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What is "Embedded - Microcontrollers"?

"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.

Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	e200z0h
Core Size	32-Bit Single-Core
Speed	48MHz
Connectivity	CANbus, I²C, LINbus, SCI, SPI
Peripherals	DMA, POR, PWM, WDT
Number of I/O	79
Program Memory Size	384KB (384K x 8)
Program Memory Type	FLASH
EEPROM Size	64K x 8
RAM Size	28K x 8
Voltage - Supply (Vcc/Vdd)	3V ~ 5.5V
Data Converters	A/D 28x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	100-LQFP
Supplier Device Package	100-LQFP (14x14)
Purchase URL	https://www.e-xfl.com/product-detail/nxp-semiconductors/spc5603bf2cll4

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Table 2 summarizes the functions of all blocks present in the MPC5604B/C series of microcontrollers. Please note that the presence and number of blocks vary by device and package.

Table 2. MPC5604B/C series block summary

Block	Function
Analog-to-digital converter (ADC)	Multi-channel, 10-bit analog-to-digital converter
Boot assist module (BAM)	A block of read-only memory containing VLE code which is executed according to the boot mode of the device
Clock monitor unit (CMU)	Monitors clock source (internal and external) integrity
Cross triggering unit (CTU)	Enables synchronization of ADC conversions with a timer event from the eMIOS or from the PIT
Deserial serial peripheral interface (DSPI)	Provides a synchronous serial interface for communication with external devices
Error Correction Status Module (ECSM)	Provides a myriad of miscellaneous control functions for the device including program-visible information about configuration and revision levels, a reset status register, wakeup control for exiting sleep modes, and optional features such as information on memory errors reported by error-correcting codes
Enhanced Direct Memory Access (eDMA)	Performs complex data transfers with minimal intervention from a host processor via "*n*" programmable channels.
Enhanced modular input output system (eMIOS)	Provides the functionality to generate or measure events
Flash memory	Provides non-volatile storage for program code, constants and variables
FlexCAN (controller area network)	Supports the standard CAN communications protocol
Frequency-modulated phase-locked loop (FMPLL)	Generates high-speed system clocks and supports programmable frequency modulation
Internal multiplexer (IMUX) SIU subblock	Allows flexible mapping of peripheral interface on the different pins of the device
Inter-integrated circuit (I^2C™) bus	A two wire bidirectional serial bus that provides a simple and efficient method of data exchange between devices
Interrupt controller (INTC)	Provides priority-based preemptive scheduling of interrupt requests
JTAG controller	Provides the means to test chip functionality and connectivity while remaining transparent to system logic when not in test mode
LINFlex controller	Manages a high number of LIN (Local Interconnect Network protocol) messages efficiently with a minimum of CPU load
Clock generation module (MC_CGM)	Provides logic and control required for the generation of system and peripheral clocks
Mode entry module (MC_ME)	Provides a mechanism for controlling the device operational mode and mode transition sequences in all functional states; also manages the power control unit, reset generation module and clock generation module, and holds the configuration, control and status registers accessible for applications
Power control unit (MC_PCU)	Reduces the overall power consumption by disconnecting parts of the device from the power supply via a power switching device; device components are grouped into sections called "power domains" which are controlled by the PCU
Reset generation module (MC_RGM)	Centralizes reset sources and manages the device reset sequence of the device

Table 5. Functional port pin descriptions (continued)

Port pin	PCR	Alternate function[1]	Function	Peripheral	I/O direction[2]	Pad type	RESET configuration	Pin number				
								MPC560xB 64 LQFP	MPC560xC 64 LQFP	100 LQFP	144 LQFP	208 MAPBGA[3]
PE[8]	PCR[72]	AF0 AF1 AF2 AF3	GPIO[72] CAN2TX[12] E0UC[22] CAN3TX[11]	SIUL FlexCAN_2 eMIOS_0 FlexCAN_3	I/O O I/O O	M	Tristate	—	—	9	13	G2
PE[9]	PCR[73]	AF0 AF1 AF2 AF3 — — —	GPIO[73] — E0UC[23] — WKPU[7][4] CAN2RX[12] CAN3RX[11]	SIUL — eMIOS_0 — WKPU FlexCAN_2 FlexCAN_3	I/O — I/O — I I I	S	Tristate	—	—	10	14	G1
PE[10]	PCR[74]	AF0 AF1 AF2 AF3 —	GPIO[74] LIN3TX CS3_1 — EIRQ[10]	SIUL LINFlex_3 DSPI_1 — SIUL	I/O O O — I	S	Tristate	—	—	11	15	G3
PE[11]	PCR[75]	AF0 AF1 AF2 AF3 — —	GPIO[75] — CS4_1 — LIN3RX WKPU[14][4]	SIUL — DSPI_1 — LINFlex_3 WKPU	I/O — O — I I	S	Tristate	—	—	13	17	H2
PE[12]	PCR[76]	AF0 AF1 AF2 AF3 — —	GPIO[76] — E1UC[19][13] — SIN_2 EIRQ[11]	SIUL — eMIOS_1 — DSPI_2 SIUL	I/O — I/O — I I	S	Tristate	—	—	76	109	C14
PE[13]	PCR[77]	AF0 AF1 AF2 AF3	GPIO[77] SOUT2 E1UC[20] —	SIUL DSPI_2 eMIOS_1 —	I/O O I/O —	S	Tristate	—	—	—	103	D15
PE[14]	PCR[78]	AF0 AF1 AF2 AF3 —	GPIO[78] SCK_2 E1UC[21] — EIRQ[12]	SIUL DSPI_2 eMIOS_1 — SIUL	I/O I/O I/O — I	S	Tristate	—	—	—	112	C13
PE[15]	PCR[79]	AF0 AF1 AF2 AF3	GPIO[79] CS0_2 E1UC[22] —	SIUL DSPI_2 eMIOS_1 —	I/O I/O I/O —	M	Tristate	—	—	—	113	A13

Table 5. Functional port pin descriptions (continued)

Port pin	PCR	Alternate function[1]	Function	Peripheral	I/O direction[2]	Pad type	RESET configuration	Pin number				
								MPC560xB 64 LQFP	MPC560xC 64 LQFP	100 LQFP	144 LQFP	208 MAPBGA[3]
PH[2]	PCR[114]	AF0 AF1 AF2 AF3	GPIO[114] E1UC[4] SCK_1 —	SIUL eMIOS_1 DSPI_1 —	I/O I/O I/O —	M	Tristate	—	—	—	95	F16
PH[3]	PCR[115]	AF0 AF1 AF2 AF3	GPIO[115] E1UC[5] CS0_1 —	SIUL eMIOS_1 DSPI_1 —	I/O I/O I/O —	M	Tristate	—	—	—	96	F15
PH[4]	PCR[116]	AF0 AF1 AF2 AF3	GPIO[116] E1UC[6] — —	SIUL eMIOS_1 — —	I/O I/O — —	M	Tristate	—	—	—	134	A6
PH[5]	PCR[117]	AF0 AF1 AF2 AF3	GPIO[117] E1UC[7] — —	SIUL eMIOS_1 — —	I/O I/O — —	S	Tristate	—	—	—	135	B6
PH[6]	PCR[118]	AF0 AF1 AF2 AF3	GPIO[118] E1UC[8] — MA[2]	SIUL eMIOS_1 — ADC	I/O I/O — O	M	Tristate	—	—	—	136	D5
PH[7]	PCR[119]	AF0 AF1 AF2 AF3	GPIO[119] E1UC[9] CS3_2 MA[1]	SIUL eMIOS_1 DSPI_2 ADC	I/O I/O O O	M	Tristate	—	—	—	137	C5
PH[8]	PCR[120]	AF0 AF1 AF2 AF3	GPIO[120] E1UC[10] CS2_2 MA[0]	SIUL eMIOS_1 DSPI_2 ADC	I/O I/O O O	M	Tristate	—	—	—	138	A5
PH[9][9]	PCR[121]	AF0 AF1 AF2 AF3	GPIO[121] — TCK —	SIUL — JTAGC —	I/O — I —	S	Input, weak pull-up	60	60	88	127	B8
PH[10][9]	PCR[122]	AF0 AF1 AF2 AF3	GPIO[122] — TMS —	SIUL — JTAGC —	I/O — I —	S	Input, weak pull-up	53	53	81	120	B9

[1] Alternate functions are chosen by setting the values of the PCR.PA bitfields inside the SIUL module. PCR.PA = 00 → AF0; PCR.PA = 01 → AF1; PCR.PA = 10 → AF2; PCR.PA = 11 → AF3. This is intended to select the output functions; to use one of the input functions, the PCR.IBE bit must be written to '1', regardless of the values selected in the PCR.PA bitfields. For this reason, the value corresponding to an input only function is reported as "—".

