/W
		BGA125 Package, 2-Layer PCB, Air velocity = 0 m/s	—	90.7	—	°C/W
		BGA125 Package, 2-Layer PCB, Air velocity = 1 m/s	—	73.7	—	°C/W
		BGA125 Package, 2-Layer PCB, Air velocity = 2 m/s	—	66.4	—	°C/W
		BGA125 Package, 4-Layer PCB, Air velocity = 0 m/s	—	45	—	°C/W
		BGA125 Package, 4-Layer PCB, Air velocity = 1 m/s	—	39.6	—	°C/W
		BGA125 Package, 4-Layer PCB, Air velocity = 2 m/s	—	37.6	—	°C/W

## 4.1.4 DC-DC Converter

Test conditions: L\_DCDC=4.7  $\mu$ H (Murata LQH3NPN4R7MM0L), C\_DCDC=4.7  $\mu$ F (Samsung CL10B475KQ8NQNC), V\_DCDC\_I=3.3 V, V\_DCDC\_O=1.8 V, I\_DCDC\_LOAD=50 mA, Heavy Drive configuration, F\_DCDC\_LN=7 MHz, unless otherwise indicated.

Table 4.4. DC-DC Converter

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Input voltage range	V <sub>DCDC_I</sub>	Bypass mode, I <sub>DCDC_LOAD</sub> = 50 mA	1.8	—	V <sub>VREGVDD_MAX</sub>	V
		Low noise (LN) mode, 1.8 V output, I <sub>DCDC_LOAD</sub> = 100 mA, or Low power (LP) mode, 1.8 V output, I <sub>DCDC_LOAD</sub> = 10 mA	2.4	—	V <sub>VREGVDD_MAX</sub>	V
		Low noise (LN) mode, 1.8 V output, I <sub>DCDC_LOAD</sub> = 200 mA	2.6	—	V <sub>VREGVDD_MAX</sub>	V
Output voltage programmable range <sup>1</sup>	V <sub>DCDC_O</sub>		1.8	—	V <sub>VREGVDD</sub>	V
Regulation DC accuracy	ACC <sub>DC</sub>	Low Noise (LN) mode, 1.8 V target output	1.7	—	1.9	V
Regulation window <sup>4</sup>	WIN <sub>REG</sub>	Low Power (LP) mode, LPCMPBIASEM <sub>xx</sub> <sup>3</sup> = 0, 1.8 V target output, I <sub>DCDC_LOAD</sub> $\leq$ 75 $\mu$ A	1.63	—	2.2	V
		Low Power (LP) mode, LPCMPBIASEM <sub>xx</sub> <sup>3</sup> = 3, 1.8 V target output, I <sub>DCDC_LOAD</sub> $\leq$ 10 mA	1.63	—	2.1	V
Steady-state output ripple	V <sub>R</sub>		—	3	—	mV <sub>pp</sub>
Output voltage under/overshoot	V <sub>OV</sub>	CCM Mode (LNFORCECCM <sup>3</sup> = 1), Load changes between 0 mA and 100 mA	—	25	60	mV
		DCM Mode (LNFORCECCM <sup>3</sup> = 0), Load changes between 0 mA and 10 mA	—	45	90	mV
		Overshoot during LP to LN CCM/DCM mode transitions compared to DC level in LN mode	—	200	—	mV
		Undershoot during BYP/LP to LN CCM (LNFORCECCM <sup>3</sup> = 1) mode transitions compared to DC level in LN mode	—	40	—	mV
		Undershoot during BYP/LP to LN DCM (LNFORCECCM <sup>3</sup> = 0) mode transitions compared to DC level in LN mode	—	100	—	mV
DC line regulation	V <sub>REG</sub>	Input changes between V <sub>VREGVDD_MAX</sub> and 2.4 V	—	0.1	—	%
DC load regulation	I <sub>REG</sub>	Load changes between 0 mA and 100 mA in CCM mode	—	0.1	—	%

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Max load current	I <sub>LOAD_MAX</sub>	Low noise (LN) mode, Heavy Drive <sup>2</sup> , T ≤ 85 °C	—	—	200	mA
		Low noise (LN) mode, Heavy Drive <sup>2</sup> , T > 85 °C	—	—	100	mA
		Low noise (LN) mode, Medium Drive <sup>2</sup>	—	—	100	mA
		Low noise (LN) mode, Light Drive <sup>2</sup>	—	—	50	mA
		Low power (LP) mode, LPCMPBIASEMxx <sup>3</sup> = 0	—	—	75	μA
		Low power (LP) mode, LPCMPBIASEMxx <sup>3</sup> = 3	—	—	10	mA
DCDC nominal output capacitor <sup>5</sup>	C <sub>DCDC</sub>	25% tolerance	1	4.7	4.7	μF
DCDC nominal output inductor	L <sub>DCDC</sub>	20% tolerance	4.7	4.7	4.7	μH
Resistance in Bypass mode	R <sub>BYP</sub>		—	1.2	2.5	Ω

**Note:**

1. Due to internal dropout, the DC-DC output will never be able to reach its input voltage, V<sub>VREGVDD</sub>.
2. Drive levels are defined by configuration of the PFETCNT and NFETCNT registers. Light Drive: PFETCNT=NFETCNT=3; Medium Drive: PFETCNT=NFETCNT=7; Heavy Drive: PFETCNT=NFETCNT=15.
3. LPCMPBIASEMxx refers to either LPCMPBIASEM234H in the EMU\_DCDCMISCCTRL register or LPCMPBIASEM01 in the EMU\_DCDCLOEM01CFG register, depending on the energy mode.
4. LP mode controller is a hysteretic controller that maintains the output voltage within the specified limits.
5. Output voltage under/over-shoot and regulation are specified with C<sub>DCDC</sub> 4.7 μF. Different settings for DCDCLNCOMPCTRL must be used if C<sub>DCDC</sub> is lower than 4.7 μF. See Application Note AN0948 for details.

## 4.1.5 Current Consumption

### 4.1.5.1 Current Consumption 3.3 V without DC-DC Converter

Unless otherwise indicated, typical conditions are: VREGVDD = AVDD = DVDD = 3.3 V. T = 25 °C. DCDC is off. Minimum and maximum values in this table represent the worst conditions across supply voltage and process variation at T = 25 °C.

**Table 4.5. Current Consumption 3.3 V without DC-DC Converter**

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Current consumption in EM0 mode with all peripherals disabled	I <sub>ACTIVE</sub>	38.4 MHz crystal, CPU running while loop from flash <sup>1</sup>	—	126	—	μA/MHz
		38 MHz HFRCO, CPU running Prime from flash	—	99	—	μA/MHz
		38 MHz HFRCO, CPU running while loop from flash	—	99	105	μA/MHz
		38 MHz HFRCO, CPU running CoreMark from flash	—	124	—	μA/MHz
		26 MHz HFRCO, CPU running while loop from flash	—	102	108	μA/MHz
		1 MHz HFRCO, CPU running while loop from flash	—	280	435	μA/MHz
Current consumption in EM0 mode with all peripherals disabled and voltage scaling enabled	I <sub>ACTIVE_VS</sub>	19 MHz HFRCO, CPU running while loop from flash	—	88	—	μA/MHz
		1 MHz HFRCO, CPU running while loop from flash	—	234	—	μA/MHz
Current consumption in EM1 mode with all peripherals disabled	I <sub>EM1</sub>	38.4 MHz crystal <sup>1</sup>	—	76	—	μA/MHz
		38 MHz HFRCO	—	50	54	μA/MHz
		26 MHz HFRCO	—	52	58	μA/MHz
		1 MHz HFRCO	—	230	400	μA/MHz
Current consumption in EM1 mode with all peripherals disabled and voltage scaling enabled	I <sub>EM1_VS</sub>	19 MHz HFRCO	—	47	—	μA/MHz
		1 MHz HFRCO	—	193	—	μA/MHz
Current consumption in EM2 mode, with voltage scaling enabled	I <sub>EM2_VS</sub>	Full 256 kB RAM retention and RTCC running from LFXO	—	2.9	—	μA
		Full 256 kB RAM retention and RTCC running from LFRCO	—	3.2	—	μA
		16 kB (1 bank) RAM retention and RTCC running from LFRCO <sup>2</sup>	—	2.1	3.5	μA
Current consumption in EM3 mode, with voltage scaling enabled	I <sub>EM3_VS</sub>	Full 256 kB RAM retention and CRYOTIMER running from ULFR-CO	—	2.56	4.8	μA
Current consumption in EM4H mode, with voltage scaling enabled	I <sub>EM4H_VS</sub>	128 byte RAM retention, RTCC running from LFXO	—	1.0	—	μA
		128 byte RAM retention, CRYO-TIMER running from ULFRCO	—	0.45	—	μA
		128 byte RAM retention, no RTCC	—	0.43	0.9	μA

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Current consumption in EM4S mode	$I_{EM4S}$	No RAM retention, no RTCC	—	0.04	0.1	$\mu\text{A}$

**Note:**

1. CMU\_HFXOCTRL\_LOWPOWER=1.
2. CMU\_LFRCOCTRL\_ENVREF = 1, CMU\_LFRCOCTRL\_VREFUPDATE = 1

## 4.1.5.2 Current Consumption 3.3 V using DC-DC Converter

Unless otherwise indicated, typical conditions are: VREGVDD = AVDD = IOVDD = 3.3 V, DVDD = 1.8 V DC-DC output. T = 25 °C. Minimum and maximum values in this table represent the worst conditions across supply voltage and process variation at T = 25 °C.

Table 4.6. Current Consumption 3.3 V using DC-DC Converter

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Current consumption in EM0 mode with all peripherals disabled, DCDC in Low Noise DCM mode <sup>2</sup>	I <sub>ACTIVE_DCM</sub>	38.4 MHz crystal, CPU running while loop from flash <sup>4</sup>	—	86	—	μA/MHz
		38 MHz HFRCO, CPU running Prime from flash	—	70	—	μA/MHz
		38 MHz HFRCO, CPU running while loop from flash	—	70	—	μA/MHz
		38 MHz HFRCO, CPU running CoreMark from flash	—	85	—	μA/MHz
		26 MHz HFRCO, CPU running while loop from flash	—	77	—	μA/MHz
		1 MHz HFRCO, CPU running while loop from flash	—	636	—	μA/MHz
Current consumption in EM0 mode with all peripherals disabled, DCDC in Low Noise CCM mode <sup>1</sup>	I <sub>ACTIVE_CCM</sub>	38.4 MHz crystal, CPU running while loop from flash <sup>4</sup>	—	96	—	μA/MHz
		38 MHz HFRCO, CPU running Prime from flash	—	81	—	μA/MHz
		38 MHz HFRCO, CPU running while loop from flash	—	82	—	μA/MHz
		38 MHz HFRCO, CPU running CoreMark from flash	—	95	—	μA/MHz
		26 MHz HFRCO, CPU running while loop from flash	—	95	—	μA/MHz
		1 MHz HFRCO, CPU running while loop from flash	—	1155	—	μA/MHz
Current consumption in EM0 mode with all peripherals disabled, DCDC in LP mode <sup>3</sup>	I <sub>ACTIVE_LPM</sub>	38.4 MHz crystal, CPU running while loop from flash <sup>4</sup>	—	80	—	μA/MHz
		38 MHz HFRCO, CPU running Prime from flash	—	64	—	μA/MHz
		38 MHz HFRCO, CPU running while loop from flash	—	64	—	μA/MHz
		38 MHz HFRCO, CPU running CoreMark from flash	—	79	—	μA/MHz
		26 MHz HFRCO, CPU running while loop from flash	—	66	—	μA/MHz
		1 MHz HFRCO, CPU running while loop from flash	—	224	—	μA/MHz
Current consumption in EM0 mode with all peripherals disabled and voltage scaling enabled, DCDC in Low Noise CCM mode <sup>1</sup>	I <sub>ACTIVE_CCM_VS</sub>	19 MHz HFRCO, CPU running while loop from flash	—	101	—	μA/MHz
		1 MHz HFRCO, CPU running while loop from flash	—	1128	—	μA/MHz

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Current consumption in EM0 mode with all peripherals disabled and voltage scaling enabled, DCDC in LP mode <sup>3</sup>	I <sub>ACTIVE_LPM_VS</sub>	19 MHz HFRCO, CPU running while loop from flash	—	58	—	μA/MHz
		1 MHz HFRCO, CPU running while loop from flash	—	196	—	μA/MHz
Current consumption in EM1 mode with all peripherals disabled, DCDC in Low Noise DCM mode <sup>2</sup>	I <sub>EM1_DCM</sub>	38.4 MHz crystal <sup>4</sup>	—	56	—	μA/MHz
		38 MHz HFRCO	—	41	—	μA/MHz
		26 MHz HFRCO	—	48	—	μA/MHz
		1 MHz HFRCO	—	610	—	μA/MHz
Current consumption in EM1 mode with all peripherals disabled, DCDC in Low Power mode <sup>3</sup>	I <sub>EM1_LPM</sub>	38.4 MHz crystal <sup>4</sup>	—	49	—	μA/MHz
		38 MHz HFRCO	—	33	—	μA/MHz
		26 MHz HFRCO	—	35	—	μA/MHz
		1 MHz HFRCO	—	194	—	μA/MHz
Current consumption in EM1 mode with all peripherals disabled and voltage scaling enabled, DCDC in Low Noise DCM mode <sup>2</sup>	I <sub>EM1_DCM_VS</sub>	19 MHz HFRCO	—	52	—	μA/MHz
		1 MHz HFRCO	—	587	—	μA/MHz
Current consumption in EM1 mode with all peripherals disabled and voltage scaling enabled. DCDC in LP mode <sup>3</sup>	I <sub>EM1_LPM_VS</sub>	19 MHz HFRCO	—	32	—	μA/MHz
		1 MHz HFRCO	—	170	—	μA/MHz
Current consumption in EM2 mode, with voltage scaling enabled, DCDC in LP mode <sup>3</sup>	I <sub>EM2_VS</sub>	Full 256 kB RAM retention and RTCC running from LFXO	—	2.1	—	μA
		Full 256 kB RAM retention and RTCC running from LFRCO	—	2.2	—	μA
		16 kB (1 bank) RAM retention and RTCC running from LFRCO <sup>5</sup>	—	1.5	—	μA
Current consumption in EM3 mode, with voltage scaling enabled	I <sub>EM3_VS</sub>	Full 256 kB RAM retention and CRYOTIMER running from ULFRCO	—	1.81	—	μA
Current consumption in EM4H mode, with voltage scaling enabled	I <sub>EM4H_VS</sub>	128 byte RAM retention, RTCC running from LFXO	—	0.69	—	μA
		128 byte RAM retention, CRYOTIMER running from ULFRCO	—	0.39	—	μA
		128 byte RAM retention, no RTCC	—	0.39	—	μA
Current consumption in EM4S mode	I <sub>EM4S</sub>	No RAM retention, no RTCC	—	0.06	—	μA

**Note:**

- DCDC Low Noise CCM Mode = Light Drive (PFETCNT=NFETCNT=3), F=6.4 MHz (RCOBAND=4), ANASW=DVDD.
- DCDC Low Noise DCM Mode = Light Drive (PFETCNT=NFETCNT=3), F=3.0 MHz (RCOBAND=0), ANASW=DVDD.
- DCDC Low Power Mode = Medium Drive (PFETCNT=NFETCNT=7), LPOSCDIV=1, LPCMPBIASEM234H=0, LPCLIMLIMSEL=1, ANASW=DVDD.
- CMU\_HFXOCTRL\_LOWPOWER=1.
- CMU\_LFRCOCTRL\_ENVREF = 1, CMU\_LFRCOCTRL\_VREFUPDATE = 1

**4.1.5.3 Current Consumption 1.8 V without DC-DC Converter**

Unless otherwise indicated, typical conditions are: VREGVDD = AVDD = DVDD = 1.8 V. T = 25 °C. DCDC is off. Minimum and maximum values in this table represent the worst conditions across supply voltage and process variation at T = 25 °C.

**Table 4.7. Current Consumption 1.8 V without DC-DC Converter**

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Current consumption in EM0 mode with all peripherals disabled	I <sub>ACTIVE</sub>	38.4 MHz crystal, CPU running while loop from flash <sup>1</sup>	—	126	—	μA/MHz
		38 MHz HFRCO, CPU running Prime from flash	—	99	—	μA/MHz
		38 MHz HFRCO, CPU running while loop from flash	—	99	—	μA/MHz
		38 MHz HFRCO, CPU running CoreMark from flash	—	124	—	μA/MHz
		26 MHz HFRCO, CPU running while loop from flash	—	102	—	μA/MHz
		1 MHz HFRCO, CPU running while loop from flash	—	277	—	μA/MHz
Current consumption in EM0 mode with all peripherals disabled and voltage scaling enabled	I <sub>ACTIVE_VS</sub>	19 MHz HFRCO, CPU running while loop from flash	—	87	—	μA/MHz
		1 MHz HFRCO, CPU running while loop from flash	—	231	—	μA/MHz
Current consumption in EM1 mode with all peripherals disabled	I <sub>EM1</sub>	38.4 MHz crystal <sup>1</sup>	—	76	—	μA/MHz
		38 MHz HFRCO	—	50	—	μA/MHz
		26 MHz HFRCO	—	52	—	μA/MHz
		1 MHz HFRCO	—	227	—	μA/MHz
Current consumption in EM1 mode with all peripherals disabled and voltage scaling enabled	I <sub>EM1_VS</sub>	19 MHz HFRCO	—	47	—	μA/MHz
		1 MHz HFRCO	—	190	—	μA/MHz
Current consumption in EM2 mode, with voltage scaling enabled	I <sub>EM2_VS</sub>	Full 256 kB RAM retention and RTCC running from LFXO	—	2.8	—	μA
		Full 256 kB RAM retention and RTCC running from LFRCO	—	3.0	—	μA
		16 kB (1 bank) RAM retention and RTCC running from LFRCO <sup>2</sup>	—	1.9	—	μA
Current consumption in EM3 mode, with voltage scaling enabled	I <sub>EM3_VS</sub>	Full 256 kB RAM retention and CRYOTIMER running from ULFR-CO	—	2.47	—	μA
Current consumption in EM4H mode, with voltage scaling enabled	I <sub>EM4H_VS</sub>	128 byte RAM retention, RTCC running from LFXO	—	0.91	—	μA
		128 byte RAM retention, CRYOTIMER running from ULFR-CO	—	0.35	—	μA
		128 byte RAM retention, no RTCC	—	0.35	—	μA
Current consumption in EM4S mode	I <sub>EM4S</sub>	No RAM retention, no RTCC	—	0.04	—	μA

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
<b>Note:</b>						
1. CMU_HFXOCTRL_LOWPOWER=1.						
2. CMU_LFRCOCTRL_ENVREF = 1, CMU_LFRCOCTRL_VREFUPDATE = 1						

#### 4.1.6 Wake Up Times

**Table 4.8. Wake Up Times**

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Wakeup time from EM1	$t_{EM1\_WU}$		—	3	—	AHB Clocks
Wake up from EM2	$t_{EM2\_WU}$	Code execution from flash	—	10.1	—	$\mu\text{s}$
		Code execution from RAM	—	3.2	—	$\mu\text{s}$
Wake up from EM3	$t_{EM3\_WU}$	Code execution from flash	—	10.1	—	$\mu\text{s}$
		Code execution from RAM	—	3.2	—	$\mu\text{s}$
Wake up from EM4H <sup>1</sup>	$t_{EM4H\_WU}$	Executing from flash	—	80	—	$\mu\text{s}$
Wake up from EM4S <sup>1</sup>	$t_{EM4S\_WU}$	Executing from flash	—	291	—	$\mu\text{s}$
Time from release of reset source to first instruction execution	$t_{RESET}$	Soft Pin Reset released	—	43	—	$\mu\text{s}$
		Any other reset released	—	350	—	$\mu\text{s}$
Power mode scaling time	$t_{SCALE}$	VSCALE0 to VSCALE2, HFCLK = 19 MHz <sup>4 2</sup>	—	31.8	—	$\mu\text{s}$
		VSCALE2 to VSCALE0, HFCLK = 19 MHz <sup>3</sup>	—	4.3	—	$\mu\text{s}$

**Note:**

1. Time from wakeup request until first instruction is executed. Wakeup results in device reset.
2. VSCALE0 to VSCALE2 voltage change transitions occur at a rate of 10 mV/ $\mu\text{s}$  for approximately 20  $\mu\text{s}$ . During this transition, peak currents will be dependent on the value of the DECOUPLE output capacitor, from 35 mA (with a 1  $\mu\text{F}$  capacitor) to 70 mA (with a 2.7  $\mu\text{F}$  capacitor).
3. Scaling down from VSCALE2 to VSCALE0 requires approximately 2.8  $\mu\text{s}$  + 29 HFCLKs.
4. Scaling up from VSCALE0 to VSCALE2 requires approximately 30.3  $\mu\text{s}$  + 28 HFCLKs.

## 4.1.7 Brown Out Detector (BOD)

Table 4.9. Brown Out Detector (BOD)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
DVDD BOD threshold	V <sub>DVddbOD</sub>	DVDD rising	—	—	1.62	V
		DVDD falling (EM0/EM1)	1.35	—	—	V
		DVDD falling (EM2/EM3)	1.3	—	—	V
DVDD BOD hysteresis	V <sub>DVddbOD_HYST</sub>		—	18	—	mV
DVDD BOD response time	t <sub>DVddbOD_DELAY</sub>	Supply drops at 0.1V/μs rate	—	2.4	—	μs
AVDD BOD threshold	V <sub>AVddbOD</sub>	AVDD rising	—	—	1.8	V
		AVDD falling (EM0/EM1)	1.62	—	—	V
		AVDD falling (EM2/EM3)	1.53	—	—	V
AVDD BOD hysteresis	V <sub>AVddbOD_HYST</sub>		—	20	—	mV
AVDD BOD response time	t <sub>AVddbOD_DELAY</sub>	Supply drops at 0.1V/μs rate	—	2.4	—	μs
EM4 BOD threshold	V <sub>EM4dBOD</sub>	AVDD rising	—	—	1.7	V
		AVDD falling	1.45	—	—	V
EM4 BOD hysteresis	V <sub>EM4dBOD_HYST</sub>		—	25	—	mV
EM4 BOD response time	t <sub>EM4dBOD_DELAY</sub>	Supply drops at 0.1V/μs rate	—	300	—	μs

## 4.1.8 Oscillators

## 4.1.8.1 Low-Frequency Crystal Oscillator (LFXO)

Table 4.10. Low-Frequency Crystal Oscillator (LFXO)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Crystal frequency	$f_{LFXO}$		—	32.768	—	kHz
Supported crystal equivalent series resistance (ESR)	$ESR_{LFXO}$		—	—	70	k $\Omega$
Supported range of crystal load capacitance <sup>1</sup>	$C_{LFXO\_CL}$		6	—	18	pF
On-chip tuning cap range <sup>2</sup>	$C_{LFXO\_T}$	On each of LFX TAL_N and LFX TAL_P pins	8	—	40	pF
On-chip tuning cap step size	$SS_{LFXO}$		—	0.25	—	pF
Current consumption after startup <sup>3</sup>	$I_{LFXO}$	ESR = 70 k $\Omega$ , $C_L$ = 7 pF, GAIN <sup>4</sup> = 2, AGC <sup>4</sup> = 1	—	273	—	nA
Start-up time	$t_{LFXO}$	ESR = 70 k $\Omega$ , $C_L$ = 7 pF, GAIN <sup>4</sup> = 2	—	308	—	ms

**Note:**

1. Total load capacitance as seen by the crystal.
2. The effective load capacitance seen by the crystal will be  $C_{LFXO\_T} / 2$ . This is because each XTAL pin has a tuning cap and the two caps will be seen in series by the crystal.
3. Block is supplied by AVDD if ANASW = 0, or DVDD if ANASW=1 in EMU\_PWRCTRL register.
4. In CMU\_LFXOCTRL register.

## 4.1.8.2 High-Frequency Crystal Oscillator (HFXO)

Table 4.11. High-Frequency Crystal Oscillator (HFXO)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Crystal frequency	$f_{\text{HFXO}}$		38	38.4	40	MHz
Supported crystal equivalent series resistance (ESR)	$\text{ESR}_{\text{HFXO}_38\text{M4}}$	Crystal frequency 38.4 MHz	—	—	60	$\Omega$
Supported range of crystal load capacitance <sup>1</sup>	$C_{\text{HFXO\_CL}}$		6	—	12	pF
On-chip tuning cap range <sup>2</sup>	$C_{\text{HFXO\_T}}$	On each of HFXTAL_N and HFXTAL_P pins	9	20	25	pF
On-chip tuning capacitance step	$\text{SS}_{\text{HFXO}}$		—	0.04	—	pF
Startup time	$t_{\text{HFXO}}$	38.4 MHz, ESR = 50 Ohm, $C_L = 10$ pF	—	300	—	$\mu\text{s}$
Frequency tolerance for the crystal	$\text{FT}_{\text{HFXO}}$	38.4 MHz, ESR = 50 Ohm, $C_L = 10$ pF	-40	—	40	ppm

**Note:**

- Total load capacitance as seen by the crystal.
- The effective load capacitance seen by the crystal will be  $C_{\text{HFXO\_T}}/2$ . This is because each XTAL pin has a tuning cap and the two caps will be seen in series by the crystal.

## 4.1.8.3 Low-Frequency RC Oscillator (LFRCO)

Table 4.12. Low-Frequency RC Oscillator (LFRCO)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Oscillation frequency	$f_{\text{LFRCO}}$	$\text{ENVREF}^2 = 1$	31.3	32.768	33.6	kHz
		$\text{ENVREF}^2 = 1, T > 85^\circ\text{C}$	31.6	32.768	36.8	kHz
		$\text{ENVREF}^2 = 0$	31.3	32.768	33.4	kHz
		$\text{ENVREF}^2 = 0, T > 85^\circ\text{C}$	30.0	32.768	33.4	kHz
Startup time	$t_{\text{LFRCO}}$		—	500	—	$\mu\text{s}$
Current consumption <sup>1</sup>	$I_{\text{LFRCO}}$	$\text{ENVREF} = 1$ in CMU_LFRCOCTRL	—	370	—	nA
		$\text{ENVREF} = 0$ in CMU_LFRCOCTRL	—	520	—	nA

**Note:**

- Block is supplied by AVDD if ANASW = 0, or DVDD if ANASW=1 in EMU\_PWRCTRL register.
- In CMU\_LFRCOCTRL register.

## 4.1.8.4 High-Frequency RC Oscillator (HFRCO)

Table 4.13. High-Frequency RC Oscillator (HFRCO)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Frequency accuracy	$f_{\text{HFRCO\_ACC}}$	At production calibrated frequencies, across supply voltage and temperature	-2.5	—	2.5	%
Start-up time	$t_{\text{HFRCO}}$	$f_{\text{HFRCO}} \geq 19 \text{ MHz}$	—	300	—	ns
		$4 < f_{\text{HFRCO}} < 19 \text{ MHz}$	—	1	—	$\mu\text{s}$
		$f_{\text{HFRCO}} \leq 4 \text{ MHz}$	—	2.5	—	$\mu\text{s}$
Maximum DPLL lock time <sup>1</sup>	$t_{\text{DPLL\_LOCK}}$	$f_{\text{REF}} = 32.768 \text{ kHz}$ , $f_{\text{HFRCO}} = 39.98 \text{ MHz}$ , $N = 1219$ , $M = 0$	—	183	—	$\mu\text{s}$
Current consumption on all supplies	$I_{\text{HFRCO}}$	$f_{\text{HFRCO}} = 38 \text{ MHz}$	—	244	265	$\mu\text{A}$
		$f_{\text{HFRCO}} = 32 \text{ MHz}$	—	204	222	$\mu\text{A}$
		$f_{\text{HFRCO}} = 26 \text{ MHz}$	—	173	188	$\mu\text{A}$
		$f_{\text{HFRCO}} = 19 \text{ MHz}$	—	143	156	$\mu\text{A}$
		$f_{\text{HFRCO}} = 16 \text{ MHz}$	—	123	136	$\mu\text{A}$
		$f_{\text{HFRCO}} = 13 \text{ MHz}$	—	110	124	$\mu\text{A}$
		$f_{\text{HFRCO}} = 7 \text{ MHz}$	—	85	94	$\mu\text{A}$
		$f_{\text{HFRCO}} = 4 \text{ MHz}$	—	32	37	$\mu\text{A}$
		$f_{\text{HFRCO}} = 2 \text{ MHz}$	—	28	34	$\mu\text{A}$
		$f_{\text{HFRCO}} = 1 \text{ MHz}$	—	26	31	$\mu\text{A}$
		$f_{\text{HFRCO}} = 40 \text{ MHz}$ , DPLL enabled	—	423	470	$\mu\text{A}$
		$f_{\text{HFRCO}} = 32 \text{ MHz}$ , DPLL enabled	—	338	375	$\mu\text{A}$
		$f_{\text{HFRCO}} = 16 \text{ MHz}$ , DPLL enabled	—	192	220	$\mu\text{A}$
		$f_{\text{HFRCO}} = 4 \text{ MHz}$ , DPLL enabled	—	51	75	$\mu\text{A}$
$f_{\text{HFRCO}} = 1 \text{ MHz}$ , DPLL enabled	—	36	50	$\mu\text{A}$		
Coarse trim step size (% of period)	$SS_{\text{HFRCO\_COARSE}}$		—	0.8	—	%
Fine trim step size (% of period)	$SS_{\text{HFRCO\_FINE}}$		—	0.1	—	%
Period jitter	$PJ_{\text{HFRCO}}$		—	0.2	—	% RMS
<b>Note:</b>						
1. Maximum DPLL lock time $\sim 6 \times (M+1) \times t_{\text{REF}}$ , where $t_{\text{REF}}$ is the reference clock period.						

## 4.1.8.5 Auxiliary High-Frequency RC Oscillator (AUXHFRCO)

Table 4.14. Auxiliary High-Frequency RC Oscillator (AUXHFRCO)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Frequency accuracy	$f_{\text{AUXHFRCO\_ACC}}$	At production calibrated frequencies, across supply voltage and temperature	-3	—	3	%
Start-up time	$t_{\text{AUXHFRCO}}$	$f_{\text{AUXHFRCO}} \geq 19 \text{ MHz}$	—	400	—	ns
		$4 < f_{\text{AUXHFRCO}} < 19 \text{ MHz}$	—	1.4	—	$\mu\text{s}$
		$f_{\text{AUXHFRCO}} \leq 4 \text{ MHz}$	—	2.5	—	$\mu\text{s}$
Current consumption on all supplies	$I_{\text{AUXHFRCO}}$	$f_{\text{AUXHFRCO}} = 38 \text{ MHz}$	—	193	213	$\mu\text{A}$
		$f_{\text{AUXHFRCO}} = 32 \text{ MHz}$	—	157	175	$\mu\text{A}$
		$f_{\text{AUXHFRCO}} = 26 \text{ MHz}$	—	135	151	$\mu\text{A}$
		$f_{\text{AUXHFRCO}} = 19 \text{ MHz}$	—	108	122	$\mu\text{A}$
		$f_{\text{AUXHFRCO}} = 16 \text{ MHz}$	—	100	113	$\mu\text{A}$
		$f_{\text{AUXHFRCO}} = 13 \text{ MHz}$	—	77	88	$\mu\text{A}$
		$f_{\text{AUXHFRCO}} = 7 \text{ MHz}$	—	53	63	$\mu\text{A}$
		$f_{\text{AUXHFRCO}} = 4 \text{ MHz}$	—	29	36	$\mu\text{A}$
		$f_{\text{AUXHFRCO}} = 2 \text{ MHz}$	—	28	34	$\mu\text{A}$
		$f_{\text{AUXHFRCO}} = 1 \text{ MHz}$	—	27	31	$\mu\text{A}$
Coarse trim step size (% of period)	$SS_{\text{AUXHFRCO\_COARSE}}$		—	0.8	—	%
Fine trim step size (% of period)	$SS_{\text{AUXHFRCO\_FINE}}$		—	0.1	—	%
Period jitter	$PJ_{\text{AUXHFRCO}}$		—	0.2	—	% RMS

## 4.1.8.6 Ultra-low Frequency RC Oscillator (ULFRCO)

Table 4.15. Ultra-low Frequency RC Oscillator (ULFRCO)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Oscillation frequency	$f_{\text{ULFRCO}}$		0.95	1	1.07	kHz

4.1.9 Flash Memory Characteristics<sup>5</sup>Table 4.16. Flash Memory Characteristics<sup>5</sup>

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Flash erase cycles before failure	EC <sub>FLASH</sub>		10000	—	—	cycles
Flash data retention	RET <sub>FLASH</sub>	T ≤ 85 °C	10	—	—	years
		T ≤ 125 °C	10	—	—	years
Word (32-bit) programming time	t <sub>W_PROG</sub>	Burst write, 128 words, average time per word	20	24.4	30	μs
		Single word	60	68.4	80	μs
Page erase time <sup>4</sup>	t <sub>PERASE</sub>		20	26.4	35	ms
Mass erase time <sup>1</sup>	t <sub>MERASE</sub>		20	26.5	35	ms
Device erase time <sup>2 3</sup>	t <sub>DERASE</sub>	T ≤ 85 °C	—	82	100	ms
		T ≤ 125 °C	—	82	110	ms
Erase current <sup>6</sup>	I <sub>ERASE</sub>	Page Erase	—	—	1.6	mA
Write current <sup>6</sup>	I <sub>WRITE</sub>		—	—	3.8	mA
Supply voltage during flash erase and write	V <sub>FLASH</sub>		1.62	—	3.6	V

**Note:**

1. Mass erase is issued by the CPU and erases all flash.
2. Device erase is issued over the AAP interface and erases all flash, SRAM, the Lock Bit (LB) page, and the User data page Lock Word (ULW).
3. From setting the DEVICEERASE bit in AAP\_CMD to 1 until the ERASEBUSY bit in AAP\_STATUS is cleared to 0. Internal setup and hold times for flash control signals are included.
4. From setting the ERASEPAGE bit in MSC\_WRITECMD to 1 until the BUSY bit in MSC\_STATUS is cleared to 0. Internal setup and hold times for flash control signals are included.
5. Flash data retention information is published in the Quarterly Quality and Reliability Report.
6. Measured at 25 °C.

