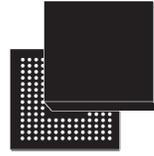
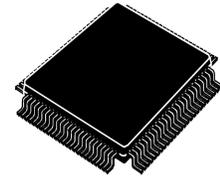


## MPC5607B Microcontroller Data Sheet

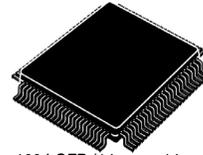
### MPC5607B



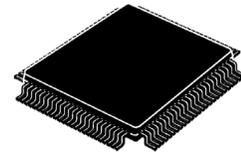
208 MAPBGA (17 mm x 17 mm)



144 LQFP (20 mm x 20 mm)



100 LQFP (14 mm x 14 mm)



LQFP176 (24 mm x 24 mm)

#### Features

- Single issue, 32-bit CPU core complex (e200z0h)
  - Compliant with the Power Architecture® technology embedded category
  - Enhanced instruction set allowing variable length encoding (VLE) for code size footprint reduction. With the optional encoding of mixed 16-bit and 32-bit instructions, it is possible to achieve significant code size footprint reduction.
- Up to 1.5 MB on-chip code flash memory supported with the flash memory controller
- 64 (4 × 16) KB on-chip data flash memory with ECC
- Up to 96 KB on-chip SRAM
- Memory protection unit (MPU) with 8 region descriptors and 32-byte region granularity on certain family members (Refer to [Table 1](#) for details.)
- Interrupt controller (INTC) capable of handling 204 selectable-priority interrupt sources
- Frequency modulated phase-locked loop (FMPLL)
- Crossbar switch architecture for concurrent access to peripherals, Flash, or RAM from multiple bus masters
- 16-channel eDMA controller with multiple transfer request sources using DMA multiplexer
- Boot assist module (BAM) supports internal Flash programming via a serial link (CAN or SCI)
- Timer supports I/O channels providing a range of 16-bit input capture, output compare, and pulse width modulation functions (eMIOS)
- 2 analog-to-digital converters (ADC): one 10-bit and one 12-bit
- Cross Trigger Unit to enable synchronization of ADC conversions with a timer event from the eMIOS or PIT
- Up to 6 serial peripheral interface (DSPI) modules
- Up to 10 serial communication interface (LINFlex) modules
- Up to 6 enhanced full CAN (FlexCAN) modules with configurable buffers
- 1 inter-integrated circuit (I<sup>2</sup>C) interface module
- Up to 149 configurable general purpose pins supporting input and output operations (package dependent)
- Real-Time Counter (RTC)
- Clock source from internal 128 kHz or 16 MHz oscillator supporting autonomous wakeup with 1 ms resolution with maximum timeout of 2 seconds
- Optional support for RTC with clock source from external 32 kHz crystal oscillator, supporting wakeup with 1 sec resolution and maximum timeout of 1 hour
- Up to 8 periodic interrupt timers (PIT) with 32-bit counter resolution
- Nexus development interface (NDI) per IEEE-ISTO 5001-2003 Class Two Plus
- Device/board boundary scan testing supported per Joint Test Action Group (JTAG) of IEEE (IEEE 1149.1)
- On-chip voltage regulator (VREG) for regulation of input supply for all internal levels

# Table of Contents

|       |   |    |        |   |     |
|-------|---|----|--------|---|-----|
| 1     | Introduction                                    | 3  | 4.9.1  | Program/erase characteristics   | 63  |
| 1.1   | Description                                     | 3  | 4.9.2  | Flash power supply DC characteristics                                     | 64  |
| 2     | Block diagram                                   | 5  | 4.9.3  | Start-up/Switch-off timings   | 65  |
| 3     | Package pinouts and signal descriptions         | 8  | 4.10   | Electromagnetic compatibility (EMC) characteristics                       | 65  |
| 3.1   | Package pinouts                                 | 8  | 4.10.1 | Designing hardened software to avoid noise problems                       | 65  |
| 3.2   | Pad configuration during reset phases           | 11 | 4.10.2 | Electromagnetic interference (EMI)  | 66  |
| 3.3   | Pad configuration during standby mode exit      | 12 | 4.10.3 | Absolute maximum ratings (electrical sensitivity)                         | 66  |
| 3.4   | Voltage supply pins                             | 12 | 4.11   | Fast external crystal oscillator (4 to 16 MHz) electrical characteristics | 67  |
| 3.5   | Pad types                                       | 13 | 4.12   | Slow external crystal oscillator (32 kHz) electrical characteristics      | 70  |
| 3.6   | System pins                                     | 13 | 4.13   | FMPLL electrical characteristics  | 72  |
| 3.7   | Functional port pins                            | 14 | 4.14   | Fast internal RC oscillator (16 MHz) electrical characteristics           | 73  |
| 3.8   | Nexus 2+ pins                                   | 34 | 4.15   | Slow internal RC oscillator (128 kHz) electrical characteristics          | 74  |
| 4     | Electrical characteristics                      | 34 | 4.16   | ADC electrical characteristics  | 75  |
| 4.1   | Parameter classification                        | 35 | 4.16.1 | Introduction  | 75  |
| 4.2   | NVUSRO register                                 | 35 | 4.16.2 | Input impedance and ADC accuracy  | 76  |
| 4.2.1 | NVUSRO[PAD3V5V] field description               | 35 | 4.16.3 | ADC electrical characteristics  | 81  |
| 4.2.2 | NVUSRO[OSCILLATOR_MARGIN] field description     | 36 | 4.17   | On-chip peripherals   | 86  |
| 4.2.3 | NVUSRO[WATCHDOG_EN] field description           | 36 | 4.17.1 | Current consumption   | 86  |
| 4.3   | Absolute maximum ratings                        | 36 | 4.17.2 | DSPI characteristics  | 88  |
| 4.4   | Recommended operating conditions                | 37 | 4.17.3 | Nexus characteristics   | 94  |
| 4.5   | Thermal characteristics                         | 40 | 4.17.4 | JTAG characteristics  | 95  |
| 4.5.1 | External ballast resistor recommendations       | 40 | 5      | Package characteristics   | 97  |
| 4.5.2 | Package thermal characteristics                 | 40 | 5.1    | Package mechanical data   | 97  |
| 4.5.3 | Power considerations                            | 41 | 5.1.1  | 176 LQFP  | 97  |
| 4.6   | I/O pad electrical characteristics              | 42 | 5.1.2  | 144 LQFP  | 100 |
| 4.6.1 | I/O pad types                                   | 42 | 5.1.3  | 100 LQFP  | 102 |
| 4.6.2 | I/O input DC characteristics                    | 42 | 5.1.4  | 208 MAPBGA  | 105 |
| 4.6.3 | I/O output DC characteristics                   | 43 | 6      | Ordering information  | 107 |
| 4.6.4 | Output pin transition times                     | 46 | 7      | Revision history  | 109 |
| 4.6.5 | I/O pad current specification                   | 47 |        |   |     |
| 4.6.6 | RESET electrical characteristics                | 54 |        |   |     |
| 4.7   | Power management electrical characteristics     | 57 |        |   |     |
| 4.7.1 | Voltage regulator electrical characteristics    | 57 |        |   |     |
| 4.7.2 | Low voltage detector electrical characteristics | 59 |        |   |     |
| 4.8   | Power consumption                               | 61 |        |   |     |
| 4.9   | Flash memory electrical characteristics         | 63 |        |   |     |

# 1 Introduction

This document describes the features of the family and options available within the family members, and highlights important electrical and physical characteristics of the device.

## 1.1 Description

This family of 32-bit system-on-chip (SoC) microcontrollers is the latest achievement in integrated automotive application controllers. It belongs to an expanding family of automotive-focused products designed to address the next wave of body electronics applications within the vehicle.

The advanced and cost-efficient e200z0h host processor core of this automotive controller family complies with the Power Architecture technology and only implements the VLE (variable-length encoding) APU (Auxiliary Processor Unit), providing improved code density. It operates at speeds of up to 64 MHz and offers high performance processing optimized for low power consumption. It capitalizes on the available development infrastructure of current Power Architecture devices and is supported with software drivers, operating systems and configuration code to assist with users implementations.

**Table 1. MPC5607B family comparison<sup>1</sup>**

| Feature  | MPC5605B         |               |       | MPC5606B |       | MPC5607B |
|--|------------------|---------------|-------|----------|-------|----------|
| CPU  | e200z0h          |               |       |          |       |          |
| Execution speed <sup>2</sup>                     | Up to 64 MHz     |               |       |          |       |          |
| Code flash memory                                | 768 KB           |               |       | 1 MB     |       | 1.5 MB   |
| Data flash memory                                | 64 (4 × 16) KB   |               |       |          |       |          |
| SRAM   | 64 KB            |               |       | 80 KB    |       | 96 KB    |
| MPU  | 8-entry          |               |       |          |       |          |
| eDMA   | 16 ch            |               |       |          |       |          |
| 10-bit ADC                                       | Yes              |               |       |          |       |          |
| dedicated <sup>3</sup>                           | 7 ch             | 15 ch         | 29 ch | 15 ch    | 29 ch |          |
| shared with 12-bit ADC                           | 19 ch            |               |       |          |       |          |
| 12-bit ADC                                       | Yes              |               |       |          |       |          |
| dedicated <sup>4</sup>                           | 5 ch             |               |       |          |       |          |
| shared with 10-bit ADC                           | 19 ch            |               |       |          |       |          |
| Total timer I/O <sup>5</sup> eMIOS               | 37 ch,<br>16-bit | 64 ch, 16-bit |       |          |       |          |
| Counter / OPWM / ICOC <sup>6</sup>               | 10 ch            |               |       |          |       |          |
| O(I)PWM / OPWFMB /<br>OPWMCB / ICOC <sup>7</sup> | 7 ch             |               |       |          |       |          |
| O(I)PWM / ICOC <sup>8</sup>                      | 7 ch             | 14 ch         |       |          |       |          |
| OPWM / ICOC <sup>9</sup>                         | 13 ch            | 33 ch         |       |          |       |          |
| SCI (LINFlex)                                    | 4                | 8             |       |          |       | 10       |
| SPI (DSPI)                                       | 3                | 5             | 6     | 5        | 6     |          |
| CAN (FlexCAN)                                    | 6                |               |       |          |       |          |
| I <sup>2</sup> C                                 | 1                |               |       |          |       |          |

**Table 1. MPC5607B family comparison<sup>1</sup> (continued)**

| Feature            | MPC5605B |          |          | MPC5606B |          | MPC5607B |                           |
|--------------------|----------|----------|----------|----------|----------|----------|---------------------------|
| 32 KHz oscillator  | Yes      |          |          |          |          |          |                           |
| GPIO <sup>10</sup> | 77       | 121      | 149      | 121      | 149      |          |                           |
| Debug              | JTAG     |          |          |          |          |          | N2+                       |
| Package            | 100 LQFP | 144 LQFP | 176 LQFP | 144 LQFP | 176 LQFP | 176 LQFP | 208 MAP BGA <sup>11</sup> |

- <sup>1</sup> Feature set dependent on selected peripheral multiplexing; table shows example
- <sup>2</sup> Based on 125 °C ambient operating temperature
- <sup>3</sup> Not shared with 12-bit ADC, but possibly shared with other alternate functions
- <sup>4</sup> Not shared with 10-bit ADC, but possibly shared with other alternate functions
- <sup>5</sup> See the eMIOS section of the chip reference manual for information on the channel configuration and functions.
- <sup>6</sup> Each channel supports a range of modes including Modulus counters, PWM generation, Input Capture, Output Compare.
- <sup>7</sup> Each channel supports a range of modes including PWM generation with dead time, Input Capture, Output Compare.
- <sup>8</sup> Each channel supports a range of modes including PWM generation, Input Capture, Output Compare, Period and Pulse width measurement.
- <sup>9</sup> Each channel supports a range of modes including PWM generation, Input Capture, and Output Compare.
- <sup>10</sup> Maximum I/O count based on multiplexing with peripherals
- <sup>11</sup> 208 MAPBGA available only as development package for Nexus2+

## 2 Block diagram

Figure 1 shows a top-level block diagram of the MPC5607B.

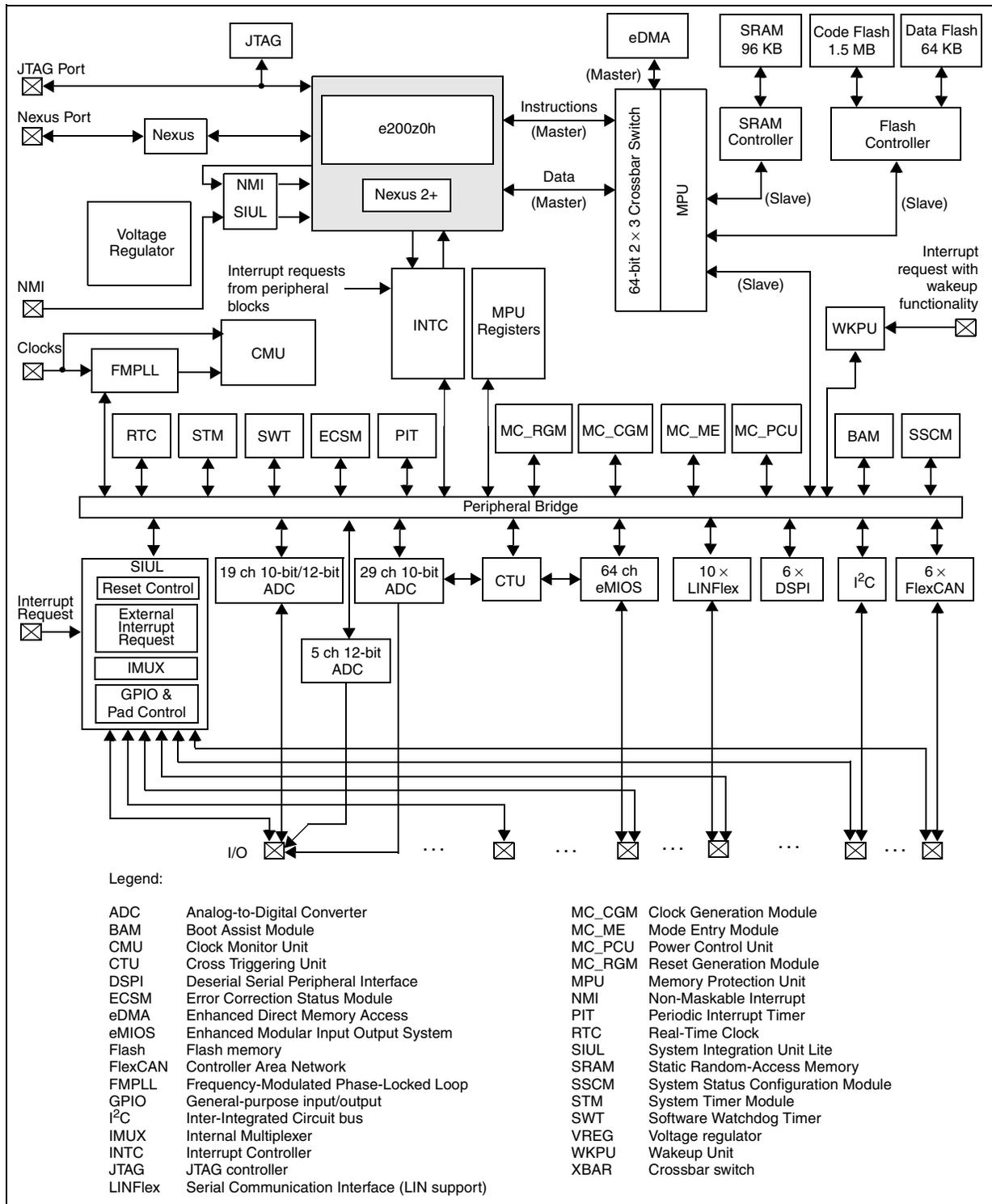


Figure 1. MPC5607B block diagram

Table 2 summarizes the functions of the blocks present on the MPC5607B.

Table 2. MPC5607B series block summary

| Block   | Function  |
|---|---|
| Analog-to-digital converter (ADC)               | Converts analog voltages to digital values  |
| 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 generation module (MC_CGM)                | Provides logic and control required for the generation of system and peripheral clocks  |
| 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  |
| Crossbar switch (XBAR)                          | Supports simultaneous connections between two master ports and three slave ports. The crossbar supports a 32-bit address bus width and a 64-bit data bus width.   |
| Deserial serial peripheral interface (DSPI)     | Provides a synchronous serial interface for communication with external devices   |
| 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  |
| 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 |
| 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   |
| Inter-integrated circuit (I <sup>2</sup> C) bus | Two-wire bidirectional serial bus that provides a simple and efficient method of data exchange between devices  |
| Internal multiplexer (IMUX) SIU subblock        | Allows flexible mapping of peripheral interface on the different pins of the device   |
| Interrupt controller (INTC)                     | Provides priority-based preemptive scheduling of interrupt requests   |
| JTAG controller (JTAGC)                         | 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  |
| Memory protection unit (MPU)                    | Provides hardware access control for all memory references generated in a device  |
| Mode entry module (MC_ME)                       | Provides a mechanism for controlling the device operational mode and modetransition 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           |
| Non-maskable interrupt (NMI)                    | Handles external events that must produce an immediate response, such as power down detection   |

Table 2. MPC5607B series block summary (continued)

| Block   | Function  |
|---|---|
| Periodic interrupt timer (PIT)                | Produces periodic interrupts and triggers   |
| 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 |
| Real-time counter (RTC)                       | A free running counter used for time keeping applications, the RTC can be configured to generate an interrupt at a predefined interval independent of the mode of operation (run mode or low-power mode)                          |
| Reset generation module (MC_RGM)              | Centralizes reset sources and manages the device reset sequence of the device   |
| Static random-access memory (SRAM)            | Provides storage for program code, constants, and variables   |
| System integration unit lite (SIUL)           | Provides control over all the electrical pad controls and up to 32 ports with 16 bits of bidirectional, general-purpose input and output signals and supports up to 32 external interrupts with trigger event configuration       |
| System status and configuration module (SSCM) | Provides system configuration and status data (such as memory size and status, device mode and security status), device identification data, debug status port enable and selection, and bus and peripheral abort enable/disable  |
| System timer module (STM)                     | Provides a set of output compare events to support AUTOSAR (Automotive Open System Architecture) and operating system tasks   |
| Software watchdog timer (SWT)                 | Provides protection from runaway code   |
| Wakeup unit (WKPU)                            | The wakeup unit supports up to 27 external sources that can generate interrupts or wakeup events, of which 1 can cause non-maskable interrupt requests or wakeup events.  |

# 3 Package pinouts and signal descriptions

## 3.1 Package pinouts

The available LQFP pinouts and the ballmap are provided in the following figures. For pin signal descriptions, please see Table 5.

Figure 2 shows the MPC5607B in the 176 LQFP package.

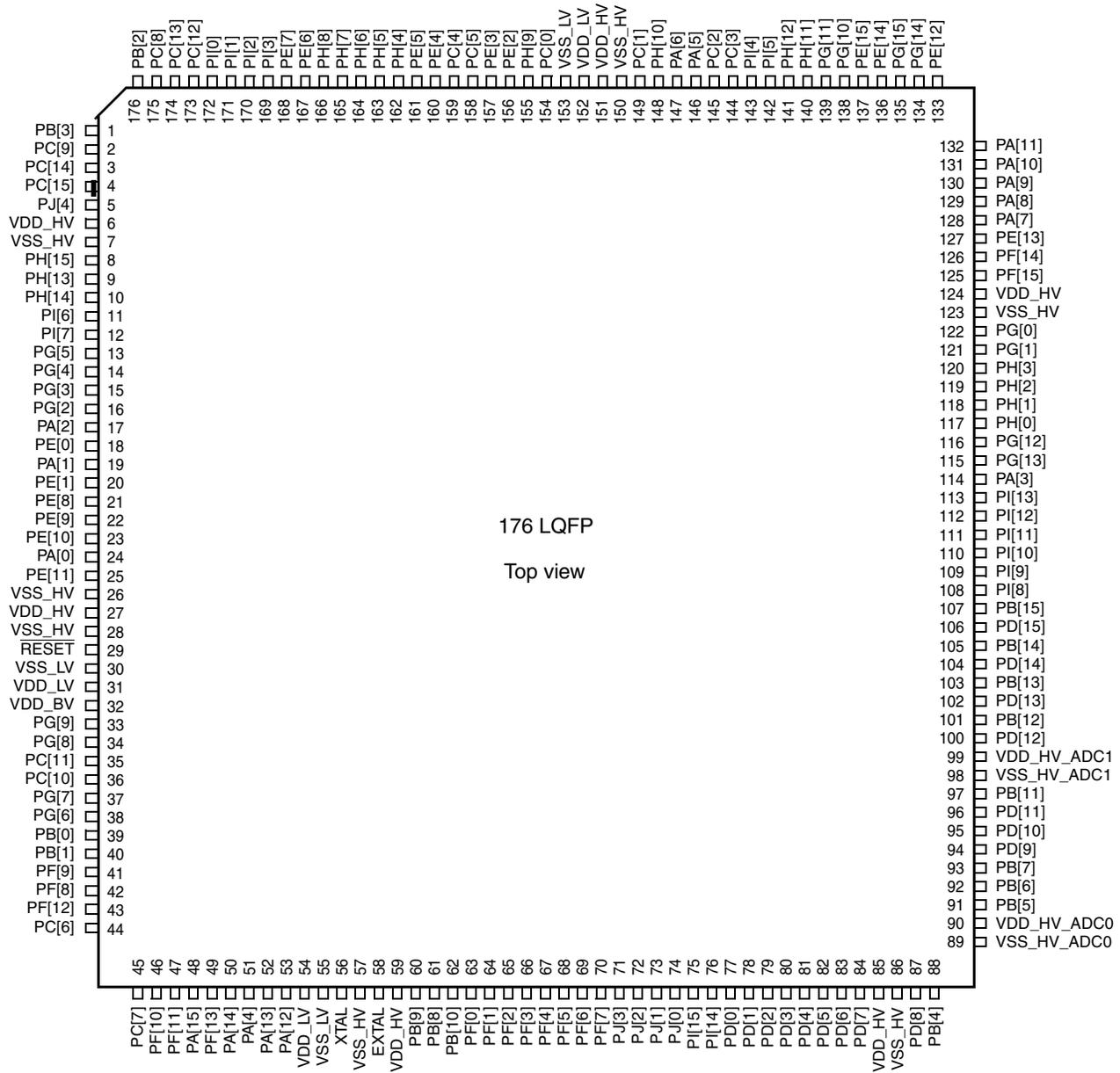


Figure 2. 176 LQFP pin configuration

Figure 3 shows the MPC5607B in the 144 LQFP package.

