

Power optimized Arm® multi-core line of products running up to 320 MHz with up to 6.5 MB SRAM and 512 KB RRAM. Capable of a 480 times uplift in ML performance over existing Cortex®-M based systems. Integrated accelerators for machine learning security, and graphics.

Features

• Compute

- 320 MHz Arm® Cortex®-M55 with Helium DSP, FPU, 32 KB I/D caches and 512 KB of 0-wait state SRAM tightly coupled memory
- Power optimized 160 MHz Arm® Cortex®-M33 and proprietary>NNLITE NPU
- 320 MHz Arm® Ethos-U55 NPU with 128 MACs per cycle

• Memory

- Up to 5 MB system SRAM to support machine learning and graphics
- 1 MB of SRAM coupled with the low power Arm® Cortex®-M33 CPU
- 512 KB of ultra low power RRAM for non-volatile storage
- 256 KB instruction, 256 KB data tightly coupled memory for Arm® Cortex®-M55
- 64 KB boot ROM

• Security

- Lockstep secure enclave with option to be compliant to Arm® PSA L4/Infineon Edge Protect Category 4 (EPC4) providing tamper protection, Arm® Trusted Firmware-M (TF-M) and mbedTLS libraries for cyber security regulation conformance
- Cryptographic accelerators and essential security capability including protected Root-of-Trust (RoT), secure boot, secure firmware updates
- PSA L4 iSE certified hardware secure enclave (certification pending)
- PSA L3 certified system security (certification pending)

• Human Machine Interface

- 2.5D GPU, display controller and MIPI-DSI interface for reducing latency and memory required to support rich graphics
- 2x TDM/I2S to interface to audio codec
- PDM/PCM for up to 6 DMIC connections and acoustic activity detect (AAD)
- Comprehensive audio and voice processing: Integrated DEEPCRAFT™ middleware, configurable audio front-end (AFE), staged voice control, and low-power autonomous analog capabilities for intelligent audio applications

• Communication

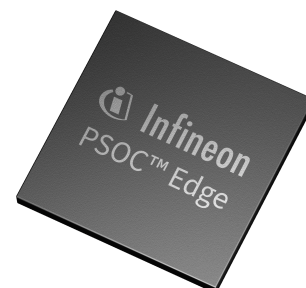
- 11x serial communications block (SCB) with flexibility to support I²C, UART and SPI. 1x SCB, deep sleep capable supporting only I²C and SPI
- High speed/full speed USB with PHY
- I3C
- 2x serial memory interface to support external quad/octal SPI and HYPERBUS™ interface
- 2x SD host controller to support SD, SDIO and eMMC
- Optional CAN-FD and 10/100 ethernet support

• Analog

- Analog front end integration with 12-bit ADC, 2x DAC, OPAMP, PGA and comparators
- Autonomous operation support for I/O, analog and audio peripherals

• System

- Multiple power modes with integrated DC-DC buck converter; dynamic voltage and frequency management
- Internal and external support for clock sources with multiple integrated PLLs
- Programmable GPIO pins: drive modes, strengths, and slew rates; over-voltage tolerant (OVT) I/O programmable logic array



Green



Halogen-free



Lead-free

Potential applications

- Power supply range: 1.8 V to 4.8 V
- Ambient temperature range: -40°C to 105°C Ta
- **Enablement**
 - ModusToolbox™ software ecosystem providing embedded development tools and run-time assets, including support for multiple IDE/toolchains, extensive example projects, and middleware resources
 - DEEPCRAFT™ Studio enabling the full journey from ML model development to embedded software
 - Supports Zephyr RTOS ecosystem for a wide range of applications, including AI/ML, IoT, and industrial control systems
 - Multiple hardware development boards with integrated wireless connectivity for rapid prototyping and evaluation

Potential applications

- Access control
- Medical equipment
- Industrial automation
- Industrial robotics



Description

Description

This product line is a dual-CPU microcontroller with a neural net companion processor, DSP capability, high-performance memory expansion capability, low-power analog subsystem with high-performance analog-to-digital conversion and low-power comparators, IoT connectivity, communication channels, and programmable analog and digital blocks. It also has audio and graphics blocks.

COMPUTE

High Performance (HP) Domain

Arm® Cortex®-M55 up to 320 MHz	Helium DSP	Arm® Ethos-U55 NPU up to 320 MHz
NVIC	FPU	MPU
32 KB I-Cache	32 KB D-Cache	4-ch HPDMA
256 KB I-TCM	256 KB D-TCM	WIC

Low Power (LP) Domain

Arm® Cortex®-M33 up to 160 MHz	DSP	NNLite NPU up to 160 MHz
NVIC	FPU	Arm® TrustZone
16 KB I-Cache	2x 16-ch DMA	WIC

MEMORY

Up to 5 MB System SRAM	2x Serial Memory I/F (Octal SPI/HYPERBUS™)
1 MB SRAM (LP Domain)	2x SD Host Controller (SD 6.0/SDIO 4.10/eMMC 5.1)
512 KB RRAM	64 KB Boot ROM

HUMAN MACHINE INTERFACE

Acoustic Activity Detect	Wake Word Detection	
6x PDM	2x TDM/I2S	
2.5D GPU	DC	MIPI DSI/DBI

SYSTEM CONTROL

32x TCPWM	3x DPLL
2x Smart I/O	Clock Control
LDO/Buck	2x MCWDT
BOD	Watchdog Timer
POR	RTC
Up to 132 GPIOs, 6 SMIF, 7 DSI and 2 USB I/Os	16x 32-bit Backup Registers

SECURE ENCLAVE

Secure Boot	Side Channel Resistance
TRNG	Crypto Accelerator
Tamper Protection	Secure JTAG
OTP	Secure Key Storage

ANALOG

ADC 12-20 bit 5 Msps/200 ksps**	4x Opamp/PGA/TIA/ Buffer/Comp
2x 12-bit DAC	2x 4-bit Prog. Reference
2x PTCOMP	2x LPCOMP

COMMUNICATION

USB HS/FS	1x I3C
10/100 Ethernet	2x CAN-FD
1x SCB (I2C, SPI)	11x SCB (UART, I2C, SPI)

System Power Modes

HP/LP

Deep Sleep

Hibernate

** 5 Msps in HP/LP, 200 ksps in Deep Sleep

Table of contents

	Features	1
	Potential applications	2
	Description	3
	Table of contents	4
1	Introduction	8
2	Detailed features	10
3	Development ecosystem	13
3.1	PSOC™ Edge MCU resources	13
3.2	ModusToolbox™ software	13
3.3	Zephyr	14
4	Chip-level functional description	15
4.1	Power	15
4.1.1	Power connections	15
4.1.2	Power distribution and domains	18
4.1.3	Power modes	20
4.1.4	Power mode transitions	21
4.1.5	Power block support	21
4.2	Security	23
4.2.1	Security features	23
4.2.2	Security architecture overview	25
4.3	Audio and voice system capabilities	25
4.3.1	DEEPCRAFT™ audio enhancement middleware	26
4.3.2	Configurable Audio Front-End (AFE)	27
4.3.3	Audio codec support	28
4.3.4	Staged voice control and wake word detection	28
4.3.5	Autonomous analog audio processing	29
4.3.6	AI-enhanced audio intelligence	30
4.3.7	Wireless audio streaming support	30
5	Block functional description	31
5.1	Processors	31
5.2	Inter-Processor Communication (IPC)	31
5.3	DMA	32
5.4	Cryptographic accelerator (CRYPTO)	32
5.5	Memory	32
5.5.1	Nonvolatile memory	32
5.5.2	EEPROM	33
5.5.3	SRAM	33

Table of contents

5.5.4	Serial Memory Interface (SMIF)	33
5.5.5	Wait states and latencies	33
5.6	Protection units	35
5.7	Clocks	36
5.7.1	Internal high-speed oscillator (IHO)	36
5.7.2	Precision internal low-speed oscillator (PILO)	36
5.7.3	Watchdog timer (WDT)	37
5.7.4	External crystal oscillators (ECO)	37
5.7.5	Real time clock	38
5.8	Reset	38
5.9	Autonomous Analog	39
5.9.1	SAR ADC	39
5.9.2	DAC	40
5.9.3	Continuous time block (CTB)	40
5.9.4	PTComp	40
5.10	Low-power comparator	41
5.11	Fixed function digital	41
5.11.1	Timer/counter/PWM (TCPWM)	41
5.11.2	Serial communication block (SCB)	41
5.11.3	CAN FD	42
5.11.4	Ethernet media access control (MAC)	42
5.11.5	I3C	42
5.11.6	SD host controller	42
5.11.7	USB	43
5.12	GPIO ports	43
5.13	Smart I/O (programmable I/O)	45
5.14	Neural net processing for machine learning	49
5.14.1	Arm® Ethos-U55	49
5.14.2	NNLite	49
5.15	Audio functions	50
5.15.1	PDM/PCM block	50
5.15.2	TDM/I2S block	50
5.15.3	Autonomous analog block with analog mic	51
5.16	Graphics functions	51
5.17	Boot source and alternate serial interfaces configuration	51
6	Pins	53
7	GPIO alternate functions	59
8	Electrical specifications	77
8.1	Absolute maximum ratings	77
8.2	Device-level specifications	77
8.2.1	Device power summary	77

Table of contents

8.2.2	Power supplies	79
8.2.3	Power measurement configurations	80
8.2.4	Device current specification organization	82
8.2.4.1	System HP active mode: CPU current in battery-powered configuration	83
8.2.4.2	System LP active mode: CPU current in battery-powered configuration	85
8.2.4.3	System deep sleep and hibernate mode: CPU current in battery-powered configuration	87
8.2.4.4	System HP active mode: CPU current in supply-powered configuration	89
8.2.4.5	System LP active mode: CPU current in supply-powered configuration	91
8.2.4.6	System deep sleep and hibernate mode: CPU current in supply-powered configuration	92
8.2.5	Root clock divider frequencies	94
8.2.6	Power mode transition times	94
8.2.7	Estimation of device power	95
8.2.8	XRES	97
8.2.9	GPIO	98
8.3	Analog peripherals	101
8.3.1	Autonomous analog specifications	101
8.3.2	LP Comparator	102
8.3.3	ADC	103
8.3.4	DAC	106
8.3.5	CTBL Op Amp	108
8.3.6	PT Comp	123
8.3.7	PRB	124
8.4	Digital peripherals	125
8.4.1	Timer Counter Pulse Width Modulator TCPWM	125
8.4.2	Serial Communication Block SCB	126
8.5	System Resources	128
8.5.1	System Resource	128
8.5.2	Single Wire Debug SWD and Trace Interface	128
8.5.3	Internal Oscillators Crystal Oscillators External Clock and PLLs	129
8.6	PLLs	131
8.7	Serial Memory Interface SMIF Controller	131
8.8	SDHC and eMMC	133
8.9	Audio Sub system	137
8.10	Ethernet MAC	138
8.11	CAN FD	138
8.12	JTAG and Boundary Scan	139
8.13	USB HS	139
8.14	MIPI DSI PHY	139
8.15	MIPI DBI	139
8.16	I3C	140
8.17	NNlite	140
8.18	SmartIO	140



Table of contents

8.19 GPU 140

9 Ordering information 141

9.1 Part number nomenclature 141

10 Package information 144

11 Errata 146

12 Acronyms 149

13 Document conventions 154

13.1 Units of measure 154

Revision history 155

Trademarks 156

Disclaimer 157

1 Introduction

This product line is a high-performance, low-power MCU family, designed for compute performance, human-machine interface (HMI), machine learning (ML), enhanced sensing, real-time control, and low-power applications. Robust and easy-to-use ML and HMI software and tools are also provided.

Functions supported include security, communications and control, and DSP, in a multi-domain architecture which enables fine-grained power optimization and dynamic frequency scaling. The always-on domain supports voice recognition, battery monitoring, and other sensing applications. These functions are provided at extremely low power.

A detailed block diagram is shown in [Figure 1](#).

Device identification and revisions

Family ID = 0x115 (12-bit); Si ID range = 0xED80-0xEDBF, 0xF180-0xF1BF

Firmware Revisions: Rom Boot: 2.0.0.6022, RRAM Boot: 2.0.0.7127

Silicon revision ID	Description
0x21 (B0)	Initial production release
0x22 (B1)	Silicon fix to resolve Autonomous analog wake up timer glitch errata

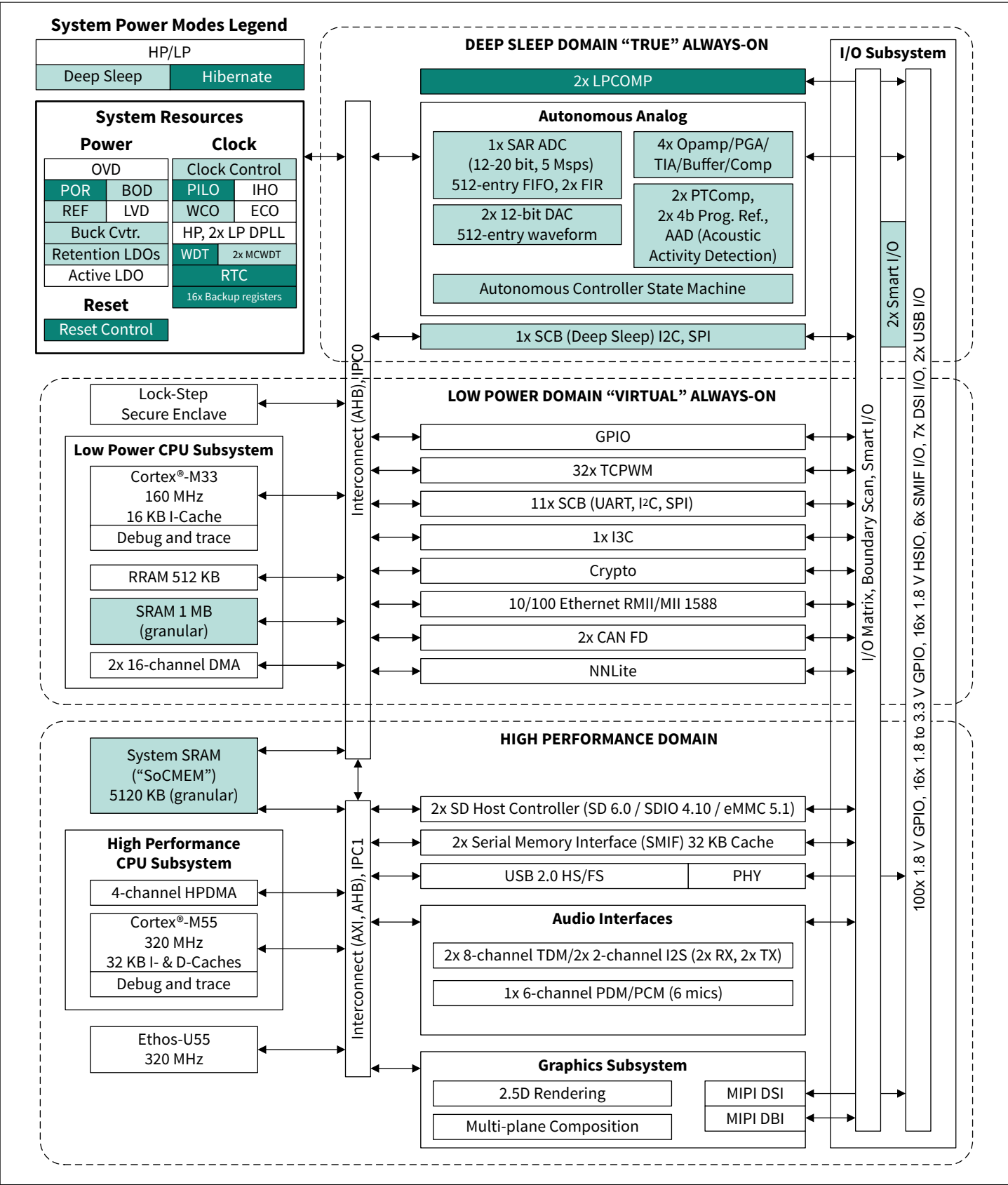


Figure 1 Detailed diagram

2 Detailed features

This product line has the following features:

- **Autonomous analog**
 - 2x Continuous-Time Blocks (CTB) offering Analog Front-End (AFE) functions such as:
 - Programmable Gain Amplifier (PGA)
 - Transimpedance Amplifier (TIA)
 - Pseudo-Differential Amplifier
 - Comparator
 - SAR ADC with
 - 5 Msps sample rate at 12 bits or 250 ksps at 16 bits in System High Performance mode
 - 200 ksps sample rate at 12 bits or 12.5 ksps at 16 bits in System Deep-Sleep mode
 - Accumulation and averaging – 2x, 4x, 8x ... 256x
 - Limit detection, Offset and gain calibration
 - 2x 12-bit DAC with 1 μ s refresh time, automatic waveform generation
 - 2x Programmable Threshold Comparators (PTComp) with post-processing supporting Audio Activity Detection (AAD) and Motor Control
 - Autonomous controller capable of performing following functions in Device Deep Sleep mode
 - Power cycling of individual blocks
 - Send triggers and/or interrupts to the CPU
 - Digital output to as many as four GPIOs
- **Security features**
 - Up to Infineon Edge Protect Category 4 (EPC 4), depending on part number (see [Ordering information](#)). For more information on Infineon Edge Protect, see [here](#)
 - Lockstep Secure Enclave in low-power always-on domain
 - Secure Infineon RoT key storage; secure boot
 - Tamper detection, side channel attack (SCA) mitigation, and protection against fault injection attacks
 - On EPC 4 part numbers only: Secure Enclave runtime services for Arm® Platform Security Architecture (PSA) compliant cryptography, key management, secure storage and attestation services (see [Ordering information](#))
 - Off-the-shelf Trusted Firmware-M enablement and Mbed-TLS for crypto operations
 - Secure isolation of processing environments via Arm® TrustZone with root-of-trust established at boot by Cortex®-M33 CPU
 - Factory provisioned device unique keypair (DICE_DeviceID), Hardware Unique Key (HUK), Unique Device Secret (UDS) and Infineon device certificates
 - Infineon proprietary protection units for memory and peripherals
 - Secure firmware update; secure debug, secure RMA mode for field failure analysis
- **Low-power security, control, and communication CPU**
 - Cortex®-M33 with FPU, DSP, and MPU at 160 MHz in System High Performance (HP) power mode (see [Power modes](#))
 - 16-KB I-cache
 - RRAM module for NVM
 - DMA
 - Hardware crypto accelerator with comprehensive support of cryptographic algorithms
- **High-performance compute, DSP, and machine learning (ML) blocks**
 - Cortex®-M55 CPU with DSP extension at 320 MHz in System High Performance (HP) power mode (see [Power modes](#))
 - FPU, MVE extension with vectored fixed and floating point

2 Detailed features

- 32-KB I-cache and 32-KB D-cache
- 256-KB I- and 256-KB D-TCMs
- Ethos-U55 NN coprocessor with 128 multiply-accumulate operations (MACs) per cycle; 102.4 billion operations per second
- HPDMA
- Multi-AXI high-bandwidth interconnect
- **Communications and connectivity**
 - HS USB host/device, 480 Mbps
 - SD host controllers with eMMC mode
 - 2x Serial memory interfaces (SMIF with 32 KB cache) with octal DDR
 - Ethernet 10/100 media access control (MAC)
 - CAN FD
 - I3C bus for 2-wire sensor hubs
 - I²C, SPI, and UART via serial communication blocks (SCB). SCB0 supports only I²C and SPI
- **HMI functional blocks**
 - 2.5D graphics processor for rendering images and text
 - Display controller with MIPI DSI
 - Audio: PDM microphone interface with 3 pairs of inputs, 2x TDM (Time Division Multiplexing) with 8 channels each interface, supporting I2S full and half-duplex modes
- **Comprehensive audio and voice processing**
 - **DEEPCRAFT™ audio enhancement middleware:** Advanced audio signal processing, including noise suppression, acoustic echo cancellation, dereverberation, and automatic gain control for superior audio clarity
 - **Configurable Audio Front-End (AFE) with intuitive tools:** Visual configurator and middleware supporting flexible audio input/output channel management with sampling rates up to 32 kHz
 - **Staged voice control middleware:** Multi-stage power-management framework that progressively activates audio-processing capabilities based on detected acoustic activity for optimized power consumption
 - **Integrated audio software codec support:** Native support for industry-standard codecs, including Opus, LC3, SBC, MP3, and AAC, for versatile audio streaming and compression
 - **Autonomous analog audio processing:** Always-on, low-power audio signal chain with an autonomous analog controller for continuous audio monitoring without CPU intervention
 - **AI-enhanced audio features:** Machine-learning capabilities for wake-word detection, voice identification, sound classification, onset detection, and acoustic-scene analysis
- **Optimizable power**
 - Independent voltage domains allowing selectable domain power for low-power or high-performance (see [Power modes](#))
 - Active, sleep, deep sleep, and hibernate modes
 - On-chip DC-DC buck converter
 - Dynamic frequency scaling for real-time power optimization
 - Granular SRAM blocks for selectable SRAM retention
- **Programmable GPIO pins**
 - Programmable drive modes, strengths, and slew rates
 - Overvoltage tolerant (OVT) pins for I²C compliance
- RTC with 16 backup registers
- **ModusToolbox™ design environment**
 - Code development and debugging in a cross-OS (Windows, Linux, Mac OS) IDE-neutral environment supporting Visual Studio Code, IAR, Keil and Eclipse IDEs
 - Installable software development kits (SDK) for peripheral initialization, clock and pin configuration, and middleware selection

2 Detailed features

- Peripheral driver library (PDL) for peripheral APIs, including SD host controller for connection to IoT devices; and ML library
- Industry-standard CMSIS pack support
- RTOS support, including FreeRTOS
- DEEPCRAFT™ Studio enabling the full journey from ML model development to embedded software
- **Zephyr integration**
 - Compatible with the Zephyr RTOS ecosystem, providing a secure and reliable development environment
 - Supports various Zephyr features, including device management, networking, and file systems
 - Includes Zephyr documentation and board support for the PSOC™ Edge E84 AI Evaluation Kit and PSOC™ Edge E84 Evaluation Kit

3 Development ecosystem

3.1 PSOC™ Edge MCU resources

A wealth of data available at www.infineon.com helps you to select the right PSOC™ MCU and quickly and effectively integrate it into your design. The following is an abbreviated list of resources for PSOC™ Edge E8 MCU.

- **Overview:** [PSOC™ portfolio](#)
- [PSOC™ Edge E8x2, E8x3, E8x5, E8x6 Architecture Reference Manual](#): This document contains architectural descriptions of hardware blocks
- [PSOC™ Edge E8x2, E8x3, E8x5, E8x6 Registers Reference Manual](#): This document contains a list of registers and bit-fields in the hardware blocks
- **Application notes** cover a broad range of topics, from basic to advanced level, and include the following:
 - [AN235935](#): Getting started with PSOC™ Edge E84 on ModusToolbox™ software
 - [AN239191](#): Getting started with graphics on PSOC™ Edge MCU
 - [AN236697](#): Getting started with PSOC™ MCU and AIROC™ connectivity devices
 - [AN237849](#): Getting started with PSOC™ Edge security
 - [AN240096](#): Getting started with Trusted Firmware-M (TF-M) on PSOC™ Edge
 - [AN236282](#): Device Firmware Update (DFU) Middleware (MW) for ModusToolbox™
 - [AN238041](#): PSOC™ Edge provisioning specification
 - [AN236517](#): PCB layout guidelines for PSOC™ Edge E84 MCU
 - [AN237976](#): PSOC™ Edge E84 MCU low-power modes and power reduction techniques
 - [AN239774](#): Selecting and configuring memories for power and performance in PSOC™ Edge MCU
 - [AN242253](#): PSOC™ Edge E84 MCU voice and audio firmware components guide
 - [AN239757](#): Authenticated debug for PSOC™ Edge
 - [AN240857](#): PSOC™ Edge MCU Lifetime Estimate
- **Code Examples:** Numerous example applications featuring various peripherals and system middleware are available on [Infineon GitHub repositories](#)
- **Development kits including documentation, schematics and layout files**
 - General purpose evaluation kit: [KIT_PSE84_EVAL](#)
 - Artificial Intelligence/Machine Learning kit: [KIT_PSE84_AI](#)
- **Training**
 - [PSOC™ Edge lab-based training modules](#)
 - [Video training](#) on Infineon products and tools
- **Technical Support:** [PSOC™ development community forum](#), [Knowledge base articles](#), [My cases](#)

3.2 ModusToolbox™ software

ModusToolbox™ Software is Infineon's comprehensive collection of multi-platform tools and software libraries that enable an immersive development experience for creating converged MCU and wireless systems. It is:

- Comprehensive - it has the resources you need
- Flexible - you can use the resources in your own work flow
- Atomic - you can get just the resources you want

Infineon provides a large collection of code repositories on GitHub. This includes:

- Board support packages (BSPs) aligned with Infineon kits

3 Development ecosystem

- Peripheral driver library (PDL) provides the low-level, device-specific firmware drivers for accessing the hardware sub-systems and peripherals
- Middleware enabling industry-leading features such as CAPSENSE™, Bluetooth® Low Energy, and mesh networks. Additionally, a Hardware abstraction layer (HAL) provides middleware portability across product families
- An extensive set of thoroughly tested code example applications

ModusToolbox™ software is IDE-neutral and easily adaptable to your workflow and preferred development environment. It supports Windows, Linux, MacOS, IAR, Keil, and Visual Studio Code. As [Figure 2](#) shows, it includes (1) a project creator, (2) peripheral and library configurators, (3) a library manager, and (4) an optional Eclipse IDE for ModusToolbox™. For information on using Infineon tools, refer to the documentation delivered with ModusToolbox™ software, and [AN235935](#) – Getting started with PSOC™ Edge E84 on ModusToolbox™ software.

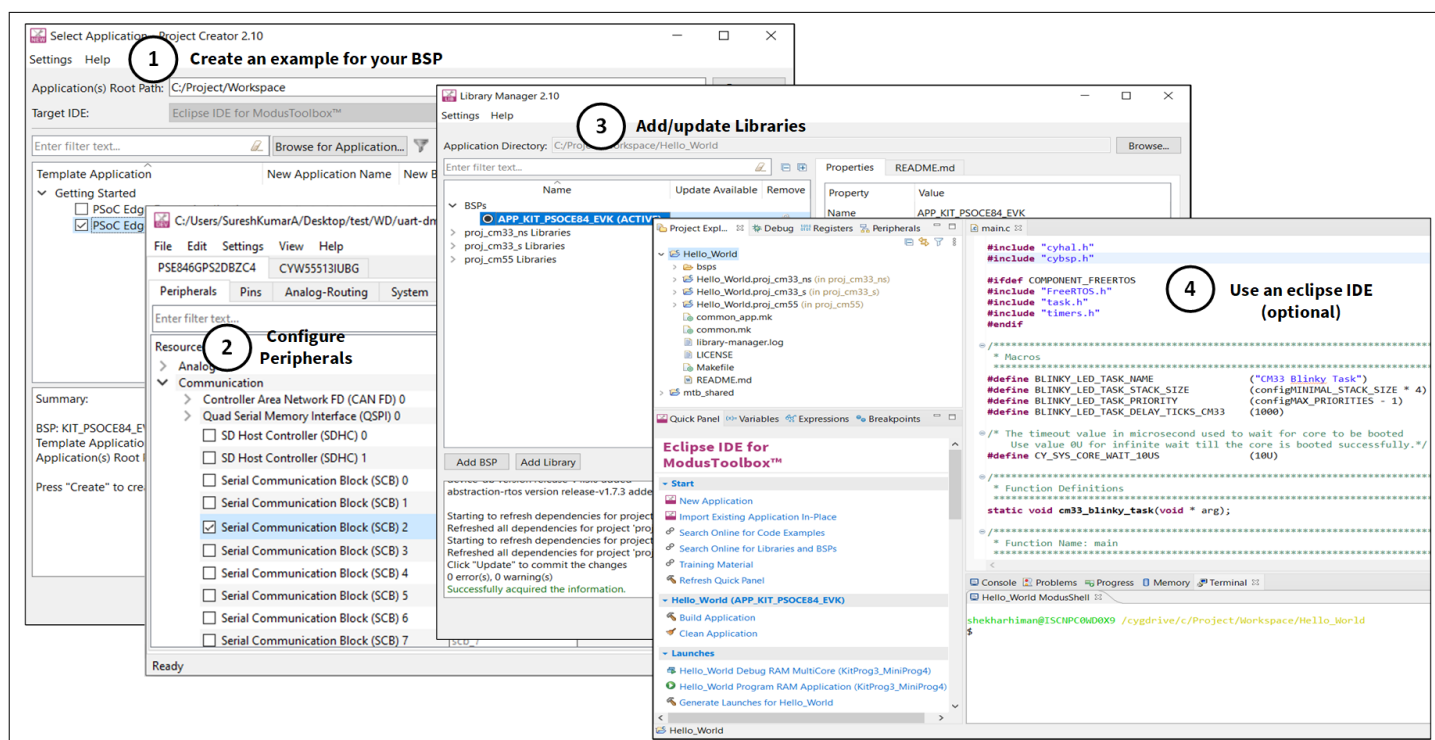


Figure 2 ModusToolbox™ Software Tools

3.3 Zephyr

The PSOC™ Edge family of devices is supported by the Zephyr project, an open-source RTOS ecosystem that provides a scalable and secure development environment. This support enables developers to leverage the advanced features of the PSOC™ Edge family, including AI/ML acceleration, advanced security, and high-performance processing, as well as proprietary audio and vision pipelines. The Zephyr project offers a wide range of tools and resources, including documentation, example projects, and community support, to help developers get started with their projects. The following PSOC™ Edge boards are supported:

[PSOC™ Edge E84 Evaluation Kit](#)

[PSOC™ Edge E84 AI Evaluation Kit](#)

See the [Infineon Technologies](#) page under Zephyr Supported Boards and Shields for other Zephyr-enabled device families.

4 Chip-level functional description

4.1 Power

This product line offers multiple features for managing and reducing power draw. Multiple power modes include active, sleep, deep sleep, and hibernate. Deep sleep has three variations based on retention of SRAM.

The power control block provides assurance that voltage levels meet the requirements of the respective modes. It can:

- Delay mode entry (for example, at power-on reset (POR)) until voltage levels are as required for proper functioning
- Detect operation below safe power supply levels:
 - Generates interrupts for low-voltage detection (LVD)
 - Generates reset for brownout detection (BOD)

This product line operates with a single 1.8 V $\pm 5\%$ regulated supply, or from a 2.7 to 4.8 V supply along with a 1.8 V 5% regulated supply. The core logic can operate at different levels with a trade-off in performance and power. In conjunction with clock gating at peripheral and bus levels, this permits fine-grained optimization of energy usage.

A buck regulator powers the core logic at three levels: 0.7 V, 0.8 V, and 0.9 V; (see [Power modes](#)). The buck efficiency is $\geq 80\%$ in the active power mode. The buck configuration is single in, single out (SISO).

Dynamic voltage and frequency scaling are supported. Voltage level switching is implemented by writing to power control registers.

4.1.1 Power connections

The following power system diagrams show typical connections for power pins for all supported packages. In these diagrams, the package pin is shown with the pin name, for example "VDDQ , A11". For VDDIOx pins, the I/O port that is powered by that pin is also shown, for example "VDDIO1; E6,; I/O port P8".

The diagrams show two ways to power the device:

- **Supply-powered:** All VDDx pins are tied to 1.8 V. Isolated sources can be used, for example to isolate analog circuits or to isolate the rest of the system from noisy GPIOs. All "VBAT" related pins are grounded
- **Battery-powered:** VBAT is connected to a supply ranging from 2.7 V to 4.8 V. Other VDDx pins must still be connected to 1.8 V. All "IP8" pins are grounded

Note that the smaller packages do not have a VBAT pin; these packages can only be supply-powered.

In both cases, VDD.USB is tied to 3.3 V if USB is being used. If not, should be tied to ground.

When none of the ports associated with VDDIOx are in use, except for VDDIO7, tie all remaining VDDIOx pins to ground and VDDIO7 to 1.8 V, as it has the power detect circuit for all IOs in the chip.

There is no dependency on power supply sequencing. See [System Resource](#); they apply to both power-up and power-down.

Note: *The bypass capacitors shown in the following diagrams are recommendations for typical use only. Actual bypass capacitor usage and size depend on the application.*

4 Chip-level functional description

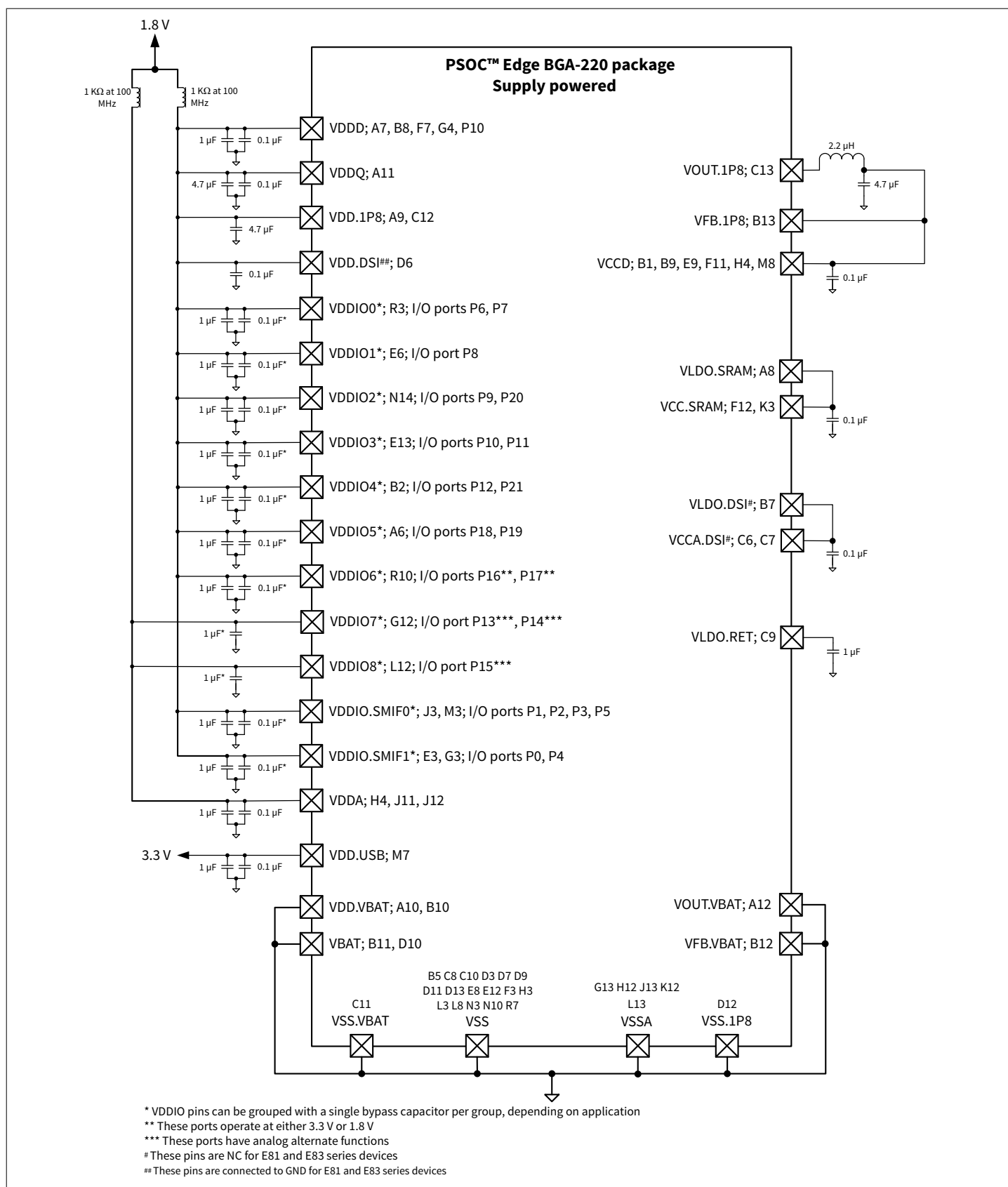


Figure 3 BGA-220 package, supply-powered

4 Chip-level functional description

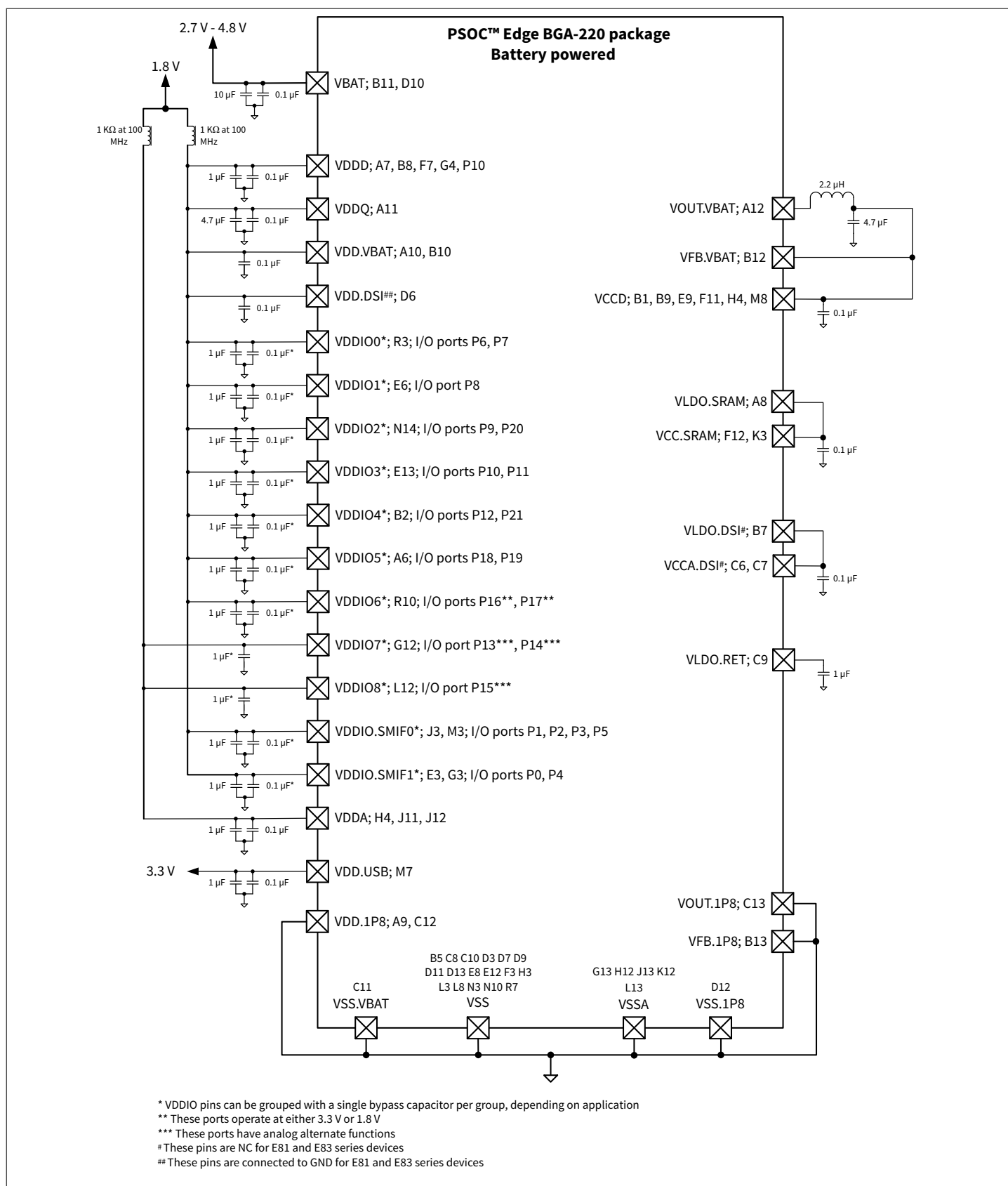


Figure 4 BGA-220 package, battery-powered

4.1.2 Power distribution and domains

This product line has independent voltage domains, allowing domain power to be for low-power or high-performance (see [Power modes](#)).

Diagrams of power distribution are shown in [Figure 5](#) through [Figure 7](#).

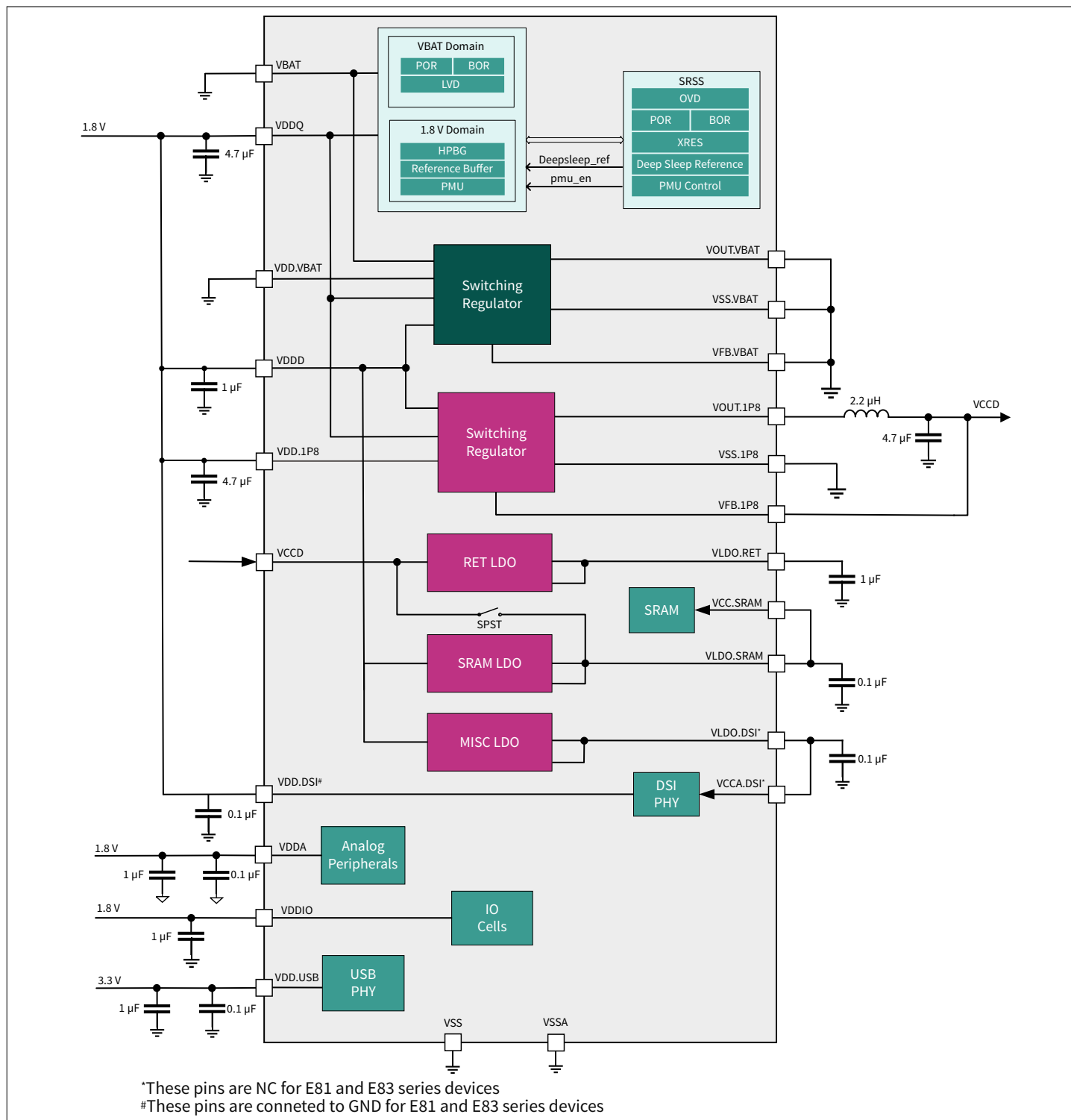


Figure 5 **Power distribution, supply-powered**

4 Chip-level functional description

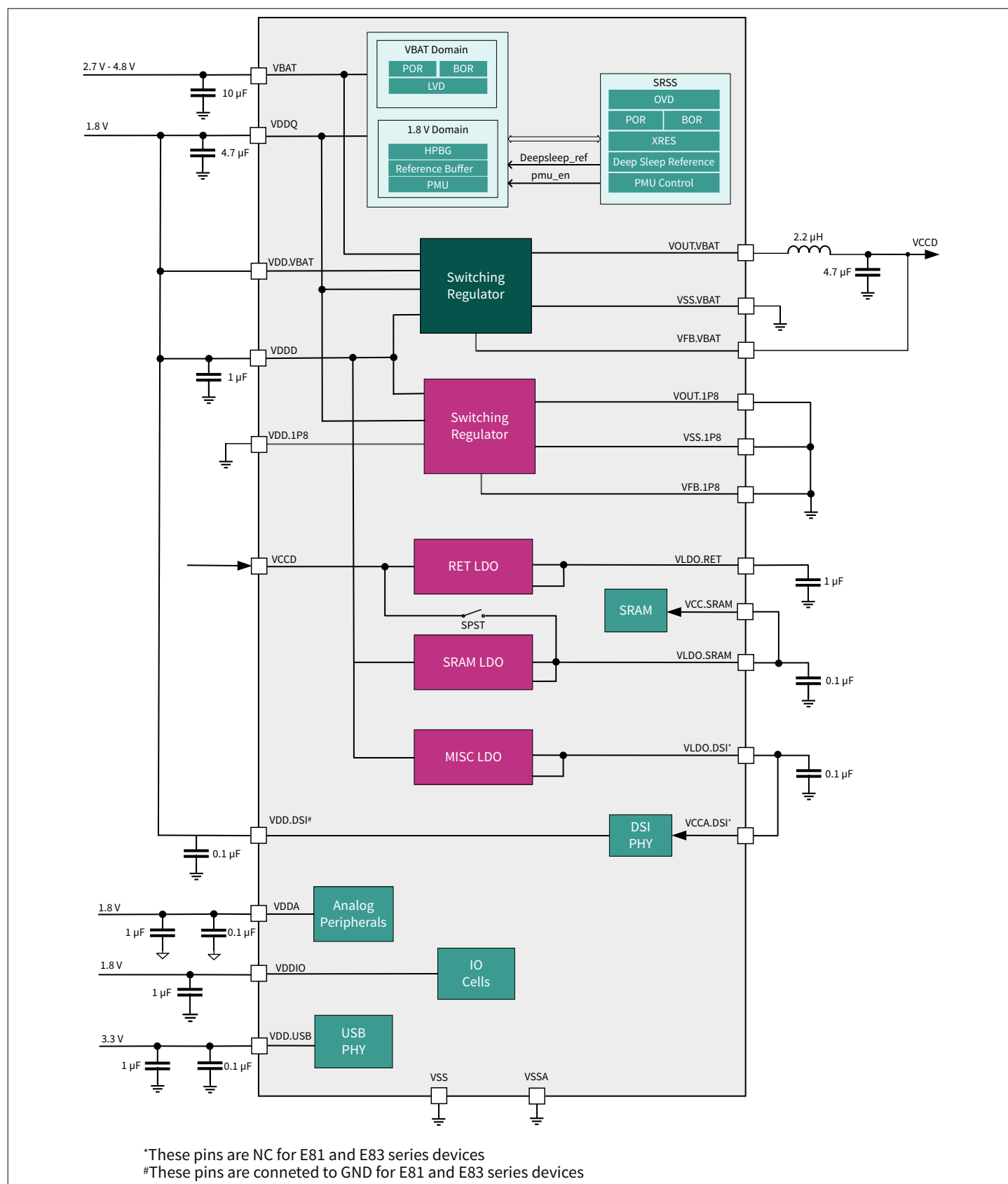


Figure 6 Power distribution, battery-powered

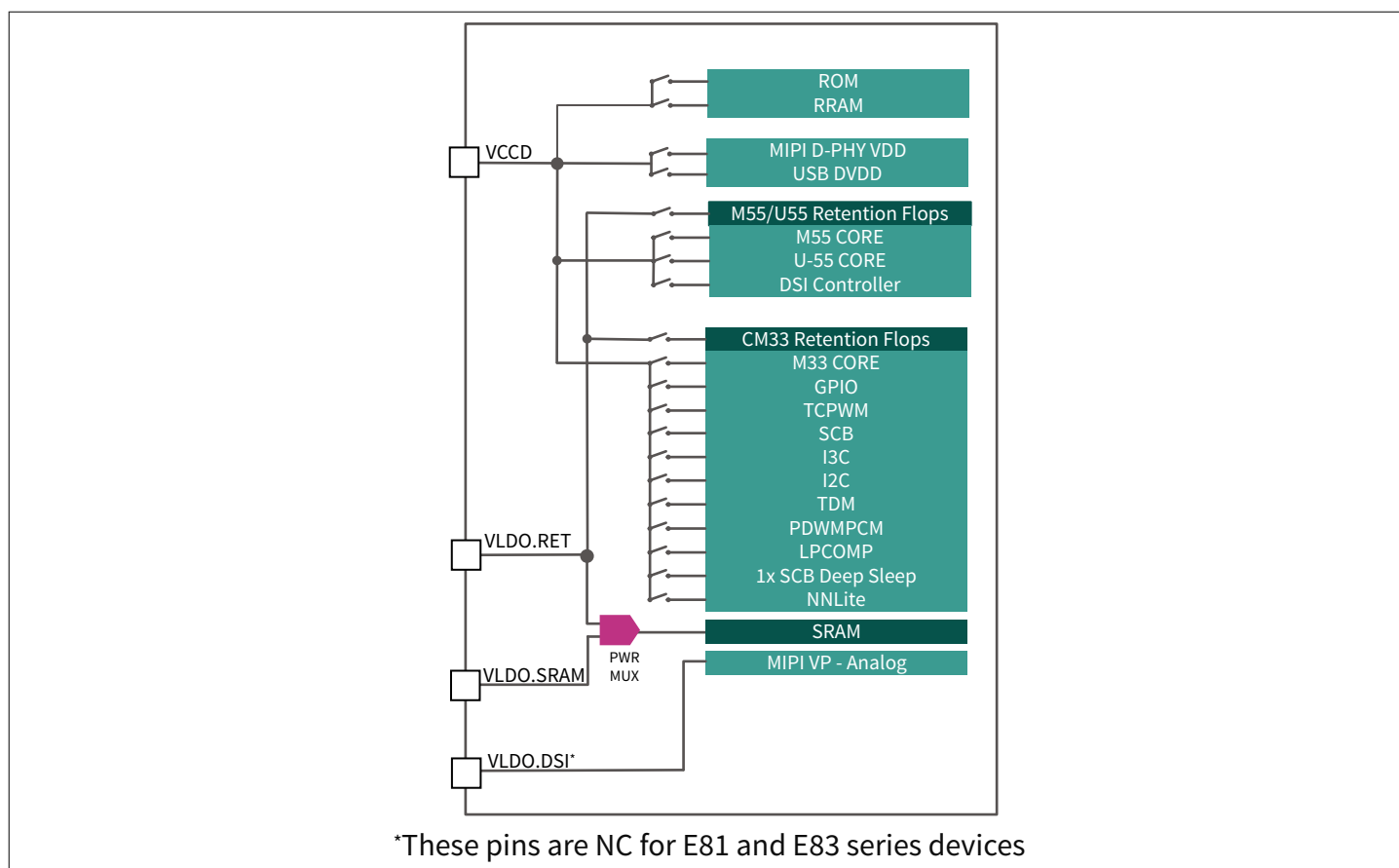


Figure 7 Power distribution to internal blocks

In a typical use case:

- The low-power domain is never switched off unless chip power is cut off, and
- The high-performance domain is used for high-speed communication channels (>100 MHz, display controller outputting frames via MIPI DSI), and DSP and neural network processing, where work is done as fast as possible to reduce real time constraints for applications. Additionally, the high-performance domain can be selectively powered down to save energy and reactivated when needed, while the low-power domain continues to remain active.

