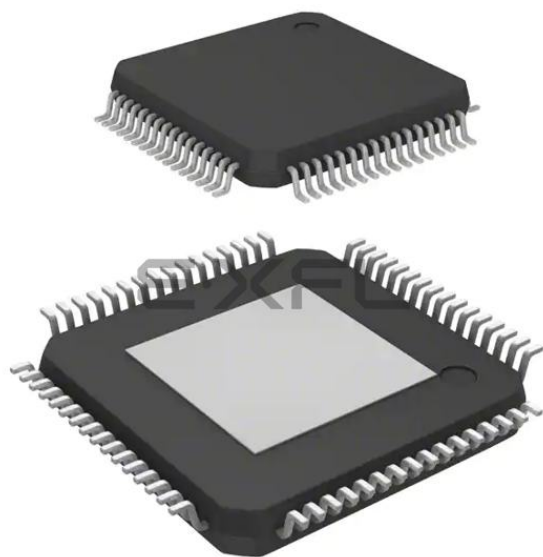




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"[Embedded - Microcontrollers](#)" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable 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®-M0
Core Size	32-Bit Single-Core
Speed	48MHz
Connectivity	CANbus, I ² C, LINbus, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, I ² S, LED, POR, PWM, WDT
Number of I/O	48
Program Memory Size	200KB (200K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	16K x 8
Voltage - Supply (Vcc/Vdd)	1.8V ~ 5.5V
Data Converters	A/D 12x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 105°C (TA)
Mounting Type	Surface Mount
Package / Case	64-LQFP Exposed Pad
Supplier Device Package	PG-LQFP-64-6
Purchase URL	https://www.e-xfl.com/product-detail/infineon-technologies/xmc1404f064x0200aaxuma1

Table 1 Features of XMC1400 Device Types¹⁾ (cont'd)

Features		XMC1401-Q048	XMC1401-F064	XMC1402-T038	XMC1402-Q040	XMC1402-Q048	XMC1402-Q064	XMC1402-F064	XMC1403-Q040	XMC1403-Q048	XMC1403-Q064	XMC1404-Q048	XMC1404-Q064	XMC1404-F064
Analog	ADC (kernels / analog inputs)	2 / 12	2 / 12	2 / 12	2 / 12	2 / 12	2 / 12	2 / 12	2 / 12	2 / 12	2 / 12	2 / 12	2 / 12	2 / 12
	ACMP	-	-	3	3	4	4	4	-	-	-	4	4	4
GPIOs		34	48	26	27	34	48	48	27	34	48	34	48	48
GPIOs		8	8	8	8	8	8	8	8	8	8	8	8	8
Packages		VQFN-48	LQFP-64	TSSOP-38	VQFN-40	VQFN-48	VQFN-64	LQFP-64	VQFN-40	VQFN-48	VQFN-64	VQFN-48	VQFN-64	LQFP-64

1) Features that are not included in this table are available in all the derivatives

1.2 Ordering Information

The ordering code for an Infineon microcontroller provides an exact reference to a specific product. The code "XMC1<DDD>-<Z><PPP><T><FFFF>" identifies:

- <DDD> the derivatives function set
- <Z> the package variant
 - T: TSSOP
 - Q: VQFN
 - F: LQFP
- <PPP> package pin count
- <T> the temperature range:
 - F: -40°C to 85°C
 - X: -40°C to 105°C
- <FFFF> the Flash memory size in Kbytes.

For ordering codes for the XMC1400 please contact your sales representative or local distributor.

This document describes several derivatives of the XMC1400 series, some descriptions may not apply to a specific product. Please see [Table 2](#).

For simplicity the term **XMC1400** is used for all derivatives throughout this document.

1.3 Device Types

These device types are available and can be ordered through Infineon's direct and/or distribution channels.

Table 2 Synopsis of XMC1400 Device Types

Derivative	Package	Flash Kbytes
XMC1401-Q048F0064	PG-VQFN-48	64
XMC1401-Q048F0128	PG-VQFN-48	128
XMC1401-F064F0064	PG-LQFP-64	64
XMC1401-F064F0128	PG-LQFP-64	128
XMC1402-T038X0032	PG-TSSOP-38	32
XMC1402-T038X0064	PG-TSSOP-38	64
XMC1402-T038X0128	PG-TSSOP-38	128
XMC1402-T038X0200	PG-TSSOP-38	200
XMC1402-Q040X0032	PG-VQFN-40	32
XMC1402-Q040X0064	PG-VQFN-40	64
XMC1402-Q040X0128	PG-VQFN-40	128
XMC1402-Q040X0200	PG-VQFN-40	200
XMC1402-Q048X0032	PG-VQFN-48	32
XMC1402-Q048X0064	PG-VQFN-48	64
XMC1402-Q048X0128	PG-VQFN-48	128
XMC1402-Q048X0200	PG-VQFN-48	200
XMC1402-Q064X0064	PG-VQFN-64	64
XMC1402-Q064X0128	PG-VQFN-64	128
XMC1402-Q064X0200	PG-VQFN-64	200
XMC1402-F064X0064	PG-LQFP-64	64
XMC1402-F064X0128	PG-LQFP-64	128
XMC1402-F064X0200	PG-LQFP-64	200
XMC1403-Q040X0064	PG-VQFN-40	64
XMC1403-Q040X0128	PG-VQFN-40	128
XMC1403-Q040X0200	PG-VQFN-40	200
XMC1403-Q048X0064	PG-VQFN-48	64
XMC1403-Q048X0128	PG-VQFN-48	128

1.4 Chip Identification Number

The Chip Identification Number allows software to identify the marking. It is an 8 words value with the most significant 7 words stored in Flash configuration sector 0 (CS0) at address location : 1000 0F00_H (MSB) - 1000 0F1B_H (LSB). The least significant word and most significant word of the Chip Identification Number are the value of registers DBGROMID and IDCHIP, respectively.