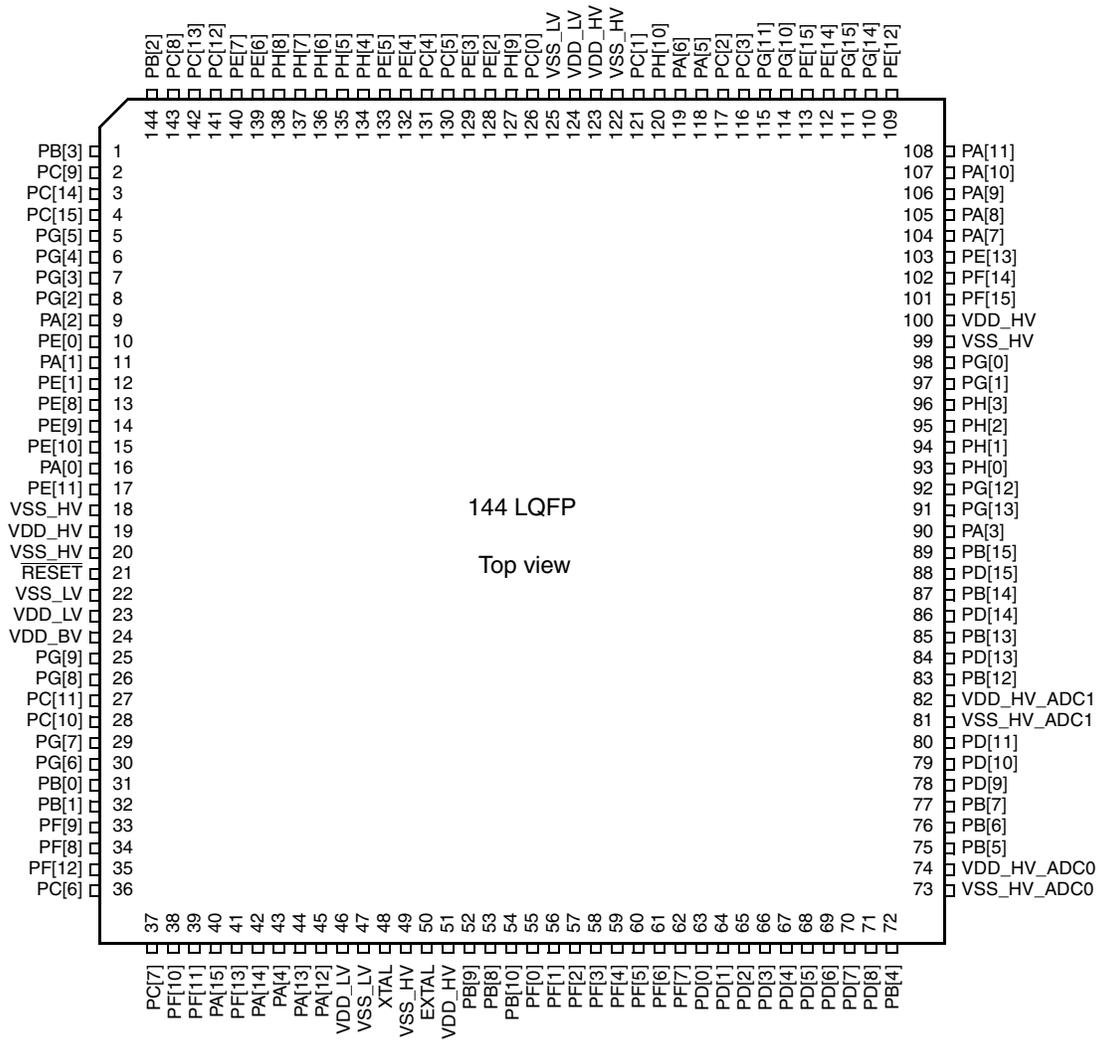


Figure 3. 144 LQFP pin configuration

Figure 4 shows the MPC5607B in the 100 LQFP package.

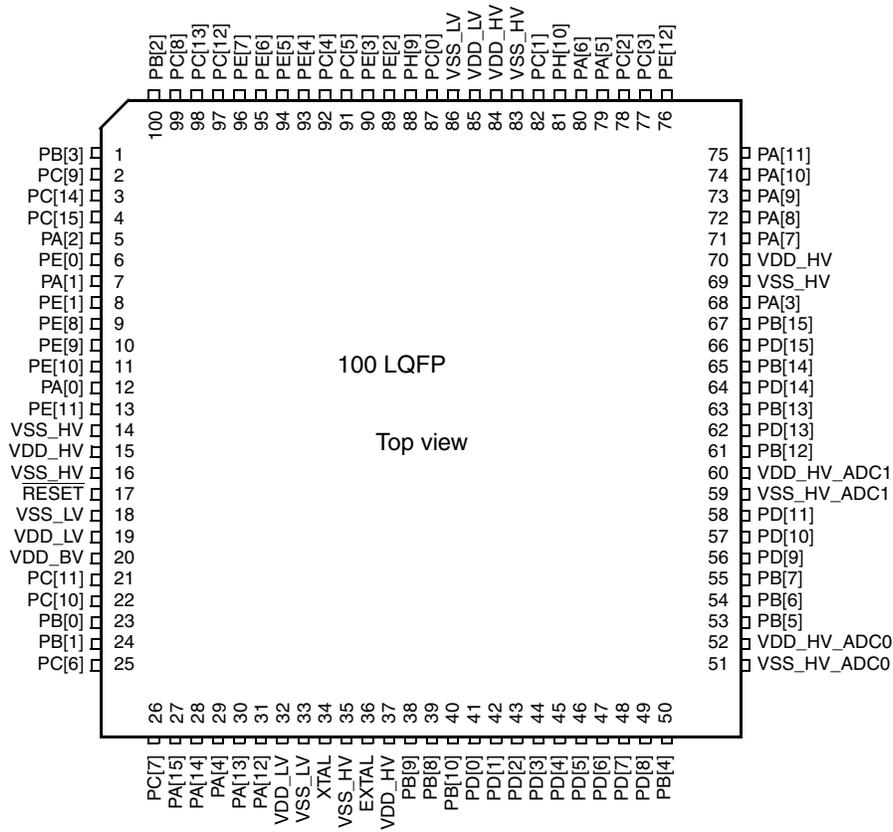


Figure 4. 100 LQFP pin configuration

Figure 5 shows the MPC5607B in the 208 MAPBGA package.

|   | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9       | 10     | 11     | 12          | 13          | 14          | 15          | 16     |        |        |      |   |
|---|--------|--------|--------|--------|--------|--------|--------|--------|---------|--------|--------|-------------|-------------|-------------|-------------|--------|--------|--------|------|---|
| A | PC[8]  | PC[13] | PH[15] | PJ[4]  | PH[8]  | PH[4]  | PC[5]  | PC[0]  | PI[0]   | PI[1]  | PC[2]  | PI[4]       | PE[15]      | PH[11]      | NC          | NC     | A      |        |      |   |
| B | PC[9]  | PB[2]  | PH[13] | PC[12] | PE[6]  | PH[5]  | PC[4]  | PH[9]  | PH[10]  | PI[2]  | PC[3]  | PG[11]      | PG[15]      | PG[14]      | PA[11]      | PA[10] | B      |        |      |   |
| C | PC[14] | VDD_HV | PB[3]  | PE[7]  | PH[7]  | PE[5]  | PE[3]  | VSS_LV | PC[1]   | PI[3]  | PA[5]  | PI[5]       | PE[14]      | PE[12]      | PA[9]       | PA[8]  | C      |        |      |   |
| D | PH[14] | PI[6]  | PC[15] | PI[7]  | PH[6]  | PE[4]  | PE[2]  | VDD_LV | VDD_HV  | NC     | PA[6]  | PH[12]      | PG[10]      | PF[14]      | PE[13]      | PA[7]  | D      |        |      |   |
| E | PG[4]  | PG[5]  | PG[3]  | PG[2]  |        |        |        |        |         |        |        |             | PG[1]       | PG[0]       | PF[15]      | VDD_HV | E      |        |      |   |
| F | PE[0]  | PA[2]  | PA[1]  | PE[1]  |        |        |        |        |         |        |        |             | PH[0]       | PH[1]       | PH[3]       | PH[2]  | F      |        |      |   |
| G | PE[9]  | PE[8]  | PE[10] | PA[0]  | VSS_HV |        |        |        | VSS_HV  | VSS_HV | VSS_HV | VSS_HV      | VDD_HV      |             |             |        | PI[12] | PI[13] | MSEO | G |
| H | VSS_HV | PE[11] | VDD_HV | NC     | VSS_HV |        |        |        | VSS_HV  | VSS_HV | VSS_HV | VSS_HV      | MDO3        | MDO2        | MDO0        | MDO1   | H      |        |      |   |
| J | RESET  | VSS_LV | NC     | NC     | VSS_HV |        |        |        | VSS_HV  | VSS_HV | VSS_HV | VSS_HV      | PI[8]       | PI[9]       | PI[10]      | PI[11] | J      |        |      |   |
| K | EVTI   | NC     | VDD_BV | VDD_LV | VSS_HV |        |        |        | VSS_HV  | VSS_HV | VSS_HV | VSS_HV      | VDD_HV_ADC1 | PG[12]      | PA[3]       | PG[13] | K      |        |      |   |
| L | PG[9]  | PG[8]  | NC     | EVTO   |        |        |        |        |         |        |        |             | PB[15]      | PD[15]      | PD[14]      | PB[14] | L      |        |      |   |
| M | PG[7]  | PG[6]  | PC[10] | PC[11] |        |        |        |        |         |        |        |             | PB[13]      | PD[13]      | PD[12]      | PB[12] | M      |        |      |   |
| N | PB[1]  | PF[9]  | PB[0]  | VDD_HV | PJ[0]  | PA[4]  | VSS_LV | EXTAL  | VDD_HV  | PF[0]  | PF[4]  | VSS_HV_ADC1 | PB[11]      | PD[10]      | PD[9]       | PD[11] | N      |        |      |   |
| P | PF[8]  | PJ[3]  | PC[7]  | PJ[2]  | PJ[1]  | PA[14] | VDD_LV | XTAL   | PB[10]  | PF[1]  | PF[5]  | PD[0]       | PD[3]       | VDD_HV_ADC0 | PB[6]       | PB[7]  | P      |        |      |   |
| R | PF[12] | PC[6]  | PF[10] | PF[11] | VDD_HV | PA[15] | PA[13] | PI[14] | XTAL32  | PF[3]  | PF[7]  | PD[2]       | PD[4]       | PD[7]       | VSS_HV_ADC0 | PB[5]  | R      |        |      |   |
| T | NC     | NC     | NC     | MCKO   | NC     | PF[13] | PA[12] | PI[15] | EXTAL32 | PF[2]  | PF[6]  | PD[1]       | PD[5]       | PD[6]       | PD[8]       | PB[4]  | T      |        |      |   |

NOTE: The 208 MAPBGA is available only as development package for Nexus 2+.

NC = Not connected

Figure 5. 208 MAPBGA configuration

### 3.2 Pad configuration during reset phases

All pads have a fixed configuration under reset.

During the power-up phase, all pads are forced to tristate.

After power-up phase, all pads are tristate with the following exceptions:

- PA[9] (FAB) is pull-down. Without external strong pull-up the device starts fetching from flash.
- PA[8], PC[0] and PH[9:10] are in input weak pull-up when out of reset.
- RESET pad is driven low by the device till 40 FIRC clock cycles after phase2 completion. Minimum phase3 duration is 40 FIRC cycles.
- Nexus output pads (MDO[n], MCKO, EVTO, MSEO) are forced to output.

### 3.3 Pad configuration during standby mode exit

Pad configuration (input buffer enable, pull enable) for low-power wakeup pads is controlled by both the SIUL and WKPU modules. During standby exit, all low power pads PA[0,1,2,4,15], PB[1,3,8,9,10]<sup>1</sup>, PC[7,9,11], PD[0,1], PE[0,9,11], PF[9,11,13]<sup>2</sup>, PG[3,5,7,9]<sup>2</sup>, PI[1,3]<sup>3</sup> are configured according to their respective configuration done in the WKPU module. All other pads will have the same configuration as expected after a reset.

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 kOhms should be added between the TDO pin and VDD. Only if the TDO pin is used as an application pin and a pull-up cannot be used should a pull-down resistor with the same value be used instead between the TDO pin and GND.

### 3.4 Voltage supply pins

Voltage supply pins are used to provide power to the device. Three dedicated VDD\_LV/VSS\_LV supply pairs are used for 1.2 V regulator stabilization.

**Table 3. Voltage supply pin descriptions**

| Port pin | Function  | Pin number         |                     |                             |  |
|----------|---|--------------------|---------------------|-----------------------------|--|
|          |   | 100 LQFP           | 144 LQFP            | 176 LQFP                    | 208 MAPBGA   |
| VDD_HV   | Digital supply voltage  | 15, 37, 70, 84     | 19, 51, 100, 123    | 6, 27, 59, 85, 124, 151     | C2, D9, E16, G13, H3, N4, N9, R5                                   |
| VSS_HV   | Digital ground  | 14, 16, 35, 69, 83 | 18, 20, 49, 99, 122 | 7, 26, 28, 57, 86, 123, 150 | G7, G8, G9, G10, H7, H8, H9, H10, J7, J8, J9, J10, K7, K8, K9, K10 |
| VDD_LV   | 1.2 V decoupling pins. Decoupling capacitor must be connected between these pins and the nearest VSS_LV pin. <sup>1</sup> | 19, 32, 85         | 23, 46, 124         | 31, 54, 152                 | D8, K4, P7   |
| VSS_LV   | 1.2 V decoupling pins. Decoupling capacitor must be connected between these pins and the nearest VDD_LV pin. <sup>1</sup> | 18, 33, 86         | 22, 47, 125         | 30, 55, 153                 | C8, J2, N7   |
| VDD_BV   | Internal regulator supply voltage   | 20                 | 24                  | 32                          | K3   |

1. PB[8, 9] ports have wakeup functionality in all modes except STANDBY.

2. PF[9,11,13], PG[3,5,7,9], PI[1,3] are not available in the 100-pin LQFP.

3. PI[1,3] are not available in the 144-pin LQFP.

Table 3. Voltage supply pin descriptions (continued)

| Port pin    | Function   | Pin number |          |          |            |
|-------------|--|------------|----------|----------|------------|
|             |  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAPBGA |
| VSS_HV_ADC0 | Reference ground and analog ground for the A/D converter 0 (10-bit)  | 51         | 73       | 89       | R15        |
| VDD_HV_ADC0 | Reference voltage and analog supply for the A/D converter 0 (10-bit) | 52         | 74       | 90       | P14        |
| VSS_HV_ADC1 | Reference ground and analog ground for the A/D converter 1 (12-bit)  | 59         | 81       | 98       | N12        |
| VDD_HV_ADC1 | Reference voltage and analog supply for the A/D converter 1 (12-bit) | 60         | 82       | 99       | K13        |

<sup>1</sup> A decoupling capacitor must be placed between each of the three VDD\_LV/VSS\_LV supply pairs to ensure stable voltage (see the recommended operating conditions in the device data sheet).

### 3.5 Pad types

In the device the following types of pads are available for system pins and functional port pins:

S = Slow<sup>1</sup>

M = Medium<sup>1 2</sup>

F = Fast<sup>1 2</sup>

I = Input only with analog feature<sup>1</sup>

J = Input/Output ('S' pad) with analog feature

X = Oscillator

### 3.6 System pins

The system pins are listed in [Table 4](#).

Table 4. System pin descriptions

| Port pin | Function   | I/O direction | Pad type | RESET configuration                                    | Pin number |          |          |                          |
|----------|--|---------------|----------|--|------------|----------|----------|--------------------------|
|          |  |               |          |  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sub>1</sub> |
| RESET    | Bidirectional reset with Schmitt-Trigger characteristics and noise filter. | I/O           | M        | Input weak pull-up after RGM PHASE2 and 40 FIRC cycles | 17         | 21       | 29       | J1                       |

1. See the I/O pad electrical characteristics in the chip data sheet for details.

2. All medium and fast pads are in slow configuration by default at reset and can be configured as fast or medium. The only exception is PC[1] which is in medium configuration by default (see the PCR.SRC description in the chip reference manual, Pad Configuration Registers (PCR0–PCR148)).

**Table 4. System pin descriptions (continued)**

| Port pin | Function   | I/O direction | Pad type | RESET configuration | Pin number |          |          |                          |
|----------|--|---------------|----------|---------------------|------------|----------|----------|--------------------------|
|          |  |               |          |                     | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sub>1</sub> |
| EXTAL    | Analog output of the oscillator amplifier circuit, when the oscillator is not in bypass mode.<br>Analog input for the clock generator when the oscillator is in bypass mode. | I/O           | X        | Tristate            | 36         | 50       | 58       | N8                       |
| XTAL     | Analog input of the oscillator amplifier circuit. Needs to be grounded if oscillator bypass mode is used.  | I             | X        | Tristate            | 34         | 48       | 56       | P8                       |

<sup>1</sup> 208 MAPBGA available only as development package for Nexus2+

### 3.7 Functional port pins

The functional port pins are listed in [Table 5](#).

**Table 5. Functional port pin descriptions**

| Port pin      | PCR    | Alternate function <sup>1</sup> | Function  | Peripheral                                   | I/O direction <sup>2</sup>  | Pad type | RESET configuration <sup>3</sup> | Pin number |          |          |                          |
|---------------|--------|---------------------------------|---|--|-----------------------------|----------|----------------------------------|------------|----------|----------|--------------------------|
|               |        |                                 |   |  |                             |          |                                  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sub>4</sub> |
| <b>Port A</b> |        |                                 |   |  |                             |          |                                  |            |          |          |                          |
| PA[0]         | PCR[0] | AF0<br>AF1<br>AF2<br>AF3<br>—   | GPIO[0]<br>E0UC[0]<br>CLKOUT<br>E0UC[13]<br>WKPU[19] <sup>5</sup>   | SIUL<br>eMIOS_0<br>MC_CGM<br>eMIOS_0<br>WKPU | I/O<br>I/O<br>O<br>I/O<br>I | M        | Tristate                         | 12         | 16       | 24       | G4                       |
| PA[1]         | PCR[1] | AF0<br>AF1<br>AF2<br>AF3<br>—   | GPIO[1]<br>E0UC[1]<br>NMI <sup>6</sup><br>—<br>WKPU[2] <sup>5</sup> | SIUL<br>eMIOS_0<br>WKPU<br>—<br>WKPU         | I/O<br>I/O<br>I<br>—<br>I   | S        | Tristate                         | 7          | 11       | 19       | F3                       |
| PA[2]         | PCR[2] | AF0<br>AF1<br>AF2<br>AF3<br>—   | GPIO[2]<br>E0UC[2]<br>—<br>MA[2]<br>WKPU[3] <sup>5</sup>            | SIUL<br>eMIOS_0<br>—<br>ADC_0<br>WKPU        | I/O<br>I/O<br>—<br>O<br>I   | S        | Tristate                         | 5          | 9        | 17       | F2                       |

Table 5. Functional port pin descriptions (continued)

| Port pin | PCR    | Alternate function <sup>1</sup>                        | Function   | Peripheral  | I/O direction <sup>2</sup>            | Pad type | RESET configuration <sup>3</sup> | Pin number |          |          |                          |
|----------|--------|--|--|---|---------------------------------------|----------|----------------------------------|------------|----------|----------|--------------------------|
|          |        |  |  |   |                                       |          |                                  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sup>4</sup> |
| PA[3]    | PCR[3] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—                     | GPIO[3]<br>E0UC[3]<br>LIN5TX<br>CS4_1<br>EIRQ[0]<br>ADC1_S[0]      | SIUL<br>eMIOS_0<br>LINFlex_5<br>DSPI_1<br>SIUL<br>ADC_1     | I/O<br>I/O<br>O<br>O<br>I<br>I        | J        | Tristate                         | 68         | 90       | 114      | K15                      |
| PA[4]    | PCR[4] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—                     | GPIO[4]<br>E0UC[4]<br>—<br>CS0_1<br>LIN5RX<br>WKPU[9] <sup>5</sup> | SIUL<br>eMIOS_0<br>—<br>DSPI_1<br>LINFlex_5<br>WKPU         | I/O<br>I/O<br>—<br>I/O<br>I<br>I      | S        | Tristate                         | 29         | 43       | 51       | N6                       |
| PA[5]    | PCR[5] | AF0<br>AF1<br>AF2<br>AF3                               | GPIO[5]<br>E0UC[5]<br>LIN4TX<br>—                                  | SIUL<br>eMIOS_0<br>LINFlex_4<br>—                           | I/O<br>I/O<br>O<br>—                  | M        | Tristate                         | 79         | 118      | 146      | C11                      |
| PA[6]    | PCR[6] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—                     | GPIO[6]<br>E0UC[6]<br>—<br>CS1_1<br>EIRQ[1]<br>LIN4RX              | SIUL<br>eMIOS_0<br>—<br>DSPI_1<br>SIUL<br>LINFlex_4         | I/O<br>I/O<br>—<br>O<br>I<br>I        | S        | Tristate                         | 80         | 119      | 147      | D11                      |
| PA[7]    | PCR[7] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—                     | GPIO[7]<br>E0UC[7]<br>LIN3TX<br>—<br>EIRQ[2]<br>ADC1_S[1]          | SIUL<br>eMIOS_0<br>LINFlex_3<br>—<br>SIUL<br>ADC_1          | I/O<br>I/O<br>O<br>—<br>I<br>I        | J        | Tristate                         | 71         | 104      | 128      | D16                      |
| PA[8]    | PCR[8] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>N/A <sup>7</sup><br>— | GPIO[8]<br>E0UC[8]<br>E0UC[14]<br>—<br>EIRQ[3]<br>ABS[0]<br>LIN3RX | SIUL<br>eMIOS_0<br>eMIOS_0<br>—<br>SIUL<br>BAM<br>LINFlex_3 | I/O<br>I/O<br>I/O<br>—<br>I<br>I<br>I | S        | Input,<br>weak<br>pull-up        | 72         | 105      | 129      | C16                      |
| PA[9]    | PCR[9] | AF0<br>AF1<br>AF2<br>AF3<br>N/A <sup>7</sup>           | GPIO[9]<br>E0UC[9]<br>—<br>CS2_1<br>FAB                            | SIUL<br>eMIOS_0<br>—<br>DSPI_1<br>BAM                       | I/O<br>I/O<br>—<br>O<br>I             | S        | Pull-<br>down                    | 73         | 106      | 130      | C15                      |