[2] Multiple inputs are routed to all respective modules internally. The input of some modules must be configured by setting the values of the PSMIO.PADSELx bitfields inside the SIUL module.

[3] 208 MAPBGA available only as development package for Nexus2+

[4] All WKPU pins also support external interrupt capability. See wakeup unit chapter for further details.

[5] NMI has higher priority than alternate function. When NMI is selected, the PCR.AF field is ignored.

[6] "Not applicable" because these functions are available only while the device is booting. Refer to BAM chapter of the reference manual for details.

[7] Value of PCR.IBE bit must be 0

[8] Be aware that this pad is used on the MPC5607B 100-pin and 144-pin to provide VDD_HV_ADC and VSS_HV_ADC1. Therefore, you should be careful in ensuring compatibility between MPC5604B/C and MPC5607B.

[9] Out of reset all the functional pins except PC[0:1] and PH[9:10] are available to the user as GPIO.
PC[0:1] are available as JTAG pins (TDI and TDO respectively).
PH[9:10] are available as JTAG pins (TCK and TMS respectively).
If the user configures these JTAG pins in GPIO mode the device is no longer compliant with IEEE 1149.1-2001.

[10] The TDO pad has been moved into the STANDBY domain in order to allow low-power debug handshaking in STANDBY mode. However, no pull-resistor is active on the TDO pad while in STANDBY mode. At this time the pad is configured as an input. When no debugger is connected the TDO pad is floating causing additional current consumption. To avoid the extra consumption TDO must be connected. An external pull-up resistor in the range of 47–100 kΩ should be added between the TDO pin and VDD_HV. Only in case the TDO pin is used as application pin and a pull-up cannot be used then a pull-down resistor with the same value should be used between TDO pin and GND instead.

[11] Available only on MPC560xC versions, MPC5603B 64 LQFP, MPC5604B 64 LQFP and MPC5604B 208 MAPBGA devices

[12] Not available on MPC5602B devices

[13] Not available in 100 LQFP package

[14] Available only on MPC5604B 208 MAPBGA devices

[15] Not available on MPC5603B 144-pin devices

2.7 Nexus 2+ pins

In the 208 MAPBGA package, eight additional debug pins are available (see Table 6).

Table 6. Nexus 2+ pin descriptions

Debug pin	Function	I/O direction	Pad type	Function after reset	Pin number		
					100 LQFP	144 LQFP	208 MAP BGA
MCKO	Message clock out	O	F	—	—	—	T4
MDO0	Message data out 0	O	M	—	—	—	H15
MDO1	Message data out 1	O	M	—	—	—	H16
MDO2	Message data out 2	O	M	—	—	—	H14
MDO3	Message data out 3	O	M	—	—	—	H13

2.13 Recommended operating conditions

Table 12. Recommended operating conditions (3.3 V)

Symbol		Parameter	Conditions	Value		Unit
				Min	Max	
V_{SS}	SR	Digital ground on VSS_HV pins	—	0	0	V
V_{DD}[1]	SR	Voltage on VDD_HV pins with respect to ground (V_{SS})	—	3.0	3.6	V
V_{SS_LV}[2]	SR	Voltage on VSS_LV (low voltage digital supply) pins with respect to ground (V_{SS})	—	V_{SS}–0.1	V_{SS}+0.1	V
V_{DD_BV}[3]	SR	Voltage on VDD_BV pin (regulator supply) with respect to ground (V_{SS})	—	3.0	3.6	V
			Relative to V_{DD}	V_{DD}–0.1	V_{DD}+0.1	
V_{SS_ADC}	SR	Voltage on VSS_HV_ADC (ADC reference) pin with respect to ground (V_{SS})	—	V_{SS}–0.1	V_{SS}+0.1	V
V_{DD_ADC}[4]	SR	Voltage on VDD_HV_ADC pin (ADC reference) with respect to ground (V_{SS})	—	3.0[5]	3.6	V
			Relative to V_{DD}	V_{DD}–0.1	V_{DD}+0.1	
V_{IN}	SR	Voltage on any GPIO pin with respect to ground (V_{SS})	—	V_{SS}–0.1	—	V
			Relative to V_{DD}	—	V_{DD}+0.1	
I_{INJPAD}	SR	Injected input current on any pin during overload condition	—	–5	5	mA
I_{INJSUM}	SR	Absolute sum of all injected input currents during overload condition	—	–50	50	
TV_{DD}	SR	V_{DD} slope to ensure correct power up[6]	—	3.0[7]	0.25[V/µs])	V/s
T_{A} C-Grade Part	SR	Ambient temperature under bias	$f_{CPU} \leq 64$ MHz	–40	85	°C
T_{J} C-Grade Part	SR	Junction temperature under bias		–40	110	
T_{A} V-Grade Part	SR	Ambient temperature under bias		–40	105	
T_{J} V-Grade Part	SR	Junction temperature under bias		–40	130	
T_{A} M-Grade Part	SR	Ambient temperature under bias		–40	125	
T_{J} M-Grade Part	SR	Junction temperature under bias		–40	150	

1 100 nF capacitance needs to be provided between each V_{DD}/V_{SS} pair

2 330 nF capacitance needs to be provided between each V_{DD_LV}/V_{SS_LV} supply pair.

3 400 nF capacitance needs to be provided between V_{DD_BV} and the nearest V_{SS_LV} (higher value may be needed depending on external regulator characteristics).

4 100 nF capacitance needs to be provided between V_{DD_ADC}/V_{SS_ADC} pair.

5 Full electrical specification cannot be guaranteed when voltage drops below 3.0 V. In particular, ADC electrical characteristics and I/Os DC electrical specification may not be guaranteed. When voltage drops below V_{LVDHVL}, device is reset.

6 Guaranteed by device validation.

7 Minimum value of TV_{DD} must be guaranteed until V_{DD} reaches 2.6 V (maximum value of V_{PORH}).

K is a constant for the particular part, which may be determined from Equation 3 by measuring P_D (at equilibrium) for a known T_A. Using this value of K, the values of P_D and T_J may be obtained by solving equations 1 and 2 iteratively for any value of T_A.

2.15 I/O pad electrical characteristics

2.15.1 I/O pad types

The device provides four main I/O pad types depending on the associated alternate functions:

- Slow pads—These pads are the most common pads, providing a good compromise between transition time and low electromagnetic emission.
- Medium pads—These pads provide transition fast enough for the serial communication channels with controlled current to reduce electromagnetic emission.
- Fast pads—These pads provide maximum speed. There are used for improved Nexus debugging capability.
- Input only pads—These pads are associated to ADC channels and the external 32 kHz crystal oscillator (SXOSC) providing low input leakage.

Medium and Fast pads can use slow configuration to reduce electromagnetic emission, at the cost of reducing AC performance.

2.15.2 I/O input DC characteristics

Table 15 provides input DC electrical characteristics as described in Figure 7.

