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"[Embedded - Microcontrollers](#)" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

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Details

Product Status	Active
Core Processor	ARM® Cortex®-M4
Core Size	32-Bit Single-Core
Speed	120MHz
Connectivity	CANbus, Ethernet, I ² C, LINbus, SPI, UART, USB
Peripherals	DMA, I ² S, LED, POR, PWM, WDT
Number of I/O	55
Program Memory Size	256KB (256K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	80K x 8
Voltage - Supply (Vcc/Vdd)	3.13V ~ 3.63V
Data Converters	A/D 24x12b; D/A 2x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 125°C (TA)
Mounting Type	Surface Mount
Package / Case	100-LQFP Exposed Pad
Supplier Device Package	PG-LQFP-100-11
Purchase URL	https://www.e-xfl.com/product-detail/infineon-technologies/xmc4400f100k256baxuma2

XMC4400

Microcontroller Series
for Industrial Applications

XMC4000 Family

ARM[®] Cortex[®]-M4
32-bit processor core

Data Sheet

V1.2 2015-12

Microcontrollers

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About this Document

This Data Sheet is addressed to embedded hardware and software developers. It provides the reader with detailed descriptions about the ordering designations, available features, electrical and physical characteristics of the XMC4400 series devices.

The document describes the characteristics of a superset of the XMC4400 series devices. For simplicity, the various device types are referred to by the collective term XMC4400 throughout this manual.

XMC4000 Family User Documentation

The set of user documentation includes:

- **Reference Manual**
 - describes the functionality of the superset of devices.
- **Data Sheets**
 - list the complete ordering designations, available features and electrical characteristics of derivative devices.
- **Errata Sheets**
 - list deviations from the specifications given in the related Reference Manual or Data Sheets. Errata Sheets are provided for the superset of devices.

Attention: Please consult all parts of the documentation set to attain consolidated knowledge about your device.

Application related guidance is provided by **Users Guides** and **Application Notes**.

Please refer to <http://www.infineon.com/xmc4000> to get access to the latest versions of those documents.

1 Summary of Features

The XMC4400 devices are members of the XMC4000 Family of microcontrollers based on the ARM Cortex-M4 processor core. The XMC4000 is a family of high performance and energy efficient microcontrollers optimized for Industrial Connectivity, Industrial Control, Power Conversion, Sense & Control.

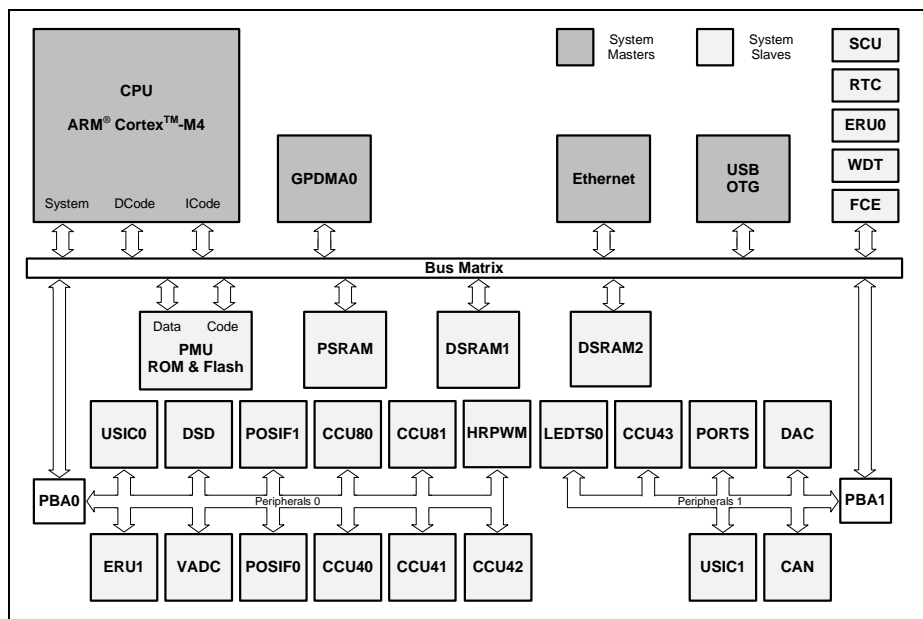


Figure 1 System Block Diagram

CPU Subsystem

- CPU Core
 - High Performance 32-bit ARM Cortex-M4 CPU
 - 16-bit and 32-bit Thumb2 instruction set
 - DSP/MAC instructions
 - System timer (SysTick) for Operating System support
- Floating Point Unit
- Memory Protection Unit
- Nested Vectored Interrupt Controller
- One General Purpose DMA with up-to 8 channels
- Event Request Unit (ERU) for programmable processing of external and internal service requests
- Flexible CRC Engine (FCE) for multiple bit error detection