## 4.1.10 General-Purpose I/O (GPIO)

Table 4.17. General-Purpose I/O (GPIO)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Input low voltage	$V_{IL}$	GPIO pins	—	—	IOVDD*0.3	V
		RESETn	—	—	AVDD*0.3	V
Input high voltage	$V_{IH}$	GPIO pins	IOVDD*0.7	—	—	V
		RESETn	AVDD*0.7	—	—	V
Output high voltage relative to IOVDD	$V_{OH}$	Sourcing 3 mA, IOVDD $\geq$ 3 V, DRIVESTRENGTH <sup>1</sup> = WEAK	IOVDD*0.8	—	—	V
		Sourcing 1.2 mA, IOVDD $\geq$ 1.62 V, DRIVESTRENGTH <sup>1</sup> = WEAK	IOVDD*0.6	—	—	V
		Sourcing 20 mA, IOVDD $\geq$ 3 V, DRIVESTRENGTH <sup>1</sup> = STRONG	IOVDD*0.8	—	—	V
		Sourcing 8 mA, IOVDD $\geq$ 1.62 V, DRIVESTRENGTH <sup>1</sup> = STRONG	IOVDD*0.6	—	—	V
Output low voltage relative to IOVDD	$V_{OL}$	Sinking 3 mA, IOVDD $\geq$ 3 V, DRIVESTRENGTH <sup>1</sup> = WEAK	—	—	IOVDD*0.2	V
		Sinking 1.2 mA, IOVDD $\geq$ 1.62 V, DRIVESTRENGTH <sup>1</sup> = WEAK	—	—	IOVDD*0.4	V
		Sinking 20 mA, IOVDD $\geq$ 3 V, DRIVESTRENGTH <sup>1</sup> = STRONG	—	—	IOVDD*0.2	V
		Sinking 8 mA, IOVDD $\geq$ 1.62 V, DRIVESTRENGTH <sup>1</sup> = STRONG	—	—	IOVDD*0.4	V
Input leakage current	$I_{IOLEAK}$	All GPIO except LFXO pins, GPIO $\leq$ IOVDD, T $\leq$ 85 °C	—	0.1	30	nA
		LFXO Pins, GPIO $\leq$ IOVDD, T $\leq$ 85 °C	—	0.1	50	nA
		All GPIO except LFXO pins, GPIO $\leq$ IOVDD, T > 85 °C	—	—	110	nA
		LFXO Pins, GPIO $\leq$ IOVDD, T > 85 °C	—	—	250	nA
Input leakage current on 5VTOL pads above IOVDD	$I_{5VTOLLEAK}$	IOVDD < GPIO $\leq$ IOVDD + 2 V	—	3.3	15	$\mu$ A
I/O pin pull-up/pull-down resistor	$R_{PUD}$		30	40	65	k $\Omega$
Pulse width of pulses removed by the glitch suppression filter	$t_{IOGLITCH}$		15	25	45	ns

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Output fall time, From 70% to 30% of $V_{IO}$	$t_{IOF}$	$C_L = 50$ pF, DRIVESTRENGTH <sup>1</sup> = STRONG, SLEWRATE <sup>1</sup> = 0x6	—	1.8	—	ns
		$C_L = 50$ pF, DRIVESTRENGTH <sup>1</sup> = WEAK, SLEWRATE <sup>1</sup> = 0x6	—	4.5	—	ns
Output rise time, From 30% to 70% of $V_{IO}$	$t_{IOR}$	$C_L = 50$ pF, DRIVESTRENGTH <sup>1</sup> = STRONG, SLEWRATE = 0x6 <sup>1</sup>	—	2.2	—	ns
		$C_L = 50$ pF, DRIVESTRENGTH <sup>1</sup> = WEAK, SLEWRATE <sup>1</sup> = 0x6	—	7.4	—	ns
RESETn low time to ensure pin reset	$T_{RESET}$		100	—	—	ns
<b>Note:</b> 1. In GPIO_Pn_CTRL register.						

## 4.1.11 Voltage Monitor (VMON)

Table 4.18. Voltage Monitor (VMON)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Supply current (including I <sub>SENSE</sub> )	I <sub>VMON</sub>	In EM0 or EM1, 1 supply monitored, T ≤ 85 °C	—	6.3	10	μA
		In EM0 or EM1, 1 supply monitored, T > 85 °C	—	—	14	μA
		In EM0 or EM1, 4 supplies monitored, T ≤ 85 °C	—	12.5	17	μA
		In EM0 or EM1, 4 supplies monitored, T > 85 °C	—	—	21	μA
		In EM2, EM3 or EM4, 1 supply monitored and above threshold	—	62	—	nA
		In EM2, EM3 or EM4, 1 supply monitored and below threshold	—	62	—	nA
		In EM2, EM3 or EM4, 4 supplies monitored and all above threshold	—	99	—	nA
		In EM2, EM3 or EM4, 4 supplies monitored and all below threshold	—	99	—	nA
Loading of monitored supply	I <sub>SENSE</sub>	In EM0 or EM1	—	2	—	μA
		In EM2, EM3 or EM4	—	2	—	nA
Threshold range	V <sub>VMON_RANGE</sub>		1.62	—	3.4	V
Threshold step size	N <sub>VMON_STESP</sub>	Coarse	—	200	—	mV
		Fine	—	20	—	mV
Response time	t <sub>VMON_RES</sub>	Supply drops at 1V/μs rate	—	460	—	ns
Hysteresis	V <sub>VMON_HYST</sub>		—	26	—	mV

## 4.1.12 Analog to Digital Converter (ADC)

Specified at 1 Msps, ADCCLK = 16 MHz, BIASPROG = 0, GPBIASACC = 0, unless otherwise indicated.

Table 4.19. Analog to Digital Converter (ADC)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Resolution	$V_{RESOLUTION}$		6	—	12	Bits
Input voltage range <sup>5</sup>	$V_{ADCIN}$	Single ended	—	—	$V_{FS}$	V
		Differential	$-V_{FS}/2$	—	$V_{FS}/2$	V
Input range of external reference voltage, single ended and differential	$V_{ADCREFIN\_P}$		1	—	$V_{AVDD}$	V
Power supply rejection <sup>2</sup>	$PSRR_{ADC}$	At DC	—	80	—	dB
Analog input common mode rejection ratio	$CMRR_{ADC}$	At DC	—	80	—	dB
Current from all supplies, using internal reference buffer. Continuous operation. $WAR\_MUPMODE^4 = KEEPADC\_WARM$	$I_{ADC\_CONTINUOUS\_LP}$	1 Msps / 16 MHz ADCCLK, BIASPROG = 0, GPBIASACC = 1 <sup>3</sup>	—	270	315	$\mu A$
		250 kbps / 4 MHz ADCCLK, BIASPROG = 6, GPBIASACC = 1 <sup>3</sup>	—	125	—	$\mu A$
		62.5 kbps / 1 MHz ADCCLK, BIASPROG = 15, GPBIASACC = 1 <sup>3</sup>	—	80	—	$\mu A$
Current from all supplies, using internal reference buffer. Duty-cycled operation. $WAR\_MUPMODE^4 = NORMAL$	$I_{ADC\_NORMAL\_LP}$	35 kbps / 16 MHz ADCCLK, BIASPROG = 0, GPBIASACC = 1 <sup>3</sup>	—	45	—	$\mu A$
		5 kbps / 16 MHz ADCCLK BIASPROG = 0, GPBIASACC = 1 <sup>3</sup>	—	8	—	$\mu A$
Current from all supplies, using internal reference buffer. Duty-cycled operation. $AWARMUPMODE^4 = KEEPINSTANDBY$ or $KEEPIN\_SLOWACC$	$I_{ADC\_STANDBY\_LP}$	125 kbps / 16 MHz ADCCLK, BIASPROG = 0, GPBIASACC = 1 <sup>3</sup>	—	105	—	$\mu A$
		35 kbps / 16 MHz ADCCLK, BIASPROG = 0, GPBIASACC = 1 <sup>3</sup>	—	70	—	$\mu A$
Current from all supplies, using internal reference buffer. Continuous operation. $WAR\_MUPMODE^4 = KEEPADC\_WARM$	$I_{ADC\_CONTINUOUS\_HP}$	1 Msps / 16 MHz ADCCLK, BIASPROG = 0, GPBIASACC = 0 <sup>3</sup>	—	325	—	$\mu A$
		250 kbps / 4 MHz ADCCLK, BIASPROG = 6, GPBIASACC = 0 <sup>3</sup>	—	175	—	$\mu A$
		62.5 kbps / 1 MHz ADCCLK, BIASPROG = 15, GPBIASACC = 0 <sup>3</sup>	—	125	—	$\mu A$
Current from all supplies, using internal reference buffer. Duty-cycled operation. $WAR\_MUPMODE^4 = NORMAL$	$I_{ADC\_NORMAL\_HP}$	35 kbps / 16 MHz ADCCLK, BIASPROG = 0, GPBIASACC = 0 <sup>3</sup>	—	85	—	$\mu A$
		5 kbps / 16 MHz ADCCLK BIASPROG = 0, GPBIASACC = 0 <sup>3</sup>	—	16	—	$\mu A$
Current from all supplies, using internal reference buffer. Duty-cycled operation. $AWARMUPMODE^4 = KEEPINSTANDBY$ or $KEEPIN\_SLOWACC$	$I_{ADC\_STANDBY\_HP}$	125 kbps / 16 MHz ADCCLK, BIASPROG = 0, GPBIASACC = 0 <sup>3</sup>	—	160	—	$\mu A$
		35 kbps / 16 MHz ADCCLK, BIASPROG = 0, GPBIASACC = 0 <sup>3</sup>	—	125	—	$\mu A$
Current from HFPERCLK	$I_{ADC\_CLK}$	HFPERCLK = 16 MHz	—	160	—	$\mu A$

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
ADC clock frequency	$f_{\text{ADCCLK}}$		—	—	16	MHz
Throughput rate	$f_{\text{ADCRATE}}$		—	—	1	Msp/s
Conversion time <sup>1</sup>	$t_{\text{ADCCONV}}$	6 bit	—	7	—	cycles
		8 bit	—	9	—	cycles
		12 bit	—	13	—	cycles
Startup time of reference generator and ADC core	$t_{\text{ADCSTART}}$	WARMUPMODE <sup>4</sup> = NORMAL	—	—	5	$\mu\text{s}$
		WARMUPMODE <sup>4</sup> = KEEPIN-STANDBY	—	—	2	$\mu\text{s}$
		WARMUPMODE <sup>4</sup> = KEEPINSLOWACC	—	—	1	$\mu\text{s}$
SNDR at 1Msp/s and $f_{\text{IN}} = 10\text{kHz}$	SNDR <sub>ADC</sub>	Internal reference <sup>7</sup> , differential measurement	58	67	—	dB
		External reference <sup>6</sup> , differential measurement	—	68	—	dB
Spurious-free dynamic range (SFDR)	SFDR <sub>ADC</sub>	1 MSamples/s, 10 kHz full-scale sine wave	—	75	—	dB
Differential non-linearity (DNL)	DNL <sub>ADC</sub>	12 bit resolution, No missing codes	-1	—	2	LSB
Integral non-linearity (INL), End point method	INL <sub>ADC</sub>	12 bit resolution	-6	—	6	LSB
Offset error	$V_{\text{ADCOFFSETERR}}$		-3	0	3	LSB
Gain error in ADC	$V_{\text{ADCGAIN}}$	Using internal reference	—	-0.2	3.5	%
		Using external reference	—	-1	—	%
Temperature sensor slope	$V_{\text{TS\_SLOPE}}$		—	-1.84	—	mV/°C

**Note:**

- Derived from ADCCLK.
- PSRR is referenced to AVDD when ANASW=0 and to DVDD when ANASW=1 in EMU\_PWRCTRL.
- In ADCn\_BIASPROG register.
- In ADCn\_CNTL register.
- The absolute voltage allowed at any ADC input is dictated by the power rail supplied to on-chip circuitry, and may be lower than the effective full scale voltage. All ADC inputs are limited to the ADC supply (AVDD or DVDD depending on EMU\_PWRCTRL\_ANASW). Any ADC input routed through the APORT will further be limited by the IOVDD supply to the pin.
- External reference is 1.25 V applied externally to ADCnEXTREFP, with the selection CONF in the SINGLECTRL\_REF or SCANCTRL\_REF register field and VREFP in the SINGLECTRLX\_VREFSEL or SCANCTRLX\_VREFSEL field. The differential input range with this configuration is  $\pm 1.25\text{ V}$ .
- Internal reference option used corresponds to selection 2V5 in the SINGLECTRL\_REF or SCANCTRL\_REF register field. The differential input range with this configuration is  $\pm 1.25\text{ V}$ . Typical value is characterized using full-scale sine wave input. Minimum value is production-tested using sine wave input at 1.5 dB lower than full scale.

## 4.1.13 Analog Comparator (ACMP)

Table 4.20. Analog Comparator (ACMP)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Input voltage range	$V_{ACMPIN}$	ACMPVDD = ACMPn_CTRL_PWRSEL <sup>1</sup>	—	—	$V_{ACMPVDD}$	V
Supply voltage	$V_{ACMPVDD}$	BIASPROG <sup>4</sup> ≤ 0x10 or FULL- BIAS <sup>4</sup> = 0	1.8	—	$V_{VREGVDD\_MAX}$	V
		0x10 < BIASPROG <sup>4</sup> ≤ 0x20 and FULLBIAS <sup>4</sup> = 1	2.1	—	$V_{VREGVDD\_MAX}$	V
Active current not including voltage reference <sup>2</sup>	$I_{ACMP}$	BIASPROG <sup>4</sup> = 0x10, FULLBIAS <sup>4</sup> = 0	—	306	—	nA
		BIASPROG <sup>4</sup> = 0x02, FULLBIAS <sup>4</sup> = 1	—	6.5	—	μA
		BIASPROG <sup>4</sup> = 0x20, FULLBIAS <sup>4</sup> = 1	—	75	92	μA
Current consumption of inter- nal voltage reference <sup>2</sup>	$I_{ACMPREF}$	VLP selected as input using 2.5 V Reference / 4 (0.625 V)	—	50	—	nA
		VLP selected as input using VDD	—	20	—	nA
		VBDIV selected as input using 1.25 V reference / 1	—	4.1	—	μA
		VADIV selected as input using VDD/1	—	2.4	—	μA
Hysteresis ( $V_{CM} = 1.25$ V, BIASPROG <sup>4</sup> = 0x10, FULL- BIAS <sup>4</sup> = 1)	$V_{ACMPHYST}$	HYSTSEL <sup>5</sup> = HYST0	-3	0	3	mV
		HYSTSEL <sup>5</sup> = HYST1	5	18	27	mV
		HYSTSEL <sup>5</sup> = HYST2	12	33	50	mV
		HYSTSEL <sup>5</sup> = HYST3	17	46	67	mV
		HYSTSEL <sup>5</sup> = HYST4	23	57	86	mV
		HYSTSEL <sup>5</sup> = HYST5	26	68	104	mV
		HYSTSEL <sup>5</sup> = HYST6	30	79	130	mV
		HYSTSEL <sup>5</sup> = HYST7	34	90	150	mV
		HYSTSEL <sup>5</sup> = HYST8	-3	0	3	mV
		HYSTSEL <sup>5</sup> = HYST9	-27	-18	-5	mV
		HYSTSEL <sup>5</sup> = HYST10	-50	-33	-12	mV
		HYSTSEL <sup>5</sup> = HYST11	-67	-45	-17	mV
		HYSTSEL <sup>5</sup> = HYST12	-86	-57	-23	mV
		HYSTSEL <sup>5</sup> = HYST13	-104	-67	-26	mV
		HYSTSEL <sup>5</sup> = HYST14	-130	-78	-30	mV
HYSTSEL <sup>5</sup> = HYST15	-155	-88	-34	mV		

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Comparator delay <sup>3</sup>	$t_{ACMPDELAY}$	BIASPROG <sup>4</sup> = 0x10, FULLBIAS <sup>4</sup> = 0	—	3.7	—	$\mu$ s
		BIASPROG <sup>4</sup> = 0x02, FULLBIAS <sup>4</sup> = 1	—	360	—	ns
		BIASPROG <sup>4</sup> = 0x20, FULLBIAS <sup>4</sup> = 1	—	35	—	ns
Offset voltage	$V_{ACMPOFFSET}$	BIASPROG <sup>4</sup> = 0x10, FULLBIAS <sup>4</sup> = 1	-35	—	35	mV
Reference voltage	$V_{ACMPREF}$	Internal 1.25 V reference	1	1.25	1.47	V
		Internal 2.5 V reference	2	2.5	2.8	V
Capacitive sense internal resistance	$R_{CSRES}$	CSRESSEL <sup>6</sup> = 0	—	infinite	—	k $\Omega$
		CSRESSEL <sup>6</sup> = 1	—	15	—	k $\Omega$
		CSRESSEL <sup>6</sup> = 2	—	27	—	k $\Omega$
		CSRESSEL <sup>6</sup> = 3	—	39	—	k $\Omega$
		CSRESSEL <sup>6</sup> = 4	—	51	—	k $\Omega$
		CSRESSEL <sup>6</sup> = 5	—	100	—	k $\Omega$
		CSRESSEL <sup>6</sup> = 6	—	162	—	k $\Omega$
		CSRESSEL <sup>6</sup> = 7	—	235	—	k $\Omega$

**Note:**

1. ACMPVDD is a supply chosen by the setting in ACMPn\_CTRL\_PWRSEL and may be IOVDD, AVDD or DVDD.
2. The total ACMP current is the sum of the contributions from the ACMP and its internal voltage reference.  $I_{ACMPTOTAL} = I_{ACMP} + I_{ACMPREF}$ .
3.  $\pm 100$  mV differential drive.
4. In ACMPn\_CTRL register.
5. In ACMPn\_HYSTERESIS registers.
6. In ACMPn\_INPUTSEL register.

## 4.1.14 Digital to Analog Converter (VDAC)

DRIVESTRENGTH = 2 unless otherwise specified. Primary VDAC output.

Table 4.21. Digital to Analog Converter (VDAC)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Output voltage	$V_{DACOUT}$	Single-Ended	0	—	$V_{VREF}$	V
		Differential <sup>2</sup>	$-V_{VREF}$	—	$V_{VREF}$	V
Current consumption including references (2 channels) <sup>1</sup>	$I_{DAC}$	500 ksps, 12-bit, DRIVESTRENGTH = 2, REFSEL = 4	—	396	—	$\mu A$
		44.1 ksps, 12-bit, DRIVESTRENGTH = 1, REFSEL = 4	—	72	—	$\mu A$
		200 Hz refresh rate, 12-bit Sample-Off mode in EM2, DRIVESTRENGTH = 2, BGRREQTIME = 1, EM2REFENTIME = 9, REFSEL = 4, SETTLETIME = 0x0A, WARMUPTIME = 0x02	—	1.2	—	$\mu A$
Current from HFPERCLK <sup>4</sup>	$I_{DAC\_CLK}$		—	5.8	—	$\mu A/MHz$
Sample rate	$SR_{DAC}$		—	—	500	ksps
DAC clock frequency	$f_{DAC}$		—	—	1	MHz
Conversion time	$t_{DACCONV}$	$f_{DAC} = 1MHz$	2	—	—	$\mu s$
Settling time	$t_{DACSETTLE}$	50% fs step settling to 5 LSB	—	2.5	—	$\mu s$
Startup time	$t_{DACSTARTUP}$	Enable to 90% fs output, settling to 10 LSB	—	—	12	$\mu s$
Output impedance	$R_{OUT}$	DRIVESTRENGTH = 2, $0.4 V \leq V_{OUT} \leq V_{OPA} - 0.4 V$ , $-8 mA < I_{OUT} < 8 mA$ , Full supply range	—	2	—	$\Omega$
		DRIVESTRENGTH = 0 or 1, $0.4 V \leq V_{OUT} \leq V_{OPA} - 0.4 V$ , $-400 \mu A < I_{OUT} < 400 \mu A$ , Full supply range	—	2	—	$\Omega$
		DRIVESTRENGTH = 2, $0.1 V \leq V_{OUT} \leq V_{OPA} - 0.1 V$ , $-2 mA < I_{OUT} < 2 mA$ , Full supply range	—	2	—	$\Omega$
		DRIVESTRENGTH = 0 or 1, $0.1 V \leq V_{OUT} \leq V_{OPA} - 0.1 V$ , $-100 \mu A < I_{OUT} < 100 \mu A$ , Full supply range	—	2	—	$\Omega$
Power supply rejection ratio <sup>6</sup>	PSRR	$V_{out} = 50\% fs. DC$	—	65.5	—	dB

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Signal to noise and distortion ratio (1 kHz sine wave), Noise band limited to 250 kHz	SNDR <sub>DAC</sub>	500 ksps, single-ended, internal 1.25V reference	—	60.4	—	dB
		500 ksps, single-ended, internal 2.5V reference	—	61.6	—	dB
		500 ksps, single-ended, 3.3V VDD reference	—	64.0	—	dB
		500 ksps, differential, internal 1.25V reference	—	63.3	—	dB
		500 ksps, differential, internal 2.5V reference	—	64.4	—	dB
		500 ksps, differential, 3.3V VDD reference	—	65.8	—	dB
Signal to noise and distortion ratio (1 kHz sine wave), Noise band limited to 22 kHz	SNDR <sub>DAC_BAND</sub>	500 ksps, single-ended, internal 1.25V reference	—	65.3	—	dB
		500 ksps, single-ended, internal 2.5V reference	—	66.7	—	dB
		500 ksps, single-ended, 3.3V VDD reference	—	70.0	—	dB
		500 ksps, differential, internal 1.25V reference	—	67.8	—	dB
		500 ksps, differential, internal 2.5V reference	—	69.0	—	dB
		500 ksps, differential, 3.3V VDD reference	—	68.5	—	dB
Total harmonic distortion	THD		—	70.2	—	dB
Differential non-linearity <sup>3</sup>	DNL <sub>DAC</sub>		-0.99	—	1	LSB
Integral non-linearity	INL <sub>DAC</sub>		-4	—	4	LSB
Offset error <sup>5</sup>	V <sub>OFFSET</sub>	T = 25 °C	-8	—	8	mV
		Across operating temperature range	-25	—	25	mV
Gain error <sup>5</sup>	V <sub>GAIN</sub>	T = 25 °C, Low-noise internal reference (REFSEL = 1V25LN or 2V5LN)	-2.5	—	2.5	%
		T = 25 °C, Internal reference (REFSEL = 1V25 or 2V5)	-5	—	5	%
		T = 25 °C, External reference (REFSEL = VDD or EXT)	-1.8	—	1.8	%
		Across operating temperature range, Low-noise internal reference (REFSEL = 1V25LN or 2V5LN)	-3.5	—	3.5	%
		Across operating temperature range, Internal reference (REFSEL = 1V25 or 2V5)	-7.5	—	7.5	%
		Across operating temperature range, External reference (REFSEL = VDD or EXT)	-2.0	—	2.0	%

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
External load capacitance, OUTSCALE=0	C <sub>LOAD</sub>		—	—	75	pF

**Note:**

1. Supply current specifications are for VDAC circuitry operating with static output only and do not include current required to drive the load.
2. In differential mode, the output is defined as the difference between two single-ended outputs. Absolute voltage on each output is limited to the single-ended range.
3. Entire range is monotonic and has no missing codes.
4. Current from HUPERCLK is dependent on HUPERCLK frequency. This current contributes to the total supply current used when the clock to the DAC module is enabled in the CMU.
5. Gain is calculated by measuring the slope from 10% to 90% of full scale. Offset is calculated by comparing actual VDAC output at 10% of full scale to ideal VDAC output at 10% of full scale with the measured gain.
6. PSRR calculated as  $20 * \log_{10}(\Delta V_{DD} / \Delta V_{OUT})$ , VDAC output at 90% of full scale

## 4.1.15 Current Digital to Analog Converter (IDAC)

Table 4.22. Current Digital to Analog Converter (IDAC)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Number of ranges	$N_{IDAC\_RANGES}$		—	4	—	ranges
Output current	$I_{IDAC\_OUT}$	RANGSEL <sup>1</sup> = RANGE0	0.05	—	1.6	μA
		RANGSEL <sup>1</sup> = RANGE1	1.6	—	4.7	μA
		RANGSEL <sup>1</sup> = RANGE2	0.5	—	16	μA
		RANGSEL <sup>1</sup> = RANGE3	2	—	64	μA
Linear steps within each range	$N_{IDAC\_STEPS}$		—	32	—	steps
Step size	$SS_{IDAC}$	RANGSEL <sup>1</sup> = RANGE0	—	50	—	nA
		RANGSEL <sup>1</sup> = RANGE1	—	100	—	nA
		RANGSEL <sup>1</sup> = RANGE2	—	500	—	nA
		RANGSEL <sup>1</sup> = RANGE3	—	2	—	μA
Total accuracy, STEPSEL <sup>1</sup> = 0x10	$ACC_{IDAC}$	EM0 or EM1, AVDD=3.3 V, T = 25 °C	-3	—	3	%
		EM0 or EM1, Across operating temperature range	-18	—	22	%
		EM2 or EM3, Source mode, RANGSEL <sup>1</sup> = RANGE0, AVDD=3.3 V, T = 25 °C	—	-2	—	%
		EM2 or EM3, Source mode, RANGSEL <sup>1</sup> = RANGE1, AVDD=3.3 V, T = 25 °C	—	-1.7	—	%
		EM2 or EM3, Source mode, RANGSEL <sup>1</sup> = RANGE2, AVDD=3.3 V, T = 25 °C	—	-0.8	—	%
		EM2 or EM3, Source mode, RANGSEL <sup>1</sup> = RANGE3, AVDD=3.3 V, T = 25 °C	—	-0.5	—	%
		EM2 or EM3, Sink mode, RANGSEL <sup>1</sup> = RANGE0, AVDD=3.3 V, T = 25 °C	—	-0.7	—	%
		EM2 or EM3, Sink mode, RANGSEL <sup>1</sup> = RANGE1, AVDD=3.3 V, T = 25 °C	—	-0.6	—	%
		EM2 or EM3, Sink mode, RANGSEL <sup>1</sup> = RANGE2, AVDD=3.3 V, T = 25 °C	—	-0.5	—	%
		EM2 or EM3, Sink mode, RANGSEL <sup>1</sup> = RANGE3, AVDD=3.3 V, T = 25 °C	—	-0.5	—	%
Start up time	$t_{IDAC\_SU}$	Output within 1% of steady state value	—	5	—	μs

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Settling time, (output settled within 1% of steady state value),	$t_{IDAC\_SETTLE}$	Range setting is changed	—	5	—	$\mu s$
		Step value is changed	—	1	—	$\mu s$
Current consumption <sup>2</sup>	$I_{IDAC}$	EM0 or EM1 Source mode, excluding output current, Across operating temperature range	—	11	18	$\mu A$
		EM0 or EM1 Sink mode, excluding output current, Across operating temperature range	—	13	21	$\mu A$
		EM2 or EM3 Source mode, excluding output current, T = 25 °C	—	0.023	—	$\mu A$
		EM2 or EM3 Sink mode, excluding output current, T = 25 °C	—	0.041	—	$\mu A$
		EM2 or EM3 Source mode, excluding output current, T $\geq$ 85 °C	—	11	—	$\mu A$
		EM2 or EM3 Sink mode, excluding output current, T $\geq$ 85 °C	—	13	—	$\mu A$
Output voltage compliance in source mode, source current change relative to current sourced at 0 V	$I_{COMP\_SRC}$	RANGESEL1=0, output voltage = $\min(V_{IOVDD}, V_{AVDD}^2-100 \text{ mV})$	—	0.11	—	%
		RANGESEL1=1, output voltage = $\min(V_{IOVDD}, V_{AVDD}^2-100 \text{ mV})$	—	0.06	—	%
		RANGESEL1=2, output voltage = $\min(V_{IOVDD}, V_{AVDD}^2-150 \text{ mV})$	—	0.04	—	%
		RANGESEL1=3, output voltage = $\min(V_{IOVDD}, V_{AVDD}^2-250 \text{ mV})$	—	0.03	—	%
Output voltage compliance in sink mode, sink current change relative to current sunk at IOVDD	$I_{COMP\_SINK}$	RANGESEL1=0, output voltage = 100 mV	—	0.12	—	%
		RANGESEL1=1, output voltage = 100 mV	—	0.05	—	%
		RANGESEL1=2, output voltage = 150 mV	—	0.04	—	%
		RANGESEL1=3, output voltage = 250 mV	—	0.03	—	%

**Note:**

1. In IDAC\_CURPROG register.
2. The IDAC is supplied by either AVDD, DVDD, or IOVDD based on the setting of ANASW in the EMU\_PWRCTRL register and PWRSEL in the IDAC\_CTRL register. Setting PWRSEL to 1 selects IOVDD. With PWRSEL cleared to 0, ANASW selects between AVDD (0) and DVDD (1).

## 4.1.16 Capacitive Sense (CSEN)

Table 4.23. Capacitive Sense (CSEN)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Single conversion time (1x accumulation)	$t_{CNV}$	12-bit SAR Conversions	—	20.2	—	$\mu\text{s}$
		16-bit SAR Conversions	—	26.4	—	$\mu\text{s}$
		Delta Modulation Conversion (single comparison)	—	1.55	—	$\mu\text{s}$
Maximum external capacitive load	$C_{EXTMAX}$	CS0CG=7 (Gain = 1x), including routing parasitics	—	68	—	pF
		CS0CG=0 (Gain = 10x), including routing parasitics	—	680	—	pF
Maximum external series impedance	$R_{EXTMAX}$		—	1	—	k $\Omega$
Supply current, EM2 bonded conversions, WARMUP-MODE=NORMAL, WARMUPCNT=0	$I_{CSEN\_BOND}$	12-bit SAR conversions, 20 ms conversion rate, CS0CG=7 (Gain = 1x), 10 channels bonded (total capacitance of 330 pF) <sup>1</sup>	—	326	—	nA
		Delta Modulation conversions, 20 ms conversion rate, CS0CG=7 (Gain = 1x), 10 channels bonded (total capacitance of 330 pF) <sup>1</sup>	—	226	—	nA
		12-bit SAR conversions, 200 ms conversion rate, CS0CG=7 (Gain = 1x), 10 channels bonded (total capacitance of 330 pF) <sup>1</sup>	—	33	—	nA
		Delta Modulation conversions, 200 ms conversion rate, CS0CG=7 (Gain = 1x), 10 channels bonded (total capacitance of 330 pF) <sup>1</sup>	—	25	—	nA
Supply current, EM2 scan conversions, WARMUP-MODE=NORMAL, WARMUPCNT=0	$I_{CSEN\_EM2}$	12-bit SAR conversions, 20 ms scan rate, CS0CG=0 (Gain = 10x), 8 samples per scan <sup>1</sup>	—	690	—	nA
		Delta Modulation conversions, 20 ms scan rate, 8 comparisons per sample (DMCR = 1, DMR = 2), CS0CG=0 (Gain = 10x), 8 samples per scan <sup>1</sup>	—	515	—	nA
		12-bit SAR conversions, 200 ms scan rate, CS0CG=0 (Gain = 10x), 8 samples per scan <sup>1</sup>	—	79	—	nA
		Delta Modulation conversions, 200 ms scan rate, 8 comparisons per sample (DMCR = 1, DMR = 2), CS0CG=0 (Gain = 10x), 8 samples per scan <sup>1</sup>	—	57	—	nA

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Supply current, continuous conversions, WARMUP-MODE=KEEPCSENWARM	I <sub>CSEN_ACTIVE</sub>	SAR or Delta Modulation conversions of 33 pF capacitor, CS0CG=0 (Gain = 10x), always on	—	90.5	—	μA
HFPERCLK supply current	I <sub>CSEN_HFPERCLK</sub>	Current contribution from HFPERCLK when clock to CSEN block is enabled.	—	2.25	—	μA/MHz

**Note:**

- Current is specified with a total external capacitance of 33 pF per channel. Average current is dependent on how long the module is actively sampling channels within the scan period, and scales with the number of samples acquired. Supply current for a specific application can be estimated by multiplying the current per sample by the total number of samples per period ( $\text{total\_current} = \text{single\_sample\_current} * (\text{number\_of\_channels} * \text{accumulation})$ ).

#### 4.1.17 Operational Amplifier (OPAMP)

Unless otherwise indicated, specified conditions are: Non-inverting input configuration, VDD = 3.3 V, DRIVESTRENGTH = 2, MAIN-OUTEN = 1, C<sub>LOAD</sub> = 75 pF with OUTSCALE = 0, or C<sub>LOAD</sub> = 37.5 pF with OUTSCALE = 1. Unit gain buffer and 3X-gain connection as specified in table footnotes<sup>8</sup> 1.