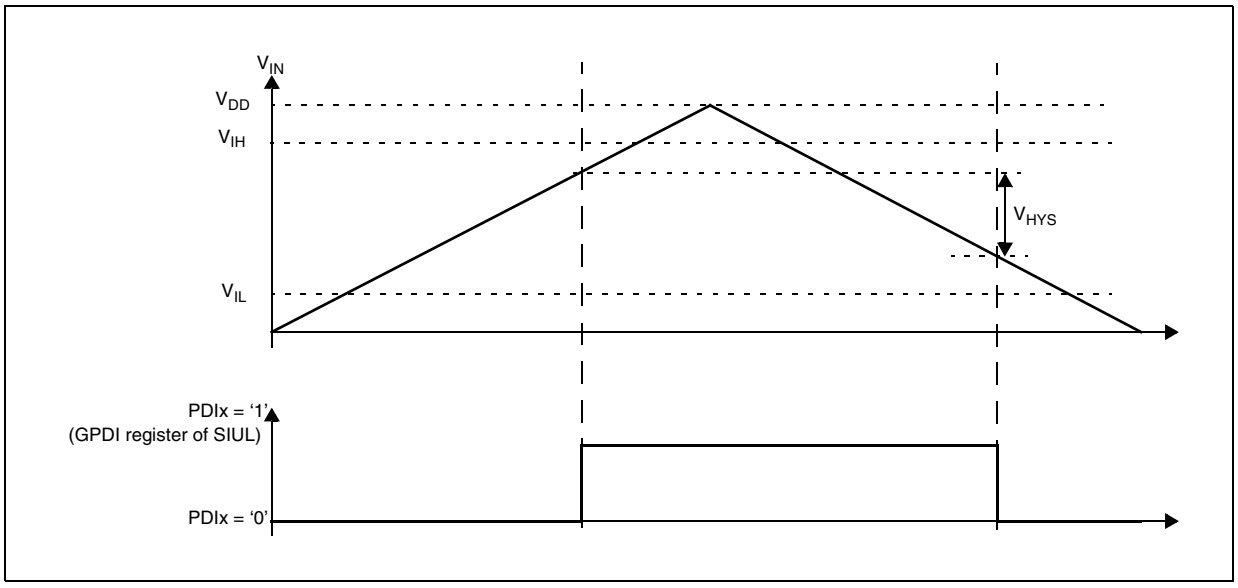


Figure 7. I/O input DC electrical characteristics definition

2.15.4 Output pin transition times

Table 20. Output pin transition times

Symbol		C	Parameter	Conditions[1]		Value			Unit
						Min	Typ	Max	
t_{tr}	CC	D	Output transition time output pin[2] SLOW configuration	C_L = 25 pF	V_{DD} = 5.0 V ± 10%, PAD3V5V = 0	—	—	50	ns
		T		C_L = 50 pF		—	—	100	
		D		C_L = 100 pF		—	—	125	
		D		C_L = 25 pF	V_{DD} = 3.3 V ± 10%, PAD3V5V = 1	—	—	50	
		T		C_L = 50 pF		—	—	100	
		D		C_L = 100 pF		—	—	125	
t_{tr}	CC	D	Output transition time output pin[2] MEDIUM configuration	C_L = 25 pF	V_{DD} = 5.0 V ± 10%, PAD3V5V = 0 SIUL.PCRx.SRC = 1	—	—	10	ns
		T		C_L = 50 pF		—	—	20	
		D		C_L = 100 pF		—	—	40	
		D		C_L = 25 pF	V_{DD} = 3.3 V ± 10%, PAD3V5V = 1 SIUL.PCRx.SRC = 1	—	—	12	
		T		C_L = 50 pF		—	—	25	
		D		C_L = 100 pF		—	—	40	
t_{tr}	CC	D	Output transition time output pin[2] FAST configuration	C_L = 25 pF	V_{DD} = 5.0 V ± 10%, PAD3V5V = 0	—	—	4	ns
				C_L = 50 pF		—	—	6	
				C_L = 100 pF		—	—	12	
				C_L = 25 pF	V_{DD} = 3.3 V ± 10%, PAD3V5V = 1	—	—	4	
				C_L = 50 pF		—	—	7	
				C_L = 100 pF		—	—	12	

1 V_{DD} = 3.3 V ± 10% / 5.0 V ± 10%, T_A = –40 to 125 °C, unless otherwise specified

2 C_L includes device and package capacitances (C_{PKG} < 5 pF).

2.15.5 I/O pad current specification

The I/O pads are distributed across the I/O supply segment. Each I/O supply segment is associated to a V_{DD}/V_{SS} supply pair as described in Table 21.

Table 21. I/O supply segment

Package	Supply segment					
	1	2	3	4	5	6
208 MAPBGA[1]	Equivalent to 144 LQFP segment pad distribution				MCKO	MDOn/MSEO
144 LQFP	pin20–pin49	pin51–pin99	pin100–pin122	pin 123–pin19	—	—
100 LQFP	pin16–pin35	pin37–pin69	pin70–pin83	pin 84–pin15	—	—
64 LQFP	pin8–pin26	pin28–pin55	pin56–pin7	—	—	—

Table 22. I/O consumption (continued)

Symbol		C	Parameter	Conditions[1]	Value			Unit
					Min	Typ	Max	
I_{AVGSEG}	SR	D	Sum of all the static I/O current within a supply segment	V_{DD} = 5.0 V ± 10%, PAD3V5V = 0	—	—	70	mA
				V_{DD} = 3.3 V ± 10%, PAD3V5V = 1	—	—	65	

1 V_{DD} = 3.3 V ± 10% / 5.0 V ± 10%, T_A = –40 to125 °C, unless otherwise specified

2 Stated maximum values represent peak consumption that lasts only a few ns during I/O transition.

Table 23 provides the weight of concurrent switching I/Os.

Due to the dynamic current limitations, the sum of the weight of concurrent switching I/Os on a single segment must not exceed 100% to ensure device functionality.

Table 23. I/O weight[1]

Supply segment			Pad	144/100 LQFP				64 LQFP			
				Weight 5 V		Weight 3.3 V		Weight 5 V		Weight 3.3 V	
144 LQFP	100 LQFP	64 LQFP[2]		SRC[3] = 0	SRC = 1	SRC = 0	SRC = 1	SRC = 0	SRC = 1	SRC = 0	SRC = 1
4	4	3	PB[3]	10%	—	12%	—	10%	—	12%	—
			PC[9]	10%	—	12%	—	10%	—	12%	—
		—	PC[14]	9%	—	11%	—	—	—	—	—
		—	PC[15]	9%	13%	11%	12%	—	—	—	—
	—	—	PG[5]	9%	—	11%	—	—	—	—	—
	—	—	PG[4]	9%	12%	10%	11%	—	—	—	—
	—	—	PG[3]	9%	—	10%	—	—	—	—	—
4	—	—	PG[2]	8%	12%	10%	10%	—	—	—	—
	4	3	PA[2]	8%	—	9%	—	8%	—	9%	—
		—	PE[0]	8%	—	9%	—	—	—	—	—
		3	PA[1]	7%	—	9%	—	7%	—	9%	—
		—	PE[1]	7%	10%	8%	9%	—	—	—	—
		—	PE[8]	7%	9%	8%	8%	—	—	—	—
		—	PE[9]	6%	—	7%	—	—	—	—	—
		—	PE[10]	6%	—	7%	—	—	—	—	—
		3	PA[0]	5%	8%	6%	7%	5%	8%	6%	7%
		—	PE[11]	5%	—	6%	—	—	—	—	—

Table 23. I/O weight[1] (continued)