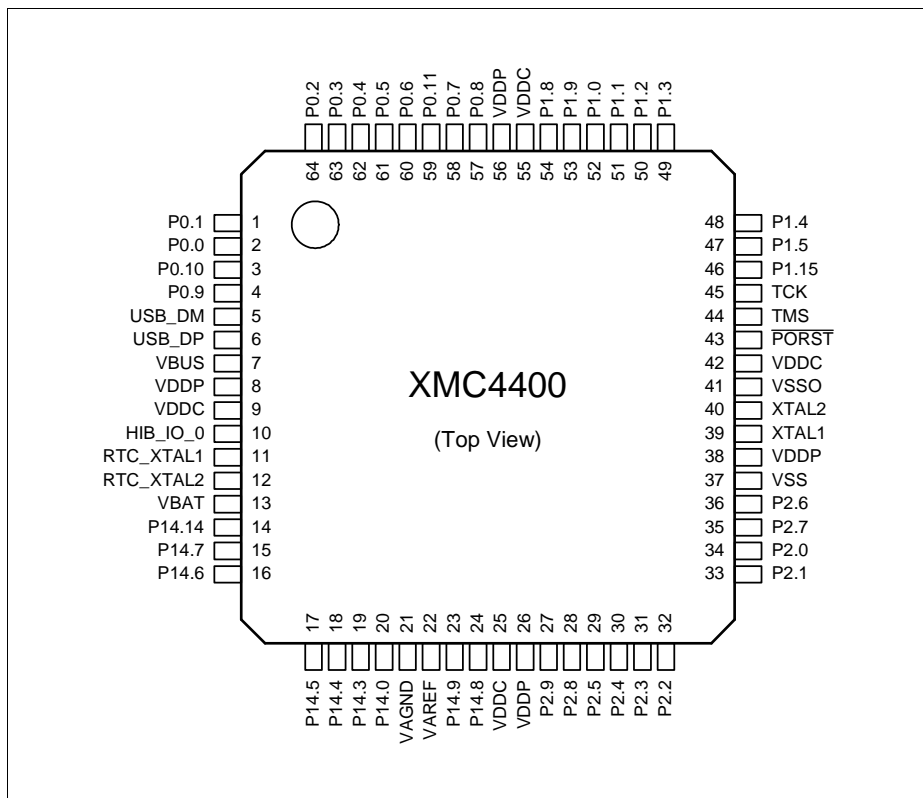


Figure 5 XMC4400 PG-LQFP-64 and PG-TQFP-64 Pin Configuration (top view)

2.2.1 Package Pin Summary

The following general scheme is used to describe each pin:

Table 9 Package Pin Mapping Description

Function	Package A	Package B	...	Pad Type	Notes
Name	N	Ax	...	A2	

The table is sorted by the “Function” column, starting with the regular Port pins (Px.y), followed by the dedicated pins (i.e. PORST) and supply pins.

The following columns, titled with the supported package variants, lists the package pin number to which the respective function is mapped in that package.

The “Pad Type” indicates the employed pad type (A1, A1+, A2, special=special pad, In=input pad, AN/DIG_IN=analog and digital input, Power=power supply). Details about the pad properties are defined in the Electrical Parameters.

In the “Notes”, special information to the respective pin/function is given, i.e. deviations from the default configuration after reset. Per default the regular Port pins are configured as direct input with no internal pull device active.

Table 10 Package Pin Mapping

Function	LQFP-100	LQFP-64 TQFP-64	Pad Type	Notes
P0.0	2	2	A1+	
P0.1	1	1	A1+	
P0.2	100	64	A2	
P0.3	99	63	A2	
P0.4	98	62	A2	
P0.5	97	61	A2	
P0.6	96	60	A2	
P0.7	89	58	A2	After a system reset, via HWSEL this pin selects the DB.TDI function.
P0.8	88	57	A2	After a system reset, via HWSEL this pin selects the DB.TRST function, with a weak pull-down active.
P0.9	4	4	A2	
P0.10	3	3	A1+	

Electrical Parameters

The power-up calibration of the ADC requires a maximum number of $4\,352 f_{\text{ADCI}}$ cycles.