Table 5. Functional port pin descriptions (continued)

| Port pin      | PCR     | Alternate function <sup>1</sup>         | Function  | Peripheral   | I/O direction <sup>2</sup>            | Pad type | RESET configuration <sup>3</sup> | Pin number |          |          |                          |
|---------------|---------|---|---|--|---------------------------------------|----------|----------------------------------|------------|----------|----------|--------------------------|
|               |         |   |   |  |                                       |          |                                  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sup>4</sup> |
| PA[10]        | PCR[10] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[10]<br>E0UC[10]<br>SDA<br>LIN2TX<br>ADC1_S[2]                  | SIUL<br>eMIOS_0<br>I <sup>2</sup> C_0<br>LINFlex_2<br>ADC_1              | I/O<br>I/O<br>I/O<br>O<br>I           | J        | Tristate                         | 74         | 107      | 131      | B16                      |
| PA[11]        | PCR[11] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—<br>— | GPIO[11]<br>E0UC[11]<br>SCL<br>—<br>EIRQ[16]<br>LIN2RX<br>ADC1_S[3] | SIUL<br>eMIOS_0<br>I <sup>2</sup> C_0<br>—<br>SIUL<br>LINFlex_2<br>ADC_1 | I/O<br>I/O<br>I/O<br>—<br>I<br>I<br>I | J        | Tristate                         | 75         | 108      | 132      | B15                      |
| PA[12]        | PCR[12] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—      | GPIO[12]<br>—<br>E0UC[28]<br>CS3_1<br>EIRQ[17]<br>SIN_0             | SIUL<br>—<br>eMIOS_0<br>DSPI_1<br>SIUL<br>DSPI_0                         | I/O<br>—<br>I/O<br>O<br>I<br>I        | S        | Tristate                         | 31         | 45       | 53       | T7                       |
| PA[13]        | PCR[13] | AF0<br>AF1<br>AF2<br>AF3                | GPIO[13]<br>SOUT_0<br>E0UC[29]<br>—                                 | SIUL<br>DSPI_0<br>eMIOS_0<br>—   | I/O<br>O<br>I/O<br>—                  | M        | Tristate                         | 30         | 44       | 52       | R7                       |
| PA[14]        | PCR[14] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[14]<br>SCK_0<br>CS0_0<br>E0UC[0]<br>EIRQ[4]                    | SIUL<br>DSPI_0<br>DSPI_0<br>eMIOS_0<br>SIUL                              | I/O<br>I/O<br>I/O<br>I/O<br>I         | M        | Tristate                         | 28         | 42       | 50       | P6                       |
| PA[15]        | PCR[15] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[15]<br>CS0_0<br>SCK_0<br>E0UC[1]<br>WKPU[10] <sup>5</sup>      | SIUL<br>DSPI_0<br>DSPI_0<br>eMIOS_0<br>WKPU                              | I/O<br>I/O<br>I/O<br>I/O<br>I         | M        | Tristate                         | 27         | 40       | 48       | R6                       |
| <b>Port B</b> |         |   |   |  |                                       |          |                                  |            |          |          |                          |
| PB[0]         | PCR[16] | AF0<br>AF1<br>AF2<br>AF3                | GPIO[16]<br>CAN0TX<br>E0UC[30]<br>LIN0TX                            | SIUL<br>FlexCAN_0<br>eMIOS_0<br>LINFlex_0                                | I/O<br>O<br>I/O<br>O                  | M        | Tristate                         | 23         | 31       | 39       | N3                       |

Table 5. Functional port pin descriptions (continued)

| Port pin | PCR     | Alternate function <sup>1</sup>         | Function   | Peripheral  | I/O direction <sup>2</sup>          | Pad type | RESET configuration <sup>3</sup> | Pin number |          |          |                          |
|----------|---------|---|--|---|-------------------------------------|----------|----------------------------------|------------|----------|----------|--------------------------|
|          |         |   |  |   |                                     |          |                                  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sup>4</sup> |
| PB[1]    | PCR[17] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—<br>— | GPIO[17]<br>—<br>E0UC[31]<br>—<br>WKPU[4] <sup>5</sup><br>CAN0RX<br>LIN0RX | SIUL<br>—<br>eMIOS_0<br>—<br>WKPU<br>FlexCAN_0<br>LINFlex_0     | I/O<br>—<br>I/O<br>—<br>I<br>I<br>I | S        | Tristate                         | 24         | 32       | 40       | N1                       |
| PB[2]    | PCR[18] | AF0<br>AF1<br>AF2<br>AF3                | GPIO[18]<br>LIN0TX<br>SDA<br>E0UC[30]                                      | SIUL<br>LINFlex_0<br>I <sup>2</sup> C_0<br>eMIOS_0              | I/O<br>O<br>I/O<br>I/O              | M        | Tristate                         | 100        | 144      | 176      | B2                       |
| PB[3]    | PCR[19] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—      | GPIO[19]<br>E0UC[31]<br>SCL<br>—<br>WKPU[11] <sup>5</sup><br>LIN0RX        | SIUL<br>eMIOS_0<br>I <sup>2</sup> C_0<br>—<br>WKPU<br>LINFlex_0 | I/O<br>I/O<br>I/O<br>—<br>I<br>I    | S        | Tristate                         | 1          | 1        | 1        | C3                       |
| PB[4]    | PCR[20] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—<br>— | —<br>—<br>—<br>—<br>ADC0_P[0]<br>ADC1_P[0]<br>GPIO[20]                     | —<br>—<br>—<br>—<br>ADC_0<br>ADC_1<br>SIUL                      | —<br>—<br>—<br>—<br>I<br>I<br>I     | I        | Tristate                         | 50         | 72       | 88       | T16                      |
| PB[5]    | PCR[21] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—<br>— | —<br>—<br>—<br>—<br>ADC0_P[1]<br>ADC1_P[1]<br>GPIO[21]                     | —<br>—<br>—<br>—<br>ADC_0<br>ADC_1<br>SIUL                      | —<br>—<br>—<br>—<br>I<br>I<br>I     | I        | Tristate                         | 53         | 75       | 91       | R16                      |
| PB[6]    | PCR[22] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—<br>— | —<br>—<br>—<br>—<br>ADC0_P[2]<br>ADC1_P[2]<br>GPIO[22]                     | —<br>—<br>—<br>—<br>ADC_0<br>ADC_1<br>SIUL                      | —<br>—<br>—<br>—<br>I<br>I<br>I     | I        | Tristate                         | 54         | 76       | 92       | P15                      |

Table 5. Functional port pin descriptions (continued)

| Port pin | PCR       | Alternate function <sup>1</sup> | Function                  | Peripheral | I/O direction <sup>2</sup> | Pad type | RESET configuration <sup>3</sup> | Pin number |          |          |                          |
|----------|-----------|---------------------------------|---------------------------|------------|----------------------------|----------|----------------------------------|------------|----------|----------|--------------------------|
|          |           |                                 |                           |            |                            |          |                                  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sup>4</sup> |
| PB[7]    | PCR[23]   | AF0                             | —                         | —          | —                          | I        | Tristate                         | 55         | 77       | 93       | P16                      |
|          |           | AF1                             | —                         | —          | —                          | —        |                                  |            |          |          |                          |
|          |           | AF2                             | —                         | —          | —                          | —        |                                  |            |          |          |                          |
|          |           | AF3                             | —                         | —          | —                          | —        |                                  |            |          |          |                          |
|          |           | —                               | ADC0_P[3]                 | ADC_0      | I                          | —        |                                  |            |          |          |                          |
|          |           | —                               | ADC1_P[3]                 | ADC_1      | I                          | —        |                                  |            |          |          |                          |
| —        | GPIO[23]  | SIUL                            | I                         | —          |                            |          |                                  |            |          |          |                          |
| PB[8]    | PCR[24]   | AF0                             | GPIO[24]                  | SIUL       | I                          | I        | —                                | 39         | 53       | 61       | R9                       |
|          |           | AF1                             | —                         | —          | —                          | —        |                                  |            |          |          |                          |
|          |           | AF2                             | —                         | —          | —                          | —        |                                  |            |          |          |                          |
|          |           | AF3                             | —                         | —          | —                          | —        |                                  |            |          |          |                          |
|          |           | —                               | OSC32K_XTAL <sup>8</sup>  | OSC32K     | —                          | —        |                                  |            |          |          |                          |
|          |           | —                               | WKPU[25] <sup>5</sup>     | WKPU       | I <sup>9</sup>             | —        |                                  |            |          |          |                          |
| —        | ADC0_S[0] | ADC_0                           | I                         | —          |                            |          |                                  |            |          |          |                          |
| —        | ADC1_S[4] | ADC_1                           | I                         | —          |                            |          |                                  |            |          |          |                          |
| PB[9]    | PCR[25]   | AF0                             | GPIO[25]                  | SIUL       | I                          | I        | —                                | 38         | 52       | 60       | T9                       |
|          |           | AF1                             | —                         | —          | —                          | —        |                                  |            |          |          |                          |
|          |           | AF2                             | —                         | —          | —                          | —        |                                  |            |          |          |                          |
|          |           | AF3                             | —                         | —          | —                          | —        |                                  |            |          |          |                          |
|          |           | —                               | OSC32K_EXTAL <sup>8</sup> | OSC32K     | —                          | —        |                                  |            |          |          |                          |
|          |           | —                               | WKPU[26] <sup>5</sup>     | WKPU       | I <sup>9</sup>             | —        |                                  |            |          |          |                          |
| —        | ADC0_S[1] | ADC_0                           | I                         | —          |                            |          |                                  |            |          |          |                          |
| —        | ADC1_S[5] | ADC_1                           | I                         | —          |                            |          |                                  |            |          |          |                          |
| PB[10]   | PCR[26]   | AF0                             | GPIO[26]                  | SIUL       | I/O                        | J        | Tristate                         | 40         | 54       | 62       | P9                       |
|          |           | AF1                             | —                         | —          | —                          | —        |                                  |            |          |          |                          |
|          |           | AF2                             | —                         | —          | —                          | —        |                                  |            |          |          |                          |
|          |           | AF3                             | —                         | —          | —                          | —        |                                  |            |          |          |                          |
|          |           | —                               | WKPU[8] <sup>5</sup>      | WKPU       | I                          | —        |                                  |            |          |          |                          |
|          |           | —                               | ADC0_S[2]                 | ADC_0      | I                          | —        |                                  |            |          |          |                          |
| —        | ADC1_S[6] | ADC_1                           | I                         | —          |                            |          |                                  |            |          |          |                          |
| PB[11]   | PCR[27]   | AF0                             | GPIO[27]                  | SIUL       | I/O                        | J        | Tristate                         | —          | —        | 97       | N13                      |
|          |           | AF1                             | E0UC[3]                   | eMIOS_0    | I/O                        | —        |                                  |            |          |          |                          |
|          |           | AF2                             | —                         | —          | —                          | —        |                                  |            |          |          |                          |
|          |           | AF3                             | CS0_0                     | DSPI_0     | I/O                        | —        |                                  |            |          |          |                          |
|          |           | —                               | ADC0_S[3]                 | ADC_0      | I                          | —        |                                  |            |          |          |                          |
| PB[12]   | PCR[28]   | AF0                             | GPIO[28]                  | SIUL       | I/O                        | J        | Tristate                         | 61         | 83       | 101      | M16                      |
|          |           | AF1                             | E0UC[4]                   | eMIOS_0    | I/O                        | —        |                                  |            |          |          |                          |
|          |           | AF2                             | —                         | —          | —                          | —        |                                  |            |          |          |                          |
|          |           | AF3                             | CS1_0                     | DSPI_0     | O                          | —        |                                  |            |          |          |                          |
|          |           | —                               | ADC0_X[0]                 | ADC_0      | I                          | —        |                                  |            |          |          |                          |

Table 5. Functional port pin descriptions (continued)

| Port pin            | PCR     | Alternate function <sup>1</sup>         | Function  | Peripheral  | I/O direction <sup>2</sup>          | Pad type        | RESET configuration <sup>3</sup> | Pin number |          |          |                          |
|---------------------|---------|---|---|---|-------------------------------------|-----------------|----------------------------------|------------|----------|----------|--------------------------|
|                     |         |   |   |   |                                     |                 |                                  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sup>4</sup> |
| PB[13]              | PCR[29] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[29]<br>E0UC[5]<br>—<br>CS2_0<br>ADC0_X[1]                        | SIUL<br>eMIOS_0<br>—<br>DSPI_0<br>ADC_0                           | I/O<br>I/O<br>—<br>O<br>I           | J               | Tristate                         | 63         | 85       | 103      | M13                      |
| PB[14]              | PCR[30] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[30]<br>E0UC[6]<br>—<br>CS3_0<br>ADC0_X[2]                        | SIUL<br>eMIOS_0<br>—<br>DSPI_0<br>ADC_0                           | I/O<br>I/O<br>—<br>O<br>I           | J               | Tristate                         | 65         | 87       | 105      | L16                      |
| PB[15]              | PCR[31] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[31]<br>E0UC[7]<br>—<br>CS4_0<br>ADC0_X[3]                        | SIUL<br>eMIOS_0<br>—<br>DSPI_0<br>ADC_0                           | I/O<br>I/O<br>—<br>O<br>I           | J               | Tristate                         | 67         | 89       | 107      | L13                      |
| <b>Port C</b>       |         |   |   |   |                                     |                 |                                  |            |          |          |                          |
| PC[0] <sup>10</sup> | PCR[32] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[32]<br>—<br>TDI<br>—   | SIUL<br>—<br>JTAGC<br>—   | I/O<br>—<br>I<br>—                  | M               | Input,<br>weak<br>pull-up        | 87         | 126      | 154      | A8                       |
| PC[1] <sup>10</sup> | PCR[33] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[33]<br>—<br>TDO<br>—   | SIUL<br>—<br>JTAGC<br>—   | I/O<br>—<br>O<br>—                  | F <sup>11</sup> | Tristate                         | 82         | 121      | 149      | C9                       |
| PC[2]               | PCR[34] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[34]<br>SCK_1<br>CAN4TX<br>DEBUG[0]<br>EIRQ[5]                    | SIUL<br>DSPI_1<br>FlexCAN_4<br>SSCM<br>SIUL                       | I/O<br>I/O<br>O<br>O<br>I           | M               | Tristate                         | 78         | 117      | 145      | A11                      |
| PC[3]               | PCR[35] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—<br>— | GPIO[35]<br>CS0_1<br>MA[0]<br>DEBUG[1]<br>EIRQ[6]<br>CAN1RX<br>CAN4RX | SIUL<br>DSPI_1<br>ADC_0<br>SSCM<br>SIUL<br>FlexCAN_1<br>FlexCAN_4 | I/O<br>I/O<br>O<br>O<br>I<br>I<br>I | S               | Tristate                         | 77         | 116      | 144      | B11                      |
| PC[4]               | PCR[36] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—<br>— | GPIO[36]<br>E1UC[31]<br>—<br>DEBUG[2]<br>EIRQ[18]<br>SIN_1<br>CAN3RX  | SIUL<br>eMIOS_1<br>—<br>SSCM<br>SIUL<br>DSPI_1<br>FlexCAN_3       | I/O<br>I/O<br>—<br>O<br>I<br>I<br>I | M               | Tristate                         | 92         | 131      | 159      | B7                       |

Table 5. Functional port pin descriptions (continued)

| Port pin | PCR     | Alternate function <sup>1</sup>         | Function   | Peripheral  | I/O direction <sup>2</sup>        | Pad type | RESET configuration <sup>3</sup> | Pin number |          |          |                          |
|----------|---------|---|--|---|-----------------------------------|----------|----------------------------------|------------|----------|----------|--------------------------|
|          |         |   |  |   |                                   |          |                                  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sup>4</sup> |
| PC[5]    | PCR[37] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[37]<br>SOUT_1<br>CAN3TX<br>DEBUG[3]<br>EIRQ[7]                      | SIUL<br>DSPI_1<br>FlexCAN_3<br>SSCM<br>SIUL               | I/O<br>O<br>O<br>O<br>I           | M        | Tristate                         | 91         | 130      | 158      | A7                       |
| PC[6]    | PCR[38] | AF0<br>AF1<br>AF2<br>AF3                | GPIO[38]<br>LIN1TX<br>E1UC[28]<br>DEBUG[4]                               | SIUL<br>LINFlex_1<br>eMIOS_1<br>SSCM                      | I/O<br>O<br>I/O<br>O              | S        | Tristate                         | 25         | 36       | 44       | R2                       |
| PC[7]    | PCR[39] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—      | GPIO[39]<br>—<br>E1UC[29]<br>DEBUG[5]<br>LIN1RX<br>WKPU[12] <sup>5</sup> | SIUL<br>—<br>eMIOS_1<br>SSCM<br>LINFlex_1<br>WKPU         | I/O<br>—<br>I/O<br>O<br>I<br>I    | S        | Tristate                         | 26         | 37       | 45       | P3                       |
| PC[8]    | PCR[40] | AF0<br>AF1<br>AF2<br>AF3                | GPIO[40]<br>LIN2TX<br>E0UC[3]<br>DEBUG[6]                                | SIUL<br>LINFlex_2<br>eMIOS_0<br>SSCM                      | I/O<br>O<br>I/O<br>O              | S        | Tristate                         | 99         | 143      | 175      | A1                       |
| PC[9]    | PCR[41] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—      | GPIO[41]<br>—<br>E0UC[7]<br>DEBUG[7]<br>WKPU[13] <sup>5</sup><br>LIN2RX  | SIUL<br>—<br>eMIOS_0<br>SSCM<br>WKPU<br>LINFlex_2         | I/O<br>—<br>I/O<br>O<br>I<br>I    | S        | Tristate                         | 2          | 2        | 2        | B1                       |
| PC[10]   | PCR[42] | AF0<br>AF1<br>AF2<br>AF3                | GPIO[42]<br>CAN1TX<br>CAN4TX<br>MA[1]                                    | SIUL<br>FlexCAN_1<br>FlexCAN_4<br>ADC_0                   | I/O<br>O<br>O<br>O                | M        | Tristate                         | 22         | 28       | 36       | M3                       |
| PC[11]   | PCR[43] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—<br>— | GPIO[43]<br>—<br>—<br>MA[2]<br>WKPU[5] <sup>5</sup><br>CAN1RX<br>CAN4RX  | SIUL<br>—<br>—<br>ADC_0<br>WKPU<br>FlexCAN_1<br>FlexCAN_4 | I/O<br>—<br>—<br>O<br>I<br>I<br>I | S        | Tristate                         | 21         | 27       | 35       | M4                       |
| PC[12]   | PCR[44] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—      | GPIO[44]<br>E0UC[12]<br>—<br>—<br>EIRQ[19]<br>SIN_2                      | SIUL<br>eMIOS_0<br>—<br>—<br>SIUL<br>DSPI_2               | I/O<br>I/O<br>—<br>—<br>I<br>I    | M        | Tristate                         | 97         | 141      | 173      | B4                       |

Table 5. Functional port pin descriptions (continued)

| Port pin      | PCR     | Alternate function <sup>1</sup>         | Function   | Peripheral                                    | I/O direction <sup>2</sup>      | Pad type | RESET configuration <sup>3</sup> | Pin number |          |          |                          |
|---------------|---------|---|--|---|---------------------------------|----------|----------------------------------|------------|----------|----------|--------------------------|
|               |         |   |  |   |                                 |          |                                  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sup>4</sup> |
| PC[13]        | PCR[45] | AF0<br>AF1<br>AF2<br>AF3                | GPIO[45]<br>E0UC[13]<br>SOUT_2<br>—  | SIUL<br>eMIOS_0<br>DSPI_2<br>—                | I/O<br>I/O<br>O<br>—            | S        | Tristate                         | 98         | 142      | 174      | A2                       |
| PC[14]        | PCR[46] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[46]<br>E0UC[14]<br>SCK_2<br>—<br>EIRQ[8]                              | SIUL<br>eMIOS_0<br>DSPI_2<br>—<br>SIUL        | I/O<br>I/O<br>I/O<br>—<br>I     | S        | Tristate                         | 3          | 3        | 3        | C1                       |
| PC[15]        | PCR[47] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[47]<br>E0UC[15]<br>CS0_2<br>—<br>EIRQ[20]                             | SIUL<br>eMIOS_0<br>DSPI_2<br>—<br>SIUL        | I/O<br>I/O<br>I/O<br>—<br>I     | M        | Tristate                         | 4          | 4        | 4        | D3                       |
| <b>Port D</b> |         |   |  |   |                                 |          |                                  |            |          |          |                          |
| PD[0]         | PCR[48] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—<br>— | GPIO[48]<br>—<br>—<br>—<br>WKPU[27] <sup>5</sup><br>ADC0_P[4]<br>ADC1_P[4] | SIUL<br>—<br>—<br>—<br>WKPU<br>ADC_0<br>ADC_1 | I<br>—<br>—<br>—<br>I<br>I<br>I | I        | Tristate                         | 41         | 63       | 77       | P12                      |
| PD[1]         | PCR[49] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—<br>— | GPIO[49]<br>—<br>—<br>—<br>WKPU[28] <sup>5</sup><br>ADC0_P[5]<br>ADC1_P[5] | SIUL<br>—<br>—<br>—<br>WKPU<br>ADC_0<br>ADC_1 | I<br>—<br>—<br>—<br>I<br>I<br>I | I        | Tristate                         | 42         | 64       | 78       | T12                      |
| PD[2]         | PCR[50] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—      | GPIO[50]<br>—<br>—<br>—<br>ADC0_P[6]<br>ADC1_P[6]                          | SIUL<br>—<br>—<br>—<br>ADC_0<br>ADC_1         | I<br>—<br>—<br>—<br>I<br>I      | I        | Tristate                         | 43         | 65       | 79       | R12                      |
| PD[3]         | PCR[51] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—      | GPIO[51]<br>—<br>—<br>—<br>ADC0_P[7]<br>ADC1_P[7]                          | SIUL<br>—<br>—<br>—<br>ADC_0<br>ADC_1         | I<br>—<br>—<br>—<br>I<br>I      | I        | Tristate                         | 44         | 66       | 80       | P13                      |