The low and high power domains are powered by the same buck converter output — all power domains operate at the same voltage domain.

4.1.3 Power modes

This product line can operate in four system and three CPU power modes. These modes are intended to minimize the average power consumption in an application.

Power modes supported are:

- **System High Performance (HP):** All peripherals and CPU power modes are available at maximum speed. Core logic runs at 0.9 V.
- **System Low Power (LP):** All peripherals and CPU power modes are available at reduced speed. Core logic runs at 0.8 V.
- **CPU Active:** CPU executes code in system HP or LP mode.
- **CPU Sleep:** CPU code execution is halted — the CPU clock is gated off — in system HP or LP mode.
- **CPU Deep Sleep:** Same as CPU Sleep; in addition the CPU's System Deep Sleep request signal is activated.

4 Chip-level functional description

- **System Deep Sleep:** Only Deep Sleep-capable peripherals are available after both CPUs enter CPU Deep Sleep mode. This mode has two sub-modes: System Deep Sleep RAM and System Deep Sleep Off. See [Table 1](#) for details.

The device transitions to System Deep Sleep mode only when either of the following conditions are met:

- Both CPUs are in Deep Sleep mode
- The high-performance domain is powered OFF, and the Cortex®-M33 is in Deep Sleep mode

- **System Hibernate:** This is the lowest current mode. Almost all functionality is powered off in this mode except for the RTC, watchdog timer (WDT), and low-power comparators (LPCOMP), along with the ability to wake up on activity on a limited set of pins and retaining limited application data using backup registers. Wakeup is tantamount to a cold boot. GPIO states are retained in this mode.

CPU Active, Sleep, and Deep Sleep are standard Arm® defined power modes supported by the Arm® CPU instruction set architecture (ISA). System HP, LP, Deep Sleep and Hibernate modes are additional power modes provided by the device.

4.1.4 Power mode transitions

This product line generally supports Arm® standard power modes; see [Power modes](#) for details. [Table 1](#) lists the supported power modes.

Table 1 Power mode support

	CPU Active/ Sleep	System Deep Sleep	System Deep Sleep-RAM	System Deep Sleep-Off	System Hibernate	Off
Parameters						
Wake source	Any interrupt	DS peripherals	DS peripherals	DS peripherals	RTC/HIB peripherals	Power on
Wake action	Resume	Resume	Warm boot	Reset/cold boot	Reset	Reset
Wake time	One CPU cycle	< 20 µs	Deep sleep+warm boot	Deep sleep+cold boot	POR+coldboot; < 1 ms	
Resources						
IHO	On	Off	Off	Off	Off	Off
PILO	On/Off	On/Off	On/Off	On/Off	On/Off	Off
ECO	On/Off	On/Off	On/Off	On/Off	Off	Off
WCO	On/Off	On/Off	On/Off	On/Off	On/Off	Off
CPU	On/Sleep	retention	Off	Off	Off	Off
SRAM	On/select off	Off/select retention	Off/select retention	Off	Off	Off

4.1.5 Power block support

[Table 2](#) shows the available operational states for the major blocks in this product line. Note that operational states possible in low-power modes are generally limited in functionality and parametric performance as compared to their capabilities in the active modes. Also, blocks that do not support low power modes such as System Deep Sleep and System Hibernate cannot wake up the CPUs from these modes. See [Power modes](#) for details.

4 Chip-level functional description

Table 2 **Block power modes**

Block	Power mode			
	CPU Active	CPU Sleep	System Deep Sleep	System Hibernate
CPU subsystem				
CPU _s	Y	N	N	N
NPU _s	Y	Y	N	N
NVIC	Y	Y	N	N
WIC	Y	Y	Y	Y
RRAM	Y	Y	N	N
SRAM	Y	Y	Programmable	N
DMA	Y	Y	N	N
Programmable digital				
Smart I/O	Y	Y	Y	N
Fixed-function digital				
TCPWM	Y	Y	N	N
SCB	Y	Y	N, SCB0 is supported in System Deep Sleep power mode	N
SMIF	Y	Y	N	N
SD host controller	Y	Y	N	N
USB	Y	Y	N	N
CAN FD	Y	Y	N	N
Ethernet	Y	Y	N	N
I3C	Y	Y	N	N
MIPI-DSI	Y	Y	N	N
TDM/I2S	Y	Y	N	N
PDM	Y	Y	N	N
Crypto	Y	Y	N	N
Special function				
Graphics subsystem	Y	Y	N	N
Programmable analog				
LPComp	Y	Y	Y	Y
SAR ADC	Y	Y	Y (duty cycled)	N
DAC	Y	Y	Y	N
PTComp	Y	Y	Y	N
CTB	Y	Y	Y	N

(table continues...)

Table 2 (continued) Block power modes

Block	Power mode			
	CPU Active	CPU Sleep	System Deep Sleep	System Hibernate
IO				
GPIO	Y	Y	Y	Y
System resources				
WDT	Y	Y	Y	Y
MCWDT	Y	Y	Y	N
RTC	Y	Y	Y	Y
Backup registers	Y	Y	Y	Y
OVD	Y	Y	N	N
LVD	Y	Y	N	N

4.2 Security

This product line includes a Cortex®-M55 and an Arm® TrustZone enabled Cortex®-M33 CPU. It provides an isolated fully secure hardware-based Root-of-Trust (RoT) that supports secure boot, secure provisioning, and secure debugging. This RoT is initially owned by Infineon and is extended to the user or OEM during the provisioning process. Provisioning installs the OEM keys; debug, boot, and system configuration policies; and extended boot.

Secure and non-secure debug access is supported; in non-secure access, areas marked "secure" are not accessible by the debugger. In the most secure case provided, the device can be "locked" such that it may not be acquired for test/debug.

Certificate management assures appropriate accesses are provided at different stages of development and production.

This product line is fully compliant with Arm® TrustZone at hardware and software levels. An extra layer of security is implemented with the help of Infineon-proprietary protection units.

For EPC 4 part numbers only (see [Ordering information](#)): secure enclave runtime services provide access to PSA compliant cryptographic services, key management, attestation, and secure storage services.

4.2.1 Security features

- Infineon Edge Protect Category 2 (EPC 2) supporting SESIP/PSA level 2 or Edge Protect Category 4 (EPC 4) supporting SESIP/PSA level 3 + secure enclave, depending on part number (see [Ordering information](#))
- Exclusive access to 5120 bytes of OTP memory for storage of security assets (see [Nonvolatile memory](#))
- Hardware crypto accelerator with comprehensive support of cryptographic algorithms
- Secure isolation of processing environments via Arm® TrustZone
- Infineon proprietary Memory Protection Unit (MPU), Memory Protection Controller (MPC), Peripheral Protection Controller (PPC) for memory and peripheral access control
- Lock-step secure enclave with the following features:
 - Secure boot with hardware-based root of trust (RoT) enabled
 - Device identifier composition engine (DICE) mechanisms for device attestation
 - Cryptography services

4 Chip-level functional description

- EPC 4 part numbers only (see [Ordering information](#)): secure enclave runtime services
- Tamper detection, side channel attack (SCA) mitigation, and protection against fault injection attacks
- Off-the-shelf secure isolation using Trusted Firmware-M (TF-M); and mbedTLS crypto acceleration package

For more information on EPC2 and EPC4, refer to [Infineon Edge Protect](#).

4.2.2 Security architecture overview

This product line has an isolated secure enclave and two CPUs: Cortex®-M33, and Cortex®-M55; as Figure 8 shows:

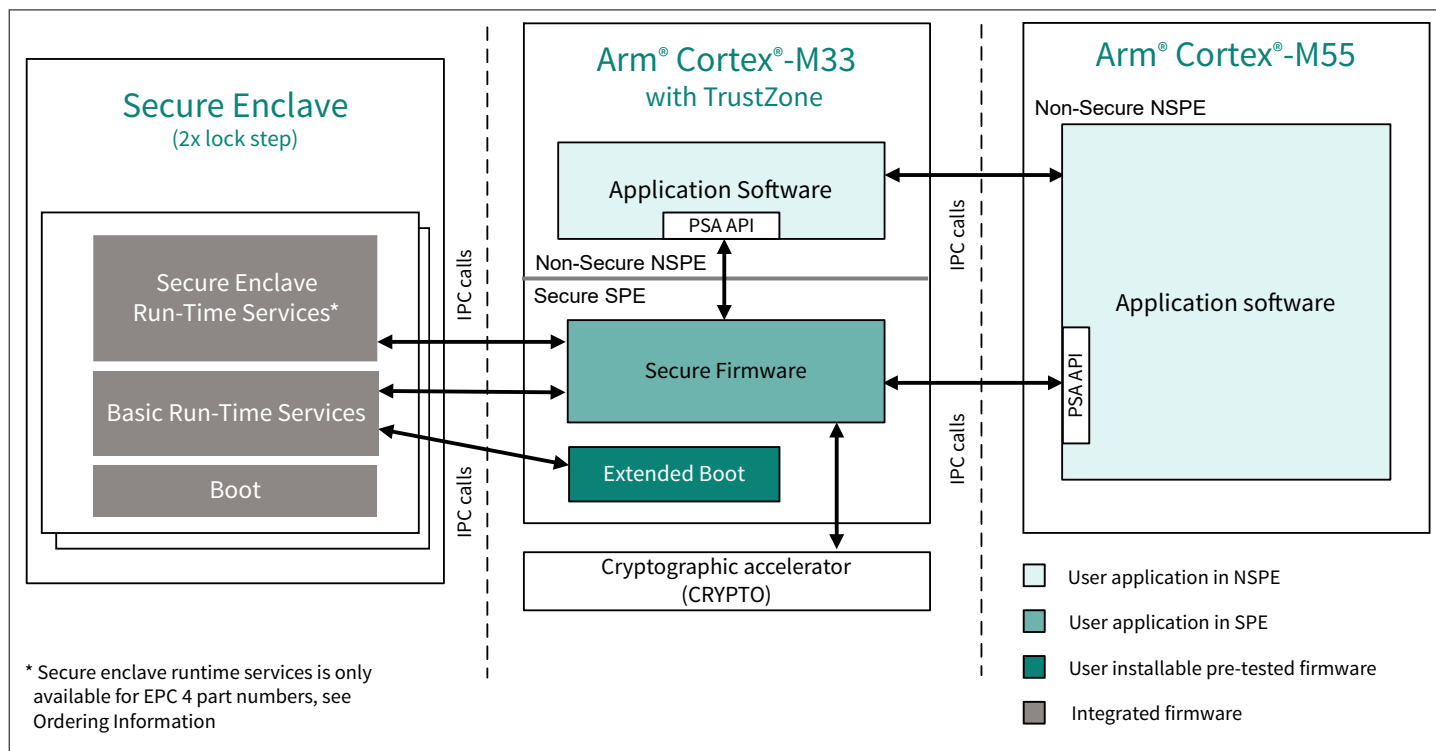


Figure 8 Security architecture diagram

Secure enclave:

- Provides secure boot process including root of trust (RoT) and DICE mechanisms. Boot starts from ROM_BOOT stored in local ROM
- Provides local crypto block for secure cryptographic operations, including SCA and DPA protected crypto
- Provides run-time services to support secure boot, secure firmware update, and other RoT services
- Supports lockstep architecture with two islands of replication for CPU (2x) and crypto (2x), for protection against fault attacks and semi-invasive attacks inside the CPU

Cortex®-M33:

- Arm® TrustZone enabled core with two processing environments: secure (SPE) and non-secure (NSPE)
- Infineon proprietary protection units for memory and peripheral protection
- Integrated mbedTLS crypto acceleration package that supports software and hardware cryptography services
- Infineon-provided Trusted firmware-M (TF-M) implemented in SPE — its services are leveraged by Cortex®-M33 NSPE and Cortex®-M55, fully enabled to use hardware accelerated crypto operations

Cortex®-M55:

- This is an application core operating in NSPE. Applications run by this CPU can request TF-M services using PSA API calls

4.3 Audio and voice system capabilities

The PSOC™ Edge platform integrates comprehensive audio and voice processing capabilities that combine advanced hardware blocks, intelligent middleware, and AI-enhanced functionality to deliver professional-grade audio solutions. This integrated approach enables developers to create sophisticated audio applications while maintaining ultra-low power consumption essential for battery-powered IoT devices.

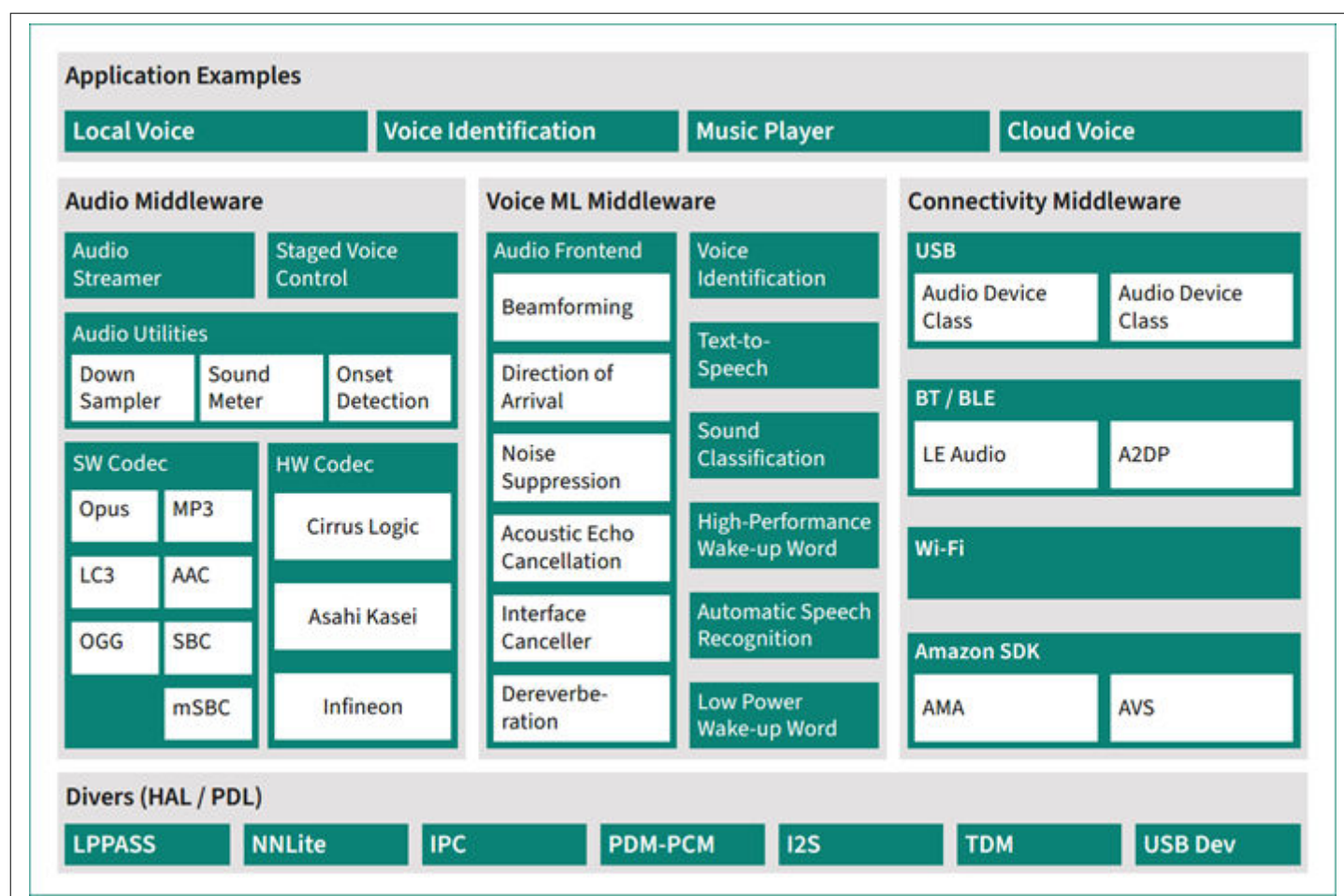


Figure 9 PSOC™ Edge audio and voice architecture

4.3.1 DEEPCRAFT™ audio enhancement middleware

The audio architecture is built around the DEEPCRAFT™ audio enhancement middleware, which provides professional-grade audio processing capabilities, including acoustic echo cancellation, noise suppression, dereverberation, and automatic gain control. These enhancement algorithms significantly improve audio quality across various environmental conditions, making the platform suitable for demanding applications such as hands-free communication systems, smart speakers, and industrial audio monitoring devices. The acoustic echo cancellation delivers superior echo return loss enhancement (ERLE) performance for full-duplex communication, while the intelligent noise suppression and dereverberation ensure clear audio capture even in challenging acoustic environments.

Key audio enhancement features:

- Advanced acoustic echo cancellation (AEC) with superior ERLE performance
- Intelligent noise suppression and dereverberation for clear audio capture in challenging acoustic environments
- Multi-microphone beamforming with direction of arrival (DOA) using correlation factor difference of arrival (CDOA) techniques
- Automatic gain control for consistent audio levels across varying input conditions

The DEEPCRAFT™ audio enhancement requires the Ethos-U55 for noise suppression and echo suppression processing, with memory configured to be 16-bit aligned. All configurable components are accessible through the AFE configurator window, providing a streamlined development experience.

4.3.2 Configurable Audio Front-End (AFE)

The configurable audio front-end (AFE) middleware provides a flexible foundation for audio system design through an intuitive visual configurator that allows developers to configure audio pathways and optimize signal routing without complex coding. This hardware abstraction layer significantly reduces development complexity while supporting multi-channel configurations for various microphone arrays and speaker setups. The AFE Configurator offers both Tuner and Configurator views, enabling developers to fine-tune audio parameters and visualize the complete signal chain during development.

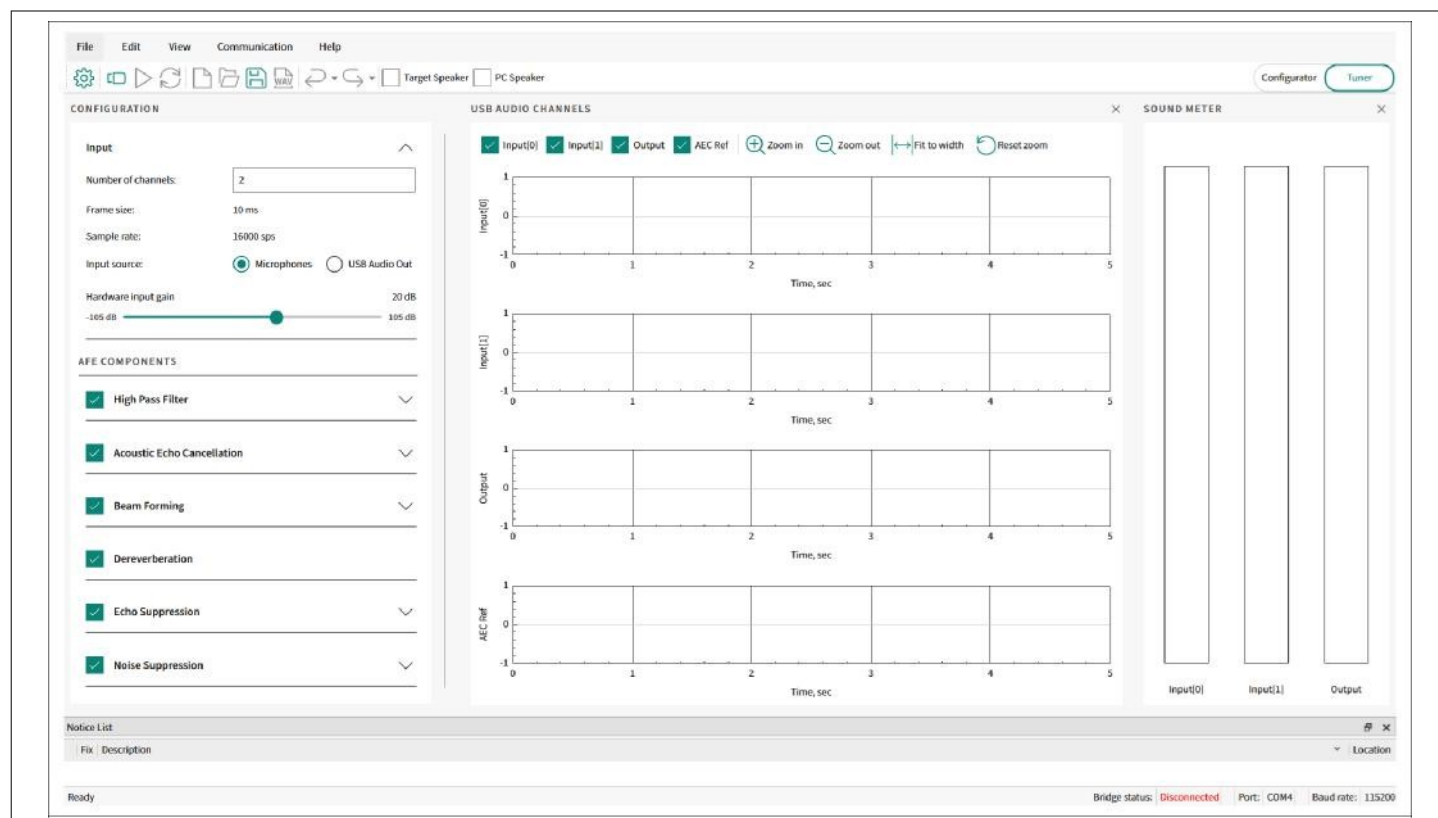


Figure 10 AFE Configurator - Tuner view

4 Chip-level functional description

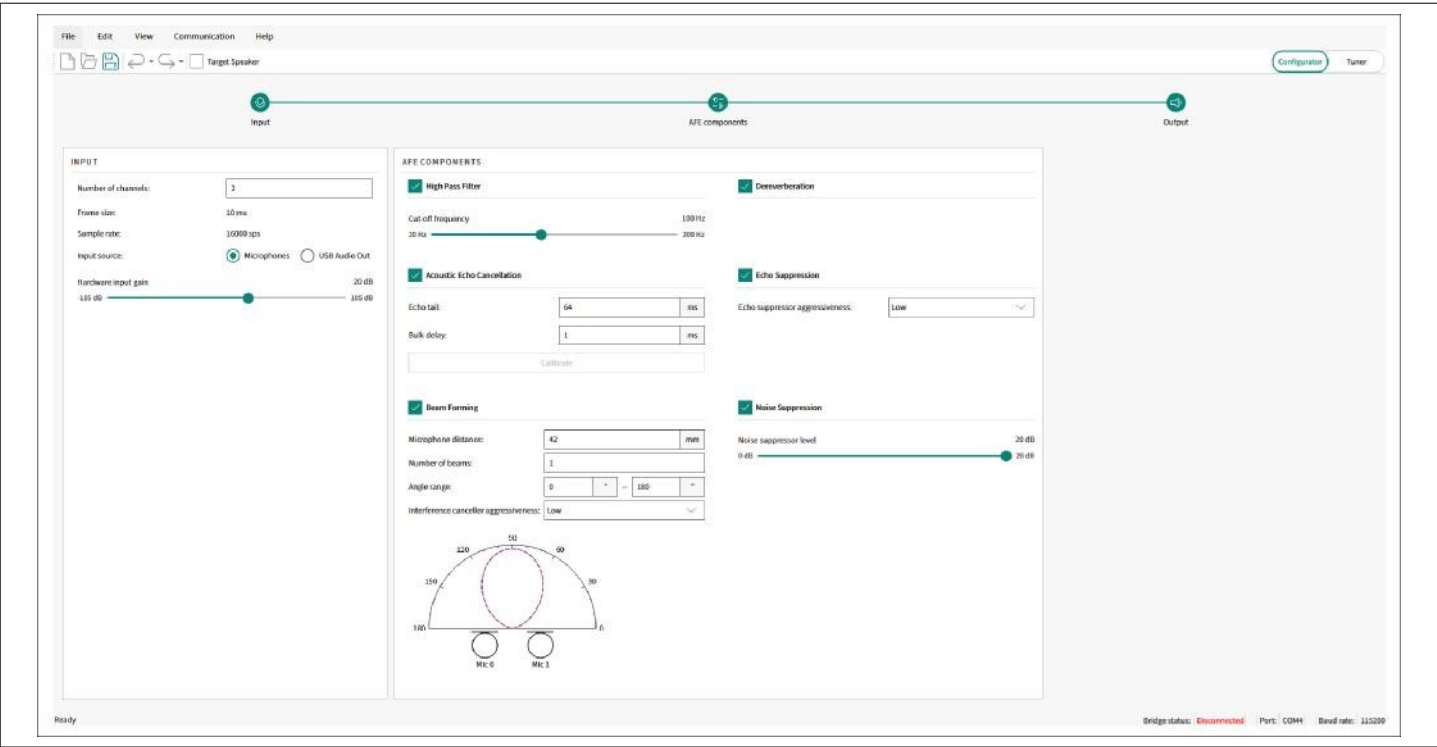


Figure 11 AFE Configurator – Configurator view

4.3.3 Audio codec support

Audio codec support encompasses a comprehensive range of industry-standard formats, including Opus for ultra-low latency applications, along with MP3, AAC, SBC, and LC3 for compatibility with existing audio ecosystems. The Opus codec implementation is particularly optimized for real-time communication applications, providing high-quality voice transmission with minimal latency requirements. This extensive codec support enables developers to select the optimal compression format based on their specific application requirements for audio quality, latency, and bandwidth utilization. Audio codecs are provided in the ModusToolbox™ Audio SW Codecs Technology Pack.

4.3.4 Staged voice control and wake word detection

The staged voice control (SVC) middleware provides an intelligent power management framework that progressively activates audio processing capabilities based on detected acoustic activity. This multi-stage approach enables the system to remain in ultra-low power states during silence while rapidly transitioning to full processing capability when voice activity is detected. The SVC middleware coordinates between the low-power subsystem and main processing cores, managing analog microphone power states, ADC activation, and CPU wake-up sequences to optimize the trade-off between responsiveness and power consumption.

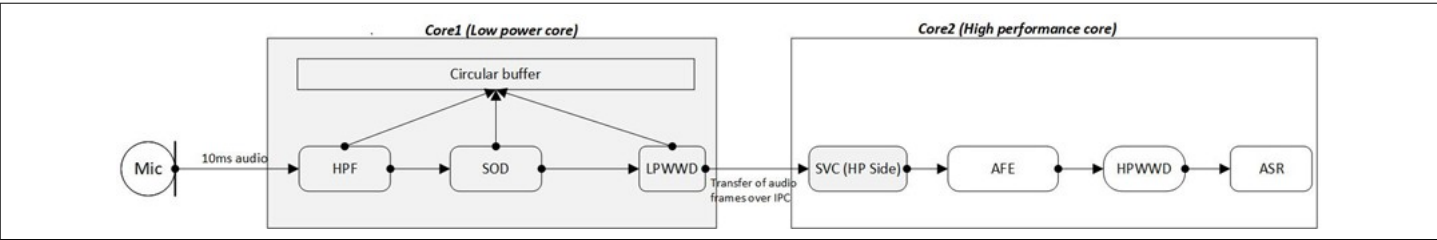


Figure 12 Staged voice control pipeline

The staged approach includes multiple distinct operating modes. In Stage 0, the system operates with Programmable Threshold Comparator (PTComp) monitoring while the analog microphone is powered on and the ADC is off. As

acoustic activity is detected, the system progressively transitions through stages, ultimately reaching Stage 3 for full audio streaming supporting high-performance wake word detection (HPWWD) or automatic speech recognition (ASR) processing. During these transitions, both the M33 and M55 cores activate for processing as needed.

The platform supports both low-power wake word detection (LPWWD) and high-performance wake word detection (HPWWD) capabilities, that enable always-on voice activation with minimal power draw. The LPWWD operates in the low-power subsystem (CM33) for continuous monitoring, while HPWWD provides higher accuracy recognition when additional processing capability is warranted on the high-performance core (CM55). This tiered approach to wake word detection allows the system to balance between power consumption and recognition accuracy based on application requirements. Audio data flows from the CM33 through a circular buffer with high-pass filtering and speech onset detection before transfer to the CM55 for advanced processing.

The platform's power management system is specifically optimized for audio workloads through the multi-core architecture with dedicated high-performance and low-power domains. The low-power domain is designed to remain active for continuous monitoring functions and is never switched off unless chip power is cut off, while the high-performance domain is activated only when advanced processing is required. This architecture enables the staged voice control approach to maximize battery life while maintaining system responsiveness. Dynamic power scaling automatically adjusts processing power based on audio complexity and quality requirements, enabling months of continuous audio monitoring capability in battery-powered devices.

Power optimization features:

- Staged voice control with progressive capability activation based on acoustic events
- Multi-core coordination for optimized power transitions between processing stages
- Always-on acoustic monitoring with configurable wake-up thresholds
- Dynamic power scaling based on audio workload complexity
- Autonomous operation reducing CPU wake-up events
- Specialized ultra-low power audio modes in deep sleep operation

4.3.5 Autonomous analog audio processing

The autonomous analog subsystem represents a significant advancement in always-on audio monitoring, enabling continuous audio processing with minimal power consumption through intelligent preprocessing and decision-making capabilities. This autonomous analog controller can reduce system power consumption by up to 90% compared to traditional digital-only approaches by maintaining an always-on signal chain that operates without CPU intervention. The autonomous controller manages the complete audio signal chain, including pre-amplifiers, filters, threshold comparators, and ADC triggering—all while the Cortex®-M CPUs remain in an off state during deep-sleep mode. This capability is particularly valuable for acoustic activity detection where the system must remain responsive to audio events while preserving battery life.

4 Chip-level functional description

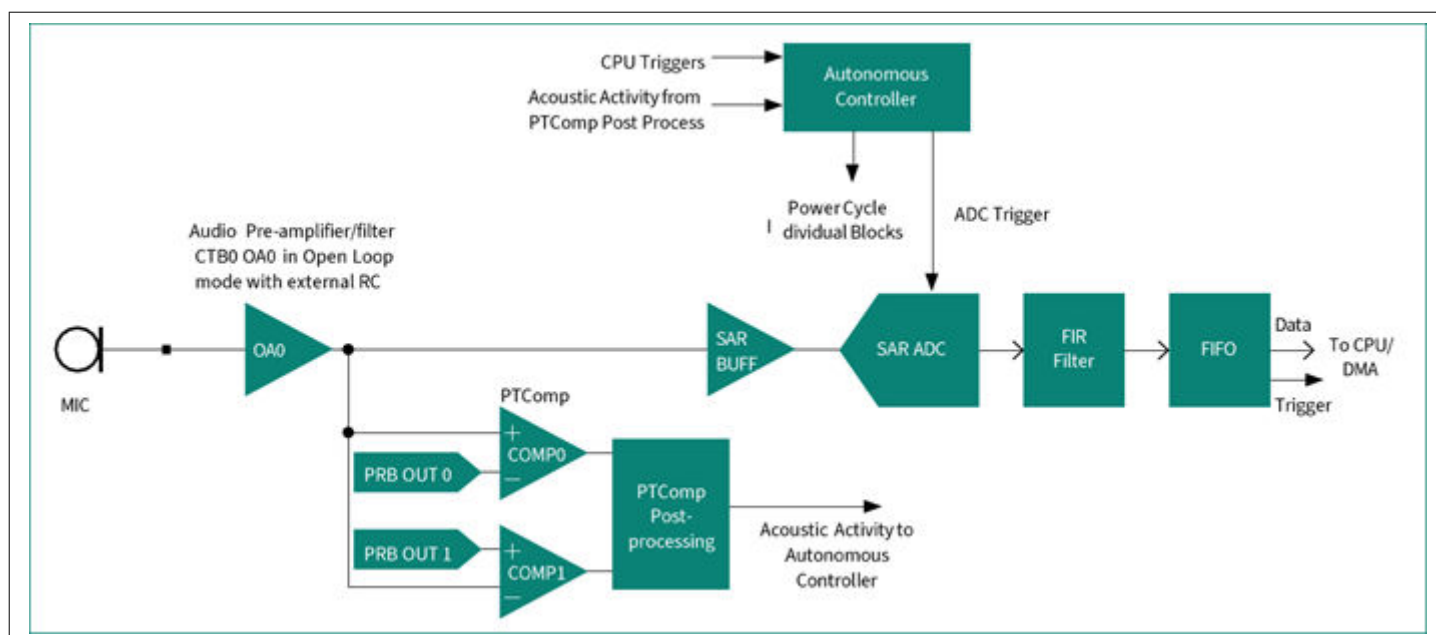


Figure 13 Audio/voice signal chain

The audio/voice signal chain integrates multiple components controlled by the autonomous controller, including the audio pre-amplifier/filter, acoustic activity detection via PTComp, post-processing blocks, and SAR ADC triggering. The entire sequencing—including PTComps and their post-processing, switching to data acquisition mode, and ADC sampling/power cycling—is done entirely in Deep Sleep mode without switching to Active Mode or involving the CPU. The autonomous controller can power cycle individual blocks and trigger CPU wake-up only when acoustic events of interest are detected, dramatically reducing average power consumption in always-listening applications.

4.3.6 AI-enhanced audio intelligence

Machine learning integration provides advanced audio intelligence capabilities, including wake word detection, voice identification, sound classification, onset detection, and acoustic scene analysis. These AI-enhanced features enable on-device speaker recognition, real-time identification of acoustic events, and intelligent interpretation of complex audio environments for context-aware applications. The integration of the Infineon neural network lite (NNLite) and Arm® Ethos-U55 neural processing unit (NPU) with the audio processing pipeline enables sophisticated inference capabilities without requiring cloud connectivity, ensuring privacy and reducing latency for voice-controlled applications.

Voice identification capabilities allow the system to authenticate users based on their voice characteristics, combining LPWWD and HPWWD blocks with voice identification algorithms running on the Cortex®-M55 and Ethos-U55. This provides a powerful security feature for voice-activated systems requiring user authentication.

4.3.7 Wireless audio streaming support

The platform provides comprehensive firmware support for wireless audio streaming through Bluetooth® Low Energy audio protocols. When paired with appropriate wireless connectivity solutions, the audio firmware stack enables low-latency audio streaming with power-efficient transmission. The BLE audio profiles are specifically designed to reduce power consumption while maintaining high audio quality, supporting both unicast and broadcast audio streaming modes.

Wireless audio streaming capabilities:

- Low-latency audio streaming optimized for real-time applications
- Power-efficient BLE audio profiles for extended battery life
- Support for both unicast and broadcast audio streaming modes

5 Block functional description

5.1 Processors

This product line has a multiple CPU architecture:

- Arm® Cortex®-M55, running at up to 320 MHz
- A machine learning (ML) coprocessor with the Cortex®-M55 CPU: the Arm® Ethos-U55 CPU, running at the same clock frequency as the U55
- Arm® Cortex®-M33 CPU, running at up to 160 MHz
- A neural network (NNLite) coprocessor with the Cortex®-M33 CPU, running at the same clock frequency as the M33

An inter-processor communication (IPC) block is included for synchronizing the CPUs' tasks.

The M33 CPU has Floating Point Unit (FPU), Digital Signal Processor (DSP), and Memory Protection Unit (MPU). It has Arm® TrustZone technology, and provides secure boot and secure zone settings. The M55 CPU has FPU with vectored fixed and floating point, and Arm® M-Profile Vector Extension (MVE).

The M33 CPU domain is a low-power domain. The M55 domain is a high-performance domain for high-performance compute purposes. The CPUs can access resources in each others' domains via a bus bridge.

Both CPUs have single-cycle cache memories to increase performance and reduce power. The M33 CPU has a 16-KB 4-way set associative I-cache. The M55 CPU has 32-KB I- and D-caches with the same cache architecture.

M55 TCM sizes are 256 KB each (I and D).

Each CPU has an Arm® Nested Vectored Interrupt Controller (NVIC) and an Arm® Wakeup Interrupt Controller (WIC). A WIC can wake up its processor from its CPU Deep Sleep mode. See [Power modes](#) for details.

Both CPUs have debug interfaces and support both SWD and JTAG. The chip also supports boundary scan for testing on a PCB; a separate TAP controller is provided for controlling boundary scan functions.

Both CPUs have trace capability. The M55 and M33 support 8-bit Instrumentation Trace Macrocell (ITM) and 4-bit Embedded Trace Macrocell (ETM), which capture CPU execution flow and generate outputs on the Advanced Trace Bus (ATB). These outputs go to the CoreSight Trace Funnel (CSTF), which consolidates multiple streams onto a single bus. The traces are stored in an 8-KB Embedded Trace FIFO (ETF) and can be accessed via the SWJ interface.

The debugger infrastructure of PSOC™ Edge includes a 4-bit Trace Port Interface Unit (TPIU) that drives external pins via the I/O subsystem interface, allowing trace capture by an external trace port analyzer (TPA). The TPIU supports simultaneous tracing from both the Cortex®-M55 and Cortex®-M33 CPUs. The maximum trace clock frequency is 200 MHz, allowing CPUCLK/2 tracing.

[Table 3](#) shows the maximum operating frequency of each set of CPU for each of the system power modes (see [Power modes](#)).

Table 3 CPU maximum frequencies vs. system power mode

System power mode	M55/U55	M33/NNLite
High Performance (HP)	320 MHz	160 MHz
Low Power (LP)	140 MHz	80 MHz

5.2 Inter-Processor Communication (IPC)

In addition to the Arm® SEV and WFE instructions, this product line incorporates two Inter-Processor Communication (IPC) blocks, namely IPC0 in the low-power domain and IPC1 in the high-performance domain. IPCs are not system deep sleep capable; however, IPC can wake up other CPUs from deep sleep. IPC0 can wakeup the high-performance CPU subsystem, whereas IPC1 can wake up the low-power CPU subsystem from CPU deep sleep. Each IPC instance includes 16 channels and 8 interrupt structures. The IPC channels can be used for communication and synchronization between CPUs. Each IPC channel also implements a locking scheme that can be used to manage

shared resources. The IPC interrupts let one CPU interrupt the other, signaling an event. This is used to trigger events such as *Notify* and *Release* of the corresponding IPC channels. IPC0 channels 0 and 1 are reserved for the secure enclave.

5.3 DMA

The high performance and low power domains each include a DMA controller that can be used to transfer data to and from memory, peripherals, and registers. This allows for autonomous, deterministic control of peripherals such as the PWM, or enables large data transfers from a peripheral such as the ADC to memory.

There are two distinct DMA types, the HPDMA (AXI DMAC) and the DMA. The HPDMA and DMA are differentiated by their performance and their usage. The DMA controllers are bus masters in their respective domains:

- **High Performance Domain:** A high-performance DMA (HPDMA) with 4 channels. Each channel has a 128-byte FIFO and its own transfer engine that arbitrates for bus master access. The HPDMA uses the 64-bit AXI bus that shares a clock with the high performance CPU. The HPDMA is typically used to transfer large amounts of data.
- **Low Power Domain:** Two DMA controllers with 16 channels each. The two transfer engines independently request and utilize 16 channels each, arbitrating for bus master control as needed. This DMA uses the 32-bit AHB bus that shares a clock with the low power CPU. The DMA is optimal for small data size, transactional DMA, which would typically be used to transfer bytes between peripherals such as from ADC to RAM.

5.4 Cryptographic accelerator (CRYPTO)

This subsystem is a hardware implementation for acceleration of cryptographic functions and random number generators. It is accessible by Cortex®-M33 and Cortex®-M55 CPUs.

The cryptographic accelerator implements hardware support for the following:

- True random number generator (TRNG) and pseudo-random number generator (PRNG)
- CRC, up to 32 bits
- Symmetric algorithms and key lengths
 - AES (128/192/256), triple DES (112/168)
 - CHACHA20 stream cipher
- Asymmetric algorithms, key lengths, and curves
 - Elliptic curve cryptography (ECDSA) and RSA
 - ECC curves: 224, 256, 384, 521
 - RSA key length: 1024, 2048, 4096
 - Vector unit for acceleration of asymmetric key cryptography
- Hashes: SHA2 (256/384/512), SHA3 (256/384/512)

5.5 Memory

This product line has a variety of volatile and nonvolatile memory types, including access to external memory ICs (see [Serial Memory Interface \(SMIF\)](#)). All CPUs and other bus masters can access any memory block. The number of wait states depends on the access path, see [Wait states and latencies](#).

5.5.1 Nonvolatile memory

This product line has 512 KB of nonvolatile resistive random access memory (RRAM) in the low power domain. Read access time is 35 ns. RRAM is read 128 bits at a time; with word caching. There are also 25 bits for ECC. Write access is one bit at a time, at approximately 1 µs/bit.

5120 bytes of RRAM are dedicated to OTP use cases, including storage of security assets (see [Security features](#)).

For detailed memory map of the RRAM, refer RRAM regions section in [PSOC™ Edge E8x2, E8x3, E8x5, E8x6 architecture reference manual](#).

Table 4 RRAM endurance and retention

Parameter	Conditions ¹⁾	Minimum
RRAM endurance	-40 to +105 °C ambient	10k write cycles
RRAM retention	Ta ≤ 105 °C, 10k P/E cycles	10 years

1) Some packages have a smaller operating ambient temperature range. See [Package information](#)

5.5.2 EEPROM

In this product line, part of the RRAM may be used to emulate EEPROM using the supplied software driver. The implementation uses redundancy (an integer multiple of the EEPROM memory size) for simplicity. The EEPROM-like memory has the following properties:

- Byte-programmable
- Size selectable from 1 KB to 64 KB in binary increments
- 1 million cycles endurance at 25 °C, 200k cycles over -40 to +85 °C with 20-year life

5.5.3 SRAM

This product line has SRAM and system SRAM, in the low-power and high-performance domains:

- **SRAM:** 1 MB in the low power CPU subsystem (Cortex®-M33). Portions of this SRAM can be retained during the System Deep Sleep power mode; the retained amount is selectable in 64-KB increments. The SRAM is implemented as several independent blocks to allow simultaneous access from different processors to different regions.
- **System SRAM ("SoCMEM"):** 5120 KB in the high-performance domain. This memory is organized in ten partitions of 512-KB each, with retention of individual partitions. It can be accessed from either the M55 or the M33, with bus arbitration.

5.5.4 Serial Memory Interface (SMIF)

This product line features two SMIF interfaces, each equipped with a 32 KB cache (see [Table 12](#) and [Ordering information](#)). Each interface can access up to 1 GB of address space allocated in the memory map.

The SMIF allows code execution-in-place (XIP) from the external memory; it is not required to copy code into the internal memory to execute it. Up to 64 MB is supported in XIP mode.

On-the-fly (OTF) encryption and decryption are supported. The SMIF supports a clock speed of 200 MHz in octal xSPI DDR mode. Infineon HYPERBUS™ is also supported.

5.5.5 Wait states and latencies

When accessing a memory area from the CPU, specifically the CM33 or CM55 cores, the primary focus is on the time required to retrieve data (read) at the relevant system operating frequencies. While write access times are also relevant, writes can typically be posted, allowing the operation to proceed without requiring immediate acknowledgment. In contrast, reads must traverse the full outbound address and control signal path, as well as the inbound data access path, which directly affects system performance and response times. This section focuses only on scenarios where the CPU is the bus master, excluding other potential bus masters in the system.

Generally, there are two components in the access time:

5 Block functional description

1. Wait states of the memories being read
2. Delay through the Network Inter-Connect (NIC)

Note: This section covers wait states for RRAM and SRAMs, which are of primary interest to users.

1. Wait states (WS):

- a. RRAM: RRAM writes are much slower than RRAM reads (as it is typical for most non-volatile memory) and are not considered here.

RRAM read is controlled by an internal 160 MHz read state machine clock, which is designed to produce data in 30 ns (also referred to as “analog read time”) irrespective of the voltage mode (0.7 to 0.9 V). Besides this time, the following times are required for an RRAM read: 1 clock for address read and 1 clock for ECC correction (assuming 0 or 1 bit correction; otherwise, it will be longer).

Based on 30 ns, the WS values for a cycle time of Tcyc in nanoseconds will be $\text{ceil}(30/T_{\text{cyc}})$. For example, for a 200 MHz AHB clock frequency, the WS value will be 6; for 50 MHz, it will be 2.