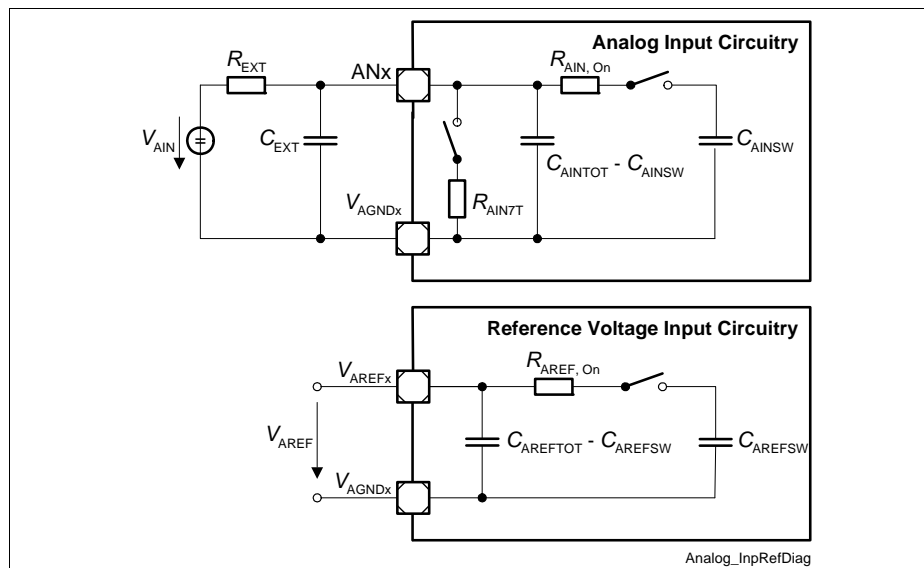


Figure 13 ADCx Input Circuits

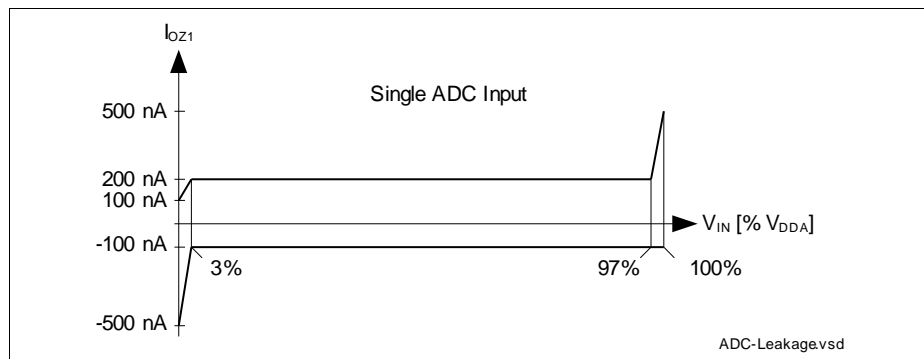


Figure 14 ADCx Analog Input Leakage Current

Conversion Time
Table 26 Conversion Time (Operating Conditions apply)

Parameter	Symbol	Values	Unit	Note
Conversion time	t_C CC	$2 \times T_{ADC} + (2 + N + STC + PC + DM) \times T_{ADCI}$	μs	N = 8, 10, 12 for N-bit conversion $T_{ADC} = 1 / f_{PERIPH}$ $T_{ADCI} = 1 / f_{ADCI}$

- STC defines additional clock cycles to extend the sample time
- PC adds two cycles if post-calibration is enabled
- DM adds one cycle for an extended conversion time of the MSB

Conversion Time Examples

System assumptions:

$f_{ADC} = 120 \text{ MHz}$ i.e. $t_{ADC} = 8.33 \text{ ns}$, $DIVA = 3$, $f_{ADCI} = 30 \text{ MHz}$ i.e. $t_{ADCI} = 33.3 \text{ ns}$

According to the given formulas the following minimum conversion times can be achieved ($STC = 0$, $DM = 0$):

12-bit post-calibrated conversion ($PC = 2$):

$$t_{CN12C} = (2 + 12 + 2) \times t_{ADCI} + 2 \times t_{ADC} = 16 \times 33.3 \text{ ns} + 2 \times 8.33 \text{ ns} = 550 \text{ ns}$$

12-bit uncalibrated conversion:

$$t_{CN12} = (2 + 12) \times t_{ADCI} + 2 \times t_{ADC} = 14 \times 33.3 \text{ ns} + 2 \times 8.33 \text{ ns} = 483 \text{ ns}$$

10-bit uncalibrated conversion:

$$t_{CN10} = (2 + 10) \times t_{ADCI} + 2 \times t_{ADC} = 12 \times 33.3 \text{ ns} + 2 \times 8.33 \text{ ns} = 417 \text{ ns}$$

8-bit uncalibrated:

$$t_{CN8} = (2 + 8) \times t_{ADCI} + 2 \times t_{ADC} = 10 \times 33.3 \text{ ns} + 2 \times 8.33 \text{ ns} = 350 \text{ ns}$$

3.2.4 Out-of-Range Comparator (ORC)

The Out-of-Range Comparator (ORC) triggers on analog input voltages (V_{AIN}) above the analog reference¹⁾ (V_{AREF}) on selected input pins (GxORCy) and generates a service request trigger (GxORCOUTy).