**Table 4.24. Operational Amplifier (OPAMP)**

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Supply voltage (from AVDD)	V <sub>OPA</sub>	HCMDIS = 0, Rail-to-rail input range	2	—	3.8	V
		HCMDIS = 1	1.62	—	3.8	V
Input voltage	V <sub>IN</sub>	HCMDIS = 0, Rail-to-rail input range	V <sub>VSS</sub>	—	V <sub>OPA</sub>	V
		HCMDIS = 1	V <sub>VSS</sub>	—	V <sub>OPA</sub> -1.2	V
Input impedance	R <sub>IN</sub>		100	—	—	MΩ
Output voltage	V <sub>OUT</sub>		V <sub>VSS</sub>	—	V <sub>OPA</sub>	V
Load capacitance <sup>2</sup>	C <sub>LOAD</sub>	OUTSCALE = 0	—	—	75	pF
		OUTSCALE = 1	—	—	37.5	pF
Output impedance	R <sub>OUT</sub>	DRIVESTRENGTH = 2 or 3, 0.4 V ≤ V <sub>OUT</sub> ≤ V <sub>OPA</sub> - 0.4 V, -8 mA < I <sub>OUT</sub> < 8 mA, Buffer connection, Full supply range	—	0.25	—	Ω
		DRIVESTRENGTH = 0 or 1, 0.4 V ≤ V <sub>OUT</sub> ≤ V <sub>OPA</sub> - 0.4 V, -400 μA < I <sub>OUT</sub> < 400 μA, Buffer connection, Full supply range	—	0.6	—	Ω
		DRIVESTRENGTH = 2 or 3, 0.1 V ≤ V <sub>OUT</sub> ≤ V <sub>OPA</sub> - 0.1 V, -2 mA < I <sub>OUT</sub> < 2 mA, Buffer connection, Full supply range	—	0.4	—	Ω
		DRIVESTRENGTH = 0 or 1, 0.1 V ≤ V <sub>OUT</sub> ≤ V <sub>OPA</sub> - 0.1 V, -100 μA < I <sub>OUT</sub> < 100 μA, Buffer connection, Full supply range	—	1	—	Ω
Internal closed-loop gain	G <sub>CL</sub>	Buffer connection	0.99	1	1.01	-
		3x Gain connection	2.93	2.99	3.05	-
		16x Gain connection	15.07	15.7	16.33	-
Active current <sup>4</sup>	I <sub>OPA</sub>	DRIVESTRENGTH = 3, OUTSCALE = 0	—	580	—	μA
		DRIVESTRENGTH = 2, OUTSCALE = 0	—	176	—	μA
		DRIVESTRENGTH = 1, OUTSCALE = 0	—	13	—	μA
		DRIVESTRENGTH = 0, OUTSCALE = 0	—	4.7	—	μA

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Open-loop gain	G <sub>OL</sub>	DRIVESTRENGTH = 3	—	135	—	dB
		DRIVESTRENGTH = 2	—	137	—	dB
		DRIVESTRENGTH = 1	—	121	—	dB
		DRIVESTRENGTH = 0	—	109	—	dB
Loop unit-gain frequency <sup>7</sup>	UGF	DRIVESTRENGTH = 3, Buffer connection	—	3.38	—	MHz
		DRIVESTRENGTH = 2, Buffer connection	—	0.9	—	MHz
		DRIVESTRENGTH = 1, Buffer connection	—	132	—	kHz
		DRIVESTRENGTH = 0, Buffer connection	—	34	—	kHz
		DRIVESTRENGTH = 3, 3x Gain connection	—	2.57	—	MHz
		DRIVESTRENGTH = 2, 3x Gain connection	—	0.71	—	MHz
		DRIVESTRENGTH = 1, 3x Gain connection	—	113	—	kHz
		DRIVESTRENGTH = 0, 3x Gain connection	—	28	—	kHz
Phase margin	PM	DRIVESTRENGTH = 3, Buffer connection	—	67	—	°
		DRIVESTRENGTH = 2, Buffer connection	—	69	—	°
		DRIVESTRENGTH = 1, Buffer connection	—	63	—	°
		DRIVESTRENGTH = 0, Buffer connection	—	68	—	°
Output voltage noise	N <sub>OUT</sub>	DRIVESTRENGTH = 3, Buffer connection, 10 Hz - 10 MHz	—	146	—	μVrms
		DRIVESTRENGTH = 2, Buffer connection, 10 Hz - 10 MHz	—	163	—	μVrms
		DRIVESTRENGTH = 1, Buffer connection, 10 Hz - 1 MHz	—	170	—	μVrms
		DRIVESTRENGTH = 0, Buffer connection, 10 Hz - 1 MHz	—	176	—	μVrms
		DRIVESTRENGTH = 3, 3x Gain connection, 10 Hz - 10 MHz	—	313	—	μVrms
		DRIVESTRENGTH = 2, 3x Gain connection, 10 Hz - 10 MHz	—	271	—	μVrms
		DRIVESTRENGTH = 1, 3x Gain connection, 10 Hz - 1 MHz	—	247	—	μVrms
		DRIVESTRENGTH = 0, 3x Gain connection, 10 Hz - 1 MHz	—	245	—	μVrms

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Slew rate <sup>5</sup>	SR	DRIVESTRENGTH = 3, INCBW=1 <sup>3</sup>	—	4.7	—	V/ $\mu$ s
		DRIVESTRENGTH = 3, INCBW=0	—	1.5	—	V/ $\mu$ s
		DRIVESTRENGTH = 2, INCBW=1 <sup>3</sup>	—	1.27	—	V/ $\mu$ s
		DRIVESTRENGTH = 2, INCBW=0	—	0.42	—	V/ $\mu$ s
		DRIVESTRENGTH = 1, INCBW=1 <sup>3</sup>	—	0.17	—	V/ $\mu$ s
		DRIVESTRENGTH = 1, INCBW=0	—	0.058	—	V/ $\mu$ s
		DRIVESTRENGTH = 0, INCBW=1 <sup>3</sup>	—	0.044	—	V/ $\mu$ s
		DRIVESTRENGTH = 0, INCBW=0	—	0.015	—	V/ $\mu$ s
Startup time <sup>6</sup>	T <sub>START</sub>	DRIVESTRENGTH = 2	—	—	12	$\mu$ s
Input offset voltage	V <sub>OSI</sub>	DRIVESTRENGTH = 2 or 3, T = 25 °C	-2	—	2	mV
		DRIVESTRENGTH = 1 or 0, T = 25 °C	-2	—	2	mV
		DRIVESTRENGTH = 2 or 3, across operating temperature range	-12	—	12	mV
		DRIVESTRENGTH = 1 or 0, across operating temperature range	-30	—	30	mV
DC power supply rejection ratio <sup>9</sup>	PSRR <sub>DC</sub>	Input referred	—	70	—	dB
DC common-mode rejection ratio <sup>9</sup>	CMRR <sub>DC</sub>	Input referred	—	70	—	dB
Total harmonic distortion	THD <sub>OPA</sub>	DRIVESTRENGTH = 2, 3x Gain connection, 1 kHz, V <sub>OUT</sub> = 0.1 V to V <sub>OPA</sub> - 0.1 V	—	90	—	dB
		DRIVESTRENGTH = 0, 3x Gain connection, 0.1 kHz, V <sub>OUT</sub> = 0.1 V to V <sub>OPA</sub> - 0.1 V	—	90	—	dB

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
<b>Note:</b>						
1. Specified configuration for 3X-Gain configuration is: INCBW = 1, HCMDIS = 1, RESINSEL = VSS, $V_{INPUT} = 0.5\text{ V}$ , $V_{OUTPUT} = 1.5\text{ V}$ . Nominal voltage gain is 3.						
2. If the maximum $C_{LOAD}$ is exceeded, an isolation resistor is required for stability.						
3. When INCBW is set to 1 the OPAMP bandwidth is increased. This is allowed only when the non-inverting close-loop gain is $\geq 3$ , or the OPAMP may not be stable.						
4. Current into the load resistor is excluded. When the OPAMP is connected with closed-loop gain $> 1$ , there will be extra current to drive the resistor feedback network. The internal resistor feedback network has total resistance of 143.5 kOhm, which will cause another $\sim 10\text{ }\mu\text{A}$ current when the OPAMP drives 1.5 V between output and ground.						
5. Step between 0.2V and $V_{OPA}-0.2\text{V}$ , 10%-90% rising/falling range.						
6. From enable to output settled. In sample-and-off mode, RC network after OPAMP will contribute extra delay. Settling error $< 1\text{mV}$ .						
7. In unit gain connection, UGF is the gain-bandwidth product of the OPAMP. In 3x Gain connection, UGF is the gain-bandwidth product of the OPAMP and 1/3 attenuation of the feedback network.						
8. Specified configuration for Unit gain buffer configuration is: INCBW = 0, HCMDIS = 0, RESINSEL = DISABLE. $V_{INPUT} = 0.5\text{ V}$ , $V_{OUTPUT} = 0.5\text{ V}$ .						
9. When HCMDIS=1 and input common mode transitions the region from $V_{OPA}-1.4\text{V}$ to $V_{OPA}-1\text{V}$ , input offset will change. PSRR and CMRR specifications do not apply to this transition region.						

#### 4.1.18 Pulse Counter (PCNT)

**Table 4.25. Pulse Counter (PCNT)**

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Input frequency	$F_{IN}$	Asynchronous Single and Quadrature Modes	—	—	20	MHz
		Sampled Modes with Debounce filter set to 0.	—	—	8	kHz

#### 4.1.19 Analog Port (APORT)

**Table 4.26. Analog Port (APORT)**

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Supply current <sup>2 1</sup>	$I_{APORT}$	Operation in EM0/EM1	—	7	—	$\mu\text{A}$
		Operation in EM2/EM3	—	67	—	nA

**Note:**

- Specified current is for continuous APORT operation. In applications where the APORT is not requested continuously (e.g. periodic ACMP requests from LESENSE in EM2), the average current requirements can be estimated by multiplying the duty cycle of the requests by the specified continuous current number.
- Supply current increase that occurs when an analog peripheral requests access to APORT. This current is not included in reported module currents. Additional peripherals requesting access to APORT do not incur further current.

## 4.1.20 I2C

4.1.20.1 I2C Standard-mode (Sm)<sup>1</sup>Table 4.27. I2C Standard-mode (Sm)<sup>1</sup>

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
SCL clock frequency <sup>2</sup>	f <sub>SCL</sub>		0	—	100	kHz
SCL clock low time	t <sub>LOW</sub>		4.7	—	—	μs
SCL clock high time	t <sub>HIGH</sub>		4	—	—	μs
SDA set-up time	t <sub>SU_DAT</sub>		250	—	—	ns
SDA hold time <sup>3</sup>	t <sub>HD_DAT</sub>		100	—	3450	ns
Repeated START condition set-up time	t <sub>SU_STA</sub>		4.7	—	—	μs
(Repeated) START condition hold time	t <sub>HD_STA</sub>		4	—	—	μs
STOP condition set-up time	t <sub>SU_STO</sub>		4	—	—	μs
Bus free time between a STOP and START condition	t <sub>BUF</sub>		4.7	—	—	μs

**Note:**

1. For CLHR set to 0 in the I2Cn\_CTRL register.
2. For the minimum HPPERCLK frequency required in Standard-mode, refer to the I2C chapter in the reference manual.
3. The maximum SDA hold time (t<sub>HD\_DAT</sub>) needs to be met only when the device does not stretch the low time of SCL (t<sub>LOW</sub>).

4.1.20.2 I2C Fast-mode (Fm)<sup>1</sup>Table 4.28. I2C Fast-mode (Fm)<sup>1</sup>

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
SCL clock frequency <sup>2</sup>	f <sub>SCL</sub>		0	—	400	kHz
SCL clock low time	t <sub>LOW</sub>		1.3	—	—	μs
SCL clock high time	t <sub>HIGH</sub>		0.6	—	—	μs
SDA set-up time	t <sub>SU_DAT</sub>		100	—	—	ns
SDA hold time <sup>3</sup>	t <sub>HD_DAT</sub>		100	—	900	ns
Repeated START condition set-up time	t <sub>SU_STA</sub>		0.6	—	—	μs
(Repeated) START condition hold time	t <sub>HD_STA</sub>		0.6	—	—	μs
STOP condition set-up time	t <sub>SU_STO</sub>		0.6	—	—	μs
Bus free time between a STOP and START condition	t <sub>BUF</sub>		1.3	—	—	μs

**Note:**

1. For CLHR set to 1 in the I2Cn\_CTRL register.
2. For the minimum HPPERCLK frequency required in Fast-mode, refer to the I2C chapter in the reference manual.
3. The maximum SDA hold time (t<sub>HD,DAT</sub>) needs to be met only when the device does not stretch the low time of SCL (t<sub>LOW</sub>).

4.1.20.3 I2C Fast-mode Plus (Fm+)<sup>1</sup>Table 4.29. I2C Fast-mode Plus (Fm+)<sup>1</sup>

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
SCL clock frequency <sup>2</sup>	f <sub>SCL</sub>		0	—	1000	kHz
SCL clock low time	t <sub>LOW</sub>		0.5	—	—	μs
SCL clock high time	t <sub>HIGH</sub>		0.26	—	—	μs
SDA set-up time	t <sub>SU_DAT</sub>		50	—	—	ns
SDA hold time	t <sub>HD_DAT</sub>		100	—	—	ns
Repeated START condition set-up time	t <sub>SU_STA</sub>		0.26	—	—	μs
(Repeated) START condition hold time	t <sub>HD_STA</sub>		0.26	—	—	μs
STOP condition set-up time	t <sub>SU_STO</sub>		0.26	—	—	μs
Bus free time between a STOP and START condition	t <sub>BUF</sub>		0.5	—	—	μs

**Note:**

1. For CLHR set to 0 or 1 in the I2Cn\_CTRL register.
2. For the minimum HPPERCLK frequency required in Fast-mode Plus, refer to the I2C chapter in the reference manual.

4.1.21 USART SPI

SPI Master Timing

Table 4.30. SPI Master Timing

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
SCLK period <sup>1 3 2</sup>	$t_{SCLK}$		$2 * t_{H\text{FPERCLK}}$	—	—	ns
CS to MOSI <sup>1 3</sup>	$t_{CS\_MO}$		-14.5	—	13.5	ns
SCLK to MOSI <sup>1 3</sup>	$t_{SCLK\_MO}$		-8.5	—	8	ns
MISO setup time <sup>1 3</sup>	$t_{SU\_MI}$	IOVDD = 1.62 V	92	—	—	ns
		IOVDD = 3.0 V	42	—	—	ns
MISO hold time <sup>1 3</sup>	$t_{H\_MI}$		-10	—	—	ns

Note:

1. Applies for both CLKPHA = 0 and CLKPHA = 1 (figure only shows CLKPHA = 0).
2.  $t_{H\text{FPERCLK}}$  is one period of the selected H\text{FPERCLK}.
3. Measurement done with 8 pF output loading at 10% and 90% of  $V_{DD}$  (figure shows 50% of  $V_{DD}$ ).

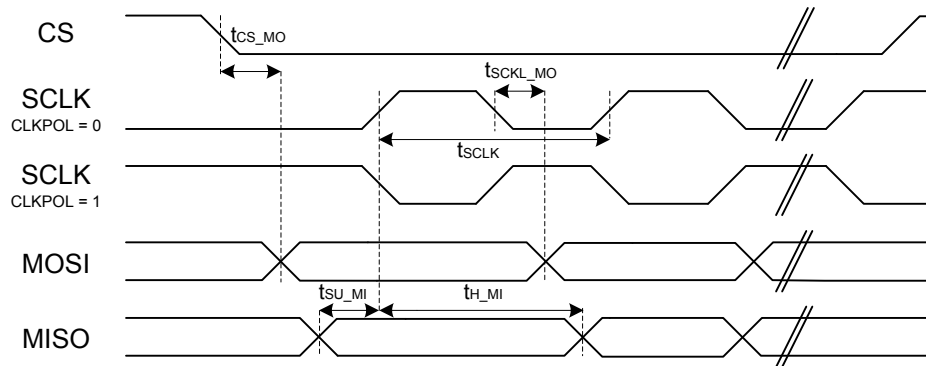


Figure 4.1. SPI Master Timing Diagram (SMSDELAY = 0)

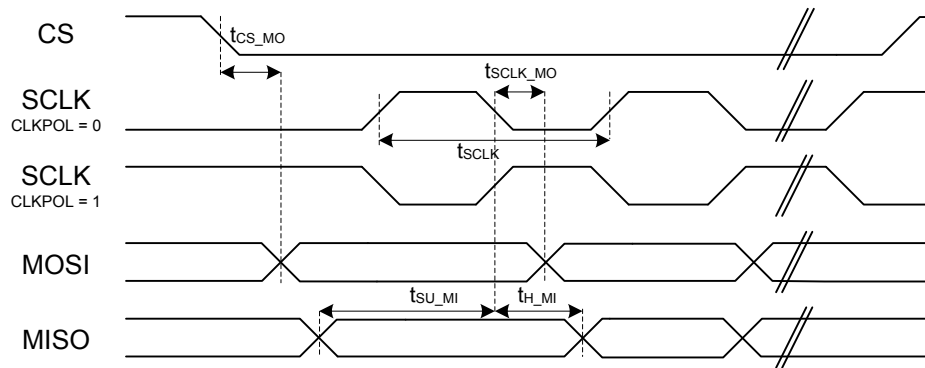


Figure 4.2. SPI Master Timing Diagram (SMSDELAY = 1)

SPI Slave Timing

Table 4.31. SPI Slave Timing

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
SCLK period <sup>1 3 2</sup>	$t_{SCLK}$		6 * $t_{H\text{FPERCLK}}$	—	—	ns
SCLK high time <sup>1 3 2</sup>	$t_{SCLK\_HI}$		2.5 * $t_{H\text{FPERCLK}}$	—	—	ns
SCLK low time <sup>1 3 2</sup>	$t_{SCLK\_LO}$		2.5 * $t_{H\text{FPERCLK}}$	—	—	ns
CS active to MISO <sup>1 3</sup>	$t_{CS\_ACT\_MI}$		4	—	70	ns
CS disable to MISO <sup>1 3</sup>	$t_{CS\_DIS\_MI}$		4	—	50	ns
MOSI setup time <sup>1 3</sup>	$t_{SU\_MO}$		8	—	—	ns
MOSI hold time <sup>1 3 2</sup>	$t_{H\_MO}$		7	—	—	ns
SCLK to MISO <sup>1 3 2</sup>	$t_{SCLK\_MI}$		10 + 1.5 * $t_{H\text{FPERCLK}}$	—	65 + 2.5 * $t_{H\text{FPERCLK}}$	ns

Note:

1. Applies for both CLKPHA = 0 and CLKPHA = 1 (figure only shows CLKPHA = 0).
2.  $t_{H\text{FPERCLK}}$  is one period of the selected H<sub>FPERCLK</sub>.
3. Measurement done with 8 pF output loading at 10% and 90% of V<sub>DD</sub> (figure shows 50% of V<sub>DD</sub>).

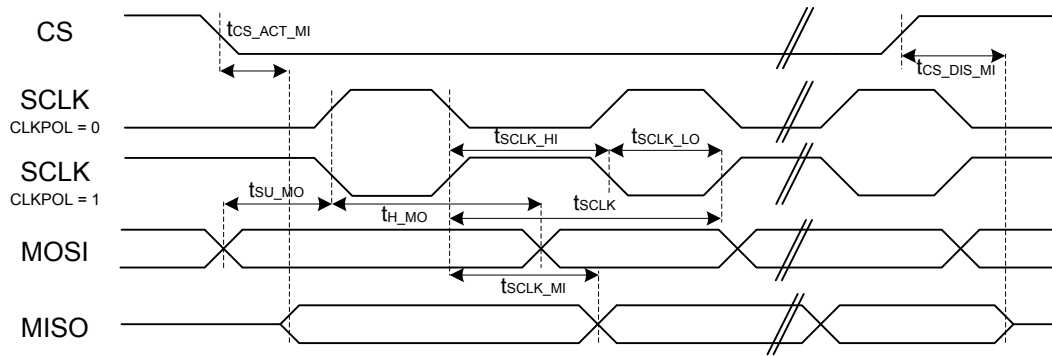


Figure 4.3. SPI Slave Timing Diagram

4.2 Typical Performance Curves

Typical performance curves indicate typical characterized performance under the stated conditions.

## 4.2.1 Supply Current

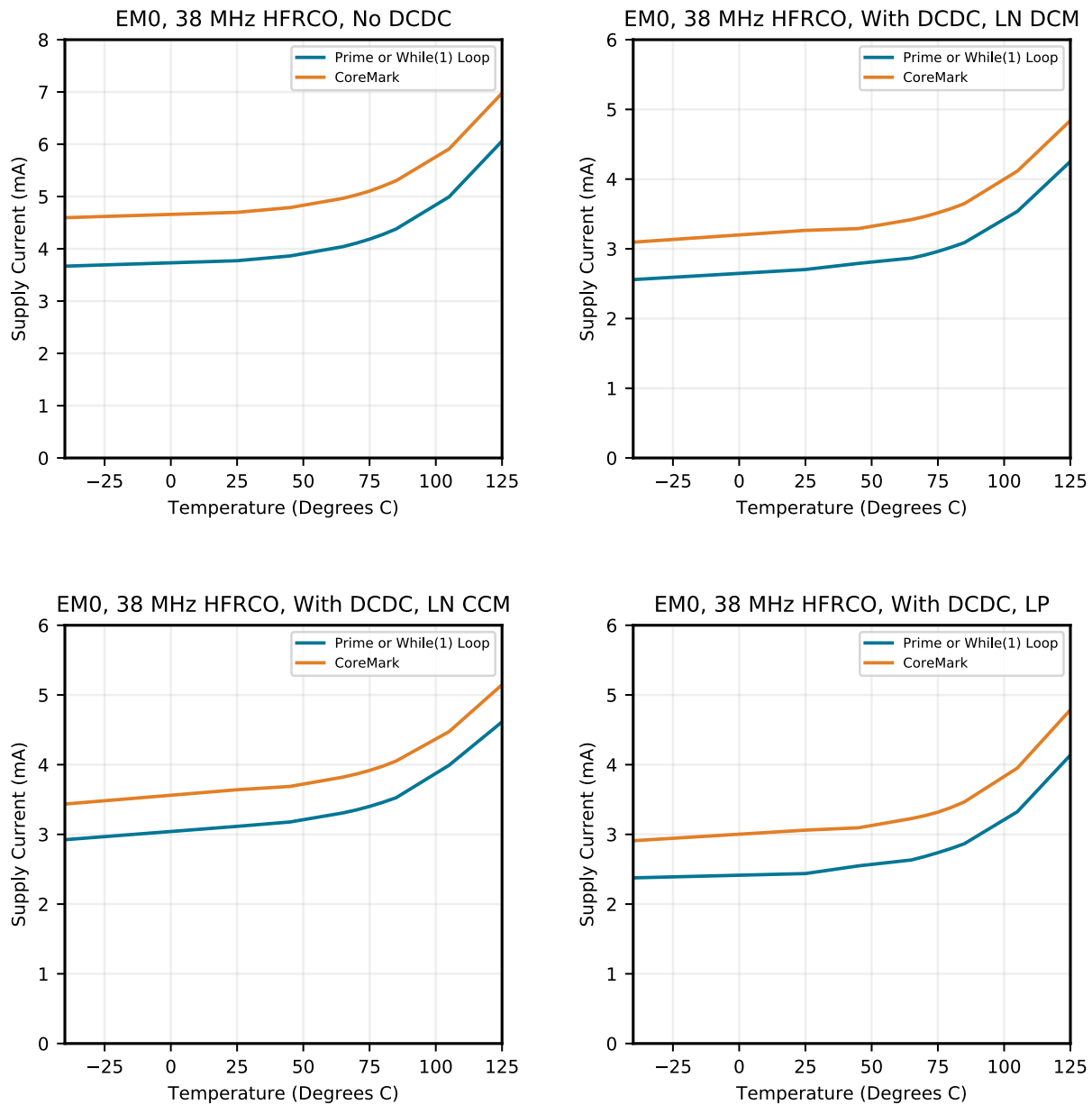


Figure 4.4. EM0 Active Mode Typical Supply Current vs. Temperature

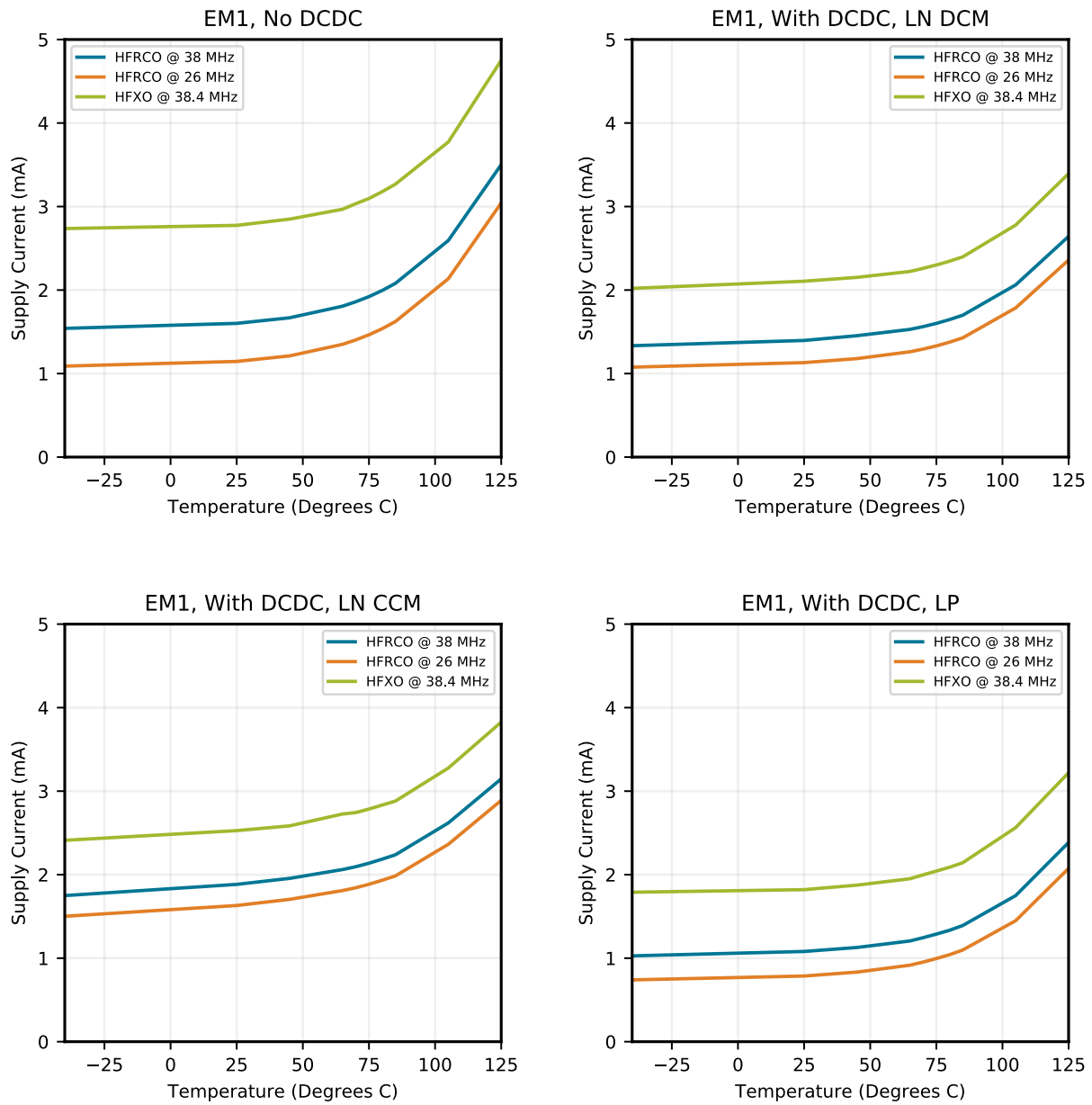


Figure 4.5. EM1 Sleep Mode Typical Supply Current vs. Temperature

Typical supply current for EM2, EM3 and EM4H using standard software libraries from Silicon Laboratories.

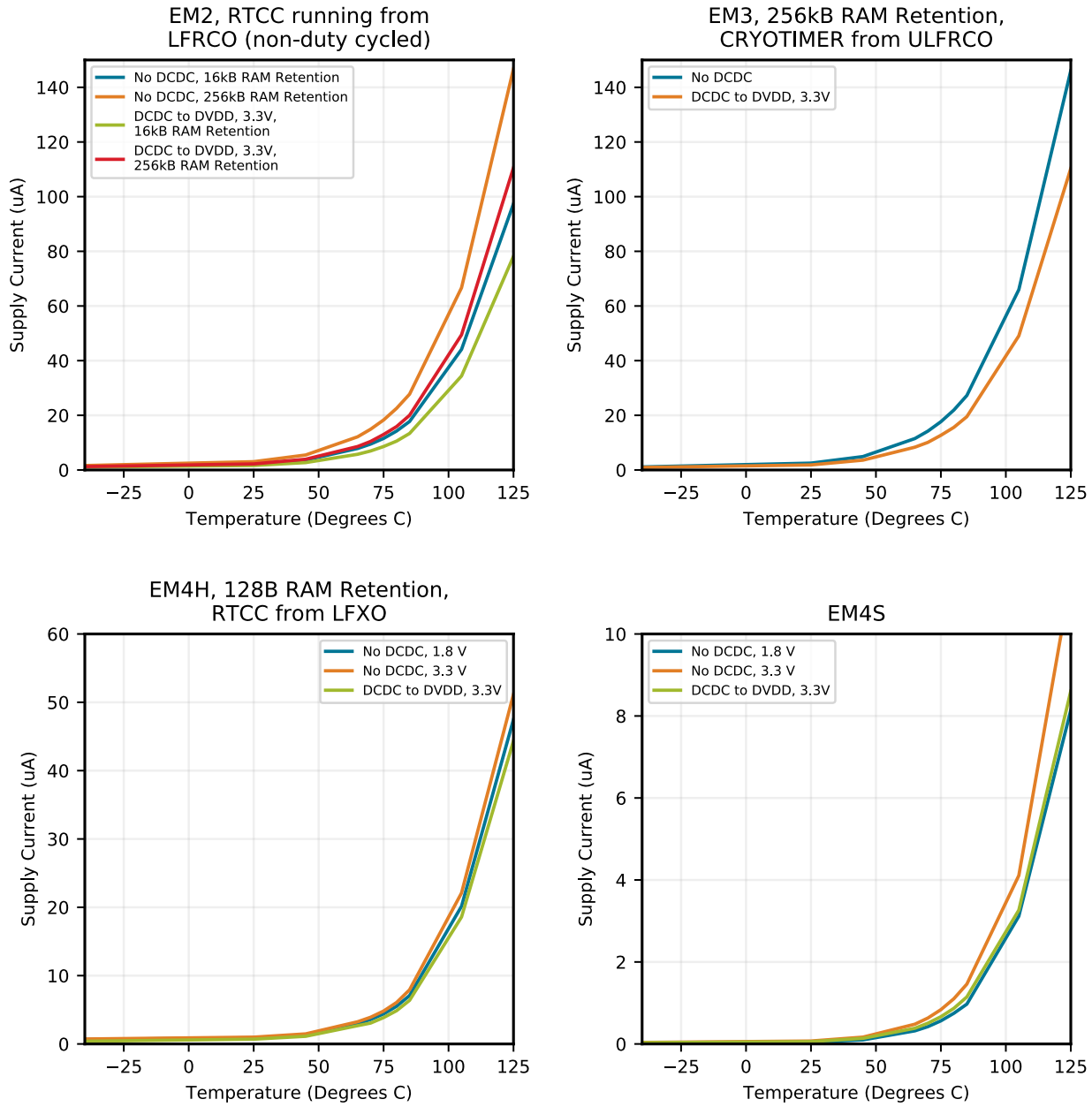


Figure 4.6. EM2, EM3, EM4H and EM4S Typical Supply Current vs. Temperature

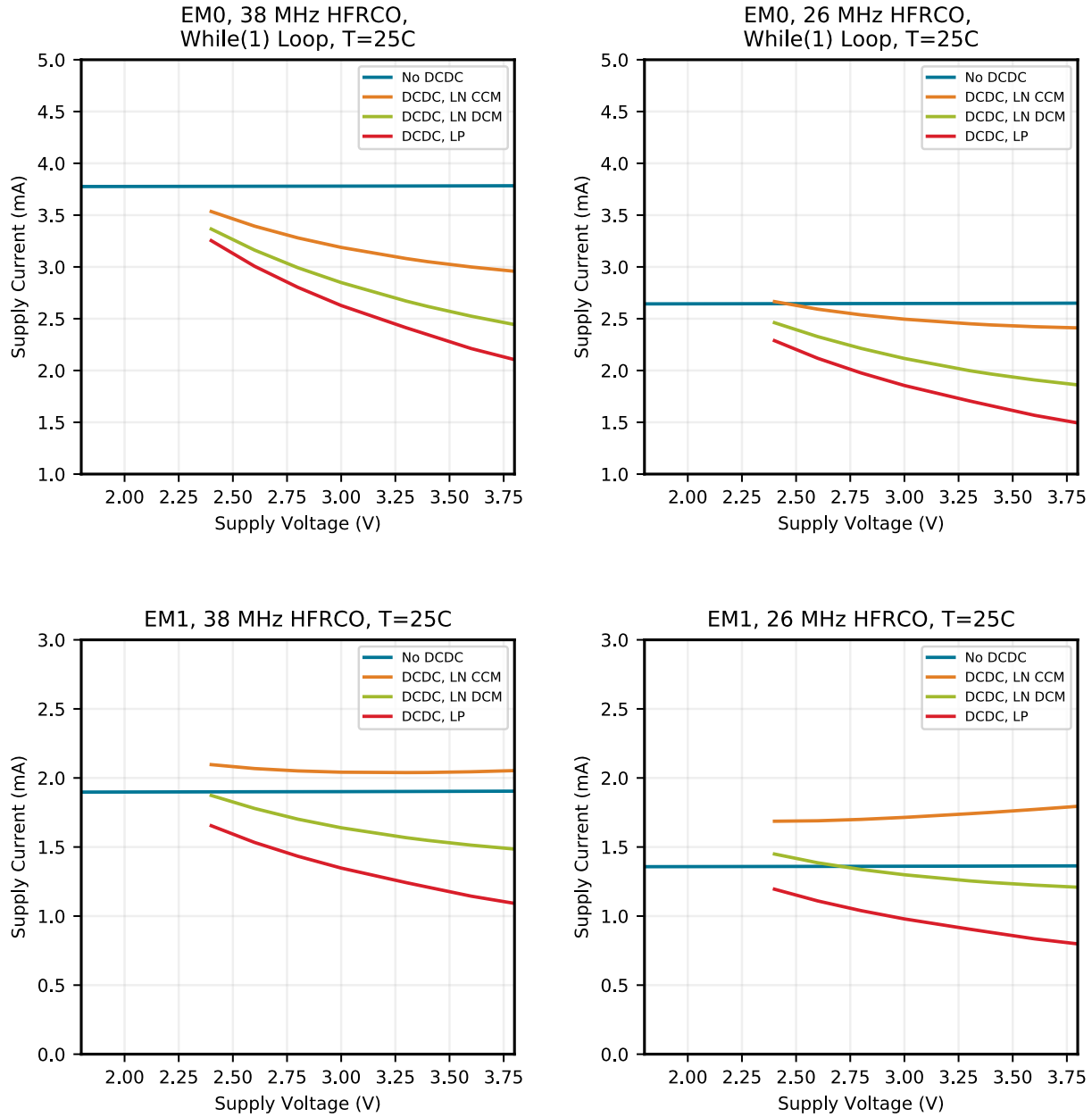


Figure 4.7. EM0 and EM1 Mode Typical Supply Current vs. Supply

Typical supply current for EM2, EM3 and EM4H using standard software libraries from Silicon Laboratories.