Table 5. Functional port pin descriptions (continued)

| Port pin | PCR     | Alternate function <sup>1</sup> | Function                 | Peripheral     | I/O direction <sup>2</sup> | Pad type | RESET configuration <sup>3</sup> | Pin number |          |          |                          |
|----------|---------|---------------------------------|--------------------------|----------------|----------------------------|----------|----------------------------------|------------|----------|----------|--------------------------|
|          |         |                                 |                          |                |                            |          |                                  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sup>4</sup> |
| PD[4]    | PCR[52] | AF0                             | GPIO[52]                 | SIUL           | I                          | I        | Tristate                         | 45         | 67       | 81       | R13                      |
|          |         | AF1                             | —                        | —              | —                          | —        | —                                |            |          |          |                          |
|          |         | AF2                             | —                        | —              | —                          | —        | —                                |            |          |          |                          |
|          |         | AF3                             | —                        | —              | —                          | —        | —                                |            |          |          |                          |
|          |         | —                               | ADC0_P[8]<br>ADC1_P[8]   | ADC_0<br>ADC_1 | I<br>I                     | I<br>I   | —                                |            |          |          |                          |
| PD[5]    | PCR[53] | AF0                             | GPIO[53]                 | SIUL           | I                          | I        | Tristate                         | 46         | 68       | 82       | T13                      |
|          |         | AF1                             | —                        | —              | —                          | —        | —                                |            |          |          |                          |
|          |         | AF2                             | —                        | —              | —                          | —        | —                                |            |          |          |                          |
|          |         | AF3                             | —                        | —              | —                          | —        | —                                |            |          |          |                          |
|          |         | —                               | ADC0_P[9]<br>ADC1_P[9]   | ADC_0<br>ADC_1 | I<br>I                     | I<br>I   | —                                |            |          |          |                          |
| PD[6]    | PCR[54] | AF0                             | GPIO[54]                 | SIUL           | I                          | I        | Tristate                         | 47         | 69       | 83       | T14                      |
|          |         | AF1                             | —                        | —              | —                          | —        | —                                |            |          |          |                          |
|          |         | AF2                             | —                        | —              | —                          | —        | —                                |            |          |          |                          |
|          |         | AF3                             | —                        | —              | —                          | —        | —                                |            |          |          |                          |
|          |         | —                               | ADC0_P[10]<br>ADC1_P[10] | ADC_0<br>ADC_1 | I<br>I                     | I<br>I   | —                                |            |          |          |                          |
| PD[7]    | PCR[55] | AF0                             | GPIO[55]                 | SIUL           | I                          | I        | Tristate                         | 48         | 70       | 84       | R14                      |
|          |         | AF1                             | —                        | —              | —                          | —        | —                                |            |          |          |                          |
|          |         | AF2                             | —                        | —              | —                          | —        | —                                |            |          |          |                          |
|          |         | AF3                             | —                        | —              | —                          | —        | —                                |            |          |          |                          |
|          |         | —                               | ADC0_P[11]<br>ADC1_P[11] | ADC_0<br>ADC_1 | I<br>I                     | I<br>I   | —                                |            |          |          |                          |
| PD[8]    | PCR[56] | AF0                             | GPIO[56]                 | SIUL           | I                          | I        | Tristate                         | 49         | 71       | 87       | T15                      |
|          |         | AF1                             | —                        | —              | —                          | —        | —                                |            |          |          |                          |
|          |         | AF2                             | —                        | —              | —                          | —        | —                                |            |          |          |                          |
|          |         | AF3                             | —                        | —              | —                          | —        | —                                |            |          |          |                          |
|          |         | —                               | ADC0_P[12]<br>ADC1_P[12] | ADC_0<br>ADC_1 | I<br>I                     | I<br>I   | —                                |            |          |          |                          |
| PD[9]    | PCR[57] | AF0                             | GPIO[57]                 | SIUL           | I                          | I        | Tristate                         | 56         | 78       | 94       | N15                      |
|          |         | AF1                             | —                        | —              | —                          | —        | —                                |            |          |          |                          |
|          |         | AF2                             | —                        | —              | —                          | —        | —                                |            |          |          |                          |
|          |         | AF3                             | —                        | —              | —                          | —        | —                                |            |          |          |                          |
|          |         | —                               | ADC0_P[13]<br>ADC1_P[13] | ADC_0<br>ADC_1 | I<br>I                     | I<br>I   | —                                |            |          |          |                          |
| PD[10]   | PCR[58] | AF0                             | GPIO[58]                 | SIUL           | I                          | I        | Tristate                         | 57         | 79       | 95       | N14                      |
|          |         | AF1                             | —                        | —              | —                          | —        | —                                |            |          |          |                          |
|          |         | AF2                             | —                        | —              | —                          | —        | —                                |            |          |          |                          |
|          |         | AF3                             | —                        | —              | —                          | —        | —                                |            |          |          |                          |
|          |         | —                               | ADC0_P[14]<br>ADC1_P[14] | ADC_0<br>ADC_1 | I<br>I                     | I<br>I   | —                                |            |          |          |                          |

Table 5. Functional port pin descriptions (continued)

| Port pin      | PCR     | Alternate function <sup>1</sup>    | Function   | Peripheral                                     | I/O direction <sup>2</sup>     | Pad type | RESET configuration <sup>3</sup> | Pin number |          |          |                          |
|---------------|---------|------------------------------------|--|--|--------------------------------|----------|----------------------------------|------------|----------|----------|--------------------------|
|               |         |                                    |  |  |                                |          |                                  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sup>4</sup> |
| PD[11]        | PCR[59] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>— | GPIO[59]<br>—<br>—<br>—<br>ADC0_P[15]<br>ADC1_P[15]              | SIUL<br>—<br>—<br>—<br>ADC_0<br>ADC_1          | I<br>—<br>—<br>—<br>I<br>I     | I        | Tristate                         | 58         | 80       | 96       | N16                      |
| PD[12]        | PCR[60] | AF0<br>AF1<br>AF2<br>AF3<br>—      | GPIO[60]<br>CS5_0<br>E0UC[24]<br>—<br>ADC0_S[4]                  | SIUL<br>DSPI_0<br>eMIOS_0<br>—<br>ADC_0        | I/O<br>O<br>I/O<br>—<br>I      | J        | Tristate                         | —          | —        | 100      | M15                      |
| PD[13]        | PCR[61] | AF0<br>AF1<br>AF2<br>AF3<br>—      | GPIO[61]<br>CS0_1<br>E0UC[25]<br>—<br>ADC0_S[5]                  | SIUL<br>DSPI_1<br>eMIOS_0<br>—<br>ADC_0        | I/O<br>I/O<br>I/O<br>—<br>I    | J        | Tristate                         | 62         | 84       | 102      | M14                      |
| PD[14]        | PCR[62] | AF0<br>AF1<br>AF2<br>AF3<br>—      | GPIO[62]<br>CS1_1<br>E0UC[26]<br>—<br>ADC0_S[6]                  | SIUL<br>DSPI_1<br>eMIOS_0<br>—<br>ADC_0        | I/O<br>O<br>I/O<br>—<br>I      | J        | Tristate                         | 64         | 86       | 104      | L15                      |
| PD[15]        | PCR[63] | AF0<br>AF1<br>AF2<br>AF3<br>—      | GPIO[63]<br>CS2_1<br>E0UC[27]<br>—<br>ADC0_S[7]                  | SIUL<br>DSPI_1<br>eMIOS_0<br>—<br>ADC_0        | I/O<br>O<br>I/O<br>—<br>I      | J        | Tristate                         | 66         | 88       | 106      | L14                      |
| <b>Port E</b> |         |                                    |  |  |                                |          |                                  |            |          |          |                          |
| PE[0]         | PCR[64] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>— | GPIO[64]<br>E0UC[16]<br>—<br>—<br>WKPU[6] <sup>5</sup><br>CAN5RX | SIUL<br>eMIOS_0<br>—<br>—<br>WKPU<br>FlexCAN_5 | I/O<br>I/O<br>—<br>—<br>I<br>I | S        | Tristate                         | 6          | 10       | 18       | F1                       |
| PE[1]         | PCR[65] | AF0<br>AF1<br>AF2<br>AF3           | GPIO[65]<br>E0UC[17]<br>CAN5TX<br>—                              | SIUL<br>eMIOS_0<br>FlexCAN_5<br>—              | I/O<br>I/O<br>O<br>—           | M        | Tristate                         | 8          | 12       | 20       | F4                       |
| PE[2]         | PCR[66] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>— | GPIO[66]<br>E0UC[18]<br>—<br>—<br>EIRQ[21]<br>SIN_1              | SIUL<br>eMIOS_0<br>—<br>—<br>SIUL<br>DSPI_1    | I/O<br>I/O<br>—<br>—<br>I<br>I | M        | Tristate                         | 89         | 128      | 156      | D7                       |

Table 5. Functional port pin descriptions (continued)

| Port pin | PCR     | Alternate function <sup>1</sup>         | Function   | Peripheral  | I/O direction <sup>2</sup>          | Pad type | RESET configuration <sup>3</sup> | Pin number |          |          |                          |
|----------|---------|---|--|---|-------------------------------------|----------|----------------------------------|------------|----------|----------|--------------------------|
|          |         |   |  |   |                                     |          |                                  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sup>4</sup> |
| PE[3]    | PCR[67] | AF0<br>AF1<br>AF2<br>AF3                | GPIO[67]<br>E0UC[19]<br>SOUT_1<br>—  | SIUL<br>eMIOS_0<br>DSPI_1<br>—                              | I/O<br>I/O<br>O<br>—                | M        | Tristate                         | 90         | 129      | 157      | C7                       |
| PE[4]    | PCR[68] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[68]<br>E0UC[20]<br>SCK_1<br>—<br>EIRQ[9]                              | SIUL<br>eMIOS_0<br>DSPI_1<br>—<br>SIUL                      | I/O<br>I/O<br>I/O<br>—<br>I         | M        | Tristate                         | 93         | 132      | 160      | D6                       |
| PE[5]    | PCR[69] | AF0<br>AF1<br>AF2<br>AF3                | GPIO[69]<br>E0UC[21]<br>CS0_1<br>MA[2]                                     | SIUL<br>eMIOS_0<br>DSPI_1<br>ADC_0                          | I/O<br>I/O<br>I/O<br>O              | M        | Tristate                         | 94         | 133      | 161      | C6                       |
| PE[6]    | PCR[70] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[70]<br>E0UC[22]<br>CS3_0<br>MA[1]<br>EIRQ[22]                         | SIUL<br>eMIOS_0<br>DSPI_0<br>ADC_0<br>SIUL                  | I/O<br>I/O<br>O<br>O<br>I           | M        | Tristate                         | 95         | 139      | 167      | B5                       |
| PE[7]    | PCR[71] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[71]<br>E0UC[23]<br>CS2_0<br>MA[0]<br>EIRQ[23]                         | SIUL<br>eMIOS_0<br>DSPI_0<br>ADC_0<br>SIUL                  | I/O<br>I/O<br>O<br>O<br>I           | M        | Tristate                         | 96         | 140      | 168      | C4                       |
| PE[8]    | PCR[72] | AF0<br>AF1<br>AF2<br>AF3                | GPIO[72]<br>CAN2TX<br>E0UC[22]<br>CAN3TX                                   | SIUL<br>FlexCAN_2<br>eMIOS_0<br>FlexCAN_3                   | I/O<br>O<br>I/O<br>O                | M        | Tristate                         | 9          | 13       | 21       | G2                       |
| PE[9]    | PCR[73] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—<br>— | GPIO[73]<br>—<br>E0UC[23]<br>—<br>WKPU[7] <sup>5</sup><br>CAN2RX<br>CAN3RX | SIUL<br>—<br>eMIOS_0<br>—<br>WKPU<br>FlexCAN_2<br>FlexCAN_3 | I/O<br>—<br>I/O<br>—<br>I<br>I<br>I | S        | Tristate                         | 10         | 14       | 22       | G1                       |
| PE[10]   | PCR[74] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[74]<br>LIN3TX<br>CS3_1<br>E1UC[30]<br>EIRQ[10]                        | SIUL<br>LINFlex_3<br>DSPI_1<br>eMIOS_1<br>SIUL              | I/O<br>O<br>O<br>I/O<br>I           | S        | Tristate                         | 11         | 15       | 23       | G3                       |

Table 5. Functional port pin descriptions (continued)

| Port pin      | PCR     | Alternate function <sup>1</sup>         | Function   | Peripheral   | I/O direction <sup>2</sup>          | Pad type | RESET configuration <sup>3</sup> | Pin number |          |          |                          |
|---------------|---------|---|--|--|-------------------------------------|----------|----------------------------------|------------|----------|----------|--------------------------|
|               |         |   |  |  |                                     |          |                                  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sup>4</sup> |
| PE[11]        | PCR[75] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—      | GPIO[75]<br>E0UC[24]<br>CS4_1<br>—<br>LIN3RX<br>WKPU[14] <sup>5</sup>          | SIUL<br>eMIOS_0<br>DSPI_1<br>—<br>LINFlex_3<br>WKPU  | I/O<br>I/O<br>O<br>—<br>I<br>I      | S        | Tristate                         | 13         | 17       | 25       | H2                       |
| PE[12]        | PCR[76] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—<br>— | GPIO[76]<br>—<br>E1UC[19] <sup>12</sup><br>—<br>EIRQ[11]<br>SIN_2<br>ADC1_S[7] | SIUL<br>—<br>eMIOS_1<br>—<br>SIUL<br>DSPI_2<br>ADC_1 | I/O<br>—<br>I/O<br>—<br>I<br>I<br>I | J        | Tristate                         | 76         | 109      | 133      | C14                      |
| PE[13]        | PCR[77] | AF0<br>AF1<br>AF2<br>AF3                | GPIO[77]<br>SOUT_2<br>E1UC[20]<br>—  | SIUL<br>DSPI_2<br>eMIOS_1<br>—                       | I/O<br>O<br>I/O<br>—                | S        | Tristate                         | —          | 103      | 127      | D15                      |
| PE[14]        | PCR[78] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[78]<br>SCK_2<br>E1UC[21]<br>—<br>EIRQ[12]                                 | SIUL<br>DSPI_2<br>eMIOS_1<br>—<br>SIUL               | I/O<br>I/O<br>I/O<br>—<br>I         | S        | Tristate                         | —          | 112      | 136      | C13                      |
| PE[15]        | PCR[79] | AF0<br>AF1<br>AF2<br>AF3                | GPIO[79]<br>CS0_2<br>E1UC[22]<br>—   | SIUL<br>DSPI_2<br>eMIOS_1<br>—                       | I/O<br>I/O<br>I/O<br>—              | M        | Tristate                         | —          | 113      | 137      | A13                      |
| <b>Port F</b> |         |   |  |  |                                     |          |                                  |            |          |          |                          |
| PF[0]         | PCR[80] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[80]<br>E0UC[10]<br>CS3_1<br>—<br>ADC0_S[8]                                | SIUL<br>eMIOS_0<br>DSPI_1<br>—<br>ADC_0              | I/O<br>I/O<br>O<br>—<br>I           | J        | Tristate                         | —          | 55       | 63       | N10                      |
| PF[1]         | PCR[81] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[81]<br>E0UC[11]<br>CS4_1<br>—<br>ADC0_S[9]                                | SIUL<br>eMIOS_0<br>DSPI_1<br>—<br>ADC_0              | I/O<br>I/O<br>O<br>—<br>I           | J        | Tristate                         | —          | 56       | 64       | P10                      |
| PF[2]         | PCR[82] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[82]<br>E0UC[12]<br>CS0_2<br>—<br>ADC0_S[10]                               | SIUL<br>eMIOS_0<br>DSPI_2<br>—<br>ADC_0              | I/O<br>I/O<br>I/O<br>—<br>I         | J        | Tristate                         | —          | 57       | 65       | T10                      |

Table 5. Functional port pin descriptions (continued)

| Port pin | PCR     | Alternate function <sup>1</sup>         | Function   | Peripheral   | I/O direction <sup>2</sup>          | Pad type | RESET configuration <sup>3</sup> | Pin number |          |          |                          |
|----------|---------|---|--|--|-------------------------------------|----------|----------------------------------|------------|----------|----------|--------------------------|
|          |         |   |  |  |                                     |          |                                  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sup>4</sup> |
| PF[3]    | PCR[83] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[83]<br>E0UC[13]<br>CS1_2<br>—<br>ADC0_S[11]                               | SIUL<br>eMIOS_0<br>DSPI_2<br>—<br>ADC_0                          | I/O<br>I/O<br>O<br>—<br>I           | J        | Tristate                         | —          | 58       | 66       | R10                      |
| PF[4]    | PCR[84] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[84]<br>E0UC[14]<br>CS2_2<br>—<br>ADC0_S[12]                               | SIUL<br>eMIOS_0<br>DSPI_2<br>—<br>ADC_0                          | I/O<br>I/O<br>O<br>—<br>I           | J        | Tristate                         | —          | 59       | 67       | N11                      |
| PF[5]    | PCR[85] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[85]<br>E0UC[22]<br>CS3_2<br>—<br>ADC0_S[13]                               | SIUL<br>eMIOS_0<br>DSPI_2<br>—<br>ADC_0                          | I/O<br>I/O<br>O<br>—<br>I           | J        | Tristate                         | —          | 60       | 68       | P11                      |
| PF[6]    | PCR[86] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[86]<br>E0UC[23]<br>CS1_1<br>—<br>ADC0_S[14]                               | SIUL<br>eMIOS_0<br>DSPI_1<br>—<br>ADC_0                          | I/O<br>I/O<br>O<br>—<br>I           | J        | Tristate                         | —          | 61       | 69       | T11                      |
| PF[7]    | PCR[87] | AF0<br>AF1<br>AF2<br>AF3<br>—           | GPIO[87]<br>—<br>CS2_1<br>—<br>ADC0_S[15]                                      | SIUL<br>—<br>DSPI_1<br>—<br>ADC_0                                | I/O<br>—<br>O<br>—<br>I             | J        | Tristate                         | —          | 62       | 70       | R11                      |
| PF[8]    | PCR[88] | AF0<br>AF1<br>AF2<br>AF3                | GPIO[88]<br>CAN3TX<br>CS4_0<br>CAN2TX  | SIUL<br>FlexCAN_3<br>DSPI_0<br>FlexCAN_2                         | I/O<br>O<br>O<br>O                  | M        | Tristate                         | —          | 34       | 42       | P1                       |
| PF[9]    | PCR[89] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—<br>— | GPIO[89]<br>E1UC[1]<br>CS5_0<br>—<br>WKPU[22] <sup>5</sup><br>CAN2RX<br>CAN3RX | SIUL<br>eMIOS_1<br>DSPI_0<br>—<br>WKPU<br>FlexCAN_2<br>FlexCAN_3 | I/O<br>I/O<br>O<br>—<br>I<br>I<br>I | S        | Tristate                         | —          | 33       | 41       | N2                       |
| PF[10]   | PCR[90] | AF0<br>AF1<br>AF2<br>AF3                | GPIO[90]<br>CS1_0<br>LIN4TX<br>E1UC[2]   | SIUL<br>DSPI_0<br>LINFlex_4<br>eMIOS_1                           | I/O<br>O<br>O<br>I/O                | M        | Tristate                         | —          | 38       | 46       | R3                       |

Table 5. Functional port pin descriptions (continued)

| Port pin      | PCR     | Alternate function <sup>1</sup>         | Function   | Peripheral   | I/O direction <sup>2</sup>               | Pad type | RESET configuration <sup>3</sup> | Pin number |          |          |                          |
|---------------|---------|---|--|--|--|----------|----------------------------------|------------|----------|----------|--------------------------|
|               |         |   |  |  |  |          |                                  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sup>4</sup> |
| PF[11]        | PCR[91] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—      | GPIO[91]<br>CS2_0<br>E1UC[3]<br>—<br>WKPU[15] <sup>5</sup><br>LIN4RX   | SIUL<br>DSPI_0<br>eMIOS_1<br>—<br>WKPU<br>LINFlex_4              | I/O<br>O<br>I/O<br>—<br>I<br>I           | S        | Tristate                         | —          | 39       | 47       | R4                       |
| PF[12]        | PCR[92] | AF0<br>AF1<br>AF2<br>AF3                | GPIO[92]<br>E1UC[25]<br>LIN5TX<br>—                                    | SIUL<br>eMIOS_1<br>LINFlex_5<br>—                                | I/O<br>I/O<br>O<br>—                     | M        | Tristate                         | —          | 35       | 43       | R1                       |
| PF[13]        | PCR[93] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—      | GPIO[93]<br>E1UC[26]<br>—<br>—<br>—<br>WKPU[16] <sup>5</sup><br>LIN5RX | SIUL<br>eMIOS_1<br>—<br>—<br>—<br>WKPU<br>LINFlex_5              | I/O<br>I/O<br>—<br>—<br>—<br>I<br>I      | S        | Tristate                         | —          | 41       | 49       | T6                       |
| PF[14]        | PCR[94] | AF0<br>AF1<br>AF2<br>AF3                | GPIO[94]<br>CAN4TX<br>E1UC[27]<br>CAN1TX                               | SIUL<br>FlexCAN_4<br>eMIOS_1<br>FlexCAN_1                        | I/O<br>O<br>I/O<br>O                     | M        | Tristate                         | —          | 102      | 126      | D14                      |
| PF[15]        | PCR[95] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—<br>— | GPIO[95]<br>E1UC[4]<br>—<br>—<br>—<br>EIRQ[13]<br>CAN1RX<br>CAN4RX     | SIUL<br>eMIOS_1<br>—<br>—<br>—<br>SIUL<br>FlexCAN_1<br>FlexCAN_4 | I/O<br>I/O<br>—<br>—<br>—<br>I<br>I<br>I | S        | Tristate                         | —          | 101      | 125      | E15                      |
| <b>Port G</b> |         |   |  |  |  |          |                                  |            |          |          |                          |
| PG[0]         | PCR[96] | AF0<br>AF1<br>AF2<br>AF3                | GPIO[96]<br>CAN5TX<br>E1UC[23]<br>—                                    | SIUL<br>FlexCAN_5<br>eMIOS_1<br>—                                | I/O<br>O<br>I/O<br>—                     | M        | Tristate                         | —          | 98       | 122      | E14                      |
| PG[1]         | PCR[97] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>—      | GPIO[97]<br>—<br>E1UC[24]<br>—<br>—<br>EIRQ[14]<br>CAN5RX              | SIUL<br>—<br>eMIOS_1<br>—<br>—<br>SIUL<br>FlexCAN_5              | I/O<br>—<br>I/O<br>—<br>—<br>I<br>I      | S        | Tristate                         | —          | 97       | 121      | E13                      |
| PG[2]         | PCR[98] | AF0<br>AF1<br>AF2<br>AF3                | GPIO[98]<br>E1UC[11]<br>SOUT_3<br>—                                    | SIUL<br>eMIOS_1<br>DSPI_3<br>—                                   | I/O<br>I/O<br>O<br>—                     | M        | Tristate                         | —          | 8        | 16       | E4                       |