Note: These parameters are not subject to production test, but verified by design and/or characterization.

The parameters in **Table 28** apply for the maximum reference voltage $V_{AREF} = V_{DDA} + 50 \text{ mV}$.

Table 28 ORC Parameters (Operating Conditions apply)

Parameter	Symbol		Values			Unit	Note / Test Condition
			Min.	Typ.	Max.		
DC Switching Level	V_{ODC}	CC	100	125	200	mV	$V_{AIN} \geq V_{AREF} + V_{ODC}$
Hysteresis	V_{OHYS}	CC	50	–	V_{ODC}	mV	
Detection Delay of a persistent Overvoltage	t_{ODD}	CC	55	–	450	ns	$V_{AIN} \geq V_{AREF} + 200 \text{ mV}$
			45	–	105	ns	$V_{AIN} \geq V_{AREF} + 400 \text{ mV}$
Always detected Overvoltage Pulse	t_{OPDD}	CC	440	–	–	ns	$V_{AIN} \geq V_{AREF} + 200 \text{ mV}$
			90	–	–	ns	$V_{AIN} \geq V_{AREF} + 400 \text{ mV}$
Never detected Overvoltage Pulse	t_{OPDN}	CC	–	–	49	ns	$V_{AIN} \geq V_{AREF} + 200 \text{ mV}$
			–	–	30	ns	$V_{AIN} \geq V_{AREF} + 400 \text{ mV}$
Release Delay	t_{ORD}	CC	65	–	105	ns	$V_{AIN} \leq V_{AREF}$
Enable Delay	t_{OED}	CC	–	100	200	ns	

1) Always the standard VADC reference, alternate references do not apply to the ORC.

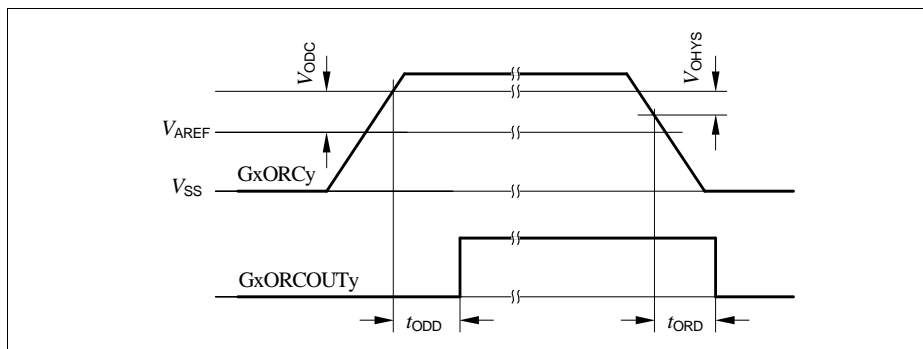


Figure 16 GxORCOUTy Trigger Generation

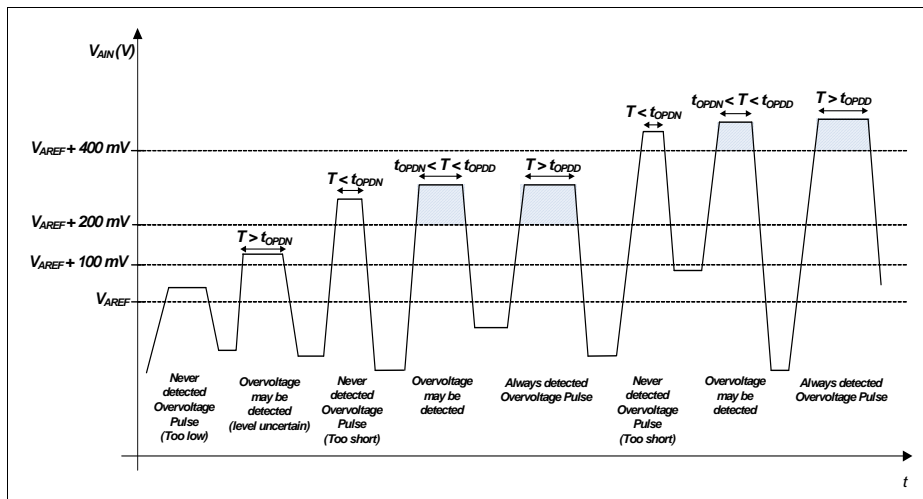


Figure 17 ORC Detection Ranges

3.2.7 Die Temperature Sensor

The Die Temperature Sensor (DTS) measures the junction temperature T_J .