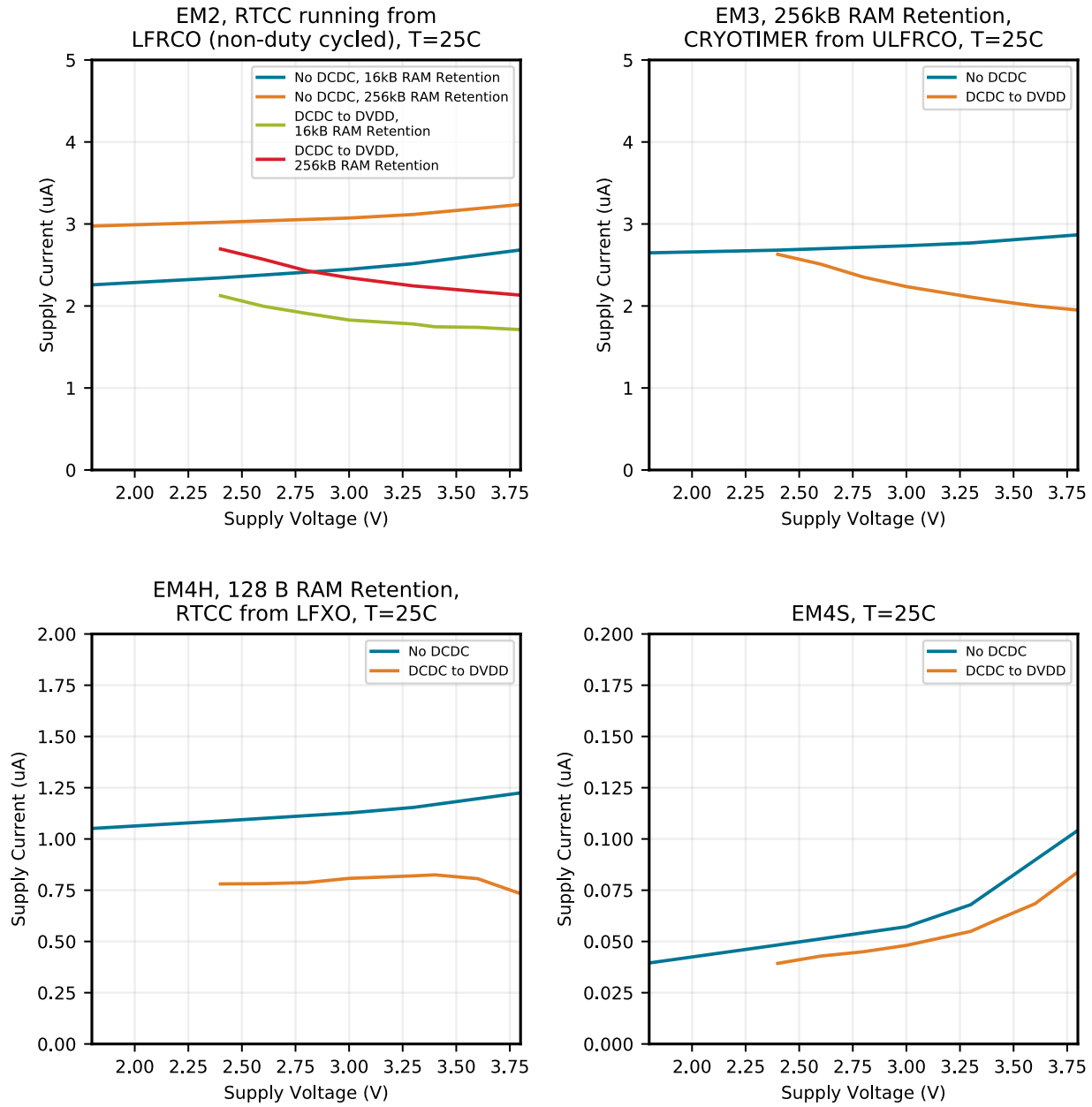


Figure 4.8. EM2, EM3, EM4H and EM4S Typical Supply Current vs. Supply

### 4.2.2 DC-DC Converter

Default test conditions: CCM mode, LDCDC = 4.7  $\mu$ H, CDCDC = 4.7  $\mu$ F, VDCDC\_I = 3.3 V, VDCDC\_O = 1.8 V, FDCDC\_LN = 7 MHz

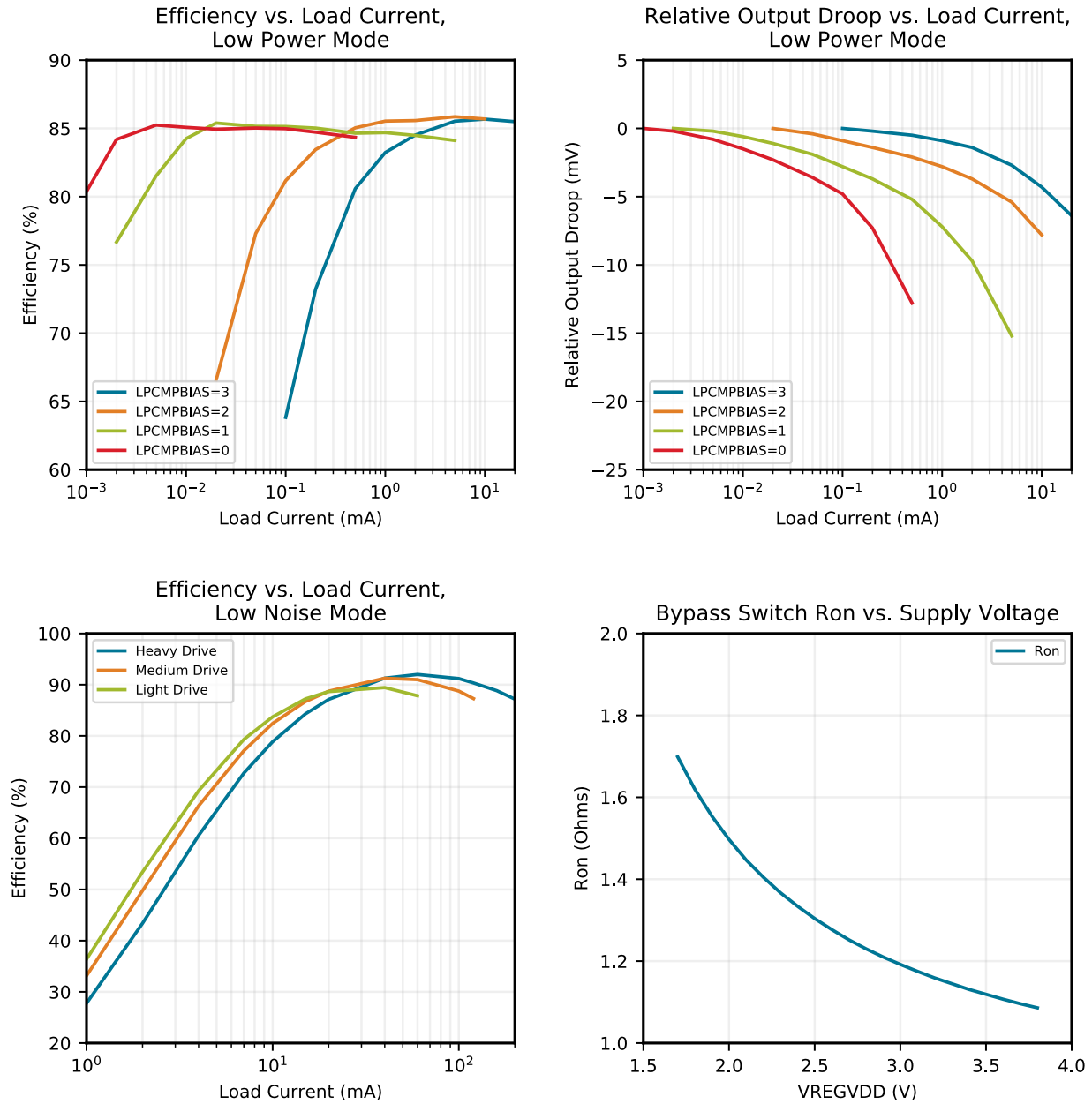


Figure 4.9. DC-DC Converter Typical Performance Characteristics

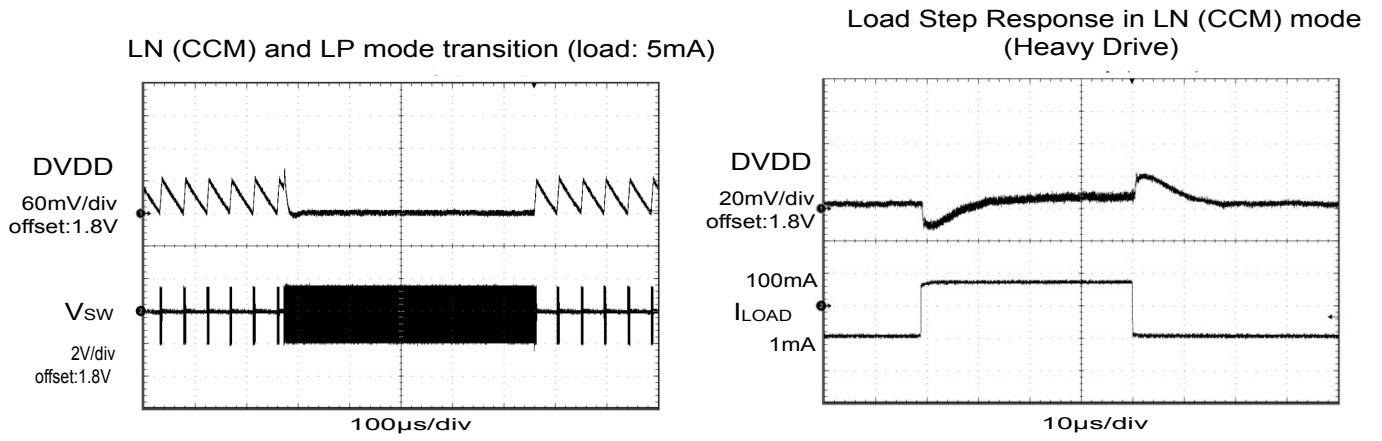
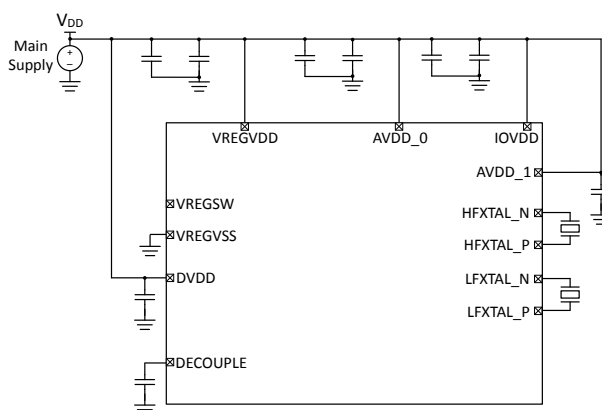


Figure 4.10. DC-DC Converter Transition Waveforms

## 5. Typical Connection Diagrams

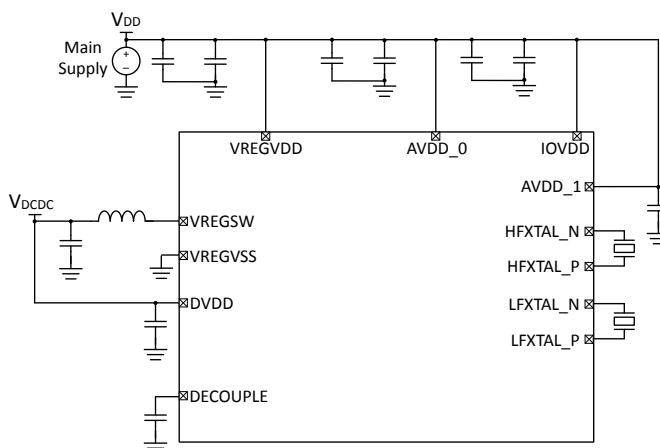
### 5.1 Power

Typical power supply connections for direct supply, without using the internal DC-DC converter, are shown in [Figure 5.1 EFM32PG12 Typical Application Circuit, Direct Supply, No DC-DC Converter on page 66](#).



**Figure 5.1. EFM32PG12 Typical Application Circuit, Direct Supply, No DC-DC Converter**

A typical application circuit using the internal DC-DC converter is shown in [Figure 5.2 EFM32PG12 Typical Application Circuit Using the DC-DC Converter on page 66](#). The MCU operates from the DC-DC converter supply.



**Figure 5.2. EFM32PG12 Typical Application Circuit Using the DC-DC Converter**

### 5.2 Other Connections

Other components or connections may be required to meet the system-level requirements. Application Note AN0002: "Hardware Design Considerations" contains detailed information on these connections. Application Notes can be accessed on the Silicon Labs website ([www.silabs.com/32bit-appnotes](http://www.silabs.com/32bit-appnotes)).

## 6. Pin Definitions

### 6.1 EFM32PG12B5xx in BGA125 Device Pinout

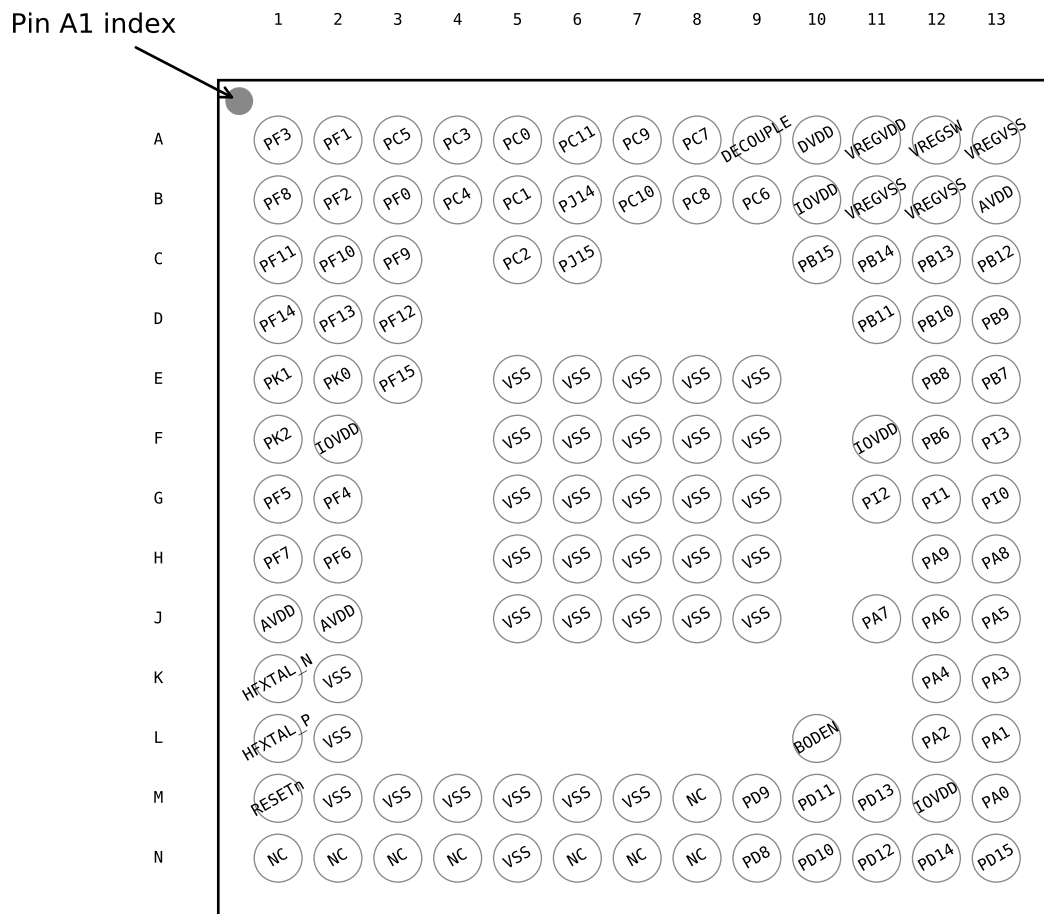


Figure 6.1. EFM32PG12B5xx in BGA125 Device Pinout

The following table provides package pin connections and general descriptions of pin functionality. For detailed information on the supported features for each GPIO pin, see [6.3 GPIO Functionality Table](#) or [6.4 Alternate Functionality Overview](#).

Table 6.1. EFM32PG12B5xx in BGA125 Device Pinout

Pin Name	Pin(s)	Description	Pin Name	Pin(s)	Description
PF3	A1	GPIO (5V)	PF1	A2	GPIO (5V)
PC5	A3	GPIO (5V)	PC3	A4	GPIO (5V)
PC0	A5	GPIO (5V)	PC11	A6	GPIO (5V)
PC9	A7	GPIO (5V)	PC7	A8	GPIO (5V)

Pin Name	Pin(s)	Description	Pin Name	Pin(s)	Description
DECOUPLE	A9	Decouple output for on-chip voltage regulator. An external decoupling capacitor is required at this pin.	DVDD	A10	Digital power supply.
VREGVDD	A11	Voltage regulator VDD input	VREGSW	A12	DCDC regulator switching node
VREGVSS	A13 B11 B12	Voltage regulator VSS	PF8	B1	GPIO (5V)
PF2	B2	GPIO (5V)	PF0	B3	GPIO (5V)
PC4	B4	GPIO (5V)	PC1	B5	GPIO (5V)
PJ14	B6	GPIO (5V)	PC10	B7	GPIO (5V)
PC8	B8	GPIO (5V)	PC6	B9	GPIO (5V)
IOVDD	B10 F2 F11 M12	Digital IO power supply.	AVDD	B13 J1 J2	Analog power supply.
PF11	C1	GPIO (5V)	PF10	C2	GPIO (5V)
PF9	C3	GPIO (5V)	PC2	C5	GPIO (5V)
PJ15	C6	GPIO (5V)	PB15	C10	GPIO
PB14	C11	GPIO	PB13	C12	GPIO
PB12	C13	GPIO	PF14	D1	GPIO (5V)
PF13	D2	GPIO (5V)	PF12	D3	GPIO (5V)
PB11	D11	GPIO	PB10	D12	GPIO (5V)
PB9	D13	GPIO (5V)	PK1	E1	GPIO (5V)
PK0	E2	GPIO	PF15	E3	GPIO (5V)

Pin Name	Pin(s)	Description	Pin Name	Pin(s)	Description
VSS	E5 E6 E7 E8 E9 F5 F6 F7 F8 F9 G5 G6 G7 G8 G9 H5 H6 H7 H8 H9 J5 J6 J7 J8 J9 K2 L2 M2 M3 M4 M5 M6 M7 N5	Ground	PB8	E12	GPIO (5V)
PB7	E13	GPIO (5V)	PK2	F1	GPIO (5V)
PB6	F12	GPIO (5V)	PI3	F13	GPIO (5V)
PF5	G1	GPIO (5V)	PF4	G2	GPIO (5V)
PI2	G11	GPIO (5V)	PI1	G12	GPIO (5V)
PI0	G13	GPIO (5V)	PF7	H1	GPIO (5V)
PF6	H2	GPIO (5V)	PA9	H12	GPIO (5V)
PA8	H13	GPIO (5V)	PA7	J11	GPIO (5V)
PA6	J12	GPIO (5V)	PA5	J13	GPIO (5V)
HFXTAL_N	K1	High Frequency Crystal input pin.	PA4	K12	GPIO
PA3	K13	GPIO	HFXTAL_P	L1	High Frequency Crystal output pin.
BODEN	L10	Brown-Out Detector Enable. This pin may be left disconnected or tied to AVDD.	PA2	L12	GPIO
PA1	L13	GPIO	RESETn	M1	Reset input, active low. To apply an external reset source to this pin, it is required to only drive this pin low during reset, and let the internal pull-up ensure that reset is released.

Pin Name	Pin(s)	Description	Pin Name	Pin(s)	Description
NC	M8 N1 N2 N3 N4 N6 N7 N8	No Connect.	PD9	M9	GPIO (5V)
PD11	M10	GPIO (5V)	PD13	M11	GPIO
PA0	M13	GPIO	PD8	N9	GPIO (5V)
PD10	N10	GPIO (5V)	PD12	N11	GPIO (5V)
PD14	N12	GPIO	PD15	N13	GPIO

**Note:**

1. GPIO with 5V tolerance are indicated by (5V).

### 6.2 EFM32PG12B5xx in QFN48 Device Pinout

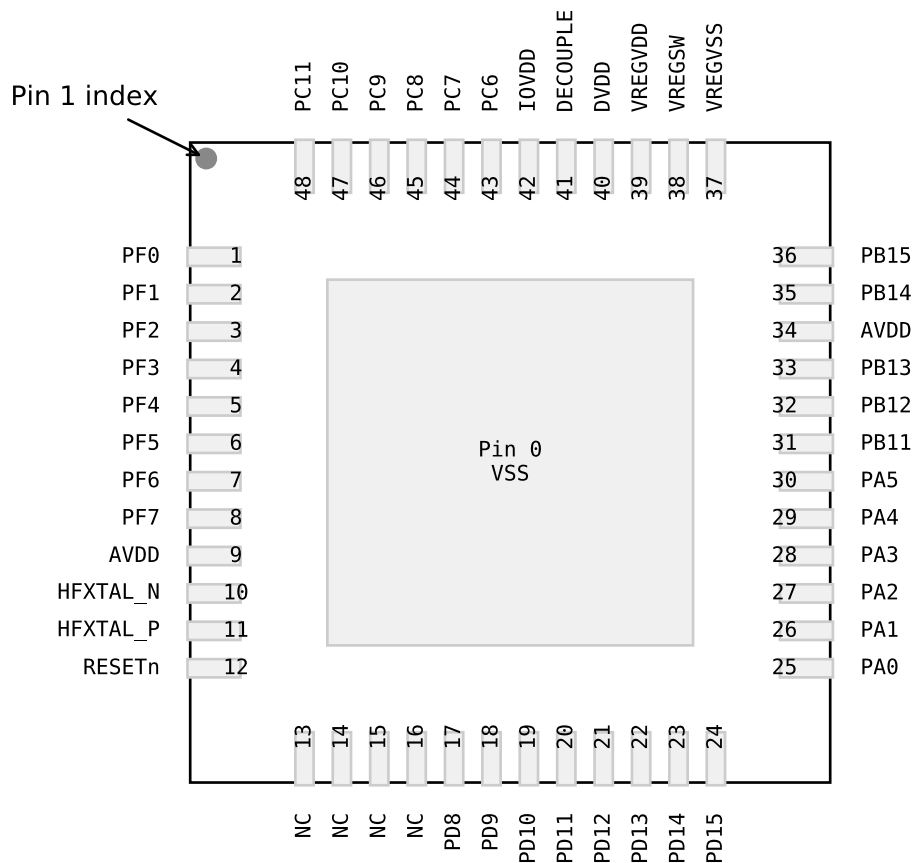


Figure 6.2. EFM32PG12B5xx in QFN48 Device Pinout

The following table provides package pin connections and general descriptions of pin functionality. For detailed information on the supported features for each GPIO pin, see [6.3 GPIO Functionality Table](#) or [6.4 Alternate Functionality Overview](#).

Table 6.2. EFM32PG12B5xx in QFN48 Device Pinout

Pin Name	Pin(s)	Description	Pin Name	Pin(s)	Description
VSS	0	Ground	PF0	1	GPIO (5V)
PF1	2	GPIO (5V)	PF2	3	GPIO (5V)
PF3	4	GPIO (5V)	PF4	5	GPIO (5V)
PF5	6	GPIO (5V)	PF6	7	GPIO (5V)
PF7	8	GPIO (5V)	AVDD	9 34	Analog power supply.
HFXTAL_N	10	High Frequency Crystal input pin.	HFXTAL_P	11	High Frequency Crystal output pin.

Pin Name	Pin(s)	Description	Pin Name	Pin(s)	Description
RESETn	12	Reset input, active low. To apply an external reset source to this pin, it is required to only drive this pin low during reset, and let the internal pull-up ensure that reset is released.	NC	13 14 15 16	No Connect.
PD8	17	GPIO (5V)	PD9	18	GPIO (5V)
PD10	19	GPIO (5V)	PD11	20	GPIO (5V)
PD12	21	GPIO (5V)	PD13	22	GPIO
PD14	23	GPIO	PD15	24	GPIO
PA0	25	GPIO	PA1	26	GPIO
PA2	27	GPIO	PA3	28	GPIO
PA4	29	GPIO	PA5	30	GPIO (5V)
PB11	31	GPIO	PB12	32	GPIO
PB13	33	GPIO	PB14	35	GPIO
PB15	36	GPIO	VREGVSS	37	Voltage regulator VSS
VREGSW	38	DCDC regulator switching node	VREGVDD	39	Voltage regulator VDD input
DVDD	40	Digital power supply.	DECOUPLE	41	Decouple output for on-chip voltage regulator. An external decoupling capacitor is required at this pin.
IOVDD	42	Digital IO power supply.	PC6	43	GPIO (5V)
PC7	44	GPIO (5V)	PC8	45	GPIO (5V)
PC9	46	GPIO (5V)	PC10	47	GPIO (5V)
PC11	48	GPIO (5V)			

**Note:**

- GPIO with 5V tolerance are indicated by (5V).
- The PD8 GPIO pin is not available (no-connect) on other device families, and should not be used if direct pin compatibility across multiple families is required.

### 6.3 GPIO Functionality Table

A wide selection of alternate functionality is available for multiplexing to various pins. The following table shows the name of each GPIO pin, followed by the functionality available on that pin. Refer to [6.4 Alternate Functionality Overview](#) for a list of GPIO locations available for each function.

**Table 6.3. GPIO Functionality Table**

GPIO Name	Pin Alternate Functionality / Description			
	Analog	Timers	Communication	Other
PF3	BUSAY BUSBX	TIM0_CC0 #27 TIM0_CC1 #26 TIM0_CC2 #25 TIM0_CDTI0 #24 TIM0_CDTI1 #23 TIM0_CDTI2 #22 TIM1_CC0 #27 TIM1_CC1 #26 TIM1_CC2 #25 TIM1_CC3 #24 WTIM0_CDTI2 #31 WTIM1_CC0 #27 WTIM1_CC1 #25 WTIM1_CC2 #23 WTIM1_CC3 #21 LE- TIM0_OUT0 #27 LE- TIM0_OUT1 #26 PCNT0_S0IN #27 PCNT0_S1IN #26	US0_TX #27 US0_RX #26 US0_CLK #25 US0_CS #24 US0_CTS #23 US0_RTS #22 US1_TX #27 US1_RX #26 US1_CLK #25 US1_CS #24 US1_CTS #23 US1_RTS #22 US2_TX #16 US2_RX #15 US2_CLK #14 US2_CS #13 US2_CTS #12 US2_RTS #11 LEU0_TX #27 LEU0_RX #26 I2C0_SDA #27 I2C0_SCL #26	CMU_CLK1 #6 PRS_CH0 #3 PRS_CH1 #2 PRS_CH2 #1 PRS_CH3 #0 ACMP0_O #27 ACMP1_O #27 DBG_TDI
PF1	BUSAY BUSBX	TIM0_CC0 #25 TIM0_CC1 #24 TIM0_CC2 #23 TIM0_CDTI0 #22 TIM0_CDTI1 #21 TIM0_CDTI2 #20 TIM1_CC0 #25 TIM1_CC1 #24 TIM1_CC2 #23 TIM1_CC3 #22 WTIM0_CDTI1 #31 WTIM0_CDTI2 #29 WTIM1_CC0 #25 WTIM1_CC1 #23 WTIM1_CC2 #21 WTIM1_CC3 #19 LE- TIM0_OUT0 #25 LE- TIM0_OUT1 #24 PCNT0_S0IN #25 PCNT0_S1IN #24	US0_TX #25 US0_RX #24 US0_CLK #23 US0_CS #22 US0_CTS #21 US0_RTS #20 US1_TX #25 US1_RX #24 US1_CLK #23 US1_CS #22 US1_CTS #21 US1_RTS #20 US2_TX #15 US2_RX #14 US2_CLK #13 US2_CS #12 US2_CTS #11 US2_RTS #10 LEU0_TX #25 LEU0_RX #24 I2C0_SDA #25 I2C0_SCL #24	PRS_CH0 #1 PRS_CH1 #0 PRS_CH2 #7 PRS_CH3 #6 ACMP0_O #25 ACMP1_O #25 DBG_SWDIOTMS BOOT_RX

GPIO Name	Pin Alternate Functionality / Description			
	Analog	Timers	Communication	Other
PC5	BUSAY BUSBX	WTIM0_CC0 #25 WTIM0_CC1 #23 WTIM0_CC2 #21 WTIM0_CDTI0 #17 WTIM0_CDTI1 #15 WTIM0_CDTI2 #13 WTIM1_CC0 #9 WTIM1_CC1 #7 WTIM1_CC2 #5 WTIM1_CC3 #3 PCNT1_S0IN #18 PCNT1_S1IN #17 PCNT2_S0IN #18 PCNT2_S1IN #17	US3_TX #23 US3_RX #22 US3_CLK #21 US3_CS #20 US3_CTS #19 US3_RTS #18 I2C1_SDA #18 I2C1_SCL #17	
PC3	BUSAY BUSBX	WTIM0_CC0 #23 WTIM0_CC1 #21 WTIM0_CC2 #19 WTIM0_CDTI0 #15 WTIM0_CDTI1 #13 WTIM0_CDTI2 #11 WTIM1_CC0 #7 WTIM1_CC1 #5 WTIM1_CC2 #3 WTIM1_CC3 #1 PCNT1_S0IN #16 PCNT1_S1IN #15 PCNT2_S0IN #16 PCNT2_S1IN #15	US3_TX #21 US3_RX #20 US3_CLK #19 US3_CS #18 US3_CTS #17 US3_RTS #16 I2C1_SDA #16 I2C1_SCL #15	
PC0	BUSBY BUSAX	WTIM0_CC0 #20 WTIM0_CC1 #18 WTIM0_CC2 #16 WTIM0_CDTI0 #12 WTIM0_CDTI1 #10 WTIM0_CDTI2 #8 WTIM1_CC0 #4 WTIM1_CC1 #2 WTIM1_CC2 #0 PCNT1_S0IN #13 PCNT1_S1IN #12 PCNT2_S0IN #13 PCNT2_S1IN #12	US3_TX #18 US3_RX #17 US3_CLK #16 US3_CS #15 US3_CTS #14 US3_RTS #13 I2C1_SDA #13 I2C1_SCL #12	

GPIO Name	Pin Alternate Functionality / Description			
	Analog	Timers	Communication	Other
PC11	BUSAY BUSBX	TIM0_CC0 #16 TIM0_CC1 #15 TIM0_CC2 #14 TIM0_CDTI0 #13 TIM0_CDTI1 #12 TIM0_CDTI2 #11 TIM1_CC0 #16 TIM1_CC1 #15 TIM1_CC2 #14 TIM1_CC3 #13 WTIM0_CC0 #31 WTIM0_CC1 #29 WTIM0_CC2 #27 WTIM0_CDTI0 #23 WTIM0_CDTI1 #21 WTIM0_CDTI2 #19 WTIM1_CC0 #15 WTIM1_CC1 #13 WTIM1_CC2 #11 WTIM1_CC3 #9 LE- TIM0_OUT0 #16 LE- TIM0_OUT1 #15 PCNT0_S0IN #16 PCNT0_S1IN #15 PCNT2_S0IN #20 PCNT2_S1IN #19	US0_TX #16 US0_RX #15 US0_CLK #14 US0_CS #13 US0_CTS #12 US0_RTS #11 US1_TX #16 US1_RX #15 US1_CLK #14 US1_CS #13 US1_CTS #12 US1_RTS #11 LEU0_TX #16 LEU0_RX #15 I2C0_SDA #16 I2C0_SCL #15 I2C1_SDA #20 I2C1_SCL #19	CMU_CLK0 #3 PRS_CH0 #13 PRS_CH9 #16 PRS_CH10 #5 PRS_CH11 #4 ACMP0_O #16 ACMP1_O #16 DBG_SWO #3
PC9	BUSAY BUSBX	TIM0_CC0 #14 TIM0_CC1 #13 TIM0_CC2 #12 TIM0_CDTI0 #11 TIM0_CDTI1 #10 TIM0_CDTI2 #9 TIM1_CC0 #14 TIM1_CC1 #13 TIM1_CC2 #12 TIM1_CC3 #11 WTIM0_CC0 #29 WTIM0_CC1 #27 WTIM0_CC2 #25 WTIM0_CDTI0 #21 WTIM0_CDTI1 #19 WTIM0_CDTI2 #17 WTIM1_CC0 #13 WTIM1_CC1 #11 WTIM1_CC2 #9 WTIM1_CC3 #7 LE- TIM0_OUT0 #14 LE- TIM0_OUT1 #13 PCNT0_S0IN #14 PCNT0_S1IN #13	US0_TX #14 US0_RX #13 US0_CLK #12 US0_CS #11 US0_CTS #10 US0_RTS #9 US1_TX #14 US1_RX #13 US1_CLK #12 US1_CS #11 US1_CTS #10 US1_RTS #9 LEU0_TX #14 LEU0_RX #13 I2C0_SDA #14 I2C0_SCL #13	PRS_CH0 #11 PRS_CH9 #14 PRS_CH10 #3 PRS_CH11 #2 ACMP0_O #14 ACMP1_O #14 ETM_TD2 #3