Table 3 XMC1400 Chip Identification Number

Derivative	Value	Marking
XMC1401-Q048F0064	00014082 07CF00FF 1E071FF7 20006000 00000D00 00001000 00011000 10204083 _H	AA
XMC1401-Q048F0128	00014082 07CF00FF 1E071FF7 20006000 00000D00 00001000 00021000 10204083 _H	AA
XMC1401-F064F0064	000140A2 07CF00FF 1E071FF7 20006000 00000D00 00001000 00011000 10204083 _H	AA
XMC1401-F064F0128	000140A2 07CF00FF 1E071FF7 20006000 00000D00 00001000 00021000 10204083 _H	AA
XMC1402-T038X0032	00014013 07FF00FF 1E071FF7 000F900F 00000D00 00001000 00009000 10204083 _H	AA
XMC1402-T038X0064	00014013 07FF00FF 1E071FF7 000F900F 00000D00 00001000 00011000 10204083 _H	AA
XMC1402-T038X0128	00014013 07FF00FF 1E071FF7 000F900F 00000D00 00001000 00021000 10204083 _H	AA
XMC1402-T038X0200	00014013 07FF00FF 1E071FF7 000F900F 00000D00 00001000 00033000 10204083 _H	AA
XMC1402-Q040X0032	00014043 07FF00FF 1E071FF7 000F900F 00000D00 00001000 00009000 10204083 _H	AA
XMC1402-Q040X0064	00014043 07FF00FF 1E071FF7 000F900F 00000D00 00001000 00011000 10204083 _H	AA
XMC1402-Q040X0128	00014043 07FF00FF 1E071FF7 000F900F 00000D00 00001000 00021000 10204083 _H	AA
XMC1402-Q040X0200	00014043 07FF00FF 1E071FF7 000F900F 00000D00 00001000 00033000 10204083 _H	AA
XMC1402-Q048X0032	00014083 07FF00FF 1E071FF7 100F900F 00000D00 00001000 00009000 10204083 _H	AA

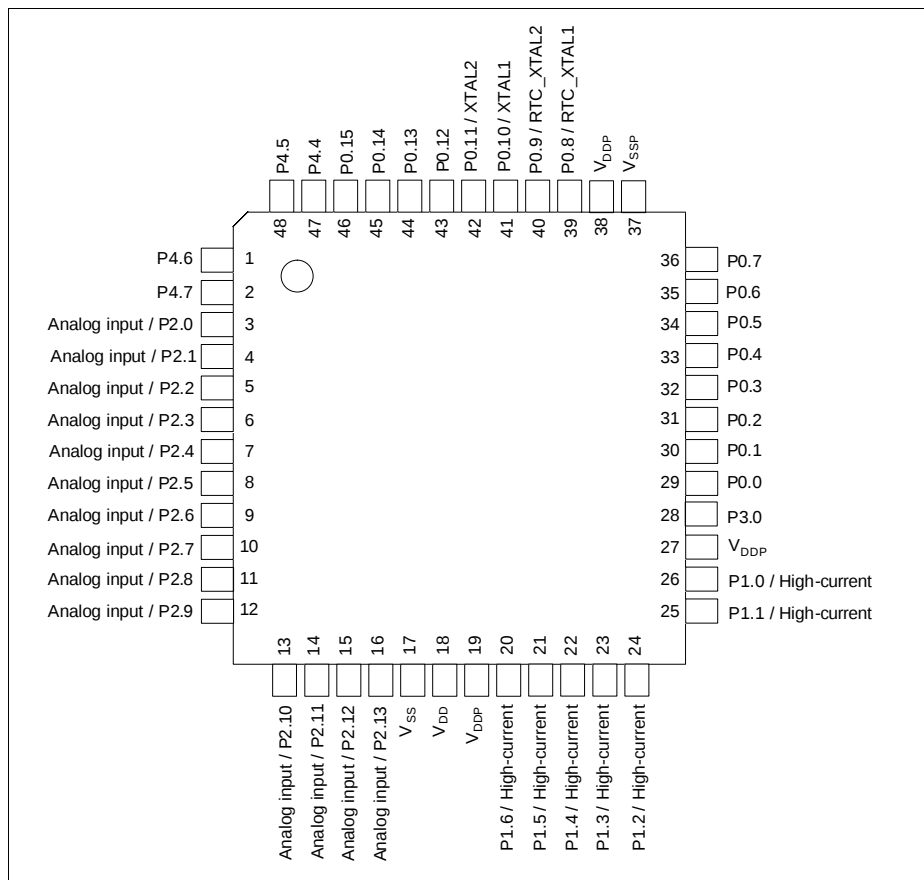


Figure 8 XMC1400 PG-VQFN-48-73 Pin Configuration (top view)