Table 5. Functional port pin descriptions (continued)

| Port pin | PCR      | Alternate function <sup>1</sup>    | Function   | Peripheral  | I/O direction <sup>2</sup>            | Pad type | RESET configuration <sup>3</sup> | Pin number |          |          |                          |
|----------|----------|------------------------------------|--|---|---------------------------------------|----------|----------------------------------|------------|----------|----------|--------------------------|
|          |          |                                    |  |   |                                       |          |                                  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sup>4</sup> |
| PG[3]    | PCR[99]  | AF0<br>AF1<br>AF2<br>AF3<br>—      | GPIO[99]<br>E1UC[12]<br>CS0_3<br>—<br>WKPU[17] <sup>5</sup>                    | SIUL<br>eMIOS_1<br>DSPI_3<br>—<br>WKPU                    | I/O<br>I/O<br>I/O<br>—<br>I           | S        | Tristate                         | —          | 7        | 15       | E3                       |
| PG[4]    | PCR[100] | AF0<br>AF1<br>AF2<br>AF3           | GPIO[100]<br>E1UC[13]<br>SCK_3<br>—  | SIUL<br>eMIOS_1<br>DSPI_3<br>—                            | I/O<br>I/O<br>I/O<br>—                | M        | Tristate                         | —          | 6        | 14       | E1                       |
| PG[5]    | PCR[101] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>— | GPIO[101]<br>E1UC[14]<br>—<br>—<br>—<br>WKPU[18] <sup>5</sup><br>SIN_3         | SIUL<br>eMIOS_1<br>—<br>—<br>—<br>WKPU<br>DSPI_3          | I/O<br>I/O<br>—<br>—<br>—<br>I<br>I   | S        | Tristate                         | —          | 5        | 13       | E2                       |
| PG[6]    | PCR[102] | AF0<br>AF1<br>AF2<br>AF3           | GPIO[102]<br>E1UC[15]<br>LIN6TX<br>—   | SIUL<br>eMIOS_1<br>LINFlex_6<br>—                         | I/O<br>I/O<br>O<br>—                  | M        | Tristate                         | —          | 30       | 38       | M2                       |
| PG[7]    | PCR[103] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>— | GPIO[103]<br>E1UC[16]<br>E1UC[30]<br>—<br>—<br>WKPU[20] <sup>5</sup><br>LIN6RX | SIUL<br>eMIOS_1<br>eMIOS_1<br>—<br>—<br>WKPU<br>LINFlex_6 | I/O<br>I/O<br>I/O<br>—<br>—<br>I<br>I | S        | Tristate                         | —          | 29       | 37       | M1                       |
| PG[8]    | PCR[104] | AF0<br>AF1<br>AF2<br>AF3<br>—      | GPIO[104]<br>E1UC[17]<br>LIN7TX<br>CS0_2<br>EIRQ[15]                           | SIUL<br>eMIOS_1<br>LINFlex_7<br>DSPI_2<br>SIUL            | I/O<br>I/O<br>O<br>I/O<br>I           | S        | Tristate                         | —          | 26       | 34       | L2                       |
| PG[9]    | PCR[105] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>— | GPIO[105]<br>E1UC[18]<br>—<br>—<br>SCK_2<br>WKPU[21] <sup>5</sup><br>LIN7RX    | SIUL<br>eMIOS_1<br>—<br>—<br>DSPI_2<br>WKPU<br>LINFlex_7  | I/O<br>I/O<br>—<br>—<br>I/O<br>I<br>I | S        | Tristate                         | —          | 25       | 33       | L1                       |
| PG[10]   | PCR[106] | AF0<br>AF1<br>AF2<br>AF3<br>—      | GPIO[106]<br>E0UC[24]<br>E1UC[31]<br>—<br>SIN_4                                | SIUL<br>eMIOS_0<br>eMIOS_1<br>—<br>DSPI_4                 | I/O<br>I/O<br>I/O<br>—<br>I           | S        | Tristate                         | —          | 114      | 138      | D13                      |

Table 5. Functional port pin descriptions (continued)

| Port pin      | PCR      | Alternate function <sup>1</sup> | Function                                 | Peripheral                             | I/O direction <sup>2</sup> | Pad type | RESET configuration <sup>3</sup> | Pin number |          |          |                          |
|---------------|----------|---------------------------------|--|--|----------------------------|----------|----------------------------------|------------|----------|----------|--------------------------|
|               |          |                                 |  |  |                            |          |                                  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sup>4</sup> |
| PG[11]        | PCR[107] | AF0<br>AF1<br>AF2<br>AF3        | GPIO[107]<br>E0UC[25]<br>CS0_4<br>—      | SIUL<br>eMIOS_0<br>DSPI_4<br>—         | I/O<br>I/O<br>I/O<br>—     | M        | Tristate                         | —          | 115      | 139      | B12                      |
| PG[12]        | PCR[108] | AF0<br>AF1<br>AF2<br>AF3        | GPIO[108]<br>E0UC[26]<br>SOUT_4<br>—     | SIUL<br>eMIOS_0<br>DSPI_4<br>—         | I/O<br>I/O<br>O<br>—       | M        | Tristate                         | —          | 92       | 116      | K14                      |
| PG[13]        | PCR[109] | AF0<br>AF1<br>AF2<br>AF3        | GPIO[109]<br>E0UC[27]<br>SCK_4<br>—      | SIUL<br>eMIOS_0<br>DSPI_4<br>—         | I/O<br>I/O<br>I/O<br>—     | M        | Tristate                         | —          | 91       | 115      | K16                      |
| PG[14]        | PCR[110] | AF0<br>AF1<br>AF2<br>AF3        | GPIO[110]<br>E1UC[0]<br>LIN8TX<br>—      | SIUL<br>eMIOS_1<br>LINFlex_8<br>—      | I/O<br>I/O<br>O<br>—       | S        | Tristate                         | —          | 110      | 134      | B14                      |
| PG[15]        | PCR[111] | AF0<br>AF1<br>AF2<br>AF3<br>—   | GPIO[111]<br>E1UC[1]<br>—<br>—<br>LIN8RX | SIUL<br>eMIOS_1<br>—<br>—<br>LINFlex_8 | I/O<br>I/O<br>—<br>—<br>I  | M        | Tristate                         | —          | 111      | 135      | B13                      |
| <b>Port H</b> |          |                                 |  |  |                            |          |                                  |            |          |          |                          |
| PH[0]         | PCR[112] | AF0<br>AF1<br>AF2<br>AF3<br>—   | GPIO[112]<br>E1UC[2]<br>—<br>—<br>SIN_1  | SIUL<br>eMIOS_1<br>—<br>—<br>DSPI_1    | I/O<br>I/O<br>—<br>—<br>I  | M        | Tristate                         | —          | 93       | 117      | F13                      |
| PH[1]         | PCR[113] | AF0<br>AF1<br>AF2<br>AF3        | GPIO[113]<br>E1UC[3]<br>SOUT_1<br>—      | SIUL<br>eMIOS_1<br>DSPI_1<br>—         | I/O<br>I/O<br>O<br>—       | M        | Tristate                         | —          | 94       | 118      | F14                      |
| PH[2]         | PCR[114] | AF0<br>AF1<br>AF2<br>AF3        | GPIO[114]<br>E1UC[4]<br>SCK_1<br>—       | SIUL<br>eMIOS_1<br>DSPI_1<br>—         | I/O<br>I/O<br>I/O<br>—     | M        | Tristate                         | —          | 95       | 119      | F16                      |
| PH[3]         | PCR[115] | AF0<br>AF1<br>AF2<br>AF3        | GPIO[115]<br>E1UC[5]<br>CS0_1<br>—       | SIUL<br>eMIOS_1<br>DSPI_1<br>—         | I/O<br>I/O<br>I/O<br>—     | M        | Tristate                         | —          | 96       | 120      | F15                      |

Table 5. Functional port pin descriptions (continued)

| Port pin             | PCR      | Alternate function <sup>1</sup> | Function                                 | Peripheral                          | I/O direction <sup>2</sup> | Pad type | RESET configuration <sup>3</sup> | Pin number |          |          |                          |
|----------------------|----------|---------------------------------|--|-------------------------------------|----------------------------|----------|----------------------------------|------------|----------|----------|--------------------------|
|                      |          |                                 |  |                                     |                            |          |                                  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sub>4</sub> |
| PH[4]                | PCR[116] | AF0<br>AF1<br>AF2<br>AF3        | GPIO[116]<br>E1UC[6]<br>—<br>—           | SIUL<br>eMIOS_1<br>—<br>—           | I/O<br>I/O<br>—<br>—       | M        | Tristate                         | —          | 134      | 162      | A6                       |
| PH[5]                | PCR[117] | AF0<br>AF1<br>AF2<br>AF3        | GPIO[117]<br>E1UC[7]<br>—<br>—           | SIUL<br>eMIOS_1<br>—<br>—           | I/O<br>I/O<br>—<br>—       | S        | Tristate                         | —          | 135      | 163      | B6                       |
| PH[6]                | PCR[118] | AF0<br>AF1<br>AF2<br>AF3        | GPIO[118]<br>E1UC[8]<br>—<br>MA[2]       | SIUL<br>eMIOS_1<br>—<br>ADC_0       | I/O<br>I/O<br>—<br>O       | M        | Tristate                         | —          | 136      | 164      | D5                       |
| PH[7]                | PCR[119] | AF0<br>AF1<br>AF2<br>AF3        | GPIO[119]<br>E1UC[9]<br>CS3_2<br>MA[1]   | SIUL<br>eMIOS_1<br>DSPI_2<br>ADC_0  | I/O<br>I/O<br>O<br>O       | M        | Tristate                         | —          | 137      | 165      | C5                       |
| PH[8]                | PCR[120] | AF0<br>AF1<br>AF2<br>AF3        | GPIO[120]<br>E1UC[10]<br>CS2_2<br>MA[0]  | SIUL<br>eMIOS_1<br>DSPI_2<br>ADC_0  | I/O<br>I/O<br>O<br>O       | M        | Tristate                         | —          | 138      | 166      | A5                       |
| PH[9] <sup>10</sup>  | PCR[121] | AF0<br>AF1<br>AF2<br>AF3        | GPIO[121]<br>—<br>TCK<br>—               | SIUL<br>—<br>JTAGC<br>—             | I/O<br>—<br>I<br>—         | S        | Input,<br>weak<br>pull-up        | 88         | 127      | 155      | B8                       |
| PH[10] <sup>10</sup> | PCR[122] | AF0<br>AF1<br>AF2<br>AF3        | GPIO[122]<br>—<br>TMS<br>—               | SIUL<br>—<br>JTAGC<br>—             | I/O<br>—<br>I<br>—         | M        | Input,<br>weak<br>pull-up        | 81         | 120      | 148      | B9                       |
| PH[11]               | PCR[123] | AF0<br>AF1<br>AF2<br>AF3        | GPIO[123]<br>SOUT_3<br>CS0_4<br>E1UC[5]  | SIUL<br>DSPI_3<br>DSPI_4<br>eMIOS_1 | I/O<br>O<br>I/O<br>I/O     | M        | Tristate                         | —          | —        | 140      | A14                      |
| PH[12]               | PCR[124] | AF0<br>AF1<br>AF2<br>AF3        | GPIO[124]<br>SCK_3<br>CS1_4<br>E1UC[25]  | SIUL<br>DSPI_3<br>DSPI_4<br>eMIOS_1 | I/O<br>I/O<br>O<br>I/O     | M        | Tristate                         | —          | —        | 141      | D12                      |
| PH[13]               | PCR[125] | AF0<br>AF1<br>AF2<br>AF3        | GPIO[125]<br>SOUT_4<br>CS0_3<br>E1UC[26] | SIUL<br>DSPI_4<br>DSPI_3<br>eMIOS_1 | I/O<br>O<br>I/O<br>I/O     | M        | Tristate                         | —          | —        | 9        | B3                       |

Table 5. Functional port pin descriptions (continued)

| Port pin      | PCR      | Alternate function <sup>1</sup>    | Function   | Peripheral                                     | I/O direction <sup>2</sup>     | Pad type | RESET configuration <sup>3</sup> | Pin number |          |          |                          |
|---------------|----------|------------------------------------|--|--|--------------------------------|----------|----------------------------------|------------|----------|----------|--------------------------|
|               |          |                                    |  |  |                                |          |                                  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sup>4</sup> |
| PH[14]        | PCR[126] | AF0<br>AF1<br>AF2<br>AF3           | GPIO[126]<br>SCK_4<br>CS1_3<br>E1UC[27]                            | SIUL<br>DSPI_4<br>DSPI_3<br>eMIOS_1            | I/O<br>I/O<br>O<br>I/O         | M        | Tristate                         | —          | —        | 10       | D1                       |
| PH[15]        | PCR[127] | AF0<br>AF1<br>AF2<br>AF3           | GPIO[127]<br>SOUT_5<br>—<br>E1UC[17]                               | SIUL<br>DSPI_5<br>—<br>eMIOS_1                 | I/O<br>O<br>—<br>I/O           | M        | Tristate                         | —          | —        | 8        | A3                       |
| <b>Port I</b> |          |                                    |  |  |                                |          |                                  |            |          |          |                          |
| PI[0]         | PCR[128] | AF0<br>AF1<br>AF2<br>AF3           | GPIO[128]<br>E0UC[28]<br>LIN8TX<br>—                               | SIUL<br>eMIOS_0<br>LINFlex_8<br>—              | I/O<br>I/O<br>O<br>—           | S        | Tristate                         | —          | —        | 172      | A9                       |
| PI[1]         | PCR[129] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>— | GPIO[129]<br>E0UC[29]<br>—<br>—<br>WKPU[24] <sup>5</sup><br>LIN8RX | SIUL<br>eMIOS_0<br>—<br>—<br>WKPU<br>LINFlex_8 | I/O<br>I/O<br>—<br>—<br>I<br>I | S        | Tristate                         | —          | —        | 171      | A10                      |
| PI[2]         | PCR[130] | AF0<br>AF1<br>AF2<br>AF3           | GPIO[130]<br>E0UC[30]<br>LIN9TX<br>—                               | SIUL<br>eMIOS_0<br>LINFlex_9<br>—              | I/O<br>I/O<br>O<br>—           | S        | Tristate                         | —          | —        | 170      | B10                      |
| PI[3]         | PCR[131] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>— | GPIO[131]<br>E0UC[31]<br>—<br>—<br>WKPU[23] <sup>5</sup><br>LIN9RX | SIUL<br>eMIOS_0<br>—<br>—<br>WKPU<br>LINFlex_9 | I/O<br>I/O<br>—<br>—<br>I<br>I | S        | Tristate                         | —          | —        | 169      | C10                      |
| PI[4]         | PCR[132] | AF0<br>AF1<br>AF2<br>AF3           | GPIO[132]<br>E1UC[28]<br>SOUT_4<br>—                               | SIUL<br>eMIOS_1<br>DSPI_4<br>—                 | I/O<br>I/O<br>O<br>—           | S        | Tristate                         | —          | —        | 143      | A12                      |
| PI[5]         | PCR[133] | AF0<br>AF1<br>AF2<br>AF3           | GPIO[133]<br>E1UC[29]<br>SCK_4<br>—                                | SIUL<br>eMIOS_1<br>DSPI_4<br>—                 | I/O<br>I/O<br>I/O<br>—         | S        | Tristate                         | —          | —        | 142      | C12                      |
| PI[6]         | PCR[134] | AF0<br>AF1<br>AF2<br>AF3           | GPIO[134]<br>E1UC[30]<br>CS0_4<br>—                                | SIUL<br>eMIOS_1<br>DSPI_4<br>—                 | I/O<br>I/O<br>I/O<br>—         | S        | Tristate                         | —          | —        | 11       | D2                       |

Table 5. Functional port pin descriptions (continued)

| Port pin | PCR      | Alternate function <sup>1</sup>    | Function  | Peripheral                             | I/O direction <sup>2</sup>   | Pad type | RESET configuration <sup>3</sup> | Pin number |          |          |                          |
|----------|----------|------------------------------------|---|--|------------------------------|----------|----------------------------------|------------|----------|----------|--------------------------|
|          |          |                                    |   |  |                              |          |                                  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sup>4</sup> |
| PI[7]    | PCR[135] | AF0<br>AF1<br>AF2<br>AF3           | GPIO[135]<br>E1UC[31]<br>CS1_4<br>—             | SIUL<br>eMIOS_1<br>DSPI_4<br>—         | I/O<br>I/O<br>O<br>—         | S        | Tristate                         | —          | —        | 12       | D3                       |
| PI[8]    | PCR[136] | AF0<br>AF1<br>AF2<br>AF3<br>—      | GPIO[136]<br>—<br>—<br>—<br>ADC0_S[16]          | SIUL<br>—<br>—<br>—<br>ADC_0           | I/O<br>—<br>—<br>—<br>I      | J        | Tristate                         | —          | —        | 108      | J13                      |
| PI[9]    | PCR[137] | AF0<br>AF1<br>AF2<br>AF3<br>—      | GPIO[137]<br>—<br>—<br>—<br>ADC0_S[17]          | SIUL<br>—<br>—<br>—<br>ADC_0           | I/O<br>—<br>—<br>—<br>I      | J        | Tristate                         | —          | —        | 109      | J14                      |
| PI[10]   | PCR[138] | AF0<br>AF1<br>AF2<br>AF3<br>—      | GPIO[138]<br>—<br>—<br>—<br>ADC0_S[18]          | SIUL<br>—<br>—<br>—<br>ADC_0           | I/O<br>—<br>—<br>—<br>I      | J        | Tristate                         | —          | —        | 110      | J15                      |
| PI[11]   | PCR[139] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>— | GPIO[139]<br>—<br>—<br>—<br>ADC0_S[19]<br>SIN_3 | SIUL<br>—<br>—<br>—<br>ADC_0<br>DSPI_3 | I/O<br>—<br>—<br>—<br>I<br>I | J        | Tristate                         | —          | —        | 111      | J16                      |
| PI[12]   | PCR[140] | AF0<br>AF1<br>AF2<br>AF3<br>—      | GPIO[140]<br>CS0_3<br>—<br>—<br>ADC0_S[20]      | SIUL<br>DSPI_3<br>—<br>—<br>ADC_0      | I/O<br>I/O<br>—<br>—<br>I    | J        | Tristate                         | —          | —        | 112      | G14                      |
| PI[13]   | PCR[141] | AF0<br>AF1<br>AF2<br>AF3<br>—      | GPIO[141]<br>CS1_3<br>—<br>—<br>ADC0_S[21]      | SIUL<br>DSPI_3<br>—<br>—<br>ADC_0      | I/O<br>O<br>—<br>—<br>I      | J        | Tristate                         | —          | —        | 113      | G15                      |
| PI[14]   | PCR[142] | AF0<br>AF1<br>AF2<br>AF3<br>—<br>— | GPIO[142]<br>—<br>—<br>—<br>ADC0_S[22]<br>SIN_4 | SIUL<br>—<br>—<br>—<br>ADC_0<br>DSPI_4 | I/O<br>—<br>—<br>—<br>I<br>I | J        | Tristate                         | —          | —        | 76       | R8                       |

Table 5. Functional port pin descriptions (continued)

| Port pin      | PCR      | Alternate function <sup>1</sup> | Function   | Peripheral | I/O direction <sup>2</sup> | Pad type | RESET configuration <sup>3</sup> | Pin number |          |          |                          |
|---------------|----------|---------------------------------|------------|------------|----------------------------|----------|----------------------------------|------------|----------|----------|--------------------------|
|               |          |                                 |            |            |                            |          |                                  | 100 LQFP   | 144 LQFP | 176 LQFP | 208 MAP BGA <sup>4</sup> |
| PI[15]        | PCR[143] | AF0                             | GPIO[143]  | SIUL       | I/O                        | J        | Tristate                         | —          | —        | 75       | T8                       |
|               |          | AF1                             | CS0_4      | DSPI_4     | I/O                        |          |                                  |            |          |          |                          |
|               |          | AF2                             | —          | —          | —                          |          |                                  |            |          |          |                          |
|               |          | AF3                             | —          | —          | —                          |          |                                  |            |          |          |                          |
|               |          | —                               | ADC0_S[23] | ADC_0      | I                          |          |                                  |            |          |          |                          |
| <b>Port J</b> |          |                                 |            |            |                            |          |                                  |            |          |          |                          |
| PJ[0]         | PCR[144] | AF0                             | GPIO[144]  | SIUL       | I/O                        | J        | Tristate                         | —          | —        | 74       | N5                       |
|               |          | AF1                             | CS1_4      | DSPI_4     | O                          |          |                                  |            |          |          |                          |
|               |          | AF2                             | —          | —          | —                          |          |                                  |            |          |          |                          |
|               |          | AF3                             | —          | —          | —                          |          |                                  |            |          |          |                          |
|               |          | —                               | ADC0_S[24] | ADC_0      | I                          |          |                                  |            |          |          |                          |
| PJ[1]         | PCR[145] | AF0                             | GPIO[145]  | SIUL       | I/O                        | J        | Tristate                         | —          | —        | 73       | P5                       |
|               |          | AF1                             | —          | —          | —                          |          |                                  |            |          |          |                          |
|               |          | AF2                             | —          | —          | —                          |          |                                  |            |          |          |                          |
|               |          | AF3                             | —          | —          | —                          |          |                                  |            |          |          |                          |
|               |          | —                               | ADC0_S[25] | ADC_0      | I                          |          |                                  |            |          |          |                          |
| —             | SIN_5    | DSPI_5                          | I          |            |                            |          |                                  |            |          |          |                          |
| PJ[2]         | PCR[146] | AF0                             | GPIO[146]  | SIUL       | I/O                        | J        | Tristate                         | —          | —        | 72       | P4                       |
|               |          | AF1                             | CS0_5      | DSPI_5     | I/O                        |          |                                  |            |          |          |                          |
|               |          | AF2                             | —          | —          | —                          |          |                                  |            |          |          |                          |
|               |          | AF3                             | —          | —          | —                          |          |                                  |            |          |          |                          |
|               |          | —                               | ADC0_S[26] | ADC_0      | I                          |          |                                  |            |          |          |                          |
| PJ[3]         | PCR[147] | AF0                             | GPIO[147]  | SIUL       | I/O                        | J        | Tristate                         | —          | —        | 71       | P2                       |
|               |          | AF1                             | CS1_5      | DSPI_5     | O                          |          |                                  |            |          |          |                          |
|               |          | AF2                             | —          | —          | —                          |          |                                  |            |          |          |                          |
|               |          | AF3                             | —          | —          | —                          |          |                                  |            |          |          |                          |
|               |          | —                               | ADC0_S[27] | ADC_0      | I                          |          |                                  |            |          |          |                          |
| PJ[4]         | PCR[148] | AF0                             | GPIO[148]  | SIUL       | I/O                        | M        | Tristate                         | —          | —        | 5        | A4                       |
|               |          | AF1                             | SCK_5      | DSPI_5     | I/O                        |          |                                  |            |          |          |                          |
|               |          | AF2                             | E1UC[18]   | eMIOS_1    | I/O                        |          |                                  |            |          |          |                          |
|               |          | AF3                             | —          | —          | —                          |          |                                  |            |          |          |                          |
|               |          | —                               | —          | —          | —                          |          |                                  |            |          |          |                          |

<sup>1</sup> 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 → AF2. 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 "—".

<sup>2</sup> 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.

<sup>3</sup> The RESET configuration applies during and after reset.

<sup>4</sup> **208 MAPBGA available only as development package for Nexus2+**

<sup>5</sup> All WKPU pins also support external interrupt capability. See the WKPU chapter for further details.

<sup>6</sup> NMI has higher priority than alternate function. When NMI is selected, the PCR.AF field is ignored.