GPIO Name	Pin Alternate Functionality / Description			
	Analog	Timers	Communication	Other
PC7	BUSAY BUSBX	TIM0_CC0 #12 TIM0_CC1 #11 TIM0_CC2 #10 TIM0_CDTI0 #9 TIM0_CDTI1 #8 TIM0_CDTI2 #7 TIM1_CC0 #12 TIM1_CC1 #11 TIM1_CC2 #10 TIM1_CC3 #9 WTIM0_CC0 #27 WTIM0_CC1 #25 WTIM0_CC2 #23 WTIM0_CDTI0 #19 WTIM0_CDTI1 #17 WTIM0_CDTI2 #15 WTIM1_CC0 #11 WTIM1_CC1 #9 WTIM1_CC2 #7 WTIM1_CC3 #5 LE- TIM0_OUT0 #12 LE- TIM0_OUT1 #11 PCNT0_S0IN #12 PCNT0_S1IN #11	US0_TX #12 US0_RX #11 US0_CLK #10 US0_CS #9 US0_CTS #8 US0_RTS #7 US1_TX #12 US1_RX #11 US1_CLK #10 US1_CS #9 US1_CTS #8 US1_RTS #7 LEU0_TX #12 LEU0_RX #11 I2C0_SDA #12 I2C0_SCL #11	CMU_CLK1 #2 PRS_CH0 #9 PRS_CH9 #12 PRS_CH10 #1 PRS_CH11 #0 ACMP0_O #12 ACMP1_O #12 ETM_TD0 #3
PF8	BUSBY BUSAX	WTIM1_CC1 #30 WTIM1_CC2 #28 WTIM1_CC3 #26 PCNT1_S0IN #21 PCNT1_S1IN #20 PCNT2_S0IN #21 PCNT2_S1IN #20	US2_TX #21 US2_RX #20 US2_CLK #19 US2_CS #18 US2_CTS #17 US2_RTS #16 I2C1_SDA #21 I2C1_SCL #20	ETM_TCLK #0
PF2	BUSBY BUSAX	TIM0_CC0 #26 TIM0_CC1 #25 TIM0_CC2 #24 TIM0_CDTI0 #23 TIM0_CDTI1 #22 TIM0_CDTI2 #21 TIM1_CC0 #26 TIM1_CC1 #25 TIM1_CC2 #24 TIM1_CC3 #23 WTIM0_CDTI2 #30 WTIM1_CC0 #26 WTIM1_CC1 #24 WTIM1_CC2 #22 WTIM1_CC3 #20 LE- TIM0_OUT0 #26 LE- TIM0_OUT1 #25 PCNT0_S0IN #26 PCNT0_S1IN #25	US0_TX #26 US0_RX #25 US0_CLK #24 US0_CS #23 US0_CTS #22 US0_RTS #21 US1_TX #26 US1_RX #25 US1_CLK #24 US1_CS #23 US1_CTS #22 US1_RTS #21 LEU0_TX #26 LEU0_RX #25 I2C0_SDA #26 I2C0_SCL #25	CMU_CLK0 #6 PRS_CH0 #2 PRS_CH1 #1 PRS_CH2 #0 PRS_CH3 #7 ACMP0_O #26 ACMP1_O #26 DBG_TDO DBG_SWO #0 GPIO_EM4WU0

GPIO Name	Pin Alternate Functionality / Description			
	Analog	Timers	Communication	Other
PF0	BUSBY BUSAX	TIM0_CC0 #24 TIM0_CC1 #23 TIM0_CC2 #22 TIM0_CDTI0 #21 TIM0_CDTI1 #20 TIM0_CDTI2 #19 TIM1_CC0 #24 TIM1_CC1 #23 TIM1_CC2 #22 TIM1_CC3 #21 WTIM0_CDTI1 #30 WTIM0_CDTI2 #28 WTIM1_CC0 #24 WTIM1_CC1 #22 WTIM1_CC2 #20 WTIM1_CC3 #18 LE- TIM0_OUT0 #24 LE- TIM0_OUT1 #23 PCNT0_S0IN #24 PCNT0_S1IN #23	US0_TX #24 US0_RX #23 US0_CLK #22 US0_CS #21 US0_CTS #20 US0_RTS #19 US1_TX #24 US1_RX #23 US1_CLK #22 US1_CS #21 US1_CTS #20 US1_RTS #19 US2_TX #14 US2_RX #13 US2_CLK #12 US2_CS #11 US2_CTS #10 US2_RTS #9 LEU0_TX #24 LEU0_RX #23 I2C0_SDA #24 I2C0_SCL #23	PRS_CH0 #0 PRS_CH1 #7 PRS_CH2 #6 PRS_CH3 #5 ACMP0_O #24 ACMP1_O #24 DBG_SWCLKTCK BOOT_TX
PC4	BUSBY BUSAX	WTIM0_CC0 #24 WTIM0_CC1 #22 WTIM0_CC2 #20 WTIM0_CDTI0 #16 WTIM0_CDTI1 #14 WTIM0_CDTI2 #12 WTIM1_CC0 #8 WTIM1_CC1 #6 WTIM1_CC2 #4 WTIM1_CC3 #2 PCNT1_S0IN #17 PCNT1_S1IN #16 PCNT2_S0IN #17 PCNT2_S1IN #16	US3_TX #22 US3_RX #21 US3_CLK #20 US3_CS #19 US3_CTS #18 US3_RTS #17 I2C1_SDA #17 I2C1_SCL #16	
PC1	BUSAY BUSBX	WTIM0_CC0 #21 WTIM0_CC1 #19 WTIM0_CC2 #17 WTIM0_CDTI0 #13 WTIM0_CDTI1 #11 WTIM0_CDTI2 #9 WTIM1_CC0 #5 WTIM1_CC1 #3 WTIM1_CC2 #1 PCNT1_S0IN #14 PCNT1_S1IN #13 PCNT2_S0IN #14 PCNT2_S1IN #13	US3_TX #19 US3_RX #18 US3_CLK #17 US3_CS #16 US3_CTS #15 US3_RTS #14 I2C1_SDA #14 I2C1_SCL #13	
PJ14	BUSACMP1Y BU- SACMP1X	PCNT1_S0IN #11 PCNT1_S1IN #10 PCNT2_S0IN #11 PCNT2_S1IN #10	US3_TX #16 US3_RX #15 US3_CLK #14 US3_CS #13 US3_CTS #12 US3_RTS #11 I2C1_SDA #11 I2C1_SCL #10	LES_ALTEX2

GPIO Name	Pin Alternate Functionality / Description			
	Analog	Timers	Communication	Other
PC10	BUSBY BUSAX	TIM0_CC0 #15 TIM0_CC1 #14 TIM0_CC2 #13 TIM0_CDTI0 #12 TIM0_CDTI1 #11 TIM0_CDTI2 #10 TIM1_CC0 #15 TIM1_CC1 #14 TIM1_CC2 #13 TIM1_CC3 #12 WTIM0_CC0 #30 WTIM0_CC1 #28 WTIM0_CC2 #26 WTIM0_CDTI0 #22 WTIM0_CDTI1 #20 WTIM0_CDTI2 #18 WTIM1_CC0 #14 WTIM1_CC1 #12 WTIM1_CC2 #10 WTIM1_CC3 #8 LE- TIM0_OUT0 #15 LE- TIM0_OUT1 #14 PCNT0_S0IN #15 PCNT0_S1IN #14 PCNT2_S0IN #19 PCNT2_S1IN #18	US0_TX #15 US0_RX #14 US0_CLK #13 US0_CS #12 US0_CTS #11 US0_RTS #10 US1_TX #15 US1_RX #14 US1_CLK #13 US1_CS #12 US1_CTS #11 US1_RTS #10 LEU0_TX #15 LEU0_RX #14 I2C0_SDA #15 I2C0_SCL #14 I2C1_SDA #19 I2C1_SCL #18	CMU_CLK1 #3 PRS_CH0 #12 PRS_CH9 #15 PRS_CH10 #4 PRS_CH11 #3 ACMP0_O #15 ACMP1_O #15 ETM_TD3 #3 GPIO_EM4WU12
PC8	BUSBY BUSAX	TIM0_CC0 #13 TIM0_CC1 #12 TIM0_CC2 #11 TIM0_CDTI0 #10 TIM0_CDTI1 #9 TIM0_CDTI2 #8 TIM1_CC0 #13 TIM1_CC1 #12 TIM1_CC2 #11 TIM1_CC3 #10 WTIM0_CC0 #28 WTIM0_CC1 #26 WTIM0_CC2 #24 WTIM0_CDTI0 #20 WTIM0_CDTI1 #18 WTIM0_CDTI2 #16 WTIM1_CC0 #12 WTIM1_CC1 #10 WTIM1_CC2 #8 WTIM1_CC3 #6 LE- TIM0_OUT0 #13 LE- TIM0_OUT1 #12 PCNT0_S0IN #13 PCNT0_S1IN #12	US0_TX #13 US0_RX #12 US0_CLK #11 US0_CS #10 US0_CTS #9 US0_RTS #8 US1_TX #13 US1_RX #12 US1_CLK #11 US1_CS #10 US1_CTS #9 US1_RTS #8 LEU0_TX #13 LEU0_RX #12 I2C0_SDA #13 I2C0_SCL #12	PRS_CH0 #10 PRS_CH9 #13 PRS_CH10 #2 PRS_CH11 #1 ACMP0_O #13 ACMP1_O #13 ETM_TD1 #3

GPIO Name	Pin Alternate Functionality / Description			
	Analog	Timers	Communication	Other
PC6	BUSBY BUSAX	TIM0_CC0 #11 TIM0_CC1 #10 TIM0_CC2 #9 TIM0_CDTI0 #8 TIM0_CDTI1 #7 TIM0_CDTI2 #6 TIM1_CC0 #11 TIM1_CC1 #10 TIM1_CC2 #9 TIM1_CC3 #8 WTIM0_CC0 #26 WTIM0_CC1 #24 WTIM0_CC2 #22 WTIM0_CDTI0 #18 WTIM0_CDTI1 #16 WTIM0_CDTI2 #14 WTIM1_CC0 #10 WTIM1_CC1 #8 WTIM1_CC2 #6 WTIM1_CC3 #4 LE-TIM0_OUT0 #11 LE-TIM0_OUT1 #10 PCNT0_S0IN #11 PCNT0_S1IN #10	US0_TX #11 US0_RX #10 US0_CLK #9 US0_CS #8 US0_CTS #7 US0_RTS #6 US1_TX #11 US1_RX #10 US1_CLK #9 US1_CS #8 US1_CTS #7 US1_RTS #6 LEU0_TX #11 LEU0_RX #10 I2C0_SDA #11 I2C0_SCL #10	CMU_CLK0 #2 CMU_CLKI0 #2 PRS_CH0 #8 PRS_CH9 #11 PRS_CH10 #0 PRS_CH11 #5 ACMP0_O #11 ACMP1_O #11 ETM_TCLK #3
PF11	BUSAY BUSBX	WTIM1_CC2 #31 WTIM1_CC3 #29 PCNT1_S0IN #24 PCNT1_S1IN #23 PCNT2_S0IN #24 PCNT2_S1IN #23	US2_TX #24 US2_RX #23 US2_CLK #22 US2_CS #21 US2_CTS #20 US2_RTS #19 US3_TX #24 US3_RX #23 US3_CLK #22 US3_CS #21 US3_CTS #20 US3_RTS #19 I2C1_SDA #24 I2C1_SCL #23	ETM_TD2 #0
PF10	BUSBY BUSAX	WTIM1_CC2 #30 WTIM1_CC3 #28 PCNT1_S0IN #23 PCNT1_S1IN #22 PCNT2_S0IN #23 PCNT2_S1IN #22	US2_TX #23 US2_RX #22 US2_CLK #21 US2_CS #20 US2_CTS #19 US2_RTS #18 I2C1_SDA #23 I2C1_SCL #22	ETM_TD1 #0
PF9	BUSAY BUSBX	WTIM1_CC1 #31 WTIM1_CC2 #29 WTIM1_CC3 #27 PCNT1_S0IN #22 PCNT1_S1IN #21 PCNT2_S0IN #22 PCNT2_S1IN #21	US2_TX #22 US2_RX #21 US2_CLK #20 US2_CS #19 US2_CTS #18 US2_RTS #17 I2C1_SDA #22 I2C1_SCL #21	ETM_TD0 #0

GPIO Name	Pin Alternate Functionality / Description			
	Analog	Timers	Communication	Other
PC2	BUSBY BUSAX	WTIM0_CC0 #22 WTIM0_CC1 #20 WTIM0_CC2 #18 WTIM0_CDTI0 #14 WTIM0_CDTI1 #12 WTIM0_CDTI2 #10 WTIM1_CC0 #6 WTIM1_CC1 #4 WTIM1_CC2 #2 WTIM1_CC3 #0 PCNT1_S0IN #15 PCNT1_S1IN #14 PCNT2_S0IN #15 PCNT2_S1IN #14	US3_TX #20 US3_RX #19 US3_CLK #18 US3_CS #17 US3_CTS #16 US3_RTS #15 I2C1_SDA #15 I2C1_SCL #14	
PJ15	BUSACMP1Y BU- SACMP1X	PCNT1_S0IN #12 PCNT1_S1IN #11 PCNT2_S0IN #12 PCNT2_S1IN #11	US3_TX #17 US3_RX #16 US3_CLK #15 US3_CS #14 US3_CTS #13 US3_RTS #12 I2C1_SDA #12 I2C1_SCL #11	LES_ALTEX3
PB15	BUSCY BUSDX LFXTAL_P	TIM0_CC0 #10 TIM0_CC1 #9 TIM0_CC2 #8 TIM0_CDTI0 #7 TIM0_CDTI1 #6 TIM0_CDTI2 #5 TIM1_CC0 #10 TIM1_CC1 #9 TIM1_CC2 #8 TIM1_CC3 #7 WTIM0_CC0 #19 WTIM0_CC1 #17 WTIM0_CC2 #15 WTIM0_CDTI0 #11 WTIM0_CDTI1 #9 WTIM0_CDTI2 #7 WTIM1_CC0 #3 WTIM1_CC1 #1 LE- TIM0_OUT0 #10 LE- TIM0_OUT1 #9 PCNT0_S0IN #10 PCNT0_S1IN #9	US0_TX #10 US0_RX #9 US0_CLK #8 US0_CS #7 US0_CTS #6 US0_RTS #5 US1_TX #10 US1_RX #9 US1_CLK #8 US1_CS #7 US1_CTS #6 US1_RTS #5 LEU0_TX #10 LEU0_RX #9 I2C0_SDA #10 I2C0_SCL #9	CMU_CLK0 #1 PRS_CH6 #10 PRS_CH7 #9 PRS_CH8 #8 PRS_CH9 #7 ACMP0_O #10 ACMP1_O #10
PB14	BUSDY BUSCX LFXTAL_N	TIM0_CC0 #9 TIM0_CC1 #8 TIM0_CC2 #7 TIM0_CDTI0 #6 TIM0_CDTI1 #5 TIM0_CDTI2 #4 TIM1_CC0 #9 TIM1_CC1 #8 TIM1_CC2 #7 TIM1_CC3 #6 WTIM0_CC0 #18 WTIM0_CC1 #16 WTIM0_CC2 #14 WTIM0_CDTI0 #10 WTIM0_CDTI1 #8 WTIM0_CDTI2 #6 WTIM1_CC0 #2 WTIM1_CC1 #0 LE- TIM0_OUT0 #9 LE- TIM0_OUT1 #8 PCNT0_S0IN #9 PCNT0_S1IN #8	US0_TX #9 US0_RX #8 US0_CLK #7 US0_CS #6 US0_CTS #5 US0_RTS #4 US1_TX #9 US1_RX #8 US1_CLK #7 US1_CS #6 US1_CTS #5 US1_RTS #4 LEU0_TX #9 LEU0_RX #8 I2C0_SDA #9 I2C0_SCL #8	CMU_CLK1 #1 PRS_CH6 #9 PRS_CH7 #8 PRS_CH8 #7 PRS_CH9 #6 ACMP0_O #9 ACMP1_O #9

GPIO Name	Pin Alternate Functionality / Description			
	Analog	Timers	Communication	Other
PB13	BUSCY BUSDX OPA2_N	TIM0_CC0 #8 TIM0_CC1 #7 TIM0_CC2 #6 TIM0_CDTI0 #5 TIM0_CDTI1 #4 TIM0_CDTI2 #3 TIM1_CC0 #8 TIM1_CC1 #7 TIM1_CC2 #6 TIM1_CC3 #5 WTIM0_CC0 #17 WTIM0_CC1 #15 WTIM0_CC2 #13 WTIM0_CDTI0 #9 WTIM0_CDTI1 #7 WTIM0_CDTI2 #5 WTIM1_CC0 #1 LE-TIM0_OUT0 #8 LE-TIM0_OUT1 #7 PCNT0_S0IN #8 PCNT0_S1IN #7	US0_TX #8 US0_RX #7 US0_CLK #6 US0_CS #5 US0_CTS #4 US0_RTS #3 US1_TX #8 US1_RX #7 US1_CLK #6 US1_CS #5 US1_CTS #4 US1_RTS #3 LEU0_TX #8 LEU0_RX #7 I2C0_SDA #8 I2C0_SCL #7	CMU_CLKI0 #0 PRS_CH6 #8 PRS_CH7 #7 PRS_CH8 #6 PRS_CH9 #5 ACMP0_O #8 ACMP1_O #8 DBG_SWO #1 GPIO_EM4WU9
PB12	BUSDY BUSCX OPA2_OUT	TIM0_CC0 #7 TIM0_CC1 #6 TIM0_CC2 #5 TIM0_CDTI0 #4 TIM0_CDTI1 #3 TIM0_CDTI2 #2 TIM1_CC0 #7 TIM1_CC1 #6 TIM1_CC2 #5 TIM1_CC3 #4 WTIM0_CC0 #16 WTIM0_CC1 #14 WTIM0_CC2 #12 WTIM0_CDTI0 #8 WTIM0_CDTI1 #6 WTIM0_CDTI2 #4 WTIM1_CC0 #0 LE-TIM0_OUT0 #7 LE-TIM0_OUT1 #6 PCNT0_S0IN #7 PCNT0_S1IN #6	US0_TX #7 US0_RX #6 US0_CLK #5 US0_CS #4 US0_CTS #3 US0_RTS #2 US1_TX #7 US1_RX #6 US1_CLK #5 US1_CS #4 US1_CTS #3 US1_RTS #2 LEU0_TX #7 LEU0_RX #6 I2C0_SDA #7 I2C0_SCL #6	PRS_CH6 #7 PRS_CH7 #6 PRS_CH8 #5 PRS_CH9 #4 ACMP0_O #7 ACMP1_O #7
PF14	BUSBY BUSAX	PCNT1_S0IN #27 PCNT1_S1IN #26 PCNT2_S0IN #27 PCNT2_S1IN #26	US2_TX #27 US2_RX #26 US2_CLK #25 US2_CS #24 US2_CTS #23 US2_RTS #22 US3_TX #27 US3_RX #26 US3_CLK #25 US3_CS #24 US3_CTS #23 US3_RTS #22 I2C1_SDA #27 I2C1_SCL #26	
PF13	BUSAY BUSBX	WTIM1_CC3 #31 PCNT1_S0IN #26 PCNT1_S1IN #25 PCNT2_S0IN #26 PCNT2_S1IN #25	US2_TX #26 US2_RX #25 US2_CLK #24 US2_CS #23 US2_CTS #22 US2_RTS #21 US3_TX #26 US3_RX #25 US3_CLK #24 US3_CS #23 US3_CTS #22 US3_RTS #21 I2C1_SDA #26 I2C1_SCL #25	

GPIO Name	Pin Alternate Functionality / Description			
	Analog	Timers	Communication	Other
PF12	BUSBY BUSAX	WTIM1_CC3 #30 PCNT1_S0IN #25 PCNT1_S1IN #24 PCNT2_S0IN #25 PCNT2_S1IN #24	US2_TX #25 US2_RX #24 US2_CLK #23 US2_CS #22 US2_CTS #21 US2_RTS #20 US3_TX #25 US3_RX #24 US3_CLK #23 US3_CS #22 US3_CTS #21 US3_RTS #20 I2C1_SDA #25 I2C1_SCL #24	ETM_TD3 #0
PB11	BUSCY BUSDX OPA2_P	TIM0_CC0 #6 TIM0_CC1 #5 TIM0_CC2 #4 TIM0_CDTI0 #3 TIM0_CDTI1 #2 TIM0_CDTI2 #1 TIM1_CC0 #6 TIM1_CC1 #5 TIM1_CC2 #4 TIM1_CC3 #3 WTIM0_CC0 #15 WTIM0_CC1 #13 WTIM0_CC2 #11 WTIM0_CDTI0 #7 WTIM0_CDTI1 #5 WTIM0_CDTI2 #3 LE-TIM0_OUT0 #6 LE-TIM0_OUT1 #5 PCNT0_S0IN #6 PCNT0_S1IN #5	US0_TX #6 US0_RX #5 US0_CLK #4 US0_CS #3 US0_CTS #2 US0_RTS #1 US1_TX #6 US1_RX #5 US1_CLK #4 US1_CS #3 US1_CTS #2 US1_RTS #1 US3_TX #15 US3_RX #14 US3_CLK #13 US3_CS #12 US3_CTS #11 US3_RTS #10 LEU0_TX #6 LEU0_RX #5 I2C0_SDA #6 I2C0_SCL #5	PRS_CH6 #6 PRS_CH7 #5 PRS_CH8 #4 PRS_CH9 #3 ACMP0_O #6 ACMP1_O #6
PB10	OPA2_OUTALT #1 BUSDY BUSCX	WTIM0_CC0 #14 WTIM0_CC1 #12 WTIM0_CC2 #10 WTIM0_CDTI0 #6 WTIM0_CDTI1 #4 WTIM0_CDTI2 #2 PCNT1_S0IN #10 PCNT1_S1IN #9 PCNT2_S0IN #10 PCNT2_S1IN #9	US2_TX #13 US2_RX #12 US2_CLK #11 US2_CS #10 US2_CTS #9 US2_RTS #8 US3_TX #14 US3_RX #13 US3_CLK #12 US3_CS #11 US3_CTS #10 US3_RTS #9 I2C1_SDA #10 I2C1_SCL #9	
PB9	OPA2_OUTALT #0 BUSCY BUSDX	WTIM0_CC0 #13 WTIM0_CC1 #11 WTIM0_CC2 #9 WTIM0_CDTI0 #5 WTIM0_CDTI1 #3 WTIM0_CDTI2 #1 PCNT1_S0IN #9 PCNT1_S1IN #8 PCNT2_S0IN #9 PCNT2_S1IN #8	US2_TX #12 US2_RX #11 US2_CLK #10 US2_CS #9 US2_CTS #8 US2_RTS #7 US3_TX #13 US3_RX #12 US3_CLK #11 US3_CS #10 US3_CTS #9 US3_RTS #8 I2C1_SDA #9 I2C1_SCL #8	
PK1		PCNT1_S0IN #30 PCNT1_S1IN #29 PCNT2_S0IN #30 PCNT2_S1IN #29	US2_TX #30 US2_RX #29 US2_CLK #28 US2_CS #27 US2_CTS #26 US2_RTS #25 US3_TX #30 US3_RX #29 US3_CLK #28 US3_CS #27 US3_CTS #26 US3_RTS #25 I2C1_SDA #30 I2C1_SCL #29	

GPIO Name	Pin Alternate Functionality / Description			
	Analog	Timers	Communication	Other
PK0	IDAC0_OUT	PCNT1_S0IN #29 PCNT1_S1IN #28 PCNT2_S0IN #29 PCNT2_S1IN #28	US2_TX #29 US2_RX #28 US2_CLK #27 US2_CS #26 US2_CTS #25 US2_RTS #24 US3_TX #29 US3_RX #28 US3_CLK #27 US3_CS #26 US3_CTS #25 US3_RTS #24 I2C1_SDA #29 I2C1_SCL #28	
PF15	BUSAY BUSBX	PCNT1_S0IN #28 PCNT1_S1IN #27 PCNT2_S0IN #28 PCNT2_S1IN #27	US2_TX #28 US2_RX #27 US2_CLK #26 US2_CS #25 US2_CTS #24 US2_RTS #23 US3_TX #28 US3_RX #27 US3_CLK #26 US3_CS #25 US3_CTS #24 US3_RTS #23 I2C1_SDA #28 I2C1_SCL #27	
PB8	BUSDY BUSCX	WTIM0_CC0 #12 WTIM0_CC1 #10 WTIM0_CC2 #8 WTIM0_CDTI0 #4 WTIM0_CDTI1 #2 WTIM0_CDTI2 #0 PCNT1_S0IN #8 PCNT1_S1IN #7 PCNT2_S0IN #8 PCNT2_S1IN #7	US2_TX #11 US2_RX #10 US2_CLK #9 US2_CS #8 US2_CTS #7 US2_RTS #6 US3_TX #12 US3_RX #11 US3_CLK #10 US3_CS #9 US3_CTS #8 US3_RTS #7 I2C1_SDA #8 I2C1_SCL #7	ETM_TD3 #2
PB7	BUSCY BUSDX	WTIM0_CC0 #11 WTIM0_CC1 #9 WTIM0_CC2 #7 WTIM0_CDTI0 #3 WTIM0_CDTI1 #1 PCNT1_S0IN #7 PCNT1_S1IN #6 PCNT2_S0IN #7 PCNT2_S1IN #6	US2_TX #10 US2_RX #9 US2_CLK #8 US2_CS #7 US2_CTS #6 US2_RTS #5 US3_TX #11 US3_RX #10 US3_CLK #9 US3_CS #8 US3_CTS #7 US3_RTS #6 I2C1_SDA #7 I2C1_SCL #6	ETM_TD2 #2
PK2		PCNT1_S0IN #31 PCNT1_S1IN #30 PCNT2_S0IN #31 PCNT2_S1IN #30	US2_TX #31 US2_RX #30 US2_CLK #29 US2_CS #28 US2_CTS #27 US2_RTS #26 US3_TX #31 US3_RX #30 US3_CLK #29 US3_CS #28 US3_CTS #27 US3_RTS #26 I2C1_SDA #31 I2C1_SCL #30	
PB6	BUSDY BUSCX	WTIM0_CC0 #10 WTIM0_CC1 #8 WTIM0_CC2 #6 WTIM0_CDTI0 #2 WTIM0_CDTI1 #0 PCNT1_S0IN #6 PCNT1_S1IN #5 PCNT2_S0IN #6 PCNT2_S1IN #5	US2_TX #9 US2_RX #8 US2_CLK #7 US2_CS #6 US2_CTS #5 US2_RTS #4 US3_TX #10 US3_RX #9 US3_CLK #8 US3_CS #7 US3_CTS #6 US3_RTS #5 I2C1_SDA #6 I2C1_SCL #5	CMU_CLKI0 #3 ETM_TD1 #2

GPIO Name	Pin Alternate Functionality / Description			
	Analog	Timers	Communication	Other
PI3	BUSADC0Y BUSADC0X	PCNT1_S0IN #5 PCNT1_S1IN #4 PCNT2_S0IN #5 PCNT2_S1IN #4	US2_TX #8 US2_RX #7 US2_CLK #6 US2_CS #5 US2_CTS #4 US2_RTS #3 US3_TX #9 US3_RX #8 US3_CLK #7 US3_CS #6 US3_CTS #5 US3_RTS #4 I2C1_SDA #5 I2C1_SCL #4	LES_ALTEX7 ETM_TD0 #2
PF5	BUSAY BUSBX	TIM0_CC0 #29 TIM0_CC1 #28 TIM0_CC2 #27 TIM0_CDTI0 #26 TIM0_CDTI1 #25 TIM0_CDTI2 #24 TIM1_CC0 #29 TIM1_CC1 #28 TIM1_CC2 #27 TIM1_CC3 #26 WTIM1_CC0 #29 WTIM1_CC1 #27 WTIM1_CC2 #25 WTIM1_CC3 #23 LE- TIM0_OUT0 #29 LE- TIM0_OUT1 #28 PCNT0_S0IN #29 PCNT0_S1IN #28	US0_TX #29 US0_RX #28 US0_CLK #27 US0_CS #26 US0_CTS #25 US0_RTS #24 US1_TX #29 US1_RX #28 US1_CLK #27 US1_CS #26 US1_CTS #25 US1_RTS #24 US2_TX #18 US2_RX #17 US2_CLK #16 US2_CS #15 US2_CTS #14 US2_RTS #13 LEU0_TX #29 LEU0_RX #28 I2C0_SDA #29 I2C0_SCL #28	PRS_CH0 #5 PRS_CH1 #4 PRS_CH2 #3 PRS_CH3 #2 ACMP0_O #29 ACMP1_O #29
PF4	BUSBY BUSAX	TIM0_CC0 #28 TIM0_CC1 #27 TIM0_CC2 #26 TIM0_CDTI0 #25 TIM0_CDTI1 #24 TIM0_CDTI2 #23 TIM1_CC0 #28 TIM1_CC1 #27 TIM1_CC2 #26 TIM1_CC3 #25 WTIM1_CC0 #28 WTIM1_CC1 #26 WTIM1_CC2 #24 WTIM1_CC3 #22 LE- TIM0_OUT0 #28 LE- TIM0_OUT1 #27 PCNT0_S0IN #28 PCNT0_S1IN #27	US0_TX #28 US0_RX #27 US0_CLK #26 US0_CS #25 US0_CTS #24 US0_RTS #23 US1_TX #28 US1_RX #27 US1_CLK #26 US1_CS #25 US1_CTS #24 US1_RTS #23 US2_TX #17 US2_RX #16 US2_CLK #15 US2_CS #14 US2_CTS #13 US2_RTS #12 LEU0_TX #28 LEU0_RX #27 I2C0_SDA #28 I2C0_SCL #27	PRS_CH0 #4 PRS_CH1 #3 PRS_CH2 #2 PRS_CH3 #1 ACMP0_O #28 ACMP1_O #28
PI2	BUSADC0Y BUSADC0X	PCNT1_S0IN #4 PCNT1_S1IN #3 PCNT2_S0IN #4 PCNT2_S1IN #3	US2_TX #7 US2_RX #6 US2_CLK #5 US2_CS #4 US2_CTS #3 US2_RTS #2 US3_TX #8 US3_RX #7 US3_CLK #6 US3_CS #5 US3_CTS #4 US3_RTS #3 I2C1_SDA #4 I2C1_SCL #3	LES_ALTEX6 ETM_TCLK #2
PI1	BUSADC0Y BUSADC0X		US2_TX #6 US2_RX #5 US2_CLK #4 US2_CS #3 US2_CTS #2 US2_RTS #1	LES_ALTEX5

GPIO Name	Pin Alternate Functionality / Description			
	Analog	Timers	Communication	Other
PI0	BUSADC0Y BUSADC0X		US2_TX #5 US2_RX #4 US2_CLK #3 US2_CS #2 US2_CTS #1 US2_RTS #0	LES_ALTEX4
PF7	BUSAY BUSBX	TIM0_CC0 #31 TIM0_CC1 #30 TIM0_CC2 #29 TIM0_CDTI0 #28 TIM0_CDTI1 #27 TIM0_CDTI2 #26 TIM1_CC0 #31 TIM1_CC1 #30 TIM1_CC2 #29 TIM1_CC3 #28 WTIM1_CC0 #31 WTIM1_CC1 #29 WTIM1_CC2 #27 WTIM1_CC3 #25 LE- TIM0_OUT0 #31 LE- TIM0_OUT1 #30 PCNT0_S0IN #31 PCNT0_S1IN #30 PCNT1_S0IN #20 PCNT1_S1IN #19	US0_TX #31 US0_RX #30 US0_CLK #29 US0_CS #28 US0_CTS #27 US0_RTS #26 US1_TX #31 US1_RX #30 US1_CLK #29 US1_CS #28 US1_CTS #27 US1_RTS #26 US2_TX #20 US2_RX #19 US2_CLK #18 US2_CS #17 US2_CTS #16 US2_RTS #15 LEU0_TX #31 LEU0_RX #30 I2C0_SDA #31 I2C0_SCL #30	CMU_CLKI0 #1 CMU_CLK0 #7 PRS_CH0 #7 PRS_CH1 #6 PRS_CH2 #5 PRS_CH3 #4 ACMP0_O #31 ACMP1_O #31 GPIO_EM4WU1
PF6	BUSBY BUSAX	TIM0_CC0 #30 TIM0_CC1 #29 TIM0_CC2 #28 TIM0_CDTI0 #27 TIM0_CDTI1 #26 TIM0_CDTI2 #25 TIM1_CC0 #30 TIM1_CC1 #29 TIM1_CC2 #28 TIM1_CC3 #27 WTIM1_CC0 #30 WTIM1_CC1 #28 WTIM1_CC2 #26 WTIM1_CC3 #24 LE- TIM0_OUT0 #30 LE- TIM0_OUT1 #29 PCNT0_S0IN #30 PCNT0_S1IN #29 PCNT1_S0IN #19 PCNT1_S1IN #18	US0_TX #30 US0_RX #29 US0_CLK #28 US0_CS #27 US0_CTS #26 US0_RTS #25 US1_TX #30 US1_RX #29 US1_CLK #28 US1_CS #27 US1_CTS #26 US1_RTS #25 US2_TX #19 US2_RX #18 US2_CLK #17 US2_CS #16 US2_CTS #15 US2_RTS #14 LEU0_TX #30 LEU0_RX #29 I2C0_SDA #30 I2C0_SCL #29	CMU_CLK1 #7 PRS_CH0 #6 PRS_CH1 #5 PRS_CH2 #4 PRS_CH3 #3 ACMP0_O #30 ACMP1_O #30
PA9	BUSACMP0Y BU- SACMP0X	WTIM0_CC0 #9 WTIM0_CC1 #7 WTIM0_CC2 #5 WTIM0_CDTI0 #1 PCNT1_S0IN #3 PCNT1_S1IN #2 PCNT2_S0IN #3 PCNT2_S1IN #2	US2_TX #4 US2_RX #3 US2_CLK #2 US2_CS #1 US2_CTS #0 US2_RTS #31 I2C1_SDA #3 I2C1_SCL #2	LES_ALTEX1 ETM_TD3 #1