General Device Information
Table 5 Package Pin Mapping (cont'd)

Function	LQFP 64, VQFN 64	VQFN 48	VQFN 40	TSSOP 38	Pad Type	Notes
P0.9/ RTC_ XTAL2	52	40	34	28	STD_INOUT /clock_O	
P0.10/ XTAL1	53	41	35	29	STD_INOUT /clock_IN	
P0.11/ XTAL2	54	42	36	30	STD_INOUT /clock_O	
P0.12	55	43	37	31	STD_INOUT	
P0.13	56	44	38	32	STD_INOUT	
P0.14	57	45	39	33	STD_INOUT	
P0.15	58	46	40	34	STD_INOUT	
P1.0	34	26	22	16	High Current	
P1.1	33	25	21	15	High Current	
P1.2	32	24	20	14	High Current	
P1.3	31	23	19	13	High Current	
P1.4	30	22	18	12	High Current	
P1.5	29	21	17	11	High Current	
P1.6	28	20	16	-	High Current	
P1.7	27	-	-	-	High Current	
P1.8	26	-	-	-	STD_INOUT	
P2.0	9	3	1	35	STD_INOUT /AN	
P2.1	10	4	2	36	STD_INOUT /AN	
P2.2	11	5	3	37	STD_IN/AN	
P2.3	12	6	4	38	STD_IN/AN	
P2.4	13	7	5	1	STD_IN/AN	
P2.5	14	8	6	2	STD_IN/AN	
P2.6	15	9	7	3	STD_IN/AN	
P2.7	16	10	8	4	STD_IN/AN	

General Device Information
Table 5 Package Pin Mapping (cont'd)

Function	LQFP 64, VQFN 64	VQFN 48	VQFN 40	TSSOP 38	Pad Type	Notes
P2.8	17	11	9	5	STD_IN/AN	
P2.9	18	12	10	6	STD_IN/AN	
P2.10	19	13	11	7	STD_INOUT /AN	
P2.11	20	14	12	8	STD_INOUT /AN	
P2.12	21	15	-	-	STD_INOUT /AN	
P2.13	22	16	-	-	STD_INOUT /AN	
P3.0	36	28	-	-	STD_INOUT	
P3.1	37	-	-	-	STD_INOUT	
P3.2	38	-	-	-	STD_INOUT	
P3.3	39	-	-	-	STD_INOUT	
P3.4	40	-	-	-	STD_INOUT	
P4.0	59	-	-	-	STD_INOUT	
P4.1	60	-	-	-	STD_INOUT	
P4.2	61	-	-	-	STD_INOUT	
P4.3	62	-	-	-	STD_INOUT	
P4.4	63	47	-	-	STD_INOUT	
P4.5	64	48	-	-	STD_INOUT	
P4.6	3	1	-	-	STD_INOUT	
P4.7	4	2	-	-	STD_INOUT	
P4.8	5	-	-	-	STD_INOUT	
P4.9	6	-	-	-	STD_INOUT	
P4.10	7	-	-	-	STD_INOUT	
P4.11	8	-	-	-	STD_INOUT	
VSS	23	17	13	9	Power	Supply GND, ADC reference GND

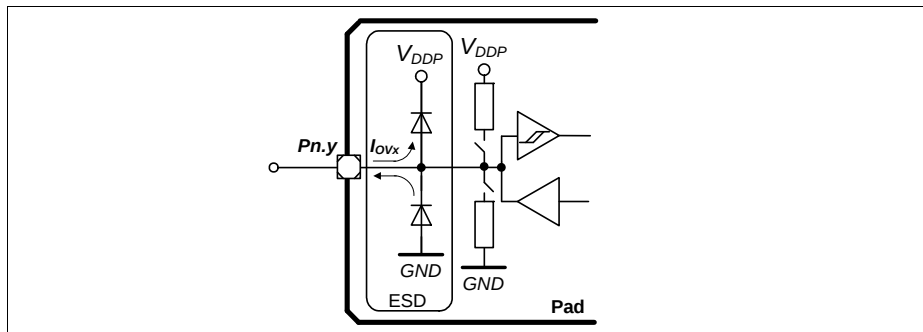


Figure 11 Input Overload Current via ESD structures

Table 13 and **Table 14** list input voltages that can be reached under overload conditions. Note that the absolute maximum input voltages as defined in the **Absolute Maximum Ratings** must not be exceeded during overload.

Table 13 PN-Junction Characteristics for positive Overload

Pad Type	$I_{OV} = 5 \text{ mA}$
Standard, High-current, AN/DIG_IN	$V_{IN} = V_{DDP} + 0.5 \text{ V}$ $V_{AIN} = V_{DDP} + 0.5 \text{ V}$ $V_{AREF} = V_{DDP} + 0.5 \text{ V}$
P2.[1,2,6:9,11]	$V_{INP2} = V_{DDP} + 0.3 \text{ V}$

Table 14 PN-Junction Characteristics for negative Overload

Pad Type	$I_{OV} = 5 \text{ mA}$
Standard, High-current, AN/DIG_IN	$V_{IN} = V_{SS} - 0.5 \text{ V}$ $V_{AIN} = V_{SS} - 0.5 \text{ V}$ $V_{AREF} = V_{SS} - 0.5 \text{ V}$
P2.[1,2,6:9,11]	$V_{INP2} = V_{SS} - 0.3 \text{ V}$

3.1.4 Operating Conditions

The following operating conditions must not be exceeded in order to ensure correct operation and reliability of the XMC1400. All parameters specified in the following tables refer to these operating conditions, unless noted otherwise.