Voltage (V)	Frequency (MHz)	Wait states (WS)
0.9 (HP mode)	200	6
0.8 (LP mode)	80	3

- b. SRAM: All SRAMs are designed to have zero wait states at their peak target frequencies. This is the time for SRAM to deliver data, meaning that the address is latched on one clock edge and data is available on the next edge.

Access cycles do not change with voltage and frequency scaling so that provided voltage and frequency limits are observed; all SRAM wait states remain zero wait states. This implies that the number of cycles to access SRAM (CLK_HF0) and system SRAM (CLK_HF2) do not change.

2. Delay through the Network Interconnect (NIC):

- a. **Table 5 Memory access cycles using CM33 CPU**

Memory resource	Outbound clock cycles	Memory access cycles	Inbound clock cycles	Comment
RRAM	3 AHB clocks	Ceil (30ns/AHB Tcyc)	2 AHB clocks	128-bit C-AHB. Icache refill. 32-bit access is similar
SRAM	-	-	1 AHB clock	No wait states
System SRAM	3 AHB clocks	6 System SRAM clocks	2 AHB clocks	32-bit access and 128-bit access (parallel bank read)

- b. **Table 6 Memory access cycles using CM55 CPU**

Memory resource	Outbound clock cycles	Memory access cycles	Inbound clock cycles	Comment
RRAM	3 AXI + 5 AHB cycles	2 * Ceil(30 ns/AHB Tcyc)	4 AHB + 4 AXI cycles	64-bit word read takes 2x cycles
SRAM	3 AXI clocks + 3 AHB clocks	4 AHB cycles (2 accesses)	7 AXI clocks + 3 AHB clocks	64-bit word read takes 2x cycles

(table continues...)

Table 6 (continued) Memory access cycles using CM55 CPU

Memory resource	Outbound clock cycles	Memory access cycles	Inbound clock cycles	Comment
System SRAM	3 AXI clocks	6 System SRAM clocks	2 AXI clocks	The first word access takes 6 System SRAM clocks, and each subsequent access requires one system SRAM clock cycle

Note: AHB clock (HCLK) denotes the CM33 SYSCPUSS/AHB bus clock (up to 200 MHz), while AXI clock (ACLK) indicates the CM55 APPCPUSS/AXI bus clock (up to 400 MHz). Wait state counts shown as “n AHB cycles” or “m AXI cycles” are measured in those clock domains.

Note: Ceil denotes the ceiling function, which rounds the result up to the nearest integer.

Read and write accesses to memory must consider the inbound and outbound paths, in addition to the memory access time and synchronization cycles.

- **Outbound (request path):** The CPU/bus sends address/control to the memory side
- **Memory access:** The cycles required by the memory (or its controller) to return data
- **Inbound (return path):** Data returns to the CPU
- **Synchronization cycles:** Clock domain crossing (for example, from the CPU domain to the memory domain and vice versa) can cause a delay due to synchronization

As such, the read and write cycles can be estimated as:

- **Read cycles:** Outbound clock cycles + access time + inbound clock cycles [+ clock sync]
- **Write cycles:** Outbound clock cycles + access time [+ clock sync]

For example, a read access of System SRAM running at 300 MHz from the CM55 CPU running at an AXI clock frequency of 400 MHz could be calculated as:

Read cycles (first access) = 3 AXI clocks + 6 system SRAM clocks + 2 AXI clocks [+1 SRAM clock sync] [+1 AXI clock sync]

Read time (first access) = $3/400 \text{ MHz} + 6/300 \text{ MHz} + 2/400 \text{ MHz} [+1/300 \text{ MHz}] [+1/400 \text{ MHz}] = 7.5 \text{ ns} + 20 \text{ ns} + 5 \text{ ns} [+3.33 \text{ ns}] [+2.5 \text{ ns}] = 32.5 \text{ ns to } 38.33 \text{ ns}$

32.5 ns is equivalent to 13 AXI cycles, while 38.33 ns is equivalent to 16 AXI cycles, concluding that this read access requires between 13 and 16 AXI cycles.

It should be noted that the total cycles must be rounded up to the next CPU cycle.

Additionally, Table 5 and Table 6 show the delays without considering other factors, such as burst accesses and buffering, which will reduce the latency for subsequent read and write accesses.

5.6 Protection units

Protection units are hardware blocks that implement schemes to protect memory, peripherals and shared resources from bus masters, preventing unauthorized code from accessing those resources. This product line has multiple protection units. Implementation Defined Attribution Unit (IDAU), Secure Attribution Unit (SAU) and Memory Protection Unit (MPU) are part of Arm® TrustZone technology; in addition Infineon provides proprietary protection units such as MPCs and PPCs.

The MPCs and PPCs use the concept of secured and non-secured address aliases. They use the aliases to control the accessibility of memory regions and peripherals, to make them secured or non-secured. They also isolate memory regions and peripherals from CPU masters by means of protection contexts.

Protection context (PC) is a pseudo state of a bus master, controlled with a set of hardware registers that configure each bus master with certain attributes, which the protection units use to determine access. The protection units support memory and peripheral access attributes including address range, read/write, code/data, privilege level, secured/non-secured, as well as protection context. For example, PCs can be set up to isolate a memory region or peripheral such that it is accessible by a single CPU, and not accessible by the other CPU.

This product line supports up to eight protection contexts. Some protection unit resources and protection contexts are reserved for system usage, see the reference manual for details.

5.7 Clocks

This product line has fully integrated clocks. It provides clocks to all blocks that require clocks. It switches between different clock sources without glitches, and ensures that no metastable conditions occur.

The clock sources are:

- Internal high-speed oscillator (IHO): 50 MHz $\pm 1\%$
- Precision internal low-speed oscillator (PILO): 32 kHz, no external crystal needed. Periodic calibration can be done by software (driver / library supplied).
- External crystal oscillators (ECO and WCO)
- Three digital phase-locked loops (DPLL) are available for clock generation. They operate in the System HP and LP power modes (see [Power modes](#)).
- External clock input

The DPLLs provide fast wake-up at high clock speeds. DPLL jitter levels are low and allow 12-bit SAR ADC operation. There are two types of DPLL:

- Two lower frequency and optimized for low power (DPLL LP)
- One high-frequency and high-performance (DPLL HP)

The HP DPLL is optimized for high-speed operation. It works over a broad range of frequencies, i.e., 50 MHz to 500 MHz. The LP DPLL operating range is 10 MHz to 500 MHz

Clocks can be divided down to generate synchronous clocks for the analog and digital peripherals. Integer and fractional clock dividers are provided:

- Eight 8-bit clock dividers
- Sixteen 16-bit integer clock dividers
- Four 16.5 fractional clock dividers
- One 24.5 fractional clock divider

The 16-bit dividers allow more flexibility in generating fine-grained frequency values. The digital clock dividers generate either 1 in N clocking where $N = \text{divisor}$ or an approximately 50% duty cycle clock for the analog circuitry.

5.7.1 Internal high-speed oscillator (IHO)

The IHO operates at a fixed 50 MHz frequency. Its tolerance is $\pm 1\%$. A high-speed clock can be derived using the IHO plus a DPLL. The IHO is used as the clock source during wakeup.

5.7.2 Precision internal low-speed oscillator (PILO)

The PILO is a precision low-power oscillator with a typical current of 1.15 μA and frequency of 32.768 kHz with 250 ppm accuracy. The PILO can operate in the System Hibernate power mode.

5.7.3 Watchdog timer (WDT)

This product line has one free-running watchdog timer (WDT) and two multi-counter watchdog timers (MCWDT). Both WDTs generate device reset if not serviced within a configurable interval. In addition, the WDTs can be used as an interrupt source or a wakeup source in low-power modes (MCWDT is recommended for this use case). The Free-running WDT can be clocked by PILO and is available in all device power modes. MCWDT can be clocked by PILO or WCO and is available in all except Hibernate power-mode.

5.7.4 External crystal oscillators (ECO)

This product line has two oscillators that use external crystals: high-frequency and low-frequency (watch crystal). Both oscillators can be used in precision timing applications. The WCO is low-power and has a frequency tolerance of 250 ppm.

Figure 14 shows all of the external crystal oscillator circuits for this product line. The component values shown are typical; check crystal datasheet for the load capacitor values.

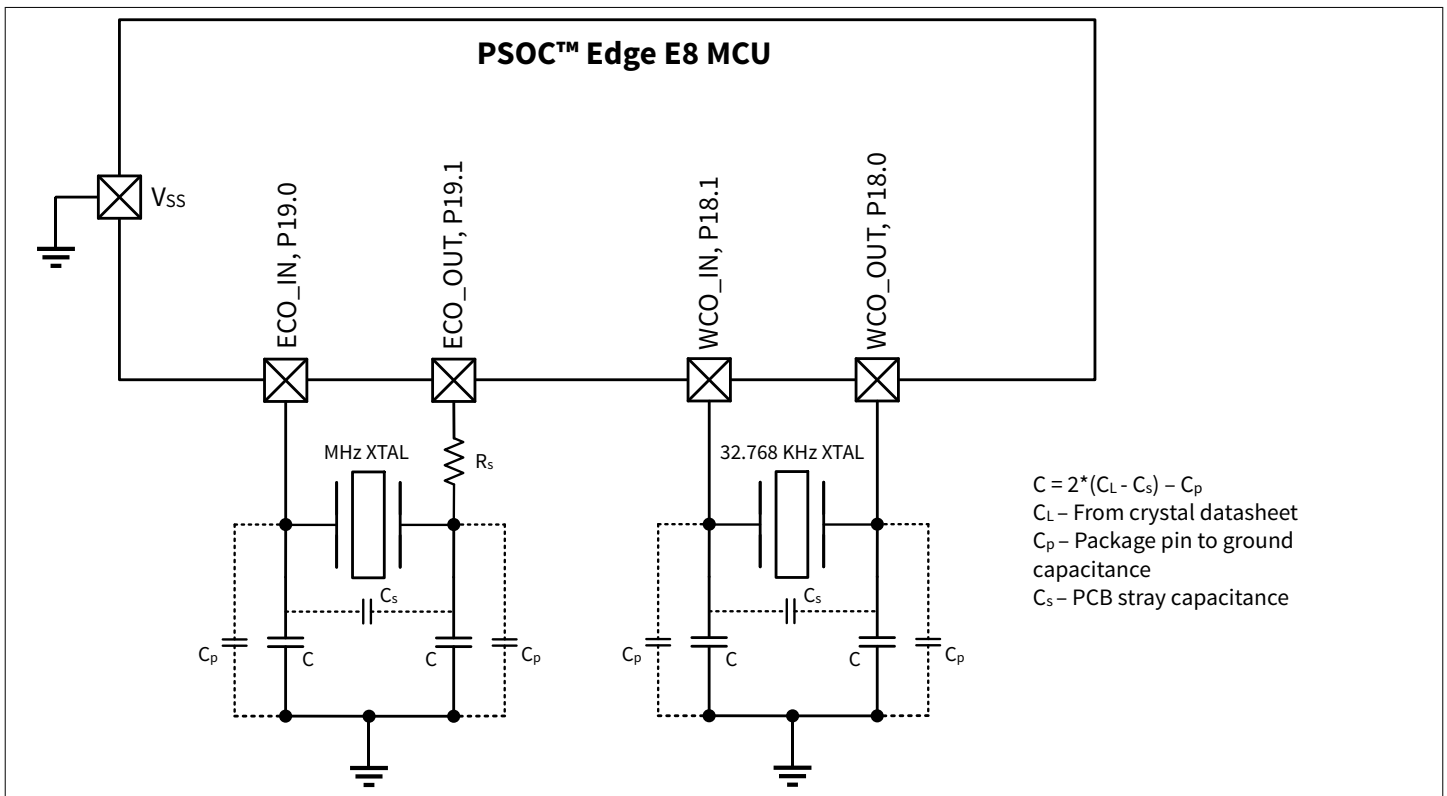


Figure 14 External Oscillator Circuits

Rs is key to limiting power delivered to XTAL/resonator so that it does not get damaged. It also contributes to phase shift of the overall network.

Following are the recommended crystal specifications:

- ECO
 - Nominal frequency: 4 to 35 MHz
 - Drive level protection: 100 ~ 200 μW at minimum
 - Equivalent Series Resistance (ESR): Upto 200 Ω for oscillation
 - Crystal load capacitance (C_L): 10 pF
- WCO
 - Nominal frequency: 32.768 kHz
 - Drive level protection: 0.1 ~ 0.5 μW

5 Block functional description

- Equivalent Series Resistance (ESR): Upto 90 kΩ for oscillation
- Crystal load capacitance (C_L): 4 pF to 14 pF (5% tolerance)
- Typical current of 120 nA @ 4 pF load

For more information, see the [PSOC™ Edge E8x2, E8x3, E8x5, E8x6 architecture reference manual](#) and [AN236517](#) PCB layout guidelines for PSOC™ Edge E84 MCU.

5.7.5 Real time clock

This product line includes a real time clock (RTC). The RTC has the following features:

- Binary values for time (hour, minute, and second fields), date (day, month, and year fields), and day of week
- 12-hour or 24-hour format
- Automatic leap year correction with century interrupt
- Sixteen 32-bit backup registers to retain application data in all low-power modes, including Deep Sleep-OFF and Hibernate mode

In addition to the above features, the RTC has two individual alarms with matching for six RTC fields (hour, minute, second, date/month, and day of week). Both alarms have interrupts to notify matching; these interrupts can wake up the system.

5.8 Reset

This product line is reset from a variety of sources including a software reset (SRES). Reset events are asynchronous and guarantee reversion to a known state. The reset cause is recorded in a register, which retains its state through reset and allows software to determine the cause of the reset. An XRES pin is reserved for external reset input.

The XRES pin is active low. It should be externally pulled up to V_{DD} via a 4.7 kΩ resistor as shown in [Figure 15](#). This will make sure that the XRES pin is not left floating in the design and that the device can function properly. It is recommended to connect a capacitor (typically 0.1 μF) to the XRES pin to filter out glitches and give the reset signal better noise immunity. Optionally, if the device is controlled by an external host, the XRES pin can be directly driven by the host.

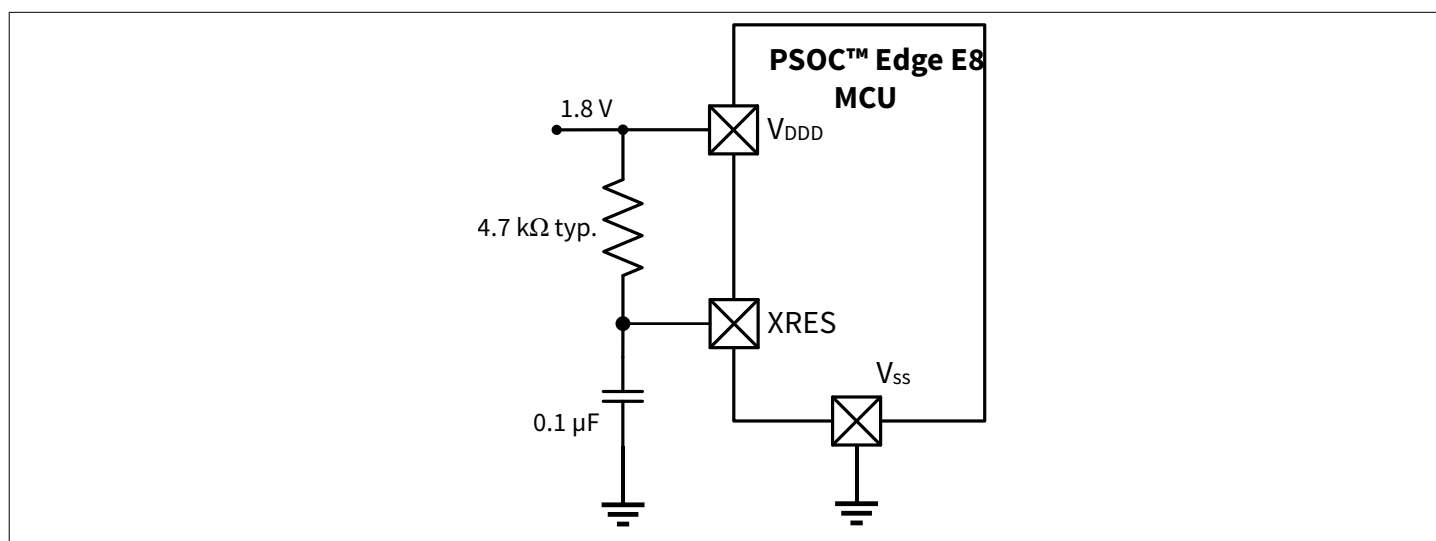


Figure 15 XRES Connection Diagram

5 Block functional description

5.9 Autonomous Analog

Autonomous Analog is a low-power, reconfigurable, mixed-signal, sensing, conditioning, and response system that operates independently of the CPU.

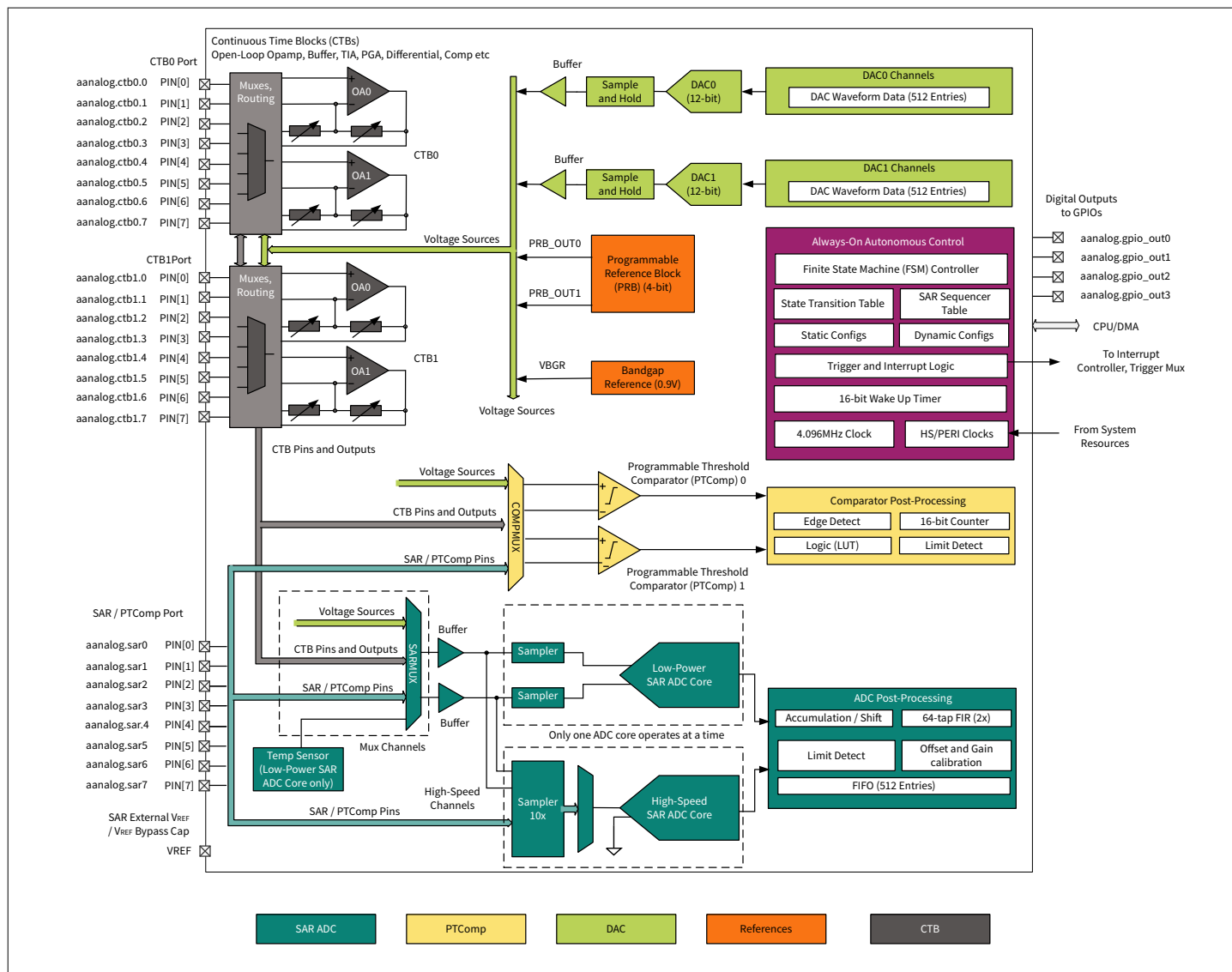


Figure 16 Autonomous Analog block diagram

The run-time control activities, such as enabling or disabling blocks, changing the power modes of the blocks, switching inputs/routing, waiting for the ADC scan to finish, triggering the DAC, and so on, are done by the Always-On Autonomous Controller independent of the CPU. For this purpose, most analog blocks in Autonomous Analog have a static configuration (unchanged by the Autonomous Controller during run-time) and a Dynamic Configuration (can be changed by the Autonomous Controller during run-time).

5.9.1 SAR ADC

Autonomous analog in this product line has a SAR ADC with the following features:

- 12- to 20-bit (with accumulation) results
- 5-Msps sample rate at 12 bits or 250-kps at 16 bits in System High Performance mode (HS mode ADC)
- 200-kps sample rate at 12 bits or 12.5-kps at 16 bits in System Deep Sleep mode (LP mode ADC)
- Buffered Inputs

5 Block functional description

- Inputs from 16 pins or 7 internal signals (from opamps, DACs, temperature sensor etc.)
- Simultaneous sampling of as many as 10 inputs
- 32 logical channels
- Post processing and storage
 - Accumulation and averaging – 2x, 4x, 8x ... 256x
 - Two 64-tap FIR filters
 - A 512-entry FIFO that can be subdivided into 2, 4, or 8 FIFOs
 - Limit detection
 - Offset and gain calibration

5.9.2 DAC

Autonomous Analog in this product line has two digital-to-analog converters (DACs) with the following features:

- 12-bit continuous time output
- 1- μ s settling time
- Waveform generation using a 512-entry waveform data memory
- Buffers with sample and hold support
- 16 input channels (15 hardware and 1 firmware)
- Selectable voltage reference:
 - VDDA
 - VDDA/2
 - Internal 0.9-V band-gap reference
 - External VREF buffered through CTB opamps

5.9.3 Continuous time block (CTB)

Continuous-Time Blocks (CTB) consist of opamp circuits that can perform analog front-end functions.

Autonomous-Analog in this product line has two CTBs, each consisting of two opamps, feedback resistor networks, and multiplexers that can form topologies such as:

- Programmable Gain Amplifier (PGA)
- Trans-impedance Amplifier (TIA)
- Pseudo-Differential Amplifier
- Unity Gain Buffer (Voltage Follower)
- Open Loop Opamp
- Comparator

5.9.4 PTComp

Programmable-Threshold Comparators (PTComp) are used to compare an input with another input or a reference.

Autonomous analog in this product line has two PTComps with the following features:

- Programmable power and response times
- Selectable inputs from as many as 16 GPIOs and eight internal signals
- A 30-mV hysteresis option

5 Block functional description

- Rising edge, falling edge, and combined rising and falling edge detection at the comparator output
- Post-processing to detect comparator activity - used for applications such as acoustic activity detect and Motor Control

5.10 Low-power comparator

This product line has two low-power comparators, which operate in System DeepSleep and System Hibernate power modes. This allows other analog blocks to be disabled while retaining the ability to monitor external voltage levels during low-power modes. The comparator outputs are synchronized to avoid metastability, unless operating in an asynchronous power mode (that is, System Hibernate) where the wake-up circuit is activated by a comparator switch event.

5.11 Fixed function digital

5.11.1 Timer/counter/PWM (TCPWM)

This product line has 32 TCPWM blocks. Eight have 32-bit counters and 24 have 16-bit counters. Each TCPWM block consists of the following:

- a counter
- a period register to either stop or auto-reload the counter
- a capture register to record the counter value at the time of an event
- compare registers to control PWM duty cycle
- Edge-aligned, center-aligned, and asymmetric-aligned PWM
- PWM true and complementary outputs with a programmable offset to create a dead-band between the outputs
- PWM kill input; can be driven by an external voltage level via a comparator
- Quadrature input measurement

5.11.2 Serial communication block (SCB)

This product line has 12 SCBs. SCB1 to SCB11 can be configured to implement an I²C, UART, or SPI interface, and can be masters or slaves. SCB0 can operate in the System Deep Sleep power mode with an external clock; and it only supports I²C slave mode and SPI slave mode.

Each SCB has a 256-byte FIFO for receive (Rx) and transmit (Tx). This reduces the need for I²C clock stretching caused by the CPU not having read data on time. The FIFO is available for all modes.

All of the SCB blocks support DMA transfers.

I²C mode: This mode implements full multi-master and slave interface capable of multi-master arbitration. It operates at speeds of up to 1 Mbps (Fast Mode Plus) and has flexible buffering options to reduce interrupt overhead and latency for the CPU.

This mode also supports EZI²C, which creates a mailbox address range in memory and effectively reduces I²C communication to reading from and writing to an array in memory.

UART mode: This is a full-feature UART operating at up to 8 Mbps. It also supports the 9-bit multiprocessor mode that allows addressing of peripherals connected over common Rx and Tx lines. Common UART functions such as parity error, break detect, and frame error are supported.

SPI mode: This mode supports full Motorola SPI, TI SSP (essentially adds a start pulse used to synchronize SPI codecs), and National Microwire (a half-duplex form of SPI). This mode also supports EZ SPI, in which data interchange is reduced to reading and writing an array in memory. One SCB can run SPI in high speed mode at up to 50 Mbps. The remaining SCBs can run SPI at up to 25 Mbps.

5.11.3 CAN FD

This product line has two CAN FD channels, each operating at up to 8 Mbps, with a shared 8-KB message buffer. Each channel includes:

- Up to 64 dedicated receive buffers
- Two configurable receive FIFOs (up to 64 buffers each) with acceptance filters
- Up to 32 dedicated transmit buffers with configurable FIFO and queue

The CAN FD controller complies with the ISO 11898-1 (CAN specification Rev. 2.0 parts A and B). In addition, it supports the Time-Triggered CAN (TTCAN) protocol defined in ISO 11898-4. It has AUTOSAR support.

The CAN FD controller functions only in Active and Sleep power modes. In DeepSleep mode, it is not functional but is fully retained.

5.11.4 Ethernet media access control (MAC)

This product line has an Ethernet MAC supporting 10/100 Mbps transfer rates and IEEE 1588 timestamp support. The bus interfaces support MII and RMII. Local buffer size is 8 KB, allowing storage of two Rx and Tx frames. This block supports flow control, virtual local area network (VLAN) tagging, and quality of service (QoS) prioritization. It also supports audio video bridging (AVB) applications.

5.11.5 I3C

This product line has an I3C block. I3C is a MIPI Alliance standard that aims to unify sensor serial interfaces into one pair of wires. All nodes connect to one pair of wires providing protocol support via frame encapsulation at a higher rate, thereby reducing the need for multiple I²C and SPI interfaces. The I3C block provides global signaling, in-band interrupts, time awareness, multi-master capability, and error detection. Controller and target modes are supported, except that single-role target mode is not supported. This block supports a base interface SDR clock of 12.5 MHz as both Controller and Target, and HDR-DDR mode (2X data rate) as Controller only.

5.11.6 SD host controller

This product line has two SD host controllers. They are primarily intended for communication with IoT combo chips providing Bluetooth®, Bluetooth® LE, and WiFi connectivity. These controllers can be programmed to support eMMC and SD cards.

Its key features are

- Complies with eMMC 5.1, SD 6.0 and SDIO 4.10 standards
- Supports host controller interface (HCI) 4.2 shared by eMMC and SD
- Supports three DMA modes - SDMA, ADMA2, and ADMA3 - through a dedicated DMA engine
- Supports command queuing engine (CQE)
- Provides 2 KB SRAM for buffering up to two 1 KB blocks
- Provides I/O interfaces for functions such as card detection, mechanical write protection, eMMC card reset, and LED control

It supports following interface modes:

Table 7 SDHC interface modes

Mode	Protocol speed	I/O (V)	Max Freq. (MHz)	Data width (bits)	Max throughput (MB/s)
SD	Default speed (DS)	3.3	25	1, 4	12.5
SD	High speed (HS)	3.3	50	1, 4	25
SD	SDR12	1.8	25	1, 4	12.5
SD	SDR25	1.8	50	1, 4	25
SD	SDR50	1.8	100	1, 4	50
SD	DDR50	1.8	50	1, 4	50
eMMC	Legacy/Backward compatible (BWC)	1.8/3.3	26	1, 4, 8	26
eMMC	SDR	1.8/3.3	52	1, 4, 8	52
eMMC	DDR	1.8/3.3	52	1, 4, 8	104

5.11.7 USB

This product line has a High-Speed 480 Mbps USB interface with integrated PHY. It has Host and Device capability, allowing connection to USB peripherals and hosts. It supports 16 endpoints plus one control endpoint. Of these, eight are IN and eight are OUT endpoints. Each endpoint is user-configurable as bulk, interrupt, or isochronous.

The USB interface has a 4-KB SRAM buffer which is configured at runtime to support the application endpoint configuration. It has a DMA interface so that packet transfers can be done without interrupting either CPU. The block supports a sleep state with rapid wakeup (50 µs) from suspend as defined in the USB specification.

The PHY includes series resistors to meet minimum driver impedance specifications: USB pull-down resistors in host mode (nominally 15 kΩ), and idle mode and FS device mode D+ pull-up resistor.

Type-C upstream facing port (UFP) support is provided by detecting the voltage levels on the CC1 and CC2 pins (using GPIOs) with external pull-down resistors, and measuring the voltage on the pins using the ADC and internal reference to determine the orientation and current capability.

5.12 GPIO ports

This product line has up to 147 IO Pins. There are 16 1.8 V HSIOs (high-speed IO; 200 MHz); 92 1.8 V standard (100 MHz) GPIOs; 8 1.8 V OVT (over-voltage tolerant; 100 MHz) GPIOs; 16 1.8 V / 3.3 V (50 MHz) GPIOs; and 15 FFIO (fixed-function IO) pins for a total of 147. 6 FFIO pins are designed for 200 MHz clock and SMIF functions, 7 are used for graphics driving MIPI-DSI signals, and 2 are dedicated for USB. The 16 HSIOs on P1 and P4 are shared with SMIF functionality. 16 pins on P16 and P17 operate at 3.3 V (max voltage 3.6 V) or 1.8 V. 8 1.8 V OVT pins of port 11 (P11.0 to P11.7) are over-voltage tolerant for I²C compliance. Two ports P16 and P17 operate at 1.8 V.

Each of the GPIO pins implement the following:

- Eight drive modes including strong push-pull, resistive pull-up and pull-down, weak (resistive) pull-up and pull-down, open drain and open source, input only, and disabled. Some GPIO pins are input only; the resistive pull-up and pull-down modes are not available on these GPIOs. See [Table 12](#) for details on which GPIOs are input only
- Analog signal input capability (IO buffers disabled, signal passed through switches)
- Input threshold select (CMOS or LVTTTL)
- Individual control of input and output disables

5 Block functional description

- Hold mode for latching previous state (used for retaining IO state in System Deep Sleep and System Hibernate modes)
- Selectable slew rates for dV/dt-related noise control

The OVT pins allow input voltages of up to 1.8 V regardless of the V_{DDIO} voltage. These pins allow interfacing to open-drain devices operating at higher voltages as well as provide high-impedance inputs for hot swap and power switching. These are primarily used for I²C; these must not draw more than 10 μ A when their power supply is grounded and the pins they are connected to are at 1.8 V.

The pins are organized in logical entities called ports, which are 8 bits in width. During power-on and reset, these blocks are forced to the disabled state so as not to crowbar any inputs and/or cause excess turn-on current. A multiplexing network known as a high-speed IO matrix (HSIOM) is used to multiplex between various signals that may connect to an IO pin.

A simple register interface maximizes driver reuse. Data output and pin state registers store, respectively, the values to be driven on the pins and the states of the pins themselves.

Every IO pin can generate an interrupt if so enabled; each IO port has an interrupt request (IRQ) and interrupt service routine (ISR) vector associated with it.

The IO ports retain their state during the System Hibernate power mode. If operation is restored using a reset, the pins go the High-Z state. If operation is restored by using a wakeup pin, the pin drivers retain their previously frozen state until firmware chooses to change it.

Simultaneous switching of outputs in high-current mode requires attention to line termination and a decoupling capacitor to control switching transient voltages.

GPIO pins can be ganged to sink 16 mA or higher values.

5.13 Smart I/O (programmable I/O)

Overview

The Smart I/O block is a small, port-associated programmable logic array that sits between the physical GPIO pad and the device's high-speed I/O matrix (HSIOM). The PSOC™ Edge E8x family includes two Smart I/O instances, each covering one GPIO port. When Smart I/O is not used, the block is transparent—signals pass through with no impact on propagation delay.

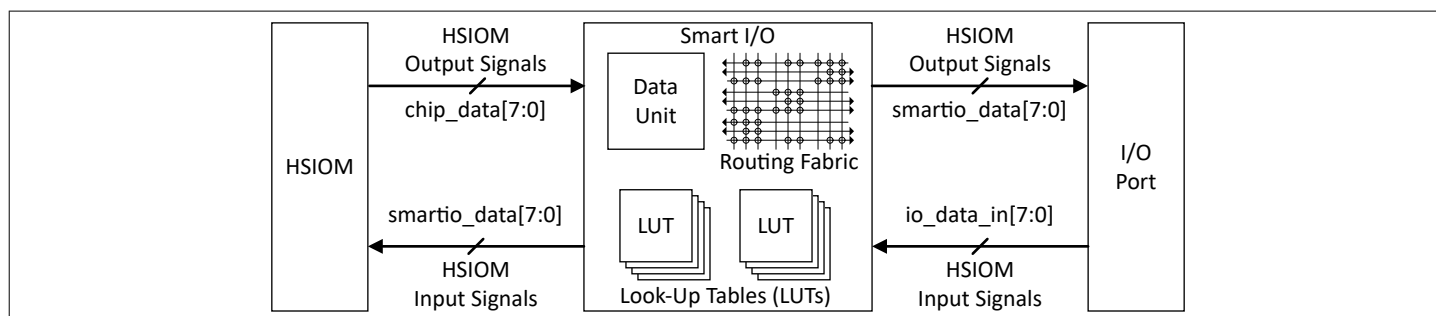


Figure 17 Smart I/O placement

Smart I/O is designed to offload simple but time-critical signal processing tasks from the CPUs, implement glue logic that would otherwise require external components, and keep selected logic operational even when the main processor cores are in deep sleep. The block consists of:

- Eight 3-input Look-Up Tables (LUT0-LUT7), each fully user-configurable to implement any Boolean function of the three inputs, with options for combinational output, registered (D-flip-flop) output, registered output on one of the inputs, or asynchronous set/reset mode
- One 8-bit multi-function Data Unit (DU), acting as a simplified ALU capable of counting, shifting, rotating, data-matching, and majority voting
- A flexible routing fabric connecting the eight I/O pins of the port, up to eight chip-internal peripheral signals, the DU input and outputs, and the LUT inputs and outputs
- Optional input synchronizers to safely bring asynchronous external signals into the fabric's clock domain

The fabric is split into two halves: LUTs 0–3 can accept I/O and chip signals 0–3, while LUTs 4–7 accept signals 4–7. LUT outputs can cross-feed any other LUT, enabling complex logic chains within the port. A single fabric clock drives all registered elements; it can be sourced from any divided system clock and remains active in Deep Sleep, if a suitable low-frequency source is selected.

5 Block functional description

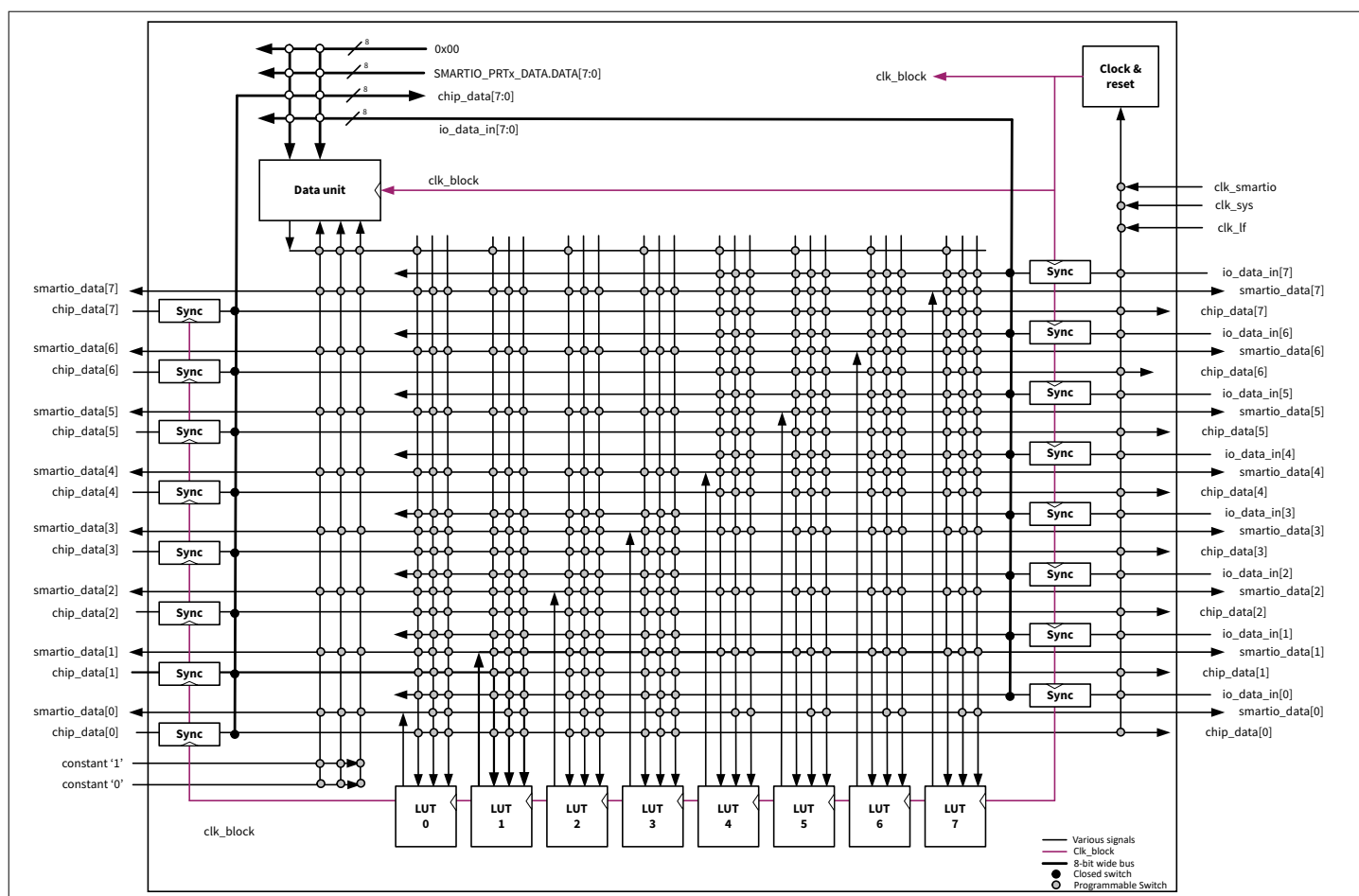


Figure 18 Smart I/O block diagram

Types of logic functions and applications

Smart I/O is broadly applicable wherever signal conditioning, glue logic, or autonomous I/O processing is needed. The following categories capture the principal use cases:

Signal routing and buffering The most straightforward use of a LUT is to follow (buffer), invert, or fan out a signal. A unity-buffer LUT replicates a clock or data line to multiple pins, increasing drive strength beyond what a single GPIO pad provides. An inverting LUT eliminates the need for a discrete inverter when an active-high peripheral output must drive an active-low input on the board.

Combinatorial glue logic. Multiple LUTs can be chained to implement arbitrarily complex combinational functions—AND, OR, NAND, NOR, XOR, multiplexers, and decoders. A common example is to use some combinational logic on two TCPWM PWM outputs to alter the way the PWM signal is routed to a GPIO pad, dynamically changing the shape and/or width of the PWM.

Sequential (registered) logic and synchronization. When LUTs are configured in registered mode, the fabric acts as a pipeline of flip-flops clocked by the selected fabric clock. This is used to implement precise fixed-length delay lines, edge detectors, and synchronizers for signals crossing from an asynchronous external source into a synchronous internal peripheral.

Counter-based pulse control. The DU, in its count (increment or decrement) modes, acts as an 8-bit hardware counter driven by any LUT or I/O signal. This enables functions such as automatically stopping a PWM-driven motor after exactly N pulses, generating a divide-by-N clock from a GPIO input, or producing a single output pulse when an event counter reaches a threshold—all without CPU intervention.

Shift-register delay and serial protocol adaptation. The DU, in shift-right or rotate-right mode, implements an up-to-8-bit serial shift register on GPIO signals. Applications include introducing a fixed-cycle delay between two signals (useful for aligning data signals with a clock signal) and adapting the timing of an SPI peripheral to match the requirements of a non-standard serial protocol such as I2S or SGPIO.

5 Block functional description

Protocol translation and interface bridging. By combining multiple LUTs and the DU, Smart I/O can translate between closely related serial formats. The I2S and SGPIO code examples listed in the table below demonstrate how an SPI block's SS and SCLK signals are reshaped by Smart I/O into the word-select and clock signals required by audio or storage interfaces, adding functionality without consuming an additional hardware peripheral.

Deep sleep autonomous operation. Because Smart I/O retains its configuration and can run from a low-frequency clock in Deep Sleep, it enables GPIO-level event processing while the CPU cores are off. Typical uses include logic-qualified wakeup interrupts (for example, "wake only if pin A is high AND pin B falls"), sensor data capture triggers, and low-power clock buffering and dividing.

Feature and example implementation reference

Table 8 summarizes Smart I/O features alongside specific example implementations from Infineon's ModusToolbox™ code example library and the Infineon Developer Community. Smart I/O is available on multiple product families, and examples can readily be migrated across families.

Table 8 Smart I/O feature examples and references

Feature/Use case	Description	Example implementation(s)
Signal inversion/ Polarity correction	A LUT programmed as a simple NOT gate inverts any peripheral or GPIO signal at the pad boundary. This avoids the need for external inverter ICs when interfacing with active-low peripherals.	PSOC™ 4 : SPI slave select inversion with smart IO (mtb-example-psoc4-spi-slave-select-inversion-with-smartio)
Signal fan-out/Clock buffering	A LUT configured as a follower (unity buffer) replicates an input signal to multiple GPIO pins on the same port. This enables driving heavier loads than a single GPIO pin is rated for, or distributing a clock to multiple peripherals without external buffer ICs.	CE236713 – PSOC™ 4: Clock buffer with smart I/O (mtb-example-psoc4-clock-buffer-with-smart-io)
Combinatorial logic gating	Multiple LUTs implement AND, OR, NAND, NOR, XOR, or more complex combinational functions entirely in hardware. Typical uses include gating a PWM signal with an enable input, qualifying a peripheral trigger with a status condition, or combining comparator outputs without CPU involvement.	CE236713 – PSOC™ 4: Clock buffer with smart I/O (mtb-example-psoc4-clock-buffer-with-smart-io), interrupt implementation
Signal delay line (Shift register)	The 8-bit Data Unit (DU) configured as a shift register introduces a precise, fixed-cycle delay to any GPIO or peripheral signal. Applications include timing alignment between channels, communication protocol adaptation, and simple debounce in deep sleep.	KBA219861 – 8-bit Delay Line using Smart I/O in PSOC™ Analog Coprocessor KBA219862 – 16-bit Delay Line using Smart I/O in PSOC™ Analog Coprocessor
Digital glitch filter	Three registered LUTs are chained to sample an input signal on consecutive clock edges; a final AND-gate LUT asserts the output only when all three samples agree, suppressing pulses narrower than three clock periods. No CPU load is required after initialization.	SMART IO Glitch Filter (mtb-t2g-example-smart-io-glitch-filters)
Ramping LED (CPU-free PWM manipulation)	Smart I/O LUTs reshape or invert a TCPWM PWM waveform to create a triangle or sawtooth brightness profile, producing a smooth breathing effect on an LED with zero CPU cycles after initialization.	- CE238608 – PSOC™ Edge MCU: Ramping LED using smart I/O (mtb-example-psoc-edge-smartio-ramping-led) - CE219490 – Ramping LED using Smart I/O (mtb-example-smartio-ramping-led)

(table continues...)

Table 8 (continued) Smart I/O feature examples and references

Feature/Use case	Description	Example implementation(s)
I2S Master interface via SPI + Smart I/O	Smart I/O LUTs and the DU counter translate the SPI peripheral's SS and SCLK signals into the I2S word select (WS) and bit-clock signals, implementing a complete I2S audio master without a dedicated I2S hardware block.	• Unleashing the potential of combining Smart I/O and SPI blog post • CE238610 – PSOC™ Edge MCU: Smart I/O I2S controller (mtb-example-psoc-edge-smartio-i2s) • CE231443 – PSOC™ 6 MCU: Smart I/O I2S master (mtb-example-psoc6-smartio-i2s)
SGPIO (SFF-8485) target interface	Smart I/O LUTs remap the SPI peripheral's chip-select and data signals to the four-signal Serial General Purpose I/O (SGPIO) bus defined in SFF-8485. This is used for storage enclosure management without requiring a dedicated SGPIO controller.	• Unleashing the potential of combining Smart I/O and SPI blog post • CE238612 – PSOC™ Edge MCU: Smart I/O SGPIO target (mtb-example-psoc-edge-smartio-sgpio-target) • CE231066 – PSOC™ 6 MCU: SGPIO Target Interface (mtb-example-psoc6-smartio-sgpio-target)
Frequency-shift keying (FSK) transmitter	A LUT configured as a 2:1 digital multiplexer selects between two TCPWM square-wave outputs based on the UART TX data level, generating a digital FSK output with no run-time CPU involvement. This is applicable to baseband modem standards (Bell 102/202) and narrow-band power line communications (PLC).	• AN221886 - Using Smart I/O to Generate a Digital FSK Transmit Signal
Frequency-shift keying (FSK) correlator receiver)	The DU and all seven registered LUTs are chained to form a 15-bit shift register; the final LUT XORs the live FSK input against its delayed copy, recovering the baseband data with no CPU involvement. An external low-pass filter and hysteresis comparator are required to clean up the correlator output.	• KBA229212: Correlator to Demodulate FSK Signals using Smart I/O
Deep Sleep operation and GPIO wakeup qualification	Smart I/O logic remains active in Deep Sleep mode (at clock frequencies up to 1 MHz), allowing GPIO signals to be logically combined or conditioned before asserting a wakeup interrupt. For example, ANDing two GPIO signals ensures the device only wakes when both conditions are met simultaneously, eliminating false wakeups.	• CE236713 –PSOC™ 4: Clock buffer with smart I/O (mtb-example-psoc4-clock-buffer-with-smart-io)

Other features and interfaces that can be implemented with Smart I/O, but that do not have specific code examples, include:

- Signal swapping (ex: UART Rx/Tx swap)
- Pulse counting/event limiting
- Multiplexer
- Demultiplexer
- Manchester encode or decode
- Display controller interface
- Low power clock divider (deep-sleep capable)

In addition to code examples, information supporting Smart I/O development can be found in the reference manuals and Peripheral Driver Library API documentation.

5.14 Neural net processing for machine learning

This section outlines advanced neural net processors designed to accelerate machine learning workloads. These co-processors work alongside Cortex® CPUs to optimize neural network inference for various AI applications, ensuring efficient data handling, low power consumption, and compatibility with leading machine learning frameworks. This makes them suitable for both performance-critical and low-power use cases.