Note: These parameters are not subject to production test, but verified by design and/or characterization.

Table 34 Die Temperature Sensor Parameters

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Temperature sensor range	T_{SR} SR	-40	–	150	°C	
Linearity Error (to the below defined formula)	ΔT_{LE} CC	–	±1	–	°C	per $\Delta T_J \leq 30$ °C
Offset Error	ΔT_{OE} CC	–	±6	–	°C	$\Delta T_{OE} = T_J - T_{DTS}$ $V_{DDP} \leq 3.3$ V ¹⁾
Measurement time	t_M CC	–	–	100	µs	
Start-up time after reset inactive	t_{TSST} SR	–	–	10	µs	

1) At $V_{DDP_max} = 3.63$ V the typical offset error increases by an additional $\Delta T_{OE} = \pm 1$ °C.

The following formula calculates the temperature measured by the DTS in [°C] from the RESULT bit field of the DTSSTAT register.

$$\text{Temperature } T_{DTS} = (\text{RESULT} - 605) / 2.05 \text{ [°C]}$$

This formula and the values defined in [Table 34](#) apply with the following calibration values:

- DTSCON.BGTRIM = 8_H
- DTSCON.REFTRIM = 4_H

3.2.8 USB OTG Interface DC Characteristics

The Universal Serial Bus (USB) Interface is compliant to the USB Rev. 2.0 Specification and the OTG Specification Rev. 1.3. High-Speed Mode is not supported.

Note: These parameters are not subject to production test, but verified by design and/or characterization.

Table 35 USB OTG VBUS and ID Parameters (Operating Conditions apply)

Parameter	Symbol		Values			Unit	Note / Test Condition
			Min.	Typ.	Max.		
VBUS input voltage range	V_{IN}	CC	0.0	–	5.25	V	
A-device VBUS valid threshold	V_{B1}	CC	4.4	–	–	V	
A-device session valid threshold	V_{B2}	CC	0.8	–	2.0	V	
B-device session valid threshold	V_{B3}	CC	0.8	–	4.0	V	
B-device session end threshold	V_{B4}	CC	0.2	–	0.8	V	
VBUS input resistance to ground	R_{VBUS_IN}	CC	40	–	100	kOhm	
B-device VBUS pull-up resistor	R_{VBUS_PU}	CC	281	–	–	Ohm	Pull-up voltage = 3.0 V
B-device VBUS pull-down resistor	R_{VBUS_PD}	CC	656	–	–	Ohm	
USB.ID pull-up resistor	R_{UID_PU}	CC	14	–	25	kOhm	
VBUS input current	I_{VBUS_IN}	CC	–	–	150	μA	$0\text{ V} \leq V_{IN} \leq 5.25\text{ V}$: $T_{AVG} = 1\text{ ms}$

Table 36 USB OTG Data Line (USB_DP, USB_DM) Parameters (Operating Conditions apply)

Parameter	Symbol		Values			Unit	Note / Test Condition
			Min.	Typ.	Max.		
Input low voltage	V_{IL}	SR	–	–	0.8	V	
Input high voltage (driven)	V_{IH}	SR	2.0	–	–	V	
Input high voltage (floating) ¹⁾	V_{IHZ}	SR	2.7	–	3.6	V	
Differential input sensitivity	V_{DIS}	CC	0.2	–	–	V	
Differential common mode range	V_{CM}	CC	0.8	–	2.5	V	
Output low voltage	V_{OL}	CC	0.0	–	0.3	V	1.5 kOhm pull-up to 3.6 V
Output high voltage	V_{OH}	CC	2.8	–	3.6	V	15 kOhm pull-down to 0 V
DP pull-up resistor (idle bus)	R_{PUI}	CC	900	–	1 575	Ohm	
DP pull-up resistor (upstream port receiving)	R_{PUA}	CC	1 425	–	3 090	Ohm	
DP, DM pull-down resistor	R_{PD}	CC	14.25	–	24.8	kOhm	
Input impedance DP, DM	Z_{INP}	CC	300	–	–	kOhm	$0 V \leq V_{IN} \leq V_{DDP}$
Driver output resistance DP, DM	Z_{DRV}	CC	28	–	44	Ohm	

1) Measured at A-connector with 1.5 kOhm \pm 5% to 3.3 V \pm 0.3 V connected to USB_DP or USB_DM and at B-connector with 15 kOhm \pm 5% to ground connected to USB_DP and USB_DM.