Table 15 Operating Conditions Parameters

Parameter	Symbol		Values			Unit	Note / Test Condition
			Min.	Typ.	Max.		
Ambient Temperature	T_A SR		-40	–	85	°C	Temp. Range F
			-40	–	105	°C	Temp. Range X
Digital supply voltage ¹⁾	V_{DDP} SR		1.8	–	5.5	V	
Short circuit current of digital outputs	I_{SC} SR		-5	–	5	mA	
Absolute sum of short circuit currents of the device	ΣI_{SC_D} SR		–	–	25	mA	

1) See also the Supply Monitoring thresholds, [Chapter 3.3.2](#).

3.2.2 Analog to Digital Converters (ADC)

Table 17 shows the Analog to Digital Converter (ADC) characteristics.

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

Table 17 ADC Characteristics (Operating Conditions apply)¹⁾

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Supply voltage range (internal reference)	V_{DD_int} SR	2.0	–	3.0	V	SHSCFG.AREF = 11 _B ; CALCTR.CALGNSTC = 0C _H for f_{SH} = 32 MHz, 12 _H for f_{SH} = 48 MHz
		3.0	–	5.5	V	SHSCFG.AREF = 10 _B
Supply voltage range (external reference)	V_{DD_ext} SR	3.0	–	5.5	V	SHSCFG.AREF = 00 _B
Analog input voltage range	V_{AIN} SR	V_{SSP} - 0.05	–	V_{DDP} + 0.05	V	
Auxiliary analog reference ground ²⁾	V_{REFGND} SR	V_{SSP} - 0.05	–	1.0	V	G0CH0
		V_{SSP} - 0.05	–	0.2	V	G1CH0
Internal reference voltage (full scale value)	V_{REFINT} CC	5			V	
Switched capacitance of an analog input	C_{AINS} CC	–	1.2	2	pF	GNCTRxz.GAINy = 00 _B (unity gain)
		–	1.2	2	pF	GNCTRxz.GAINy = 01 _B (gain g1)
		–	4.5	6	pF	GNCTRxz.GAINy = 10 _B (gain g2)
		–	4.5	6	pF	GNCTRxz.GAINy = 11 _B (gain g3)
Total capacitance of an analog input	C_{AINT} CC	–	–	10	pF	
Total capacitance of the reference input	C_{AREFT} CC	–	–	10	pF	

3.2.3 Out of Range Comparator (ORC) Characteristics

The Out-of-Range Comparator (ORC) triggers on analog input voltages (V_{AIN}) above V_{DDP} on selected input pins (ORCx.AIN) and generates a service request trigger (ORCx.OUT).

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

Table 18 Out of Range Comparator (ORC) Characteristics (Operating Conditions apply; $V_{DDP} = 3.0\text{ V} - 5.5\text{ V}$; $C_L = 0.25\text{ pF}$)

Parameter	Symbol		Values			Unit	Note / Test Condition
			Min.	Typ.	Max.		
DC Switching Level	V_{ODC}	CC	–	–	180	mV	$V_{AIN} \geq V_{DDP} + V_{ODC}$
Hysteresis	V_{OHYS}	CC	15	–	54	mV	
Always detected Overvoltage Pulse	t_{OPDD}	CC	103	–	–	ns	$V_{AIN} \geq V_{DDP} + 150\text{ mV}$
			88	–	–	ns	$V_{AIN} \geq V_{DDP} + 350\text{ mV}$
Never detected Overvoltage Pulse	t_{OPDN}	CC	–	–	21	ns	$V_{AIN} \geq V_{DDP} + 150\text{ mV}$
			–	–	11	ns	$V_{AIN} \geq V_{DDP} + 350\text{ mV}$
Detection Delay	t_{ODD}	CC	39	–	132	ns	$V_{AIN} \geq V_{DDP} + 150\text{ mV}$
			31	–	121	ns	$V_{AIN} \geq V_{DDP} + 350\text{ mV}$
Release Delay	t_{ORD}	CC	44	–	240	ns	$V_{AIN} \leq V_{DDP}$; $V_{DDP} = 5\text{ V}$
			57	–	340	ns	$V_{AIN} \leq V_{DDP}$; $V_{DDP} = 3.3\text{ V}$
Enable Delay	t_{OED}	CC	–	–	300	ns	ORCCTRL.ENORCx = 1