5.14.1 Arm® Ethos-U55

This product line includes an Arm® Ethos-U55 neural net processor, which works in conjunction with the Cortex®-M55 CPU to accelerate neural net (NN) operations. It supports 8-bit weights and weight compression to reduce memory usage. It also performs 128 MACs/clock cycle.

The U55 operates on a command stream resident in on-chip memory, which it fetches and executes autonomously, freeing the M55 for other operations, using weights stored in SRAM or system SRAM. It has a buffer for commands and for writing results to. It generates an interrupt after completing the command. In one example mode of operation, the network is trained in TensorFlow and quantized to produce an Int8 TensorFlow lite (*.tflite) file. An NN optimizer identifies graphs to run on the U55; lossless compression is used to reduce the size of the *.tflite file. Finally a runtime executable file is produced which can utilize U55 to accelerate supported kernel operations.

The combination of the M55 and U55 is roughly 50x faster than a Cortex®-M7 at the same clock frequency for computing inferences, and about 25x more energy efficient.

Multiple types of neural networks such as dense, convolutional, and recurrent are supported. In addition, a variety of NN kernels such as convolution (1d/2d/3d), fully-connected, recurrent (GRU/LSTM) may be supported. Supported NN kernels and graphs may be used to implement popular neural network architectures such as mobilenetv1, mobilnetv2, RNNoise, and so on.

Applications for neural net acceleration with Arm® Ethos-U55 includes following but not limited:

- Industrial applications: vibration detection, anomaly detection, object recognition
- Consumer applications: keyword detection, speech recognition, image/object recognition, gesture recognition

5.14.2 NNLite

This product line includes a neural network (NNLite) coprocessor, which works in conjunction with the Cortex®-M33 CPU, running at the same clock frequency as the Cortex®-M33 CPU. It is an ACTIVE state peripheral that accelerates specific set of neural network (NN) inference calculations optimized for low to moderate complexity machine learning (ML) models such as wake word detection (WWD), human activity recognition (HAR). NNLite implements single layer of neural network acceleration that can be scheduled to create various NN topologies. The NNLite coprocessor falls in low-power domain making it ideal for always-ON use cases at lowest power.

The NNLite is designed to optimize neural network inference by focusing on vector dot product operations, which are executed using a configurable 4-way integer SIMD MAC unit. This unit supports vector dot products, vector products, and vector additions. Data handling is managed by input and output streamers, which autonomously fetch data and write back results. The input streamers handle biases, weights, and activations, while the output streamer applies activation functions like ReLU and Sigmoid and packs data for efficient memory use.

NNLite supports various neural network kernels, including dense (fully connected), 2D convolution, depthwise 2D convolution, pooling (min, max, average), GRU, and LSTM. It also handles pointwise operations like add, subtract, and multiply, as well as re-quantization and rescaling. Activation functions include fused options like ReLU and Leaky ReLU, as well as unfused options like Sigmoid, tanh, and Softmax. Supported data precisions include 8-bit, 16-bit, and 32-bit for activations and weights, with zero weight skipping for efficient computation.

The MAC unit supports up to 4 multiplications/additions per clock cycle and enables high-performance operations with features like sparsity-aware weight compression. The accelerator is compatible with TensorFlow Lite for microcontrollers and other frameworks, ensuring support for common neural network models and quantization techniques. With its efficient data handling, versatile kernel support, and low power consumption, NNLite is ideal for a variety of AI applications.

5.15 Audio functions

This product line includes multiple blocks such as the PDM/PCM block, TDM/I2S block, and autonomous analog block, which collectively support a wide range of audio features.

5.15.1 PDM/PCM block

The PDM/PCM block supports up to 6 microphones, typically used in voice control applications. The Pulse Density Modulation (PDM) interface, receives data coming from a digital microphone such as a MEMS microphone. MEMS microphones, used in compact and low-cost applications, use PDM interfaces. The PDM stream is processed by PDM-PCM converter IP block, which produces Pulse Code Modulated (PCM) words. These PCM words are sent to voice recognition software either locally resident or remote (data sent over Bluetooth®, Bluetooth® LE, or Wi-Fi). If audio output is required, the PCM words are sent through an I2S interface.

The key features include:

- Supports up to 6 PDM receivers with mono and stereo configurations
- Halve-rate sampling to reduce system power consumption
- Multiple filtering options: CIC filter, FIR filter, and DC blocking filter for noise reduction and decimation
- Programmable settings for interface clock, FIR filter coefficients, decimation rates, DC blocking coefficients, sampling delay, and PCM sample size (8 to 32 bits)
- Includes a 64-entry RX FIFO with interrupt and trigger support
- Shared data path with SRAM, FIR filter, and DC blocking filter logic for efficient processing

5.15.2 TDM/I2S block

The Time-Division Multiplexing/Inter-IC Sound Bus (TDM/I2S) interface is a serial bus used for connecting digital audio devices. It implements TDM as the main interface and I2S as a special case of TDM. The 2 TDM blocks extend the I2S interface to support four channels, with two channels per extension. The interface includes a transmitter (Tx) and receiver (Rx), both supporting simultaneous operation in master or slave modes.

The key features include:

- Supports 8-channel TDM and Philips I2S digital audio formats
- Full-duplex and half-duplex operation for both Tx and Rx
- Configurable to operate with an external master clock (e.g. from an audio codec)
- Independent clock dividers for Tx and Rx to achieve required sample rates
- Programmable channel length of up to 32 bits and PCM sample/data word lengths of 8 to 32 bits
- Left-aligned and right-aligned data word formatting with programmable channel delay (0 or 1 bit)
- Hardware FIFO buffers of 128 data words for both Tx and Rx
- Supports common sampling frequencies starting from 4 kHz to 96 kHz
- Compatible with both DMA-based and CPU-based data transfers

5.15.3 Autonomous analog block with analog mic

Autonomous analog is a low-power, mixed-signal system ideal for audio sensing and processing. The autonomous analog block, configured with an analog microphone, supports always-ON use cases and operates independently of the CPU.

It features a SAR ADC with 12-bit to 20-bit resolution and simultaneous multi-channel sampling, enabling high-fidelity audio data acquisition. The system includes two 12-bit DACs with waveform generation capabilities and programmable threshold comparators supporting Audio Activity Detection (AAD). Additionally, it offers filtering options like FIR filters and supports signal conditioning through opamp-based programmable gain amplifiers (PGAs) and comparators. These features make it well-suited for low-power audio applications, even in deep sleep modes.

5.16 Graphics functions

This product line has a 2.5D graphics processing unit (GPU) with a display controller. It supports displays up to 1024 x 768 with a maximum of 60 frames/second rate. It supports up to 24 bits-per-pixel resolution and provides frame buffer compression.

The GPU supports vector graphics (draw circles, rectangles, quadratic curves) and font support. Operations such as rotate/scale, color fill, and color conversion are provided. The GPU can operate on a command list to reduce CPU intervention and partial screen updates to reduce power. It also has an autonomous operation mode where the CPU is not used.

Frames rendered by the GPU are transferred to the MIPI display serial interface (DSI) host controller by the display controller (DC). Both DBI (command mode) and DPI (video mode) standards are supported over the DSI interface as per the MIPI standards specification. In addition, MIPI DBI Types A, B, and C modes are also provided in their standard forms (i.e. not using DSI). DBI assumes that there is memory in the display. It consists of a series of commands to update the frame buffer that is resident in the display chip.

The output is 2-lane MIPI DSI; or MIPI DBI type A, B, or C; depending on the type of display. MIPI DSI is the lowest pin count and the lowest energy; it provides two lanes at up to 1500 Mbps per lane.

DSI PHY calibration requires that the DSI.REXT pin be connected to a 200 Ω resistor to ground. See [Table 12](#).

The graphics block supports 2x frame buffer compression for 24-bit RGB pixels via on-the-fly color space conversion from pixels stored in YUV 4:2:0 (12 bits per pixel) format. Up to 4-layer alpha blending is supported by the display controller. It is optimized for smaller displays and low power.

5.17 Boot source and alternate serial interfaces configuration

The extended boot executes the user application from either the OEM_APP_ADDRESS or the OEM_ALT_APP_ADDRESS, based on the configuration defined in the extended boot policy. The primary application address, OEM_APP_ADDRESS, is specified within this policy. Additionally, an alternate boot location, OEM_ALT_APP_ADDRESS, becomes valid only if the oem_alt_boot policy is enabled within the extended boot policy. When oem_alt_boot is enabled, the GPIO pin P17.6 serves a fixed function as the boot source configuration pin, as outlined in the following table:

Table 9 Boot source configuration

P17.6 pin state	Boot location
Low (V_{SS})	OEM_APP_ADDRESS
High (V_{DD})	OEM_ALT_APP_ADDRESS

Note: OEM_APP_ADDR and OEM_ALT_APP_ADDR can be either external flash or RRAM.

5 Block functional description

The default pre-programmed version of the extended boot enables alternate serial interfaces for provisioning and downloading applications using Infineon's proprietary Device Firmware Update (DFU) protocol. The selection of different serial interfaces can be configured through GPIO pins P20.1 and P20.2, as detailed in the following table.

Table 10 Extended boot alternate serial interface configuration

Serial interface configuration pins		Serial interface selected
P20.1	P20.2	
High-Z	NA	Disable
Low (V_{SS})	High-Z	SPI
Low (V_{SS})	Low (V_{SS})	
Low (V_{SS})	High (V_{DD})	I2C
High (V_{DD})	High-Z	UART
High (V_{DD})	Low (V_{SS})	
High (V_{DD})	High (V_{DD})	

To set the boot source selection and serial interface GPIO pins to a specific logic state, use pull-up or pull-down resistors of 5 k Ω or less connected to V_{DD} or V_{SS} , respectively. For more information, refer to the “Extended boot” section in the [PSOC™ Edge E8x2, E8x3, E8x5, E8x6 architecture reference manual](#).

When the alternate serial interface mode is enabled, the device is unable to boot from RRAM and external flash. Consequently, the OEM_APP_ADDRESS and OEM_ALT_APP_ADDRESS parameters defined in the policy become invalid and are not applicable in this mode.

Note: After the boot process is complete, all the above-mentioned GPIO pins can be repurposed for other functions within the application (refer to [Table 15](#)). However, it is important to consider the effect of the pull-up or pull-down configuration on these GPIO pins, as it may influence their behavior in the application.

Extended boot uses SCB 1 for serial interface configurations; GPIO pins are configured by extended boot as per the selected interface, as shown in the following table.

Table 11 Serial interface pin connection

Serial interface	Serial interface pins			
I2C	SCL	SDA		
	P9.3	P9.2		
UART	RX	TX		
	P9.3	P9.2		
SPI	SCLK	MISO	MOSI	SS
	P9.3	P9.1	P9.2	P9.0

The serial interface configurations are as follows:

- I2C: Speed = 400 kHz, Mode = Slave, 7-bit address, address = 0x35
- UART: Baud = 115200, Bits = 8, Stop Bits = 1, RTS/CTS = No, Parity = None
- SPI: Mode = Slave, Motorola 00 (MSB first, CPHA = 0, CPOL = 0), Speed <= 12 Mbps

6 Pins

GPIO ports are powered by VDDx pins as follows:

- VDDIO.SMIF1: P0, P4
- VDDIO.SMIF0: P1, P2, P3, P5
- VDDIO0: P6, P7
- VDDIO1: P8
- VDDIO2: P9, P20
- VDDIO3: P10, P11
- VDDIO4: P12, P21
- VDDIO7: P13, P14
- VDDIO8: P15
- VDDIO6: P16, P17 (these ports operate at either 3.3 V or 1.8 V)
- VDDIO5: P18, P19
- VDD.USB: USB pins DP, DM
- SMIF pins:
 - VDDIO.SMIF0: P1, P2, P3, P5
 - VDDIO.SMIF1: P0, P4
- Graphics pins:
 - VDD.DSI: DSI.CLKN, DSI.CLKP, DSI.DATA0N, DSI.DATA0P, DSI.DATA1N, DSI.DATA1P, DSI.REXT¹⁾
 - VCCA.DSI: VLDO.DSI²⁾

The number of GPIOs are limited in some packages. The BGA-220 package has the full 147 GPIOs (see [GPIO ports](#)). For detailed information on the supported packages, see [Package information](#)

If the graphics feature is used, connect the DSI.REXT pin to a 200 Ω resistor to ground. If not, tied to ground. See [Graphics functions](#).

Some GPIO pins are input only; the resistive pull-up and pull-down modes are not available on these GPIOs. See [Table 12](#) for details.

Table 12 Packages and pin information

Pin	Packages
	BGA-220
VDDD	A7 B8 F7 G4 P10
VDDA	H14 J11 J12
VDD.1P8	A9 C12
VDD.DSI	D6
VDD.USB	M7
VDD.VBAT	A10 B10
VDDIO.SMIF0	J3 M3
VDDIO.SMIF1	E3 G3
VDDIO0	R3
VDDIO1	E6
VDDIO2	N14

(table continues...)

¹ These pins are connected to GND for E81 and E83 series devices

² These pins are NC for E81 and E83 series devices

Table 12 (continued) Packages and pin information

Pin	Packages
	BGA-220
VDDIO3	E13
VDDIO4	B2
VDDIO5	A6
VDDIO6	R10
VDDIO7	G12
VDDIO8	L12
VDDQ	A11
VCCD	B1 B9 E9 F11 H4 M8
VCCA.DSI	C6 C7
VCC.SRAM	F12 K3
VSSA	G13 H12 J13 K12 L13
VSS	B5 C8 C10 D3 D7 D9 D11 D13 E8 E12 F3 H3 L3 L8 N3 N10 R7
VSS.1P8	D12
VSS.VBAT	C11
VBAT	B11 D10
VFB.1P8	B13
VFB.VBAT	B12
VLDO.DSI	B7
VLDO.RET	C9
VLDO.SRAM	A8
VOUT.1P8	C13
VOUT.VBAT	A12
VREF	K14
DSI.CLKN	A4
DSI.CLKP	A5
DSI.DATA0N	B4
DSI.DATA0P	B3
DSI.DATA1N	A3
DSI.DATA1P	A2
DSI.REXT	J6
SMIF0.CLKN	L1
SMIF0.CLKP	M1
SMIF0.RWDS	J1
SMIF1.CLKN	F1

(table continues...)

Table 12 (continued) Packages and pin information

Pin	Packages
	BGA-220
SMIF1.CLKP	E1
SMIF1.RWDS	H1
USB.DM	P7
USB.DP	N7
XRES	D8
P0.0	K5
P0.1	C4
P1.0/SMIF0.0	N2
P1.1/SMIF0.1	P1
P1.2/SMIF0.2	N1
P1.3/SMIF0.3	M2
P1.4/SMIF0.4	L2
P1.5/SMIF0.5	K2
P1.6/SMIF0.6	K1
P1.7/SMIF0.7	J2
P2.0	K4
P3.0	M4
P3.1	L6
P4.0/SMIF1.0	C2
P4.1/SMIF1.1	C1
P4.2/SMIF1.2	D2
P4.3/SMIF1.3	D1
P4.4/SMIF1.4	F2
P4.5/SMIF1.5	E2
P4.6/SMIF1.6	G2
P4.7/SMIF1.7	H2
P5.0	J4
P6.0	M6
P6.1	N6
P6.2	P6
P6.3	R6
P6.4	R5
P6.5	R2
P6.6	P5
P6.7	P2

(table continues...)

Table 12 (continued) Packages and pin information

Pin	Packages
	BGA-220
P7.0	P3
P7.1	N5
P7.2	R4
P7.3	M5
P7.4	P4
P7.5	L4
P7.6	N4
P7.7	L5
P8.0	H7
P8.1	J8
P8.2	J7
P8.3	K8
P8.4	F6
P8.5	E7
P8.6	G6
P8.7	H6
P9.0	L14
P9.1	M13
P9.2	M14
P9.3	N13
P10.0	B15
P10.1	A13
P10.2	C15
P10.3	A14
P10.4	D14
P10.5	B14
P10.6	D15
P10.7	C14
P11.0	E14
P11.1	E11
P11.2	E15
P11.3	E10
P11.4	F14
P11.5	F9
P11.6	F13

(table continues...)

Table 12 (continued) Packages and pin information

Pin	Packages
	BGA-220
P11.7	F10
P12.0	H5
P12.1	D5
P12.2	G5
P12.3	E5
P12.4	F4
P12.5	F5
P13.0 ¹⁾	G8
P13.1	G9
P13.2	G10
P13.3	F15
P13.4	G11
P13.5 ¹⁾	G14
P13.6	H11
P13.7	H15
P14.0 ¹⁾	H10
P14.1	H13
P14.2	H9
P14.3	K15
P14.4	J9
P14.5 ¹⁾	J15
P14.6	J10
P14.7	J14
P15.0	L15
P15.1	K13
P15.2	M15
P15.3	K9
P15.4	N15
P15.5	K10
P15.6	P15
P15.7	K11
P16.0	M11
P16.1	R13
P16.2	N11
P16.3	L11

(table continues...)

Table 12 (continued) Packages and pin information

Pin	Packages
	BGA-220
P16.4	P11
P16.5	L10
P16.6	R11
P16.7	M10
P17.0	M9
P17.1	R9
P17.2	R8
P17.3	P9
P17.4	P8
P17.5	N9
P17.6	N8
P17.7	L9
P18.0 ¹⁾	G7
P18.1 ¹⁾	H8
P19.0 ¹⁾	B6
P19.1 ¹⁾	F8
P20.0	P14
P20.1	M12
P20.2	R15
P20.3	N12
P20.4	R14
P20.5	P12
P20.6	P13
P20.7	R12
P21.0	J5
P21.1	E4
P21.2	K7
P21.3	D4
P21.4	K6
P21.5	C5
P21.6	L7
P21.7	C3

1) This pin is input-only

7 GPIO alternate functions

This section lists the alternate functions available at each GPIO, in multiple tables.

[Table 13](#) shows a summary of connections to all of the pins in each port. It also shows how many pins are available in each port.

Table 13 Ports, pins, and functions

Port	Pins available in the port	Functions
P0	0, 1	SMIF1 select, TCPWM, SCB
P1/SMIF0	0 - 7	SMIF0 data, TCPWM
P2	0	SMIF0 select, TCPWM
P3	0, 1	I3C, SD Host, TCPWM
P4/SMIF1	0 - 7	SMIF1 data, trace, TCPWM
P5	0	SMIF0 select, TCPWM
P6	0 - 7	SMIF0 select, SCB, SD host, SWJ, TCPWM
P7	0 - 7	SMIF0 select, fault, external clock, SWJ, SD host, trigger IO, TCPWM
P8	0 - 7	Hibernate wakeup, SWD, cal wave, SCB, PDM, trigger input, TCPWM
P9	0 - 3	SCB, PDM, TCPWM
P10	0 - 7	LPComp input, fault, SCB, Ethernet, TCPWM
P11	0 - 7	Smart I/O, SCB, TDM, trigger input, Ethernet, TCPWM
P12	0 - 5	SMIF1 select, SD host, TDM, TCPWM
P13	0 - 7	CTBL, Opamp output, DAC, SCB, PDM, Ethernet, TCPWM
P14	0 - 7	CTBL, Opamp output, DAC, SCB, PDM, TCPWM
P15	0 - 7	SARMUX, PTC, SCB, TCPWM
P16	0 - 7	CAN, SCB, Graphics, TCPWM
P17	0 - 7	Smart I/O, SCB, Graphics, Auto-analog output, TCPWM
P18	0, 1	WCO
P19	0, 1	ECO
P20	0 - 7	CAN, SCB, trace, Auto-analog output & observe, TCPWM
P21	0 - 7	SCB, TDM, SD host, TCPWM

Note: Pin availability varies across packages. Refer to [Table 12](#) for details.

[Table 14](#) shows how the HSIOM bitfield settings relate to the alternate function groups (“ACT #x”, “DS #x”, etc.), and the related power modes, for each GPIO.

Table 14 HSIOM settings, functions, and ports

HSIOM bitfield setting	Function group	Functions	Ports
0	GPIO	None, basic GPIO	all

(table continues...)

Table 14 (continued) HSIOM settings, functions, and ports

HSIOM bitfield setting	Function group	Functions	Ports
2 - 7	not used	-	-
8	ACT #0	SMIF select	P0, P2, P5, P6, P7, P12, P21
9	ACT #1	TCPWM	All except P18 and P19
10	ACT #2	TCPWM	All except P18 and P19
11	ACT #3	fault	P7, P10
12 - 13	not used	-	-
14	DS #2	SCB 0 (SPI only)	P8
15	DS #3	SCB 0 (I ² C only)	P8
16	ACT #4	SCB	P0, P21
		External clock	P7
		CAN	P16, P20
17	ACT #5	TDM	P11
		SCB	P21
18	ACT #6	SCB	P6, P7, P9, P10, P11, P13, P14, P15, P16, P17, P20, P21
19	ACT #7	SCB	P6, P9, P10, P11, P16, P17
		TDM	P12, P21
20	ACT #8	SCB	P6, P9, P10, P11, P13, P14, P15, P16, P17
21	ACT #9	PDM	P8, P9, P13, P14
22	ACT #10	Trigger IO	P7, P8, P11
23	ACT #11	Trigger IO	P7, P8, P11
24	not used	-	-
25	ACT #13	Graphics	P16.1
26	ACT #14	SD host	P3.0, P6.0
		Graphics	P16, P17
27	ACT #15	I3C	P3
		Trace	P20
		SD host	P6, P7, P12, P21
		Ethernet	P10, P11, P13
		Graphics	P16
28	DS #4	Auto-analog data out	P17, P20-
29	DS #5	SWJ	P6, P7
		Auto-analog observe	P20
30 - 31	not used	-	-

Table 15 and Table 16 list the GPIO alternate functions in detail.

Table 15 GPIO alternate functions and HSIOM routes

GPIO	Alternate functions and HSIOM routes			
P0.0	smif[1].smif0_spihb_select1	ACT #0	tcpwm.line0+	ACT #1
	tcpwm.line256+	ACT #2	scb3.spi.select0	ACT #4
P0.1	smif[1].smif0_spihb_select2	ACT #0	tcpwm.line0-	ACT #1
	tcpwm.line256-	ACT #2		
P1.0/SMIF0.0	tcpwm.line1+	ACT #1	tcpwm.line257+	ACT #2
P1.1/SMIF0.1	tcpwm.line1-	ACT #1	tcpwm.line257-	ACT #2
P1.2/SMIF0.2	tcpwm.line2+	ACT #1	tcpwm.line258+	ACT #2
P1.3/SMIF0.3	tcpwm.line2-	ACT #1	tcpwm.line258-	ACT #2
P1.4/SMIF0.4	tcpwm.line3+	ACT #1	tcpwm.line259+	ACT #2
P1.5/SMIF0.5	tcpwm.line3-	ACT #1	tcpwm.line259-	ACT #2
P1.6/SMIF0.6	tcpwm.line4+	ACT #1	tcpwm.line260+	ACT #2
P1.7/SMIF0.7	tcpwm.line4-	ACT #1	tcpwm.line260-	ACT #2
P2.0	smif[0].smif0_spihb_select1	ACT #0	tcpwm.line5+	ACT #1
	tcpwm.line261+	ACT #2		
P3.0	tcpwm.line5-	ACT #1	tcpwm.line261-	ACT #2
	sdhost1.card_mech_write_prot: 1	ACT #14	i3c.scl	ACT #15
P3.1	tcpwm.line6+	ACT #1	tcpwm.line262+	ACT #2
	i3c.sda	ACT #15		
P4.0/SMIF1.0	tcpwm.line6-	ACT #1	tcpwm.line262-	ACT #2
P4.1/SMIF1.1	tcpwm.line7+	ACT #1	tcpwm.line263+	ACT #2
P4.2/SMIF1.2	tcpwm.line7-	ACT #1	tcpwm.line263-	ACT #2
P4.3/SMIF1.3	tcpwm.line0+	ACT #1	tcpwm.line264+	ACT #2
	trace.clock	ACT #15		
P4.4/SMIF1.4	tcpwm.line0-	ACT #1	tcpwm.line264-	ACT #2
	trace.data0	ACT #15		
P4.5/SMIF1.5	tcpwm.line1+	ACT #1	tcpwm.line265+	ACT #2
	trace.data1	ACT #15		
P4.6/SMIF1.6	tcpwm.line1-	ACT #1	tcpwm.line265-	ACT #2
	trace.data2	ACT #15		
P4.7/SMIF1.7	tcpwm.line2+	ACT #1	tcpwm.line266+	ACT #2
	trace.data3	ACT #15		

(table continues...)

Table 15 (continued) GPIO alternate functions and HSIOM routes

GPIO	Alternate functions and HSIOM routes			
P5.0	smif[0].smif0_spihb_select0	ACT #0	tcpwm.line2-	ACT #1
	tcpwm.line266-	ACT #2		
P6.0	tcpwm.line3+	ACT #1	tcpwm.line267+	ACT #2
	sdhost1.card_mech_write_prot: 0	ACT #14	swj.tdo	DS #5
P6.1	tcpwm.line3-	ACT #1	tcpwm.line267-	ACT #2
	sdhost1.led_ctrl	ACT #15	swj.tdi	DS #5
P6.2	tcpwm.line4+	ACT #1	tcpwm.line268+	ACT #2
	sdhost1.card_if_pwr_en	ACT #15	swj.swdio/tms	DS #5
P6.3	tcpwm.line4-	ACT #1	tcpwm.line268-	ACT #2
	scb2.spi.select1	ACT #6	sdhost1.io_volt_sel	ACT #15
	swj.swclk/tclk	DS #5		
P6.4	tcpwm.line5+	ACT #1	tcpwm.line269+	ACT #2
	scb2.spi.miso	ACT #6	scb2.uart.cts	ACT #8
	sdhost1.card_dat_7to4_0	ACT #15		
P6.5	tcpwm.line5-	ACT #1	tcpwm.line269-	ACT #2
	scb2.spi.clk	ACT #6	scb2.i2c.scl	ACT #7
	scb2.uart.rx	ACT #8	sdhost1.card_dat_7to4_1	ACT #15
P6.6	tcpwm.line6+	ACT #1	tcpwm.line270+	ACT #2
	scb2.spi.select0	ACT #6	scb2.uart.rts	ACT #8
	sdhost1.card_dat_7to4_2	ACT #15		
P6.7	smif[0].smif0_spihb_select2	ACT #0	tcpwm.line6-	ACT #1
	tcpwm.line270-	ACT #2	scb2.spi.mosi	ACT #6
	scb2.i2c.sda	ACT #7	scb2.uart.tx	ACT #8
	sdhost1.card_dat_7to4_3	ACT #15		
P7.0	smif[0].smif0_spihb_select3	ACT #0	tcpwm.line7+	ACT #1
	tcpwm.line271+	ACT #2	m33syscpuss.fault0	ACT #3
	trig0.out0	ACT #10	trig1.out0	ACT #11
	sdhost1.card_cmd	ACT #15		
P7.1	tcpwm.line7-	ACT #1	tcpwm.line271-	ACT #2
	m33syscpuss.fault1	ACT #3	trig0.out1	ACT #10
	trig1.out1	ACT #11	sdhost1.clk_card	ACT #15
P7.2	tcpwm.line0+	ACT #1	tcpwm.line272+	ACT #2
	sdhost1.card_emmc_reset_n	ACT #15	swj.trstn	DS #5

(table continues...)

Table 15 (continued) GPIO alternate functions and HSIOM routes

GPIO	Alternate functions and HSIOM routes			
P7.3	tcpwm.line0-	ACT #1	tcpwm.line272-	ACT #2
	sdhost1.card_dat_3to0_0	ACT #15		
P7.4	tcpwm.line1+	ACT #1	tcpwm.line273+	ACT #2
	ext_clk	ACT #4	sdhost1.card_detect_n	ACT #15
P7.5	tcpwm.line1-	ACT #1	tcpwm.line273-	ACT #2
	trig0.in4	ACT #10	trig1.in4	ACT #11
	sdhost1.card_dat_3to0_1	ACT #15		
P7.6	tcpwm.line2+	ACT #1	tcpwm.line274+	ACT #2
	trig0.in5	ACT #10	trig1.in5	ACT #11
	sdhost1.card_dat_3to0_2	ACT #15		
P7.7	tcpwm.line2-	ACT #1	tcpwm.line274-	ACT #2
	trig0.in6	ACT #10	trig1.in6	ACT #11
	sdhost1.card_dat_3to0_3	ACT #15		
P8.0	tcpwm.line3+	ACT #1	tcpwm.line275+	ACT #2
	scb0.spi.clk	DS #2	scb0.i2c.scl	DS #3
	trig0.in7	ACT #10	trig1.in7	ACT #11
	m0seccpuss.m0sec_swd	DS #5		
P8.1	tcpwm.line3-	ACT #1	tcpwm.line275-	ACT #2
	scb0.spi.mosi	DS #2	scb0.i2c.sda	DS #3
	m0seccpuss.clk_m0sec_swd	DS #5		
P8.2	tcpwm.line4+	ACT #1	tcpwm.line276+	ACT #2
	scb0.spi.select0	DS #2	pdm2.clk	ACT #9
P8.3	hibernate_wakeup	fixed	tcpwm.line4-	ACT #1
	tcpwm.line276-	ACT #2	scb0.spi.select1	DS #2
P8.4	tcpwm.line5+	ACT #1	tcpwm.line277+	ACT #2
	scb0.spi.miso	DS #2	cal_wave	DS #3
	pdm2.data	ACT #9		
P8.5	tcpwm.line5-	ACT #1	tcpwm.line277-	ACT #2
	pdm3.clk	ACT #9		
P8.6	tcpwm.line6+	ACT #1	tcpwm.line278+	ACT #2
	pdm3.data	ACT #9		
P8.7	hibernate_wakeup	fixed	tcpwm.line6-	ACT #1
	tcpwm.line278-	ACT #2		

(table continues...)

Table 15 (continued) GPIO alternate functions and HSIOM routes

GPIO	Alternate functions and HSIOM routes			
P9.0	tcpwm.line7+	ACT #1	tcpwm.line279-	ACT #2
	scb1.spi.select0	ACT #6	scb1.uart.rts	ACT #8
	pdm5.clk	ACT #9		
P9.1	tcpwm.line0+	ACT #1	tcpwm.line256-	ACT #2
	scb1.spi.miso	ACT #6	scb1.uart.cts	ACT #8
	pdm5.data	ACT #9		
P9.2	tcpwm.line7-	ACT #1	tcpwm.line279+	ACT #2
	scb1.spi.mosi	ACT #6	scb1.i2c.sda	ACT #7
	scb1.uart.tx	ACT #8	pdm4.clk	ACT #9
P9.3	tcpwm.line0-	ACT #1	tcpwm.line256+	ACT #2
	scb1.spi.clk	ACT #6	scb1.i2c.scl	ACT #7
	scb1.uart.rx	ACT #8	pdm4.data	ACT #9
P10.0	tcpwm.line1+	ACT #1	tcpwm.line257+	ACT #2
	m33syscpuss.fault0	ACT #3	scb4.i2c.scl	ACT #7
	scb4.uart.rx	ACT #8	eth.tx.d3	ACT #15
P10.1	tcpwm.line1-	ACT #1	tcpwm.line257-	ACT #2
	m33syscpuss.fault1	ACT #3	scb4.spi.clk	ACT #6
	scb4.i2c.sda	ACT #7	scb4.uart.tx	ACT #8
	eth.rx.clk	ACT #15		
P10.2	tcpwm.line2+	ACT #1	tcpwm.line258+	ACT #2
	lpcomp.dsi_comp1	DS #3	scb4.spi.mosi	ACT #6
	scb4.uart.cts	ACT #8	eth.tx.er	ACT #15
P10.3	tcpwm.line2-	ACT #1	tcpwm.line258-	ACT #2
	lpcomp.dsi_comp0	DS #3	scb4.spi.miso	ACT #6
	scb4.uart.rts	ACT #8	eth.tsu_timer_cmp_val	ACT #15
P10.4	lpcomp0.in+	fixed	tcpwm.line3+	ACT #1
	tcpwm.line259+	ACT #2	scb4.spi.select0	ACT #6
	eth.rxd3	ACT #15		
P10.5	lpcomp0.in-	fixed	tcpwm.line3-	ACT #1
	tcpwm.line259-	ACT #2	scb4.spi.select1	ACT #6
	eth.rxctl	ACT #15		
P10.6	lpcomp1.in+	fixed	tcpwm.line4+	ACT #1
	tcpwm.line260+	ACT #2	eth.rxd0	ACT #15

(table continues...)

Table 15 (continued) GPIO alternate functions and HSIOM routes

GPIO	Alternate functions and HSIOM routes			
P10.7	lpcomp1.in-	fixed	tcpwm.line4-	ACT #1
	tcpwm.line260-	ACT #2	eth.rxd1	ACT #15
P11.0	smartio.io0	fixed	tcpwm.line5+	ACT #1
	tcpwm.line261+	ACT #2	tdm1.tx.sck	ACT #5
	scb6.spi.clk	ACT #6	scb6.i2c.scl	ACT #7
	scb6.uart.rx	ACT #8	trig0.in0	ACT #10
	trig1.in0	ACT #11	eth.rxd2	ACT #15
P11.1	smartio.io1	fixed	tcpwm.line5-	ACT #1
	tcpwm.line261-	ACT #2	tdm1.tx.fsync	ACT #5
	scb6.spi.mosi	ACT #6	scb6.i2c.sda	ACT #7
	scb6.uart.tx	ACT #8	trig0.in1	ACT #10
	trig1.in1	ACT #11	eth.rx.er	ACT #15
P11.2	smartio.io2	fixed	tcpwm.line6+	ACT #1
	tcpwm.line262+	ACT #2	tdm1.tx.sd	ACT #5
	scb6.spi.miso	ACT #6	scb6.uart.cts	ACT #8
	trig0.in2	ACT #10	trig1.in2	ACT #11
	eth.txd0	ACT #15		
P11.3	smartio.io3	fixed	tcpwm.line6-	ACT #1
	tcpwm.line262-	ACT #2	tdm1.rx.mck	ACT #5
	scb6.spi.select0	ACT #6	scb6.uart.rts	ACT #8
	trig0.in3	ACT #10	trig1.in3	ACT #11
	eth.txd1	ACT #15		
P11.4	smartio.io4	fixed	tcpwm.line7+	ACT #1
	tcpwm.line263+	ACT #2	tdm1.rx.sck	ACT #5
	scb6.spi.select1	ACT #6	eth.txctl	ACT #15
P11.5	smartio.io5	fixed	tcpwm.line7-	ACT #1
	tcpwm.line263-	ACT #2	tdm1.rx.fsync	ACT #5
	eth.tx.clk	ACT #15		
P11.6	smartio.io6	fixed	tcpwm.line0+	ACT #1
	tcpwm.line264+	ACT #2	tdm1.rx.sd	ACT #5
	eth.txd2	ACT #15		

(table continues...)

Table 15 (continued) GPIO alternate functions and HSIOM routes

GPIO	Alternate functions and HSIOM routes			
P11.7	smartio.io7	fixed	tcpwm.line0-	ACT #1
	tcpwm.line264-	ACT #2	tdm1.tx.mck	ACT #5
	eth.ref.clk	ACT #15		
P12.0	tcpwm.line1+	ACT #1	tcpwm.line265+	ACT #2
	sdhost0.clk_card	ACT #15		
P12.1	tcpwm.line1-	ACT #1	tcpwm.line265-	ACT #2
	sdhost0.card_dat_3to0_0	ACT #15		
P12.2	tcpwm.line2+	ACT #1	tcpwm.line266+	ACT #2
	sdhost0.card_dat_3to0_1	ACT #15		
P12.3	smif[1].smif0_spihb_select3	ACT #0	tcpwm.line2-	ACT #1
	tcpwm.line266-	ACT #2	tdm0.tx.fsync	ACT #7
P12.4	tcpwm.line3+	ACT #1	tcpwm.line267+	ACT #2
	sdhost0.card_dat_3to0_2	ACT #15		
P12.5	tcpwm.line3-	ACT #1	tcpwm.line267-	ACT #2
	sdhost0.card_dat_3to0_3	ACT #15		
P13.0	aanalog.ctb1.0	fixed		
P13.1	aanalog.ctb1.1	fixed	tcpwm.line4+	ACT #1
	tcpwm.line268+	ACT #2	scb7.spi.clk	ACT #6
	scb7.i2c.scl	ACT #7	scb7.uart.rx	ACT #8
	eth.mdc	ACT #15		
P13.2	aanalog.ctb1.2	fixed	aanalog.ctb1.opamp0.out	fixed
	tcpwm.line4-	ACT #1	tcpwm.line268-	ACT #2
	scb7.spi.mosi	ACT #6	scb7.i2c.sda	ACT #7
	scb7.uart.tx	ACT #8	pdm1.clk	ACT #9
P13.3	aanalog.ctb1.3	fixed	aanalog.ctb1.opamp1.out	fixed
	tcpwm.line5+	ACT #1	tcpwm.line269+	ACT #2
	scb7.spi.miso	ACT #6	scb7.uart.cts	ACT #8
	pdm1.data	ACT #9		
P13.4	aanalog.ctb1.4	fixed	tcpwm.line5-	ACT #1
	tcpwm.line269-	ACT #2	scb7.spi.select0	ACT #6
	scb7.uart.rts	ACT #8		
P13.5	aanalog.ctb1.5	fixed		

(table continues...)

Table 15 (continued) GPIO alternate functions and HSIOM routes

GPIO	Alternate functions and HSIOM routes			
P13.6	aanalog.ctb1.6	fixed	aanalog.dac1	fixed
	tcpwm.line6+	ACT #1	tcpwm.line270+	ACT #2
	scb7.spi.select1	ACT #6	eth.mdio	ACT #15
P13.7	aanalog.ctb1.7	fixed	tcpwm.line6-	ACT #1
	tcpwm.line270-	ACT #2	scb8.spi.miso	ACT #6
	scb8.uart.cts	ACT #8		
P14.0	aanalog.ctb0.0	fixed		
P14.1	aanalog.ctb0.1	fixed	tcpwm.line7+	ACT #1
	tcpwm.line271+	ACT #2	pdm0.clk	ACT #9
P14.2	aanalog.ctb0.2	fixed	aanalog.ctb0.opamp0.out	fixed
	tcpwm.line7-	ACT #1	tcpwm.line271-	ACT #2
P14.3	aanalog.ctb0.3	fixed	aanalog.ctb0.opamp1.out	fixed
	tcpwm.line0+	ACT #1	tcpwm.line272+	ACT #2
	scb8.spi.mosi	ACT #6	scb8.i2c.sda	ACT #7
	scb8.uart.tx	ACT #8		
P14.4	aanalog.ctb0.4	fixed	tcpwm.line0-	ACT #1
	tcpwm.line272-	ACT #2	scb8.spi.clk	ACT #6
	scb8.i2c.scl	ACT #7	scb8.uart.rx	ACT #8
	pdm0.data	ACT #9		
P14.5	aanalog.ctb0.5	fixed		
P14.6	aanalog.ctb0.6	fixed	aanalog.dac0	fixed
	tcpwm.line1+	ACT #1	tcpwm.line273+	ACT #2
	scb8.spi.select1	ACT #6		
P14.7	aanalog.ctb0.7	fixed	tcpwm.line1-	ACT #1
	tcpwm.line273-	ACT #2	scb8.spi.select0	ACT #6
	scb8.uart.rts	ACT #8		
P15.0	aanalog.ptcomp0	fixed	aanalog.sar0	fixed
	tcpwm.line2+	ACT #1	tcpwm.line274+	ACT #2
	scb9.spi.clk	ACT #6	scb9.i2c.scl	ACT #7
	scb9.uart.rx	ACT #8		

(table continues...)

Table 15 (continued) GPIO alternate functions and HSIOM routes

GPIO	Alternate functions and HSIOM routes			
P15.1	aanalog.ptcomp1	fixed	aanalog.sar1	fixed
	tcpwm.line2-	ACT #1	tcpwm.line274-	ACT #2
	scb9.spi.mosi	ACT #6	scb9.i2c.sda	ACT #7
	scb9.uart.tx	ACT #8		
P15.2	aanalog.sar2	fixed	aanalog.ptcomp2	fixed
	tcpwm.line3+	ACT #1	tcpwm.line275+	ACT #2
	scb9.spi.miso	ACT #6	scb9.uart.cts	ACT #8
P15.3	aanalog.sar3	fixed	aanalog.ptcomp3	fixed
	tcpwm.line3-	ACT #1	tcpwm.line275-	ACT #2
	scb9.spi.select0	ACT #6	scb9.uart.rts	ACT #8
P15.4	aanalog.sar4	fixed	aanalog.ptcomp4	fixed
	tcpwm.line4+	ACT #1	tcpwm.line276+	ACT #2
	scb9.spi.select1	ACT #6		
P15.5	aanalog.sar5	fixed	aanalog.ptcomp5	fixed
	tcpwm.line4-	ACT #1	tcpwm.line276-	ACT #2
P15.6	aanalog.sar6	fixed	aanalog.ptcomp6	fixed
	tcpwm.line5+	ACT #1	tcpwm.line277+	ACT #2
P15.7	aanalog.sar7	fixed	aanalog.ptcomp7	fixed
	tcpwm.line5-	ACT #1	tcpwm.line277-	ACT #2
P16.0	tcpwm.line0+	ACT #1	tcpwm.line256+	ACT #2
	can0.rx	ACT #4	scb10.spi.clk	ACT #6
	scb10.i2c.scl	ACT #7	scb10.uart.rx	ACT #8
	gfx.dbi.csx	ACT #14	gfx.spi.csx	ACT #15
P16.1	tcpwm.line1+	ACT #1	tcpwm.line257+	ACT #2
	can0.tx	ACT #4	scb10.spi.mosi	ACT #6
	scb10.i2c.sda	ACT #7	scb10.uart.tx	ACT #8
	gfx.dbi.wrx	ACT #13	gfx.dbi.e	ACT #14
	gfx.spi.scl	ACT #15		
P16.2	tcpwm.line2+	ACT #1	tcpwm.line258+	ACT #2
	can1.rx	ACT #4	scb10.spi.miso	ACT #6
	scb10.uart.cts	ACT #8	gfx.dbi.dcx	ACT #14
	gfx.spi.dout	ACT #15		

(table continues...)

Table 15 (continued) GPIO alternate functions and HSIOM routes

GPIO	Alternate functions and HSIOM routes			
P16.3	tcpwm.line3+	ACT #1	tcpwm.line259+	ACT #2
	can1.tx	ACT #4	scb10.spi.select0	ACT #6
	scb10.uart.rts	ACT #8	gfx.dbi.d0	ACT #14
	gfx.spi.dcx	ACT #15		
P16.4	tcpwm.line4+	ACT #1	tcpwm.line260+	ACT #2
	scb10.spi.select1	ACT #6	gfx.dbi.d1	ACT #14
P16.5	tcpwm.line5+	ACT #1	tcpwm.line261+	ACT #2
	scb5.spi.miso	ACT #6	scb5.uart.cts	ACT #8
	gfx.dbi.d2	ACT #14		
P16.6	tcpwm.line6+	ACT #1	tcpwm.line278+	ACT #2
	scb5.spi.select0	ACT #6	scb5.uart.rts	ACT #8
	gfx.dbi.d3	ACT #14		
P16.7	tcpwm.line7+	ACT #1	tcpwm.line279+	ACT #2
	scb5.spi.select1	ACT #6	gfx.dbi.d4	ACT #14
P17.0	smartio.io0	fixed	tcpwm.line0-	ACT #1
	tcpwm.line256-	ACT #2	scb5.spi.clk	ACT #6
	scb5.i2c.scl	ACT #7	scb5.uart.rx	ACT #8
	gfx.dbi.d5	ACT #14		
P17.1	smartio.io1	fixed	tcpwm.line1-	ACT #1
	tcpwm.line257-	ACT #2	scb5.spi.mosi	ACT #6
	scb5.i2c.sda	ACT #7	scb5.uart.tx	ACT #8
	gfx.dbi.d6	ACT #14		
P17.2	smartio.io2	fixed	tcpwm.line2-	ACT #1
	tcpwm.line258-	ACT #2	scb11.spi.clk	ACT #6
	scb11.i2c.scl	ACT #7	scb11.uart.rx	ACT #8
	gfx.dbi.d7	ACT #14		
P17.3	smartio.io3	fixed	tcpwm.line3-	ACT #1
	tcpwm.line259-	ACT #2	scb11.spi.mosi	ACT #6
	scb11.i2c.sda	ACT #7	scb11.uart.tx	ACT #8
P17.4	smartio.io4	fixed	tcpwm.line4-	ACT #1
	tcpwm.line260-	ACT #2	aanalog.gpio_out0	DS #4

(table continues...)

Table 15 (continued) GPIO alternate functions and HSIOM routes

GPIO	Alternate functions and HSIOM routes			
P17.5	smartio.io5	fixed	tcpwm.line5-	ACT #1
	tcpwm.line261-	ACT #2	scb11.spi.miso	ACT #6
	scb11.uart.cts	ACT #8	aanalog.gpio_out1	DS #4
P17.6	smartio.io6	fixed	tcpwm.line6-	ACT #1
	tcpwm.line278-	ACT #2	scb11.spi.select0	ACT #6
	scb11.uart.rts	ACT #8	aanalog.gpio_out2	DS #4
P17.7	smartio.io7	fixed	tcpwm.line7-	ACT #1
	tcpwm.line279-	ACT #2	scb11.spi.select1	ACT #6
	aanalog.gpio_out3	DS #4		
P18.0	wco_out	fixed		
P18.1	wco_in	fixed		
P19.0	eco_in	fixed		
P19.1	eco_out	fixed		
P20.0	tcpwm.line7+	ACT #1	tcpwm.line263-	ACT #2
	scb11.spi.select1	ACT #6	trace.clock	ACT #15
P20.1	tcpwm.line0+	ACT #1	tcpwm.line264-	ACT #2
	trace.data3	ACT #15		
P20.2	tcpwm.line1+	ACT #1	tcpwm.line265-	ACT #2
	trace.data2	ACT #15		
P20.3	tcpwm.line2+	ACT #1	tcpwm.line266-	ACT #2
	trace.data1	ACT #15		
P20.4	tcpwm.line7-	ACT #1	tcpwm.line263+	ACT #2
	can0.rx	ACT #4	trace.data0	ACT #15
	aanalog.gpio_out0	DS #4		
P20.5	tcpwm.line0-	ACT #1	tcpwm.line264+	ACT #2
	can0.tx	ACT #4	aanalog.gpio_out1	DS #4
P20.6	tcpwm.line1-	ACT #1	tcpwm.line265+	ACT #2
	can1.rx	ACT #4	aanalog.gpio_out2	DS #4
P20.7	tcpwm.line2-	ACT #1	tcpwm.line266+	ACT #2
	can1.tx	ACT #4	aanalog.gpio_out3	DS #4
P21.0	tcpwm.line3+	ACT #1	tcpwm.line267+	ACT #2
	sdhost0.card_cmd	ACT #15		

(table continues...)