GPIO Name	Pin Alternate Functionality / Description			
	Analog	Timers	Communication	Other
PA8	BUSACMP0Y BU-SACMP0X	WTIM0_CC0 #8 WTIM0_CC1 #6 WTIM0_CC2 #4 WTIM0_CDTI0 #0 PCNT1_S0IN #2 PCNT1_S1IN #1 PCNT2_S0IN #2 PCNT2_S1IN #1	US2_TX #3 US2_RX #2 US2_CLK #1 US2_CS #0 US2_CTS #31 US2_RTS #30 I2C1_SDA #2 I2C1_SCL #1	LES_ALTEX0 ETM_TD2 #1
PA7	BUSCY BUSDX	WTIM0_CC0 #7 WTIM0_CC1 #5 WTIM0_CC2 #3 PCNT1_S0IN #1 PCNT1_S1IN #0 PCNT2_S0IN #1 PCNT2_S1IN #0	US2_TX #2 US2_RX #1 US2_CLK #0 US2_CS #31 US2_CTS #30 US2_RTS #29 I2C1_SDA #1 I2C1_SCL #0	LES_CH15 ETM_TD1 #1
PA6	BUSDY BUSCX	WTIM0_CC0 #6 WTIM0_CC1 #4 WTIM0_CC2 #2 PCNT1_S0IN #0 PCNT1_S1IN #31 PCNT2_S0IN #0 PCNT2_S1IN #31	US2_TX #1 US2_RX #0 US2_CLK #31 US2_CS #30 US2_CTS #29 US2_RTS #28 I2C1_SDA #0 I2C1_SCL #31	LES_CH14 ETM_TD0 #1
PA5	VDAC0_OUT0ALT / OPA0_OUTALT #0 BUSCY BUSDX	TIM0_CC0 #5 TIM0_CC1 #4 TIM0_CC2 #3 TIM0_CDTI0 #2 TIM0_CDTI1 #1 TIM0_CDTI2 #0 TIM1_CC0 #5 TIM1_CC1 #4 TIM1_CC2 #3 TIM1_CC3 #2 WTIM0_CC0 #5 WTIM0_CC1 #3 WTIM0_CC2 #1 LE-TIM0_OUT0 #5 LE-TIM0_OUT1 #4 PCNT0_S0IN #5 PCNT0_S1IN #4	US0_TX #5 US0_RX #4 US0_CLK #3 US0_CS #2 US0_CTS #1 US0_RTS #0 US1_TX #5 US1_RX #4 US1_CLK #3 US1_CS #2 US1_CTS #1 US1_RTS #0 US2_TX #0 US2_RX #31 US2_CLK #30 US2_CS #29 US2_CTS #28 US2_RTS #27 LEU0_TX #5 LEU0_RX #4 I2C0_SDA #5 I2C0_SCL #4	CMU_CLKI0 #4 PRS_CH6 #5 PRS_CH7 #4 PRS_CH8 #3 PRS_CH9 #2 ACMP0_O #5 ACMP1_O #5 LES_CH13 ETM_TCLK #1
PA4	VDAC0_OUT1ALT / OPA1_OUTALT #2 BUSDY BUSCX OPA0_N	TIM0_CC0 #4 TIM0_CC1 #3 TIM0_CC2 #2 TIM0_CDTI0 #1 TIM0_CDTI1 #0 TIM0_CDTI2 #31 TIM1_CC0 #4 TIM1_CC1 #3 TIM1_CC2 #2 TIM1_CC3 #1 WTIM0_CC0 #4 WTIM0_CC1 #2 WTIM0_CC2 #0 LE-TIM0_OUT0 #4 LE-TIM0_OUT1 #3 PCNT0_S0IN #4 PCNT0_S1IN #3	US0_TX #4 US0_RX #3 US0_CLK #2 US0_CS #1 US0_CTS #0 US0_RTS #31 US1_TX #4 US1_RX #3 US1_CLK #2 US1_CS #1 US1_CTS #0 US1_RTS #31 LEU0_TX #4 LEU0_RX #3 I2C0_SDA #4 I2C0_SCL #3	PRS_CH6 #4 PRS_CH7 #3 PRS_CH8 #2 PRS_CH9 #1 ACMP0_O #4 ACMP1_O #4 LES_CH12

GPIO Name	Pin Alternate Functionality / Description			
	Analog	Timers	Communication	Other
PA3	BUSCY BUSDX VDAC0_OUT0 / OPA0_OUT	TIM0_CC0 #3 TIM0_CC1 #2 TIM0_CC2 #1 TIM0_CDTI0 #0 TIM0_CDTI1 #31 TIM0_CDTI2 #30 TIM1_CC0 #3 TIM1_CC1 #2 TIM1_CC2 #1 TIM1_CC3 #0 WTIM0_CC0 #3 WTIM0_CC1 #1 LE- TIM0_OUT0 #3 LE- TIM0_OUT1 #2 PCNT0_S0IN #3 PCNT0_S1IN #2	US0_TX #3 US0_RX #2 US0_CLK #1 US0_CS #0 US0_CTS #31 US0_RTS #30 US1_TX #3 US1_RX #2 US1_CLK #1 US1_CS #0 US1_CTS #31 US1_RTS #30 LEU0_TX #3 LEU0_RX #2 I2C0_SDA #3 I2C0_SCL #2	PRS_CH6 #3 PRS_CH7 #2 PRS_CH8 #1 PRS_CH9 #0 ACMP0_O #3 ACMP1_O #3 LES_CH11 GPIO_EM4WU8
PA2	VDAC0_OUT1ALT / OPA1_OUTALT #1 BUS- DY BUSCX OPA0_P	TIM0_CC0 #2 TIM0_CC1 #1 TIM0_CC2 #0 TIM0_CDTI0 #31 TIM0_CDTI1 #30 TIM0_CDTI2 #29 TIM1_CC0 #2 TIM1_CC1 #1 TIM1_CC2 #0 TIM1_CC3 #31 WTIM0_CC0 #2 WTIM0_CC1 #0 LE- TIM0_OUT0 #2 LE- TIM0_OUT1 #1 PCNT0_S0IN #2 PCNT0_S1IN #1	US0_TX #2 US0_RX #1 US0_CLK #0 US0_CS #31 US0_CTS #30 US0_RTS #29 US1_TX #2 US1_RX #1 US1_CLK #0 US1_CS #31 US1_CTS #30 US1_RTS #29 LEU0_TX #2 LEU0_RX #1 I2C0_SDA #2 I2C0_SCL #1	PRS_CH6 #2 PRS_CH7 #1 PRS_CH8 #0 PRS_CH9 #10 ACMP0_O #2 ACMP1_O #2 LES_CH10
PA1	BUSCY BUSDX ADC0_EXTP VDAC0_EXT	TIM0_CC0 #1 TIM0_CC1 #0 TIM0_CC2 #31 TIM0_CDTI0 #30 TIM0_CDTI1 #29 TIM0_CDTI2 #28 TIM1_CC0 #1 TIM1_CC1 #0 TIM1_CC2 #31 TIM1_CC3 #30 WTIM0_CC0 #1 LE- TIM0_OUT0 #1 LE- TIM0_OUT1 #0 PCNT0_S0IN #1 PCNT0_S1IN #0	US0_TX #1 US0_RX #0 US0_CLK #31 US0_CS #30 US0_CTS #29 US0_RTS #28 US1_TX #1 US1_RX #0 US1_CLK #31 US1_CS #30 US1_CTS #29 US1_RTS #28 LEU0_TX #1 LEU0_RX #0 I2C0_SDA #1 I2C0_SCL #0	CMU_CLK0 #0 PRS_CH6 #1 PRS_CH7 #0 PRS_CH8 #10 PRS_CH9 #9 ACMP0_O #1 ACMP1_O #1 LES_CH9

GPIO Name	Pin Alternate Functionality / Description			
	Analog	Timers	Communication	Other
PD9	BUSCY BUSDX	TIM0_CC0 #17 TIM0_CC1 #16 TIM0_CC2 #15 TIM0_CDTI0 #14 TIM0_CDTI1 #13 TIM0_CDTI2 #12 TIM1_CC0 #17 TIM1_CC1 #16 TIM1_CC2 #15 TIM1_CC3 #14 WTIM0_CC1 #31 WTIM0_CC2 #29 WTIM0_CDTI0 #25 WTIM0_CDTI1 #23 WTIM0_CDTI2 #21 WTIM1_CC0 #17 WTIM1_CC1 #15 WTIM1_CC2 #13 WTIM1_CC3 #11 LE- TIM0_OUT0 #17 LE- TIM0_OUT1 #16 PCNT0_S0IN #17 PCNT0_S1IN #16	US0_TX #17 US0_RX #16 US0_CLK #15 US0_CS #14 US0_CTS #13 US0_RTS #12 US1_TX #17 US1_RX #16 US1_CLK #15 US1_CS #14 US1_CTS #13 US1_RTS #12 US3_TX #1 US3_RX #0 US3_CLK #31 US3_CS #30 US3_CTS #29 US3_RTS #28 LEU0_TX #17 LEU0_RX #16 I2C0_SDA #17 I2C0_SCL #16	CMU_CLK0 #4 PRS_CH3 #8 PRS_CH4 #0 PRS_CH5 #6 PRS_CH6 #11 ACMP0_O #17 ACMP1_O #17 LES_CH1
PD11	BUSCY BUSDX	TIM0_CC0 #19 TIM0_CC1 #18 TIM0_CC2 #17 TIM0_CDTI0 #16 TIM0_CDTI1 #15 TIM0_CDTI2 #14 TIM1_CC0 #19 TIM1_CC1 #18 TIM1_CC2 #17 TIM1_CC3 #16 WTIM0_CC2 #31 WTIM0_CDTI0 #27 WTIM0_CDTI1 #25 WTIM0_CDTI2 #23 WTIM1_CC0 #19 WTIM1_CC1 #17 WTIM1_CC2 #15 WTIM1_CC3 #13 LE- TIM0_OUT0 #19 LE- TIM0_OUT1 #18 PCNT0_S0IN #19 PCNT0_S1IN #18	US0_TX #19 US0_RX #18 US0_CLK #17 US0_CS #16 US0_CTS #15 US0_RTS #14 US1_TX #19 US1_RX #18 US1_CLK #17 US1_CS #16 US1_CTS #15 US1_RTS #14 US3_TX #3 US3_RX #2 US3_CLK #1 US3_CS #0 US3_CTS #31 US3_RTS #30 LEU0_TX #19 LEU0_RX #18 I2C0_SDA #19 I2C0_SCL #18	PRS_CH3 #10 PRS_CH4 #2 PRS_CH5 #1 PRS_CH6 #13 ACMP0_O #19 ACMP1_O #19 LES_CH3

GPIO Name	Pin Alternate Functionality / Description			
	Analog	Timers	Communication	Other
PD13	VDAC0_OUT0ALT / OPA0_OUTALT #1 BUS- CY BUSDX OPA1_P	TIM0_CC0 #21 TIM0_CC1 #20 TIM0_CC2 #19 TIM0_CDTI0 #18 TIM0_CDTI1 #17 TIM0_CDTI2 #16 TIM1_CC0 #21 TIM1_CC1 #20 TIM1_CC2 #19 TIM1_CC3 #18 WTIM0_CDTI0 #29 WTIM0_CDTI1 #27 WTIM0_CDTI2 #25 WTIM1_CC0 #21 WTIM1_CC1 #19 WTIM1_CC2 #17 WTIM1_CC3 #15 LE- TIM0_OUT0 #21 LE- TIM0_OUT1 #20 PCNT0_S0IN #21 PCNT0_S1IN #20	US0_TX #21 US0_RX #20 US0_CLK #19 US0_CS #18 US0_CTS #17 US0_RTS #16 US1_TX #21 US1_RX #20 US1_CLK #19 US1_CS #18 US1_CTS #17 US1_RTS #16 US3_TX #5 US3_RX #4 US3_CLK #3 US3_CS #2 US3_CTS #1 US3_RTS #0 LEU0_TX #21 LEU0_RX #20 I2C0_SDA #21 I2C0_SCL #20	PRS_CH3 #12 PRS_CH4 #4 PRS_CH5 #3 PRS_CH6 #15 ACMP0_O #21 ACMP1_O #21 LES_CH5
PA0	BUSDY BUSCX ADC0_EXTN	TIM0_CC0 #0 TIM0_CC1 #31 TIM0_CC2 #30 TIM0_CDTI0 #29 TIM0_CDTI1 #28 TIM0_CDTI2 #27 TIM1_CC0 #0 TIM1_CC1 #31 TIM1_CC2 #30 TIM1_CC3 #29 WTIM0_CC0 #0 LE- TIM0_OUT0 #0 LE- TIM0_OUT1 #31 PCNT0_S0IN #0 PCNT0_S1IN #31	US0_TX #0 US0_RX #31 US0_CLK #30 US0_CS #29 US0_CTS #28 US0_RTS #27 US1_TX #0 US1_RX #31 US1_CLK #30 US1_CS #29 US1_CTS #28 US1_RTS #27 LEU0_TX #0 LEU0_RX #31 I2C0_SDA #0 I2C0_SCL #31	CMU_CLK1 #0 PRS_CH6 #0 PRS_CH7 #10 PRS_CH8 #9 PRS_CH9 #8 ACMP0_O #0 ACMP1_O #0 LES_CH8
PD8	BUSDY BUSCX	WTIM0_CC1 #30 WTIM0_CC2 #28 WTIM0_CDTI0 #24 WTIM0_CDTI1 #22 WTIM0_CDTI2 #20 WTIM1_CC0 #16 WTIM1_CC1 #14 WTIM1_CC2 #12 WTIM1_CC3 #10	US3_TX #0 US3_RX #31 US3_CLK #30 US3_CS #29 US3_CTS #28 US3_RTS #27	LES_CH0

GPIO Name	Pin Alternate Functionality / Description			
	Analog	Timers	Communication	Other
PD10	BUSDY BUSCX	TIM0_CC0 #18 TIM0_CC1 #17 TIM0_CC2 #16 TIM0_CDTI0 #15 TIM0_CDTI1 #14 TIM0_CDTI2 #13 TIM1_CC0 #18 TIM1_CC1 #17 TIM1_CC2 #16 TIM1_CC3 #15 WTIM0_CC2 #30 WTIM0_CDTI0 #26 WTIM0_CDTI1 #24 WTIM0_CDTI2 #22 WTIM1_CC0 #18 WTIM1_CC1 #16 WTIM1_CC2 #14 WTIM1_CC3 #12 LE- TIM0_OUT0 #18 LE- TIM0_OUT1 #17 PCNT0_S0IN #18 PCNT0_S1IN #17	US0_TX #18 US0_RX #17 US0_CLK #16 US0_CS #15 US0_CTS #14 US0_RTS #13 US1_TX #18 US1_RX #17 US1_CLK #16 US1_CS #15 US1_CTS #14 US1_RTS #13 US3_TX #2 US3_RX #1 US3_CLK #0 US3_CS #31 US3_CTS #30 US3_RTS #29 LEU0_TX #18 LEU0_RX #17 I2C0_SDA #18 I2C0_SCL #17	CMU_CLK1 #4 PRS_CH3 #9 PRS_CH4 #1 PRS_CH5 #0 PRS_CH6 #12 ACMP0_O #18 ACMP1_O #18 LES_CH2
PD12	VDAC0_OUT1ALT / OPA1_OUTALT #0 BUS- DY BUSCX	TIM0_CC0 #20 TIM0_CC1 #19 TIM0_CC2 #18 TIM0_CDTI0 #17 TIM0_CDTI1 #16 TIM0_CDTI2 #15 TIM1_CC0 #20 TIM1_CC1 #19 TIM1_CC2 #18 TIM1_CC3 #17 WTIM0_CDTI0 #28 WTIM0_CDTI1 #26 WTIM0_CDTI2 #24 WTIM1_CC0 #20 WTIM1_CC1 #18 WTIM1_CC2 #16 WTIM1_CC3 #14 LE- TIM0_OUT0 #20 LE- TIM0_OUT1 #19 PCNT0_S0IN #20 PCNT0_S1IN #19	US0_TX #20 US0_RX #19 US0_CLK #18 US0_CS #17 US0_CTS #16 US0_RTS #15 US1_TX #20 US1_RX #19 US1_CLK #18 US1_CS #17 US1_CTS #16 US1_RTS #15 US3_TX #4 US3_RX #3 US3_CLK #2 US3_CS #1 US3_CTS #0 US3_RTS #31 LEU0_TX #20 LEU0_RX #19 I2C0_SDA #20 I2C0_SCL #19	PRS_CH3 #11 PRS_CH4 #3 PRS_CH5 #2 PRS_CH6 #14 ACMP0_O #20 ACMP1_O #20 LES_CH4

GPIO Name	Pin Alternate Functionality / Description			
	Analog	Timers	Communication	Other
PD14	BUSDY BUSCX VDAC0_OUT1 / OPA1_OUT	TIM0_CC0 #22 TIM0_CC1 #21 TIM0_CC2 #20 TIM0_CDTI0 #19 TIM0_CDTI1 #18 TIM0_CDTI2 #17 TIM1_CC0 #22 TIM1_CC1 #21 TIM1_CC2 #20 TIM1_CC3 #19 WTIM0_CDTI0 #30 WTIM0_CDTI1 #28 WTIM0_CDTI2 #26 WTIM1_CC0 #22 WTIM1_CC1 #20 WTIM1_CC2 #18 WTIM1_CC3 #16 LE- TIM0_OUT0 #22 LE- TIM0_OUT1 #21 PCNT0_S0IN #22 PCNT0_S1IN #21	US0_TX #22 US0_RX #21 US0_CLK #20 US0_CS #19 US0_CTS #18 US0_RTS #17 US1_TX #22 US1_RX #21 US1_CLK #20 US1_CS #19 US1_CTS #18 US1_RTS #17 US3_TX #6 US3_RX #5 US3_CLK #4 US3_CS #3 US3_CTS #2 US3_RTS #1 LEU0_TX #22 LEU0_RX #21 I2C0_SDA #22 I2C0_SCL #21	CMU_CLK0 #5 PRS_CH3 #13 PRS_CH4 #5 PRS_CH5 #4 PRS_CH6 #16 ACMP0_O #22 ACMP1_O #22 LES_CH6 GPIO_EM4WU4
PD15	VDAC0_OUT0ALT / OPA0_OUTALT #2 BUS- CY BUSDX OPA1_N	TIM0_CC0 #23 TIM0_CC1 #22 TIM0_CC2 #21 TIM0_CDTI0 #20 TIM0_CDTI1 #19 TIM0_CDTI2 #18 TIM1_CC0 #23 TIM1_CC1 #22 TIM1_CC2 #21 TIM1_CC3 #20 WTIM0_CDTI0 #31 WTIM0_CDTI1 #29 WTIM0_CDTI2 #27 WTIM1_CC0 #23 WTIM1_CC1 #21 WTIM1_CC2 #19 WTIM1_CC3 #17 LE- TIM0_OUT0 #23 LE- TIM0_OUT1 #22 PCNT0_S0IN #23 PCNT0_S1IN #22	US0_TX #23 US0_RX #22 US0_CLK #21 US0_CS #20 US0_CTS #19 US0_RTS #18 US1_TX #23 US1_RX #22 US1_CLK #21 US1_CS #20 US1_CTS #19 US1_RTS #18 US3_TX #7 US3_RX #6 US3_CLK #5 US3_CS #4 US3_CTS #3 US3_RTS #2 LEU0_TX #23 LEU0_RX #22 I2C0_SDA #23 I2C0_SCL #22	CMU_CLK1 #5 PRS_CH3 #14 PRS_CH4 #6 PRS_CH5 #5 PRS_CH6 #17 ACMP0_O #23 ACMP1_O #23 LES_CH7 DBG_SWO #2

## 6.4 Alternate Functionality Overview

A wide selection of alternate functionality is available for multiplexing to various pins. The following table shows the name of the alternate functionality in the first column, followed by columns showing the possible LOCATION bitfield settings and the associated GPIO pin. Refer to [6.3 GPIO Functionality Table](#) for a list of functions available on each GPIO pin.

**Note:** Some functionality, such as analog interfaces, do not have alternate settings or a LOCATION bitfield. In these cases, the pinout is shown in the column corresponding to LOCATION 0.

**Table 6.4. Alternate Functionality Overview**

Alternate Functionality	LOCATION								Description
	0 - 3	4 - 7	8 - 11	12 - 15	16 - 19	20 - 23	24 - 27	28 - 31	
ACMP0_O	0: PA0 1: PA1 2: PA2 3: PA3	4: PA4 5: PA5 6: PB11 7: PB12	8: PB13 9: PB14 10: PB15 11: PC6	12: PC7 13: PC8 14: PC9 15: PC10	16: PC11 17: PD9 18: PD10 19: PD11	20: PD12 21: PD13 22: PD14 23: PD15	24: PF0 25: PF1 26: PF2 27: PF3	28: PF4 29: PF5 30: PF6 31: PF7	Analog comparator ACMP0, digital output.
ACMP1_O	0: PA0 1: PA1 2: PA2 3: PA3	4: PA4 5: PA5 6: PB11 7: PB12	8: PB13 9: PB14 10: PB15 11: PC6	12: PC7 13: PC8 14: PC9 15: PC10	16: PC11 17: PD9 18: PD10 19: PD11	20: PD12 21: PD13 22: PD14 23: PD15	24: PF0 25: PF1 26: PF2 27: PF3	28: PF4 29: PF5 30: PF6 31: PF7	Analog comparator ACMP1, digital output.
ADC0_EXTN	0: PA0								Analog to digital converter ADC0 external reference input negative pin.
ADC0_EXTP	0: PA1								Analog to digital converter ADC0 external reference input positive pin.
BOOT_RX	0: PF1								Bootloader RX.
BOOT_TX	0: PF0								Bootloader TX.
CMU_CLK0	0: PA1 1: PB15 2: PC6 3: PC11	4: PD9 5: PD14 6: PF2 7: PF7							Clock Management Unit, clock output number 0.
CMU_CLK1	0: PA0 1: PB14 2: PC7 3: PC10	4: PD10 5: PD15 6: PF3 7: PF6							Clock Management Unit, clock output number 1.
CMU_CLKI0	0: PB13 1: PF7 2: PC6 3: PB6	4: PA5							Clock Management Unit, clock input number 0.

Alternate	LOCATION								
Functionality	0 - 3	4 - 7	8 - 11	12 - 15	16 - 19	20 - 23	24 - 27	28 - 31	Description
DBG_SWCLKTCK	0: PF0								<p>Debug-interface Serial Wire clock input and JTAG Test Clock.</p> <p>Note that this function is enabled to the pin out of reset, and has a built-in pull down.</p>
DBG_SWDIOTMS	0: PF1								<p>Debug-interface Serial Wire data input / output and JTAG Test Mode Select.</p> <p>Note that this function is enabled to the pin out of reset, and has a built-in pull up.</p>
DBG_SWO	0: PF2 1: PB13 2: PD15 3: PC11								<p>Debug-interface Serial Wire viewer Output.</p> <p>Note that this function is not enabled after reset, and must be enabled by software to be used.</p>
DBG_TDI	0: PF3								<p>Debug-interface JTAG Test Data In.</p> <p>Note that this function becomes available after the first valid JTAG command is received, and has a built-in pull up when JTAG is active.</p>
DBG_TDO	0: PF2								<p>Debug-interface JTAG Test Data Out.</p> <p>Note that this function becomes available after the first valid JTAG command is received.</p>
ETM_TCLK	0: PF8 1: PA5 2: PI2 3: PC6								Embedded Trace Module ETM clock .

Alternate	LOCATION								
Functionality	0 - 3	4 - 7	8 - 11	12 - 15	16 - 19	20 - 23	24 - 27	28 - 31	Description
ETM_TD0	0: PF9 1: PA6 2: PI3 3: PC7								Embedded Trace Module ETM data 0.
ETM_TD1	0: PF10 1: PA7 2: PB6 3: PC8								Embedded Trace Module ETM data 1.
ETM_TD2	0: PF11 1: PA8 2: PB7 3: PC9								Embedded Trace Module ETM data 2.
ETM_TD3	0: PF12 1: PA9 2: PB8 3: PC10								Embedded Trace Module ETM data 3.
GPIO_EM4WU0	0: PF2								Pin can be used to wake the system up from EM4
GPIO_EM4WU1	0: PF7								Pin can be used to wake the system up from EM4
GPIO_EM4WU4	0: PD14								Pin can be used to wake the system up from EM4
GPIO_EM4WU8	0: PA3								Pin can be used to wake the system up from EM4
GPIO_EM4WU9	0: PB13								Pin can be used to wake the system up from EM4
GPIO_EM4WU12	0: PC10								Pin can be used to wake the system up from EM4
I2C0_SCL	0: PA1 1: PA2 2: PA3 3: PA4	4: PA5 5: PB11 6: PB12 7: PB13	8: PB14 9: PB15 10: PC6 11: PC7	12: PC8 13: PC9 14: PC10 15: PC11	16: PD9 17: PD10 18: PD11 19: PD12	20: PD13 21: PD14 22: PD15 23: PF0	24: PF1 25: PF2 26: PF3 27: PF4	28: PF5 29: PF6 30: PF7 31: PA0	I2C0 Serial Clock Line input / output.
I2C0_SDA	0: PA0 1: PA1 2: PA2 3: PA3	4: PA4 5: PA5 6: PB11 7: PB12	8: PB13 9: PB14 10: PB15 11: PC6	12: PC7 13: PC8 14: PC9 15: PC10	16: PC11 17: PD9 18: PD10 19: PD11	20: PD12 21: PD13 22: PD14 23: PD15	24: PF0 25: PF1 26: PF2 27: PF3	28: PF4 29: PF5 30: PF6 31: PF7	I2C0 Serial Data input / output.
I2C1_SCL	0: PA7 1: PA8 2: PA9 3: PI2	4: PI3 5: PB6 6: PB7 7: PB8	8: PB9 9: PB10 10: PJ14 11: PJ15	12: PC0 13: PC1 14: PC2 15: PC3	16: PC4 17: PC5 18: PC10 19: PC11	20: PF8 21: PF9 22: PF10 23: PF11	24: PF12 25: PF13 26: PF14 27: PF15	28: PK0 29: PK1 30: PK2 31: PA6	I2C1 Serial Clock Line input / output.

Alternate	LOCATION								
Functionality	0 - 3	4 - 7	8 - 11	12 - 15	16 - 19	20 - 23	24 - 27	28 - 31	Description
I2C1_SDA	0: PA6 1: PA7 2: PA8 3: PA9	4: PI2 5: PI3 6: PB6 7: PB7	8: PB8 9: PB9 10: PB10 11: PJ14	12: PJ15 13: PC0 14: PC1 15: PC2	16: PC3 17: PC4 18: PC5 19: PC10	20: PC11 21: PF8 22: PF9 23: PF10	24: PF11 25: PF12 26: PF13 27: PF14	28: PF15 29: PK0 30: PK1 31: PK2	I2C1 Serial Data input / output.
IDAC0_OUT	0: PK0								IDAC0 output.
LES_ALTEX0	0: PA8								LESENSE alternate excite output 0.
LES_ALTEX1	0: PA9								LESENSE alternate excite output 1.
LES_ALTEX2	0: PJ14								LESENSE alternate excite output 2.
LES_ALTEX3	0: PJ15								LESENSE alternate excite output 3.
LES_ALTEX4	0: PI0								LESENSE alternate excite output 4.
LES_ALTEX5	0: PI1								LESENSE alternate excite output 5.
LES_ALTEX6	0: PI2								LESENSE alternate excite output 6.
LES_ALTEX7	0: PI3								LESENSE alternate excite output 7.
LES_CH0	0: PD8								LESENSE channel 0.
LES_CH1	0: PD9								LESENSE channel 1.
LES_CH2	0: PD10								LESENSE channel 2.

Alternate	LOCATION								
Functionality	0 - 3	4 - 7	8 - 11	12 - 15	16 - 19	20 - 23	24 - 27	28 - 31	Description
LES_CH3	0: PD11								LESENSE channel 3.
LES_CH4	0: PD12								LESENSE channel 4.
LES_CH5	0: PD13								LESENSE channel 5.
LES_CH6	0: PD14								LESENSE channel 6.
LES_CH7	0: PD15								LESENSE channel 7.
LES_CH8	0: PA0								LESENSE channel 8.
LES_CH9	0: PA1								LESENSE channel 9.
LES_CH10	0: PA2								LESENSE channel 10.
LES_CH11	0: PA3								LESENSE channel 11.
LES_CH12	0: PA4								LESENSE channel 12.
LES_CH13	0: PA5								LESENSE channel 13.
LES_CH14	0: PA6								LESENSE channel 14.
LES_CH15	0: PA7								LESENSE channel 15.

Alternate	LOCATION								Description
	0 - 3	4 - 7	8 - 11	12 - 15	16 - 19	20 - 23	24 - 27	28 - 31	
LETIM0_OUT0	0: PA0 1: PA1 2: PA2 3: PA3	4: PA4 5: PA5 6: PB11 7: PB12	8: PB13 9: PB14 10: PB15 11: PC6	12: PC7 13: PC8 14: PC9 15: PC10	16: PC11 17: PD9 18: PD10 19: PD11	20: PD12 21: PD13 22: PD14 23: PD15	24: PF0 25: PF1 26: PF2 27: PF3	28: PF4 29: PF5 30: PF6 31: PF7	Low Energy Timer LETIM0, output channel 0.
LETIM0_OUT1	0: PA1 1: PA2 2: PA3 3: PA4	4: PA5 5: PB11 6: PB12 7: PB13	8: PB14 9: PB15 10: PC6 11: PC7	12: PC8 13: PC9 14: PC10 15: PC11	16: PD9 17: PD10 18: PD11 19: PD12	20: PD13 21: PD14 22: PD15 23: PF0	24: PF1 25: PF2 26: PF3 27: PF4	28: PF5 29: PF6 30: PF7 31: PA0	Low Energy Timer LETIM0, output channel 1.
LEU0_RX	0: PA1 1: PA2 2: PA3 3: PA4	4: PA5 5: PB11 6: PB12 7: PB13	8: PB14 9: PB15 10: PC6 11: PC7	12: PC8 13: PC9 14: PC10 15: PC11	16: PD9 17: PD10 18: PD11 19: PD12	20: PD13 21: PD14 22: PD15 23: PF0	24: PF1 25: PF2 26: PF3 27: PF4	28: PF5 29: PF6 30: PF7 31: PA0	LEUART0 Receive input.
LEU0_TX	0: PA0 1: PA1 2: PA2 3: PA3	4: PA4 5: PA5 6: PB11 7: PB12	8: PB13 9: PB14 10: PB15 11: PC6	12: PC7 13: PC8 14: PC9 15: PC10	16: PC11 17: PD9 18: PD10 19: PD11	20: PD12 21: PD13 22: PD14 23: PD15	24: PF0 25: PF1 26: PF2 27: PF3	28: PF4 29: PF5 30: PF6 31: PF7	LEUART0 Transmit output. Also used as receive input in half duplex communication.
LFXTAL_N	0: PB14								Low Frequency Crystal (typically 32.768 kHz) negative pin. Also used as an optional external clock input pin.
LFXTAL_P	0: PB15								Low Frequency Crystal (typically 32.768 kHz) positive pin.
OPA0_N	0: PA4								Operational Amplifier 0 external negative input.
OPA0_P	0: PA2								Operational Amplifier 0 external positive input.
OPA1_N	0: PD15								Operational Amplifier 1 external negative input.
OPA1_P	0: PD13								Operational Amplifier 1 external positive input.
OPA2_N	0: PB13								Operational Amplifier 2 external negative input.
OPA2_OUT	0: PB12								Operational Amplifier 2 output.