Supply segment			Pad	144/100 LQFP				64 LQFP			
				Weight 5 V		Weight 3.3 V		Weight 5 V		Weight 3.3 V	
144 LQFP	100 LQFP	64 LQFP[2]		SRC[3] = 0	SRC = 1	SRC = 0	SRC = 1	SRC = 0	SRC = 1	SRC = 0	SRC = 1
2	2	2	PB[13]	10%	—	12%	—	18%	—	21%	—
		—	PD[14]	10%	—	12%	—	—	—	—	—
		2	PB[14]	10%	—	12%	—	18%	—	21%	—
		—	PD[15]	10%	—	11%	—	—	—	—	—
		2	PB[15]	9%	—	11%	—	18%	—	21%	—
			PA[3]	9%	—	11%	—	18%	—	21%	—
	—	—	PG[13]	9%	13%	10%	11%	—	—	—	—
	—	—	PG[12]	9%	12%	10%	11%	—	—	—	—
	—	—	PH[0]	5%	8%	6%	7%	—	—	—	—
	—	—	PH[1]	5%	7%	6%	6%	—	—	—	—
	—	—	PH[2]	5%	6%	5%	6%	—	—	—	—
	—	—	PH[3]	4%	6%	5%	5%	—	—	—	—
	—	—	PG[1]	4%	—	4%	—	—	—	—	—
	—	—	PG[0]	3%	4%	4%	4%	—	—	—	—
3	—	—	PF[15]	3%	—	4%	—	—	—	—	—
	—	—	PF[14]	4%	5%	5%	5%	—	—	—	—
	—	—	PE[13]	4%	—	5%	—	—	—	—	—
	3	2	PA[7]	5%	—	6%	—	16%	—	19%	—
			PA[8]	5%	—	6%	—	16%	—	19%	—
			PA[9]	5%	—	6%	—	15%	—	18%	—
			PA[10]	6%	—	7%	—	15%	—	18%	—
			PA[11]	6%	—	8%	—	14%	—	17%	—
		—	PE[12]	7%	—	8%	—	—	—	—	—
	—	—	PG[14]	7%	—	8%	—	—	—	—	—
	—	—	PG[15]	7%	10%	8%	9%	—	—	—	—
	—	—	PE[14]	7%	—	8%	—	—	—	—	—
	—	—	PE[15]	7%	9%	8%	8%	—	—	—	—
	—	—	PG[10]	6%	—	8%	—	—	—	—	—
	—	—	PG[11]	6%	9%	7%	8%	—	—	—	—
	3	2	PC[3]	6%	—	7%	—	7%	—	9%	—
			PC[2]	6%	8%	7%	7%	6%	9%	8%	8%

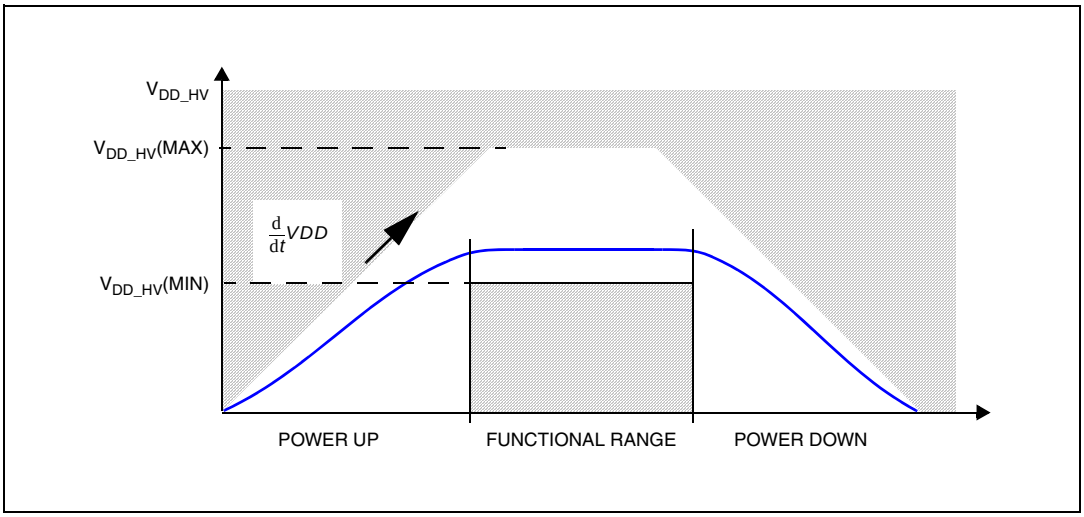


Figure 11. V_{DD_HV} and V_{DD_BV} maximum slope

When STANDBY mode is used, further constraints are applied to the both V_{DD_HV} and V_{DD_BV} in order to guarantee correct regulator function during STANDBY exit. This is described on Figure 12.

STANDBY regulator constraints should normally be guaranteed by implementing equivalent of CSTDBY capacitance on application board (capacitance and ESR typical values), but would actually depend on exact characteristics of application external regulator.

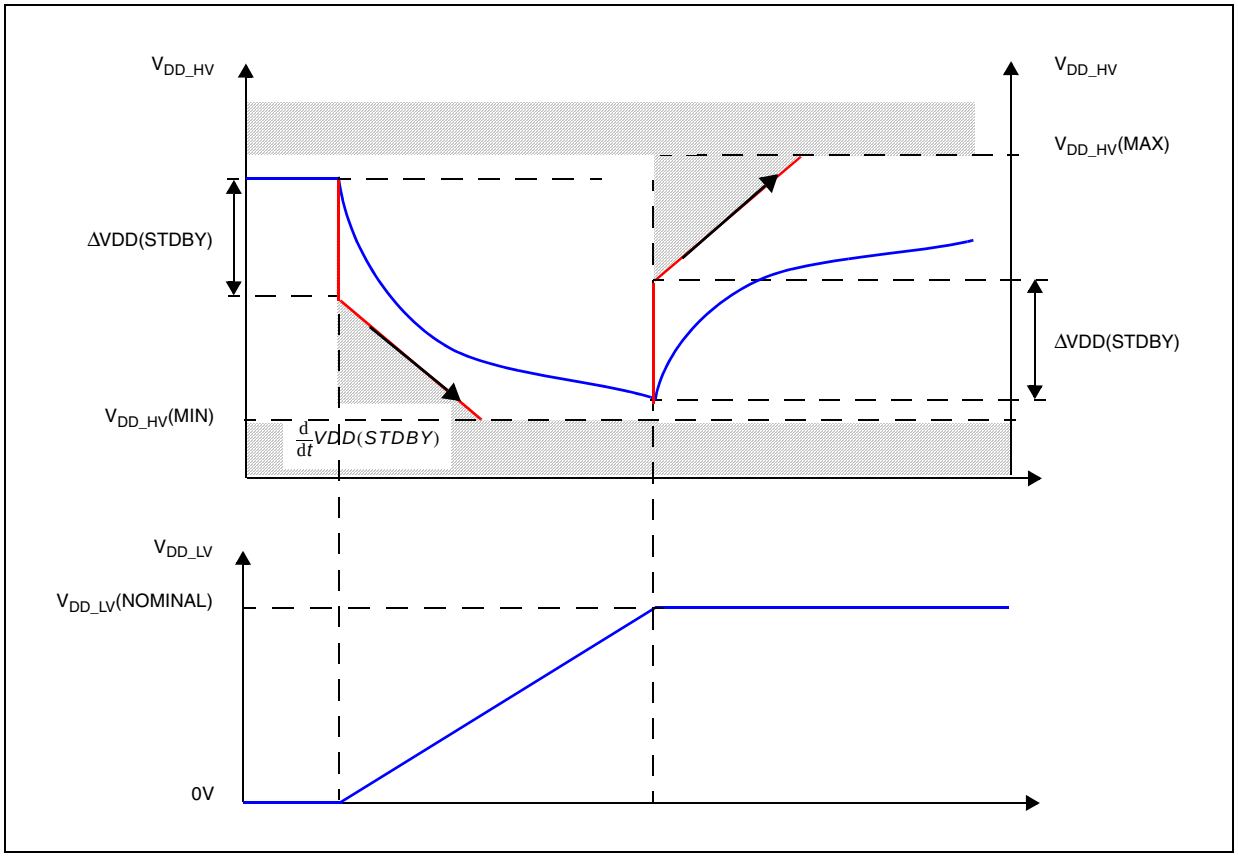


Figure 12. V_{DD_HV} and V_{DD_BV} supply constraints during STANDBY mode exit

5 Only for the “P” classification: Data and Code Flash in Normal Power. Code fetched from RAM: Serial IPs CAN and LIN in loop back mode, DSPI as Master, PLL as system Clock (4 x Multiplier) peripherals on (eMIOS/CTU/ADC) and running at max frequency, periodic SW/WDG timer reset enabled.

6 Data Flash Power Down. Code Flash in Low Power. SIRC (128 kHz) and FIRC (16 MHz) on. 10 MHz XTAL clock. FlexCAN: instances: 0, 1, 2 ON (clocked but not reception or transmission), instances: 4, 5, 6 clock gated. LINFlex: instances: 0, 1, 2 ON (clocked but not reception or transmission), instance: 3 clock gated. eMIOS: instance: 0 ON (16 channels on PA[0]–PA[11] and PC[12]–PC[15]) with PWM 20 kHz, instance: 1 clock gated. DSPI: instance: 0 (clocked but no communication). RTC/API ON. PIT ON. STM ON. ADC ON but not conversion except 2 analog watchdog.