Electrical Parameters
Table 39 Power Supply Parameters

Parameter	Symbol		Values			Unit	Note / Test Condition
			Min.	Typ.	Max.		
Power Dissipation	P_{DISS}	CC	—	—	1	W	$V_{DDP} = 3.6 \text{ V}$, $T_J = 150 \text{ }^{\circ}\text{C}$
Wake-up time from Sleep to Active mode	t_{SSA}	CC	—	6	—	cycles	
Wake-up time from Deep Sleep to Active mode			—	—	—	ms	Defined by the wake-up of the Flash module, see Section 3.2.11
Wake-up time from Hibernate mode			—	—	—	ms	Wake-up via power-on reset event, see Section 3.3.2

- 1) CPU executing code from Flash, all peripherals idle.
- 2) CPU executing code from Flash. Ethernet, USB and CCU clock off.
- 3) CPU in sleep, all peripherals idle, Flash in Active mode.
- 4) CPU in sleep, Flash in Active mode.
- 5) CPU in sleep, peripherals disabled, after wake-up code execution from RAM.
- 6) To wake-up the Flash from its Sleep mode, $f_{CPU} \geq 1 \text{ MHz}$ is required.
- 7) OSC_ULP operating with external crystal on RTC_XTAL
- 8) OSC_ULP off, Hibernate domain operating with OSC_SI clock
- 9) Test Power Loop: $f_{SYS} = 120 \text{ MHz}$, CPU executing benchmark code from Flash, all CCUs in 100kHz timer mode, all ADC groups in continuous conversion mode, USICs as SPI in internal loop-back mode, CAN in 500kHz internal loop-back mode, interrupt triggered DMA block transfers to parity protected RAMs and FCE, DTS measurements and FPU calculations.
The power consumption of each customer application will most probably be lower than this value, but must be evaluated separately.
- 10) I_{DDP} decreases typically by 5 mA when f_{SYS} decreases by 10 MHz, at constant T_J
- 11) Sum of currents of all active converters (ADC and DAC)

Table 41 Flash Memory Parameters

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Data Retention Time, User Configuration Block (UCB) ³⁾⁴⁾	t_{RTU} CC	20	–	–	years	Max. 4 erase/program cycles per UCB
Endurance on 64 Kbyte Physical Sector PS4	N_{EPS4} CC	10000	–	–	cycles	BA-marking devices only! Cycling distributed over life time ⁵⁾

- 1) In case the Program Verify feature detects weak bits, these bits will be programmed once more. The reprogramming takes an additional time of 5.5 ms.
- 2) The following formula applies to the wait state configuration: $FCON.WSPFLASH \times (1 / f_{CPU}) \geq t_a$.
- 3) Storage and inactive time included.
- 4) Values given are valid for an average weighted junction temperature of $T_j = 110^\circ\text{C}$.
- 5) Only valid with robust EEPROM emulation algorithm, equally cycling the logical sectors. For more details see the Reference Manual.

3.3.9 Peripheral Timing

Note: These parameters are not subject to production test, but verified by design and/or characterization.

Note: Operating conditions apply.

3.3.9.1 Delta-Sigma Demodulator Digital Interface Timing

The following parameters are applicable for the digital interface of the Delta-Sigma Demodulator (DSD).

The data timing is relative to the active clock edge. Depending on the operation mode of the connected modulator that can be the rising and falling clock edge.

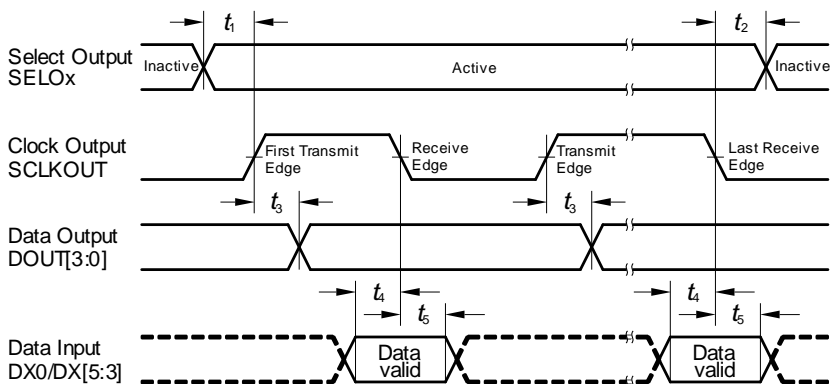
Note: These parameters are not subject to production test, but verified by design and/or characterization.