Alternate	LOCATION								Description
	0 - 3	4 - 7	8 - 11	12 - 15	16 - 19	20 - 23	24 - 27	28 - 31	
OPA2_OUTALT	0: PB9 1: PB10								Operational Amplifier 2 alternative output.
OPA2_P	0: PB11								Operational Amplifier 2 external positive input.
PCNT0_S0IN	0: PA0 1: PA1 2: PA2 3: PA3	4: PA4 5: PA5 6: PB11 7: PB12	8: PB13 9: PB14 10: PB15 11: PC6	12: PC7 13: PC8 14: PC9 15: PC10	16: PC11 17: PD9 18: PD10 19: PD11	20: PD12 21: PD13 22: PD14 23: PD15	24: PF0 25: PF1 26: PF2 27: PF3	28: PF4 29: PF5 30: PF6 31: PF7	Pulse Counter PCNT0 input number 0.
PCNT0_S1IN	0: PA1 1: PA2 2: PA3 3: PA4	4: PA5 5: PB11 6: PB12 7: PB13	8: PB14 9: PB15 10: PC6 11: PC7	12: PC8 13: PC9 14: PC10 15: PC11	16: PD9 17: PD10 18: PD11 19: PD12	20: PD13 21: PD14 22: PD15 23: PF0	24: PF1 25: PF2 26: PF3 27: PF4	28: PF5 29: PF6 30: PF7 31: PA0	Pulse Counter PCNT0 input number 1.
PCNT1_S0IN	0: PA6 1: PA7 2: PA8 3: PA9	4: PI2 5: PI3 6: PB6 7: PB7	8: PB8 9: PB9 10: PB10 11: PJ14	12: PJ15 13: PC0 14: PC1 15: PC2	16: PC3 17: PC4 18: PC5 19: PF6	20: PF7 21: PF8 22: PF9 23: PF10	24: PF11 25: PF12 26: PF13 27: PF14	28: PF15 29: PK0 30: PK1 31: PK2	Pulse Counter PCNT1 input number 0.
PCNT1_S1IN	0: PA7 1: PA8 2: PA9 3: PI2	4: PI3 5: PB6 6: PB7 7: PB8	8: PB9 9: PB10 10: PJ14 11: PJ15	12: PC0 13: PC1 14: PC2 15: PC3	16: PC4 17: PC5 18: PF6 19: PF7	20: PF8 21: PF9 22: PF10 23: PF11	24: PF12 25: PF13 26: PF14 27: PF15	28: PK0 29: PK1 30: PK2 31: PA6	Pulse Counter PCNT1 input number 1.
PCNT2_S0IN	0: PA6 1: PA7 2: PA8 3: PA9	4: PI2 5: PI3 6: PB6 7: PB7	8: PB8 9: PB9 10: PB10 11: PJ14	12: PJ15 13: PC0 14: PC1 15: PC2	16: PC3 17: PC4 18: PC5 19: PC10	20: PC11 21: PF8 22: PF9 23: PF10	24: PF11 25: PF12 26: PF13 27: PF14	28: PF15 29: PK0 30: PK1 31: PK2	Pulse Counter PCNT2 input number 0.
PCNT2_S1IN	0: PA7 1: PA8 2: PA9 3: PI2	4: PI3 5: PB6 6: PB7 7: PB8	8: PB9 9: PB10 10: PJ14 11: PJ15	12: PC0 13: PC1 14: PC2 15: PC3	16: PC4 17: PC5 18: PC10 19: PC11	20: PF8 21: PF9 22: PF10 23: PF11	24: PF12 25: PF13 26: PF14 27: PF15	28: PK0 29: PK1 30: PK2 31: PA6	Pulse Counter PCNT2 input number 1.
PRS_CH0	0: PF0 1: PF1 2: PF2 3: PF3	4: PF4 5: PF5 6: PF6 7: PF7	8: PC6 9: PC7 10: PC8 11: PC9	12: PC10 13: PC11					Peripheral Reflex System PRS, channel 0.
PRS_CH1	0: PF1 1: PF2 2: PF3 3: PF4	4: PF5 5: PF6 6: PF7 7: PF0							Peripheral Reflex System PRS, channel 1.
PRS_CH2	0: PF2 1: PF3 2: PF4 3: PF5	4: PF6 5: PF7 6: PF0 7: PF1							Peripheral Reflex System PRS, channel 2.
PRS_CH3	0: PF3 1: PF4 2: PF5 3: PF6	4: PF7 5: PF0 6: PF1 7: PF2	8: PD9 9: PD10 10: PD11 11: PD12	12: PD13 13: PD14 14: PD15					Peripheral Reflex System PRS, channel 3.
PRS_CH4	0: PD9 1: PD10 2: PD11 3: PD12	4: PD13 5: PD14 6: PD15							Peripheral Reflex System PRS, channel 4.

Alternate	LOCATION								
Functionality	0 - 3	4 - 7	8 - 11	12 - 15	16 - 19	20 - 23	24 - 27	28 - 31	Description
PRS_CH5	0: PD10 1: PD11 2: PD12 3: PD13	4: PD14 5: PD15 6: PD9							Peripheral Reflex System PRS, channel 5.
PRS_CH6	0: PA0 1: PA1 2: PA2 3: PA3	4: PA4 5: PA5 6: PB11 7: PB12	8: PB13 9: PB14 10: PB15 11: PD9	12: PD10 13: PD11 14: PD12 15: PD13	16: PD14 17: PD15				Peripheral Reflex System PRS, channel 6.
PRS_CH7	0: PA1 1: PA2 2: PA3 3: PA4	4: PA5 5: PB11 6: PB12 7: PB13	8: PB14 9: PB15 10: PA0						Peripheral Reflex System PRS, channel 7.
PRS_CH8	0: PA2 1: PA3 2: PA4 3: PA5	4: PB11 5: PB12 6: PB13 7: PB14	8: PB15 9: PA0 10: PA1						Peripheral Reflex System PRS, channel 8.
PRS_CH9	0: PA3 1: PA4 2: PA5 3: PB11	4: PB12 5: PB13 6: PB14 7: PB15	8: PA0 9: PA1 10: PA2 11: PC6	12: PC7 13: PC8 14: PC9 15: PC10	16: PC11				Peripheral Reflex System PRS, channel 9.
PRS_CH10	0: PC6 1: PC7 2: PC8 3: PC9	4: PC10 5: PC11							Peripheral Reflex System PRS, channel 10.
PRS_CH11	0: PC7 1: PC8 2: PC9 3: PC10	4: PC11 5: PC6							Peripheral Reflex System PRS, channel 11.
TIM0_CC0	0: PA0 1: PA1 2: PA2 3: PA3	4: PA4 5: PA5 6: PB11 7: PB12	8: PB13 9: PB14 10: PB15 11: PC6	12: PC7 13: PC8 14: PC9 15: PC10	16: PC11 17: PD9 18: PD10 19: PD11	20: PD12 21: PD13 22: PD14 23: PD15	24: PF0 25: PF1 26: PF2 27: PF3	28: PF4 29: PF5 30: PF6 31: PF7	Timer 0 Capture Compare input / output channel 0.
TIM0_CC1	0: PA1 1: PA2 2: PA3 3: PA4	4: PA5 5: PB11 6: PB12 7: PB13	8: PB14 9: PB15 10: PC6 11: PC7	12: PC8 13: PC9 14: PC10 15: PC11	16: PD9 17: PD10 18: PD11 19: PD12	20: PD13 21: PD14 22: PD15 23: PF0	24: PF1 25: PF2 26: PF3 27: PF4	28: PF5 29: PF6 30: PF7 31: PA0	Timer 0 Capture Compare input / output channel 1.
TIM0_CC2	0: PA2 1: PA3 2: PA4 3: PA5	4: PB11 5: PB12 6: PB13 7: PB14	8: PB15 9: PC6 10: PC7 11: PC8	12: PC9 13: PC10 14: PC11 15: PD9	16: PD10 17: PD11 18: PD12 19: PD13	20: PD14 21: PD15 22: PF0 23: PF1	24: PF2 25: PF3 26: PF4 27: PF5	28: PF6 29: PF7 30: PA0 31: PA1	Timer 0 Capture Compare input / output channel 2.
TIM0_CDT10	0: PA3 1: PA4 2: PA5 3: PB11	4: PB12 5: PB13 6: PB14 7: PB15	8: PC6 9: PC7 10: PC8 11: PC9	12: PC10 13: PC11 14: PD9 15: PD10	16: PD11 17: PD12 18: PD13 19: PD14	20: PD15 21: PF0 22: PF1 23: PF2	24: PF3 25: PF4 26: PF5 27: PF6	28: PF7 29: PA0 30: PA1 31: PA2	Timer 0 Complimentary Dead Time Insertion channel 0.
TIM0_CDT11	0: PA4 1: PA5 2: PB11 3: PB12	4: PB13 5: PB14 6: PB15 7: PC6	8: PC7 9: PC8 10: PC9 11: PC10	12: PC11 13: PD9 14: PD10 15: PD11	16: PD12 17: PD13 18: PD14 19: PD15	20: PF0 21: PF1 22: PF2 23: PF3	24: PF4 25: PF5 26: PF6 27: PF7	28: PA0 29: PA1 30: PA2 31: PA3	Timer 0 Complimentary Dead Time Insertion channel 1.
TIM0_CDT12	0: PA5 1: PB11 2: PB12 3: PB13	4: PB14 5: PB15 6: PC6 7: PC7	8: PC8 9: PC9 10: PC10 11: PC11	12: PD9 13: PD10 14: PD11 15: PD12	16: PD13 17: PD14 18: PD15 19: PF0	20: PF1 21: PF2 22: PF3 23: PF4	24: PF5 25: PF6 26: PF7 27: PA0	28: PA1 29: PA2 30: PA3 31: PA4	Timer 0 Complimentary Dead Time Insertion channel 2.

Alternate	LOCATION								
Functionality	0 - 3	4 - 7	8 - 11	12 - 15	16 - 19	20 - 23	24 - 27	28 - 31	Description
TIM1_CC0	0: PA0 1: PA1 2: PA2 3: PA3	4: PA4 5: PA5 6: PB11 7: PB12	8: PB13 9: PB14 10: PB15 11: PC6	12: PC7 13: PC8 14: PC9 15: PC10	16: PC11 17: PD9 18: PD10 19: PD11	20: PD12 21: PD13 22: PD14 23: PD15	24: PF0 25: PF1 26: PF2 27: PF3	28: PF4 29: PF5 30: PF6 31: PF7	Timer 1 Capture Compare input / output channel 0.
TIM1_CC1	0: PA1 1: PA2 2: PA3 3: PA4	4: PA5 5: PB11 6: PB12 7: PB13	8: PB14 9: PB15 10: PC6 11: PC7	12: PC8 13: PC9 14: PC10 15: PC11	16: PD9 17: PD10 18: PD11 19: PD12	20: PD13 21: PD14 22: PD15 23: PF0	24: PF1 25: PF2 26: PF3 27: PF4	28: PF5 29: PF6 30: PF7 31: PA0	Timer 1 Capture Compare input / output channel 1.
TIM1_CC2	0: PA2 1: PA3 2: PA4 3: PA5	4: PB11 5: PB12 6: PB13 7: PB14	8: PB15 9: PC6 10: PC7 11: PC8	12: PC9 13: PC10 14: PC11 15: PD9	16: PD10 17: PD11 18: PD12 19: PD13	20: PD14 21: PD15 22: PF0 23: PF1	24: PF2 25: PF3 26: PF4 27: PF5	28: PF6 29: PF7 30: PA0 31: PA1	Timer 1 Capture Compare input / output channel 2.
TIM1_CC3	0: PA3 1: PA4 2: PA5 3: PB11	4: PB12 5: PB13 6: PB14 7: PB15	8: PC6 9: PC7 10: PC8 11: PC9	12: PC10 13: PC11 14: PD9 15: PD10	16: PD11 17: PD12 18: PD13 19: PD14	20: PD15 21: PF0 22: PF1 23: PF2	24: PF3 25: PF4 26: PF5 27: PF6	28: PF7 29: PA0 30: PA1 31: PA2	Timer 1 Capture Compare input / output channel 3.
US0_CLK	0: PA2 1: PA3 2: PA4 3: PA5	4: PB11 5: PB12 6: PB13 7: PB14	8: PB15 9: PC6 10: PC7 11: PC8	12: PC9 13: PC10 14: PC11 15: PD9	16: PD10 17: PD11 18: PD12 19: PD13	20: PD14 21: PD15 22: PF0 23: PF1	24: PF2 25: PF3 26: PF4 27: PF5	28: PF6 29: PF7 30: PA0 31: PA1	USART0 clock input / output.
US0_CS	0: PA3 1: PA4 2: PA5 3: PB11	4: PB12 5: PB13 6: PB14 7: PB15	8: PC6 9: PC7 10: PC8 11: PC9	12: PC10 13: PC11 14: PD9 15: PD10	16: PD11 17: PD12 18: PD13 19: PD14	20: PD15 21: PF0 22: PF1 23: PF2	24: PF3 25: PF4 26: PF5 27: PF6	28: PF7 29: PA0 30: PA1 31: PA2	USART0 chip select input / output.
US0_CTS	0: PA4 1: PA5 2: PB11 3: PB12	4: PB13 5: PB14 6: PB15 7: PC6	8: PC7 9: PC8 10: PC9 11: PC10	12: PC11 13: PD9 14: PD10 15: PD11	16: PD12 17: PD13 18: PD14 19: PD15	20: PF0 21: PF1 22: PF2 23: PF3	24: PF4 25: PF5 26: PF6 27: PF7	28: PA0 29: PA1 30: PA2 31: PA3	USART0 Clear To Send hardware flow control input.
US0_RTS	0: PA5 1: PB11 2: PB12 3: PB13	4: PB14 5: PB15 6: PC6 7: PC7	8: PC8 9: PC9 10: PC10 11: PC11	12: PD9 13: PD10 14: PD11 15: PD12	16: PD13 17: PD14 18: PD15 19: PF0	20: PF1 21: PF2 22: PF3 23: PF4	24: PF5 25: PF6 26: PF7 27: PA0	28: PA1 29: PA2 30: PA3 31: PA4	USART0 Request To Send hardware flow control output.
US0_RX	0: PA1 1: PA2 2: PA3 3: PA4	4: PA5 5: PB11 6: PB12 7: PB13	8: PB14 9: PB15 10: PC6 11: PC7	12: PC8 13: PC9 14: PC10 15: PC11	16: PD9 17: PD10 18: PD11 19: PD12	20: PD13 21: PD14 22: PD15 23: PF0	24: PF1 25: PF2 26: PF3 27: PF4	28: PF5 29: PF6 30: PF7 31: PA0	USART0 Asynchronous Receive.  USART0 Synchronous mode Master Input / Slave Output (MISO).
US0_TX	0: PA0 1: PA1 2: PA2 3: PA3	4: PA4 5: PA5 6: PB11 7: PB12	8: PB13 9: PB14 10: PB15 11: PC6	12: PC7 13: PC8 14: PC9 15: PC10	16: PC11 17: PD9 18: PD10 19: PD11	20: PD12 21: PD13 22: PD14 23: PD15	24: PF0 25: PF1 26: PF2 27: PF3	28: PF4 29: PF5 30: PF6 31: PF7	USART0 Asynchronous Transmit. Also used as receive input in half duplex communication.  USART0 Synchronous mode Master Output / Slave Input (MOSI).
US1_CLK	0: PA2 1: PA3 2: PA4 3: PA5	4: PB11 5: PB12 6: PB13 7: PB14	8: PB15 9: PC6 10: PC7 11: PC8	12: PC9 13: PC10 14: PC11 15: PD9	16: PD10 17: PD11 18: PD12 19: PD13	20: PD14 21: PD15 22: PF0 23: PF1	24: PF2 25: PF3 26: PF4 27: PF5	28: PF6 29: PF7 30: PA0 31: PA1	USART1 clock input / output.

Alternate	LOCATION								
Functionality	0 - 3	4 - 7	8 - 11	12 - 15	16 - 19	20 - 23	24 - 27	28 - 31	Description
US1_CS	0: PA3 1: PA4 2: PA5 3: PB11	4: PB12 5: PB13 6: PB14 7: PB15	8: PC6 9: PC7 10: PC8 11: PC9	12: PC10 13: PC11 14: PD9 15: PD10	16: PD11 17: PD12 18: PD13 19: PD14	20: PD15 21: PF0 22: PF1 23: PF2	24: PF3 25: PF4 26: PF5 27: PF6	28: PF7 29: PA0 30: PA1 31: PA2	USART1 chip select input / output.
US1_CTS	0: PA4 1: PA5 2: PB11 3: PB12	4: PB13 5: PB14 6: PB15 7: PC6	8: PC7 9: PC8 10: PC9 11: PC10	12: PC11 13: PD9 14: PD10 15: PD11	16: PD12 17: PD13 18: PD14 19: PD15	20: PF0 21: PF1 22: PF2 23: PF3	24: PF4 25: PF5 26: PF6 27: PF7	28: PA0 29: PA1 30: PA2 31: PA3	USART1 Clear To Send hardware flow control input.
US1_RTS	0: PA5 1: PB11 2: PB12 3: PB13	4: PB14 5: PB15 6: PC6 7: PC7	8: PC8 9: PC9 10: PC10 11: PC11	12: PD9 13: PD10 14: PD11 15: PD12	16: PD13 17: PD14 18: PD15 19: PF0	20: PF1 21: PF2 22: PF3 23: PF4	24: PF5 25: PF6 26: PF7 27: PA0	28: PA1 29: PA2 30: PA3 31: PA4	USART1 Request To Send hardware flow control output.
US1_RX	0: PA1 1: PA2 2: PA3 3: PA4	4: PA5 5: PB11 6: PB12 7: PB13	8: PB14 9: PB15 10: PC6 11: PC7	12: PC8 13: PC9 14: PC10 15: PC11	16: PD9 17: PD10 18: PD11 19: PD12	20: PD13 21: PD14 22: PD15 23: PF0	24: PF1 25: PF2 26: PF3 27: PF4	28: PF5 29: PF6 30: PF7 31: PA0	USART1 Asynchronous Receive.  USART1 Synchronous mode Master Input / Slave Output (MISO).
US1_TX	0: PA0 1: PA1 2: PA2 3: PA3	4: PA4 5: PA5 6: PB11 7: PB12	8: PB13 9: PB14 10: PB15 11: PC6	12: PC7 13: PC8 14: PC9 15: PC10	16: PC11 17: PD9 18: PD10 19: PD11	20: PD12 21: PD13 22: PD14 23: PD15	24: PF0 25: PF1 26: PF2 27: PF3	28: PF4 29: PF5 30: PF6 31: PF7	USART1 Asynchronous Transmit. Also used as receive input in half duplex communication.  USART1 Synchronous mode Master Output / Slave Input (MOSI).
US2_CLK	0: PA7 1: PA8 2: PA9 3: PI0	4: PI1 5: PI2 6: PI3 7: PB6	8: PB7 9: PB8 10: PB9 11: PB10	12: PF0 13: PF1 14: PF3 15: PF4	16: PF5 17: PF6 18: PF7 19: PF8	20: PF9 21: PF10 22: PF11 23: PF12	24: PF13 25: PF14 26: PF15 27: PK0	28: PK1 29: PK2 30: PA5 31: PA6	USART2 clock input / output.
US2_CS	0: PA8 1: PA9 2: PI0 3: PI1	4: PI2 5: PI3 6: PB6 7: PB7	8: PB8 9: PB9 10: PB10 11: PF0	12: PF1 13: PF3 14: PF4 15: PF5	16: PF6 17: PF7 18: PF8 19: PF9	20: PF10 21: PF11 22: PF12 23: PF13	24: PF14 25: PF15 26: PK0 27: PK1	28: PK2 29: PA5 30: PA6 31: PA7	USART2 chip select input / output.
US2_CTS	0: PA9 1: PI0 2: PI1 3: PI2	4: PI3 5: PB6 6: PB7 7: PB8	8: PB9 9: PB10 10: PF0 11: PF1	12: PF3 13: PF4 14: PF5 15: PF6	16: PF7 17: PF8 18: PF9 19: PF10	20: PF11 21: PF12 22: PF13 23: PF14	24: PF15 25: PK0 26: PK1 27: PK2	28: PA5 29: PA6 30: PA7 31: PA8	USART2 Clear To Send hardware flow control input.
US2_RTS	0: PI0 1: PI1 2: PI2 3: PI3	4: PB6 5: PB7 6: PB8 7: PB9	8: PB10 9: PF0 10: PF1 11: PF3	12: PF4 13: PF5 14: PF6 15: PF7	16: PF8 17: PF9 18: PF10 19: PF11	20: PF12 21: PF13 22: PF14 23: PF15	24: PK0 25: PK1 26: PK2 27: PA5	28: PA6 29: PA7 30: PA8 31: PA9	USART2 Request To Send hardware flow control output.
US2_RX	0: PA6 1: PA7 2: PA8 3: PA9	4: PI0 5: PI1 6: PI2 7: PI3	8: PB6 9: PB7 10: PB8 11: PB9	12: PB10 13: PF0 14: PF1 15: PF3	16: PF4 17: PF5 18: PF6 19: PF7	20: PF8 21: PF9 22: PF10 23: PF11	24: PF12 25: PF13 26: PF14 27: PF15	28: PK0 29: PK1 30: PK2 31: PA5	USART2 Asynchronous Receive.  USART2 Synchronous mode Master Input / Slave Output (MISO).

Alternate	LOCATION								
Functionality	0 - 3	4 - 7	8 - 11	12 - 15	16 - 19	20 - 23	24 - 27	28 - 31	Description
US2_TX	0: PA5 1: PA6 2: PA7 3: PA8	4: PA9 5: PI0 6: PI1 7: PI2	8: PI3 9: PB6 10: PB7 11: PB8	12: PB9 13: PB10 14: PF0 15: PF1	16: PF3 17: PF4 18: PF5 19: PF6	20: PF7 21: PF8 22: PF9 23: PF10	24: PF11 25: PF12 26: PF13 27: PF14	28: PF15 29: PK0 30: PK1 31: PK2	USART2 Asynchronous Transmit. Also used as receive input in half duplex communication.  USART2 Synchronous mode Master Output / Slave Input (MOSI).
US3_CLK	0: PD10 1: PD11 2: PD12 3: PD13	4: PD14 5: PD15 6: PI2 7: PI3	8: PB6 9: PB7 10: PB8 11: PB9	12: PB10 13: PB11 14: PJ14 15: PJ15	16: PC0 17: PC1 18: PC2 19: PC3	20: PC4 21: PC5 22: PF11 23: PF12	24: PF13 25: PF14 26: PF15 27: PK0	28: PK1 29: PK2 30: PD8 31: PD9	USART3 clock input / output.
US3_CS	0: PD11 1: PD12 2: PD13 3: PD14	4: PD15 5: PI2 6: PI3 7: PB6	8: PB7 9: PB8 10: PB9 11: PB10	12: PB11 13: PJ14 14: PJ15 15: PC0	16: PC1 17: PC2 18: PC3 19: PC4	20: PC5 21: PF11 22: PF12 23: PF13	24: PF14 25: PF15 26: PK0 27: PK1	28: PK2 29: PD8 30: PD9 31: PD10	USART3 chip select input / output.
US3_CTS	0: PD12 1: PD13 2: PD14 3: PD15	4: PI2 5: PI3 6: PB6 7: PB7	8: PB8 9: PB9 10: PB10 11: PB11	12: PJ14 13: PJ15 14: PC0 15: PC1	16: PC2 17: PC3 18: PC4 19: PC5	20: PF11 21: PF12 22: PF13 23: PF14	24: PF15 25: PK0 26: PK1 27: PK2	28: PD8 29: PD9 30: PD10 31: PD11	USART3 Clear To Send hardware flow control input.
US3_RTS	0: PD13 1: PD14 2: PD15 3: PI2	4: PI3 5: PB6 6: PB7 7: PB8	8: PB9 9: PB10 10: PB11 11: PJ14	12: PJ15 13: PC0 14: PC1 15: PC2	16: PC3 17: PC4 18: PC5 19: PF11	20: PF12 21: PF13 22: PF14 23: PF15	24: PK0 25: PK1 26: PK2 27: PD8	28: PD9 29: PD10 30: PD11 31: PD12	USART3 Request To Send hardware flow control output.
US3_RX	0: PD9 1: PD10 2: PD11 3: PD12	4: PD13 5: PD14 6: PD15 7: PI2	8: PI3 9: PB6 10: PB7 11: PB8	12: PB9 13: PB10 14: PB11 15: PJ14	16: PJ15 17: PC0 18: PC1 19: PC2	20: PC3 21: PC4 22: PC5 23: PF11	24: PF12 25: PF13 26: PF14 27: PF15	28: PK0 29: PK1 30: PK2 31: PD8	USART3 Asynchronous Receive.  USART3 Synchronous mode Master Input / Slave Output (MISO).
US3_TX	0: PD8 1: PD9 2: PD10 3: PD11	4: PD12 5: PD13 6: PD14 7: PD15	8: PI2 9: PI3 10: PB6 11: PB7	12: PB8 13: PB9 14: PB10 15: PB11	16: PJ14 17: PJ15 18: PC0 19: PC1	20: PC2 21: PC3 22: PC4 23: PC5	24: PF11 25: PF12 26: PF13 27: PF14	28: PF15 29: PK0 30: PK1 31: PK2	USART3 Asynchronous Transmit. Also used as receive input in half duplex communication.  USART3 Synchronous mode Master Output / Slave Input (MOSI).
VDAC0_EXT	0: PA1								Digital to analog converter VDAC0 external reference input pin.
VDAC0_OUT0 / OPA0_OUT	0: PA3								Digital to Analog Converter DAC0 output channel number 0.
VDAC0_OUT0ALT / OPA0_OUT-ALT	0: PA5 1: PD13 2: PD15								Digital to Analog Converter DAC0 alternative output for channel 0.

Alternate	LOCATION								
Functionality	0 - 3	4 - 7	8 - 11	12 - 15	16 - 19	20 - 23	24 - 27	28 - 31	Description
VDAC0_OUT1 / OPA1_OUT	0: PD14								Digital to Analog Converter DAC0 output channel number 1.
VDAC0_OUT1AL T / OPA1_OUT-ALT	0: PD12 1: PA2 2: PA4								Digital to Analog Converter DAC0 alternative output for channel 1.
WTIM0_CC0	0: PA0 1: PA1 2: PA2 3: PA3	4: PA4 5: PA5 6: PA6 7: PA7	8: PA8 9: PA9 10: PB6 11: PB7	12: PB8 13: PB9 14: PB10 15: PB11	16: PB12 17: PB13 18: PB14 19: PB15	20: PC0 21: PC1 22: PC2 23: PC3	24: PC4 25: PC5 26: PC6 27: PC7	28: PC8 29: PC9 30: PC10 31: PC11	Wide timer 0 Capture Compare input / output channel 0.
WTIM0_CC1	0: PA2 1: PA3 2: PA4 3: PA5	4: PA6 5: PA7 6: PA8 7: PA9	8: PB6 9: PB7 10: PB8 11: PB9	12: PB10 13: PB11 14: PB12 15: PB13	16: PB14 17: PB15 18: PC0 19: PC1	20: PC2 21: PC3 22: PC4 23: PC5	24: PC6 25: PC7 26: PC8 27: PC9	28: PC10 29: PC11 30: PD8 31: PD9	Wide timer 0 Capture Compare input / output channel 1.
WTIM0_CC2	0: PA4 1: PA5 2: PA6 3: PA7	4: PA8 5: PA9 6: PB6 7: PB7	8: PB8 9: PB9 10: PB10 11: PB11	12: PB12 13: PB13 14: PB14 15: PB15	16: PC0 17: PC1 18: PC2 19: PC3	20: PC4 21: PC5 22: PC6 23: PC7	24: PC8 25: PC9 26: PC10 27: PC11	28: PD8 29: PD9 30: PD10 31: PD11	Wide timer 0 Capture Compare input / output channel 2.
WTIM0_CDTI0	0: PA8 1: PA9 2: PB6 3: PB7	4: PB8 5: PB9 6: PB10 7: PB11	8: PB12 9: PB13 10: PB14 11: PB15	12: PC0 13: PC1 14: PC2 15: PC3	16: PC4 17: PC5 18: PC6 19: PC7	20: PC8 21: PC9 22: PC10 23: PC11	24: PD8 25: PD9 26: PD10 27: PD11	28: PD12 29: PD13 30: PD14 31: PD15	Wide timer 0 Complimentary Dead Time Insertion channel 0.
WTIM0_CDTI1	0: PB6 1: PB7 2: PB8 3: PB9	4: PB10 5: PB11 6: PB12 7: PB13	8: PB14 9: PB15 10: PC0 11: PC1	12: PC2 13: PC3 14: PC4 15: PC5	16: PC6 17: PC7 18: PC8 19: PC9	20: PC10 21: PC11 22: PD8 23: PD9	24: PD10 25: PD11 26: PD12 27: PD13	28: PD14 29: PD15 30: PF0 31: PF1	Wide timer 0 Complimentary Dead Time Insertion channel 1.
WTIM0_CDTI2	0: PB8 1: PB9 2: PB10 3: PB11	4: PB12 5: PB13 6: PB14 7: PB15	8: PC0 9: PC1 10: PC2 11: PC3	12: PC4 13: PC5 14: PC6 15: PC7	16: PC8 17: PC9 18: PC10 19: PC11	20: PD8 21: PD9 22: PD10 23: PD11	24: PD12 25: PD13 26: PD14 27: PD15	28: PF0 29: PF1 30: PF2 31: PF3	Wide timer 0 Complimentary Dead Time Insertion channel 2.
WTIM1_CC0	0: PB12 1: PB13 2: PB14 3: PB15	4: PC0 5: PC1 6: PC2 7: PC3	8: PC4 9: PC5 10: PC6 11: PC7	12: PC8 13: PC9 14: PC10 15: PC11	16: PD8 17: PD9 18: PD10 19: PD11	20: PD12 21: PD13 22: PD14 23: PD15	24: PF0 25: PF1 26: PF2 27: PF3	28: PF4 29: PF5 30: PF6 31: PF7	Wide timer 1 Capture Compare input / output channel 0.
WTIM1_CC1	0: PB14 1: PB15 2: PC0 3: PC1	4: PC2 5: PC3 6: PC4 7: PC5	8: PC6 9: PC7 10: PC8 11: PC9	12: PC10 13: PC11 14: PD8 15: PD9	16: PD10 17: PD11 18: PD12 19: PD13	20: PD14 21: PD15 22: PF0 23: PF1	24: PF2 25: PF3 26: PF4 27: PF5	28: PF6 29: PF7 30: PF8 31: PF9	Wide timer 1 Capture Compare input / output channel 1.
WTIM1_CC2	0: PC0 1: PC1 2: PC2 3: PC3	4: PC4 5: PC5 6: PC6 7: PC7	8: PC8 9: PC9 10: PC10 11: PC11	12: PD8 13: PD9 14: PD10 15: PD11	16: PD12 17: PD13 18: PD14 19: PD15	20: PF0 21: PF1 22: PF2 23: PF3	24: PF4 25: PF5 26: PF6 27: PF7	28: PF8 29: PF9 30: PF10 31: PF11	Wide timer 1 Capture Compare input / output channel 2.
WTIM1_CC3	0: PC2 1: PC3 2: PC4 3: PC5	4: PC6 5: PC7 6: PC8 7: PC9	8: PC10 9: PC11 10: PD8 11: PD9	12: PD10 13: PD11 14: PD12 15: PD13	16: PD14 17: PD15 18: PF0 19: PF1	20: PF2 21: PF3 22: PF4 23: PF5	24: PF6 25: PF7 26: PF8 27: PF9	28: PF10 29: PF11 30: PF12 31: PF13	Wide timer 1 Capture Compare input / output channel 3.

### 6.5 Analog Port (APORT) Client Maps

The Analog Port (APORT) is an infrastructure used to connect chip pins with on-chip analog clients such as analog comparators, ADCs, DACs, etc. The APORT consists of a set of shared buses, switches, and control logic needed to configurably implement the signal routing. Figure 6.3 APORT Connection Diagram on page 104 shows the APORT routing for this device family (note that available features may vary by part number). A complete description of APORT functionality can be found in the Reference Manual.

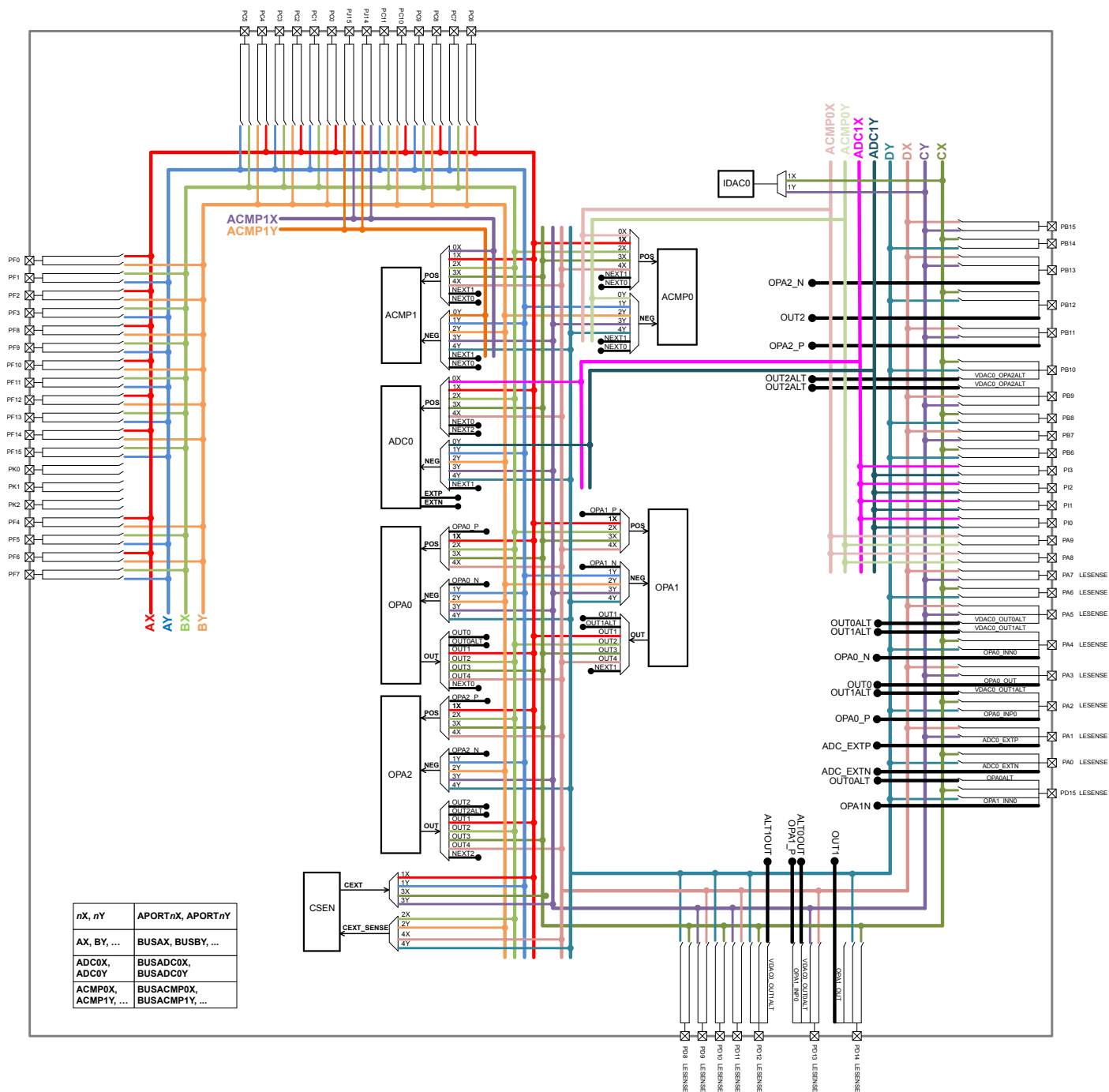


Figure 6.3. APORT Connection Diagram

Client maps for each analog circuit using the APORT are shown in the following tables. The maps are organized by bus, and show the peripheral's port connection, the shared bus, and the connection from specific bus channel numbers to GPIO pins.