7 Only for the “P” classification: No clock, FIRC (16 MHz) off, SIRC (128 kHz) on, PLL off, HPvreg off, ULPVreg/LPVreg on. All possible peripherals off and clock gated. Flash in power down mode.

8 When going from RUN to STOP mode and the core consumption is > 6 mA, it is normal operation for the main regulator module to be kept on by the on-chip current monitoring circuit. This is most likely to occur with junction temperatures exceeding 125 °C and under these circumstances, it is possible for the current to initially exceed the maximum STOP specification by up to 2 mA. After entering stop, the application junction temperature will reduce to the ambient level and the main regulator will be automatically switched off when the load current is below 6 mA.

9 Only for the “P” classification: ULPreg on, HP/LPVreg off, 32 KB RAM on, device configured for minimum consumption, all possible modules switched off.

10 ULPreg on, HP/LPVreg off, 8 KB RAM on, device configured for minimum consumption, all possible modules switched off.

2.19 Flash memory electrical characteristics

2.19.1 Program/Erase characteristics

Table 28 shows the program and erase characteristics.

Table 28. Program and erase specifications

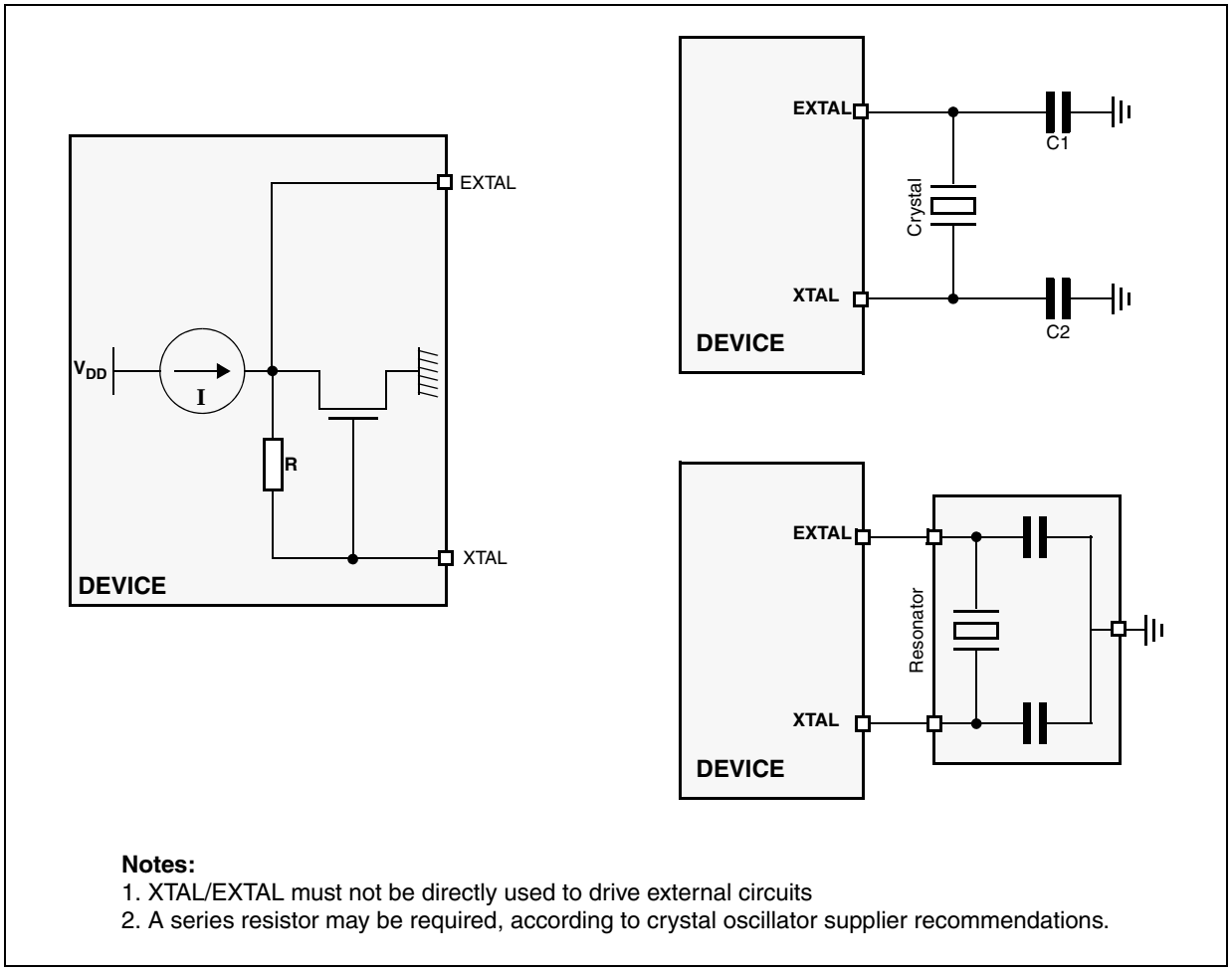
Symbol		C	Parameter	Value				Unit
				Min	Typ[1]	Initial max[2]	Max[3]	
$T_{dwprogram}$	CC	C	Double word (64 bits) program time[4]	—	22	50	500	µs
$T_{16Kpperase}$			16 KB block preprogram and erase time	—	300	500	5000	ms
$T_{32Kpperase}$			32 KB block preprogram and erase time	—	400	600	5000	ms
$T_{128Kpperase}$			128 KB block preprogram and erase time	—	800	1300	7500	ms
T_{esus}	CC	D	Erase suspend latency	—	—	30	30	µs

1 Typical program and erase times assume nominal supply values and operation at 25 °C.

2 Initial factory condition: < 100 program/erase cycles, 25 °C, typical supply voltage.

3 The maximum program and erase times occur after the specified number of program/erase cycles. These maximum values are characterized but not guaranteed.

4 Actual hardware programming times. This does not include software overhead.



Notes:
1. XTAL/EXTAL must not be directly used to drive external circuits
2. A series resistor may be required, according to crystal oscillator supplier recommendations.

Figure 14. Crystal oscillator and resonator connection scheme

Table 36. Crystal description

Nominal frequency (MHz)	NDK crystal reference	Crystal equivalent series resistance ESR Ω	Crystal motional capacitance (C_m) fF	Crystal motional inductance (L_m) mH	Load on xtalin/xtalout C1 = C2 (pF)[1]	Shunt capacitance between xtalout and xtalin C0[2] (pF)
4	NX8045GB	300	2.68	591.0	21	2.93
8	NX5032GA	300	2.46	160.7	17	3.01
10		150	2.93	86.6	15	2.91
12		120	3.11	56.5	15	2.93
16		120	3.90	25.3	10	3.00

1 The values specified for C1 and C2 are the same as used in simulations. It should be ensured that the testing includes all the parasitics (from the board, probe, crystal, etc.) as the AC / transient behavior depends upon them.

2 The value of C0 specified here includes 2 pF additional capacitance for parasitics (to be seen with bond-pads, package, etc.).

2 This is the recommended range of load capacitance at OSC32K_XTAL and OSC32K_EXTAL with respect to ground. It includes all the parasitics due to board traces, crystal and package.