## Electrical characteristics

- <sup>7</sup> “Not applicable” because these functions are available only while the device is booting. Refer to the BAM information for details.
- <sup>8</sup> Value of PCR.IBE bit must be 0
- <sup>9</sup> This wakeup input cannot be used to exit STANDBY mode.
- <sup>10</sup> 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). It is up to the user to configure these pins as GPIO when needed.
- <sup>11</sup> PC[1] is a fast/medium pad but is in medium configuration by default. This pad is in Alternate Function 2 mode after reset which has TDO functionality. The reset value of PCR.OBE is ‘1’, but this setting has no impact as long as this pad stays in AF2 mode. After configuring this pad as GPIO (PCR.PA = 0), output buffer is enabled as reset value of PCR.OBE = 1.
- <sup>12</sup> Not available in 100 LQFP package

## 3.8 Nexus 2+ pins

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

**Table 6. Nexus 2+ pin descriptions**

| Port pin                 | Function              | I/O direction | Pad type | Function after reset | Pin number |          |                          |
|--------------------------|-----------------------|---------------|----------|----------------------|------------|----------|--------------------------|
|                          |                       |               |          |                      | 100 LQFP   | 144 LQFP | 208 MAP BGA <sup>1</sup> |
| 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                      |
| $\overline{\text{EVTI}}$ | Event in              | I             | M        | Pull-up              | —          | —        | K1                       |
| $\overline{\text{EVTO}}$ | Event out             | O             | M        | —                    | —          | —        | L4                       |
| $\overline{\text{MSEO}}$ | Message start/end out | O             | M        | —                    | —          | —        | G16                      |

<sup>1</sup> 208 MAPBGA available only as development package for Nexus2+

## 4 Electrical characteristics

This section contains electrical characteristics of the device as well as temperature and power considerations.

This product contains devices to protect the inputs against damage due to high static voltages. However, it is advisable to take precautions to avoid application of any voltage higher than the specified maximum rated voltages.

To enhance reliability, unused inputs can be driven to an appropriate logic voltage level ( $V_{DD}$  or  $V_{SS}$ ). This could be done by the internal pull-up and pull-down, which is provided by the product for most general purpose pins.

The parameters listed in the following tables represent the characteristics of the device and its demands on the system.

In the tables where the device logic provides signals with their respective timing characteristics, the symbol “CC” for Controller Characteristics is included in the Symbol column.

In the tables where the external system must provide signals with their respective timing characteristics to the device, the symbol “SR” for System Requirement is included in the Symbol column.

## 4.1 Parameter classification

The electrical parameters shown in this supplement are guaranteed by various methods. To give the customer a better understanding, the classifications listed in [Table 7](#) are used and the parameters are tagged accordingly in the tables where appropriate.

**Table 7. Parameter classifications**

| Classification tag | Tag description  |
|--------------------|--|
| P                  | Those parameters are guaranteed during production testing on each individual device.   |
| C                  | Those parameters are achieved by the design characterization by measuring a statistically relevant sample size across process variations.  |
| T                  | Those parameters are achieved by design characterization on a small sample size from typical devices under typical conditions unless otherwise noted. All values shown in the typical column are within this category. |
| D                  | Those parameters are derived mainly from simulations.  |

### NOTE

The classification is shown in the column labeled “C” in the parameter tables where appropriate.

## 4.2 NVUSRO register

Bit values in the Non-Volatile User Options (NVUSRO) Register control portions of the device configuration, namely electrical parameters such as high voltage supply and oscillator margin, as well as digital functionality (watchdog enable/disable after reset).

For a detailed description of the NVUSRO register, please refer to the device reference manual.

### 4.2.1 NVUSRO[PAD3V5V] field description

The DC electrical characteristics are dependent on the PAD3V5V bit value. [Table 8](#) shows how NVUSRO[PAD3V5V] controls the device configuration.

**Table 8. PAD3V5V field description<sup>1</sup>**

| Value <sup>2</sup> | Description                  |
|--------------------|------------------------------|
| 0                  | High voltage supply is 5.0 V |
| 1                  | High voltage supply is 3.3 V |

<sup>1</sup> See the device reference manual for more information on the NVUSRO register.

## Electrical characteristics

<sup>2</sup> Default manufacturing value is '1'. Value can be programmed by customer in Shadow Flash.

### 4.2.2 NVUSRO[OSCILLATOR\_MARGIN] field description

The fast external crystal oscillator consumption is dependent on the OSCILLATOR\_MARGIN bit value. Table 9 shows how NVUSRO[OSCILLATOR\_MARGIN] controls the device configuration.

**Table 9. OSCILLATOR\_MARGIN field description<sup>1</sup>**

| Value <sup>2</sup> | Description                                 |
|--------------------|---|
| 0                  | Low consumption configuration (4 MHz/8 MHz) |
| 1                  | High margin configuration (4 MHz/16 MHz)    |

<sup>1</sup> See the device reference manual for more information on the NVUSRO register.

<sup>2</sup> Default manufacturing value is '1'. Value can be programmed by customer in Shadow Flash.

### 4.2.3 NVUSRO[WATCHDOG\_EN] field description

The watchdog enable/disable configuration after reset is dependent on the WATCHDOG\_EN bit value. Table 10 shows how NVUSRO[WATCHDOG\_EN] controls the device configuration.

**Table 10. WATCHDOG\_EN field description**

| Value <sup>1</sup> | Description         |
|--------------------|---------------------|
| 0                  | Disable after reset |
| 1                  | Enable after reset  |

<sup>1</sup> Default manufacturing value is '1'. Value can be programmed by customer in Shadow Flash.

## 4.3 Absolute maximum ratings

**Table 11. Absolute maximum ratings**

| Symbol              |    | Parameter  | Conditions                  | Value                 |                       | Unit |
|---------------------|----|--|-----------------------------|-----------------------|-----------------------|------|
|                     |    |  |                             | Min                   | Max                   |      |
| V <sub>SS</sub>     | SR | Digital ground on VSS_HV pins  | —                           | 0                     | 0                     | V    |
| V <sub>DD</sub>     | SR | Voltage on VDD_HV pins with respect to ground (V <sub>SS</sub> )                                   | —                           | -0.3                  | 6.0                   | V    |
| V <sub>SS_LV</sub>  | SR | Voltage on VSS_LV (low voltage digital supply) pins with respect to ground (V <sub>SS</sub> )      | —                           | V <sub>SS</sub> - 0.1 | V <sub>SS</sub> + 0.1 | V    |
| V <sub>DD_BV</sub>  | SR | Voltage on VDD_BV (regulator supply) pin with respect to ground (V <sub>SS</sub> )                 | —                           | -0.3                  | 6.0                   | V    |
|                     |    |  | Relative to V <sub>DD</sub> | -0.3                  | V <sub>DD</sub> + 0.3 |      |
| V <sub>SS_ADC</sub> | SR | Voltage on VSS_HV_ADC0, VSS_HV_ADC1 (ADC reference) pins with respect to ground (V <sub>SS</sub> ) | —                           | V <sub>SS</sub> - 0.1 | V <sub>SS</sub> + 0.1 | V    |
| V <sub>DD_ADC</sub> | SR | Voltage on VDD_HV_ADC0, VDD_HV_ADC1 (ADC reference) pins with respect to ground (V <sub>SS</sub> ) | —                           | -0.3                  | 6.0                   | V    |
|                     |    |  | Relative to V <sub>DD</sub> | V <sub>DD</sub> - 0.3 | V <sub>DD</sub> + 0.3 |      |

Table 11. Absolute maximum ratings (continued)

| Symbol               |    | Parameter   | Conditions                                    | Value |                       | Unit |
|----------------------|----|---|---|-------|-----------------------|------|
|                      |    |   |   | Min   | Max                   |      |
| V <sub>IN</sub>      | SR | Voltage on any GPIO pin with respect to ground (V <sub>SS</sub> )     | —   | -0.3  | 6.0                   | V    |
|                      |    |   | Relative to V <sub>DD</sub>                   | —     | V <sub>DD</sub> + 0.3 |      |
| I <sub>INJPAD</sub>  | SR | Injected input current on any pin during overload condition           | —   | -10   | 10                    | mA   |
| I <sub>INJSUM</sub>  | SR | Absolute sum of all injected input currents during overload condition | —   | -50   | 50                    |      |
| I <sub>AVGSEG</sub>  | SR | Sum of all the static I/O current within a supply segment             | V <sub>DD</sub> = 5.0 V ± 10%,<br>PAD3V5V = 0 | —     | 70                    | mA   |
|                      |    |   | V <sub>DD</sub> = 3.3 V ± 10%,<br>PAD3V5V = 1 | —     | 64                    |      |
| T <sub>STORAGE</sub> | SR | Storage temperature   | —   | -55   | 150                   | °C   |

**NOTE**

Stresses exceeding the recommended absolute maximum ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. During overload conditions ( $V_{IN} > V_{DD}$  or  $V_{IN} < V_{SS}$ ), the voltage on pins with respect to ground (V<sub>SS</sub>) must not exceed the recommended values.

**4.4 Recommended operating conditions**

Table 12. Recommended operating conditions (3.3 V)

| Symbol                           |    | Parameter   | Conditions                  | Value                 |                       | Unit |
|----------------------------------|----|---|-----------------------------|-----------------------|-----------------------|------|
|                                  |    |   |                             | Min                   | Max                   |      |
| V <sub>SS</sub>                  | SR | Digital ground on VSS_HV pins   | —                           | 0                     | 0                     | V    |
| V <sub>DD</sub> <sup>1</sup>     | SR | Voltage on VDD_HV pins with respect to ground (V <sub>SS</sub> )                                  | —                           | 3.0                   | 3.6                   | V    |
| V <sub>SS_LV</sub> <sup>2</sup>  | SR | Voltage on VSS_LV (low voltage digital supply) pins with respect to ground (V <sub>SS</sub> )     | —                           | V <sub>SS</sub> - 0.1 | V <sub>SS</sub> + 0.1 | V    |
| V <sub>DD_BV</sub> <sup>3</sup>  | SR | Voltage on VDD_BV pin (regulator supply) with respect to ground (V <sub>SS</sub> )                | —                           | 3.0                   | 3.6                   | V    |
|                                  |    |   | Relative to V <sub>DD</sub> | V <sub>DD</sub> - 0.1 | V <sub>DD</sub> + 0.1 |      |
| V <sub>SS_ADC</sub>              | SR | Voltage on VSS_HV_ADC0, VSS_HV_ADC1 (ADC reference) pin with respect to ground (V <sub>SS</sub> ) | —                           | V <sub>SS</sub> - 0.1 | V <sub>SS</sub> + 0.1 | V    |
| V <sub>DD_ADC</sub> <sup>4</sup> | SR | Voltage on VDD_HV_ADC0, VDD_HV_ADC1 (ADC reference) with respect to ground (V <sub>SS</sub> )     | —                           | 3.0 <sup>5</sup>      | 3.6                   | V    |
|                                  |    |   | Relative to V <sub>DD</sub> | V <sub>DD</sub> - 0.1 | V <sub>DD</sub> + 0.1 |      |

**Table 12. Recommended operating conditions (3.3 V) (continued)**

| Symbol                      |    | Parameter   | Conditions                             | Value                 |                       | Unit |
|-----------------------------|----|---|--|-----------------------|-----------------------|------|
|                             |    |   |  | Min                   | Max                   |      |
| V <sub>IN</sub>             | SR | Voltage on any GPIO pin with respect to ground (V <sub>SS</sub> )     | —                                      | V <sub>SS</sub> - 0.1 | —                     | V    |
|                             |    |   | Relative to V <sub>DD</sub>            | —                     | V <sub>DD</sub> + 0.1 |      |
| I <sub>INJPAD</sub>         | SR | Injected input current on any pin during overload condition           | —                                      | -5                    | 5                     | mA   |
| I <sub>INJSUM</sub>         | SR | Absolute sum of all injected input currents during overload condition | —                                      | -50                   | 50                    |      |
| TV <sub>DD</sub>            | SR | V <sub>DD</sub> slope to ensure correct power up <sup>6</sup>         | —                                      | 3.0 <sup>7</sup>      | 0.25 V/μs             | V/s  |
| T <sub>A</sub> C-Grade Part | SR | Ambient temperature under bias  | f <sub>CPU</sub> ≤ 64 MHz <sup>8</sup> | -40                   | 85                    | °C   |
| T <sub>J</sub> C-Grade Part | SR | Junction temperature under bias                                       | —                                      | -40                   | 110                   |      |
| T <sub>A</sub> V-Grade Part | SR | Ambient temperature under bias  | f <sub>CPU</sub> ≤ 64 MHz <sup>8</sup> | -40                   | 105                   |      |
| T <sub>J</sub> V-Grade Part | SR | Junction temperature under bias                                       | —                                      | -40                   | 130                   |      |
| T <sub>A</sub> M-Grade Part | SR | Ambient temperature under bias  | f <sub>CPU</sub> ≤ 64 MHz <sup>8</sup> | -40                   | 125                   |      |
| T <sub>J</sub> M-Grade Part | SR | Junction temperature under bias                                       | —                                      | -40                   | 150                   |      |

- <sup>1</sup> 100 nF capacitance needs to be provided between each V<sub>DD</sub>/V<sub>SS</sub> pair.
- <sup>2</sup> 330 nF capacitance needs to be provided between each V<sub>DD\_LV</sub>/V<sub>SS\_LV</sub> supply pair.
- <sup>3</sup> 470 nF capacitance needs to be provided between V<sub>DD\_BV</sub> and the nearest V<sub>SS\_LV</sub> (higher value may be needed depending on external regulator characteristics). Supply ramp slope on V<sub>DD\_BV</sub> should always be faster or equal to slope of V<sub>DD\_HV</sub>. Otherwise, device may enter regulator bypass mode if slope on V<sub>DD\_BV</sub> is slower.
- <sup>4</sup> 100 nF capacitance needs to be provided between V<sub>DD\_ADC</sub>/V<sub>SS\_ADC</sub> pair.
- <sup>5</sup> 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<sub>LVDHVL</sub>, device is reset.
- <sup>6</sup> Guaranteed by device validation
- <sup>7</sup> Minimum value of TV<sub>DD</sub> must be guaranteed until V<sub>DD</sub> reaches 2.6 V (maximum value of V<sub>PORH</sub>)
- <sup>8</sup> When the FMPLL uses the frequency modulation with a modulation depth of 4% from the center spread frequency, the maximum value of f<sub>CPU</sub> is 66.56 MHz.

**Table 13. Recommended operating conditions (5.0 V)**

| Symbol                          |    | Parameter   | Conditions                  | Value                 |                       | Unit |
|---------------------------------|----|---|-----------------------------|-----------------------|-----------------------|------|
|                                 |    |   |                             | Min                   | Max                   |      |
| V <sub>SS</sub>                 | SR | Digital ground on VSS_HV pins   | —                           | 0                     | 0                     | V    |
| V <sub>DD</sub> <sup>1</sup>    | SR | Voltage on VDD_HV pins with respect to ground (V <sub>SS</sub> )                              | —                           | 4.5                   | 5.5                   | V    |
|                                 |    |   | Voltage drop <sup>2</sup>   | 3.0                   | 5.5                   |      |
| V <sub>SS_LV</sub> <sup>3</sup> | SR | Voltage on VSS_LV (low voltage digital supply) pins with respect to ground (V <sub>SS</sub> ) | —                           | V <sub>SS</sub> - 0.1 | V <sub>SS</sub> + 0.1 | V    |
| V <sub>DD_BV</sub> <sup>4</sup> | SR | Voltage on VDD_BV pin (regulator supply) with respect to ground (V <sub>SS</sub> )            | —                           | 4.5                   | 5.5                   | V    |
|                                 |    |   | Voltage drop <sup>2</sup>   | 3.0                   | 5.5                   |      |
|                                 |    |   | Relative to V <sub>DD</sub> | 3.0                   | V <sub>DD</sub> + 0.1 |      |

Table 13. Recommended operating conditions (5.0 V) (continued)

| Symbol             |    | Parameter  | Conditions                      | Value          |                              | Unit |
|--------------------|----|--|---------------------------------|----------------|------------------------------|------|
|                    |    |  |                                 | Min            | Max                          |      |
| $V_{SS\_ADC}$      | SR | Voltage on $V_{SS\_HV\_ADC0}$ , $V_{SS\_HV\_ADC1}$ (ADC reference) pin with respect to ground ( $V_{SS}$ ) | —                               | $V_{SS} - 0.1$ | $V_{SS} + 0.1$               | V    |
| $V_{DD\_ADC}^5$    | SR | Voltage on $V_{DD\_HV\_ADC0}$ , $V_{DD\_HV\_ADC1}$ (ADC reference) with respect to ground ( $V_{SS}$ )     | —                               | 4.5            | 5.5                          | V    |
|                    |    |  | Voltage drop <sup>2</sup>       | 3.0            | 5.5                          |      |
|                    |    |  | 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 $V_{DD}$            | —              | $V_{DD} + 0.1$               |      |
| $I_{INPAD}$        | 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 <sup>6</sup>   | —                               | $3.0^7$        | $0.25 \text{ V}/\mu\text{s}$ |      |
| $T_A$ C-Grade Part | SR | Ambient temperature under bias   | $f_{CPU} \leq 64 \text{ MHz}^8$ | -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   | $f_{CPU} \leq 64 \text{ MHz}^8$ | -40            | 105                          |      |
| $T_J$ V-Grade Part | SR | Junction temperature under bias  | —                               | -40            | 130                          |      |
| $T_A$ M-Grade Part | SR | Ambient temperature under bias   | $f_{CPU} \leq 64 \text{ MHz}^8$ | -40            | 125                          |      |
| $T_J$ M-Grade Part | SR | Junction temperature under bias  | —                               | -40            | 150                          |      |

<sup>1</sup> 100 nF capacitance needs to be provided between each  $V_{DD}/V_{SS}$  pair.

<sup>2</sup> Full device operation is guaranteed by design when the voltage drops below 4.5 V down to 3.0 V. However, certain analog electrical characteristics will not be guaranteed to stay within the stated limits.

<sup>3</sup> 330 nF capacitance needs to be provided between each  $V_{DD\_LV}/V_{SS\_LV}$  supply pair.

<sup>4</sup> 470 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). While the supply voltage ramps up, the slope on  $V_{DD\_BV}$  should be less than  $0.9V_{DD\_HV}$  in order to ensure the device does not enter regulator bypass mode.

<sup>5</sup> 100 nF capacitance needs to be provided between  $V_{DD\_ADC}/V_{SS\_ADC}$  pair.

<sup>6</sup> Guaranteed by device validation

<sup>7</sup> Minimum value of  $TV_{DD}$  must be guaranteed until  $V_{DD}$  reaches 2.6 V (maximum value of  $V_{PORH}$ )

<sup>8</sup> When the FMPLL uses the frequency modulation with a modulation depth of 4% from the center spread frequency, the maximum value of  $f_{CPU}$  is 66.56 MHz.

## NOTE

RAM data retention is guaranteed with  $V_{DD\_LV}$  not below 1.08 V.

## 4.5 Thermal characteristics

### 4.5.1 External ballast resistor recommendations

External ballast resistor on  $V_{DD\_BV}$  pin helps in reducing the overall power dissipation inside the device. This resistor is required only when maximum power consumption exceeds the limit imposed by package thermal characteristics.

As stated in [Table 14](#) LQFP thermal characteristics, considering a thermal resistance of 144 LQFP as  $48.3\text{ }^{\circ}\text{C/W}$ , at ambient temperature  $T_A = 125\text{ }^{\circ}\text{C}$ , the junction temperature  $T_j$  will cross  $150\text{ }^{\circ}\text{C}$  if the total power dissipation is greater than  $(150 - 125)/48.3 = 517\text{ mW}$ . Therefore, the total device current  $I_{DDMAX}$  at  $125\text{ }^{\circ}\text{C}/5.5\text{ V}$  must not exceed  $94.1\text{ mA}$  (i.e.,  $PD/V_{DD}$ ). Assuming an average  $I_{DD}(V_{DD\_HV})$  of  $15\text{--}20\text{ mA}$  consumption typically during device RUN mode, the LV domain consumption  $I_{DD}(V_{DD\_BV})$  is thus limited to  $I_{DDMAX} - I_{DD}(V_{DD\_HV})$ , i.e.,  $80\text{ mA}$ .

Therefore, respecting the maximum power allowed as explained in [4.5.2, Package thermal characteristics](#), it is recommended to use this resistor only in the  $125\text{ }^{\circ}\text{C}/5.5\text{ V}$  operating corner as per the following guidelines:

- If  $I_{DD}(V_{DD\_BV}) < 80\text{ mA}$ , then no resistor is required.
- If  $80\text{ mA} < I_{DD}(V_{DD\_BV}) < 90\text{ mA}$ , then  $4\text{ }\Omega$  resistor can be used.
- If  $I_{DD}(V_{DD\_BV}) > 90\text{ mA}$ , then  $8\text{ }\Omega$  resistor can be used.

Using resistance in the range of  $4\text{--}8\text{ }\Omega$ , the gain will be around  $10\text{--}20\%$  of total consumption on  $V_{DD\_BV}$ . For example, if  $8\text{ }\Omega$  resistor is used, then power consumption when  $I_{DD}(V_{DD\_BV})$  is  $110\text{ mA}$  is equivalent to power consumption when  $I_{DD}(V_{DD\_BV})$  is  $90\text{ mA}$  (approximately) when resistor not used.

In order to ensure correct power up, the minimum  $V_{DD\_BV}$  to be guaranteed is  $30\text{ ms/V}$ . If the supply ramp is slower than this value, then LVDHV3B monitoring ballast supply  $V_{DD\_BV}$  pin gets triggered leading to device reset. Until the supply reaches certain threshold, this low voltage detector (LVD) generates destructive reset event in the system. This threshold depends on the maximum  $I_{DD}(V_{DD\_BV})$  possible across the external resistor.