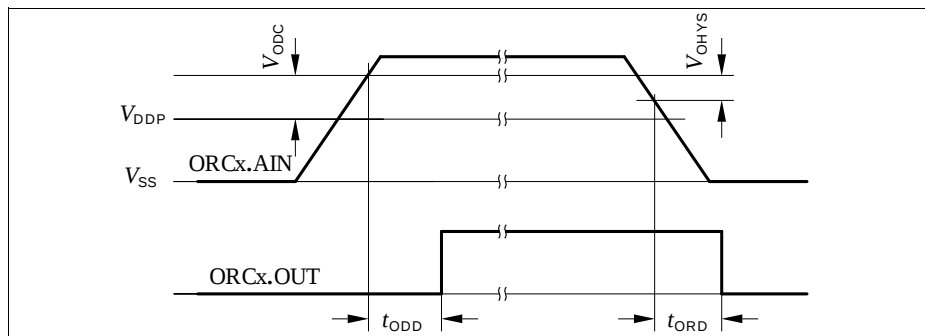


Figure 13 ORCx.OUT Trigger Generation

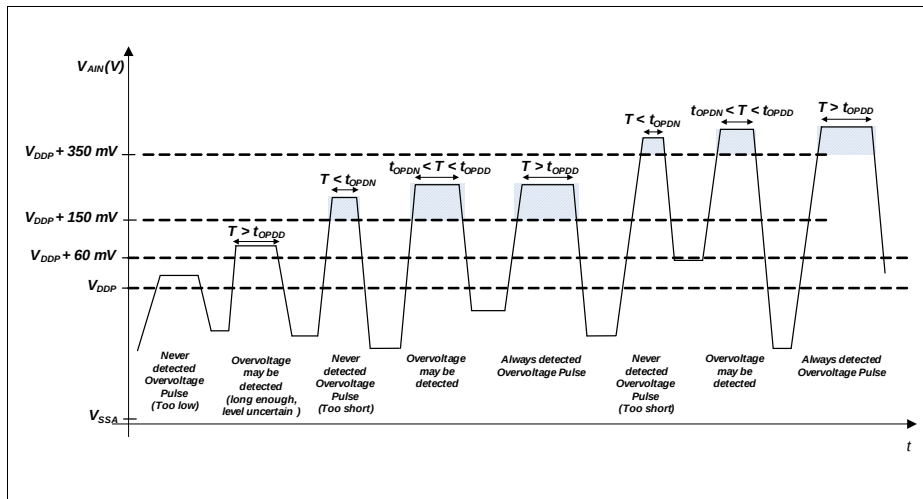


Figure 14 ORC Detection Ranges

3.2.4 Analog Comparator Characteristics

Table 19 below shows the Analog Comparator characteristics.

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

Table 19 Analog Comparator Characteristics (Operating Conditions apply)

Parameter	Symbol		Limit Values			Unit	Notes/ Test Conditions
			Min.	Typ.	Max.		
Input Voltage	V_{CMP}	SR	-0.05	—	$V_{DDP} + 0.05$	V	
Input Offset	V_{CMPOFF}	CC	—	+/-3	—	mV	High power mode $\Delta V_{CMP} < 200$ mV
Propagation Delay ¹⁾	t_{PDELAY}	CC	—	25	—	ns	High power mode, $\Delta V_{CMP} = 100$ mV
			—	80	—	ns	High power mode, $\Delta V_{CMP} = 25$ mV
			—	250	—	ns	Low power mode, $\Delta V_{CMP} = 100$ mV
			—	700	—	ns	Low power mode, $\Delta V_{CMP} = 25$ mV
Current Consumption	I_{ACMP}	CC	—	100	—	μA	First active ACMP in high power mode, $\Delta V_{CMP} > 30$ mV
			—	66	—	μA	Each additional ACMP in high power mode, $\Delta V_{CMP} > 30$ mV
			—	10	—	μA	First active ACMP in low power mode
			—	6	—	μA	Each additional ACMP in low power mode
Input Hysteresis	V_{HYS}	CC	—	+/-15	—	mV	
Filter Delay ¹⁾	t_{FDELAY}	CC	—	5	—	ns	

1) Total Analog Comparator Delay is the sum of Propagation Delay and Filter Delay.

Table 24 provides the active current consumption of some modules operating at 5 V power supply at 25 °C. The typical values shown are used as a reference guide on the current consumption when these modules are enabled.

Table 24 Typical Active Current parameter table

Active Current Consumption	Symbol	Limit Values	Unit	Test Condition
		Typ.		
Baseload current	I_{CPUDDC}	4.14	mA	Modules including Core, SCU, PORT, memories, ANATOP ¹⁾
VADC and SHS	I_{ADCDDC}	3.73	mA	Set CGATCLR0.VADC to 1 ²⁾
USICx	$I_{USIC0DDC}$	1.35	mA	Set CGATCLR0.USIC0 to 1 ³⁾
CCU4x	$I_{CCU40DDC}$	0.99	mA	Set CGATCLR0.CCU40 to 1 ⁴⁾
CCU8x	$I_{CCU80DDC}$	1.00	mA	Set CGATCLR0.CCU80 to 1 ⁵⁾
POSIFx	$I_{PIF0DDC}$	1.05	mA	Set CGATCLR0.POSIF0 to 1 ⁶⁾
LEDTSx	$I_{LTSxDCC}$	1.14	mA	Set CGATCLR0.LEDTSx to 1 ⁷⁾
BCCU0	$I_{BCCU0DDC}$	0.29	mA	Set CGATCLR0.BCCU0 to 1 ⁸⁾
MATH	$I_{MATHDDC}$	0.50	mA	Set CGATCLR0.MATH to 1 ⁹⁾
WDT	I_{WDTDDC}	0.03	mA	Set CGATCLR0.WDT to 1 ¹⁰⁾
RTC	I_{RTCDCC}	0.01	mA	Set CGATCLR0.RTC to 1 ¹¹⁾
MultiCAN	$I_{MCANDCC}$	1.38	mA	Set CGATCLR0.MCAN0 to 1 ¹²⁾

1) Baseload current is measured with device running in user mode, MCLK=PCLK=48 MHz, with an endless loop in the flash memory. The clock to the modules stated in CGATSTAT0 are gated.