7 GPIO alternate functions

Table 15 (continued) GPIO alternate functions and HSIOM routes

GPIO	Alternate functions and HSIOM routes			
P21.1	tcpwm.line3-	ACT #1	tcpwm.line267-	ACT #2
	tdm0.tx.sd	ACT #7	sdhost0.card_detect_n	ACT #15
P21.2	tcpwm.line4+	ACT #1	tcpwm.line268+	ACT #2
	tdm0.tx.sck	ACT #7	sdhost0.card_mech_write_prot	ACT #15
P21.3	tcpwm.line4-	ACT #1	tcpwm.line268-	ACT #2
	tdm0.tx.mck	ACT #7	sdhost0.io_volt_sel	ACT #15
P21.4	tcpwm.line5+	ACT #1	tcpwm.line269+	ACT #2
	scb3.spi.miso	ACT #4	scb3.uart.cts	ACT #6
	tdm0.rx.sd	ACT #7	sdhost0.card_if_pwr_en	ACT #15
P21.5	tcpwm.line5-	ACT #1	tcpwm.line269-	ACT #2
	scb3.spi.mosi	ACT #4	scb3.i2c.sda	ACT #5
	scb3.uart.tx	ACT #6	tdm0.rx.fsync	ACT #7
P21.6	tcpwm.line6+	ACT #1	tcpwm.line270+	ACT #2
	scb3.spi.clk	ACT #4	scb3.i2c.scl	ACT #5
	scb3.uart.rx	ACT #6	tdm0.rx.sck	ACT #7
P21.7	smif[1].smif0_spihb_select0	ACT #0	tcpwm.line6-	ACT #1
	tcpwm.line270-	ACT #2	scb3.spi.select1	ACT #4
	scb3.uart.rts	ACT #6	tdm0.rx.mck	ACT #7

Table 16 GPIO alternate functions

Function	GPIOs	Function	GPIOs	Function	GPIOs
aanalog.ctb0.0	P14.0	aanalog.ctb0.1	P14.1	aanalog.ctb0.2	P14.2
aanalog.ctb0.3	P14.3	aanalog.ctb0.4	P14.4	aanalog.ctb0.5	P14.5
aanalog.ctb0.6	P14.6	aanalog.ctb0.7	P14.7	aanalog.ctb0.opa mp0.out	P14.2
aanalog.ctb0.opa mp1.out	P14.3	aanalog.ctb1.0	P13.0	aanalog.ctb1.1	P13.1
aanalog.ctb1.2	P13.2	aanalog.ctb1.3	P13.3	aanalog.ctb1.4	P13.4
aanalog.ctb1.5	P13.5	aanalog.ctb1.6	P13.6	aanalog.ctb1.7	P13.7
aanalog.ctb1.opa mp0.out	P13.2	aanalog.ctb1.opa mp1.out	P13.3	aanalog.dac0	P14.6
aanalog.dac1	P13.6	aanalog.gpio_out 0	P17.4, P20.4	aanalog.gpio_out 1	P17.5, P20.5
aanalog.gpio_out 2	P17.6, P20.6	aanalog.gpio_out 3	P17.7, P20.7	aanalog.ptcomp0	P15.0

(table continues...)

7 GPIO alternate functions

Table 16 (continued) GPIO alternate functions

Function	GPIOs	Function	GPIOs	Function	GPIOs
aanalog.ptcomp1	P15.1	aanalog.ptcomp2	P15.2	aanalog.ptcomp3	P15.3
aanalog.ptcomp4	P15.4	aanalog.ptcomp5	P15.5	aanalog.ptcomp6	P15.6
aanalog.ptcomp7	P15.7	aanalog.sar0	P15.0	aanalog.sar1	P15.1
aanalog.sar2	P15.2	aanalog.sar3	P15.3	aanalog.sar4	P15.4
aanalog.sar5	P15.5	aanalog.sar6	P15.6	aanalog.sar7	P15.7
cal_wave	P8.4	can0.rx	P16.0, P20.4	can0.tx	P16.1, P20.5
can1.rx	P16.2, P20.6	can1.tx	P16.3, P20.7	eco_in	P19.0
eco_out	P19.1	eth.mdc	P13.1	eth.mdio	P13.6
eth.ref.clk	P11.7	eth.rx.clk	P10.1	eth.rx.ctl	P10.5
eth.rx.er	P11.1	eth.rxd0	P10.6	eth.rxd1	P10.7
eth.rxd2	P11.0	eth.rxd3	P10.4	eth.tsu_timer_cm p_val	P10.3
eth.tx.clk	P11.5	eth.tx.ctl	P11.4	eth.tx.er	P10.2
eth.txd0	P11.2	eth.txd1	P11.3	eth.txd2	P11.6
eth.txd3	P10.0	ext_clk	P7.4	gfx.dbi.csx	P16.0
gfx.dbi.d0	P16.3	gfx.dbi.d1	P16.4	gfx.dbi.d2	P16.5
gfx.dbi.d3	P16.6	gfx.dbi.d4	P16.7	gfx.dbi.d5	P17.0
gfx.dbi.d6	P17.1	gfx.dbi.d7	P17.2	gfx.dbi.dcx	P16.2
gfx.dbi.e	P16.1	gfx.dbi.wrx	P16.1	gfx.spi.csx	P16.0
gfx.spi.dcx	P16.3	gfx.spi.dout	P16.2	gfx.spi.scl	P16.1
hibernate_wakeup	P8.3, P8.7	i3c.scl	P3.0	i3c.sda	P3.1
lpcomp.dsi_comp 0	P10.3	lpcomp.dsi_comp 1	P10.2	lpcomp0.in+	P10.4
lpcomp0.in-	P10.5	lpcomp1.in+	P10.6	lpcomp1.in-	P10.7
m0seccpuss.clk_m 0sec_swd	P8.1	m0seccpuss.m0se c_swd	P8.0	m33syscpuss.fault t0	P7.0, P10.0
m33syscpuss.fault 1	P7.1, P10.1	pdm0.clk	P14.1	pdm0.data	P14.4
pdm1.clk	P13.2	pdm1.data	P13.3	pdm2.clk	P8.2
pdm2.data	P8.4	pdm3.clk	P8.5	pdm3.data	P8.6
pdm4.clk	P9.2	pdm4.data	P9.3	pdm5.clk	P9.0
pdm5.data	P9.1	scb0.i2c.scl	P8.0	scb0.i2c.sda	P8.1
scb0.spi.clk	P8.0	scb0.spi.miso	P8.4	scb0.spi.mosi	P8.1
scb0.spi.select0	P8.2	scb0.spi.select1	P8.3	scb1.i2c.scl	P9.3
scb1.i2c.sda	P9.2	scb1.spi.clk	P9.3	scb1.spi.miso	P9.1

(table continues...)

Table 16 (continued) GPIO alternate functions

Function	GPIOs	Function	GPIOs	Function	GPIOs
scb1.spi.mosi	P9.2	scb1.spi.select0	P9.0	scb1.spi.select1	P20.0
scb1.uart.cts	P9.1	scb1.uart.rts	P9.0	scb1.uart.rx	P9.3
scb1.uart.tx	P9.2	scb10.i2c.scl	P16.0	scb10.i2c.sda	P16.1
scb10.spi.clk	P16.0	scb10.spi.miso	P16.2	scb10.spi.mosi	P16.1
scb10.spi.select0	P16.3	scb10.spi.select1	P16.4	scb10.uart.cts	P16.2
scb10.uart.rts	P16.3	scb10.uart.rx	P16.0	scb10.uart.tx	P16.1
scb11.i2c.scl	P17.2	scb11.i2c.sda	P17.3	scb11.spi.clk	P17.2
scb11.spi.miso	P17.5	scb11.spi.mosi	P17.3	scb11.spi.select0	P17.6
scb11.spi.select1	P17.7	scb11.uart.cts	P17.5	scb11.uart.rts	P17.6
scb11.uart.rx	P17.2	scb11.uart.tx	P17.3	scb2.i2c.scl	P6.5
scb2.i2c.sda	P6.7	scb2.spi.clk	P6.5	scb2.spi.miso	P6.4
scb2.spi.mosi	P6.7	scb2.spi.select0	P6.6	scb2.spi.select1	P6.3
scb2.uart.cts	P6.4	scb2.uart.rts	P6.6	scb2.uart.rx	P6.5
scb2.uart.tx	P6.7	scb3.i2c.scl	P21.6	scb3.i2c.sda	P21.5
scb3.spi.clk	P21.6	scb3.spi.miso	P21.4	scb3.spi.mosi	P21.5
scb3.spi.select0	P0.0	scb3.spi.select1	P21.7	scb3.uart.cts	P21.4
scb3.uart.rts	P21.7	scb3.uart.rx	P21.6	scb3.uart.tx	P21.5
scb4.i2c.scl	P10.0	scb4.i2c.sda	P10.1	scb4.spi.clk	P10.1
scb4.spi.miso	P10.3	scb4.spi.mosi	P10.2	scb4.spi.select0	P10.4
scb4.spi.select1	P10.5	scb4.uart.cts	P10.2	scb4.uart.rts	P10.3
scb4.uart.rx	P10.0	scb4.uart.tx	P10.1	scb5.i2c.scl	P17.0
scb5.i2c.sda	P17.1	scb5.spi.clk	P17.0	scb5.spi.miso	P16.5
scb5.spi.mosi	P17.1	scb5.spi.select0	P16.6	scb5.spi.select1	P16.7
scb5.uart.cts	P16.5	scb5.uart.rts	P16.6	scb5.uart.rx	P17.0
scb5.uart.tx	P17.1	scb6.i2c.scl	P11.0	scb6.i2c.sda	P11.1
scb6.spi.clk	P11.0	scb6.spi.miso	P11.2	scb6.spi.mosi	P11.1
scb6.spi.select0	P11.3	scb6.spi.select1	P11.4	scb6.uart.cts	P11.2
scb6.uart.rts	P11.3	scb6.uart.rx	P11.0	scb6.uart.tx	P11.1
scb7.i2c.scl	P13.1	scb7.i2c.sda	P13.2	scb7.spi.clk	P13.1
scb7.spi.miso	P13.3	scb7.spi.mosi	P13.2	scb7.spi.select0	P13.4
scb7.spi.select1	P13.6	scb7.uart.cts	P13.3	scb7.uart.rts	P13.4
scb7.uart.rx	P13.1	scb7.uart.tx	P13.2	scb8.i2c.scl	P14.4
scb8.i2c.sda	P14.3	scb8.spi.clk	P14.4	scb8.spi.miso	P13.7

(table continues...)

Table 16 (continued) GPIO alternate functions

Function	GPIOs	Function	GPIOs	Function	GPIOs
scb8.spi.mosi	P14.3	scb8.spi.select0	P14.7	scb8.spi.select1	P14.6
scb8.uart.cts	P13.7	scb8.uart.rts	P14.7	scb8.uart.rx	P14.4
scb8.uart.tx	P14.3	scb9.i2c.scl	P15.0	scb9.i2c.sda	P15.1
scb9.spi.clk	P15.0	scb9.spi.miso	P15.2	scb9.spi.mosi	P15.1
scb9.spi.select0	P15.3	scb9.spi.select1	P15.4	scb9.uart.cts	P15.2
scb9.uart.rts	P15.3	scb9.uart.rx	P15.0	scb9.uart.tx	P15.1
sdhost0.card_cmd	P21.0	sdhost0.card_dat_3to0_0	P12.1	sdhost0.card_dat_3to0_1	P12.2
sdhost0.card_dat_3to0_2	P12.4	sdhost0.card_dat_3to0_3	P12.5	sdhost0.card_detect_n	P21.1
sdhost0.card_if_pwr_en	P21.4	sdhost0.card_mech_write_prot	P21.2	sdhost0.clk_card	P12.0
sdhost0.io_volt_sel	P21.3	sdhost1.card_cmd	P7.0	sdhost1.card_dat_3to0_0	P7.3
sdhost1.card_dat_3to0_1	P7.5	sdhost1.card_dat_3to0_2	P7.6	sdhost1.card_dat_3to0_3	P7.7
sdhost1.card_dat_7to4_0	P6.4	sdhost1.card_dat_7to4_1	P6.5	sdhost1.card_dat_7to4_2	P6.6
sdhost1.card_dat_7to4_3	P6.7	sdhost1.card_detect_n	P7.4	sdhost1.card_emmc_reset_n	P7.2
sdhost1.card_if_pwr_en	P6.2	sdhost1.card_mech_write_prot:0	P6.0	sdhost1.card_mech_write_prot:1	P3.0
sdhost1.clk_card	P7.1	sdhost1.io_volt_sel	P6.3	sdhost1.led_ctrl	P6.1
smartio.io0	P11.0, P17.0	smartio.io1	P11.1, P17.1	smartio.io2	P11.2, P17.2
smartio.io3	P11.3, P17.3	smartio.io4	P11.4, P17.4	smartio.io5	P11.5, P17.5
smartio.io6	P11.6, P17.6	smartio.io7	P11.7, P17.7	smif[0].smif0_spihb_select0	P5.0
smif[0].smif0_spihb_select1	P2.0	smif[0].smif0_spihb_select2	P6.7	smif[0].smif0_spihb_select3	P7.0
smif[1].smif0_spihb_select0	P21.7	smif[1].smif0_spihb_select1	P0.0	smif[1].smif0_spihb_select2	P0.1
smif[1].smif0_spihb_select3	P12.3	swj.swclk/tclk	P6.3	swj.swdio/tms	P6.2
swj.tdi	P6.1	swj.tdo	P6.0	swj.trstn	P7.2

(table continues...)

Table 16 (continued) GPIO alternate functions

Function	GPIOs	Function	GPIOs	Function	GPIOs
tcpwm.line0+	P0.0, P4.3/ SMIF1.3, P7.2, P9.1, P11.6, P14.3, P16.0, P20.1	tcpwm.line0-	P0.1, P4.4/ SMIF1.4, P7.3, P9.3, P11.7, P14.4, P17.0, P20.5	tcpwm.line1+	P1.0/SMIF0.0, P4.5/SMIF1.5, P7.4, P10.0, P12.0, P14.6, P16.1, P20.2
tcpwm.line1-	P1.1/SMIF0.1, P4.6/SMIF1.6, P7.5, P10.1, P12.1, P14.7, P17.1, P20.6	tcpwm.line2+	P1.2/SMIF0.2, P4.7/SMIF1.7, P7.6, P10.2, P12.2, P15.0, P16.2, P20.3	tcpwm.line2-	P1.3/SMIF0.3, P5.0, P7.7, P10.3, P12.3, P15.1, P17.2, P20.7
tcpwm.line256+	P0.0, P9.3, P16.0	tcpwm.line256-	P0.1, P9.1, P17.0	tcpwm.line257+	P1.0/SMIF0.0, P10.0, P16.1
tcpwm.line257-	P1.1/SMIF0.1, P10.1, P17.1	tcpwm.line258+	P1.2/SMIF0.2, P10.2, P16.2	tcpwm.line258-	P1.3/SMIF0.3, P10.3, P17.2
tcpwm.line259+	P1.4/SMIF0.4, P10.4, P16.3	tcpwm.line259-	P1.5/SMIF0.5, P10.5, P17.3	tcpwm.line260+	P1.6/SMIF0.6, P10.6, P16.4
tcpwm.line260-	P1.7/SMIF0.7, P10.7, P17.4	tcpwm.line261+	P2.0, P11.0, P16.5	tcpwm.line261-	P3.0, P11.1, P17.5
tcpwm.line262+	P3.1, P11.2	tcpwm.line262-	P4.0/SMIF1.0, P11.3	tcpwm.line263+	P4.1/SMIF1.1, P11.4, P20.4
tcpwm.line263-	P4.2/SMIF1.2, P11.5, P20.0	tcpwm.line264+	P4.3/SMIF1.3, P11.6, P20.5	tcpwm.line264-	P4.4/SMIF1.4, P11.7, P20.1
tcpwm.line265+	P4.5/SMIF1.5, P12.0, P20.6	tcpwm.line265-	P4.6/SMIF1.6, P12.1, P20.2	tcpwm.line266+	P4.7/SMIF1.7, P12.2, P20.7
tcpwm.line266-	P5.0, P12.3, P20.3	tcpwm.line267+	P6.0, P12.4, P21.0	tcpwm.line267-	P6.1, P12.5, P21.1
tcpwm.line268+	P6.2, P13.1, P21.2	tcpwm.line268-	P6.3, P13.2, P21.3	tcpwm.line269+	P6.4, P13.3, P21.4
tcpwm.line269-	P6.5, P13.4, P21.5	tcpwm.line270+	P6.6, P13.6, P21.6	tcpwm.line270-	P6.7, P13.7, P21.7
tcpwm.line271+	P7.0, P14.1	tcpwm.line271-	P7.1, P14.2	tcpwm.line272+	P7.2, P14.3
tcpwm.line272-	P7.3, P14.4	tcpwm.line273+	P7.4, P14.6	tcpwm.line273-	P7.5, P14.7
tcpwm.line274+	P7.6, P15.0	tcpwm.line274-	P7.7, P15.1	tcpwm.line275+	P8.0, P15.2
tcpwm.line275-	P8.1, P15.3	tcpwm.line276+	P8.2, P15.4	tcpwm.line276-	P8.3, P15.5
tcpwm.line277+	P8.4, P15.6	tcpwm.line277-	P8.5, P15.7	tcpwm.line278+	P8.6, P16.6
tcpwm.line278-	P8.7, P17.6	tcpwm.line279+	P9.2, P16.7	tcpwm.line279-	P9.0, P17.7
tcpwm.line3+	P1.4/SMIF0.4, P6.0, P8.0, P10.4, P12.4, P15.2, P16.3, P21.0	tcpwm.line3-	P1.5/SMIF0.5, P6.1, P8.1, P10.5, P12.5, P15.3, P17.3, P21.1	tcpwm.line4+	P1.6/SMIF0.6, P6.2, P8.2, P10.6, P13.1, P15.4, P16.4, P21.2

(table continues...)

Table 16 (continued) GPIO alternate functions

Function	GPIOs	Function	GPIOs	Function	GPIOs
tcpwm.line4-	P1.7/SMIF0.7, P6.3, P8.3, P10.7, P13.2, P15.5, P17.4, P21.3	tcpwm.line5+	P2.0, P6.4, P8.4, P11.0, P13.3, P15.6, P16.5, P21.4	tcpwm.line5-	P3.0, P6.5, P8.5, P11.1, P13.4, P15.7, P17.5, P21.5
tcpwm.line6+	P3.1, P6.6, P8.6, P11.2, P13.6, P16.6, P21.6	tcpwm.line6-	P4.0/SMIF1.0, P6.7, P8.7, P11.3, P13.7, P17.6, P21.7	tcpwm.line7+	P4.1/SMIF1.1, P7.0, P9.0, P11.4, P14.1, P16.7, P20.0
tcpwm.line7-	P4.2/SMIF1.2, P7.1, P9.2, P11.5, P14.2, P17.7, P20.4	tdm0.rx.fsync	P21.5	tdm0.rx.mck	P21.7
tdm0.rx.sck	P21.6	tdm0.rx.sd	P21.4	tdm0.tx.fsync	P12.3
tdm0.tx.mck	P21.3	tdm0.tx.sck	P21.2	tdm0.tx.sd	P21.1
tdm1.rx.fsync	P11.5	tdm1.rx.mck	P11.3	tdm1.rx.sck	P11.4
tdm1.rx.sd	P11.6	tdm1.tx.fsync	P11.1	tdm1.tx.mck	P11.7
tdm1.tx.sck	P11.0	tdm1.tx.sd	P11.2	trace.clock	P4.3/SMIF1.3, P20.0
trace.data0	P4.4/SMIF1.4, P20.4	trace.data1	P4.5/SMIF1.5, P20.3	trace.data2	P4.6/SMIF1.6, P20.2
trace.data3	P4.7/SMIF1.7, P20.1	trig0.in0	P11.0	trig0.in1	P11.1
trig0.in2	P11.2	trig0.in3	P11.3	trig0.in4	P7.5
trig0.in5	P7.6	trig0.in6	P7.7	trig0.in7	P8.0
trig0.out0	P7.0	trig0.out1	P7.1	trig1.in0	P11.0
trig1.in1	P11.1	trig1.in2	P11.2	trig1.in3	P11.3
trig1.in4	P7.5	trig1.in5	P7.6	trig1.in6	P7.7
trig1.in7	P8.0	trig1.out0	P7.0	trig1.out1	P7.1
wco_in	P18.1	wco_out	P18.0		

8 Electrical specifications

Specifications are valid for $-40^{\circ}\text{C} \leq \text{TA} \leq 105^{\circ}\text{C}$, and $1.71\text{ V} \leq \text{VDDD} \leq 1.89\text{ V}$, except where noted. Typical values measured at 25°C .

8.1 Absolute maximum ratings

Table 17 Absolute maximum ratings

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SID3	Supply for SRSS	VDDD	-0.5	-	2.4	V	Absolute Maximum
SID4	Current per GPIO	IGPIO_ABS	-25	-	25	mA	Absolute Maximum
SID5	GPIO injection current per pin	IGPIO_injection	-0.5	-	0.5	mA	Absolute Maximum
SID3A	Electrostatic discharge Human Body Model	ESD_HBM	2000	-	-	V	Absolute Maximum
SID4A	Electrostatic discharge Charged Device Model	ESD_CDM	500	-	-	V	Absolute Maximum
SID5A	Pin current for latchup free operation	LU	-100	-	100	mA	Absolute Maximum
SIDWA1	DC supply for the VBAT supply	VBAT	-0.5	-	5.5	V	Absolute Maximum
SIDWA2a	DC supply voltage for digital I/O	VDDIO	-0.5	-	2.4	V	Absolute Maximum
SIDWA2b	DC supply voltage for high voltage digital I/O	VDDIO6	-0.5	-	4.1	V	Absolute Maximum
SIDWA7	DC supply voltage for core	VCCD	-0.5	-	1.2	V	Absolute Maximum
SIDWA8	Maximum undershoot voltage for I/O	Vundershoot	-	-	-0.5	V	Duration not to exceed 25% of the duty cycle
SIDWA9	Maximum overshoot voltage for I/O	Vovershoot	-	-	VDDIO+0.5	V	Duration not to exceed 25% of the duty cycle
SIDWA10	Maximum junction temperature	Tj	-	-	125	$^{\circ}\text{C}$	

8.2 Device-level specifications

8.2.1 Device power summary

Two summary graphs are provided for both System Active and System Deep Sleep + System Hibernate power modes. The graphs are plotted from this datasheet's battery-powered current specifications, adjusted to show the most common operating regions. Supply-powered graphs are very similar and are not included; the only differences are minor core regulator efficiency variations.

8 Electrical specifications

System Active frequencies are shown for a subset of the most common operating configurations across HP and LP core power modes, with and without PD1 enabled. CPU clock frequencies in HP and LP core power modes also decrease linearly to 1 MHz but are truncated for chart clarity. All device-level current specifications are provided at two operating frequencies, allowing other operating frequencies to be calculated linearly across the operating range. CPU active workloads are Dhrystone unless otherwise specified.

The CPU clock frequency in the graph is the higher of the CM33 or CM55 clock frequencies. If the CM55 is disabled, the clock frequency is the fastest clock in the PD1 power domain. If both CM33 and CM55 are active, the CM33 frequency is half the CM55 frequency.

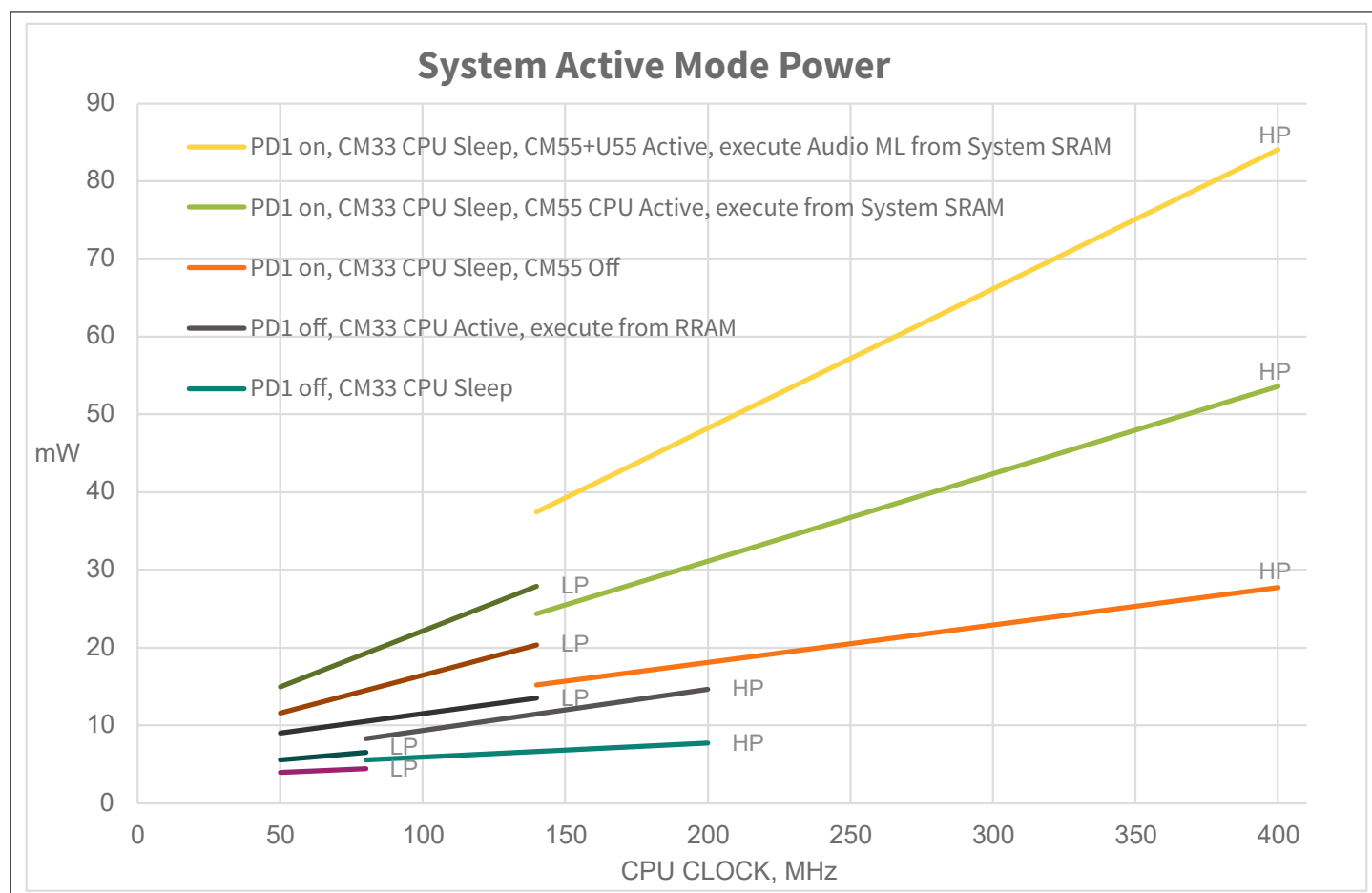


Figure 19 System active mode power consumption graph

System Deep Sleep power is graphed across the total amount of memory retained on the device in SRAM. SRAM in PD0 can be retained in 64 KB blocks, system SRAM in PD1 can be retained in 512 KB blocks, and CM55 TCM (512 KB of SRAM) is always retained when CM55 is enabled. System Deep Sleep-OFF and System Hibernate power modes do not retain any SRAM and are shown as points on the graph.

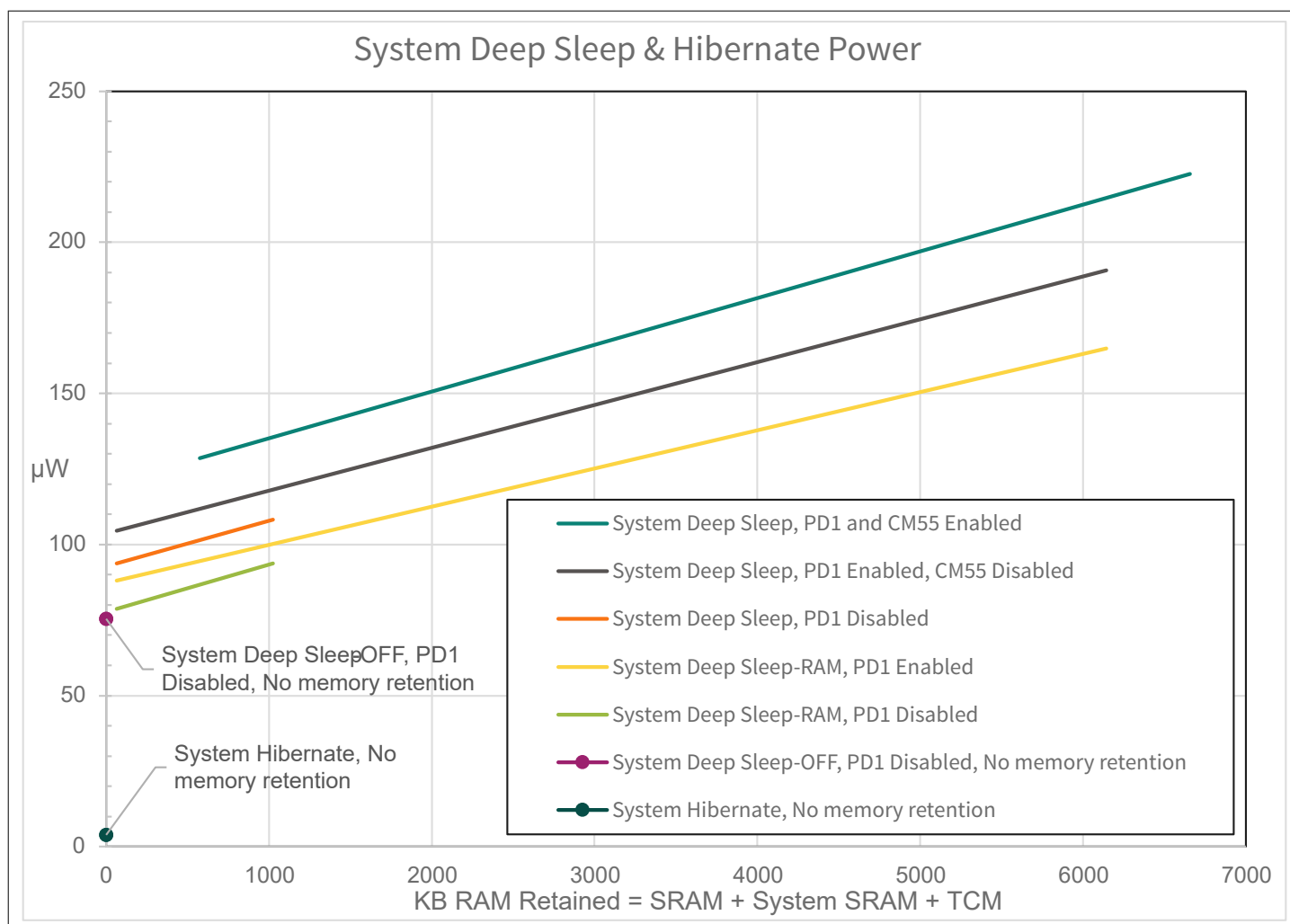


Figure 20 System deep sleep and hibernate mode power consumption graph

8.2.2 Power supplies

Table 18 Supplies

Spec ID	Description	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SID10	External regulator voltage (VCCD) bypass	CEFC	3.8	4.7	5.6	μF	X5R ceramic or better; Value for 0.8 to 1.2 V
SID11	Power supply decoupling capacitor	CEXC	-	10	-	μF	X5R ceramic or better
SID11LDO	LDO bypass capacitor	CLDO	0.8	1	1.2	μF	For all LDO outputs; 0.5 to 1.0 V
SIDWA12I	Ambient temperature (TA) for industrial operation		-40	-	105	$^{\circ}\text{C}$	
SIDWA13	Storage temperature		-40	-	125	$^{\circ}\text{C}$	
SIDWA14	Relative humidity for storage		-	-	60	%	

(table continues...)

Table 18 (continued) Supplies

Spec ID	Description	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDWA15	Relative humidity for operation		-	-	85	%	
SIDWA16	DC supply voltage for VBAT	VBAT	2.7	3.3	4.8	V	
SIDWA17	DC supply voltage for core	VCCD	0.7	0.8	0.9	V	
SIDWA18	VDDD externally regulated	VDDD	1.71	1.8	1.89	V	Either VBAT or VDDD is used
SIDWA19	DC supply voltage for digital I/O	VDDIO	1.71	1.8	1.89	V	
SIDWA19A	DC supply voltage for high voltage digital I/O	VDDIO6	2.97	3.3	3.63	V	VDDIO6 when used as 3.3 V GPIO
SIDWA19B	DC supply voltage for 1.8 V usage	VDDIO6	1.71	1.8	1.89	V	VDDIO6 when used as 1.8 V GPIO
SIDWA20	Analog supply voltage	VDDA	1.71	1.8	1.89	V	
SIDWA21	USB supply voltage	VDDUSB	3.07	3.3	3.63	V	

8.2.3 Power measurement configurations

Supply-powered devices require only a single VDD supply at 1.8 V supply while battery-powered devices require a 2.7 V – 4.8 V supply to VBAT and 1.8 V supply to VDD. Specifications are provided for both supply-powered devices with VDDD = 1.8 V and battery-powered devices with VBAT = 3.3 V and VDDD = 1.8 V. Supply-powered devices include the core regulator input current (VDD.1P8 pin) in the VDDD measurement while battery-powered devices list core regulator input current separately as VBAT (VBAT pin). Specification IDDD current includes current from the following pins: VDDD, VDDQ, VDD.BAT, VDD.DSI, VDDA, and VDD.1P8 (supply-powered only). All VDDIO [0:8, SMIF0, SMIF1] are measured separately and reported in the GPIO specification section.

All System Active, System Deep Sleep, and System Hibernate current specifications use the same base configuration defined here. Additions to the base configuration are also specified. Deviations unique to specific specifications are listed in the respective Description sections of the specification table. Condition deviations unique to specific specifications override any previously defined base or additional conditions. Final specification conditions are the sum of the base configuration, the appropriate core voltage configuration, and the appropriate common PD0 + PD1 power configuration. Then apply any specification specific changes listed in the respective Description section. Power state is defined as On or Off, clock resources are defined as Enabled or Disabled.

Base configuration:

Resource	State	Description
Core regulator	On	Required for core power
Core regulator power mode	High Power	Required for System Active operation
Source clock	50 MHz IHO	On device clock source
Clock path CLK_PATH[0,2,3] source	IHO	Route IHO to DPLL inputs and bypass path
DPLL_HP0 state	Disabled	Not used for specification conditions
DPLL_LP0 state	Enabled	DPLL active

8 Electrical specifications

Resource	State	Description
DPLL_LP0 source	IHO	DPLL clock source is IHO
DPLL_LP0 frequency	Greater of CM33 or CM55 condition frequency	DPLL output frequency is lowest to meet CPU frequency(s) in specification CM33 and CM55 columns
DPLL_LP1 state	Disabled	Not required for base conditions
clk_hf[0,1,2,3] divider source	DPLL_LP0	Root clock dividers source set to DPLL_LP0 output
clk_hf[1,2,3] divider	1	Clk_hf output frequency = input
clk_hf[0]	Enabled	SYSCPUSS and CM33 root clock
clk_hf[3]	Disabled	SoCMEM root clock
clk_hf[4:13] state	Disabled	Peripherals clock gated at root clocks
SYS_MMIO0 (PERIO_GR0_SL_CTL)	Enable all except DEBUG, M0SECCPUSS, CRYPTO	Enable clocks for all individual SYSCPUSS CM33 resources
SYS_MMIO1 (PERIO_GR1_SL_CTL)	Enable only HSIOM, GPIO	Enable GPIO required resource clocks but no peripheral clocks
SYS_MMIO[2:5] (PERIO_GR[2:5]_SL_CTL)	Disable all	Peripherals clock gated
APP_MMIO[1,3] (PERI1_GR[1,3]_SL_CTL)	Disable all	Peripherals clock gated
APP_MMIO[4] (PERI1_GR4_SL_CTL)	Enable all	Enable CM55 ITCM and DTCM clock source
CM33 cache	Enabled	Enable clock and use CM33 cache
CM55 caches	Enabled	Enable clock and use CM55 caches
CM33 and CM55 CPU active test load	Dhrystone	Standard CPU test load
DMA	Disabled	DMA masters unavailable and clock gated
Debug Access Ports (DAP)	Off	Debug unavailable and powered down
Code execution	RRAM	All code is executed from RRAM unless otherwise stated
RRAM state	Sleep	RRAM in low power state. Can not access.
All peripherals	Off	Peripheral power is listed separately in respective sections
All unlisted settings	Default state	See register TRM for POR values
External Flash device	Quad SPI	Infineon S25HS512 device

Configuration additions

System HP (High Performance) mode, VCCD core = 0.9 V:

Resource	State	Description
Power Mode	System HP	High Performance

System LP (Low Power) mode, VCCD core = 0.8 V:

8 Electrical specifications

Resource	State	Description
Power Mode	System LP	Low Power

PD0 = On, PD1 = Off:

Resource	State	Description
PD0	On	Low power domain powered
PD1	Off	High power domain not powered
clk_hf[0] divider	1	SYSCPUSS CM33 clock frequency same as source
clk_hf[1] state	Disabled	APPCPUSS CM55 root clock gated
clk_hf[2] state	Disabled	SoCMEM root clock gated
APP_MMIO0 (PERI1_GR0_SL_CTL)	All disabled	Disable clocks for all individual APPCPUSS CM55 resources
APP_MMIO2 (PERI1_GR2_SL_CTL)	All disabled	Disable clocks for U55 and SoCMEM
CM55 power	Off	CM55 CPU powered down
U55 power	Off	U55 CPU powered down

PD0 = On, PD1 = On:

Resource	State	Description
PD0	On	Low power domain powered
PD1	On	High power domain powered
clk_hf[0] divider	2	SYSCPUSS CM33 clock frequency ½ of source
clk_hf[1] state	Enabled	APPCPUSS CM55 root clock running
clk_hf[2] state	Enabled	SoCMEM CM55 root clock running
APP_MMIO0 (PERI1_GR0_SL_CTL)	All enabled	Enable clocks for all individual APPCPUSS CM55 resources
APP_MMIO2 (PERI1_GR2_SL_CTL)	Enable only SoCMEM	Enable SoCMEM clock and disable U55 clock
CM55 power	On	CM55 CPU powered
U55 power	Off	U55 CPU powered down

8.2.4 Device current specification organization

The device current specifications are categorized into six tables, grouped by core regulator configuration (battery- or supply-powered) and system power modes (Active HP, LP, and Deep Sleep + Hibernate). Each Active table is organized in the same format with the same specifications to aid in comparing power modes. Every System Active specification provides two clock frequency points, supporting linear interpolation of any frequency in the operating range.

8 Electrical specifications

	Battery-powered VBAT = 3.3 V, VDDD = 1.8 V	Supply-powered VDDD = 1.8 V
Active HP	System HP active mode: CPU current in battery-powered configuration	System HP active mode: CPU current in supply-powered configuration
Active LP	System LP active mode: CPU current in battery-powered configuration	System LP active mode: CPU current in supply-powered configuration
Deep Sleep Hibernate	System deep sleep and hibernate mode: CPU current in battery-powered configuration	System deep sleep and hibernate mode: CPU current in supply-powered configuration

Active power tables are organized into two main sections based on the state of PD1.

PD0 = On (Low power domain), PD1 = Off (High performance domain)

CM33 CPU Sleep

CM33 Active, execute from RRAM, RRAM enabled

CM33 Active, execute while(1) from SRAM

CM33 Active, execute from SRAM

PD0 = On (Low power domain), PD1 = On (High performance domain)

CM33 CPU Sleep, CM55 + U55 Off

CM33 Active, execute external Flash octal SPI, CM55 + U55 Off

CM33 CPU Sleep, CM55 CPU Sleep, U55 Off

CM33 CPU Sleep, CM55 + U55 CPU Sleep

CM33 CPU Sleep, CM55 Active execute from RRAM

CM33 CPU Sleep, CM55 Active execute while(1) from System SRAM

CM33 CPU Sleep, CM55 Active execute from System SRAM

CM33 CPU Sleep, CM55 Active execute from TCM

CM33 CPU Sleep, CM55 Active execute from external Flash octal SPI

CM33 Active execute from SRAM, CM55 Active execute from System SRAM

CM33 CPU Sleep, CM55+U55 Active execute ML from System SRAM

8.2.4.1 System HP active mode: CPU current in battery-powered configuration

Table 19 CPU currents, system HP active mode, battery-powered configuration, VBAT = 3.3 V, VDDD = 1.8 V

Spec ID	Description	CM33 (MHz)	CM55 (MHz)	IBAT		IDDD		Units
				Typical	Max 105°C	Typical	Max 105°C	

System HP (High Performance) mode (See condition details above), VCCD = 0.9 V

PD0 = On (Low Power Domain), PD1 = Off (High Performance Domain) (See condition details above)

CM33 CPU Sleep (RRAM)

SIDH00A		160	-	1.7	9.2	0.7	1.3	mA
---------	--	-----	---	-----	-----	-----	-----	----

(table continues...)

Table 19 (continued) CPU currents, system HP active mode, battery-powered configuration, VBAT = 3.3 V, VDDD = 1.8 V

Spec ID	Description	CM33 (MHz)	CM55 (MHz)	IBAT		IDDD		Units
				Typical	Max 105°C	Typical	Max 105°C	
SIDH00B		70	-	1.2	8.7	0.8	1.4	mA
CM33 Active, execute from RRAM, RRAM enabled								
SIDH01A		160	-	3.4	11.1	0.7	1.3	mA
SIDH01B		70	-	1.9	9.5	0.8	1.4	mA
CM33 Active, execute while(1) from SRAM, DPLL_LP0 = Disabled, clk_hf[0,1,2] source = CLK_PATH3, clk_hf[0] divider = 16								
SIDH02B		3.1	-	0.9	7.6	0.2	0.4	mA
CM33 Active, execute from SRAM								
SIDH03A		160	-	3.7	10.8	0.5	0.9	mA
SIDH03B		70	-	2.1	9.3	0.6	1.0	mA
PD0 = On (Low Power Domain), PD1 = On (High Performance Domain) (See condition details above)								
CM33 CPU Sleep, CM55 + U55 Off								
SIDH10A		160	320	6.8	27.8	0.9	1.6	mA
SIDH10B		70	140	4.1	25.2	0.9	1.7	mA
CM33 Active, execute external Flash octal SPI, SMIF = enabled, SMIF cache disabled, CM55 + U55 Off, clk_hf[3] = Enabled, APP_MMIO1 = Only SMIF enabled, APP_MMIO2 = Disable SOCMEM								
SIDH11A		160	320	10.3	32.8	2.1	3.7	mA
SIDH11B		70	140	5.7	28.6	1.8	3.1	mA
CM33 CPU Sleep, CM55 CPU Sleep, U55 Off								
SIDH12A		160	320	7.7	33.6	0.9	1.7	mA
SIDH12B		70	140	4.8	29.9	0.9	1.9	mA
CM33 CPU Sleep, CM55 + U55 CPU Sleep, U55 = Enabled, APP_MMIO2 = Enable SOCMEM and U55								
SIDH13A		160	320	8.0	43.5	0.9	1.7	mA
SIDH13B		70	140	4.9	40.1	0.9	1.7	mA
CM33 CPU Sleep, CM55 Active execute from RRAM, U55 Off, RRAM enabled								
SIDH14A		160	320	12.8	48.4	0.9	1.7	mA
SIDH14B		70	140	7.0	41.4	0.9	1.7	mA
CM33 CPU Sleep, CM55 Active execute while(1) from System SRAM, U55 Off, DPLL_LP0 = Disabled, clk_hf[0,1,2] source = CLK_PATH3, clk_hf[0,1,2] divider = 16								
SIDH15B		3.1	3.1	2.6	40.2	0.3	3.0	mA

CM33 CPU Sleep, CM55 Active execute from System SRAM, U55 Off

(table continues...)

Table 19 (continued) CPU currents, system HP active mode, battery-powered configuration, VBAT = 3.3 V, VDDD = 1.8 V

Spec ID	Description	CM33 (MHz)	CM55 (MHz)	IBAT		IDDD		Units
				Typical	Max 105°C	Typical	Max 105°C	
SIDH16A		160	320	13.1	41.4	0.7	1.4	mA
SIDH16B		70	140	7.0	35.9	0.7	1.4	mA
CM33 CPU Sleep, CM55 Active execute from System SRAM, System SRAM = 240 MHz, U55 Off, DPLL_LP1 = Enabled, DPLL_LP1 freq = 240 MHz, clk_hf[2] source = DPLL_LP1								
SIDH17A		160	320	13.6	45.7	1.0	2.1	mA
CM33 CPU Sleep, CM55 Active execute from TCM, U55 Off								
SIDH18A		160	320	13.2	41.6	0.7	1.4	mA
SIDH18B		70	140	7.1	35.2	0.7	1.4	mA
CM33 CPU Sleep, CM55 Active execute from external Flash octal SPI, SMIF = enabled, SMIF cache disabled, U55 Off, clk_hf[3] = Enabled, APP_MMIO1 = Only SMIF enabled								
SIDH19A		160	320	14.9	42.0	2.2	3.6	mA
SIDH19B		70	140	7.9	34.9	1.9	3.1	mA
CM33 Active execute from SRAM, CM55 Active execute from System SRAM, U55 Off								
SIDH20A		160	320	13.2	41.6	0.7	1.9	mA
SIDH20B		70	140	7.1	35.2	0.7	2.0	mA
CM33 CPU Sleep, CM55+U55 Active execute EMBCC AudioMark from System SRAM, U55 = Enabled, APP_MMIO2 = Enable SOCMEM and U55								
SIDH21A		160	320	19.9	43.7	2.3	3.5	mA
SIDH21B		70	140	10.2	33.1	2.1	3.1	mA

8.2.4.2 System LP active mode: CPU current in battery-powered configuration

Table 20 CPU currents, system LP active mode, battery-powered configuration, VBAT = 3.3 V, VDDD = 1.8 V

Spec ID	Description	CM33 (MHz)	CM55 (MHz)	IBAT		IDDD		Units
				Typical	Max 105°C	Typical	Max 105°C	

System LP (Low Power) mode, VCCD = 0.8 V

PD0 = On (Low Power Domain), PD1 = Off (High Performance Domain)

CM33 CPU Sleep

(table continues...)

8 Electrical specifications

Table 20 (continued) CPU currents, system LP active mode, battery-powered configuration, VBAT = 3.3 V, VDDD = 1.8 V

Spec ID	Description	CM33 (MHz)	CM55 (MHz)	IBAT		IDDD		Units
				Typical	Max 105°C	Typical	Max 105°C	
SIDL00B		70	-	0.9	7.2	0.7	1.3	mA
SIDL00C		50	-	0.8	7.1	0.7	1.3	mA
CM33 Active, execute from RRAM, RRAM enabled								
SIDL01B		70	-	1.5	8.0	0.7	1.3	mA
SIDL01C		50	-	1.3	7.6	0.7	1.3	mA
CM33 Active, execute while(1) from SRAM, DPLL_LP0 = Disabled, clk_hf[0,1,2] source = CLK_PATH3, clk_hf[0] divider = 16								
SIDL02B		3.1	-	0.6	7.4	0.2	0.3	mA
CM33 Active, execute from SRAM								
SIDL03B		70	-	1.6	6.8	0.4	0.8	mA
SIDL03C		50	-	1.3	6.5	0.4	0.8	mA
PD0 = On (Low Power Domain), PD1 = On (High Performance Domain)								
CM33 CPU Sleep, CM55 + U55 Off								
SIDL10B		70	140	3.7	28.0	0.7	1.3	mA
SIDL10C		50	50	2.4	26.5	0.6	1.2	mA
CM33 Active, execute external Flash octal SPI, SMIF = enabled, SMIF cache disabled, CM55 + U55 Off, clk_hf[3] = Enabled, APP_MMIO1 = Only SMIF enabled, APP_MMIO2 = Disable SOCMEM								
SIDL11B		70	140	4.6	27.4	1.7	2.7	mA
SIDL11C	clk_hf[0] divider = 1	50	50	3.8	31.5	1.5	2.4	mA
CM33 CPU Sleep, CM55 CPU Sleep, U55 Off								
SIDL12B		70	140	3.7	28.0	0.7	1.3	mA
SIDL12C	clk_hf[0] divider = 1	50	50	2.4	26.5	0.6	1.2	mA
CM33 CPU Sleep, CM55 + U55 CPU Sleep, U55 = Enabled, APP_MMIO2 = Enable SOCMEM and U55								
SIDL13B		70	140	3.9	29.4	0.7	3.3	mA
SIDL13C	clk_hf[0] divider = 1	50	50	2.6	27.8	0.6	1.2	mA
CM33 CPU Sleep, CM55 Active execute from RRAM, U55 Off, RRAM enabled								
SIDL14B		70	140	5.7	34.0	0.7	1.3	mA
SIDL14C	clk_hf[0] divider = 1	50	50	3.1	31.1	0.6	1.1	mA
CM33 CPU Sleep, CM55 Active execute while(1) from System SRAM, U55 Off, DPLL_LP0 = Disabled, clk_hf[0,1,2] source = CLK_PATH3, clk_hf[0,1,2] divider = 16								
SIDL15B		3.1	3.1	1.7	26.7	0.2	0.4	mA

(table continues...)