In general, enumerations for the pin selection field in an analog peripheral's register can be determined by finding the desired pin connection in the table and then combining the value in the Port column (APORT\_\_), and the channel identifier (CH\_\_). For example, if pin

PF7 is available on port APORT2X as CH23, the register field enumeration to connect to PF7 would be APORT2XCH23. The shared bus used by this connection is indicated in the Bus column.

**Table 6.5. ACMP0 Bus and Pin Mapping**

APORT4Y	APORT4X	APORT3Y	APORT3X	APORT2Y	APORT2X	APORT1Y	APORT1X	APORT0Y	APORT0X	Port
BUSDY	BUSDX	BUSCY	BUSCX	BUSBY	BUSBX	BUSAY	BUSAX	BUSACMP0Y	BUSACMP0X	Bus
PB14	PB15	PB15	PB14	PF14	PF15	PF15	PF14			CH31
	PB13	PB13		PF14						CH30
PB12	PB11	PB11	PB12	PF12	PF13	PF13	PF12			CH29
	PB11	PB11		PF12	PF11	PF11				CH28
PB10			PB10	PF10			PF10			CH27
	PB9	PB9		PF10	PF9	PF9				CH26
PB8			PB8	PF8			PF8			CH25
	PB7	PB7		PF8	PF7	PF7				CH24
PB6			PB6	PF6			PF6			CH23
				PF6	PF5	PF5				CH22
					PF5					CH21
				PF4			PF4			CH20
					PF3	PF3				CH19
				PF2			PF2			CH18
					PF1	PF1				CH17
				PF0			PF0			CH16
PA6	PA7	PA7								CH15
			PA6							CH14
	PA5	PA5								CH13
PA4			PA4							CH12
	PA3	PA3			PC11	PC11				CH11
PA2			PA2	PC10			PC10			CH10
	PA1	PA1			PC9	PC9				CH9
PA0			PA0	PC8			PC8			CH8
	PD15	PD15			PC7	PC7				CH7
PD14			PD14	PC6			PC6			CH6
	PD13	PD13			PC5	PC5				CH5
PD12			PD12	PC4			PC4			CH4
	PD11	PD11			PC3	PC3				CH3
PD10			PD10	PC2			PC2			CH2
	PD9	PD9			PC1	PC1		PA9	PA9	CH1
PD8			PD8	PC0			PC0	PA8	PA8	CH0

Table 6.6. ACMP1 Bus and Pin Mapping

APORT4Y	APORT4X	APORT3Y	APORT3X	APORT2Y	APORT2X	APORT1Y	APORT1X	APORT0Y	APORT0X	Port
BUSDY	BUSDX	BUSCY	BUSCX	BUSBY	BUSBX	BUSAY	BUSAX	BUSACMP1Y	BUSACMP1X	Bus
PB14	PB15	PB15	PB14	PF14	PF15	PF15	PF14			CH31
	PB13	PB13		PF14						CH30
PB12	PB11	PB11	PB12	PF12	PF13	PF13	PF12			CH29
	PB11	PB11		PF12	PF11	PF11				CH28
PB10			PB10	PF10			PF10			CH27
	PB9	PB9		PF10	PF9	PF9				CH26
PB8			PB8	PF8			PF8			CH25
	PB7	PB7		PF8	PF7	PF7				CH24
PB6			PB6	PF6	PF5	PF5	PF6			CH23
					PF5					CH22
					PF5					CH21
					PF5					CH20
					PF3	PF3	PF4			CH19
					PF3	PF3				CH18
					PF2	PF2	PF2			CH17
					PF2	PF1	PF2			CH16
					PF1	PF1	PF0			CH15
PA6	PA7	PA7	PA6							CH14
	PA5	PA5								CH13
PA4			PA4							CH12
	PA3	PA3			PC11	PC11				CH11
PA2			PA2	PC10			PC10			CH10
	PA1	PA1		PC10	PC9	PC9				CH9
PA0			PA0	PC8			PC8			CH8
	PD15	PD15		PC8	PC7	PC7		PJ15	PJ15	CH7
PD14			PD14	PC6			PC6	PJ14	PJ14	CH6
	PD13	PD13		PC6	PC5	PC5				CH5
PD12			PD12	PC4			PC4			CH4
	PD11	PD11		PC4	PC3	PC3				CH3
PD10			PD10	PC2			PC2			CH2
	PD9	PD9		PC2	PC1	PC1				CH1
PD8			PD8	PC0			PC0			CH0

Table 6.7. ADC0 Bus and Pin Mapping

APORT4Y	APORT4X	APORT3Y	APORT3X	APORT2Y	APORT2X	APORT1Y	APORT1X	APORT0Y	APORT0X	Port
BUSDY	BUSDX	BUSCY	BUSCX	BUSBY	BUSBX	BUSAY	BUSAX	BUSADC0Y	BUSADC0X	Bus
PB14	PB15	PB15	PB14	PF14	PF15	PF15	PF14			CH31
	PB13	PB13			PF13	PF13				CH30
PB12	PB11	PB11	PB12	PF12	PF11	PF11	PF12			CH29
	PB11									CH28
PB10			PB10	PF10			PF10			CH27
	PB9	PB9			PF9	PF9				CH26
PB8			PB8	PF8			PF8			CH25
	PB7	PB7			PF7	PF7				CH24
PB6			PB6	PF6			PF6			CH23
					PF5	PF5				CH22
										CH21
				PF4			PF4			CH20
					PF3	PF3				CH19
				PF2			PF2			CH18
					PF1	PF1				CH17
				PF0			PF0			CH16
	PA7	PA7								CH15
PA6			PA6							CH14
	PA5	PA5								CH13
										CH12
	PA3	PA3			PC11	PC11				CH11
PA2			PA2	PC10			PC10			CH10
	PA1	PA1			PC9	PC9				CH9
PA0			PA0	PC8			PC8			CH8
	PD15	PD15			PC7	PC7				CH7
PD14			PD14	PC6			PC6			CH6
	PD13	PD13			PC5	PC5				CH5
PD12			PD12	PC4			PC4			CH4
	PD11	PD11			PC3	PC3		PI3	PI3	CH3
PD10			PD10	PC2			PC2	PI2	PI2	CH2
	PD9	PD9			PC1	PC1		PI1	PI1	CH1
PD8			PD8	PC0			PC0	PI0	PI0	CH0



Table 6.10. VDAC0 / OPA Bus and Pin Mapping

Port	Bus	CH31	CH30	CH29	CH28	CH27	CH26	CH25	CH24	CH23	CH22	CH21	CH20	CH19	CH18	CH17	CH16	CH15	CH14	CH13	CH12	CH11	CH10	CH9	CH8	CH7	CH6	CH5	CH4	CH3	CH2	CH1	CH0
<b>OPA0_N</b>																																	
APORT1Y	BUSAY	PF15		PF13		PF11		PF9		PF7		PF5		PF3		PF1						PC11		PC9		PC7		PC5		PC3		PC1	
APORT2Y	BUSBY		PF14		PF12		PF10		PF8		PF6		PF4		PF2		PF0					PC10		PC8		PC6		PC4		PC2		PC0	
APORT3Y	BUSCY	PB15		PB13		PB11		PB9		PB7							PA7		PA5		PA3		PA1		PD15		PD13		PD11		PD9		
APORT4Y	BUSDY		PB14		PB12		PB10		PB8		PB6						PA6			PA4		PA2		PA0		PD14		PD12		PD10		PD8	
<b>OPA0_P</b>																																	
APORT1X	BUSAX		PF14		PF12		PF10		PF8		PF6		PF4		PF2		PF0					PC10		PC8		PC6		PC4		PC2		PC0	
APORT2X	BUSBX	PF15		PF13		PF11		PF9		PF7		PF5		PF3		PF1						PC11		PC9		PC7		PC5		PC3		PC1	
APORT3X	BUSCX		PB14		PB12		PB10		PB8		PB6						PA6			PA4		PA2		PA0		PD14		PD12		PD10		PD8	
APORT4X	BUSDX	PB15		PB13		PB11		PB9		PB7						PA7		PA5				PA3		PA1		PD15		PD13		PD11		PD9	

Port	Bus	CH31	CH30	CH29	CH28	CH27	CH26	CH25	CH24	CH23	CH22	CH21	CH20	CH19	CH18	CH17	CH16	CH15	CH14	CH13	CH12	CH11	CH10	CH9	CH8	CH7	CH6	CH5	CH4	CH3	CH2	CH1	CH0			
<b>OPA1_N</b>																																				
APORT1Y	BUSAY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY		
APORT2Y	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY		
APORT3Y	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY		
APORT4Y	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	

Port	Bus	CH31	CH30	CH29	CH28	CH27	CH26	CH25	CH24	CH23	CH22	CH21	CH20	CH19	CH18	CH17	CH16	CH15	CH14	CH13	CH12	CH11	CH10	CH9	CH8	CH7	CH6	CH5	CH4	CH3	CH2	CH1	CH0			
<b>OPA2_OUT</b>																																				
APORT1Y	BUSAY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY		
APORT2Y	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY	BUSBY		
APORT3Y	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	BUSCY	
APORT4Y	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	BUSDY	

Port	Bus	CH31	CH30	CH29	CH28	CH27	CH26	CH25	CH24	CH23	CH22	CH21	CH20	CH19	CH18	CH17	CH16	CH15	CH14	CH13	CH12	CH11	CH10	CH9	CH8	CH7	CH6	CH5	CH4	CH3	CH2	CH1	CH0		
<b>VDAC0_OUT1 / OPA1_OUT</b>																																			
APORT4Y	APORT3Y	APORT2Y	APORT1Y																																
BUSDY	BUSCY	BUSBY	BUSAY																																
PB14	PB15	PF14	PF15																																
PB12	PB13	PF12	PF13																																
PB10	PB11	PF10	PF11																																
PB8	PB9	PF8	PF9																																
PB6	PB7	PF6	PF7																																
PA6	PA7	PF0	PF1																																
PA4	PA5	PF4	PF5																																
PA2	PA3	PC10	PC11																																
PA0	PA1	PC8	PC9																																
PD14	PD15	PC6	PC7																																
PD12	PD13	PC4	PC5																																
PD10	PD11	PC2	PC3																																
PD8	PD9	PC0	PC1																																

## 7. BGA125 Package Specifications

### 7.1 BGA125 Package Dimensions

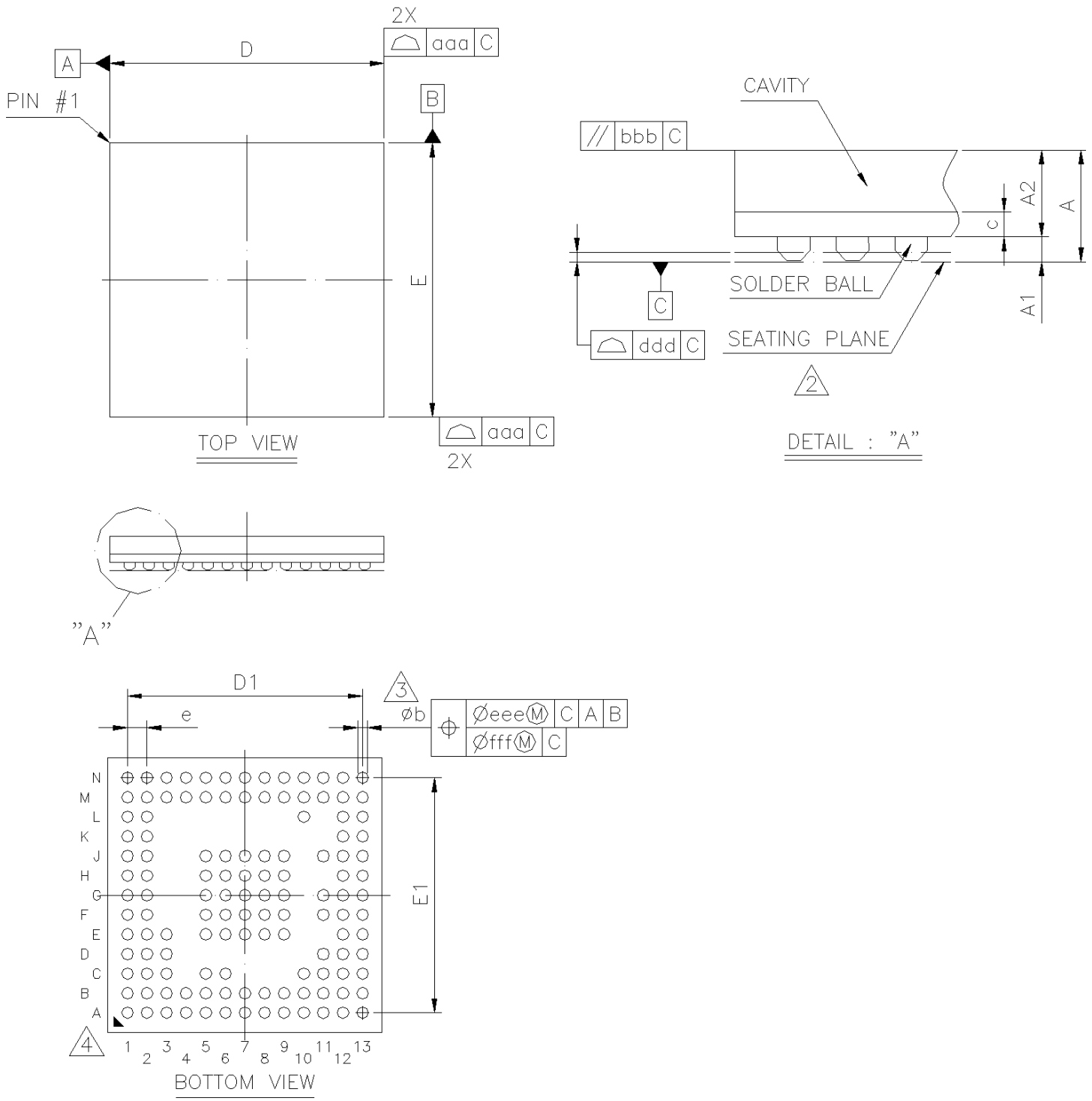


Figure 7.1. BGA125 Package Drawing

**Table 7.1. BGA125 Package Dimensions**

Dimension	Min	Typ	Max
A	0.80	0.87	0.94
A1	0.16	0.21	0.26
A2	0.61	0.66	0.71
c	0.17	0.21	0.25
D	6.90	7.00	7.10
E	6.90	7.00	7.10
D1	—	6.00	—
E1	—	6.00	—
e	—	0.50	—
b	0.25	0.30	0.35
aaa	0.10		
bbb	0.10		
ddd	0.08		
eee	0.15		
fff	0.05		

**Note:**

1. All dimensions shown are in millimeters (mm) unless otherwise noted.
2. Dimensioning and Tolerancing per ANSI Y14.5M-1994.

7.2 BGA125 PCB Land Pattern

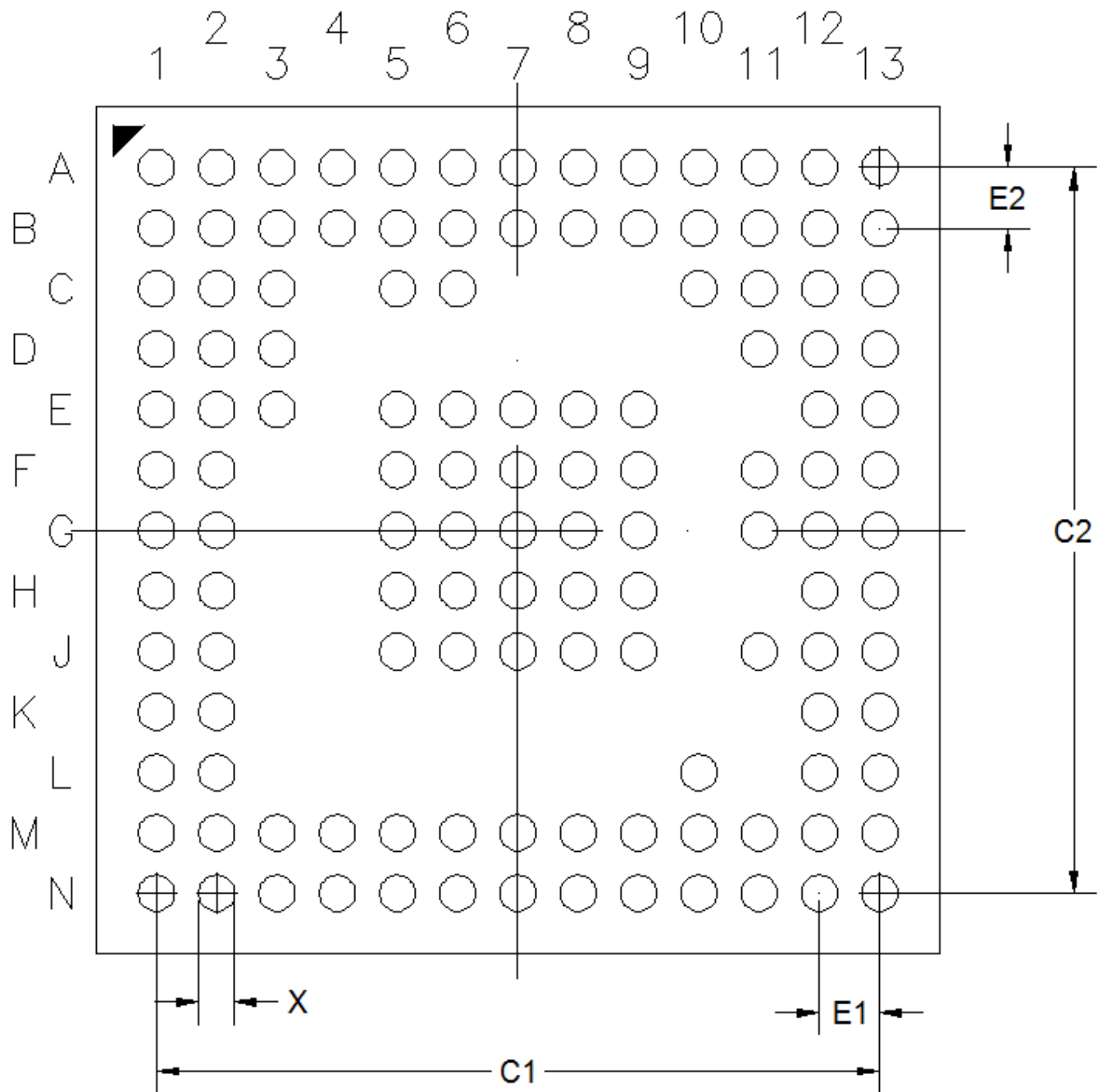


Figure 7.2. BGA125 PCB Land Pattern Drawing

**Table 7.2. BGA125 PCB Land Pattern Dimensions**

Dimension	Min	Nom	Max
X		0.25	
C1		6.00	
C2		6.00	
E1		0.5	
E2		0.5	

**Note:**

1. All dimensions shown are in millimeters (mm) unless otherwise noted.
2. Dimensioning and Tolerancing per ANSI Y14.5M-1994.
3. This Land Pattern Design is based on the IPC-7351 guidelines.
4. All metal pads are to be non-solder mask defined (NSMD). Clearance between the solder mask and the metal pad is to be 60 µm minimum, all the way around the pad.
5. A stainless steel, laser-cut and electro-polished stencil with trapezoidal walls should be used to assure good solder paste release.
6. The stencil thickness should be 0.125 mm (5 mils).
7. The ratio of stencil aperture to land pad size should be 1:1.
8. A No-Clean, Type-3 solder paste is recommended.
9. The recommended card reflow profile is per the JEDEC/IPC J-STD-020C specification for Small Body Components.

**Note:** Above notes and stencil design are shared as recommendations only. A customer or user may find it necessary to use different parameters and fine tune their SMT process as required for their application and tooling.

### 7.3 BGA125 Package Marking



**Figure 7.3. BGA125 Package Marking**

The package marking consists of:

- P P P P P P P P P P – The part number designation.
- T T T T T T – A trace or manufacturing code. The first letter is the device revision.
- Y Y – The last 2 digits of the assembly year.
- W W – The 2-digit workweek when the device was assembled.

## 8. QFN48 Package Specifications

### 8.1 QFN48 Package Dimensions

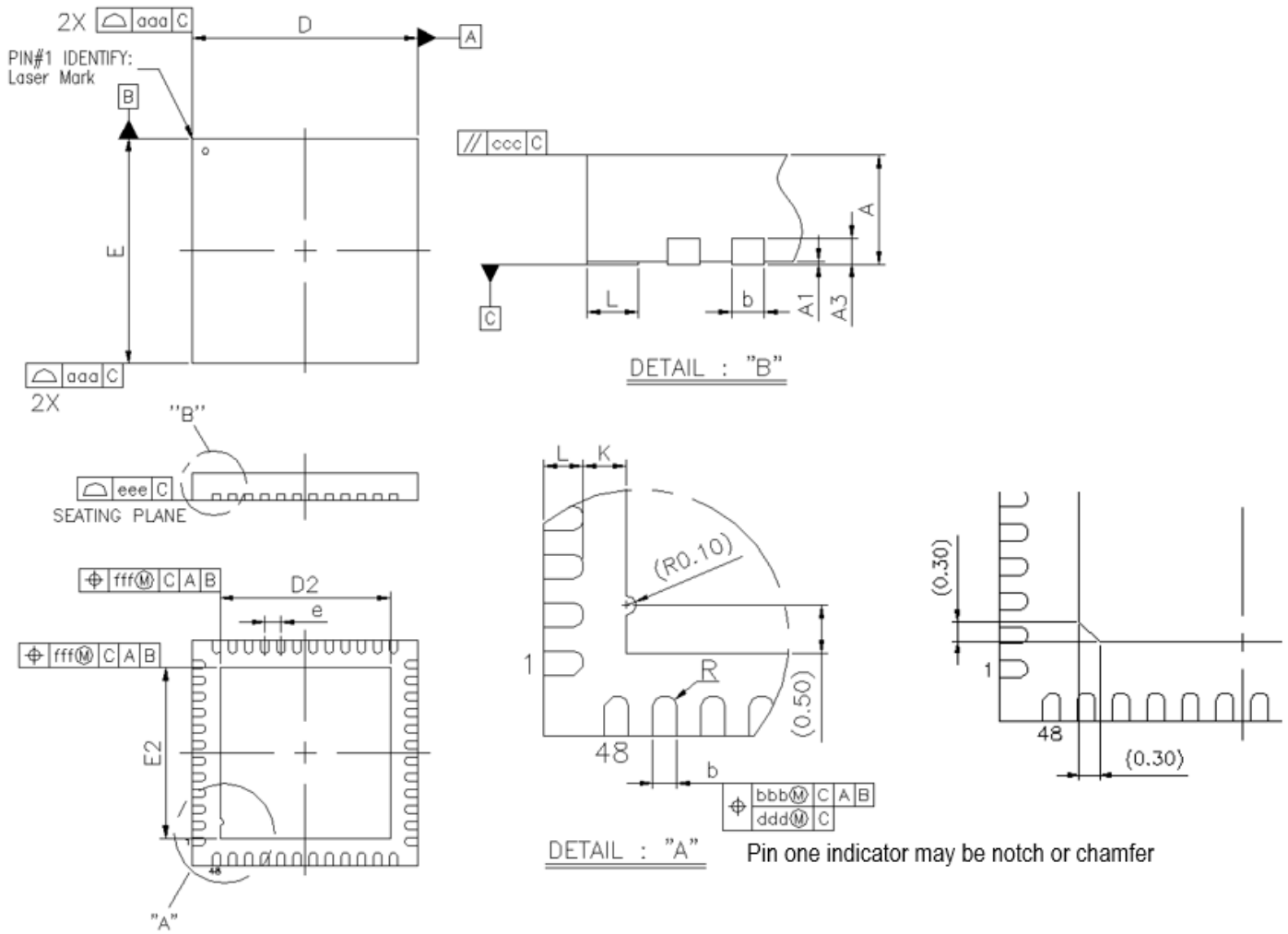


Figure 8.1. QFN48 Package Drawing

**Table 8.1. QFN48 Package Dimensions**

Dimension	Min	Typ	Max
A	0.80	0.85	0.90
A1	0.00	0.02	0.05
A3	0.20 REF		
b	0.18	0.25	0.30
D	6.90	7.00	7.10
E	6.90	7.00	7.10
D2	5.15	5.30	5.45
E2	5.15	5.30	5.45
e	0.50 BSC		
L	0.30	0.40	0.50
K	0.20	—	—
R	0.09	—	—
aaa	0.15		
bbb	0.10		
ccc	0.10		
ddd	0.05		
eee	0.08		
fff	0.10		

**Note:**

1. All dimensions shown are in millimeters (mm) unless otherwise noted.
2. Dimensioning and Tolerancing per ANSI Y14.5M-1994.
3. This drawing conforms to the JEDEC Solid State Outline MO-220, Variation VKKD-4.
4. Recommended card reflow profile is per the JEDEC/IPC J-STD-020 specification for Small Body Components.

### 8.2 QFN48 PCB Land Pattern

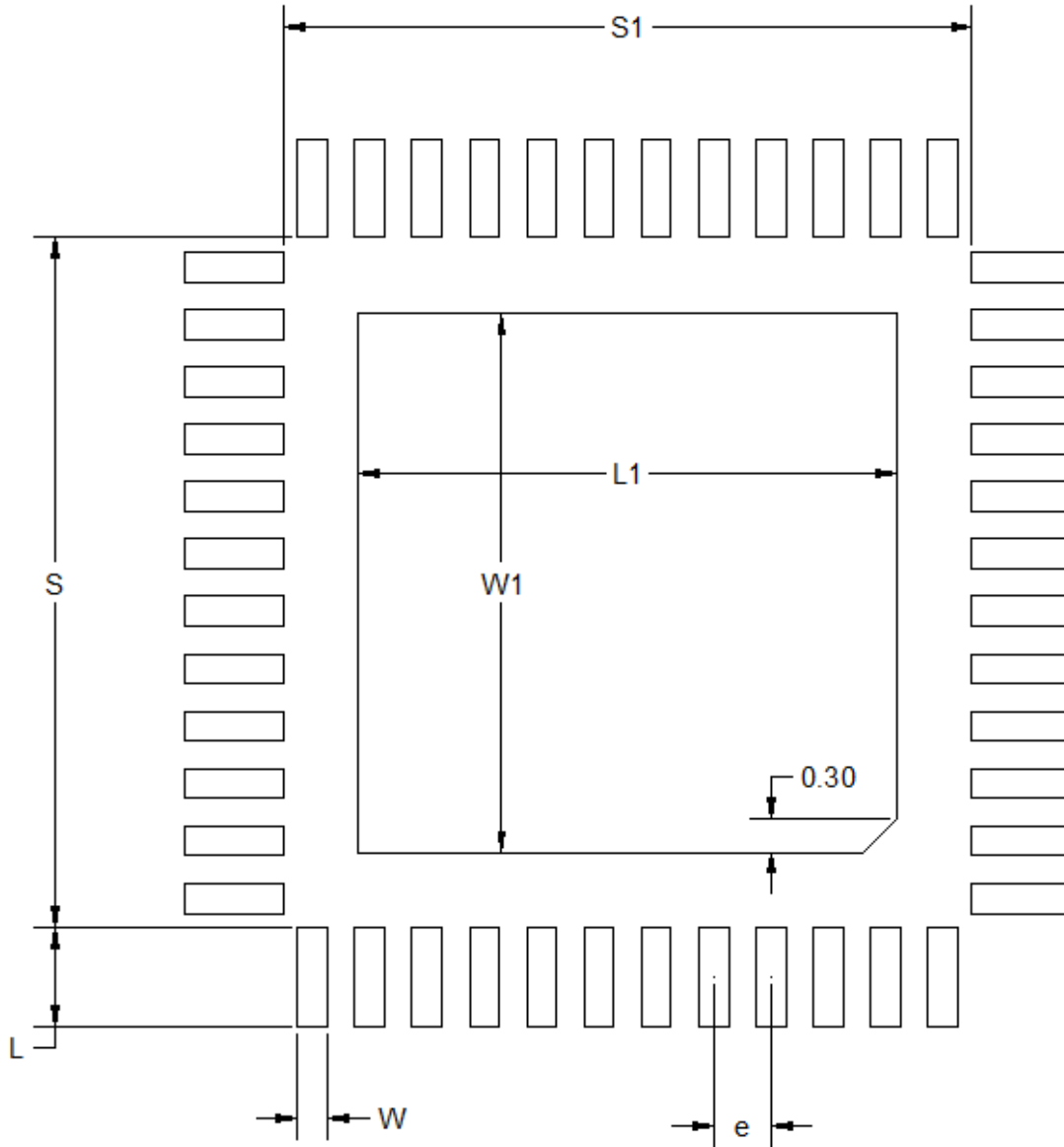


Figure 8.2. QFN48 PCB Land Pattern Drawing

**Table 8.2. QFN48 PCB Land Pattern Dimensions**

Dimension	Typ
S1	6.01
S	6.01
L1	4.70
W1	4.70
e	0.50
W	0.26
L	0.86

**Note:**

1. All dimensions shown are in millimeters (mm) unless otherwise noted.
2. This Land Pattern Design is based on the IPC-7351 guidelines.
3. All metal pads are to be non-solder mask defined (NSMD). Clearance between the solder mask and the metal pad is to be 60 µm minimum, all the way around the pad.
4. A stainless steel, laser-cut and electro-polished stencil with trapezoidal walls should be used to assure good solder paste release.
5. The stencil thickness should be 0.125 mm (5 mils).
6. The ratio of stencil aperture to land pad size can be 1:1 for all perimeter pads.
7. A 4x4 array of 0.75 mm square openings on a 1.00 mm pitch can be used for the center ground pad.
8. A No-Clean, Type-3 solder paste is recommended.
9. The recommended card reflow profile is per the JEDEC/IPC J-STD-020 specification for Small Body Components.

**Note:** Above notes and stencil design are shared as recommendations only. A customer or user may find it necessary to use different parameters and fine tune their SMT process as required for their application and tooling.

### 8.3 QFN48 Package Marking



**Figure 8.3. QFN48 Package Marking**

The package marking consists of:

- P P P P P P P P P P – The part number designation.
- T T T T T T – A trace or manufacturing code. The first letter is the device revision.
- Y Y – The last 2 digits of the assembly year.
- W W – The 2-digit workweek when the device was assembled.

## 9. Revision History

### Revision 1.3

June, 2022

- Updated [3.5.3 Real Time Counter and Calendar \(RTCC\)](#) to remove AUXHFRCO as a clock source.
- Added HFSRCCLK frequency in [Table 4.2 General Operating Conditions on page 19](#).
- Added timing specifications for RESETn low time and clarified  $V_{IL}$  and  $V_{IH}$  logic levels for RESETn pins in [Table 4.17 General-Purpose I/O \(GPIO\) on page 35](#).
- Removed BIASPROG = 1, FULLBIAS = 0 specifications from [Table 4.20 Analog Comparator \(ACMP\) on page 40](#).
- Updated Hysteresis max values in [Table 4.20 Analog Comparator \(ACMP\) on page 40](#).
- Updated the note in [Table 4.24 Operational Amplifier \(OPAMP\) on page 49](#).
- Added [Figure 4.2 SPI Master Timing Diagram \(SMSDELAY = 1\) on page 57](#).
- Added a note to [Table 8.2 QFN48 PCB Land Pattern Dimensions on page 121](#) and [Table 7.2 BGA125 PCB Land Pattern Dimensions on page 116](#).

### Revision 1.2

November, 2019

- In the front page block diagram, updated the lowest energy mode for LETIMER.
- Updated [3.5.4 Low Energy Timer \(LETIMER\)](#) lowest energy mode.
- Added a Note about the operating voltage in [3.7.3 True Random Number Generator \(TRNG\)](#).
- Reworded or removed mentions of “modules” in reference to device peripherals in system overview.

### Revision 1.1

February, 2018

- Updated [2. Ordering Information](#) to revision-C OPNs.
- [System Overview](#) Updates
  - Added "4-pin JTAG" to debug interface options in Processor Core section.
  - Memory maps updated with LE peripherals and new formatting.
- [4.1.1 Absolute Maximum Ratings](#): Added footnotes to clarify  $V_{DIGPIN}$  specification for 5V tolerant GPIO.
- [Table 4.2 General Operating Conditions on page 19](#):
  - Added footnote about IOVDD voltage restriction when CSEN peripheral is used with chopping enabled.
  - Added footnote for additional information on peak current during voltage scaling operations.
- [4.1.4 DC-DC Converter](#): Expanded footnote on control loop settings to include appnote and register field reference.
- [Table 4.16 Flash Memory Characteristics<sup>5</sup> on page 34](#): Device Erase Time typical values corrected from 69 to 82 ms.
- [Table 4.21 Digital to Analog Converter \(VDAC\) on page 42](#): Gain Error min/max specifications relaxed for REFSEL on 1V25LN, VDD, and EXT settings.
- [Table 4.22 Current Digital to Analog Converter \(IDAC\) on page 45](#): Total accuracy STEPSEL value setting corrected from 0x80 to 0x10.
- [Table 4.26 Analog Port \(APORT\) on page 52](#): Operation in EM2/EM3 supply current changed from 915 to 67 nA (silicon fix from rev B to C).

### Revision 1.0

2017-06-30

- Finalized specification tables. All tables were updated with latest characterization data and production test limits.
- Updated typical performance graphs for DC-DC.
- Minor typographical, clarity, and consistency improvements.
- Condensed pin function tables with new formatting.

**Revision 0.5**

2017-02-10

- Updated Feature List and Front Page with latest characterization numbers.
- List of OPNs in Ordering Table consolidated.
- Electrical Characteristics Table Changes
  - All specification tables updated with latest characterization data and production test limits.
  - Split HFRCO/AUXHFRCO table into separate tables for HFRCO and AUXHFRCO.
  - OPAMP, CSEN, and VDAC specification line items updated to match test conditions.
  - Added tables for Analog Port (APORT) and Pulse Counter (PCNT).
- Added Typical Performance Curves for supply current and DCDC parameters.
- Added APORT Connection Diagram.

**Revision 0.2**

December 9th, 2016

Initial release.

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