Table 50 DSD Interface Timing Parameters

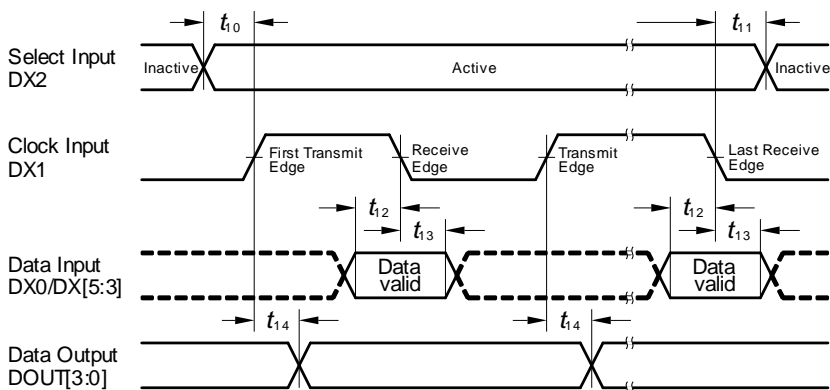
Parameter	Symbol		Values			Unit	Note / Test Condition
			Min.	Typ.	Max.		
MCLK period in master mode	t_1	CC	33.3	—	—	ns	$t_1 \geq 4 \times t_{\text{PERIPH}}^{1)}$
MCLK high time in master mode	t_2	CC	9	—	—	ns	$t_2 > t_{\text{PERIPH}}^{1)}$
MCLK low time in master mode	t_3	CC	9	—	—	ns	$t_3 > t_{\text{PERIPH}}^{1)}$
MCLK period in slave mode	t_1	SR	33.3	—	—	ns	$t_1 \geq 4 \times t_{\text{PERIPH}}^{1)}$
MCLK high time in slave mode	t_2	SR	t_{PERIPH}	—	—	ns	$^{1)}$
MCLK low time in slave mode	t_3	SR	t_{PERIPH}	—	—	ns	$^{1)}$
DIN input setup time to the active clock edge	t_4	SR	$t_{\text{PERIPH}} + 4$	—	—	ns	$^{1)}$
DIN input hold time from the active clock edge	t_5	SR	$t_{\text{PERIPH}} + 3$	—	—	ns	$^{1)}$

$^{1)} t_{\text{PERIPH}} = 1 / f_{\text{PERIPH}}$

Master Mode Timing



Slave Mode Timing



Transmit Edge: with this clock edge transmit data is shifted to transmit data output

Receive Edge: with this clock edge receive data at receive data input is latched

Drawn for BRGH.SCLKCFG = 00_b. Also valid for for SCLKCFG = 01_b with inverted SCLKOUT signal

USIC_SSC_TMGX.VSD

Figure 34 USIC - SSC Master/Slave Mode Timing

Note: This timing diagram shows a standard configuration, for which the slave select signal is low-active, and the serial clock signal is not shifted and not inverted.

3.3.9.3 Inter-IC (IIC) Interface Timing

The following parameters are applicable for a USIC channel operated in IIC mode.

Note: Operating Conditions apply.

Table 53 USIC IIC Standard Mode Timing¹⁾

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Fall time of both SDA and SCL	t_1 CC/SR	-	-	300	ns	
Rise time of both SDA and SCL	t_2 CC/SR	-	-	1000	ns	
Data hold time	t_3 CC/SR	0	-	-	µs	
Data set-up time	t_4 CC/SR	250	-	-	ns	
LOW period of SCL clock	t_5 CC/SR	4.7	-	-	µs	
HIGH period of SCL clock	t_6 CC/SR	4.0	-	-	µs	
Hold time for (repeated) START condition	t_7 CC/SR	4.0	-	-	µs	
Set-up time for repeated START condition	t_8 CC/SR	4.7	-	-	µs	
Set-up time for STOP condition	t_9 CC/SR	4.0	-	-	µs	
Bus free time between a STOP and START condition	t_{10} CC/SR	4.7	-	-	µs	
Capacitive load for each bus line	C_b SR	-	-	400	pF	

1) Due to the wired-AND configuration of an IIC bus system, the port drivers of the SCL and SDA signal lines need to operate in open-drain mode. The high level on these lines must be held by an external pull-up device, approximately 10 kOhm for operation at 100 kbit/s, approximately 2 kOhm for operation at 400 kbit/s.