Table 20 (continued) CPU currents, system LP active mode, battery-powered configuration, VBAT = 3.3 V, VDDD = 1.8 V

Spec ID	Description	CM33 (MHz)	CM55 (MHz)	IBAT		IDDD		Units
				Typical	Max 105°C	Typical	Max 105°C	
CM33 CPU Sleep, CM55 Active execute from System SRAM, U55 Off								
SIDL16B		70	140	5.9	32.8	0.5	0.9	mA
SIDL16C	clk_hf[0] divider = 1	50	50	3.3	28.3	0.4	0.8	mA
CM33 CPU Sleep, CM55 Active execute from System SRAM, System SRAM = 110 MHz, U55 Off, DPLL_LP1 = Enabled, DPLL_LP1 freq = 110 MHz, clk_hf[2] source = DPLL_LP1								
CM33 CPU Sleep, CM55 Active execute from TCM, U55 Off								
SIDL18B		70	140	5.8	28.1	0.5	0.8	mA
SIDL18C	clk_hf[0] divider = 1	50	50	3.1	25.1	0.4	1.2	mA
CM33 CPU Sleep, CM55 Active execute from external Flash octal SPI, SMIF = enabled, SMIF cache disabled, U55 Off, clk_hf[3] = Enabled, APP_MMIO1 = Only SMIF enabled								
SIDL19B		70	140	6.5	33.1	1.7	2.7	mA
SIDL19C	clk_hf[0] divider = 1	50	50	3.3	28.5	1.6	2.3	mA
CM33 Active execute from SRAM, CM55 Active execute from System SRAM, U55 Off								
SIDL20B		70	140	5.7	29.6	0.6	0.9	mA
SIDL20C	clk_hf[0] divider = 1	50	50	3.2	26.5	0.5	0.9	mA
CM33 CPU Sleep, CM55+U55 Active execute EMBCC AudioMark from System SRAM, U55 = Enabled, APP_MMIO2 = Enable SOCMEM and U55								
SIDL21B		70	140	7.3	21.7	2.1	2.8	mA
SIDL21C	clk_hf[0] divider = 1	50	50	3.7	18.1	1.5	2.0	mA

8.2.4.3 System deep sleep and hibernate mode: CPU current in battery-powered configuration

Table 21 CPU currents, system deep sleep and hibernate mode, battery-powered configuration, VBAT = 3.3 V, VDDD = 1.8 V

Spec ID	Description	IBAT		IDDD		Units
		Typical	Max 105°C	Typical	Max 105°C	
Deep Sleep Mode - Core buck regulator enabled, VDDIO currents not included, VCCD = 0.7 V						
SIDDSA	System Deep Sleep, 64 KB SRAM retention, PD1 Disabled	26.1	454.8	4.2	28.7	µA

(table continues...)

8.2.4.4 System HP active mode: CPU current in supply-powered configuration

Table 22 CPU currents, system HP active mode, supply-powered configuration, VDDD = 1.8 V

Spec ID	Description	CM33 (MHz)	CM55 (MHz)	IDDD		Units
				Typical	Max 105°C	

System HP (High Performance) mode (See condition details above), VCCD = 0.9 V

PD0 = On (Low Power Domain), PD1 = Off (High Performance Domain) (See condition details above)

CM33 CPU Sleep

SIDH00A		160	-	4.3	15.7	mA
SIDH00B		70	-	3.0	14.4	mA
SIDH00C		50	-	2.7	14.2	mA

CM33 Active, execute from RRAM, RRAM enabled

SIDH01A		160	-	8.2	20.3	mA
SIDH01B		70	-	4.3	16.2	mA
SIDH01C		50	-	3.7	15.6	mA

CM33 Active, execute while(1) from SRAM, DPLL_LP0 = Disabled, clk_hf[0,1,2] source = CLK_PATH3, clk_hf[0] divider = 16

SIDH02B		3.1	-	1.8	14.4	mA
---------	--	-----	---	-----	------	----

CM33 Active, execute from SRAM

SIDH03A		160	-	7.4	19.7	mA
SIDH03B		70	-	4.4	17.7	mA
SIDH03C		50	-	3.7	15.8	mA

PD0 = On (Low Power Domain), PD1 = On (High Performance Domain) (See condition details above)

CM33 CPU Sleep, CM55 + U55 Off

SIDH10A		160	320	13.7	76.8	mA
SIDH10B		70	140	8.6	54.4	mA
SIDH10C		50	140	5.9	52.3	mA

CM33 Active, execute external Flash octal SPI, SMIF = enabled, SMIF cache disabled, CM55 + U55 Off, clk_hf[3] = Enabled, APP_MMIO1 = Only SMIF enabled, APP_MMIO2 = Disable SOCMEM

SIDH11A		160	320	21.5	60.3	mA
SIDH11B		70	140	12.5	51.5	mA

CM33 CPU Sleep, CM55 CPU Sleep, U55 Off

SIDH12A		160	320	15.7	92.2	mA
SIDH12B		70	140	9.8	71.6	mA

CM33 CPU Sleep, CM55 + U55 CPU Sleep, U55 = Enabled, APP_MMIO2 = Enable SOCMEM and U55

(table continues...)

Table 22 (continued) CPU currents, system HP active mode, supply-powered configuration, VDDD = 1.8 V

Spec ID	Description	CM33 (MHz)	CM55 (MHz)	IDDD		Units
				Typical	Max 105°C	
SIDH13A		160	320	16.3	94.6	mA
SIDH13B		70	140	10.0	57.1	mA
CM33 CPU Sleep, CM55 Active execute from RRAM, U55 Off, RRAM enabled						
SIDH14A		160	320	26.2	92.1	mA
SIDH14B		70	140	13.9	61.3	mA
CM33 CPU Sleep, CM55 Active execute while(1) from System SRAM, U55 Off, DPLL_LP0 = Disabled, clk_hf[0,1,2] source = CLK_PATH3, clk_hf[0,1,2] divider = 16						
SIDH15B		3.1	3.1	5.2	45.7	mA
CM33 CPU Sleep, CM55 Active execute from System SRAM, U55 Off						
SIDH16A		160	320	26.2	92.1	mA
SIDH16D	clk_hf[0] divider=5	64	320	25.1	80.8	mA
SIDH16B		70	140	14.5	85.1	mA
CM33 CPU Sleep, CM55 Active execute from System SRAM, System SRAM = 240 MHz, U55 Off, DPLL_LP1 = Enabled, DPLL_LP1 freq = 240 MHz, clk_hf[2] source = DPLL_LP1						
SIDH17A		160	320	29.4	112.6	mA
CM33 CPU Sleep, CM55 Active execute from TCM, U55 Off						
SIDH18A		160	320	26.3	82.8	mA
SIDH18B		70	140	14.2	71.9	mA
CM33 CPU Sleep, CM55 Active execute from external Flash octal SPI, SMIF = enabled, SMIF cache disabled, U55 Off, clk_hf[3] = Enabled, APP_MMIO1 = Only SMIF enabled						
SIDH19A		160	320	30.5	80.8	mA
SIDH19B		70	140	16.9	66.3	mA
CM33 Active execute from SRAM, CM55 Active execute from System SRAM, U55 Off						
SIDH20A		160	320	26.9	84.0	mA
SIDH20B		70	140	14.7	70.9	mA
CM33 CPU Sleep, CM55+U55 Active execute EMBCC AudioMark from System SRAM, U55 = Enabled, APP_MMIO2 = Enable SOCMEM and U55						
SIDH21B		70	140	21.6	89.5	mA

8.2.4.5 System LP active mode: CPU current in supply-powered configuration

Table 23 CPU currents, system LP active mode, supply-powered configuration, VDDD = 1.8 V

Spec ID	Description	CM33 (MHz)	CM55 (MHz)	IDDD		Units
				Typical	Max 105°C	
System LP (Low Power) mode, VCCD = 0.8 V						
PD0 = On (Low Power Domain), PD1 = Off (High Performance Domain)						
CM33 CPU Sleep						
SIDL00B		70	-	2.2	9.7	mA
SIDL00C		50	-	2.0	9.5	mA
CM33 Active, execute from RRAM, RRAM enabled						
SIDL01B		70	-	3.2	10.8	mA
SIDL01C		50	-	2.7	10.4	mA
CM33 Active, execute while(1) from SRAM, DPLL_LP0 = Disabled, clk_hf[0,1,2] source = CLK_PATH3, clk_hf[0] divider = 16						
SIDL02B		3.1	-	1.1	8.3	mA
CM33 Active, execute from SRAM						
SIDL03B		70	-	3.1	10.5	mA
SIDL03D	DPLL=70 MHz, clk_hf[0] divider = 2	35	-	2.2	9.8	mA
SIDL03C		50	-	2.6	10.1	mA
PD0 = On (Low Power Domain), PD1 = On (High Performance Domain)						
CM33 CPU Sleep, CM55 + U55 Off						
SIDL10B		70	140	5.6	36.8	mA
SIDL10C		50	50	3.9	35.0	mA
CM33 Active, execute external Flash octal SPI, SMIF = enabled, SMIF cache disabled, CM55 + U55 Off, clk_hf[3] = Enabled, APP_MMIO1 = Only SMIF enabled, APP_MMIO2 = Disable SOCMEM						
SIDL11B		70	140	8.8	46.6	mA
SIDL11C	clk_hf[0] divider = 1	50	50	7.4	46.9	mA
CM33 CPU Sleep, CM55 CPU Sleep, U55 Off						
SIDL12B		70	140	6.4	48.3	mA
SIDL12C	clk_hf[0] divider = 1	50	50	4.4	48.1	mA
CM33 CPU Sleep, CM55 + U55 CPU Sleep, U55 = Enabled, APP_MMIO2 = Enable SOCMEM and U55						
SIDL13B		70	140	6.6	42.7	mA
SIDL13C	clk_hf[0] divider = 1	50	50	4.5	43.5	mA
CM33 CPU Sleep, CM55 Active execute from RRAM, U55 Off, RRAM enabled						
(table continues...)						

Table 23 (continued) CPU currents, system LP active mode, supply-powered configuration, VDDD = 1.8 V

Spec ID	Description	CM33 (MHz)	CM55 (MHz)	IDDD		Units
				Typical	Max 105°C	
SIDL14B		70	140	9.2	47.2	mA
SIDL14C	clk_hf[0] divider = 1	50	50	5.4	44.0	mA
CM33 CPU Sleep, CM55 Active execute while(1) from System SRAM, U55 Off, DPLL_LP0 = Disabled, clk_hf[0,1,2] source = CLK_PATH3, clk_hf[0,1,2] divider = 16						
SIDL15B		3.1	3.1	2.9	39.1	mA
CM33 CPU Sleep, CM55 Active execute from System SRAM, U55 Off						
SIDL16B		70	140	9.5	51.6	mA
SIDL16C	clk_hf[0] divider = 1	50	50	5.4	43.8	mA
CM33 CPU Sleep, CM55 Active execute from TCM, U55 Off						
SIDL18B		70	140	9.2	44.0	mA
SIDL18C	clk_hf[0] divider = 1	50	50	5.3	45.0	mA
CM33 CPU Sleep, CM55 Active execute from external Flash octal SPI, SMIF = enabled, SMIF cache disabled, U55 Off, clk_hf[3] = Enabled, APP_MMIO1 = Only SMIF enabled						
SIDL19B		70	140	11.8	54.3	mA
SIDL19C	clk_hf[0] divider = 1	50	50	6.8	54.5	mA
CM33 Active execute from SRAM, CM55 Active execute from System SRAM, U55 Off						
SIDL20B		70	140	13.1	51.9	mA
SIDL20C	clk_hf[0] divider = 1	50	50	5.9	40.8	mA
CM33 CPU Sleep, CM55+U55 Active execute EMBCC AudioMark from System SRAM, U55 = Enabled, APP_MMIO2 = Enable SOCMEM and U55						
SIDL21B		70	140	16.2	90.2	mA
SIDL21C	clk_hf[0] divider = 1	50	50	8.8	90.4	mA

8.2.4.6 System deep sleep and hibernate mode: CPU current in supply-powered configuration

Table 24 CPU currents, system deep sleep and hibernate mode, supply-powered configuration, VDDD = 1.8 V

Spec ID	Description	IDDD		Units
		Typical	Max 105°C	

Deep Sleep Mode - Core buck regulator enabled, VDDIO currents not included, VCCD = 0.7 V
(table continues...)

Table 24 (continued) CPU currents, system deep sleep and hibernate mode, supply-powered configuration, VDDD = 1.8 V

Spec ID	Description	IDDD		Units
		Typical	Max 105°C	
SIDDSA	System Deep Sleep, 64 KB SRAM retention, PD1 Disabled	46.3	744.7	µA
SIDDSB	System Deep Sleep, 512 KB SRAM retention, PD1 Disabled	49.8	812.3	µA
SIDDDSC	System Deep Sleep, 1 M SRAM retention, PD1 Disabled	53.9	889.0	µA
SIDDSG	System Deep Sleep, 64 KB SRAM retention, PD1 Enabled, CM55 Disabled	51.8	935.2	µA
SIDDSH	System Deep Sleep, 64 KB SRAM + 512 KB System SRAM retention, PD1 Enabled, CM55 Disabled	55.9	1027.1	µA
SIDDDSD	System Deep Sleep, 64 KB SRAM + 1024 KB System SRAM+TCM retention, PD1 and CM55 Enabled	72.9	1442.7	µA
SIDDDSE	System Deep Sleep, 64 KB SRAM + 5.5 MB System SRAM+TCM retention, PD1 and CM55 Enabled	106.4	2225.9	µA
SIDDSF	System Deep Sleep, 1 MB SRAM + 5.5 MB System SRAM+TCM retention, PD1 and CM55 Enabled	114.5	2168.8	µA
SIDDSRA	System Deep Sleep-RAM, 64 KB SRAM retention, PD1 Disabled	37.9	636.5	µA
SIDDSRD	System Deep Sleep-RAM, 1 M SRAM retention, PD1 Disabled	46.1	811.8	µA
SIDDSRB	System Deep Sleep-RAM, 64 KB SRAM + 512 KB System SRAM, PD1 Enabled	46.8	840.1	µA
SIDDSRC	System Deep Sleep-RAM, 64 KB SRAM + 5.0 MB System SRAM retention, PD1 Enabled	80.2	1615.0	µA
SIDDSO	System Deep Sleep-OFF, PD1 Disabled	36.1	615.3	µA

Hibernate Mode - VDDIO currents not included

SIDHIBA	No Clocks	1.8	23.2	µA
SIDHIBB	ILO+WDT	2.9	24.5	µA
SIDHIBC	WCO+RTC	1.9	24.1	µA

8.2.5 Root clock divider frequencies

Table 25 Root clock divider frequencies

High frequency root clock divider output frequencies						
Spec ID	Parameter	Min	Max			Unit
			HP	LP	ULP	
SIDHF0	CLK_HF[0] – SYSCPUSS, CM33	0	160	80	N/A	MHz
SIDHF1	CLK_HF[1] – APPCPUSS, GFXSS (GPU, DC, and MIPI DSI), CM55, U55	0	320	140	N/A	MHz
SIDHF2	CLK_HF[2] - SoCMEM	0	240	110	N/A	MHz
SIDHF3	CLK_HF[3] – SMIF[0]	0	320	200	N/A	MHz
SIDHF4	CLK_HF[4] – SMIF[1]	0	320	200	N/A	MHz
SIDHF5	CLK_HF[5] – SDHC[0], Ethernet	0	166	104	N/A	MHz
SIDHF6	CLK_HF[6] – SDHC[1], Ethernet	0	166	104	N/A	MHz
SIDHF7	CLK_HF[7] – I2S, TDM, PDM	0	80	50	N/A	MHz
SIDHF8	CLK_HF[8] - USB	0	40	50	N/A	MHz
SIDHF9	CLK_HF[9] – Analog, DACs	0	80	50	N/A	MHz
SIDHF10	CLK_HF[10] – SCB[0, 2-11], CAN, TCPWMs, SMARTI/O	0	80	40	N/A	MHz
SIDHF11	CLK_HF[11] – SCB[1], I3C	0	160	80	N/A	MHz
SIDHF12	CLK_HF[12] – MIPI DSI D-PHY PLL reference clock	0	51	N/A	N/A	MHz
SIDHF13	CLK_HF[13] – I3C	0	100	60	N/A	MHz

8.2.6 Power mode transition times

Table 26 Power mode transition times

Spec ID	Description	Parameter	Min	Typ	Max	Unit
Power mode transition times						
SID13B1	System HP to LP transition time	THP_LP	-	65	78	μs
SID13B6	System LP to HP transition time	TLP_HP	-	49	62	μs
SID13A2	System Deep Sleep to Active LP transition time	TDS_ACT	-	27	28	μs
SID13A3	System Deep Sleep to Active HP transition time	TDS_ACT	-	28	40	μs
SID14A	System Deep Sleep-RAM to Active transition time	TDSR_ACT	-	25.5	-	ms

(table continues...)

Table 26 (continued) Power mode transition times

Spec ID	Description	Parameter	Min	Typ	Max	Unit
SID14B	System Deep Sleep-OFF to Active transition time	TDSO_AC T	-	25.5	-	ms
SID14	System Hibernate to Active transition time	THIB_AC T	-	25.5	-	ms

8.2.7 Estimation of device power

Device power can be estimated for any combination of CM33, CM55, and peripherals using the datasheet specifications and the following method. Because PD0 and the CM33 are always powered, extra steps are required to remove the baseline PD0 (CM33) current contribution from PD1 (CM55) specifications when PD1 is powered on. To assist in removing the baseline PD0 current contribution, most PD1 on specifications set the CM33 to CPU Sleep mode, enabling this known condition to be subtracted out. Battery-powered core power estimation is performed the same as supply-powered core estimation by performing each step twice, once for each supply rail (VBAT and VDDD). Typical power calculations are shown with an example.

Supply-powered core, System HP power mode, CM33 active, executing at 100 MHz from RRAM, PD1 on with CM55 Active and U55 off, executing at 250 MHz from System SRAM, and two TCPWMs with 25 MHz input clocks.

1. Calculate PD0 (CM33) operating condition current
 - a. Perform linear interpolation of PD1 = Off and CM33 operating condition
 - Operating condition = PD0 on, PD1 off, CM33 Active, execute from SRAM
 - SIDH03A (CM33 200 MHz) = 8.8 mA
 - SIDH03B (CM33 70 MHz) = 4.4 mA
 - Interpolate at 100 MHz = 5.4 mA
 - b. If PD1 = Off, skip to [Step 6](#)
 - c. If PD1 = On, continue to [Step 2](#)
2. Calculate PD0 (CM33) + PD1 (CM55) combined operating condition current
 - a. Perform linear interpolation of PD1 = On, CM55/U55 operating condition.
 - Operating condition = PD0 on, PD1 on, CM33 CPU Sleep, CM55 Active execute from System SRAM, U55
 - SIDH16A (CM55 400 MHz) = 32.9 mA
 - SIDH16B (CM55 140 MHz) = 14.5 mA
 - Interpolate at 250 MHz = 22.3 mA
3. Calculate PD0 (CM33) portion of the combined PD0 (CM33) + PD1 (CM55) current in [Step 2](#)
 - a. Calculate the CM33 frequency at half of the CM55 frequency used in [Step 2](#)
 - CM55 freq = 250 MHz/2 = 125 MHz
 - b. Perform linear interpolation of PD1 = Off, CM33 CPU Sleep, operating condition. This is the standard CM33 state in most CM55 specs.
 - Operating condition = PD0 on, PD1 Off, CM33 CPU Sleep
 - SIDH00A (CM33 200 MHz) = 4.3 mA
 - SIDH00B (CM33 70 MHz) = 3.0 mA
 - Interpolate at 125 MHz = 3.6 mA

8 Electrical specifications

4. Calculate current contribution from only PD1 (CM55) by subtracting PD0 (CM33) portion ([Step 3](#)) from PD0 (CM33) + PD1 (CM55) combined current ([Step 2](#))
 - a. Subtract PD0 (CM33) current value of [Step 3](#) from [Step 2](#).
 - $22.3 \text{ mA} - 3.6 \text{ mA} = 18.7 \text{ mA}$
5. Add back in PD0 (CM33) current contribution at CM33 operating condition ([Step 1](#))
 - a. Add current values from [Step 1](#) and [Step 4](#)
 - $5.4 \text{ mA} + 18.7 \text{ mA} = 24.1 \text{ mA}$
6. Calculate peripheral and additional system resource current contributions
 - a. For each enabled peripheral, calculate its current contribution. Scale or interpolate as appropriate
 - Two TCPWMs at 25 MHz input clock
 - SIDTCPWM3H (100 MHz) = 540 μA
 - SID N/A (0 MHz) = 0 μA
 - Interpolate at 25 MHz = 135 μA
 - $2 * 135 \mu\text{A} = 270 \mu\text{A} = 0.3 \text{ mA}$
7. Add peripheral currents to system core current
 - a. If PD1 = Off
 - Add [Step 1](#) to [Step 6](#)
 - b. If PD1 = On
 - Add [Step 5](#) to [Step 6](#)
 - $24.1 \text{ mA} + 0.3 \text{ mA} = 24.4 \text{ mA}$
8. Convert current to power (Optional)
 - a. If system powered core regulator
 - Power = $I_{\text{DDD}} * 1.8 \text{ V}$
 - $24.4 \text{ mA} * 1.8 \text{ V} = 43.9 \text{ mW}$
 - b. If battery-powered core regulator
 - Power = $(I_{\text{DDD}} * 1.8 \text{ V}) + (I_{\text{BAT}} * V_{\text{BAT}})$

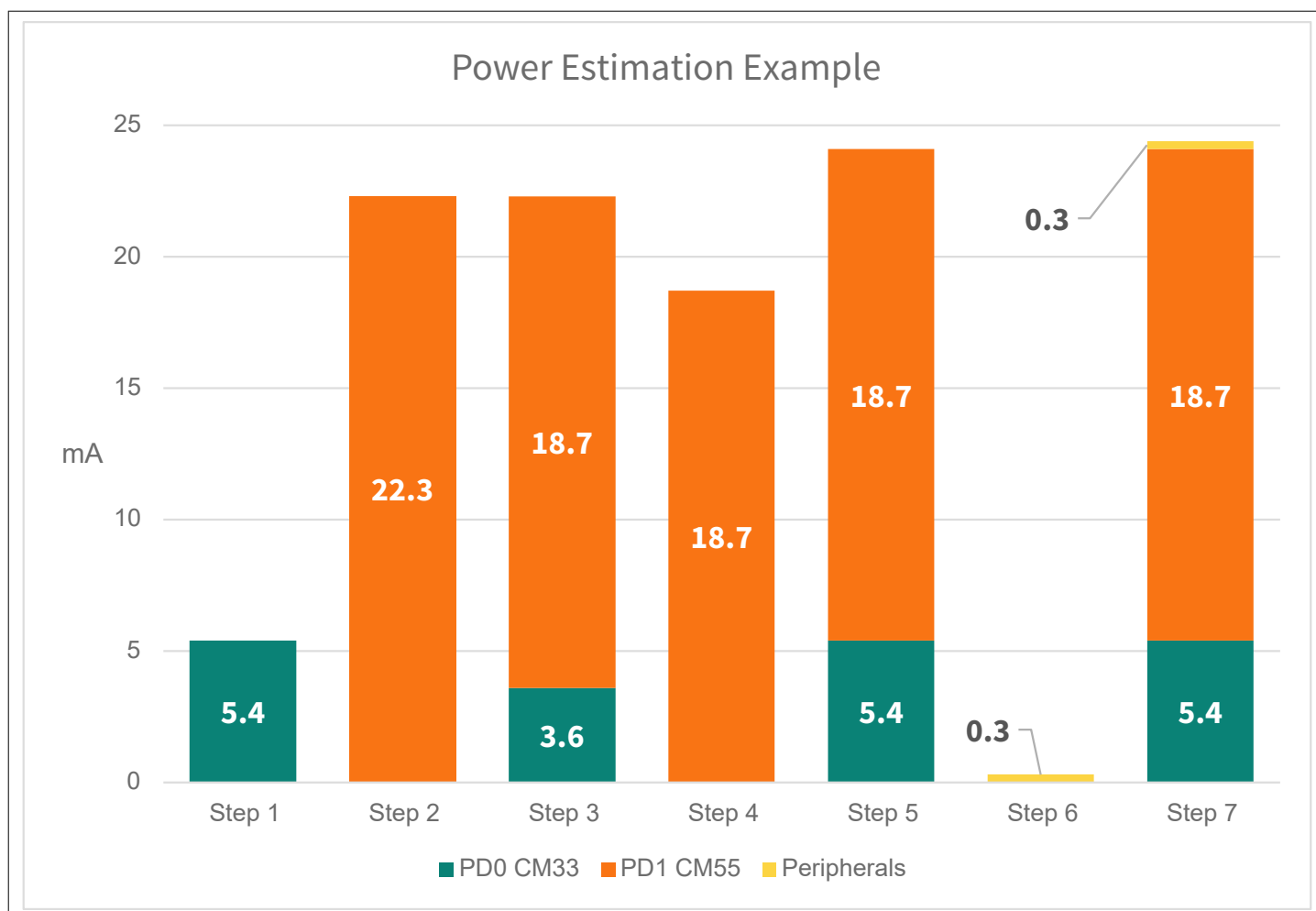


Figure 21 Power estimation example

8.2.8 XRES

Table 27 XRES

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		

XRES (Active Low) Specifications

XRES AC Specifications

SID15	POR or XRES release to Active transition time	TXRESACT	-	25.5	-	ms	From XRES release to start of Extended Boot. Does not include required Extended Boot (Cold Boot).
SID16	XRES Pulse width	TXRESPW	5	-	-	μs	
SID16P	Time to establish valid voltage levels before XRES Release	TXRESPWR	60	-	-	μs	

Extended Boot AC - From start of extended boot to start of main.c (table continues...)

Table 27 (continued) XRES

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SID15A	Non secure boot	TEXBOOT	-	29	-	ms	No authentication of initial OEM code
SID15B	Secure boot. 100 KB internal	TEXBOOT	-	200	-	ms	Authenticate initial OEM code in RRAM
SID15C	Secure boot. 100 KB external	TEXBOOT	-	217	-	ms	Authenticate initial OEM code in Octal SPI Flash
SID15D	Secure boot. 5 MB external	TEXBOOT	-	932	-	ms	Authenticate initial OEM code in Octal SPI Flash

XRES DC Specifications

SID17A	IBAT when XRES asserted	TXRESIBAT	-	0.3	-	μA	Battery-powered configuration (VBAT = 3.3 V, VDDD = 1.8 V)
	IDDD when XRES asserted	TXRESIDDD	-	1.1	-	μA	
	IDDD when XRES asserted	TXRESIDDD	-	1.2	-	μA	Supply-powered configuration (VDDD = 1.8 V)
SID77	Input Voltage high threshold	VIH	0.7*VDD	-	-	V	CMOS Input
SID78	Input Voltage low threshold	VIL	-	-	0.3*VDD	V	CMOS Input
SID80	Input Capacitance	CIN	-	3	-	pF	
SID81	Input voltage hysteresis	VHYSXRES	-	100	-	mV	
SID82	Current through protection diode to VDD/Vss	DIODE	-	-	100	μA	

8.2.9 GPIO

Table 28 GPIO

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		

1.8 V GPIO Specifications

GPIO DC Specifications

SID57	Input Voltage high threshold	VIH	0.7*VDD	-	-	v	CMOS Input
SID57A	Input current when Pad > VDDIO for OVT inputs	lihs	-	-	10	μA	per 1°C Spec
SID58	Input Voltage low threshold	VIL	-	-	0.3*VDD	V	CMOS Input
SID59	Output Voltage high level	VOH	VDD-0.5	-	-	V	Ioh = 8 mA
SID62A	Output Voltage low level	VOL	-	-	0.4	V	Iol = 8 mA
SID63	Pull-up resistor	RPULLUP	-	50	-	kΩ	

(table continues...)

8 Electrical specifications

Table 28 (continued) GPIO

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SID64	Pull-down resistor	RPULLDOWN	-	50	-	kΩ	
SID65	Input leakage current(absolute value)	IL	-	-	2	nA	25°C, VDD = 3.0 V
SID66	Input Capacitance	CIN	-	-	5	pF	
SID68	Input hysteresis CMOS	VHYSCMOS	0.05*VDD	-	-	mV	
SID69	Current through protection diode to VDD/VSS	DIODE	-	-	100	C	
SID69A	Maximum Total Source or Sink Chip Current	ITOTGPIO	-	-	200	mA	

GPIO AC Specifications

SID70	Rise time in Fast Strong Mode. 10% to 90% of VDD	TRISEF	-	-	2.5	ns	Load = 15 pF, 8 mA drive strength
SID71	Fall time in Fast Strong Mode. 10% to 90% of VDD	TFALLF	-	-	2.5	ns	Load = 15 pF, 8 mA drive strength
SID73G	Fall time (30% to 70% of VDD) in Slow Strong mode	TFALL12C	20*VDDIO/5.5	-	250	ns	Load = 10 pF to 400 pF, 8 mA drive strength
SID74	GPIO Fout. Fast Strong mode	FGPIOUT1	-	-	100	MHz	90/10%, 15 pF load, 60/40 duty cycle
SID75	GPIO Fout. Slow Strong mode	FGPIOUT2	-	-	5	MHz	90/10%, 15 pF load, 60/40 duty cycle
SID76	GPIO Fout. Fast Strong mode	FGPIOUT3	-	-	100	MHz	90/10%, 25 pF load, 60/40 duty cycle
SID245	GPIO Fout. Slow Strong mode	FGPIOUT4	-	-	5	MHz	90/10%, 25 pF load, 60/40 duty cycle
SID246	GPIO input operating frequency. 1.71 V ≤ VDDIO ≤ 1.89 V	FGPIOIN	-	-	100	MHz	90/10% Vio

1.8 V HS GPIO Specifications

GPIO DC Specifications

SID57HS	Input Voltage high threshold	VIH	0.7*VDD	-	-	V	CMOS Input
SID57AHS	Input current when Pad > VDDIO for OVT inputs	lihs	-	-	10	μA	per 1 ² C Spec
SID58HS	Input Voltage low threshold	VIL	-	-	0.3*VDD	V	CMOS Input
SID59HS	Output Voltage high level	VOH	VDD-0.5	-	-	V	Ioh = 8 mA
SID62AHS	Output Voltage low level	VOL	-	-	0.4	V	Iol = 8 mA
SID63HS	Pull-up resistor	RPULLUP	-	50	-	kΩ	

(table continues...)

8 Electrical specifications

Table 28 (continued) GPIO

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SID64HS	Pull-down resistor	RPULLDOWN	-	50	-	kΩ	
SID65HS	Input leakage current (absolute value)	IIL	-	-	2	nA	25°C, VDD=3.0 V
SID66HS	Input Capacitance	CIN	-	-	5	pF	
SID68HS	Input hysteresis CMOS	VHYSCMOS	0.05*VDD	-	-	mV	
SID69HS	Current through protection diode to VDD/VSS	IDIODE	-	-	100	μA	
SID69AHS	Maximum Total Source or Sink Chip Current	ITOTGPIO	-	-	200	mA	

GPIO AC Specifications

SID70HS	Rise time in Fast Strong Mode. 10% to 90% of VDD	TRISEF	-	-	1.2	ns	Load = 15 pF, 8 mA drive strength
SID71HS	Fall time in Fast Strong Mode. 10% to 90% of VDD	TFALLF	-	-	1.2	ns	Load = 15 pF, 8 mA drive strength
SID74HS	GPIO Fout. Fast Strong mode	FGPIOUT1	-	-	208	MHz	90/10%, 15 PF load, 60/40 duty cycle
SID76HS	GPIO Fout. Fast Strong mode	FGPIOUT3	-	-	208	MHz	90/10%, 25 PF load, 60/40 duty cycle
SID246HS	GPIO input operating frequency. 1.71 V<=VDD<=1.89 V	FGPIOIN	-	-	208	MHz	90/10% Vio

3.3 V GPIO Specifications

GPIO DC Specifications

SID57H	Input Voltage high threshold	VIH	0.7*VDD	-	-	V	CMOS Input
SID57AH	Input current when Pad > VDDIO for OVT inputs	lihs	-	-	10	μA	per 1 ² C Spec
SID58H	Input Voltage low threshold	VIL	-	-	0.3*VDD	V	CMOS Input
SID59H	Output Voltage high level	VOH	VDD-0.5	-	-	V	Ioh = 8 mA
SID62AH	Output Voltage low level	VOL	-	-	0.4	V	Iol = 8 mA
SID63H	Pull-up resistor	RPULLUP	-	50	-	kΩ	
SID64H	Pull-down resistor	RPULLDOWN	-	50	-	kΩ	
SID65H	Input leakage current (absolute value)	IIL	-	-	2	nA	25°C, VDD=3.0 V
SID66H	Input Capacitance	CIN	-	-	5	pF	
SID68H	Input hysteresis CMOS	VHYSCMOS	0.05*VDD	-	-	mV	
SID69H	Current through protection diode to VDD/VSS	DIODE	-	-	100	μA	

(table continues...)

8 Electrical specifications

Table 28 (continued) GPIO

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SID69AH	Maximum Total Source or Sink Chip Current	ITOT_GPIO	-	-	200	mA	

GPIO AC Specifications

SID70H	Rise time in Fast Strong Mode. 10% to 90% of VDD	TRISEF	-	-	5	ns	Load = 15 pF, 8 mA drive strength
SID71H	Fall time in Fast Strong Mode. 10% to 90% of VDD	TFALLF	-	-	5	ns	Load = 15 pF, 8 mA drive strength
SID74H	GPIO Fout. Fast Strong mode	FGPIOUT1	-	-	50	MHz	90/10%, 15 pF load, 60/40 duty cycle
SID75H	GPIO Fout, Slow Strong mode	FGPIOUT2	-	-	0.8	MHz	90/10%, 15 pF load, 60/40 duty cycle
SID76H	GPIO Fout. Fast Strong mode	FGPIOUT3	-	-	50	MHz	90/10%, 25 pF load, 60/40 duty cycle
SID245H	GPIO Fout. Slow Strong mode	FGPIOUT4	-	-	0.8	MHz	90/10%, 25 pF load, 60/40 duty cycle
SID246H	GPIO input operating frequency. 1.71 V ≤ VDD ≤ 3.6 V	FGPIOIN	-	-	50	MHz	90/10% Vio

8.3 Analog peripherals

8.3.1 Autonomous analog specifications

Table 29 Autonomous analog specifications

Spec ID	Description	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDW39	Analog Supply Voltage	VDD18	1.71	1.8	1.89	V	
SIDW40a	Current Consumption for VAD (PTComp + CTB Opamp + ADC, 12b-16 ksps)	ITOT-Audio	-	100	-	μA	SAR running at 16 ksps, dutycycled in the system Deep Sleep mode. FIFO is storing 10 ms of data from SAR. Op Amp, PTComp and references plus clocks enabled

(table continues...)

Table 29 (continued) Autonomous analog specifications

Spec ID	Description	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDW41	Power Down Current for the Autonomous Analog	IleakLPPASS	-	1	-	μA	All blocks off, 25°C, 1.8 V VDDA, 0.7 V Vccd
SIDW54b	Start Up time of Autonomous Analog from power down	Tstart Up	-	25	-	μs	Startup time of sub-blocks not included

8.3.2 LP Comparator

Table 30 LP Comparator

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		

LP Comparator DC Specifications

SID84	Input offset voltage for COMPI. Normal power mode	VOFFSET1	-5	-	5	mV	
SID85A	Input offset voltage. Low-power mode	VOFFSET2	-10	-	10	mV	
SID85B	Input offset voltage. Ultra low-power mode	VOFFSET3	-10	-	10	mV	
SID86	Hysteresis when enabled in Normal mode	VHYST1	-	-	60	mV	
SID86A	Hysteresis when enabled in Low-power mode	VHYST2	-	-	80	mV	
SID87	Input common mode voltage in Normal mode	VICM1	0	-	VDDIO1 -0.1	V	
SID247	Input common mode voltage in Low power mode	VICM2	0	-	VDDIO1 -0.1	V	
SID247A	Input common mode voltage in Ultra low power mode	VICM3	0	-	VDDIO1 -0.1	V	
SID88	Common mode rejection ratio in Normal power mode	CMRR	50	-	-	dB	
SID88A	Power Supply Rejection Ratio ≤ 500 kHz	PSRR	55	-	-	dB	
SID89	Block Current, Normal mode	ICMP1	-	-	150	μA	
SID248	Block Current, Low power mode	ICMP2	-	-	10	μA	
SID259	Block Current in Ultra low power mode	ICMP3	-	0.3	0.85	μA	
SID90	DC Input impedance of comparator	ZCMP	35	-	-	MΩ	

LPComparator AC Specifications

(table continues...)

Table 30 (continued) LP Comparator

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SID91	Response time, Normal mode, 100 mV overdrive	TRESP1	-	-	100	ns	
SID258	Response time, Low power mode, 100 mV overdrive	TRESP2	-	-	1000	ns	
SID92	Response time, Ultra-low power mode, 100 mV overdrive	TRESP3	-	-	7	μs	
SID92E	Time from Enabling to operation	TCMPEN1	-	-	10	μs	Normal and Lowpower modes
SID92F	Time from Enabling to operation	TCMPEN2	-	-	50	μs	Ultra low-power mode

8.3.3 ADC

Table 31 ADC

Spec ID	Description	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDW45	Numerical resolution of ADC results	Res	12	-	20	bits	With accumulation (oversampling)
SIDW52a	Conversion Rate of ADC in HS mode, continous conversion of one channel	CR1	-	-	4	Msp/s	Sequential sampling, 80 MHz Fclk
SIDW52b	Conversion Rate of ADC in HS mode, continous conversion of four channels with simultaneous sampling	CR2	-	-	5	Msp/s	Simultaneous Sampling Mode
SIDW52c	Conversion Rate of ADC in LP mode (system Deep Sleep mode), continous conversion of one channel	CR3	-	-	200	ksps	Sample Rate in Deep Sleep
SIDW47b	Clock of ADC in HS mode (available only in system Active mode)	ADCClkHF	4.1	-	80	MHz	
SIDW47a	Clock of ADC in LP mode (available in system Deep Sleep mode)	ADCClkLP	-	4.1	-	MHz	1% clock accuracy

Input from GPIOs, ADC unbuffered (Buffers bypassed)

SIDAD000	Average current from VDDA for ADC in HS mode, all channels	IDDA_HS	-	-	3.05	mA	
SIDAD002	Average VDDA current for ADC in LP mode, 100% duty cycled	IDDA_LP	-	-	410	μA	

(table continues...)

8 Electrical specifications

Table 31 (continued) ADC

Spec ID	Description	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDW42	Differential input voltage range of LP ADC	VDIFFSAR	-VREF	-	VREF	V	VREF of SAR ADC is in range 0.9 V to VDDA
SIDW43	Input common mode voltage of HS/LP ADC	VICMSAR	-	-	VDDA	V	Switched Capacitor frontend can hold 0 to Vdda.
SIDAD005	Input leakage current of ADC in HS mode while sampling	ip_leak_hs	-	-	450	nA	
SIDAD006	INL of ADC in HS mode	INL_hs	-2	-	2	LSBs	
SIDAD007	DNL of ADC in HS mode	DNL_hs	-1	-	2	LSBs	
SIDAD008	Analog offset of ADC in HS mode, calibrated	ofst_hs	-1	-	1	mV	
SIDAD009	Gain error of ADC in HS mode, with internal bandgap reference (VBGR, 0.9 V)	gerr_hs	-1	-	1	%	
SIDAD011	Input leakage current of ADC in LP mode while sampling	ip_leak_lp	-350	-	350	nA	
SIDAD012	INL of ADC in LP mode	INL_lp	-2	-	2	LSBs	
SIDAD013	DNL of ADC in LP mode	DNL_lp	-1	-	2	LSBs	
SIDAD014	Analog offset of ADC in LP mode, calibrated	ofst_lp	-1	-	1	mV	
SIDAD015	Gain error of ADC in LP mode, with internal bandgap reference (VBGR, 0.9 V)	gerr_lp	-1	-	1	%	
SIDW50a	SINAD of ADC in HS mode, VDDA as reference, 4 Msps, 80 MHz clock	SINADHF1 2b	-	63	-	dB	10 kHz sine wave input
SIDW50c	SINAD of ADC in HS mode, with VDDA as the reference, 125 ksps with 32 samples accumulated (16 b), 80 MHz clock	SINADHF1 6b	-	75	-	dB	10 kHz sine wave input

Input from GPIOs, ADC buffered (Buffer in Low, Rail to Rail power mode)

SIDAD022	Average current from VDDA for ADC in HS mode, one channel	IDDA_HS	-	-	3.2	mA	
SIDAD024	Average current from VDDA for ADC in LP mode, 100% duty cycled	IDDA_LP	-	-	650	μA	

8 Electrical specifications

Table 31 (continued) ADC

Spec ID	Description	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDAD026	Average current from VDDA for ADC in LP mode, 16 ksps, duty cycled	IDDA_LP_16 ksps	-	-	50	µA	
SIDW40b	Average current from VDDA for ADC in LP mode, 1 ksps, duty cycled	ITOT-HRV	-	20	-	µA	4 MHz Oscillator
SIDAD030	Offset voltage of ADC buffer	ofst_buffer	-1	-	1	mV	
SIDAD031	Gain error of ADC buffer	gerr_buffer	-0.1	-	0.1	%	
SIDAD032	Temperature sensor accuracy	temp_acc	-5	-	5	°C	
SIDAD033	Temperature sensor Current from VDDA	temp_idda	-	-	4	µA	
SIDAD035	Input leakage of ADC buffers	ip_leak	-150	-	150	nA	
SIDAD036	INL of ADC in HS mode, with internal bandgap reference (VBGR, 0.9 V)	INL_hs	-2	-	2	LSBs	
SIDAD037	DNL of ADC in HS mode, with internal bandgap reference (VBGR, 0.9 V)	DNL_hs	-1	-	2	LSBs	
SIDAD038	Analog offset of ADC in HS mode and buffer combined	ofst_chan_hs	-2	-	2	mV	
SIDAD039	Gain error of ADC in HS mode and buffer combined, with internal bandgap reference (VBGR, 0.9 V)	gerr_chan_hs	-1	-	1	%	
SIDAD040	Gain error of ADC in HS mode and buffer combined, with external (off-chip) reference	gerr_chan_hs_ext	-1	-	1	%	
SIDAD041	INL of ADC in LP mode, with internal bandgap reference (VBGR, 0.9 V)	INL_lp	-2	-	2	LSBs	
SIDAD042	DNL of ADC in LP mode, with internal bandgap reference (VBGR, 0.9 V)	DNL_lp	-1	-	2	LSBs	
SIDAD043	Analog offset of ADC in LP mode and buffer combined	ofst_chan_lp	-2	-	2	mV	
SIDAD044	Gain error of ADC in LP mode and buffer combined, with internal bandgap reference (VBGR, 0.9 V)	gerr_chan_lp	-1	-	1	%	

(table continues...)

Table 31 (continued) ADC

Spec ID	Description	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDAD045	Gain error of ADC in LP mode and buffer combined, with external (off-chip) reference	gerr_chan_lp_ext	-1	-	1	%	
SIDAD046	Startup time of ADC channel buffers	t_buff_startup	-	5	-	μS	
SIDAD047	Settling time at input of ADC, differential input swing from VDDA-400 mV to VDDA+400 mV	t_settle	-	2	-	μS	
SIDAD048	Temperature sensor startup time, from enabled to settled at ADC input	temp_startup	-	15	-	μS	

Bandgap reference specs

SIDW46	Bandgap reference voltage (VBGR)	VREF	-	0.9	-	V	With an accuracy of +/- 1%
SIDAD064	Current from VDDA for the bandgap reference	IDD_VBG	-	25	50	μA	
SIDAD065	Percentage variation of the bandgap voltage at room temperature, with respect to VDDA, trimmed (Vmax-Vmin)/Vtyp x 100	VBG_VDD	-0.3	-	0.3	%	
SIDAD066	Bandgap voltage temperature coefficient, trimmed [-40°C,125°C] temp co =(Vmax-Vmin)/{Vnom x (Tmax-Tmin)} x 1E6	VBG_TEM PJ	-	-	40	ppm/°C	

8.3.4 DAC

Table 32 DAC

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SID108D	Numerical Resolution of DAC	DACRES	-	-	12	bits	
SID109D	Settling time of buffered DAC with a 25 pF load capacitance	DACCONV	-	-	2	μs	
SID111D	Maximum Refresh Rate of DAC	DACRate	-	-	1.024	MHz	
SIDDA000	Current from VDDA, unbuffered DAC ("Direct" topologies), VDDA reference	IDDA_ctdac_v ddaref	-	92	133	μA	

(table continues...)

Table 32 (continued) DAC

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDDA001	Current from VDDA, unbuffered DAC ("Direct" topologies), internal bandgap reference (VBGR, 0.9 V)	IDDA_ctdac_vref0p9	-	418	700	μA	
SIDDA002	Current from VDDA buffered DAC (buffer power mode: Medium), VDDA as reference	IDDA_ctdac_buf_vddaref	-	2288	3100	μA	
SIDDA003	Current from VDDA, buffered DAC (buffer power mode: Medium), internal bandgap reference (VBGR, 0.9 V)	IDDA_ctdac_buf_vref0p9	-	2493	3500	μA	
SIDDA004	Average current from VDDA, buffered DAC (buffer power mode: Ultra-Low), 10% duty cycle, Sample and Hold enabled, VDDA reference	IDDA_duty_ctdac_buf_sh_vddaref	-	25	80	μA	
SIDDA005	Average current from VDDA, buffered DAC (buffer power mode: Ultra-Low), 10% duty cycle, Sample and Hold enabled, internal bandgap reference (VBGR, 0.9 V)	IDDA_duty_ctdac_buf_sh_vref0p9	-	448	710	μA	
SIDDA006	Average current from VDDD for DAC	IDDD_dac	-	1	7	μA	
SID111D	Integral Non-Linearity of DAC	DACINL	-4	-	4	LSBs	
SID112D	Differential Non-Linearity of DAC	DACDNL	-2	-	2	LSBs	
SID99D	Offset error with input code = 0x000 unsigned	DACOFFSET	-10	-	10	mV	
SIDDA007	Gain error of unbuffered DAC	GAINERR	-1	-	1	%	
SIDDA008	Gain error of buffered DAC	GAINERR_BUF	-1	-	1	%	
SIDDA009	Output resistance of unbuffered DAC	RO_enable	5	-	16	kΩ	
SID103D	Output impedance of buffered DAC	DACOUTRES	-	-	1	Ω	
SID104D	Value of Sample and Hold capacitors combined	DACCAP	-	-	50	pF	
SIDDA010	Output voltage range of unbuffered DAC	VRANGE	0	-	VDDA	V	
SIDDA011	Output voltage range of buffered DAC, buffer in a "rail to rail" power mode	VRANGE_BUF	0.2	-	VDDA-1 VDDA-0.2*	V	
SIDDA012	DC PSRR of buffered output	PSRR	-	-40	-	dB	

(table continues...)