3 Maximum ESR (R_m) of the crystal is 50 kΩ

4 C0 includes a parasitic capacitance of 2.0 pF between OSC32K_XTAL and OSC32K_EXTAL pins

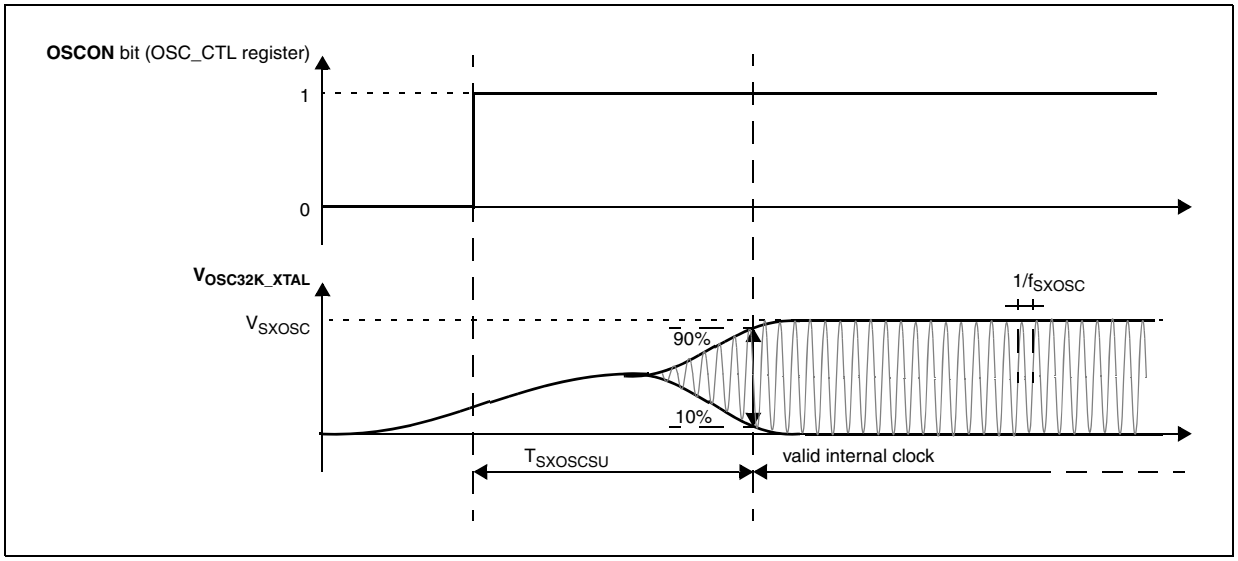


Figure 18. Slow external crystal oscillator (32 kHz) timing diagram

Table 39. Slow external crystal oscillator (32 kHz) electrical characteristics

Symbol		C	Parameter	Conditions[1]	Value			Unit
					Min	Typ	Max	
f_{SXOSC}	SR	—	Slow external crystal oscillator frequency	—	32	32.768	40	kHz
V_{SXOSC}	CC	T	Oscillation amplitude	—	—	2.1	—	V
$I_{SXOSCBIAS}$	CC	T	Oscillation bias current	—	—	2.5	—	µA
I_{SXOSC}	CC	T	Slow external crystal oscillator consumption	—	—	—	8	µA
$T_{SXOSCSU}$	CC	T	Slow external crystal oscillator start-up time	—	—	—	2^2	s

1 V_{DD} = 3.3 V ± 10% / 5.0 V ± 10%, T_A = –40 to 125 °C, unless otherwise specified. Values are specified for no neighbor GPIO pin activity. If oscillator is enabled (OSC32K_XTAL and OSC32K_EXTAL pins), neighboring pins should not toggle.

2 Start-up time has been measured with EPSON TOYOCOM MC306 crystal. Variation may be seen with other crystal.

2.23 FMPLL electrical characteristics

The device provides a frequency-modulated phase-locked loop (FMPLL) module to generate a fast system clock from the main oscillator driver.

be effective: the capacitor should be as large as possible, ideally infinite. This capacitor contributes to attenuating the noise present on the input pin; furthermore, it sources charge during the sampling phase, when the analog signal source is a high-impedance source.

A real filter can typically be obtained by using a series resistance with a capacitor on the input pin (simple RC filter). The RC filtering may be limited according to the value of source impedance of the transducer or circuit supplying the analog signal to be measured. The filter at the input pins must be designed taking into account the dynamic characteristics of the input signal (bandwidth) and the equivalent input impedance of the ADC itself.

In fact a current sink contributor is represented by the charge sharing effects with the sampling capacitance: being C_S and C_{p2} substantially two switched capacitances, with a frequency equal to the conversion rate of the ADC, it can be seen as a resistive path to ground. For instance, assuming a conversion rate of 1 MHz, with C_S+C_{p2} equal to 3 pF, a resistance of 330 kΩ is obtained (R_{EQ} = 1 / (f_c × (C_S+C_{p2})), where f_c represents the conversion rate at the considered channel). To minimize the error induced by the voltage partitioning between this resistance (sampled voltage on C_S+C_{p2}) and the sum of R_S + R_F, the external circuit must be designed to respect the Equation 4:

Eqn. 4

$$V_A \bullet \frac{R_S + R_F}{R_{EQ}} < \frac{1}{2} LSB$$

Equation 4 generates a constraint for external network design, in particular on a resistive path.

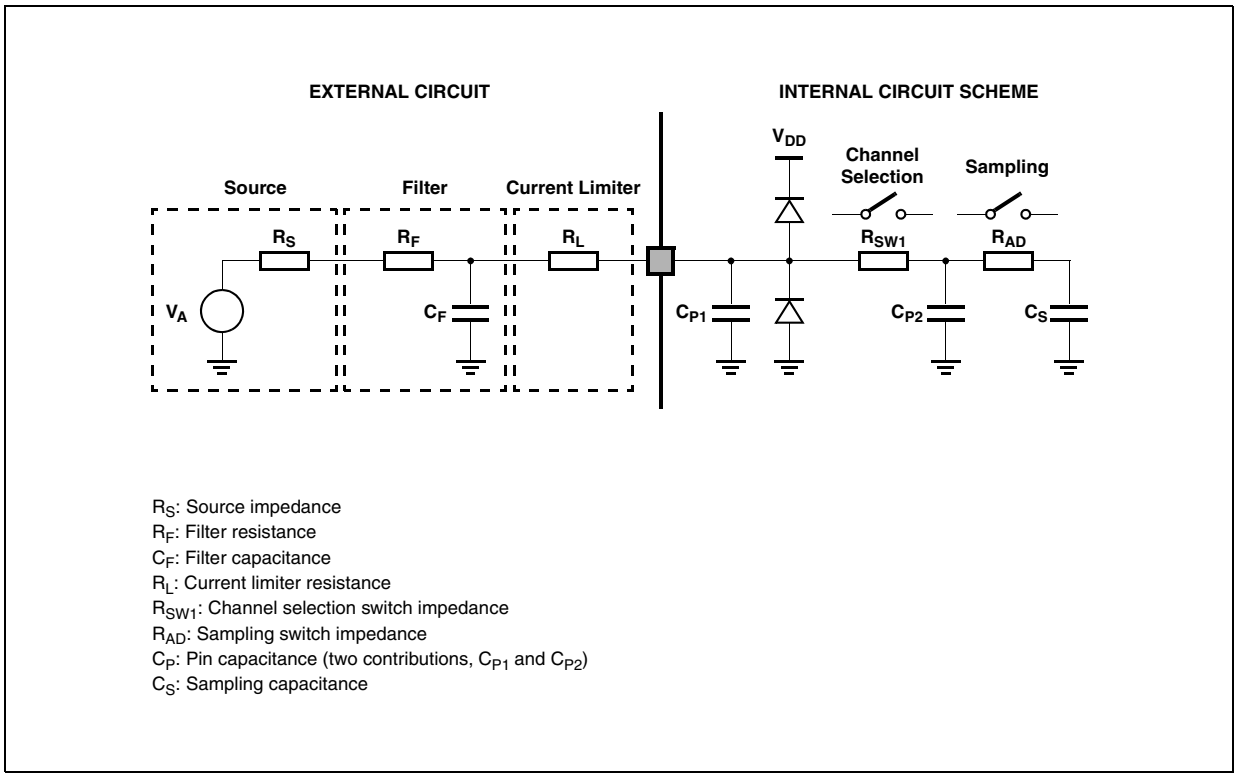


Figure 20. Input equivalent circuit (precise channels)

2.27.2 DSPI characteristics

Table 46. DSPI characteristics[1]