2) Active current is measured with: module enabled, MCLK=48 MHz, running in auto-scan conversion mode

3) Active current is measured with: module enabled, each of the 2 USIC channels sending alternate messages at 57.6 kbaud every 200 ms

4) Active current is measured with: module enabled, MCLK=PCLK=48 MHz, 1 CCU4 slice for PWM switching at 20kHz with duty cycle varying at 10%-90%, 1 CCU4 slice in capture mode for reading period and duty cycle

5) Active current is measured with: module enabled, MCLK=PCLK=48 MHz, 3 CCU8 slices with PWM frequency at 20kHz and a period match interrupt used to toggle duty cycle between 10% and 90%

6) Active current is measured with: module enabled, MCLK=48 MHz, PCLK=96 MHz, hall sensor mode

7) Active current is measured with: module enabled, MCLK=48 MHz, 1 LED column, 6 LED/TS lines, Pad Scheme A with large pad hysteresis config, time slice duration = 1.048 ms

8) Active current is measured with: module enabled, MCLK=48 MHz, PCLK=96MHz, FCLK=0.8 MHz, Normal mode (BCCU clock = FCLK/4), 4 BCCU Channels with packers enabled and 1 Dimming Engine, change color or dim every 1s

9) Active current is measured with: module enabled, MCLK=48 MHz, PCLK=96 MHz, tangent calculation in while loop; CORDIC circular rotation, no keep, autostart; 32-by-32 bit signed DIV, autostart, DVS right shift by 11

3.2.8 Flash Memory Parameters

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

Table 25 Flash Memory Parameters

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Erase time per page / sector	$t_{\text{ERASE CC}}$	6.8	7.1	7.6	ms	
Program time per block	$t_{\text{PSER CC}}$	102	152	204	μs	
Wake-Up time	$t_{\text{WU CC}}$	–	32.2	–	μs	
Read time per word	$t_{\text{a CC}}$	–	50	–	ns	
Data Retention Time	$t_{\text{RET CC}}$	10	–	–	years	Max. 100 erase / program cycles
Flash Wait States ¹⁾	$N_{\text{WSFLASH CC}}$	0	0	0		$f_{\text{MCLK}} = 8 \text{ MHz}$
		0	1	1		$f_{\text{MCLK}} = 16 \text{ MHz}$
		1	2	2		$f_{\text{MCLK}} = 32 \text{ MHz}$
		2	2	3		$f_{\text{MCLK}} = 48 \text{ MHz}$
Erase Cycles	$N_{\text{ECYC CC}}$	–	–	$5 \cdot 10^4$	cycles	Sum of page and sector erase cycles
Total Erase Cycles	$N_{\text{TECYC CC}}$	–	–	$2 \cdot 10^6$	cycles	

1) Flash wait states are automatically inserted by the Flash module during memory read when needed. Typical values are calculated from the execution of the Dhrystone benchmark program.

3.3.2 Power-Up and Supply Threshold Characteristics

Table 26 provides the characteristics of the supply threshold in XMC1400.

The guard band between the lowest valid operating voltage and the brownout reset threshold provides a margin for noise immunity and hysteresis. The electrical parameters may be violated while V_{DDP} is outside its operating range.

The brownout detection triggers a reset within the defined range. The prewarning detection can be used to trigger an early warning and issue corrective and/or fail-safe actions in case of a critical supply voltage drop.

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

Table 26 Power-Up and Supply Threshold Parameters (Operating Conditions apply)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
V_{DDP} ramp-up time	t_{RAMPUP} SR	$V_{DDP}/S_{VDDPrise}$	–	10^7	μs	
V_{DDP} slew rate	S_{VDDPOP} SR	0	–	0.1	$V/\mu s$	Slope during normal operation
	S_{VDDP10} SR	0	–	10	$V/\mu s$	Slope during fast transient within +/- 10% of V_{DDP}
	$S_{VDDPrise}$ SR	0	–	10	$V/\mu s$	Slope during power-on or restart after brownout event
	$S_{VDDPfall}^{1)}$ SR	0	–	0.25	$V/\mu s$	Slope during supply falling out of the +/- 10% limits ²⁾
V_{DDP} prewarning voltage	V_{DDPPW} CC	2.1	2.25	2.4	V	ANAVDEL.VDEL_SELECT = 00 _B
		2.85	3	3.15	V	ANAVDEL.VDEL_SELECT = 01 _B
		4.2	4.4	4.6	V	ANAVDEL.VDEL_SELECT = 10 _B