### 4.5.2 Package thermal characteristics

Table 14. LQFP thermal characteristics<sup>1</sup>

| Symbol          | C  | Parameter | Conditions <sup>2</sup>   | Pin count               | Value |     |     | Unit |                      |
|-----------------|----|-----------|---|-------------------------|-------|-----|-----|------|----------------------|
|                 |    |           |   |                         | Min   | Typ | Max |      |                      |
| $R_{\theta JA}$ | CC | D         | Thermal resistance, junction-to-ambient natural convection <sup>3</sup> | Single-layer board — 1s | 100   | —   | —   | 64   | $^{\circ}\text{C/W}$ |
|                 |    |           |   |                         | 144   | —   | —   | 64   |                      |
|                 |    |           |   |                         | 176   | —   | —   | 64   |                      |
|                 |    |           |   | Four-layer board — 2s2p | 100   | —   | —   | 49.7 |                      |
|                 |    |           |   |                         | 144   | —   | —   | 48.3 |                      |
|                 |    |           |   |                         | 176   | —   | —   | 47.3 |                      |

Table 14. LQFP thermal characteristics<sup>1</sup> (continued)

| Symbol           | C  | Parameter  | Conditions <sup>2</sup> | Pin count | Value |     |      | Unit |
|------------------|----|--|-------------------------|-----------|-------|-----|------|------|
|                  |    |  |                         |           | Min   | Typ | Max  |      |
| R <sub>θJB</sub> | CC | Thermal resistance, junction-to-board <sup>4</sup> | Single-layer board — 1s | 100       | —     | —   | 36   | °C/W |
|                  |    |  |                         | 144       | —     | —   | 38   |      |
|                  |    |  |                         | 176       | —     | —   | 38   |      |
|                  |    |  | Four-layer board — 2s2p | 100       | —     | —   | 33.6 |      |
|                  |    |  |                         | 144       | —     | —   | 33.4 |      |
|                  |    |  |                         | 176       | —     | —   | 33.4 |      |
| R <sub>θJC</sub> | CC | Thermal resistance, junction-to-case <sup>5</sup>  | Single-layer board — 1s | 100       | —     | —   | 23   | °C/W |
|                  |    |  |                         | 144       | —     | —   | 23   |      |
|                  |    |  |                         | 176       | —     | —   | 23   |      |
|                  |    |  | Four-layer board — 2s2p | 100       | —     | —   | 19.8 |      |
|                  |    |  |                         | 144       | —     | —   | 19.2 |      |
|                  |    |  |                         | 176       | —     | —   | 18.8 |      |

<sup>1</sup> Thermal characteristics are targets based on simulation.

<sup>2</sup> V<sub>DD</sub> = 3.3 V ± 10% / 5.0 V ± 10%, T<sub>A</sub> = -40 to 125 °C.

<sup>3</sup> Junction-to-ambient thermal resistance determined per JEDEC JESD51-3 and JESD51-6. Thermal test board meets JEDEC specification for this package. When Greek letters are not available, the symbols are typed as R<sub>thJA</sub> and R<sub>thJMA</sub>.

<sup>4</sup> Junction-to-board thermal resistance determined per JEDEC JESD51-8. Thermal test board meets JEDEC specification for the specified package. When Greek letters are not available, the symbols are typed as R<sub>thJB</sub>.

<sup>5</sup> Junction-to-case at the top of the package determined using MIL-STD 883 Method 1012.1. The cold plate temperature is used for the case temperature. Reported value includes the thermal resistance of the interface layer. When Greek letters are not available, the symbols are typed as R<sub>thJC</sub>.

### 4.5.3 Power considerations

The average chip-junction temperature, T<sub>J</sub>, in degrees Celsius, may be calculated using [Equation 1](#):

$$T_J = T_A + (P_D \times R_{\theta JA}) \quad \text{Eqn. 1}$$

Where:

T<sub>A</sub> is the ambient temperature in °C.

R<sub>θJA</sub> is the package junction-to-ambient thermal resistance, in °C/W.

P<sub>D</sub> is the sum of P<sub>INT</sub> and P<sub>I/O</sub> (P<sub>D</sub> = P<sub>INT</sub> + P<sub>I/O</sub>).

P<sub>INT</sub> is the product of I<sub>DD</sub> and V<sub>DD</sub>, expressed in watts. This is the chip internal power.

P<sub>I/O</sub> represents the power dissipation on input and output pins; user determined.

Most of the time for the applications, P<sub>I/O</sub> < P<sub>INT</sub> and may be neglected. On the other hand, P<sub>I/O</sub> may be significant, if the device is configured to continuously drive external modules and/or memories.

## Electrical characteristics

An approximate relationship between  $P_D$  and  $T_J$  (if  $P_{I/O}$  is neglected) is given by:

$$P_D = K / (T_J + 273 \text{ }^\circ\text{C}) \quad \text{Eqn. 2}$$

Therefore, solving equations 1 and 2:

$$K = P_D \times (T_A + 273 \text{ }^\circ\text{C}) + R_{\theta JA} \times P_D^2 \quad \text{Eqn. 3}$$

Where:

$K$  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  $T_A$ .

## 4.6 I/O pad electrical characteristics

### 4.6.1 I/O pad types

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

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

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

### 4.6.2 I/O input DC characteristics

[Table 15](#) provides input DC electrical characteristics as described in [Figure 6](#).

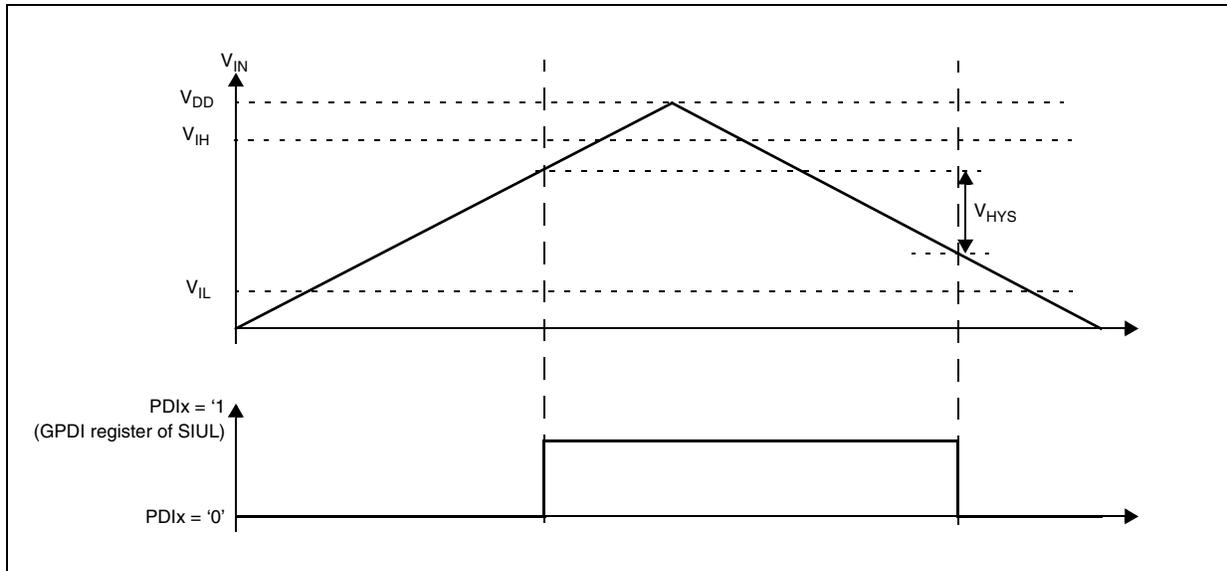


Figure 6. I/O input DC electrical characteristics definition

Table 15. I/O input DC electrical characteristics

| Symbol                        | C  | Parameter | Conditions <sup>1</sup>                 | Value                        |                         |     | Unit                  |      |    |
|-------------------------------|----|-----------|---|------------------------------|-------------------------|-----|-----------------------|------|----|
|                               |    |           |   | Min                          | Typ                     | Max |                       |      |    |
| V <sub>IH</sub>               | SR | P         | Input high level CMOS (Schmitt Trigger) | —                            | 0.65V <sub>DD</sub>     | —   | V <sub>DD</sub> + 0.4 | V    |    |
| V <sub>IL</sub>               | SR | P         | Input low level CMOS (Schmitt Trigger)  | —                            | -0.4                    | —   | 0.35V <sub>DD</sub>   |      |    |
| V <sub>HYS</sub>              | CC | C         | Input hysteresis CMOS (Schmitt Trigger) | —                            | 0.1V <sub>DD</sub>      | —   | —                     |      |    |
| I <sub>LKG</sub>              | CC | D         | Digital input leakage                   | No injection on adjacent pin | T <sub>A</sub> = -40 °C | —   | 2                     | 200  | nA |
|                               |    |           |   |                              | T <sub>A</sub> = 25 °C  | —   | 2                     | 200  |    |
|                               |    |           |   |                              | T <sub>A</sub> = 85 °C  | —   | 5                     | 300  |    |
|                               |    |           |   |                              | T <sub>A</sub> = 105 °C | —   | 12                    | 500  |    |
|                               |    |           |   |                              | T <sub>A</sub> = 125 °C | —   | 70                    | 1000 |    |
| W <sub>FI</sub> <sup>2</sup>  | SR | P         | Wakeup input filtered pulse             | —                            | —                       | —   | 40                    | ns   |    |
| W <sub>NFI</sub> <sup>2</sup> | SR | P         | Wakeup input not filtered pulse         | —                            | 1000                    | —   | —                     | ns   |    |

<sup>1</sup> V<sub>DD</sub> = 3.3 V ± 10% / 5.0 V ± 10%, T<sub>A</sub> = -40 to 125 °C, unless otherwise specified

<sup>2</sup> In the range from 40 to 1000 ns, pulses can be filtered or not filtered, according to operating temperature and voltage.

### 4.6.3 I/O output DC characteristics

The following tables provide DC characteristics for bidirectional pads:

- [Table 16](#) provides weak pull figures. Both pull-up and pull-down resistances are supported.

## Electrical characteristics

- [Table 17](#) provides output driver characteristics for I/O pads when in SLOW configuration.
- [Table 18](#) provides output driver characteristics for I/O pads when in MEDIUM configuration.
- [Table 19](#) provides output driver characteristics for I/O pads when in FAST configuration.

**Table 16. I/O pull-up/pull-down DC electrical characteristics**

| Symbol           | C  | Parameter                                     | Conditions <sup>1</sup>  | Value                    |     |     | Unit |
|------------------|----|---|--|--------------------------|-----|-----|------|
|                  |    |   |  | Min                      | Typ | Max |      |
| I <sub>WPU</sub> | CC | P<br>Weak pull-up current<br>absolute value   | V <sub>IN</sub> = V <sub>IL</sub> , V <sub>DD</sub> = 5.0 V ± 10%<br>PAD3V5V = 0 | 10                       | —   | 150 | μA   |
|                  |    |   |  | PAD3V5V = 1 <sup>2</sup> | 10  | —   |      |
|                  |    |   | V <sub>IN</sub> = V <sub>IL</sub> , V <sub>DD</sub> = 3.3 V ± 10%<br>PAD3V5V = 1 | 10                       | —   | 150 |      |
| I <sub>WPD</sub> | CC | P<br>Weak pull-down current<br>absolute value | V <sub>IN</sub> = V <sub>IH</sub> , V <sub>DD</sub> = 5.0 V ± 10%<br>PAD3V5V = 0 | 10                       | —   | 150 | μA   |
|                  |    |   |  | PAD3V5V = 1              | 10  | —   |      |
|                  |    |   | V <sub>IN</sub> = V <sub>IH</sub> , V <sub>DD</sub> = 3.3 V ± 10%<br>PAD3V5V = 1 | 10                       | —   | 150 |      |

<sup>1</sup> V<sub>DD</sub> = 3.3 V ± 10% / 5.0 V ± 10%, T<sub>A</sub> = -40 to 125 °C, unless otherwise specified.

<sup>2</sup> The configuration PAD3V5 = 1 when V<sub>DD</sub> = 5 V is only a transient configuration during power-up. All pads but RESET and Nexus output (MDOx, EVTO, MCKO) are configured in input or in high impedance state.

**Table 17. SLOW configuration output buffer electrical characteristics**

| Symbol          | C  | Parameter                                    | Conditions <sup>1</sup>   | Value  |                       |                    | Unit |                    |
|-----------------|----|--|---|--|-----------------------|--------------------|------|--------------------|
|                 |    |  |   | Min  | Typ                   | Max                |      |                    |
| V <sub>OH</sub> | CC | P<br>Output high level<br>SLOW configuration | Push Pull<br>I <sub>OH</sub> = -2 mA,<br>V <sub>DD</sub> = 5.0 V ± 10%,<br>PAD3V5V = 0<br>(recommended) | 0.8V <sub>DD</sub>   | —                     | —                  | V    |                    |
|                 |    |  |   | I <sub>OH</sub> = -2 mA,<br>V <sub>DD</sub> = 5.0 V ± 10%,<br>PAD3V5V = 1 <sup>2</sup>     | 0.8V <sub>DD</sub>    | —                  |      | —                  |
|                 |    |  |   | I <sub>OH</sub> = -1 mA,<br>V <sub>DD</sub> = 3.3 V ± 10%,<br>PAD3V5V = 1<br>(recommended) | V <sub>DD</sub> - 0.8 | —                  |      | —                  |
| V <sub>OL</sub> | CC | P<br>Output low level<br>SLOW configuration  | Push Pull<br>I <sub>OL</sub> = 2 mA,<br>V <sub>DD</sub> = 5.0 V ± 10%,<br>PAD3V5V = 0<br>(recommended)  | —  | —                     | 0.1V <sub>DD</sub> | V    |                    |
|                 |    |  |   | I <sub>OL</sub> = 2 mA,<br>V <sub>DD</sub> = 5.0 V ± 10%,<br>PAD3V5V = 1 <sup>2</sup>      | —                     | —                  |      | 0.1V <sub>DD</sub> |
|                 |    |  |   | I <sub>OL</sub> = 1 mA,<br>V <sub>DD</sub> = 3.3 V ± 10%,<br>PAD3V5V = 1<br>(recommended)  | —                     | —                  |      | 0.5                |

<sup>1</sup> V<sub>DD</sub> = 3.3 V ± 10% / 5.0 V ± 10%, T<sub>A</sub> = -40 to 125 °C, unless otherwise specified

<sup>2</sup> The configuration PAD3V5 = 1 when  $V_{DD} = 5\text{ V}$  is only a transient configuration during power-up. All pads but RESET and Nexus output (MDOx, EVTO, MCKO) are configured in input or in high impedance state.

**Table 18. MEDIUM configuration output buffer electrical characteristics**

| Symbol          | C  | Parameter                                 | Conditions <sup>1</sup> | Value   |                       |     | Unit               |   |
|-----------------|----|---|-------------------------|---|-----------------------|-----|--------------------|---|
|                 |    |   |                         | Min   | Typ                   | Max |                    |   |
| V <sub>OH</sub> | CC | Output high level<br>MEDIUM configuration | Push Pull               | I <sub>OH</sub> = -3.8 mA,<br>V <sub>DD</sub> = 5.0 V ± 10%, PAD3V5V = 0                | 0.8V <sub>DD</sub>    | —   | —                  | V |
|                 |    |   |                         | I <sub>OH</sub> = -2 mA,<br>V <sub>DD</sub> = 5.0 V ± 10%, PAD3V5V = 0<br>(recommended) | 0.8V <sub>DD</sub>    | —   | —                  |   |
|                 |    |   |                         | I <sub>OH</sub> = -1 mA,<br>V <sub>DD</sub> = 5.0 V ± 10%, PAD3V5V = 1 <sup>2</sup>     | 0.8V <sub>DD</sub>    | —   | —                  |   |
|                 |    |   |                         | I <sub>OH</sub> = -1 mA,<br>V <sub>DD</sub> = 3.3 V ± 10%, PAD3V5V = 1<br>(recommended) | V <sub>DD</sub> - 0.8 | —   | —                  |   |
|                 |    |   |                         | I <sub>OH</sub> = -100 µA,<br>V <sub>DD</sub> = 5.0 V ± 10%, PAD3V5V = 0                | 0.8V <sub>DD</sub>    | —   | —                  |   |
| V <sub>OL</sub> | CC | Output low level<br>MEDIUM configuration  | Push Pull               | I <sub>OL</sub> = 3.8 mA,<br>V <sub>DD</sub> = 5.0 V ± 10%, PAD3V5V = 0                 | —                     | —   | 0.2V <sub>DD</sub> | V |
|                 |    |   |                         | I <sub>OL</sub> = 2 mA,<br>V <sub>DD</sub> = 5.0 V ± 10%, PAD3V5V = 0<br>(recommended)  | —                     | —   | 0.1V <sub>DD</sub> |   |
|                 |    |   |                         | I <sub>OL</sub> = 1 mA,<br>V <sub>DD</sub> = 5.0 V ± 10%, PAD3V5V = 1 <sup>2</sup>      | —                     | —   | 0.1V <sub>DD</sub> |   |
|                 |    |   |                         | I <sub>OL</sub> = 1 mA,<br>V <sub>DD</sub> = 3.3 V ± 10%, PAD3V5V = 1<br>(recommended)  | —                     | —   | 0.5                |   |
|                 |    |   |                         | I <sub>OL</sub> = 100 µA,<br>V <sub>DD</sub> = 5.0 V ± 10%, PAD3V5V = 0                 | —                     | —   | 0.1V <sub>DD</sub> |   |

<sup>1</sup> V<sub>DD</sub> = 3.3 V ± 10% / 5.0 V ± 10%, T<sub>A</sub> = -40 to 125 °C, unless otherwise specified

<sup>2</sup> The configuration PAD3V5 = 1 when  $V_{DD} = 5\text{ V}$  is only a transient configuration during power-up. All pads but RESET and Nexus output (MDOx, EVTO, MCKO) are configured in input or in high impedance state.

**Table 19. FAST configuration output buffer electrical characteristics**

| Symbol          | C  | Parameter                                    | Conditions <sup>1</sup>  | Value                 |     |                    | Unit |
|-----------------|----|--|--|-----------------------|-----|--------------------|------|
|                 |    |  |  | Min                   | Typ | Max                |      |
| V <sub>OH</sub> | CC | P<br>Output high level<br>FAST configuration | Push Pull<br>I <sub>OH</sub> = -14 mA,<br>V <sub>DD</sub> = 5.0 V ± 10%,<br>PAD3V5V = 0<br>(recommended) | 0.8V <sub>DD</sub>    | —   | —                  | V    |
|                 |    |  |  | 0.8V <sub>DD</sub>    | —   | —                  |      |
|                 |    |  |  | V <sub>DD</sub> - 0.8 | —   | —                  |      |
| V <sub>OL</sub> | CC | P<br>Output low level<br>FAST configuration  | Push Pull<br>I <sub>OL</sub> = 14 mA,<br>V <sub>DD</sub> = 5.0 V ± 10%,<br>PAD3V5V = 0<br>(recommended)  | —                     | —   | 0.1V <sub>DD</sub> | V    |
|                 |    |  |  | —                     | —   | 0.1V <sub>DD</sub> |      |
|                 |    |  |  | —                     | —   | 0.5                |      |

<sup>1</sup> V<sub>DD</sub> = 3.3 V ± 10% / 5.0 V ± 10%, T<sub>A</sub> = -40 to 125 °C, unless otherwise specified

<sup>2</sup> The configuration PAD3V5 = 1 when V<sub>DD</sub> = 5 V is only a transient configuration during power-up. All pads but RESET and Nexus output (MDOx, EVTO, MCKO) are configured in input or in high impedance state.

### 4.6.4 Output pin transition times

**Table 20. Output pin transition times**

| Symbol          | C  | Parameter   | Conditions <sup>1</sup>  | Value |     |     | Unit |
|-----------------|----|---|--|-------|-----|-----|------|
|                 |    |   |  | Min   | Typ | Max |      |
| t <sub>tr</sub> | CC | D<br>Output transition time output pin <sup>2</sup><br>SLOW configuration | C <sub>L</sub> = 25 pF<br>V <sub>DD</sub> = 5.0 V ± 10%,<br>PAD3V5V = 0  | —     | —   | 50  | ns   |
|                 |    |   |  | —     | —   | 100 |      |
|                 |    |   |  | —     | —   | 125 |      |
|                 |    |   | C <sub>L</sub> = 100 pF<br>V <sub>DD</sub> = 3.3 V ± 10%,<br>PAD3V5V = 1 | —     | —   | 50  |      |
|                 |    |   |  | —     | —   | 100 |      |
|                 |    |   |  | —     | —   | 125 |      |

Table 20. Output pin transition times (continued)

| Symbol   | C  | Parameter  | Conditions <sup>1</sup> |   | Value |     |     | Unit |
|----------|----|--|-------------------------|---|-------|-----|-----|------|
|          |    |  |                         |   | Min   | Typ | Max |      |
| $t_{tr}$ | CC | Output transition time output pin <sup>2</sup><br>MEDIUM configuration | $C_L = 25$ pF           | $V_{DD} = 5.0$ V $\pm$ 10%,<br>PAD3V5V = 0<br>SIUL.PCRx.SRC = 1 | —     | —   | 10  | ns   |
|          |    |  | $C_L = 50$ pF           |   | —     | —   | 20  |      |
|          |    |  | $C_L = 100$ pF          |   | —     | —   | 40  |      |
|          |    |  | $C_L = 25$ pF           | $V_{DD} = 3.3$ V $\pm$ 10%,<br>PAD3V5V = 1<br>SIUL.PCRx.SRC = 1 | —     | —   | 12  |      |
|          |    |  | $C_L = 50$ pF           |   | —     | —   | 25  |      |
|          |    |  | $C_L = 100$ pF          |   | —     | —   | 40  |      |
| $t_{tr}$ | CC | Output transition time output pin <sup>2</sup><br>FAST configuration   | $C_L = 25$ pF           | $V_{DD} = 5.0$ V $\pm$ 10%,<br>PAD3V5V = 0                      | —     | —   | 4   | ns   |
|          |    |  | $C_L = 50$ pF           |   | —     | —   | 6   |      |
|          |    |  | $C_L = 100$ pF          |   | —     | —   | 12  |      |
|          |    |  | $C_L = 25$ pF           | $V_{DD} = 3.3$ V $\pm$ 10%,<br>PAD3V5V = 1                      | —     | —   | 4   |      |
|          |    |  | $C_L = 50$ pF           |   | —     | —   | 7   |      |
|          |    |  | $C_L = 100$ pF          |   | —     | —   | 12  |      |

<sup>1</sup>  $V_{DD} = 3.3$  V  $\pm$  10% / 5.0 V  $\pm$  10%,  $T_A = -40$  to 125 °C, unless otherwise specified

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

#### 4.6.5 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 22 provides I/O consumption figures.

In order to ensure device reliability, the average current of the I/O on a single segment should remain below the  $I_{AVGSEG}$  maximum value.