No.	Symbol		C	Parameter		DSPI0/DSPI1			DSPI2			Unit
						Min	Typ	Max	Min	Typ	Max	
1	t_{SCK}	SR	D	SCK cycle time	Master mode (MTFE = 0)	125	—	—	333	—	—	ns
			D		Slave mode (MTFE = 0)	125	—	—	333	—	—	
			D		Master mode (MTFE = 1)	83	—	—	125	—	—	
			D		Slave mode (MTFE = 1)	83	—	—	125	—	—	
—	f_{DSPI}	SR	D	DSPI digital controller frequency		—	—	f_{CPU}	—	—	f_{CPU}	MHz
—	Δt_{CSC}	CC	D	Internal delay between pad associated to SCK and pad associated to CSn in master mode for CSn1→0	Master mode	—	—	130[2]	—	—	15[3]	ns
—	Δt_{ASC}	CC	D	Internal delay between pad associated to SCK and pad associated to CSn in master mode for CSn1→1	Master mode	—	—	130[3]	—	—	130[3]	ns
2	t_{CSCext}[4]	SR	D	CS to SCK delay	Slave mode	32	—	—	32	—	—	ns
3	t_{ASCext}[5]	SR	D	After SCK delay	Slave mode	$1/f_{DSPI} + 5$	—	—	$1/f_{DSPI} + 5$	—	—	ns
4	t_{SDC}	CC	D	SCK duty cycle	Master mode	—	$t_{SCK}/2$	—	—	$t_{SCK}/2$	—	ns
		SR	D		Slave mode	$t_{SCK}/2$	—	—	$t_{SCK}/2$	—	—	
5	t_A	SR	D	Slave access time	Slave mode	—	—	$1/f_{DSPI} + 70$	—	—	$1/f_{DSPI} + 130$	ns
6	t_{DI}	SR	D	Slave SOUT disable time	Slave mode	7	—	—	7	—	—	ns
7	t_{PCSC}	SR	D	PCSx to $\overline{PCSS}$ time		0	—	—	0	—	—	ns
8	t_{PASC}	SR	D	$\overline{PCSS}$ to PCSx time		0	—	—	0	—	—	ns
9	t_{SUI}	SR	D	Data setup time for inputs	Master mode	43	—	—	145	—	—	ns
					Slave mode	5	—	—	5	—	—	
10	t_{HI}	SR	D	Data hold time for inputs	Master mode	0	—	—	0	—	—	ns
					Slave mode	2^6	—	—	2^6	—	—	
11	t_{SUO}[7]	CC	D	Data valid after SCK edge	Master mode	—	—	32	—	—	50	ns
					Slave mode	—	—	52	—	—	160	
12	t_{HO}[7]	CC	D	Data hold time for outputs	Master mode	0	—	—	0	—	—	ns
					Slave mode	8	—	—	13	—	—	

[1] Operating conditions: C_L = 10 to 50 pF, $Slew_{IN}$ = 3.5 to 15 ns.

[2] Maximum value is reached when CSn pad is configured as SLOW pad while SCK pad is configured as MEDIUM. A positive value means that SCK starts before CSn is asserted. DSPI2 has only SLOW SCK available.

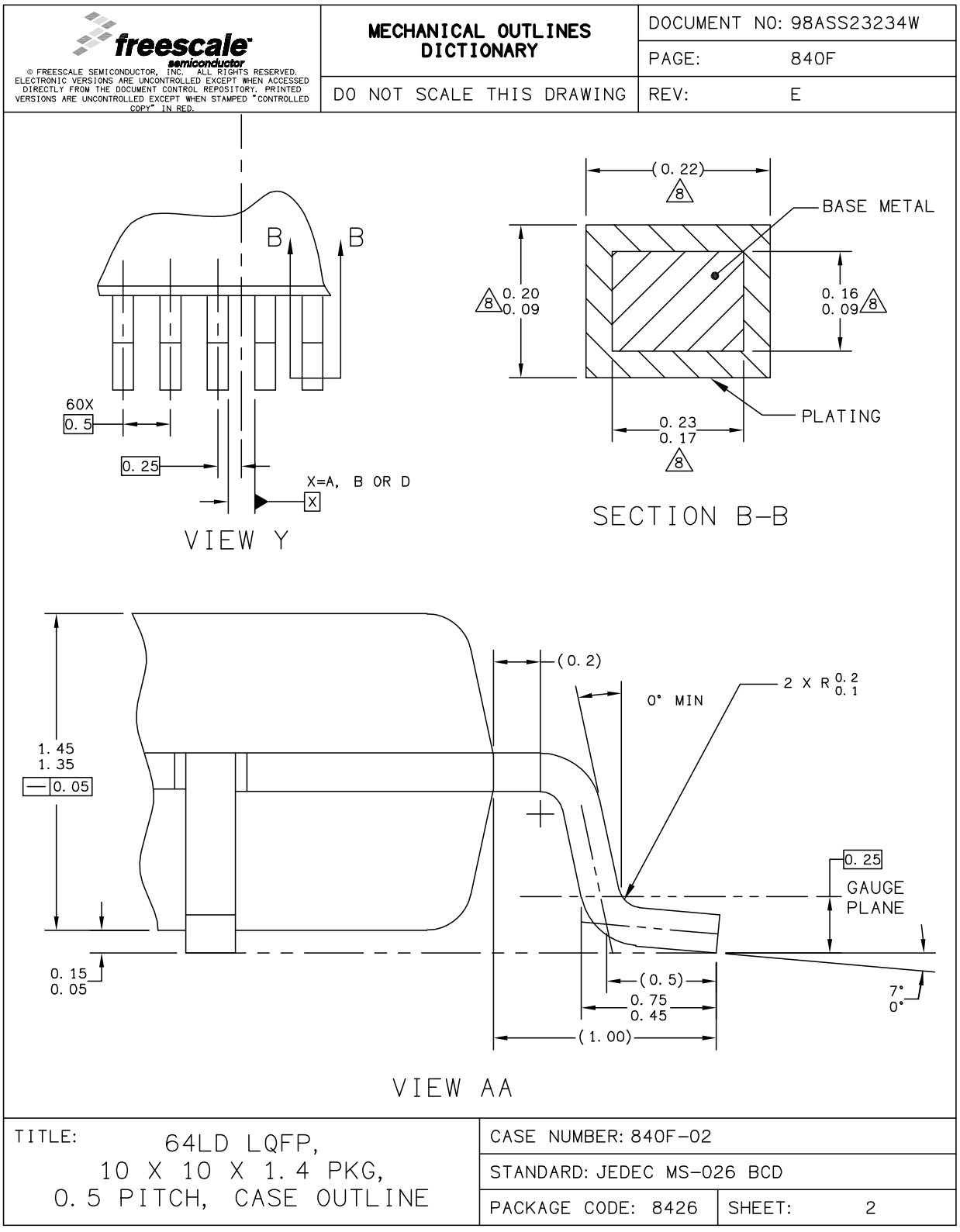


Figure 36. 64 LQFP package mechanical drawing (2 of 3)