Table 26 Power-Up and Supply Threshold Parameters (Operating Conditions apply) (cont'd)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
V_{DDP} brownout reset voltage	V_{DDPBO} CC	1.55	1.62	1.75	V	calibrated, before user code starts running
V_{DDP} voltage to ensure defined pad states	V_{DDPPA} CC	–	1.0	–	V	
Start-up time from power-on reset	t_{SSW} SR	–	260	–	μ s	Time to the first user code instruction ³⁾
BMI program time	t_{BMI} SR	–	8.25	–	ms	Time taken from a user-triggered system reset after BMI installation is requested

- 1) A capacitor of at least 100 nF has to be added between V_{DDP} and V_{SSP} to fulfill the requirement as stated for this parameter.
- 2) Valid for a 100 nF buffer capacitor connected to supply pin where current from capacitor is forwarded only to the chip. A larger capacitor value has to be chosen if the power source sink a current.
- 3) This values does not include the ramp-up time. During startup firmware execution, MCLK is running at 48 MHz and the clocks to peripheral as specified in register CGATSTAT0 are gated.

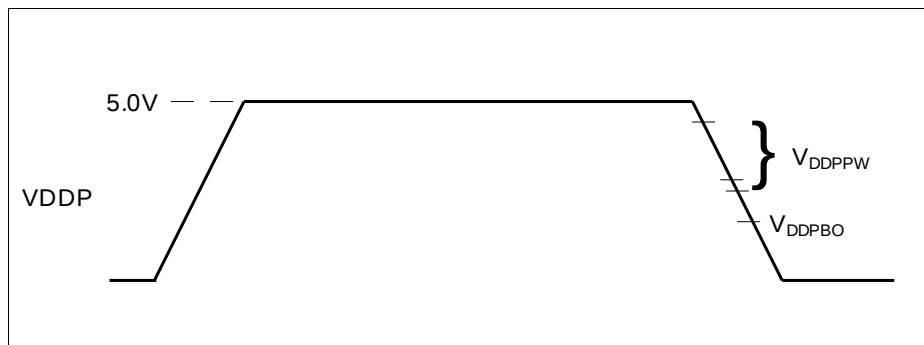


Figure 23 Supply Threshold Parameters

3.3.3 On-Chip Oscillator Characteristics

Table 27 provides the characteristics of the 96 MHz digital controlled oscillator DCO1.

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

Table 27 96 MHz DCO1 Characteristics (Operating Conditions apply)

Parameter	Symbol		Limit Values			Unit	Test Conditions
			Min.	Typ	Max.		
Nominal frequency	f_{NOM}	CC	–	96	–	MHz	under nominal conditions ¹⁾ after trimming
Accuracy with adjustment based on XTAL as reference	Δf_{LTX}	CC	-0.3	–	0.3	%	with respect to $f_{\text{NOM}}(\text{typ})$, over temperature (-40 °C to 105 °C)
Accuracy	Δf_{LT}	CC	-1.7	–	3.4	%	with respect to $f_{\text{NOM}}(\text{typ})$, over temperature (0 °C to 85 °C)
			-3.9	–	4.0	%	with respect to $f_{\text{NOM}}(\text{typ})$, over temperature (-40 °C to 105 °C)

1) The deviation is relative to the factory trimmed frequency at nominal V_{DDC} and $T_{\text{A}} = + 25\text{ °C}$.

Table 28 provides the characteristics of the 32 kHz digital controlled oscillator DCO2.

Table 28 32 kHz DCO2 Characteristics (Operating Conditions apply)

Parameter	Symbol		Limit Values			Unit	Test Conditions
			Min.	Typ.	Max.		
Nominal frequency	f_{NOM}	CC	–	32.75	–	kHz	under nominal conditions ¹⁾ after trimming
Accuracy	Δf_{LT}	CC	-1.7	–	3.4	%	with respect to $f_{\text{NOM}}(\text{typ})$, over temperature (0 °C to 85 °C)
			-3.9	–	4.0	%	with respect to $f_{\text{NOM}}(\text{typ})$, over temperature (-40 °C to 105 °C) ¹⁾

1) The deviation is relative to the factory trimmed frequency at nominal V_{DDC} and $T_{\text{A}} = + 25\text{ °C}$.

Package and Reliability

The difference between junction temperature and ambient temperature is determined by

$$\Delta T = (P_{\text{INT}} + P_{\text{IOSTAT}} + P_{\text{IODYN}}) \times R_{\Theta JA}$$

The internal power consumption is defined as

$$P_{\text{INT}} = V_{\text{DDP}} \times I_{\text{DDP}} \text{ (switching current and leakage current).}$$

The static external power consumption caused by the output drivers is defined as

$$P_{\text{IOSTAT}} = \Sigma((V_{\text{DDP}} - V_{\text{OH}}) \times I_{\text{OH}}) + \Sigma(V_{\text{OL}} \times I_{\text{OL}})$$

The dynamic external power consumption caused by the output drivers (P_{IODYN}) depends on the capacitive load connected to the respective pins and their switching frequencies.