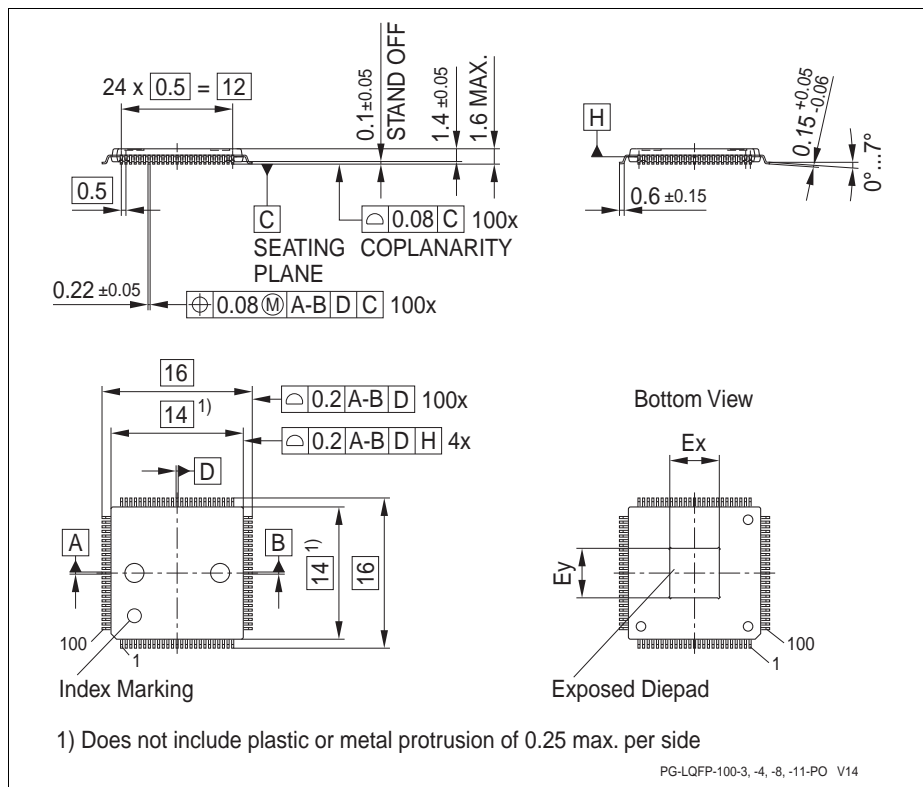


Figure 42 PG-LQFP-100-11 (Plastic Green Low Profile Quad Flat Package)

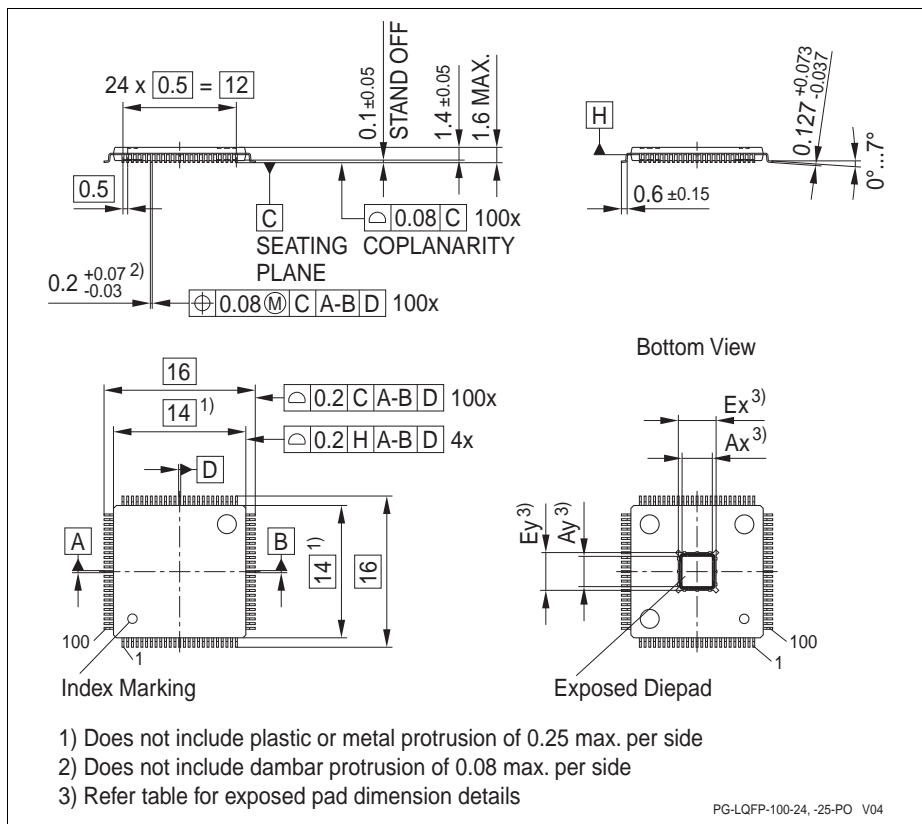


Figure 43 PG-LQFP-100-25 (Plastic Green Low Profile Quad Flat Package)