8 Electrical specifications

Table 32 (continued) DAC

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDDA013	DAC offset (output when input code = 0x000 unsigned, with respect to the VSSA)	Offset	-	-	3	mV	
SIDDA014	Drift in DAC offset across temperature (-40°C to 125°C) at constant code input and VDDA	Offset Drift	-	20	-	μV/C	
SIDDA015	Temperature coefficient of DAC output voltage (mid-scale code) (-40°C to 125°C)	Tempco	-	-	20	V/C	
SIDDA016	Analog output settling time of DAC from disabled state, VDDA reference	tsen_vddaref	-	-	1.4	μs	
SIDDA017	Analog output settling time of DAC from disabled state, internal bandgap reference (VBGR, 0.9 V)	tsen_vre0p9	-	-	1.4	μs	
SIDDA018	Maximum hold time	thold	100	-	-	μs	
SID110D	Wake-Up time (from enabling to ready for conversion)	DACWakeup	-	-	10	μs	

8.3.5 CTBL Op Amp

Table 33 CTBL Op Amp

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		

Current from VDDA for one Opamp, Output driving a pin

SIDOA000	Ultra-Low power mode, input common mode voltage from 0.2 to VDDA-1 V	Idd_ultralow_10x	-	15	45	μA	
SIDOA001	Ultra-Low power mode, Rail-to-Rail inputs, input common mode voltage 0.2 to VDDA-0.2 V	Idd_ultralow_10x	-	35	60	μA	
SIDOA002	Low power mode, Rail-to-Rail inputs, input common mode voltage 0.2 to VDDA-0.2 V	Idd_low_10x	-	150	200	μA	
SIDOA003	Medium power mode, Rail-to-Rail inputs, input common mode voltage 0.2 to VDDA-0.2 V	Idd_med_10x	-	300	350	μA	
SIDOA004	High power mode, Rail-to-Rail inputs, input common mode voltage 0.2 to VDDA-0.2 V	Idd_hi_10x	-	800	920	μA	
SIDOA005	Ultra-High power mode, Rail-to-Rail inputs, input common mode voltage 0.2 to VDDA-0.2 V	Idd_ultraHi_10x	-	1300	1500	μA	

(table continues...)

8 Electrical specifications

Table 33 (continued) CTBL Op Amp

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
Current from VDDA for one Opamp, Internal-drive only							
SIDOA006	Ultra-Low power mode, common mode voltage from 0.2 to VDDA-1 V	Idd_ultralow_1x	-	15	30	μA	
SIDOA007	Ultra-Low power mode, Rail-to-Rail inputs, input common mode voltage 0.2 to VDDA-0.2 V	Idd_ultralow_1x	-	35	60	μA	
SIDOA008	Low power mode, Rail-to-Rail inputs, input common mode voltage 0.2 to VDDA-0.2 V	Idd_low_1x	-	150	200	μA	
SIDOA009	Medium power mode, Rail-to-Rail inputs, input common mode voltage 0.2 to VDDA-0.2 V	Idd_med_1x	-	200	250	μA	
SIDOA010	High power mode, Rail-to-Rail inputs, input common mode voltage 0.2 to VDDA-0.2 V	Idd_hi_1x	-	600	700	μA	
SIDOA011	Ultra-High power mode, Rail-to-Rail inputs, input common mode voltage 0.2 to VDDA-0.2 V	Idd_ultrahi_1x	-	800	1000	μA	
Output Drive Capability, Driving a pin							
SIDOA012	Ultra-Low power mode, output 200 mV from rail , output voltage change <2 mV	Iout_max_ultralow_10x	-	-	10	μA	
SIDOA013	Low power mode, output 200 mV from rail, output voltage change <1 mV	Iout_max_low_10x	-	-	100	μA	
SIDOA014	Medium power mode, output 200 mV from rail, output voltage change <1 mV	Iout_max_med_10x	-	-	500	μA	
SIDOA015	High power mode, output 200 mV from rail, output voltage change <1 mV	Iout_max_hi_10x	-	-	1000	μA	
SIDOA016	Ultra-High power mode, output 200 mV from rail, ,output voltage change <1 mV	Iout_max_ultrahi_10x	-	-	10000	μA	
Output Drive Capability, Internal-Drive only							
SIDOA017	Ultra-Low power mode, output 200 mV from rail , output voltage change <2 mV	Iout_max_1x_ultralow	-	-	1	μA	
SIDOA018	Low power mode, output 200 mV from rail, output voltage change <1 mV	Iout_max_1x_low	-	-	10	μA	

(table continues...)

Table 33 (continued) CTBL Op Amp

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDOA019	Medium power mode, output 200 mV from rail, output voltage change <1 mV	Iout_max_1x_med	-	-	25	μA	
SIDOA020	High power mode, output 200 mV from rail, output voltage change <1 mV	Iout_max_1x_hi	-	-	100	μA	
SIDOA021	Ultra-High power mode, output 200 mV from rail, output voltage change <1 mV	Iout_max_1x_Ultrahi	-	-	200	μA	

Output Voltage Range

SIDOA022	Ultra-High power mode, output driving pin, 10 mA	Vout_1_10x_10mA_ultrahi	0.5	-	VDDA-0.5	V	
SIDOA023	High power mode, output driving pin, 1 mA	Vout_2_10x_1mA_hi	0.2	-	VDDA-0.2	V	
SIDOA024	Medium power mode, output driving pin, 1 mA	Vout_3_10x_1mA_med	0.2	-	VDDA-0.2	V	
SIDOA025	Low power mode, output driving pin, 0.1 mA	Vout_4_10x_0.1mA_lo	0.2	-	VDDA-0.2	V	

Input Voltage Range

SIDOA026	Input Voltage Range, Ultra-Low power mode	Vin_pump_of	0	-	VDDA-1	V	
SIDOA027	Input Voltage Range, power mode with Rail-to-Rail inputs	Vin_pump_on	0	-	VDDA-0.2	V	

Offset Voltage, trimmed

SIDOA028	Ultra-High power mode, output driving pin	Vos_tr_10x_ultrahi	-1	-	1	mV	
SIDOA029	High power mode, output driving pin	Vos_tr_10x_hi	-1	-	1	mV	
SIDOA030	Medium power mode, output driving pin	Vos_tr_10x_med	-1	-	1	mV	
SIDOA031	Ultra-High power mode, internal drive-only	Vos_tr_1x_ultrahi	-1	-	1	mV	
SIDOA032	High power mode, internal drive-only	Vos_tr_1x_hi	-1	-	1	mV	
SIDOA033	Medium power mode, internal drive-only	Vos_tr_1x_med	-1	-	1	mV	
SIDOA034	Offset trim step, output driving pin	Vos_step_10x_hi	300	-	500	μV	
SIDOA035	Offset trim step, internal drive-only	Vos_step_1x_hi	300	-	500	μV	

(table continues...)

Table 33 (continued) CTBL Op Amp

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
Offset Temperature Drift							
SIDOA036	Output driving pin, Medium power mode	Vos_dr_tr_10x_med	-10	-	10	μV/C	
SIDOA037	Output driving pin, High power mode	Vos_dr_tr_10x_hi	-10	-	10	μV/C	
SIDOA038	Output driving pin, Ultra-High power mode	Vos_dr_tr_10x_Ultrahi	-10	-	10	μV/C	
SIDOA039	Internal drive-only, Medium power mode	Vos_dr_tr_1x_med	-10	-	10	μV/C	
SIDOA040	Internal drive-only, High power mode	Vos_dr_tr_1x_hi	-10	-	10	μV/C	
SIDOA041	Internal drive-only, Ultra-High power mode	Vos_dr_tr_1x_Ultrahi	-10	-	10	μV/C	
Common mode rejection ratio, Rail to Rail inputs (common mode voltage 0.2 to VDDA-0.2 V)							
SIDOA042	Ultra-Low power mode, output driving pin	CMRR_ultralow_10x	-40	-	-	dB	
SIDOA043	Low power mode, output driving pin	CMRR_low_10x	-40	-	-	dB	
SIDOA044	Medium power mode, output driving pin	CMRR_med_10x	-40	-	-	dB	
SIDOA045	High power mode, output driving pin	CMRR_hi_10x	-40	-	-	dB	
SIDOA046	Ultra-High power mode, output driving pin	CMRR_ultrahi_10x	-40	-	-	dB	
SIDOA047	Ultra-Low power mode, internal drive-only	CMRR_ultralow_1x	-40	-	-	dB	
SIDOA048	Low power mode, internal drive-only	CMRR_low_1x	-40	-	-	dB	
SIDOA049	Medium power mode, internal drive-only	CMRR_med_1x	-40	-	-	dB	
SIDOA050	High power mode, internal drive-only	CMRR_hi_1x	-40	-	-	dB	
SIDOA051	Ultra-High power mode, internal drive-only	CMRR_ultrahi_1x	-40	-	-	dB	
SIDOA052	Input leakage current from CTB port pin	Input Leakage	-	2	800	nA	
Power Supply rejection ratio (DC), Rail to Rail inputs (common mode voltage 0.2 to VDDA-0.2 V)							
SIDOA053	Ultra-Low power mode, output driving pin	PSRR_ultralow_10x	-45	-	-	dB	
SIDOA054	Low power mode, output driving pin	PSRR_low_10x	-45	-	-	dB	

(table continues...)

Table 33 (continued) CTBL Op Amp

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDOA055	Medium power mode, output driving pin	PSRR_med_10x	-45	-	-	dB	
SIDOA056	High power mode, output driving pin	PSRR_hi_10x	-45	-	-	dB	
SIDOA057	Ultra-High power mode, output driving pin	PSRR_ultrahi_10x	-45	-	-	dB	
SIDOA058	Ultra-Low power mode, internal drive-only	PSRR_ultralow_1x	-45	-	-	dB	
SIDOA059	Low power mode, internal drive-only	PSRR_low_1x	-45	-	-	dB	
SIDOA060	Medium power mode, internal drive-only	PSRR_med_1x	-45	-	-	dB	
SIDOA061	High power mode, internal drive-only	PSRR_hi_1x	-45	-	-	dB	
SIDOA062	Ultra-High power mode, internal drive-only	PSRR_ultrahi_1x	-45	-	-	dB	

Power Supply rejection ratio at 1 kHz, Rail to Rail inputs (common mode voltage 0.2 to VDDA-0.2 V)

SIDOA063	Ultra-Low power mode, output driving pin	PSRR_ultralow_10x	-45	-	-	dB	
SIDOA064	Low power mode, output driving pin	PSRR_low_10x	-45	-	-	dB	
SIDOA065	Medium power mode, output driving pin	PSRR_med_10x	-45	-	-	dB	
SIDOA066	High power mode, output driving pin	PSRR_hi_10x	-45	-	-	dB	
SIDOA067	Ultra-High power mode, output driving pin	PSRR_ultrahi_10x	-45	-	-	dB	
SIDOA068	Ultra-Low power mode, internal drive-only	PSRR_ultralow_1x	-45	-	-	dB	
SIDOA069	Low power mode, internal drive-only	PSRR_low_1x	-45	-	-	dB	
SIDOA070	Medium power mode, internal drive-only	PSRR_med_1x	-45	-	-	dB	
SIDOA071	High power mode, internal drive-only	PSRR_hi_1x	-45	-	-	dB	
SIDOA072	Ultra-High power mode, internal drive-only	PSRR_ultrahi_1x	-45	-	-	dB	

Open loop Gain, Rail to Rail inputs (common mode voltage 0.2 to VDDA-0.2 V)

SIDOA073	Ultra-Low power mode, output driving pin	Gain_Ultralow_10x	60	-	-	dB	
----------	--	-------------------	----	---	---	----	--

(table continues...)

Table 33 (continued) CTBL Op Amp

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDOA074	Low power mode, output driving pin	Gain_Low_10x	70	-	-	dB	
SIDOA075	Medium power mode, output driving pin	Gain_Med_10x	70	-	-	dB	
SIDOA076	High power mode, output driving pin	Gain_Hi_10x	70	-	-	dB	
SIDOA077	Ultra-High power mode, output driving pin	Gain_UltraHi_10x	70	-	-	dB	
SIDOA078	Ultra-Low power mode, internal drive-only	Gain_UltraloW_1x	60	-	-	dB	
SIDOA079	Low power mode, internal drive-only	Gain_Low_1x	70	-	-	dB	
SIDOA080	Medium power mode, internal drive-only	Gain_Med_1x	70	-	-	dB	
SIDOA081	High power mode, internal drive-only	Gain_Hi_1x	70	-	-	dB	
SIDOA082	Ultra-High power mode, internal drive-only	Gain_UltraHi_1x	70	-	-	dB	

Input voltage noise spectral density at 100 kHz, common mode input voltage at VDDA/2

SIDOA083	Ultra-Low power mode, output driving pin	Vnoise_UltraLow_10x_100k	-	-	200	nV/ √Hz	
SIDOA084	Low power mode, output driving pin	Vnoise_Low_10x_100k	-	-	80	nV/ √Hz	
SIDOA085	Medium power mode, output driving pin	Vnoise_Med_10x_100k	-	-	70	nV/ √Hz	
SIDOA086	High power mode, output driving pin	Vnoise_Hi_10x_100k	-	-	60	nV/ √Hz	
SIDOA087	Ultra-High power mode, output driving pin	Vnoise_UltraHi_10x_100k	-	-	50	nV/ √Hz	
SIDOA088	Ultra-Low power mode, internal drive-only	Vnoise_UltraLow_1x_100k	-	-	500	nV/ √Hz	
SIDOA089	Low power mode, internal drive-only	Vnoise_Low_1x_100k	-	-	80	nV/ √Hz	
SIDOA090	Medium power mode, internal drive-only	Vnoise_Med_1x_100k	-	-	70	nV/ √Hz	
SIDOA091	High power mode, internal drive-only	Vnoise_Hi_1x_100k	-	-	60	nV/ √Hz	
SIDOA092	Ultra-High power mode, internal drive-only	Vnoise_UltraHi_1x_100k	-	-	50	nV/ √Hz	

(table continues...)

Table 33 (continued) CTBL Op Amp

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
Phase Margin, Rail to Rail inputs (common mode voltage 0.2 to VDDA-0.2 V), 50 pF load, Output driving pin							
SIDOA113	Ultra-Low power mode, compensation trim = 1	PM_Ultralow_10x	40	60	-	deg	
SIDOA114	Low power mode, compensation trim = 2	PM_Low_10x	40	60	-	deg	
SIDOA115	Medium power mode, compensation trim = 2	PM_Med_10x	40	60	-	deg	
SIDOA116	High power mode, compensation trim = 2	PM_Hi_10x	40	60	-	deg	
SIDOA117	Ultra-High power mode, compensation trim = 2	PM_Ultrahi_10x	40	60	-	deg	
Phase Margin, Rail to Rail inputs (common mode voltage 0.2 to VDDA-0.2 V), 15 pF load, internal-drive only							
SIDOA118	Ultra-Low power mode,compensation trim = 2	PM_Ultralow_1x	40	60	-	deg	
SIDOA119	Low power mode, compensation trim = 3	PM_Low_1x	40	60	-	deg	
SIDOA120	Medium power mode, compensation trim = 4	PM_Med_1x	40	60	-	deg	
SIDOA121	High power mode, compensation trim = 4	PM_Hi_1x	40	60	-	deg	
SIDOA122	Ultra-High power mode, compensation trim = 5	PM_Ultrahi_1x	40	60	-	deg	
Gain-Bandwidth product (GBW), Rail to Rail inputs common mode voltage 0.2 to VDDA-0.2 V), Output driving pin, 50 pF load							
SIDOA123	Ultra-Low power mode, compensation trim = 1	GBW_Ultralow_10x	0.1	0.15	-	MHz	
SIDOA124	Low power mode, compensation trim = 2	GBW_Low_10x	1.2	1.5	-	MHz	
SIDOA125	Medium power mode, compensation trim = 2	GBW_Med_10x	2.4	3	-	MHz	
SIDOA126	High power mode, compensation trim = 2	GBW_Hi_10x	6	7.5	-	MHz	
SIDOA127	Ultra-High power mode, compensation trim = 2	GBW_Ultrahi_10x	7.5	12	-	MHz	
Gain-Bandwidth product (GBW), Rail to Rail inputs (common mode voltage 0.2 to VDDA-0.2 V), internal-drive only, 15 pF load							
SIDOA128	Ultra-Low power mode, compensation trim = 2	GBW_Ultralow_1x	0.03	0.15	-	MHz	
SIDOA129	Low power mode, compensation trim = 3	GBW_Low_1x	0.35	1.5	-	MHz	

(table continues...)

Table 33 (continued) CTBL Op Amp

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDOA130	Medium power mode, compensation trim = 4	GBW_Med_1x	0.7	3	-	MHz	
SIDOA131	High power mode, compensation trim = 4	GBW_Hi_1x	1.75	7.5	-	MHz	
SIDOA132	Ultra-High power mode, compensation trim = 5	GBW_Ultrahi_1x	2.8	12	-	MHz	

Bandwidth (f3dB) of the PGA (non-inverting) topology, Output Driving pin, input and output common mode voltages 0.2 to VDDA-0.2, compensation capacitors enabled

SIDOA133	Ultra-High power mode, Gain = 2	f3db_2_10x_NI_GND_UltraHI	3	-	-	Mhz	
SIDOA134	Ultra-High power mode, Gain = 4	f3db_4_10x_NI_GND_UltraHI	0.5	-	-	Mhz	
SIDOA135	Ultra-High power mode, Gain = 16	f3db_16_10x_NI_GND_UltraHI	0.086	-	-	Mhz	
SIDOA136	Ultra-High power mode, Gain = 32	f3db_32_10x_NI_GND_UltraHI	0.009	-	-	Mhz	
SIDOA137	High power mode, Gain = 2	f3db_2_10x_NI_GND_HI	3.8	-	-	Mhz	
SIDOA138	High power mode, Gain = 4	f3db_4_10x_NI_GND_HI	0.5	-	-	Mhz	
SIDOA139	High power mode, Gain = 16	f3db_16_10x_NI_GND_HI	0.2	-	-	Mhz	
SIDOA140	High power mode, Gain = 32	f3db_32_10x_NI_GND_HI	0.1	-	-	Mhz	
SIDOA141	Medium power mode, Gain = 2	f3db_2_10x_NI_GND_Med	1.9	-	-	Mhz	
SIDOA142	Medium power mode, Gain = 4	f3db_4_10x_NI_GND_Med	0.4	-	-	Mhz	
SIDOA143	Medium power mode, Gain = 16	f3db_16_10x_NI_GND_Med	0.1	-	-	Mhz	
SIDOA144	Medium power mode, Gain = 32	f3db_32_10x_NI_GND_Med	0.072	-	-	Mhz	
SIDOA145	Low power mode, Gain = 2	f3db_2_10x_NI_GND_Low	1.1	-	-	Mhz	
SIDOA146	Low power mode, Gain = 4	f3db_4_10x_NI_GND_Low	0.3	-	-	Mhz	
SIDOA147	Low power mode, Gain = 16	f3db_16_10x_NI_GND_Low	0.086	-	-	Mhz	

(table continues...)

Table 33 (continued) CTBL Op Amp

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDOAI48	Low power mode, Gain = 32	f3db_32_10x_NI_GND_Low	0.043	-	-	Mhz	
SIDOAI49	Ultra-Low power mode, Gain = 2	f3db_2_10x_NI_GND_UltraLow	0.1	-	-	Mhz	
SIDOAI50	Ultra-Low power mode, Gain = 4	f3db_4_10x_NI_GND_UltraLow	0.043	-	-	Mhz	
SIDOAI51	Ultra-Low power mode, Gain = 16	f3db_16_10x_NI_GND_UltraLow	0.007	-	-	Mhz	
SIDOAI52	Ultra-Low power mode, Gain = 32	f3db_32_10x_NI_GND_UltraLow	0.005	-	-	Mhz	

Bandwidth (f3dB) of the PGA (non-inverting) topology, internal drive-only, input and output common mode voltages 0.2 to VDDA-0.2, compensation capacitors enabled

SIDOAI53	Ultra-High power mode, Gain = 2	f3db_2_1x_NI_GND_UltraHI	0.259	-	-	Mhz	
SIDOAI54	Ultra-High power mode, Gain = 4	f3db_4_1x_NI_GND_UltraHI	0.302	-	-	Mhz	
SIDOAI55	Ultra-High power mode, Gain = 16	f3db_16_1x_NI_GND_UltraHI	0.331	-	-	Mhz	
SIDOAI56	Ultra-High power mode, Gain = 32	f3db_32_1x_NI_GND_UltraHI	0.035	-	-	Mhz	
SIDOAI57	High power mode, Gain = 2	f3db_2_1x_NI_GND_HI	0.554	-	-	Mhz	
SIDOAI58	High power mode, Gain = 4	f3db_4_1x_NI_GND_HI	0.4	-	-	Mhz	
SIDOAI59	High power mode, Gain = 16	f3db_16_1x_NI_GND_HI	0.1	-	-	Mhz	
SIDOAI60	High power mode, Gain = 32	f3db_32_1x_NI_GND_HI	0.005	-	-	Mhz	
SIDOAI61	Medium power mode, Gain = 2	f3db_2_1x_NI_GND_Med	0.454	-	-	Mhz	
SIDOAI62	Medium power mode, Gain = 4	f3db_4_1x_NI_GND_Med	0.3	-	-	Mhz	
SIDOAI63	Medium power mode, Gain = 16	f3db_16_1x_NI_GND_Med	0.065	-	-	Mhz	

(table continues...)

Table 33 (continued) CTBL Op Amp

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDO164	Medium power mode, Gain = 32	f3db_32_1x_NI_GND_Med	0.004	-	-	Mhz	
SIDO165	Low power mode, Gain = 2	f3db_2_1x_NI_GND_Low	0.288	-	-	Mhz	
SIDO166	Low power mode, Gain = 4	f3db_4_1x_NI_GND_Low	0.173	-	-	Mhz	
SIDO167	Low power mode, Gain = 16	f3db_16_1x_NI_GND_Low	0.04	-	-	Mhz	
SIDO168	Low power mode, Gain = 32	f3db_32_1x_NI_GND_Low	0.02	-	-	Mhz	
SIDO169	Ultra-Low power mode, Gain = 2	f3db_2_1x_NI_GND_UltraLow	0.006	-	-	Mhz	
SIDO170	Ultra-Low power mode, Gain = 4	f3db_4_1x_NI_GND_UltraLow	0.029	-	-	Mhz	
SIDO171	Ultra-Low power mode, Gain = 16	f3db_16_1x_NI_GND_UltraLow	0.002	-	-	Mhz	
SIDO172	Ultra-Low power mode, Gain = 32	f3db_32_1x_NI_GND_UltraLow	0.003	-	-	Mhz	

Slew rate (rise and fall), output driving pin, 50 pF load, output voltage transitioning VDDA/2+500 mV to VDDA/2-500 mV

SIDO173	Ultra-Low power mode	SL_Ultralow_10x	0.10	-	-	V/μs	
SIDO174	Low power mode	SL_Low_10x	1.00	-	-	V/μs	
SIDO175	Medium power mode	SL_Med_10x	2.00	-	-	V/μs	
SIDO176	High power mode	SL_Hi_10x	3.00	-	-	V/μs	
SIDO177	Ultra-High power mode	SL_UltraHi_10x	4.00	-	-	V/μs	

Slew rate (rise and fall), internal drive-only, 15 pF load, output voltage transitioning from VDDA/2+500 mV to VDDA/2-500 mV

SIDO178	Ultra-Low power mode	SL_Ultralow_1x	0.03	-	-	V/μs	
SIDO179	Low power mode	SL_Low_1x	0.30	-	-	V/μs	
SIDO180	Medium power mode	SL_Med_1x	0.60	-	-	V/μs	
SIDO181	High power mode	SL_Hi_1x	1.80	-	-	V/μs	
SIDO182	Ultra-High power mode	SL_UltraHi_1x	3.00	-	-	V/μs	

(table continues...)

8 Electrical specifications

Table 33 (continued) CTBL Op Amp

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		

Settling time, output driving pin, 50 pF load, output voltage transitioning from VDDA/2+50 mV to VDDA/2-50 mV

SIDOA183	Ultra-Low power mode	Tsettle_Ultralow_10x	-	-	4000	ns	
SIDOA184	Low power mode	Tsettle_Low_10x	-	-	600	ns	
SIDOA185	Medium power mode	Tsettle_Med_10x	-	-	450	ns	
SIDOA186	High power mode	Tsettle_Hi_10x	-	-	300	ns	
SIDOA187	Ultra-High power mode	Tsettle_Ultrahi_10x	-	-	250	ns	

Settling time, internal drive-only, 15pF load, output voltage transitioning from VDDA/2+50 mV to VDDA/2-50 mV

SIDOA188	Ultra-Low power mode	Tsettle_Ultralow_1x	-	-	5000	ns	
SIDOA189	Low power mode	Tsettle_Low_1x	-	-	1500	ns	
SIDOA190	Medium power mode	Tsettle_Med_1x	-	-	800	ns	
SIDOA191	High power mode	Tsettle_Hi_1x	-	-	400	ns	
SIDOA192	Ultra-High power mode	Tsettle_Ultrahi_1x	-	-	300	ns	

Startup times

SIDOA198	Start up time, output driving a pin, with 50pF load, all power modes	Tstartup_10x	-	-	5000	ns	
SIDOA199	Start up time, internal-drive only, 15pf load, all power modes	Tstartup_1x	-	-	5000	ns	

CTB PGA/Differential PGA Specs

SIDW44	PGA Gain Range (Non-inverting)	PGAGAIN	1.42	-	32		
SIDOA200	PGA Gain Range (Inverting)	PGA_Inv_Gain_Range	0.42	-	31		
SIDOA201	Differential PGA Gain Range	DIFF_Gain_Range	0.42	-	31		

Current from VDDA for PGA (non-inverting) topology, Output Driving pin, Common mode output voltage = VDDA-0.2, compensation capacitors enabled

SIDOA202	Ultra-Low power mode	Idd_ultra_low_10x_PGA	-	-	60	μA	
SIDOA203	Low power mode	Idd_low_10x_PGA	-	-	200	μA	

(table continues...)

Table 33 (continued) CTBL Op Amp

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDOA204	Medium power mode	Idd_med_10x_PGA	-	-	350	μA	
SIDOA205	High power mode	Idd_hi_10x_PGA	-	-	1000	μA	
SIDOA206	Ultra-High power mode	Idd_Ultra_hi_10x_PGA	-	-	1620	μA	

Current from VDDA for PGA (non-inverting) topology, Internal-drive only, common mode output voltage = VDDA-0.2, compensation capacitors enabled

SIDOA207	Ultra-Low power mode	Idd_Ultra_low_1x_PGA	-	-	50	μA	
SIDOA208	Low power mode	Idd_low_1x_PGA	-	-	120	μA	
SIDOA209	Medium power mode	Idd_med_1x_PGA	-	-	200	μA	
SIDOA210	High power mode	Idd_hi_1x_PGA	-	-	500	μA	
SIDOA211	Ultra-High power mode	Idd_Ultra_hi_1x_PGA	-	-	800	μA	

Gain error of PGA (non-inverting) topology, internal-drive only, input and output common mode voltages 0.2 to VDDA-0.2, compensation capacitors enabled

SIDOA212	Ultra-High power mode, Gain = 2	G_error_2_1x_NI_GND_UltraHI	-5	-	5	%	
SIDOA213	Ultra-High power mode, Gain = 4	G_error_4_1x_NI_GND_UltraHI	-5	-	5	%	
SIDOA214	Ultra-High power mode, Gain = 16	G_error_16_1x_NI_GND_UltraHI	-10	-	10	%	
SIDOA215	Ultra-High power mode, Gain = 32	G_error_32_1x_NI_GND_UltraHI	-10	-	10	%	
SIDOA216	High power mode, Gain = 2	G_error_2_1x_NI_GND_HI	-5	-	5	%	
SIDOA217	High power mode, Gain = 4	G_error_4_1x_NI_GND_HI	-5	-	5	%	
SIDOA218	High power mode, Gain = 16	G_error_16_1x_NI_GND_HI	-10	-	10	%	
SIDOA219	High power mode, Gain = 32	G_error_32_1x_NI_GND_HI	-10	-	10	%	

(table continues...)

Table 33 (continued) CTBL Op Amp

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDOA220	Medium power mode, Gain = 2	G_error_2_1x_NI_GND__med	-5	-	5	%	
SIDOA221	Medium power mode, Gain = 4	G_error_4_1x_NI_GND__med	-5	-	5	%	
SIDOA222	Medium power mode, Gain = 16	G_error_16_1x_NI_GND__med	-10	-	10	%	
SIDOA223	Medium power mode, Gain = 32	G_error_32_1x_NI_GND__med	-10	-	10	%	
SIDOA224	Low power mode, Gain = 2	G_error_2_1x_NI_GND__low	-5	-	5	%	
SIDOA225	Low power mode, Gain = 4	G_error_4_1x_NI_GND__low	-5	-	5	%	
SIDOA226	Low power mode, Gain = 16	G_error_16_1x_NI_GND__low	-10	-	10	%	
SIDOA227	Low power mode, Gain = 32	G_error_32_1x_NI_GND__low	-10	-	10	%	
SIDOA228	Ultra-Low power mode, Gain = 2	G_error_2_1x_NI_GND__Ultralow	-5	-	5	%	
SIDOA229	Ultra-Low power mode, Gain = 4	G_error_4_1x_NI_GND__Ultralow	-5	-	5	%	
SIDOA230	Ultra-Low power mode, Gain = 16	G_error_16_1x_NI_GND__Ultralow	-10	-	10	%	
SIDOA231	Ultra-Low power mode, Gain = 32	G_error_32_1x_NI_GND__Ultralow	-10	-	10	%	

Gain error of PGA (non-inverting) topology, output driving pin, input and output common mode voltages 0.2 to VDDA-0.2, compensation capacitors enabled

SIDOA232	Ultra-High power mode, Gain = 2	G_error_2_10x_NI_GND__UltraHI	-5	-	5	%	
SIDOA233	Ultra-High power mode, Gain = 4	G_error_4_10x_NI_GND__UltraHI	-5	-	5	%	

(table continues...)

Table 33 (continued) CTBL Op Amp

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDO234	Ultra-High power mode, Gain = 16	G_error_16_10x_NI_GND_UltraHI	-10	-	10	%	
SIDO235	Ultra-High power mode, Gain = 32	G_error_32_10x_NI_GND_UltraHI	-10	-	10	%	
SIDO236	High power mode, Gain = 2	G_error_2_10x_NI_GND_HI	-5	-	5	%	
SIDO237	High power mode, Gain = 4	G_error_4_10x_NI_GND_HI	-5	-	5	%	
SIDO238	High power mode, Gain = 16	G_error_16_10x_NI_GND_HI	-10	-	10	%	
SIDO239	High power mode, Gain = 32	G_error_32_10x_NI_GND_HI	-10	-	10	%	
SIDO240	Medium power mode, Gain = 2	G_error_2_10x_NI_GND_med	-5	-	5	%	
SIDO241	Medium power mode, Gain = 4	G_error_4_10x_NI_GND_med	-5	-	5	%	
SIDO242	Medium power mode, Gain = 16	G_error_16_10x_NI_GND_med	-10	-	10	%	
SIDO243	Medium power mode, Gain = 32	G_error_32_10x_NI_GND_med	-10	-	10	%	
SIDO244	Low power mode, Gain = 2	G_error_2_10x_NI_GND_low	-5	-	5	%	
SIDO245	Low power mode, Gain = 4	G_error_4_10x_NI_GND_low	-5	-	5	%	
SIDO246	Low power mode, Gain = 16	G_error_16_10x_NI_GND_low	-10	-	10	%	
SIDO247	Low power mode, Gain = 32	G_error_32_10x_NI_GND_low	-10	-	10	%	
SIDO248	Ultra-Low power mode, Gain = 2	G_error_2_10x_NI_GND_Ultralow	-5	-	5	%	

(table continues...)

Table 33 (continued) CTBL Op Amp

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDOA249	Ultra-Low power mode, Gain = 4	G_error_4_10x_NI_GND___Ultralow	-5	-	5	%	
SIDOA250	Ultra-Low power mode, Gain = 16	G_error_16_10x_NI_GND___Ultralow	-10	-	10	%	
SIDOA251	Ultra-Low power mode, Gain = 32	G_error_32_10x_NI_GND___Ultralow	-10	-	10	%	

Common Mode Rejection Ratio of Differential PGA

SIDOA252	CMRR (input common mode voltage 0.2 to VDDA-0.2 V, internal drive only, High power mode, Small signal Gain=2, CL = 15 pF)	CMRR_1x_hi_diff_pga_1x	-60	-	-	dB	
SIDOA253	CMRR (input common mode voltage 0.2 to VDDA-0.2 V, internal drive only, High power mode, Small signal Gain=8, CL = 15 pF)	CMRR_1x_hi_diff_pga_8x	-60	-	-	dB	

CTB TIA Specs

SIDOA255	TIA Gain Range	TIA Gain Range	57	-	186	kΩ	
----------	----------------	----------------	----	---	-----	----	--

CTB Comparator Specs

SIDOA260	Comparator Hysteresis Ultra-High power mode, (input common mode voltage =VDDA/2,CL=300 fF)	Comparator Hyst Ultra-High power	2	-	-	mV	
SIDOA261	Comparator Hysteresis High power mode, (input common mode voltage =VDDA/2,CL=300 fF)	Comparator Hyst High power	5	-	-	mV	
SIDOA262	Comparator Hysteresis Medium power mode, (input common mode voltage =VDDA/2,CL=300 fF)	Comparator Hyst Medium power	10	-	-	mV	
SIDOA263	Comparator Hysteresis Low power mode, (input common mode voltage =VDDA/2,CL=300 fF)	Comparator Hyst Low power	20	-	-	mV	
SIDOA264	Comparator Hysteresis Ultra-Low power mode, (input common mode voltage =VDDA/2,CL=300 fF)	Comparator Hyst Ultra-Low power	40	-	-	mV	

(table continues...)

8 Electrical specifications

Table 33 (continued) CTBL Op Amp

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
Comparator-topology response time (delay) 50mV overdrive, Rail to Rail inputs (output common mode voltage 0.2 to VDDA-0.2 V), load capacitance of 300 fF							
SIDOA265	Low power mode, compensation trim = 2	Comparator Tpd_lo	-	-	150	ns	
SIDOA266	Medium power mode, compensation trim = 3	Comparator Tpd med	-	-	100	ns	
SIDOA267	High power mode, compensation trim = 4	Comparator Tpd hi	-	-	80	ns	

8.3.6 PT Comp

Table 34 PT Comp

Spec ID	Description	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
PT Comparator DC Specifications							
SID84	Input offset voltage. Normal power mode	VOFFSET 1	-5	-	5	mV	
SID85A	Input offset voltage. Low-power mode	VOFFSET 2	-10	-	10	mV	
SID85B	Input offset voltage. Ultra low-power mode	VOFFSET 3	-10	-	10	mV	
SID86	Hysteresis when enabled in Normal mode	VHYST1	-	-	60	mV	
SID86A	Hysteresis when enabled in Low-power mode	VHYST2	-	-	80	mV	
SID87	Input common mode voltage in Normal mode	VICM1	0	-	VDDA-0.1	V	
SID247	Input common mode voltage in Low power mode	VICM2	0	-	VDDA-0.1	V	
SID247A	Input common mode voltage in Ultra low power mode	VICM3	0	-	VDDA-0.1	V	
SID88	Common mode rejection ratio in Normal power mode	CMRR	50	-	-	dB	
SID89	Block Current, Normal mode	ICMP1	-	-	150	μA	Post-processing not included
SID248	Block Current, Low power mode	ICMP2	-	-	10	μA	Post-processing not included
SID259	Block Current in Ultra low power mode	ICMP3	-	0.3	0.85	μA	Post-processing not included

(table continues...)

8 Electrical specifications

Table 34 (continued) PT Comp

Spec ID	Description	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
PT Comparator AC Specifications							
SID91	Response time, Normal mode, 100 mV overdrive	TRESP1	-	-	100	ns	
SID258	Response time, Low power mode, 100 mV overdrive	TRESP2	-	-	1000	ns	
SID92	Response time, Ultra-low power mode, 100 mV overdrive	TRESP3	-	-	7	μs	
SID92E	Time from Enabling to operation	TCMPEN1	-	-	10	μs	Normal and Low power modes
SID92F	Time from Enabling to operation	TCMPEN2	-	-	50	μs	Ultra low-power mode

8.3.7 PRB

Table 35 PRB

Spec ID	Description	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDPR000	Numerical Resolution of PRB		4	-	4	bits	
SIDPR003	Current from VDDA when PRB enabled	IDDA_active	650	850	2200	nA	
SIDPR004	Total resistance of potential dividers on VDDA/VBGR	Res	1.6	2.2	2.8	MΩ	
SIDPR005	DNL of output 1 with VDDA as reference, output 0 connected to tap 7, no load	Vref_DNL_Step_Size_VDDAadder	-1	-	1	LSB	
SIDPR006	DNL of output 1 with VBGR(0.9 V) as reference, output 0 connected to tap 7, no load	Vref_DNL_Step_Size_BGadder	-1	-	1	LSB	
SIDPR007	INL of output 1 with VDDA as reference, output 0 connected to tap 7, no load	Vref_INL_Step_Size_VDDAadder	-1	-	1	LSB	
SIDPR008	INL of output 1 with VBGR(0.9 V) as reference, output 0 connected to tap 7, no load	Vref_INL_Step_Size_BGadder	-1	-	1	LSB	

(table continues...)

Table 35 (continued) PRB

Spec ID	Description	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDPR009	Start-up time (output within ± 10 mV of steady state) when both outputs from VBGR (0.9 V) reference	Tstartup_BGladder	-	-	100	μ s	
SIDPR010	Start-up time (output within ± 10 mV of the steady state) when both outputs from VDDA reference	Tstartup_VDDAladder	-	-	150	μ s	
SIDPR011	Output settling time to ± 10 mV when one code changes, VBGR (0.9 V) reference	Tsettling_code_BGladder	-	25	40	μ s	
SIDPR012	Output settling time to ± 10 mV when one code changes, VDDA reference	Tsettling_code_VDDAladder	-	45	60	μ s	

8.4 Digital peripherals

8.4.1 Timer Counter Pulse Width Modulator TCPWM

Table 36 Timer Counter Pulse Width Modulator TCPWM

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
TCPWM Specifications							
SIDTCPW M3H	Block current at 100 MHz. HP mode.	ITCPWM	-	-	540	μA	All modes (Timer/Counter/PWM)
SIDTCPW M3	Operating frequency	TCPWMFREQ	-	-	100	MHz	Fc max = Fcpu. Maximum = 100 MHz
SIDTCPW M4	Input Trigger Pulse Width for all Trigger Events	TPWMENEXT	2/Fc	-	-	ns	Trigger Events can be Stop, Start, Reload, Count, Capture, or Kill depending on which mode of operation is selected.

(table continues...)

Table 36 (continued) Timer Counter Pulse Width Modulator TCPWM

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDTCPW M5	Output Trigger Pulse widths	TPWMEXT	1.5/Fc	-	-	ns	Minimum possible width of Overflow, Underflow, and CC (Counter equals Compare value) trigger outputs
SIDTCPW M5A	Resolution of Counter	TCRES	1/Fc	-	-	ns	Minimum time between successive counts
SIDTCPW M5B	PWM Resolution	PWMRES	1/Fc	-	-	ns	Minimum pulse width of PWM Output
SIDTCPW M5C	Quadrature inputs resolution	QRES	2/Fc	-	-	ns	Minimum pulse width between Quadrature phase inputs. Delays from pins should be similar.
SIDTCPW M3H	Operating frequency. HP mode	TCPWMFREQ	-	-	100	MHz	
SIDTCPW M3L	Operating frequency. LP mode	TCPWMFREQ	-	-	40	MHz	

8.4.2 Serial Communication Block SCB

Table 37 Serial Communication Block SCB

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		

Fixed I2C AC Specifications

SID153	Bit Rate	FI2C1	-	-	1	Mbps	At all core voltages
--------	----------	-------	---	---	---	------	----------------------

Fixed UART AC Specifications

SID162B	Bit rate in HP mode	FUART1	-	-	16	Mbps	
SID162B	Bit rate at LP mode	FUART2	-	-	8	Mbps	

Fixed SPI AC Specifications

SID166	SPI Operating frequency Externally Clocked Slave	FSPI	-	-	25	MHz	0.9 V
SID166B	SPI Operating frequency Master (Fscb is SPI clock)	FSPIEXT	-	-	Fscb/4	MHz	0.9 V; Fscb max is 100 MHz
SID166A	SPI Slave Internally Clocked	FSPIIC	-	-	15	MHz	0.9 V

(table continues...)

Table 37 (continued) Serial Communication Block SCB

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SID166	SPI Operating frequency Externally Clocked Slave	FSPI	-	-	18	MHz	0.8 V
SID166B	SPI Operating frequency Master (Fscb is SPI clock)	FSPIEXT	-	-	18	MHz	0.8 V
SID166A	SPI Slave Internally Clocked	FSPIIC	-	-	10	MHz	0.8 V
SID166	SPI Operating frequency Externally Clocked Slave	FSPI	-	-	12	MHz	0.7 V core voltage
SID166B	SPI Operating frequency Master (Fscb is SPI clock)	FSPIEXT	-	-	12	MHz	0.7 V
SID166A	SPI Slave Internally Clocked	FSPIIC	-	-	5	MHz	0.7 V
SID166HS	SPI Operating frequency Externally Clocked Slave	FSPIHS	-	-	50	MHz	0.9 V
SID166BHS	SPI Operating frequency Master (Fscb is SPI clock)	FSPIEXTHS	-	-	Fscb/4	MHz	0.9 V; Fscb max is 200 MHz
SID166AHS	SPI Slave Internally Clocked	FSPIICHS	-	-	15	MHz	0.9 V

Fixed SPI Master mode AC Specifications

SID167	MOSI Valid after Sclock driving edge	TDMO	-	-	12	ns	
SID167HS	MOSI Valid after Sclock driving edge	TDMOHS	-	-	5	ns	For 50 MHz operation
SID168	MISO Valid before Sclock capturing edge	TDSI	5	-	-	ns	Full clock, late MISO sampling
SID168HS	MISO Valid before Sclock capturing edge	TDSIHS	3	-	-	ns	Full clock, late MISO sampling
SID169	MOSI and MISO data hold time	THMO	2	-	-	ns	Referred to Slave capturing edge

Fixed SPI Slave mode AC Specifications

SID170	MOSI Valid before Sclock Capturing edge	TDMI	5	-	-	ns	
SID171A	MISO Valid after Sclock driving edge in Ext. Clk. mode	TDSOEXT	-	-	20	ns	
SID171AHS	MISO Valid after Sclock driving edge in Ext. Clk. mode	TDSOEXT	-	-	7	ns	High Speed mode
SID171	MISO Valid after Sclock driving edge in Internally Clk. Mode	TDSO	-	-	TDSO_EXT + 3*Tscb	ns	Tscb is Serial Comm Block clock period.
SID171B	MISO Valid after Sclock driving edge in Internally Clk. Mode with Median filter enabled.	TDSO	-	-	TDSO_EXT + 4*Tscb	ns	Tscb is Serial Comm Block clock period.
SID172	MOSI and MISO data hold time	THSO	2	-	-	ns	

(table continues...)

Table 37 (continued) Serial Communication Block SCB

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SID172A	SSEL Valid to first SCK Valid edge	TSSELSCK1	65	-	-	ns	
SID172B	SSEL Hold after Last SCK Valid edge	TSSELSCK2	65	-	-	ns	

8.5 System Resources

8.5.1 System Resource

Table 38 System Resource

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		

Power-On-Reset with Brown-out DC specifications

SID190	VBAT BOD trip voltage in Active and Sleep modes.	VFALLPPOR	2.23	-	-	V	BOD Reset guaranteed below 2.23 V
SID192A	Maximum power supply ramp rate (any supply)	VDDRAMP	-	-	100	mV/ uSec	Active Mode
SID192DS	Maximum power supply ramp rate (any supply) in Deep Sleep	VDDR_DS	-	-	10	mV/ uSec	Deep Sleep Mode
SID194A	VDDD 1.8V BOD trip voltage in Active and Sleep modes.	VFALL1V8	1.53	-	-	V	BOD Reset guaranteed below 1.53 V

Voltage Monitors AC specification

SID212R	VBAT Voltage monitor range	VMON	2.75	-	3.15		
SID212E	VBAT Voltage monitor error	VMON	-	0.3	-	%V	

8.5.2 Single Wire Debug SWD and Trace Interface

Table 39 Single Wire Debug SWD and Trace Interface

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		

SWD and Trace Interface

SID214	1.7 V ≤ VDDD ≤ 3.6 V	FSWDCLK2	-	-	25	MHz	
SID215	T = 1/f SWDCLK	TSWDISETUP	0.25*T	-	-	ns	
SID216	T = 1/f SWDCLK	TSWDIHOLD	0.25*T	-	-	ns	
SID217	T = 1/f SWDCLK	TSWDOVALID	-	-	0.5*T	ns	
SID217A	T = 1/f SWDCLK	TSWDOHOLD	1	-	-	ns	

(table continues...)

8 Electrical specifications

Table 39 (continued) Single Wire Debug SWD and Trace Interface

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SID214T	With Trace Data setup/hold times of 2/1 ns respectively	FTRCLKLP1	-	-	50	MHz	
SID215T	With Trace Data setup/hold times of 3/2 ns respectively	FTRCLKLP2	-	-	50	MHz	

8.5.3 Internal Oscillators Crystal Oscillators External Clock and PLLs

Table 40 Internal Oscillators Crystal Oscillators External Clock and PLLs

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		

IMO DC Specifications

SID218	IMO Operating current at 4.096 MHz	IIMO1	-	5	9	μA	
--------	------------------------------------	-------	---	---	---	----	--

IMO AC Specifications

SID223	Frequency variation centered on 4.096 MHz	FIMOTOL1	-1	-	1	%	
SID227	Cycle-to-Cycle and Period jitter	TJITR	-	1	-	ns	

IHO DC Specifications

SID219	IHO Operating current at 50 MHz	IIHO	-	115	-	μA	
--------	---------------------------------	------	---	-----	---	----	--

IHO AC Specifications

SID220	Frequency variation centered on 50 MHz	FIHOTOL1	-1	-	1	%	
--------	--	----------	----	---	---	---	--

PILO DC Specifications

SID222P	PILO Operating current	IPILO	-	1.15	-	μA	
---------	------------------------	-------	---	------	---	----	--

PILO AC Specifications

SID223P	PILO Start-up time to 95% of final frequency	TSTARTPILO	-	-	150	μs	
SID224P	PILO Duty cycle	PILODUTY	45	50	55	%	
SID225P	PILO Temperature Drift	PILODRIFT	-	40	-	ppm/°C	
SID226P	PILO Accuracy	PILOACC	-	250	-	ppm	For 2°C temperature change

WCO DC Specifications

SID318	Block operating current with 32 kHz crystal	Idd_kHz	-	0.38	1.2	μA	
SID321E	Equivalent Series Resistance	ESR32K	-	80	-	kΩ	
SID322E	Drive Level	PD32K	-	-	1	μW	

WCO AC Specifications

(table continues...)