If the total power dissipation for a given system configuration exceeds the defined limit, countermeasures must be taken to ensure proper system operation:

- Reduce V_{DDP} , if possible in the system
- Reduce the system frequency
- Reduce the number of output pins
- Reduce the load on active output drivers

4.2 Package Outlines

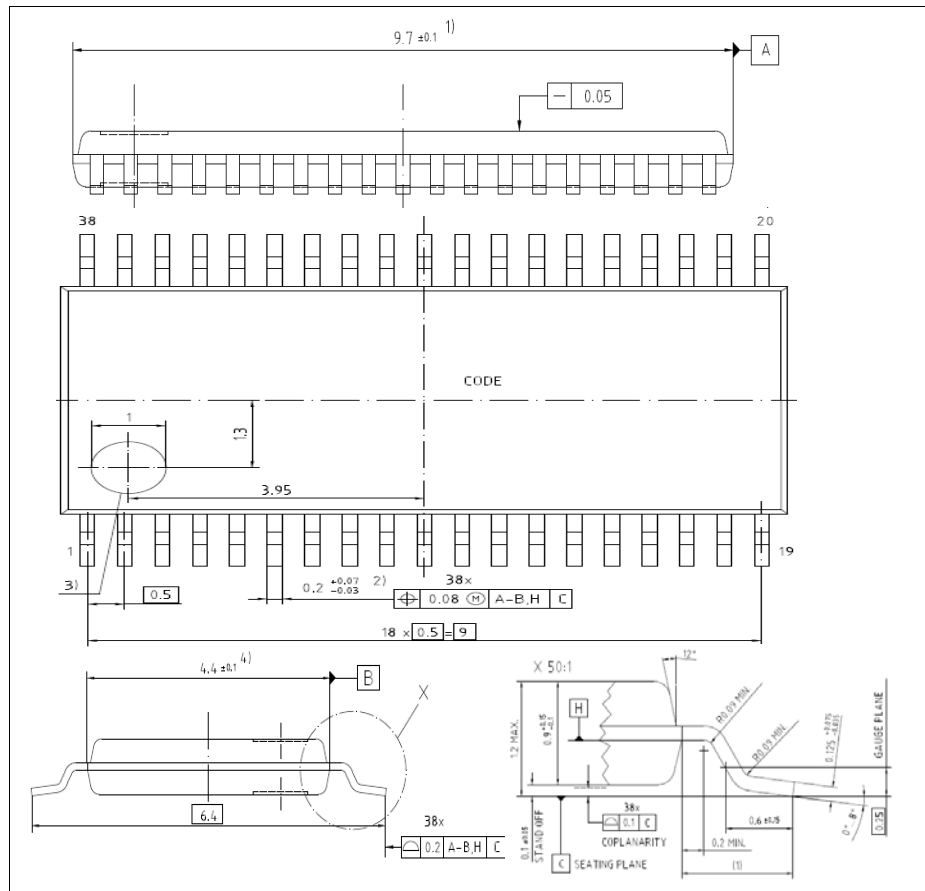


Figure 29 PG-TSSOP-38-9

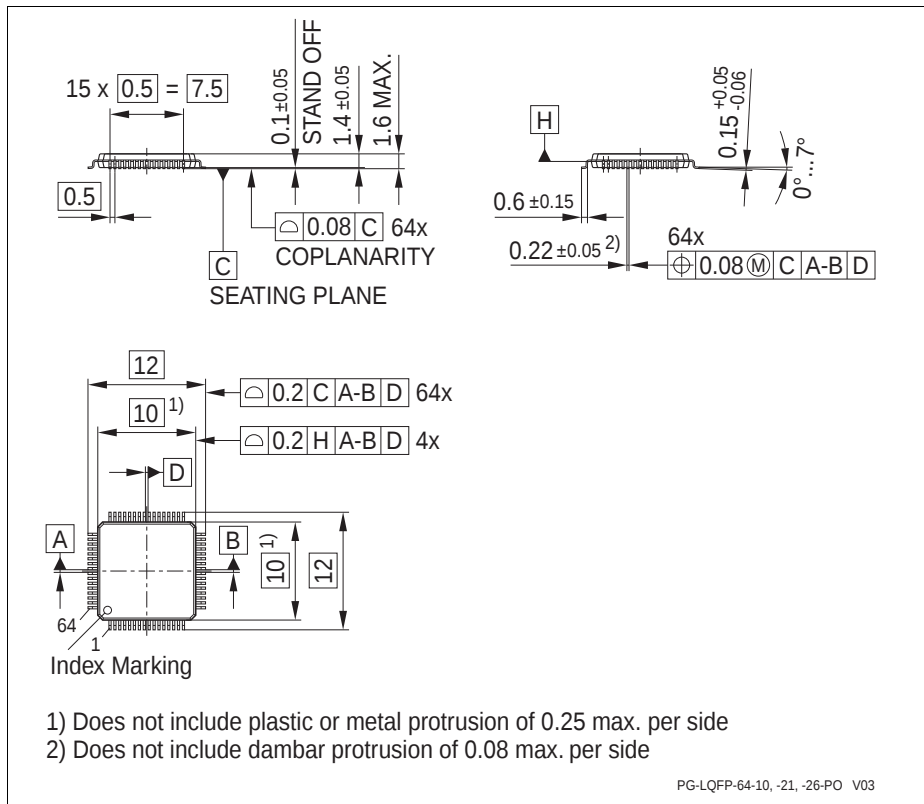


Figure 32 PG-LQFP-64-26