3.1.2 100 LQFP

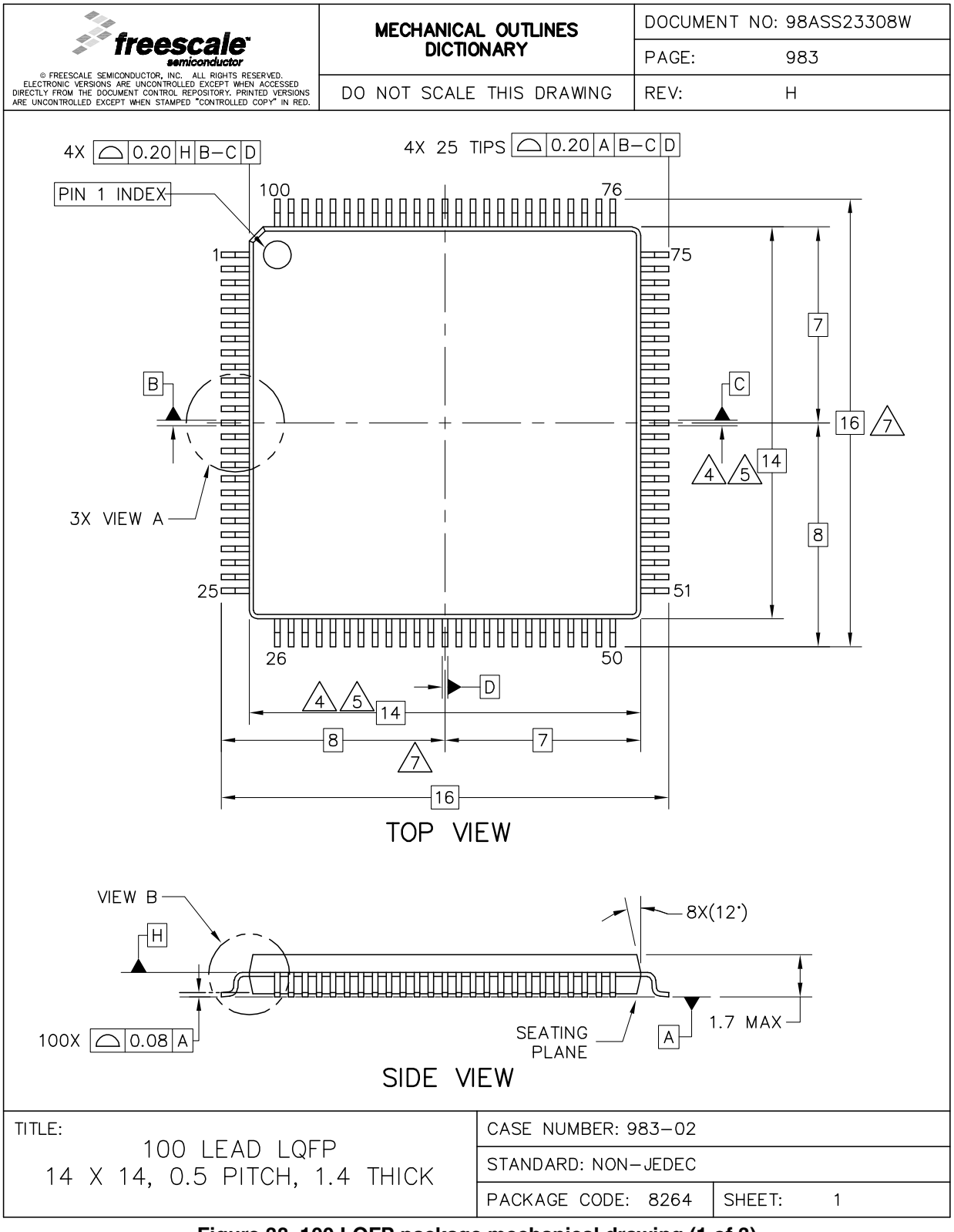


Figure 38. 100 LQFP package mechanical drawing (1 of 3)

Table 49. Revision history (continued)

Revision	Date	Description of Changes
6	15-Mar-2010	In the “Introduction” section, relocated a note. In the “MPC5604B/C device comparison” table, added footnote regarding SCI and CAN. In the “Absolute maximum ratings” table, removed the min value of V_{IN} relative to V_{DD}. In the “Recommended operating conditions (3.3 V)” table: • $T_{A\ C\text{-}Grade\ Part}$, $T_{J\ C\text{-}Grade\ Part}$, $T_{A\ V\text{-}Grade\ Part}$, $T_{J\ V\text{-}Grade\ Part}$, $T_{A\ M\text{-}Grade\ Part}$, $T_{J\ M\text{-}Grade\ Part}$: added new rows. • TV_{DD}: made single row. In the “LQFP thermal characteristics” table, added more rows. Removed “208 MAPBGA thermal characteristics” table. In the “I/O consumption” table: • Removed I_{DYNSEG} row. • Added “I/O weight” table. In the “Voltage regulator electrical characteristics” table: • Updated the values. • Removed $I_{VREGREF}$ and $I_{VREDLVD12}$. • Added a note about I_{DD_BC}. In the “Low voltage monitor electrical characteristics” table: • Updated V_{PORH} values. • Updated $V_{LVDLVCORL}$ value. Entirely updated the “Low voltage power domain electrical characteristics” table. In the “Program and erase specifications” table, inserted T_{eslat} row. Entirely updated the “Flash power supply DC electrical characteristics” table. Entirely updated the “Start-up time/Switch-off time” table. In the “Crystal oscillator and resonator connection scheme” figure, relocated a note. In the “Slow external crystal oscillator (32 kHz) electrical characteristics” table: • Removed g_{mSXOSC} row. • Inserted values of $I_{SXOSCBIAS}$. Entirely updated the “Fast internal RC oscillator (16 MHz) electrical characteristics” table. In the “ADC conversion characteristics” table: updated the description of the conditions of t_{ADC_PU} and t_{ADC_S}. Entirely updated the “DSPI characteristics” table. In the “Orderable part number summary” table, modified some orderable part number. Updated the “Commercial product code structure” figure. Removed the note about the condition from “Flash read access timing” table Removed the notes that assert the values need to be confirmed before validation Exchanged the order of “LQFP 100-pin configuration” and “LQFP 144-pin configuration” Exchanged the order of “LQFP 100-pin package mechanical drawing” and “LQFP 144-pin package mechanical drawing”

Table 49. Revision history (continued)

Revision	Date	Description of Changes
10	15 Oct 2012	Table 2 (Bolero 512K device comparison), added footnote for MPC5603BxLH and MPC5604BxLH about FlexCAN availability. Table 2 (MPC5604B/C series block summary), replaced “System watchdog timer” with “Software watchdog timer” and specified AUTOSAR (Automotive Open System Architecture) Table 5 (Functional port pin descriptions): replaced footnote “Available only on MPC560xC versions and MPC5604B 208 MAPBGA devices” with “Available only on MPC560xC versions, MPC5603B 64 LQFP, MPC5604B 64 LQFP and MPC5604B 208 MAPBGA devices”, replaced VDD with VDD_HV Figure 10 (Voltage regulator capacitance connection), updated pin name appearance Renamed Figure 11 (V_{DD_HV} and V_{DD_BV} maximum slope) (was “VDD and VDD_BV maximum slope”) Renamed Figure 12 (V_{DD_HV} and V_{DD_BV} supply constraints during STANDBY mode exit) (was “VDD and VDD_BV supply constraints during STANDBY mode exit”) Table 12 (Recommended operating conditions (3.3 V)), added minimum value of T_{VDD} and footnote about it. Table 13 (Recommended operating conditions (5.0 V)), added minimum value of T_{VDD} and footnote about it. Section 2.17.1, “Voltage regulator electrical characteristics: replaced “slew rate of V_{DD}/V_{DD_BV}” with “slew rate of both V_{DD_HV} and V_{DD_BV}” replaced “When STANDBY mode is used, further constraints apply to the V_{DD}/V_{DD_BV} in order to guarantee correct regulator functionality during STANDBY exit.” with “When STANDBY mode is used, further constraints are applied to the both V_{DD_HV} and V_{DD_BV} in order to guarantee correct regulator function during STANDBY exit.” Table 27 (Power consumption on VDD_BV and VDD_HV), updated footnotes of I_{DDMAX} and I_{DDRUN} stating that both currents are drawn only from the V_{DD_BV} pin. Table 31 (Flash memory power supply DC electrical characteristics), in the parameter column replaced V_{DD_BV} and V_{DD_HV} respectively with VDD_BV and VDD_HV. Table 45 (On-chip peripherals current consumption), in the parameter column replaced V_{DD_BV}, V_{DD_HV} and $V_{DD\_HV\_ADC}$ respectively with VDD_BV, VDD_HV and VDD_HV_ADC Updated Section 2.26.2, “Input impedance and ADC accuracy Table 46 (DSPI characteristics), modified symbol for t_{PCSC} and t_{PASC}
11	14 Nov 2012	In the cover feature list: added “and ECC” at the end of “Up to 512 KB on-chip code flash supported with the flash controller” added “with ECC” at the end of “Up to 48 KB on-chip SRAM” Table 12 (Recommended operating conditions (3.3 V)), removed minimum value of T_{VDD} and relative footnote. Table 13 (Recommended operating conditions (5.0 V)), removed minimum value of T_{VDD} and relative footnote.
12	19 Mar 2014	Added “K=TSMC Fab” against the Fab and mask indicator in Figure 45 (Commercial product code structure).