8 Electrical specifications

Table 40 (continued) Internal Oscillators Crystal Oscillators External Clock and PLLs

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SID319	32 KHz trimmed frequency	F_kHz	-	32.768	-	KHz	
SID320K	Startup time	Ton_kHz	-	-	1000	ms	
SID320E	Frequency tolerance	FTOL32K	-	50	250	ppm	May be calibrated to sub-IO ppm levels

ECO DC Specifications

SID318M1	MHz oscillator current at 4 MHz	Idd4M	-	180	-	μA	Load = 18 PF
SID318M2	MHz oscillator current at 16 MHz	Idd16M	-	360	-	μA	Load = 18 PF
SID318M3	MHz oscillator current at 38 MHz	Idd38M	-	600	-	μA	Load = 18 PF
SID321EM	External crystal load capacitance	Cload	-	-	18	pF	

ECO AC Specifications

SID319M	Crystal frequency range	ECOMHz	4	-	38	MHz	
---------	-------------------------	--------	---	---	----	-----	--

External Clock Specifications

SID305	External Clock input Frequency	EXTCLKFREQ	0	-	100	MHz	Min. 200 kHz for 32 kHz clock operation
SID306	Duty cycle; Measured at VDD/2	EXTCLKDUTY	45	-	55	%	

PLL Specifications
PLL_HP Specifications

SID306HP H	Output frequency. HP mode.	PLLOUT	-	-	500	MHz	
SID306HP L	Output frequency. LP mode.	PLLOUT	-	-	350	MHz	
SID312HP	Phase Frequency Detector (PFD) input	PLL PFD	4	-	50	MHz	Output of PDIV divider
SID308HP	Period Jitter in integer operation	PLLJTR	3	-	3	%	Percentage of Fout
SID311HP	Period Jitter in fractional operation	PLLJTRF	4	-	4	%	Percentage of Fout
SID309HP	PLL Cold Start Lock Time (After Boot)	PLLLOCKCOL D	-	-	60	μs	
SID305HP	Time to achieve PLL Lock with frequency change	PLLLOCK	-	-	20	μs	
SID310HP	Clock input	PLLCLOCKIN	4	-	400	MHz	Input of PDIV divider

PLL_LP Specifications

SID306LP H	Output frequency. HP mode.	PLL_OUT	-	-	500	MHz	
------------	----------------------------	---------	---	---	-----	-----	--

(table continues...)

8 Electrical specifications

Table 40 (continued) Internal Oscillators Crystal Oscillators External Clock and PLLs

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SID306LP	Output frequency. LP mode.	PLL_OUT	-	-	350	MHz	
SID311LP	Phase Frequency Detector (PFD) input	PLL_PFD	4	-	8	MHz	Output of PDIV and QDIV dividers
SID308LP	Period Jitter in integer operation	PLL_JTR	2	-	2	%	Percentage of Fout
SID309LP	PLL Cold Start Lock Time (After Boot)	PLL_LOCKCO LD	-	-	60	μs	
SID305LP	Time to achieve PLL Lock with frequency change	PLL_LOCK	-	-	20	μs	
SID310LP	Clock input	PLL_CLOCKIN	4	-	128	MHz	Input of PDIV divider
Clock Source Switching Time							
SID262	Clock switching from clk1 to clk2 in clock periods	TCLKSWITCH	-	-	4 clk1 + 3 clk2	periods	

8.6 PLLs

Table 41 PLLs

Spec ID	Parameter	Symbol	Min	Max		Unit
				HP	LP	
PLL Specifications						
SID306P1	Output frequency from PLL Block for Low Power PLL	PLL_OUT	-	500	350	MHz
SID306P2	Output frequency from PLL Block for High Performance PLL	PLL_OUT	-	500	350	MHz

8.7 Serial Memory Interface SMIF Controller

Table 42 Serial Memory Interface SMIF Controller

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SMIF QSPI Specifications. All specs with 15 pF Load. Switching levels are 50% clock to 30%/70% data levels. 100 ps PCB flight/skew times.							
SIDQ390Q	SMIF xSPI output clock frequency	Fsmifclock	-	-	200	MHz	
SIDQ391	SMIF HYPERBUS™ output clock frequency	Fsmifclockh	-	-	166	MHz	
HYPERBUS™/xSPI SDR and DDR							
SIDQ393	Interface frequency	f _{CK}	-	-	200	MHz	
(table continues...)							

(table continues...)

Table 42 (continued) Serial Memory Interface SMIF Controller

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDQ394	Allowable clock distortion	t_{CKDCD}	-	-	0.25	ns	
SIDQ395	Minimum clock pulse width	t_{CKMPW}	2.25	-	-	ns	
SIDQ396	Output setup time of DS and IO[7:0] to CK	$t_{OUTSETUP}$	1.045	-	-	ns	
SIDQ397	Output hold time of DS and IO[7:0] to CK	$t_{OUTHOLD}$	0.89	-	-	ns	
SIDQ398	Input min pulse width of DS	$t_{INDSMPW}$	2.05	-	-	ns	
SIDQ399	Input DS to IO[7:0] valid time	t_{INRQ}	-	-	0.4	ns	
SIDQ400	Input IO[7:0] invalid to DS time	t_{INRQH}	-	-	0.4	ns	
SIDQ401	Input data valid time of IO[7:0]	t_{INDV}	1.15	-	-	ns	
SIDQ402	CK low to CS low	$t_{CCKLCSL}$	4	-	-	ns	
SIDQ403	CS low to CK high	$t_{CCKSLCKH}$	4	-	-	ns	
SIDQ404	CK low to CS high	$t_{CCKLCSH}$	4	-	-	ns	
SIDQ405	CS high to CK high	$t_{CCKSHCKH}$	4	-	-	ns	
SIDQ406	DS low to CS high	$t_{CSDSLCSH}$	4	-	-	ns	
SIDQ407	CS high to DS tristate	$t_{CCKSHDST}$	-	-	5	ns	
SIDQ408	CS low to DS low	$t_{CCKSLDSL}$	0	-	-	ns	
SIDQ409	DS tristate to CS low	$t_{CSDSTCSL}$	0	-	-	ns	

Standard QSPI SDR

SIDQ411	Interface frequency	f_{CK}	-	-	166	MHz	
SIDQ412	Clock pulse width	t_{CKPW}	-	-	-	ns	
SIDQ413	CS# active setup to CK	t_{CSS}	4	-	-	ns	
SIDQ414	CS# active hold to CK	t_{CSH0}	4	-	-	ns	
SIDQ415	CS# High time (Read)	t_{CS}	10	-	-	ns	
SIDQ416	CS# High time (Read when Reset feature and Quad mode are both enabled and aborted transaction)	t_{CS}	20	-	-	ns	
SIDQ417	CS# High time (Program/Erase)	t_{CS}	50	-	-	ns	
SIDQ418	Output setup time of DQ[7:0] to CK high	t_{OUT_SETUP}	2.1	-	-	ns	
SIDQ419	Output hold time of DQ[7:0] to CK high	t_{OUT_HOLD}	2.1	-	-	ns	
SIDQ420	CK low to DQ[7:0] input valid time	t_{INV}	-	-	6.7	ns	
SIDQ421	CK low to DQ[7:0] input hold time	t_{INHO}	1.5	-	-	ns	
SIDQ422	Input data valid time of DQ[7:0]	t_{INDV}	3.8	-	-	ns	

(table continues...)

Table 42 (continued) Serial Memory Interface SMIF Controller

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
Standard QSPI DDR							
SIDQ424	Interface frequency	f _{CK}	-	-	100	MHz	
SIDQ425	Clock pulse width	t _{CKPW}	-	-	-	ns	
SIDQ426	CS# active setup to CK	t _{CSS}	4	-	-	ns	
SIDQ427	CS# active hold to CK (mode 0)	t _{CSH0}	4	-	-	ns	
SIDQ428	CS# High time (Read)	t _{CS}	10	-	-	ns	
SIDQ429	CS# High time (Read when Reset feature and Quad mode are both enabled and aborted transaction)	t _{CS}	20	-	-	ns	
SIDQ430	CS# High time (Program/Erase)	t _{CS}	50	-	-	ns	
SIDQ431	Output setup time of DQ[7:0] to CK edge	t _{OUTSETUP}	2.1	-	-	ns	
SIDQ432	Output hold time of DQ[7:0] to CK edge	t _{OUTHOLD}	1.3	-	-	ns	
SIDQ433	CK edge to DQ[7:0] input valid time	t _{INV}	-	-	6.7	ns	
SIDQ434	CK edge to DQ[7:0] input hold time	t _{INHO}	1.5	-	-	ns	
SIDQ435	Input data valid time of DQ[7:0]	t _{INDV}	2.9	-	-	ns	200 and 166 MHz specs

8.8 SDHC and eMMC

Table 43 SDHC and eMMC

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		

SDHC and eMMC Specifications (Block Clock must be divided by ≥ 2 when used as source in DDR modes). AC Specs from 50% clock to 30%/70% data level.

SIDSD390	IO drive select	SDDS	8	-	8	mA	drive_sel = '00' for all modes
SIDSD391	Input transition time	SDTR	0.7	-	3	ns	

SD:DS timing

SIDSD392	Interface clock period	SDCLK	-	-	25	MHz	
SIDSD394	Frequency tolerance	SDDCMDCL	30	-	30	pF	
SIDSD395	IO loading at CLK pins	SDCLKCL	30	-	30	pF	
SIDSD396	Output: Setup time of CMD/DAT prior to CLK	SDTSOUT	5.1	-	-	ns	

(table continues...)

8 Electrical specifications

Table 43 (continued) SDHC and eMMC

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDSD397	Output: Hold time of CMD/DAT after CLK	SDHLDOUT	5.1	-	-	ns	
SIDSD398	Input: Setup time of CMD/DAT prior to CLK	SDTSIN	24	-	-	ns	
SIDSD400	Input: Hold time of CMD/DAT after CLK	SDHLDIN	0	-	-	ns	

SD:HS timing

SIDSD401	Interface clock period	SDCLK	-	-	50	MHz	At 0.8 V and up
SIDSD403	IO loading at DATA/CMD pins	SDDCMDCL	30	-	30	pF	
SIDSD404	IO loading at CLK pins	SDCLKCL	30	-	30	pF	
SIDSD405	Output: Setup time of CMD/DAT prior to CLK	SDTSOUT	6.1	-	-	ns	
SIDSD406	Output: Hold time of CMD/DAT after CLK	SDHLDOUT	2.1	-	-	ns	
SIDSD407	Input: Setup time of CMD/DAT prior to CLK	SDTSIN	5.8	-	-	ns	
SIDSD409	Input: Hold time of CMD/DAT after CLK	SDHLDIN	2.5	-	-	ns	

SD:SDR-12 timing

SIDSD410	Interface clock period	SDCLK	-	-	25	MHz	
SIDSD412	Dutycycle of output CLK	SDCLKDC	30	-	70	%	
SIDSD413	IO loading at DATA/CMD pins	SDDCMDCL	30	-	30	pF	
SIDSD414	IO loading at CLK pins	SDCLKCL	30	-	30	pF	
SIDSD415	Output: Setup time of CMD/DAT prior to CLK	SDTSOUT	3.1	-	-	ns	
SIDSD416	Output: Hold time of CMD/DAT after CLK	SDHLDOUT	0.9	-	-	ns	
SIDSD417	Input: Setup time of CMD/DAT prior to CLK	SDTSIN	24	-	-	ns	
SIDSD419	Input: Hold time of CMD/DAT after CLK	SDHLDIN	1.5	-	-	ns	

SD:SDR-25 timing

SIDSD420	Interface clock period	SDCLK	-	-	50	MHz	At 0.8 V and up
SIDSD422	Dutycycle of output CLK	SDCLKDC	30	-	70	%	
SIDSD423	IO loading at DATA/CMD pins	SDDCMDCL	30	-	30	pF	
SIDSD424	IO loading at CLK pins	SDCLKCL	30	-	30	pF	
SIDSD425	Output: Setup time of CMD/DAT prior to CLK	SDTSOUT	3.1	-	-	ns	

(table continues...)

Table 43 (continued) SDHC and eMMC

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDSD426	Output: Hold time of CMD/DAT after CLK	SDHLDOUT	0.9	-	-	ns	
SIDSD427	Input: Setup time of CMD/DAT prior to CLK	SDTSIN	5.8	-	-	ns	
SIDSD429	Input: Hold time of CMD/DAT after CLK	SDHLDIN	1.5	-	-	ns	

SD:SDR-50 timing

SIDSD430	Interface clock period	SDCLK	-	-	100	MHz	At 0.9 V
SIDSD432	Dutycycle of output CLK	SDCLKDC	30	-	70	%	
SIDSD433	IO loading at DATA/CMD pins	SDDCMDCL	20	-	20	pF	
SIDSD434	IO loading at CLK pins	SDCLKCL	20	-	20	pF	
SIDSD435	Output: Setup time of CMD/DAT prior to CLK	SDTSOUT	3.1	-	-	ns	
SIDSD436	Output: Hold time of CMD/DAT after CLK	SDHLDOUT	0.9	-	-	ns	
SIDSD437	Input: Setup time of CMD/DAT prior to CLK	SDTSIN	4.8	-	-	ns	
SIDSD439	Input: Hold time of CMD/DAT after CLK	SDHLDIN	1.5	-	-	ns	

SD:DDR-50 timing

SIDSD440	Interface clock period	SDCLK	-	-	50	MHz	At 0.8 V and up
SIDSD442	Dutycycle of output CLK	SDCLKDC	45	-	55	%	
SIDSD443	IO loading at DATA/CMD pins	SDDCMDCL	30	-	30	pF	
SIDSD444	IO loading at CLK pins	SDCLKCL	30	-	30	pF	
SIDSD445	Output: Setup time of CMD/DAT prior to CLK	SDTSOUT	3.1	-	-	ns	
SIDSD446	Output: Hold time of CMD/DAT after CLK	SDHLDOUT	0.9	-	-	ns	
SIDSD447	Input: Setup time of CMD/DAT prior to CLK	SDTSIN	5.3	-	-	ns	
SIDSD449	Input: Hold time of CMD/DAT after CLK	SDHLDIN	1.5	-	-	ns	

eMMC:BWC timing

SIDSD450	Interface clock period	SDCLK	-	-	26	MHz	At 0.8 V and up
SIDSD452	IO loading at DATA/CMD pins	SDDCMDCL	30	-	30	pF	
SIDSD453	IO loading at CLK pins	SDCLKCL	30	-	30	pF	
SIDSD454	Output: Setup time of CMD/DAT prior to CLK	SDTSOUT	3.1	-	-	ns	

(table continues...)

Table 43 (continued) SDHC and eMMC

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDSD455	Output: Hold time of CMD/DAT after CLK	SDHLDOUT	3.1	-	-	ns	
SIDSD456	Input: Setup time of CMD/DAT prior to CLK	SDTSIN	9.7	-	-	ns	
SIDSD458	Input: Hold time of CMD/DAT after CLK	SDHLDIN	8.3	-	-	ns	

eMMC:SDR timing

SIDSD459	Interface clock period	SDCLK	-	-	52	MHz	0.9 V
SIDSD461	IO loading at DATA/CMD pins	SDDCMDCL	30	-	30	pF	
SIDSD462	IO loading at CLK pins	SDCLKCL	30	-	30	pF	
SIDSD463	Output: Setup time of CMD/DAT prior to CLK	SDTSOUT	3.1	-	-	ns	
SIDSD464	Output: Hold time of CMD/DAT after CLK	SDHLDOUT	3.1	-	-	ns	
SIDSD465	Input: Setup time of CMD/DAT prior to CLK	SDTSIN	5.3	-	-	ns	
SIDSD467	Input: Hold time of CMD/DAT after CLK	SDHLDIN	2.5	-	-	ns	

eMMC:DDR timing

SIDSD468	Interface clock period	SDCLK	-	-	52	MHz	0.9 V
SIDSD470	Dutycycle requirement at output CLK	SDCLKDC	45	-	55	%	
SIDSD471	IO loading at DATA/CMD pins	SDDCMDCL	20	-	20	pF	
SIDSD472	IO loading at CLK pins	SDCLKCL	20	-	20	pF	
SIDSD473	Output: Setup time of CMD/DAT prior to CLK	SDTSOUT	2.6	-	-	ns	
SIDSD474	Output: Hold time of CMD/DAT after CLK	SDHLDOUT	2.6	-	-	ns	
SIDSD475	Input: Setup time of CMD/DAT prior to CLK	SDTSIN	10	-	-	ns	
SIDSD477	Input: Hold time of CMD/DAT after CLK	SDHLDIN	1.5	-	-	ns	

8.9 Audio Sub system

Table 44 Audio Sub system

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
PDM Specifications							
SID400P	PDM Active current, Stereo operation, 1 MHz clock	PDMIDD1	-	175	-	μA	16 bit audio at 16 KSPS
SID401	PDM Active current, Stereo operation, 3 MHz clock	PDMIDD2	-	600	-	μA	24 bit audio at 48 KSPS
SID402	RMS Jitter in PDM clock	PDMJITTER	-200	-	200	ps	
SID403	PDM Clock speed	PDMCLK	0.384	-	3.072	MHz	
SID403A	PDM Block input clock	PDMBLKCLK	1.024	-	49.152	MHz	
SID403B	Data input set-up time to PDM_CLK edge	PDMSETUP	10	-	-	ns	
SID403C	Data input hold time after PDM_CLK edge	PDMHOLD	10	-	-	ns	
SID404	Audio sample rate	PDMOUT	8	-	48	ksps	
SID405	Word Length	PDMWL	16	-	24	bits	
SID406	Signal-to-Noise Ratio (A-weighted 0	PDMSNR	-	100	-	dB	PDM input, 20 Hz to 20 kHz BW
SID407	Dynamic Range (A-weighted)	PDMDR	-	100	-	dB	20 Hz to 20 kHz BW, -60 dB FS
SID408	Frequency Response	PDMFR	-0.2	-	0.2	dB	DC to 0.45f. DC Blocking filter off.
SID409	Stop Band	PDMSB	-	0.566*f	-	kHz	f is the sampling frequency
SID410	Stop Band Attenuation	PDMSBA	-	60	-	dB	> 30 dB for 8 KSPS
SID411	AdjusTable Gain	PDMGAIN	-12	-	10.5	dB	PDM to PCM, 1.5 dB/step
SID412	Startup time	PDMST	-	48	-		WS (Word Select) cycles

I2S Specifications.

SID413	Length of I2S Word	I2SWORD	8	-	32	bits	
SID414	Word Clock frequency	I2SWS	-	-	192	kHz	12.288 MHz bit clock with 32-bit word
SID414A	Word Clock frequency in TDM mode	I2SWSTDM	-	-	48	kHz	8 32-bit channels

I2S Slave Mode

SID430	WS Setup Time to the Following Rising Edge of SCK	TSWS	5	-	-	ns	
SID430A	WS Hold Time to the Following Edge of SCK	THWS	TMCLK_SOC+5	-	-	ns	

(table continues...)

Table 44 (continued) Audio Sub system

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SID432	Delay Time of TX_SDO Transition from Edge of TX_SCK	TDSDO	- (TMCLK_SOC+25)	-	TMCLK_SOC+25	ns	Associated clock edge depends on selected polarity
SID433	RX_SDI Setup Time to the Following Edge of RX_SCK in	TSSDI	5	-	-	ns	
SID434	RX_SDI Hold Time after the Rising Edge of RX_SCK	THSDI	TMCLK_SOC+5	-	-	ns	
SID435	TX/RX_SCK Bit Clock Duty Cycle	TSCKCY	45	-	55	%	

I2S Master Mode

SID437	WS Transition Delay from Associated Edge of SCK	TDWS	10	-	20	ns	
SID438	SDO Transition Delay from Associated Edge of SCK	TDSDO	10	-	20	ns	
SID439	SDI Setup Time to the Associated Edge of SCK	TSSDI	5	-	-	ns	Associated clock edge depends on selected polarity
SID440	SDI Hold Time after the Associated Edge of SCK	THSDI	TMCLK_SOC+5	-	-	ns	T is TX/RX_SCK Bit Clock period. Associated clock edge depends on selected polarity.
SID443	SCK Bit Clock Duty Cycle	TSCKCY	45	-	55	%	
SID445	MCLK_SOC Frequency	FMCLKSOC	1.024	-	98.304	MHz	FMCLK_SOC = 8*Bit-clock
SID446	MCLK_SOC Duty Cycle	TMCLKCY	45	-	55	%	
SID447	MCLK_SOC Input Jitter	TJITTER	-100	-	100	ps	

8.10 Ethernet MAC

Table 45 Ethernet MAC

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SID500E	MAC Frequency Range	Tfreq	10	-	100	Mbits/sec	

8.11 CAN FD

Table 46 CAN FD

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SID391C	CAN Bit rate (Min 8 MHz clock)	CANrate	-	-	5	Mbit	CAN FD compliant

8.12 JTAG and Boundary Scan

Table 47 JTAG and Boundary Scan

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SID468	TCK low	TCKLOW	52	-	-	ns	
SID469	TCK high	TCKHIGH	10	-	-	ns	
SID470	TCK falling edge to output valid	TCKTDO	-	-	40	ns	
SID471	Input valid to TCK rising edge	TSUTCK	12	-	-	ns	
SID472	Input hold time after TCK rising edge	TCKTHD	10	-	-	ns	
SID473	TCK falling edge to output valid	TCKTDOV	-	-	40	ns	
SID474	TCK falling edge to output High-Z	TCKTDOZ	-	-	40	ns	

8.13 USB HS

Table 48 USB HS

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SID600	HS Data Rate	USBHS	-	-	480	Mbits/sec	

8.14 MIPI DSI PHY

Table 49 MIPI DSI PHY

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SID700	D-PHY data rate per lane	MIPIFS	500	-	1500	Mbits/sec	

8.15 MIPI DBI

Table 50 MIPI DBI

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SID710	GPIO frequency for DBI Type C interface	DBICFreq	-	-	50	MHz	
SID711	GPIO frequency for DBI Type A and B interfaces	DBIABFreq	-	-	50	MHz	

8 Electrical specifications

8.16 I3C

Table 51 I3C

Spec ID	Parameter	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SID800	HDR-DDR data rate	I3CF1	-	-	25	Mbps	At 0.9 V (HP)
SID801	HDR-DDR data rate	I3CF2	-	-	12	Mbps	At 0.8 V (LP)

8.17 NNLite

Table 52 NNLite

Spec ID	Description	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDN1H	NNLite operating frequency in system HP mode	FNNLITE	0	-	200	MHz	
SIDN1L	NNLite operating frequency in system LP mode	FNNLITE	0	-	80	MHz	

8.18 SmartIO

Table 53 SmartIO

Spec ID	Description	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDSM1	Smart IO operating frequency	FSMART	0	-	100	MHz	

8.19 GPU

Table 54 GPU

Spec ID	Description	Symbol	Values			Unit	Note or test condition
			Min.	Typ.	Max.		
SIDGX1H	GPU frequency in system HP mode	FGPU	0	-	200	MHz	

9 Ordering information

The PSOC™ Edge E8x2, E8x3, E8x5, E8x6 Industrial part numbers and features are listed in [Table 55](#). This product line offers dual CPU (Arm® CM33 and Arm® CM55 with Ethos-U55), 512 KB RRAM, 5.5 KB OTP, 1 MB SRAM, HPDMA 4 channel, 2x DMA 16 channels each, HMI (optional GFX, Audio), USB-HS, 2x TDM/I2S, 32x TCPWM, 1x 12-bit SAR ADC, Crypto, 2x SD/eMMC and 2x SMIF 32 KB cache each, 4x Opamp, 2x LPComp, 2x 12-bit DAC, 12x SCB, CAN FD, Ethernet, I3C, and 6x PDM blocks in a BGA-220 package.

Table 55 PSOC™ Edge E8x2, E8x3, E8x5, E8x6 Industrial ordering information

Product	Package	System SRAM (KB)	U55	GFX	Security	I/O Count	Silicon ID
PSOC™ Edge E84							
PSE846GPS4DBZQ3	BGA-220	5120	Y	Y	EPC4	147	0xED92
PSE846GPS2DBZQ3	BGA-220	5120	Y	Y	EPC2	147	0xED95
PSE846GOS4DBZQ3	BGA-220	4096	Y	Y	EPC4	147	0xED98
PSE846GOS2DBZQ3	BGA-220	4096	Y	Y	EPC2	147	0xED9B
PSOC™ Edge E83							
PSE833GOS4DBZQ3	BGA-220	4096	Y	N	EPC4	147	0xEDA8
PSE833GOS2DBZQ3	BGA-220	4096	Y	N	EPC2	147	0xEDA9
PSE833GMS4DBZQ3	BGA-220	2048	Y	N	EPC4	147	0xEDAA
PSE833GMS2DBZQ3	BGA-220	2048	Y	N	EPC2	147	0xEDAB
PSOC™ Edge E82							
PSE823GOS4DBZQ3	BGA-220	4096	N	Y	EPC4	147	0xEDB4
PSE823GOS2DBZQ3	BGA-220	4096	N	Y	EPC2	147	0xEDB5
PSE823GMS4DBZQ3	BGA-220	2048	N	Y	EPC4	147	0xEDB6
PSE823GMS2DBZQ3	BGA-220	2048	N	Y	EPC2	147	0xEDB7
PSOC™ Edge E81							
PSE813GOS4DBZQ3	BGA-220	4096	N	N	EPC4	147	0xF180
PSE813GOS2DBZQ3	BGA-220	4096	N	N	EPC2	147	0xF181
PSE813GMS4DBZQ3	BGA-220	2048	N	N	EPC4	147	0xF182
PSE813GMS2DBZQ3	BGA-220	2048	N	N	EPC2	147	0xF183

9.1 Part number nomenclature

PS E 8 X X MS SX W C PK T X ES R S

Table 56 Product nomenclature

Field	Description	Value	Meaning
PS	Brand	PS	PSOC™
E	Family	E	PSOC™ Edge
8	Series	8	E8 series

(table continues...)

Table 56 (continued) Product nomenclature

Field	Description	Value	Meaning
X	Line	1	Base
		2	Graphics
		3	AI/ML
		4	Graphics + AI/ML
X	Features (sub-families)	7-9	Performance
		4-6	Main
		1-3	Entry
MS	Memory size (NVM, SRAM)	A/B/C/D/E/F/G/H K/L/M/N/O/P/Q/ R S/T/U/V/W/X/Y	2 letters for memories, 1st for total NVM (RRAM + Flash) and 2nd for total RAM (System SRAM + SRAM + TCM) A/B/C/D/E/F/G/H - 8/16/32/64/128/256/512/768 KB K/L/M/N/O/P/Q/R - 1/2/3/4/5/6/7/8 MB S/T/U/V/W/X/Y - 16/24/32/64/128/256/512 MB (for example, P to cover 6.x MB, S to cover 16-23.x MB)
SX	Security features (optional)	Blank	Non security
		S1	EPC 1 security
		S2	EPC 2 security
		S4	EPC 4 security
W	Wireless (optional)	Blank	Non wireless
		B	Bluetooth® LE
		W	WiFi + Bluetooth® LE
C	CPU core (optional)	Blank	Single core
		D	Dual core
		T	Triple core
		Q	Quad core
PK	Package	BZ	BGA-220
		FM	eWLB-235
		FN	WLB-154
T	Temperature range	C	-20°C to +85°C
		I	-40°C to +85°C
		Q	-40°C to +105°C
		M	-55°C to +125°C
X	Max frequency	0	0~99 MHz
		1	100~199 MHz
		2	200~299 MHz

(table continues...)



Table 56 (continued) Product nomenclature

Field	Description	Value	Meaning
		3	300~399 MHz
		4	400~499 MHz
ES	Engineering sample (optional)	Blank	Production sample
		ES	Engineering sample
S	Tape/Reel Shipment (optional)	Blank	Tray
		T	Tape & Reel shipment

10 Package information

10 Package information

This product line is offered in BGA-220 package.

For pinout details, see [Table 12](#).

Table 57 Package dimensions

Spec ID#	Package	Description	Package Dwg #
PKG_1	BGA-220	BGA-220, 10 mm x 10 mm x 1.2 mm height with 0.65-mm pitch	002-34686 Rev. *B

Table 58 Package characteristics

Parameter	Description	Conditions	Min	Typ	Max	Units
T_A	Operating ambient temperature (BGA-220)	-	-40	25	105	°C
T_J	Operating junction temperature, all packages	-	-40	-	125	°C
T_{JA}	Package θ_{JA} (BGA-220)	-	-	41	-	°C/watt
T_{JC}	Package θ_{JC} (BGA-220)	-	-	13	-	°C/watt

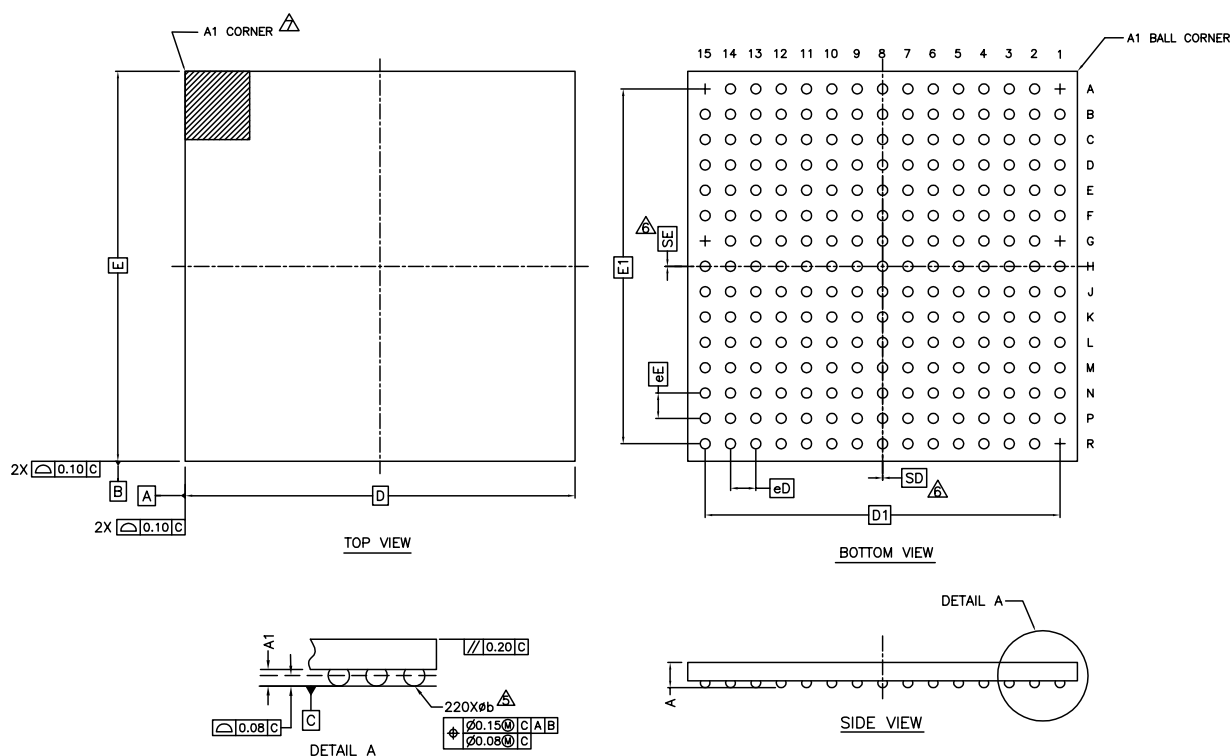
Table 59 Solder reflow peak temperature

Package	Maximum peak temperature	Maximum time at peak temperature
All packages	260°C	30 seconds

Table 60 Package moisture sensitivity level (MSL), IPC/JEDEC J-STD-2

Package	MSL
BGA-220	MSL3

10 Package information



SYMBOL	DIMENSIONS		
	MIN.	NOM.	MAX.
A	-	-	1.20
A1	0.15	-	-
D	10.00 BSC		
E	10.00 BSC		
D1	9.10 BSC		
E1	9.10 BSC		
MD	15		
ME	15		
N	220		
Øb	0.21	0.26	0.31
eD	0.65 BSC		
eE	0.65 BSC		
SD	0.00 BSC		
SE	0.00 BSC		

NOTES:

- ALL DIMENSIONS ARE IN MILLIMETERS.
- SOLDER BALL POSITION DESIGNATION PER JEP95, SECTION 3, SPP-020.
- "e" REPRESENTS THE SOLDER BALL GRID PITCH.
- SYMBOL "MD" IS THE BALL MATRIX SIZE IN THE "D" DIRECTION. SYMBOL "ME" IS THE BALL MATRIX SIZE IN THE "E" DIRECTION. N IS THE NUMBER OF POPULATED SOLDER BALL POSITIONS FOR MATRIX SIZE MD X ME.
- DIMENSION "b" IS MEASURED AT THE MAXIMUM BALL DIAMETER IN A PLANE PARALLEL TO DATUM C.
- "SD" AND "SE" ARE MEASURED WITH RESPECT TO DATUMS A AND B AND DEFINE THE POSITION OF THE CENTER SOLDER BALL IN THE OUTER ROW. WHEN THERE IS AN ODD NUMBER OF SOLDER BALLS IN THE OUTER ROW, "SD" OR "SE" = 0. WHEN THERE IS AN EVEN NUMBER OF SOLDER BALLS IN THE OUTER ROW, "SD" = eD/2 AND "SE" = eE/2.
- A1 CORNER TO BE IDENTIFIED BY CHAMFER, LASER OR INK MARK, METALIZED MARK, INDENTATION OR OTHER MEANS.
- "+" INDICATES THE THEORETICAL CENTER OF DEPOPULATED SOLDER BALLS.
- JEDEC SPECIFICATION NO. REF. : N/A.

002-34686 Rev. *B

Figure 22 BGA-220, 10 x 10 x 1.2

11 Errata

This section describes the errata for the PSOC™ Edge E8 product line. Details include errata trigger conditions, scope of impact, available workarounds, and silicon revision applicability.

For more details, contact [Infineon support](#).

Part numbers affected

Table 61 Part numbers affected

Part number	Device characteristics
All	PSOC™ Edge E8 product line

PSOC™ Edge E8 qualification status

Production

PSOC™ Edge E8 errata summary

This table defines the errata applicability to available product line devices.

Note: Errata items, in the table below, are hyperlinked. Click on any item entry to jump to its description.

Items	PSOC™ Edge E8	Silicon revision	Fix status
[1]. Autonomous analog wake up timer glitch	All	1 (B0)	Fixed in B1 silicon revision
[2]. 3.3 V GPIO high leakage	All	1 (B0)	Fix planned for B1 silicon revision
[3]. LPComp interrupt glitch on wakeup from Deep Sleep-Off/RAM	All	1 (B0)	NA
[4]. SAR ADC FIFO overflow can cause logic state errors and require the Autonomous Analog to be reset	All	1 (B0)	NA

1. Autonomous analog wake up timer glitch

Problem definition	The 16-bit wake up timer of autonomous analog may produce terminal count (TC) events inconsistent with the count value written to the timer. This TC event is responsible for triggering the TIMER_DONE_WAKE condition used by the autonomous analog's state transition table for timing purposes. This condition is used for triggering and power-cycling the ADC and the other analog blocks at periodic intervals.
Parameters affected	Inconsistent or missing terminal count from the wake up timer.
Trigger condition(s)	Whenever the wake up timer is used (TIMER_DONE_WAKE condition in the state transition table).
Scope of impact	Lack of timed power-cycling of the ADC and the analog blocks. This results in higher power consumption because duty cycling is not possible with the internal timer.

1. Autonomous analog wake up timer glitch

Workaround	Do not use the autonomous analog's wake up timer and the TIMER_DONE_WAKE condition: - Use the continuous mode of the ADC and adjust the sample time and the number of samples accumulated to set a sample rate - Use external means, such as the CPU to trigger the state transition table if external timing events are required These workarounds will still be completely functional in B1 silicon revision.
Fix status	Will be fixed in B1 silicon revision.

2. 3.3 V GPIO high leakage

Problem definition	3.3 V capable GPIOs (ports P16 and P17) on some devices show higher leakage than expected in their 3.3 V range of operation.
Parameters affected	No specific parameters beyond leakage are affected. 3.3 V capable ports are still fully functional and can be used normally at their 3.3 V range for evaluation and development and prototype builds. Note the same Ports can be used in 1.8 V mode powered by a 1.8 V supply with full 1.8 V spec compliance.
Trigger condition(s)	Use of 3.3 V range of 3.3 V capable GPIOs
Scope of impact	Inability to use 3.3 V range of 3.3 V capable GPIOs in production on B0 silicon with leakage spec compliance
Workaround	Use 3.3 V GPIOs for evaluation and development and prototype builds
Fix status	Will be fixed in B1 silicon

3. LPComp interrupt glitch on wakeup from Deep Sleep-Off/RAM

Problem definition	The LP Comparator interrupt bit is not set after a Deep Sleep Off or Deep Sleep RAM wake event caused by an LP Comparator interrupt. Since the LP Comparator interrupt bit is not set, it cannot be cleared.
Parameters affected	A continuous interrupt that cannot be cleared once enabled.
Trigger condition(s)	When the LP Comparator interrupt is used as a Deep Sleep Off or Deep Sleep RAM wake source and the application enables the LP Comparator interrupt without reconfiguring the LP Comparator.
Scope of impact	A continuous interrupt that prevents the application from continuing.
Workaround	When using the LP Comparator interrupt as a wake source for Deep Sleep Off or Deep Sleep RAM, reconfigure the LP Comparator before enabling the LP Comparator interrupt. As the interrupt bit is not set, there is no method to check that the LP Comparator was the wake source. This means that the application should always reconfigure the LP Comparator after a Deep Sleep Off or Deep Sleep RAM wake event.
Fix status	NA

4. SAR ADC FIFO overflow can cause logic state errors and require the Autonomous Analog to be reset

Problem definition	In the Autonomous Analog, when using SAR ADC FIFO division mode (with the "Number of FIFOs" option set to two, four or eight), a FIFO full or overflow condition can cause logic state errors and require the Autonomous Analog to be reset.
Parameters affected	Autonomous Analog operation, states and contents.
Trigger condition(s)	FIFO full or overflow condition if the "Number of FIFOs" option set to two, four or eight.

4. SAR ADC FIFO overflow can cause logic state errors and require the Autonomous Analog to be reset

Scope of impact	The Autonomous Analog enters invalid states; therefore, the block must be reset.
Workaround 1	Even if the application requires storing results from more than one channel in the FIFO, keep the “Number of FIFOs” setting to one and enable “Include channel ID” in the SAR ADC settings. This option adds a channel identifier to the most significant byte (bit field [31:24]) of each channel result stored in the FIFO. After reading the FIFO, the firmware can use this identifier to segregate the results by channel.
Workaround 2	When the “Number of FIFOs” option is set to two, four, or eight, the FIFO-level interrupt must be configured and enabled for each FIFO. When the interrupt asserts, the FIFO must be read before it becomes full or overflows. The interrupt service time, including data readout, must be less than the time it takes the FIFO to fill to the level that triggers the FIFO-level interrupt; if this cannot be guaranteed, the block must be reset (disabled and then re-enabled). The FIFO-overflow interrupt flag will not be set reliably when the FIFO becomes full, so it should not be used to detect this condition.
Fix status	NA

12 Acronyms

Table 62 Acronyms used in this document

Acronym	Description
AAD	acoustic activity detection
ADC	analog-to-digital converter
AES	advanced encryption standard
AVB	audio video bridging
AXI	advanced extensible interface
BLE	Bluetooth® low energy
BOD	brown-out detect
BT	Bluetooth®
CAN	controller area network
CANFD	controller area network flexible data-rate
CMOS	complementary metal oxide semiconductor
CPU	central processing unit
CRC	cyclic redundancy checker
CRYPTO	cryptographic accelerator
DAC	digital to analog converter
DBI	display bus interface
D-Cache	data cache
DES	data encryption standard
DICE	device identifier composition engine
DMA	direct memory access
DPLL	digital phase locked loop
DSI	digital Serial Interface (Usually in relation to MIPI DSI)
DSP	digital signal processor
D-TCM	data tightly coupled memory
ECC	error correcting code
ECC	elliptic curve cryptography
ECO	external crystal oscillators
EEPROM	electrically erasable programmable read-only memory
eMMC	embedded multimedia card
EPC	edge protect category
ETF	Embedded Trace FIFO
ETM	embedded trace macrocell

(table continues...)

Table 62 (continued) Acronyms used in this document

Acronym	Description
FIFO	first in, first out
FPU	floating point unit
GPIO	general purpose input/output
GPU	graphics processing unit
HDR	high data rate
HFCLK DIV	high frequency clock divider
HMI	human-machine interface
HP	high performance
HPDMA	high performance direct memory access
HS USB	Hi-Speed universal serial bus
HSIOM	high-speed I/O matrix
HUK	hardware unique key
I2C	inter-integrated circuit
I2S	inter IC sound bus
I3C	improved inter integrated circuit
I-cache	instruction-cache
IDAU	implementation defined attribution unit
IHO	internal high-speed oscillator
IMO	internal main oscillator
IO	input output
IPC	inter-processor communication
IRQ	interrupt request
ISR	interrupt service routine
I-TCM	instruction tightly coupled memory
JTAG	joint test action group
LDO	low dropout
LP	low power
LPComp	low-power comparator
LUT	lookup table
LVD	low-voltage detection
LVTTTL	low-voltage transistor-transistor logic
MAC	media access control
MEMS	micro electro mechanical systems

(table continues...)

Table 62 (continued) Acronyms used in this document

Acronym	Description
MIPI	mobile industry preprocessor interface
ML	machine learning
MMIO	memory mapped I/O
MPC	memory protection controller
MPU	memory protection unit
MTB	micro trace buffer
MVE	m-profile vector extension
NNLite	neural network lite
NVIC	nested vectored interrupt controller
NVM	non volatile memory
OTF	on-the-fly
OTP	one-time programmable
OVD	over voltage detection
OVT	over voltage tolerant
PAL	programmable array logic
PC	protection context
PCM	pulse code modulation
PDL	peripheral driver library
PDM	pulse density modulation
PGA	programmable gain amplifier
PHY	physical layer
PILO	precision Internal Low-speed Oscillator
PLD	programmable logic device
PLL	phase-locked loops
PMU	power management unit
POR	power-on reset
PPC	peripheral protection controller
PRNG	pseudo random number generator
PSA	platform security architecture
PTCOMP	programmable threshold comparator
QoS	quality of service
ROM	read-only memory
RoT	root of trust

(table continues...)

Table 62 (continued) Acronyms used in this document

Acronym	Description
RRAM	resistive random access memory
RSA	rivest-shamir-adleman, a public-key cryptography algorithm
RTC	real-time clock
RTOS	real time operating system
SAR	successive approximation register
SAU	secure attribution unit
SCA	side channel attack
SCB	serial communication blocks
SD	secure digital
SDHC	secure digital host controller
SDIO	secure digital input output
SDK	software development kit
SDR	single data rate
SHA	secure hash algorithm
SISO	single in single out
SMIF	serial memory interface
SNR	signal-to-noise ratio
SoCMEM	system on chip memory, also called system SRAM
SOD	speech onset detection
SPI	serial peripheral interface
SRAM	static random access memory
SRES	software reset
SRSS	system resources subsystem
TCPWM	timer/counter pulse-width modulator
TDM	time division multiplexing
TIA	transimpedance amplifier
TPIU	trace port interface unit
TRNG	true random number generator
UART	universal asynchronous transmitter receiver
UDS	unique device secret
ULP	ultra low power
USB	universal serial bus
VLAN	virtual local area network

(table continues...)



Table 62 (continued) Acronyms used in this document

Acronym	Description
WCO	watch crystal oscillator
WDT	watch dog timer
WFE	wait for event
WIC	wakeup interrupt controller
Wifi	wireless fidelity
XIP	execute-in-place
XRES	external reset

13 Document conventions

13.1 Units of measure

Symbol	Units of measure
°C	Degree Celsius
KB	1024 bytes
kHz	Kilohertz
Mbps	Megabits per second
Msps	Megasamples per second
MHz	Megahertz
ns	Nanosecond
%	Percent
V	Volt
mV	Millivolt
Ω	Ohm
kΩ	Kiloohm
MΩ	Megaohm
μF	Microfarad
μH	Microhenry
μs	Microseconds
ms	Millisecond
ps	Picosecond
MB	Megabyte
ksps	Kilosamples per second
pF	Picofarad
F	Farad
μA	Microampere
mA	Milliampere
nA	Nanoampere
μW	Microwatt
dB	Decibel
FSR	Full scale range
ppm	Parts per million

Revision history

Revision history

Document revision	Date	Description of changes
*M	2025-11-04	Release to web
*N	2026-03-24	Added LPComp interrupt glitch errata to the Errata section Added ETF support in the Processors section
*O	2026-07-10	- Updated Human Machine Interface in the Features - Made minor corrections to Arm® Ethos-U55 performance numbers in the Detailed features section - Added Comprehensive audio and voice processing in the Detailed features section - Updated AN237186 to AN242253 in the PSOC™ Edge MCU resources section - Resolved ambiguity regarding SMIF availability across all packages in the Serial Memory Interface (SMIF) section - Corrected values for SIDGX1H, SIDH10B, and SIDH10C - Categorized power specifications under the new section Device current specification organization - Updated the following sections for better clarity: Security features Processors Wait states and latencies - Added new sections: Device power summary Estimation of device power Audio and voice system capabilities DEEPCRAFT™ audio enhancement middleware Configurable Audio Front-End (AFE) Audio codec support Staged voice control and wake word detection Autonomous analog audio processing AI-enhanced audio intelligence Wireless audio streaming support

Trademarks

The Bluetooth® word mark and logos are registered trademarks owned by Bluetooth SIG, Inc., and any use of such marks by Infineon is under license.

PSOC™, formerly known as PSoC™, is a trademark of Infineon Technologies. Any references to PSoC™ in this document or others shall be deemed to refer to PSOC™.

Trademarks

All referenced product or service names and trademarks are the property of their respective owners.

Edition 2026-07-10

Published by

Infineon Technologies AG

81726 Munich, Germany

© 2026 Infineon Technologies AG

All Rights Reserved.

Do you have a question about any aspect of this document?

Email: erratum@infineon.com

Document reference

IFX-osu1670862341876

Important notice

Products which may also include samples and may be comprised of hardware or software or both ("Product(s)") are sold or provided and delivered by Infineon Technologies AG and its affiliates ("Infineon") subject to the terms and conditions of the frame supply contract or other written agreement(s) executed by a customer and Infineon or, in the absence of the foregoing, the applicable Sales Conditions of Infineon. General terms and conditions of a customer or deviations from applicable Sales Conditions of Infineon shall only be binding for Infineon if and to the extent Infineon has given its express written consent.

For the avoidance of doubt, Infineon disclaims all warranties of non-infringement of third-party rights and implied warranties such as warranties of fitness for a specific use/purpose or merchantability. Infineon shall not be responsible for any information with respect to samples, the application or customer's specific use of any Product or for any examples or typical values given in this document.

If this document is marked as 'Preliminary', 'Target', 'Draft' or 'Proposal', Infineon reserves the right to change all information given in this document at any time without notice. Subject to the development and release of a Product for series supply by Infineon, the technical specifications of the Product are set forth in the relevant datasheet provided by Infineon without such marking.

The data contained in this document is exclusively intended for technically qualified and skilled customer representatives. It is the responsibility of the customer to evaluate the suitability of the Product for the intended application and the customer's specific use and to verify all relevant technical data contained in this document in the intended application and the customer's specific use. The customer is responsible for properly designing, programming, and testing the functionality and safety of the intended application, as well as complying with any legal requirements related to its use.

Unless otherwise explicitly approved by Infineon, Products may not be used in any application where a failure of the Products or any consequences of the use thereof can reasonably be expected to result in personal injury.

However, the foregoing shall not prevent the customer from using any Product in such fields of use that Infineon has explicitly designed and sold it for, provided that the overall responsibility for the application lies with the customer. Infineon expressly reserves the right to use its content for commercial text and data mining (TDM) according to applicable laws, e.g. Section 44b of the German Copyright Act (UrhG). If the Product includes security features:

Because no computing device can be absolutely secure, and despite security measures implemented in the Product, Infineon does not guarantee that the Product will be free from intrusion, data theft or loss, or other breaches ("Security Breaches"), and Infineon shall have no liability arising out of any Security Breaches.

If this document includes or references software:

The software is owned by Infineon under the intellectual property laws and treaties of the United States, Germany, and other countries worldwide. All rights reserved. Therefore, you may use the software only as provided in the software license agreement accompanying the software.

If no software license agreement applies, Infineon hereby grants you a personal, non-exclusive, non-transferable license (without the right to sublicense) under its intellectual property rights in the software (a) for software provided in source code form, to modify and reproduce the software solely for use with Infineon hardware products, only internally within your organization, and (b) to distribute the software in binary code form externally to end users, solely for use on Infineon hardware products. Any other use, reproduction, modification, translation, or compilation of the software is prohibited.

For further information on the Product, technology, delivery terms and conditions, and prices, please contact your nearest Infineon office or visit www.infineon.com.