Table 21. I/O supply segments

| Package                 | Supply segment                                  |               |                 |                 |                 |               |      |             |
|-------------------------|---|---------------|-----------------|-----------------|-----------------|---------------|------|-------------|
|                         | 1   | 2             | 3               | 4               | 5               | 6             | 7    | 8           |
| 208 MAPBGA <sup>1</sup> | Equivalent to 176 LQFP segment pad distribution |               |                 |                 |                 |               | MCKO | MDOOn /MSEO |
| 176 LQFP                | pin7 – pin27                                    | pin28 – pin57 | pin59 – pin85   | pin86 – pin123  | pin124 – pin150 | pin151 – pin6 | —    | —           |
| 144 LQFP                | pin20 – pin49                                   | pin51 – pin99 | pin100 – pin122 | pin 123 – pin19 | —               | —             | —    | —           |
| 100 LQFP                | pin16 – pin35                                   | pin37 – pin69 | pin70 – pin83   | pin84 – pin15   | —               | —             | —    | —           |

<sup>1</sup> 208 MAPBGA available only as development package for Nexus2+

Table 22. I/O consumption

| Symbol                           | C  | Parameter | Conditions <sup>1</sup>                                   |  | Value   |     |     | Unit |    |
|----------------------------------|----|-----------|---|--|---|-----|-----|------|----|
|                                  |    |           |   |  | Min   | Typ | Max |      |    |
| I <sub>SWTSLW</sub> <sup>2</sup> | CC | D         | Dynamic I/O current for SLOW configuration                | C <sub>L</sub> = 25 pF                     | V <sub>DD</sub> = 5.0 V ± 10%,<br>PAD3V5V = 0 | —   | —   | 20   | mA |
|                                  |    |           |   |  | V <sub>DD</sub> = 3.3 V ± 10%,<br>PAD3V5V = 1 | —   | —   | 16   |    |
| I <sub>SWTMED</sub> <sup>2</sup> | CC | D         | Dynamic I/O current for MEDIUM configuration              | C <sub>L</sub> = 25 pF                     | V <sub>DD</sub> = 5.0 V ± 10%,<br>PAD3V5V = 0 | —   | —   | 29   | mA |
|                                  |    |           |   |  | V <sub>DD</sub> = 3.3 V ± 10%,<br>PAD3V5V = 1 | —   | —   | 17   |    |
| I <sub>SWTFST</sub> <sup>2</sup> | CC | D         | Dynamic I/O current for FAST configuration                | C <sub>L</sub> = 25 pF                     | V <sub>DD</sub> = 5.0 V ± 10%,<br>PAD3V5V = 0 | —   | —   | 110  | mA |
|                                  |    |           |   |  | V <sub>DD</sub> = 3.3 V ± 10%,<br>PAD3V5V = 1 | —   | —   | 50   |    |
| I <sub>RMSLW</sub>               | CC | D         | Root mean square I/O current for SLOW configuration       | C <sub>L</sub> = 25 pF, 2 MHz              | V <sub>DD</sub> = 5.0 V ± 10%,<br>PAD3V5V = 0 | —   | —   | 2.3  | mA |
|                                  |    |           |   | C <sub>L</sub> = 25 pF, 4 MHz              |   | —   | —   | 3.2  |    |
|                                  |    |           |   | C <sub>L</sub> = 100 pF, 2 MHz             |   | —   | —   | 6.6  |    |
|                                  |    |           |   | C <sub>L</sub> = 25 pF, 2 MHz              | V <sub>DD</sub> = 3.3 V ± 10%,<br>PAD3V5V = 1 | —   | —   | 1.6  |    |
|                                  |    |           |   | C <sub>L</sub> = 25 pF, 4 MHz              |   | —   | —   | 2.3  |    |
|                                  |    |           |   | C <sub>L</sub> = 100 pF, 2 MHz             |   | —   | —   | 4.7  |    |
| I <sub>RMSMED</sub>              | CC | D         | Root mean square I/O current for MEDIUM configuration     | C <sub>L</sub> = 25 pF, 13 MHz             | V <sub>DD</sub> = 5.0 V ± 10%,<br>PAD3V5V = 0 | —   | —   | 6.6  | mA |
|                                  |    |           |   | C <sub>L</sub> = 25 pF, 40 MHz             |   | —   | —   | 13.4 |    |
|                                  |    |           |   | C <sub>L</sub> = 100 pF, 13 MHz            |   | —   | —   | 18.3 |    |
|                                  |    |           |   | C <sub>L</sub> = 25 pF, 13 MHz             | V <sub>DD</sub> = 3.3 V ± 10%,<br>PAD3V5V = 1 | —   | —   | 5    |    |
|                                  |    |           |   | C <sub>L</sub> = 25 pF, 40 MHz             |   | —   | —   | 8.5  |    |
|                                  |    |           |   | C <sub>L</sub> = 100 pF, 13 MHz            |   | —   | —   | 11   |    |
| I <sub>RMSFST</sub>              | CC | D         | Root mean square I/O current for FAST configuration       | C <sub>L</sub> = 25 pF, 40 MHz             | V <sub>DD</sub> = 5.0 V ± 10%,<br>PAD3V5V = 0 | —   | —   | 22   | mA |
|                                  |    |           |   | C <sub>L</sub> = 25 pF, 64 MHz             |   | —   | —   | 33   |    |
|                                  |    |           |   | C <sub>L</sub> = 100 pF, 40 MHz            |   | —   | —   | 56   |    |
|                                  |    |           |   | C <sub>L</sub> = 25 pF, 40 MHz             | V <sub>DD</sub> = 3.3 V ± 10%,<br>PAD3V5V = 1 | —   | —   | 14   |    |
|                                  |    |           |   | C <sub>L</sub> = 25 pF, 64 MHz             |   | —   | —   | 20   |    |
|                                  |    |           |   | C <sub>L</sub> = 100 pF, 40 MHz            |   | —   | —   | 35   |    |
| I <sub>AVGSEG</sub>              | SR | D         | Sum of all the static I/O current within a supply segment | V <sub>DD</sub> = 5.0 V ± 10%, PAD3V5V = 0 | —   | —   | 70  | mA   |    |
|                                  |    |           |   | V <sub>DD</sub> = 3.3 V ± 10%, PAD3V5V = 1 | —   | —   | 65  |      |    |

<sup>1</sup> V<sub>DD</sub> = 3.3 V ± 10% / 5.0 V ± 10%, T<sub>A</sub> = -40 to 125 °C, unless otherwise specified

<sup>2</sup> 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<sup>1</sup>

| Supply segment |          |          | Pad    | 176 LQFP             |         |              |         | 144/100 LQFP |         |              |         |     |    |
|----------------|----------|----------|--------|----------------------|---------|--------------|---------|--------------|---------|--------------|---------|-----|----|
|                |          |          |        | Weight 5 V           |         | Weight 3.3 V |         | Weight 5 V   |         | Weight 3.3 V |         |     |    |
| 176 LQFP       | 144 LQFP | 100 LQFP |        | SRC <sup>2</sup> = 0 | SRC = 1 | SRC = 0      | SRC = 1 | SRC = 0      | SRC = 1 | SRC = 0      | SRC = 1 |     |    |
| 6              | 4        | 4        | PB[3]  | 5%                   | —       | 6%           | —       | 13%          | —       | 15%          | —       |     |    |
|                |          |          | PC[9]  | 4%                   | —       | 5%           | —       | 13%          | —       | 15%          | —       |     |    |
|                |          |          | PC[14] | 4%                   | —       | 4%           | —       | 13%          | —       | 15%          | —       |     |    |
|                |          |          | PC[15] | 3%                   | 4%      | 4%           | 4%      | 12%          | 18%     | 15%          | 16%     |     |    |
|                |          |          | —      | —                    | PJ[4]   | 3%           | 4%      | 3%           | 3%      | —            | —       | —   | —  |
| 1              | —        | —        | PH[15] | 2%                   | 3%      | 3%           | 3%      | —            | —       | —            | —       |     |    |
|                | —        | —        | PH[13] | 3%                   | 4%      | 3%           | 4%      | —            | —       | —            | —       |     |    |
|                | —        | —        | PH[14] | 3%                   | 4%      | 4%           | 4%      | —            | —       | —            | —       |     |    |
|                | —        | —        | PI[6]  | 4%                   | —       | 4%           | —       | —            | —       | —            | —       |     |    |
|                | —        | —        | PI[7]  | 4%                   | —       | 4%           | —       | —            | —       | —            | —       |     |    |
|                | 4        | —        | —      | PG[5]                | 4%      | —            | 5%      | —            | 10%     | —            | 12%     | —   |    |
|                |          |          |        | PG[4]                | 4%      | 6%           | 5%      | 5%           | 9%      | 13%          | 11%     | 12% |    |
|                |          |          |        | PG[3]                | 4%      | —            | 5%      | —            | 9%      | —            | 11%     | —   |    |
|                |          |          |        | PG[2]                | 4%      | 6%           | 5%      | 5%           | 9%      | 12%          | 10%     | 11% |    |
|                |          | 4        | 4      | 4                    | PA[2]   | 4%           | —       | 5%           | —       | 8%           | —       | 10% | —  |
|                |          |          |        |                      | PE[0]   | 4%           | —       | 5%           | —       | 8%           | —       | 9%  | —  |
|                |          |          |        |                      | PA[1]   | 4%           | —       | 5%           | —       | 8%           | —       | 9%  | —  |
|                |          |          |        |                      | PE[1]   | 4%           | 6%      | 5%           | 6%      | 7%           | 10%     | 9%  | 9% |
|                |          |          |        |                      | PE[8]   | 4%           | 6%      | 5%           | 6%      | 7%           | 10%     | 8%  | 9% |
|                |          |          |        |                      | PE[9]   | 4%           | —       | 5%           | —       | 6%           | —       | 8%  | —  |
| PE[10]         | 4%       |          |        |                      | —       | 5%           | —       | 6%           | —       | 7%           | —       |     |    |
| PA[0]          | 4%       | 6%       | 5%     | 5%                   | 6%      | 8%           | 7%      | 7%           |         |              |         |     |    |
| PE[11]         | 4%       | —        | 5%     | —                    | 5%      | —            | 6%      | —            |         |              |         |     |    |

Table 23. I/O weight<sup>1</sup> (continued)

| Supply segment |          |          | Pad    | 176 LQFP             |         |              |         | 144/100 LQFP |         |              |         |
|----------------|----------|----------|--------|----------------------|---------|--------------|---------|--------------|---------|--------------|---------|
|                |          |          |        | Weight 5 V           |         | Weight 3.3 V |         | Weight 5 V   |         | Weight 3.3 V |         |
| 176 LQFP       | 144 LQFP | 100 LQFP |        | SRC <sup>2</sup> = 0 | SRC = 1 | SRC = 0      | SRC = 1 | SRC = 0      | SRC = 1 | SRC = 0      | SRC = 1 |
| 2              | 1        | —        | PG[9]  | 9%                   | —       | 10%          | —       | 9%           | —       | 10%          | —       |
|                |          | —        | PG[8]  | 9%                   | —       | 11%          | —       | 9%           | —       | 11%          | —       |
|                |          | 1        | PC[11] | 9%                   | —       | 11%          | —       | 9%           | —       | 11%          | —       |
|                |          |          | PC[10] | 9%                   | 13%     | 11%          | 12%     | 9%           | 13%     | 11%          | 12%     |
|                |          | —        | PG[7]  | 9%                   | —       | 11%          | —       | 9%           | —       | 11%          | —       |
|                |          | —        | PG[6]  | 10%                  | 14%     | 11%          | 12%     | 10%          | 14%     | 11%          | 12%     |
|                |          | 1        | PB[0]  | 10%                  | 14%     | 12%          | 12%     | 10%          | 14%     | 12%          | 12%     |
|                |          |          | PB[1]  | 10%                  | —       | 12%          | —       | 10%          | —       | 12%          | —       |
|                |          | —        | PF[9]  | 10%                  | —       | 12%          | —       | 10%          | —       | 12%          | —       |
|                |          | —        | PF[8]  | 10%                  | 14%     | 12%          | 13%     | 10%          | 14%     | 12%          | 13%     |
|                |          | —        | PF[12] | 10%                  | 15%     | 12%          | 13%     | 10%          | 15%     | 12%          | 13%     |
|                |          | 1        | PC[6]  | 10%                  | —       | 12%          | —       | 10%          | —       | 12%          | —       |
|                |          |          | PC[7]  | 10%                  | —       | 12%          | —       | 10%          | —       | 12%          | —       |
|                |          | —        | PF[10] | 10%                  | 14%     | 11%          | 12%     | 10%          | 14%     | 11%          | 12%     |
|                |          | —        | PF[11] | 9%                   | —       | 11%          | —       | 9%           | —       | 11%          | —       |
|                |          | 1        | PA[15] | 8%                   | 12%     | 10%          | 10%     | 8%           | 12%     | 10%          | 10%     |
|                |          | —        | PF[13] | 8%                   | —       | 10%          | —       | 8%           | —       | 10%          | —       |
|                |          | 1        | PA[14] | 8%                   | 11%     | 9%           | 10%     | 8%           | 11%     | 9%           | 10%     |
|                |          |          | PA[4]  | 7%                   | —       | 9%           | —       | 7%           | —       | 9%           | —       |
|                |          |          | PA[13] | 7%                   | 10%     | 8%           | 9%      | 7%           | 10%     | 8%           | 9%      |
| PA[12]         | 7%       |          | —      | 8%                   | —       | 7%           | —       | 8%           | —       |              |         |

Table 23. I/O weight<sup>1</sup> (continued)

| Supply segment |          |          | Pad    | 176 LQFP             |         |              |         | 144/100 LQFP |         |              |         |     |   |
|----------------|----------|----------|--------|----------------------|---------|--------------|---------|--------------|---------|--------------|---------|-----|---|
|                |          |          |        | Weight 5 V           |         | Weight 3.3 V |         | Weight 5 V   |         | Weight 3.3 V |         |     |   |
| 176 LQFP       | 144 LQFP | 100 LQFP |        | SRC <sup>2</sup> = 0 | SRC = 1 | SRC = 0      | SRC = 1 | SRC = 0      | SRC = 1 | SRC = 0      | SRC = 1 |     |   |
| 3              | 2        | 2        | PB[9]  | 1%                   | —       | 1%           | —       | 1%           | —       | 1%           | —       |     |   |
|                |          |          | PB[8]  | 1%                   | —       | 1%           | —       | 1%           | —       | 1%           | —       |     |   |
|                |          |          | PB[10] | 5%                   | —       | 6%           | —       | 6%           | —       | 7%           | —       |     |   |
|                |          | —        | —      | —                    | PF[0]   | 5%           | —       | 6%           | —       | 6%           | —       | 8%  | — |
|                |          | —        | —      | —                    | PF[1]   | 5%           | —       | 6%           | —       | 7%           | —       | 8%  | — |
|                |          | —        | —      | —                    | PF[2]   | 6%           | —       | 7%           | —       | 7%           | —       | 9%  | — |
|                |          | —        | —      | —                    | PF[3]   | 6%           | —       | 7%           | —       | 8%           | —       | 9%  | — |
|                |          | —        | —      | —                    | PF[4]   | 6%           | —       | 7%           | —       | 8%           | —       | 10% | — |
|                |          | —        | —      | —                    | PF[5]   | 6%           | —       | 7%           | —       | 9%           | —       | 10% | — |
|                |          | —        | —      | —                    | PF[6]   | 6%           | —       | 7%           | —       | 9%           | —       | 11% | — |
|                |          | —        | —      | —                    | PF[7]   | 6%           | —       | 7%           | —       | 9%           | —       | 11% | — |
|                |          | —        | —      | —                    | PJ[3]   | 6%           | —       | 7%           | —       | —            | —       | —   | — |
|                |          | —        | —      | —                    | PJ[2]   | 6%           | —       | 7%           | —       | —            | —       | —   | — |
|                |          | —        | —      | —                    | PJ[1]   | 6%           | —       | 7%           | —       | —            | —       | —   | — |
|                |          | —        | —      | —                    | PJ[0]   | 6%           | —       | 7%           | —       | —            | —       | —   | — |
|                |          | —        | —      | —                    | PI[15]  | 6%           | —       | 7%           | —       | —            | —       | —   | — |
|                |          | —        | —      | —                    | PI[14]  | 6%           | —       | 7%           | —       | —            | —       | —   | — |
|                |          | 2        | 2      | 2                    | PD[0]   | 1%           | —       | 1%           | —       | 1%           | —       | 1%  | — |
|                |          |          |        |                      | PD[1]   | 1%           | —       | 1%           | —       | 1%           | —       | 1%  | — |
| PD[2]          | 1%       |          |        |                      | —       | 1%           | —       | 1%           | —       | 1%           | —       |     |   |
| PD[3]          | 1%       |          |        |                      | —       | 1%           | —       | 1%           | —       | 1%           | —       |     |   |
| PD[4]          | 1%       |          |        |                      | —       | 1%           | —       | 1%           | —       | 1%           | —       |     |   |
| PD[5]          | 1%       |          |        |                      | —       | 1%           | —       | 1%           | —       | 1%           | —       |     |   |
| PD[6]          | 1%       |          |        |                      | —       | 1%           | —       | 1%           | —       | 2%           | —       |     |   |
| PD[7]          | 1%       |          |        |                      | —       | 1%           | —       | 1%           | —       | 2%           | —       |     |   |

Table 23. I/O weight<sup>1</sup> (continued)

| Supply segment |          |          | Pad    | 176 LQFP             |         |              |         | 144/100 LQFP |         |              |         |
|----------------|----------|----------|--------|----------------------|---------|--------------|---------|--------------|---------|--------------|---------|
|                |          |          |        | Weight 5 V           |         | Weight 3.3 V |         | Weight 5 V   |         | Weight 3.3 V |         |
| 176 LQFP       | 144 LQFP | 100 LQFP |        | SRC <sup>2</sup> = 0 | SRC = 1 | SRC = 0      | SRC = 1 | SRC = 0      | SRC = 1 | SRC = 0      | SRC = 1 |
| 4              | 2        | 2        | PD[8]  | 1%                   | —       | 1%           | —       | 1%           | —       | 2%           | —       |
|                |          |          | PB[4]  | 1%                   | —       | 1%           | —       | 1%           | —       | 2%           | —       |
|                |          |          | PB[5]  | 1%                   | —       | 1%           | —       | 1%           | —       | 2%           | —       |
|                |          |          | PB[6]  | 1%                   | —       | 1%           | —       | 1%           | —       | 2%           | —       |
|                |          |          | PB[7]  | 1%                   | —       | 1%           | —       | 1%           | —       | 2%           | —       |
|                |          |          | PD[9]  | 1%                   | —       | 1%           | —       | 1%           | —       | 2%           | —       |
|                |          |          | PD[10] | 1%                   | —       | 1%           | —       | 1%           | —       | 2%           | —       |
|                |          |          | PD[11] | 1%                   | —       | 1%           | —       | 1%           | —       | 2%           | —       |
| 4              | —        | —        | PB[11] | 1%                   | —       | 1%           | —       | —            | —       | —            | —       |
|                | —        | —        | PD[12] | 11%                  | —       | 13%          | —       | —            | —       | —            | —       |
|                | 2        | 2        | PB[12] | 11%                  | —       | 13%          | —       | 15%          | —       | 17%          | —       |
|                |          |          | PD[13] | 11%                  | —       | 13%          | —       | 14%          | —       | 17%          | —       |
|                |          |          | PB[13] | 11%                  | —       | 13%          | —       | 14%          | —       | 17%          | —       |
|                |          |          | PD[14] | 11%                  | —       | 13%          | —       | 14%          | —       | 17%          | —       |
|                |          |          | PB[14] | 11%                  | —       | 13%          | —       | 14%          | —       | 16%          | —       |
|                |          |          | PD[15] | 11%                  | —       | 13%          | —       | 13%          | —       | 16%          | —       |
|                |          |          | PB[15] | 11%                  | —       | 13%          | —       | 13%          | —       | 15%          | —       |
|                | —        | —        | PI[8]  | 10%                  | —       | 12%          | —       | —            | —       | —            | —       |
|                | —        | —        | PI[9]  | 10%                  | —       | 12%          | —       | —            | —       | —            | —       |
|                | —        | —        | PI[10] | 10%                  | —       | 12%          | —       | —            | —       | —            | —       |
|                | —        | —        | PI[11] | 10%                  | —       | 12%          | —       | —            | —       | —            | —       |
|                | —        | —        | PI[12] | 10%                  | —       | 12%          | —       | —            | —       | —            | —       |
|                | —        | —        | PI[13] | 10%                  | —       | 11%          | —       | —            | —       | —            | —       |
|                | 2        | 2        | PA[3]  | 9%                   | —       | 11%          | —       | 11%          | —       | 13%          | —       |
|                |          |          | PG[13] | 9%                   | 13%     | 11%          | 11%     | 10%          | 14%     | 12%          | 13%     |
|                |          |          | PG[12] | 9%                   | 13%     | 10%          | 11%     | 10%          | 14%     | 12%          | 12%     |
|                |          |          | PH[0]  | 6%                   | 8%      | 7%           | 7%      | 6%           | 9%      | 7%           | 8%      |
|                |          |          | PH[1]  | 6%                   | 8%      | 7%           | 7%      | 6%           | 8%      | 7%           | 7%      |
| PH[2]          |          |          | 5%     | 7%                   | 6%      | 6%           | 5%      | 7%           | 6%      | 7%           |         |
| PH[3]          |          |          | 5%     | 7%                   | 5%      | 6%           | 5%      | 7%           | 6%      | 6%           |         |
| PG[1]          |          |          | 4%     | —                    | 5%      | —            | 4%      | —            | 5%      | —            |         |
| —              | —        | PG[0]    | 4%     | 5%                   | 4%      | 5%           | 4%      | 5%           | 4%      | 5%           |         |

Table 23. I/O weight<sup>1</sup> (continued)

| Supply segment |          |          | Pad    | 176 LQFP             |         |              |         | 144/100 LQFP |         |              |         |
|----------------|----------|----------|--------|----------------------|---------|--------------|---------|--------------|---------|--------------|---------|
|                |          |          |        | Weight 5 V           |         | Weight 3.3 V |         | Weight 5 V   |         | Weight 3.3 V |         |
| 176 LQFP       | 144 LQFP | 100 LQFP |        | SRC <sup>2</sup> = 0 | SRC = 1 | SRC = 0      | SRC = 1 | SRC = 0      | SRC = 1 | SRC = 0      | SRC = 1 |
| 5              | 3        | —        | PF[15] | 4%                   | —       | 4%           | —       | 4%           | —       | 4%           | —       |
|                |          | —        | PF[14] | 4%                   | 6%      | 5%           | 5%      | 4%           | 6%      | 5%           | 5%      |
|                |          | —        | PE[13] | 4%                   | —       | 5%           | —       | 4%           | —       | 5%           | —       |
|                |          | 3        | PA[7]  | 5%                   | —       | 6%           | —       | 5%           | —       | 6%           | —       |
|                |          |          | PA[8]  | 5%                   | —       | 6%           | —       | 5%           | —       | 6%           | —       |
|                |          |          | PA[9]  | 6%                   | —       | 7%           | —       | 6%           | —       | 7%           | —       |
|                |          |          | PA[10] | 6%                   | —       | 8%           | —       | 6%           | —       | 8%           | —       |
|                |          |          | PA[11] | 8%                   | —       | 9%           | —       | 8%           | —       | 9%           | —       |
|                |          |          | PE[12] | 8%                   | —       | 9%           | —       | 8%           | —       | 9%           | —       |
|                |          |          | —      | PG[14]               | 8%      | —            | 9%      | —            | 8%      | —            | 9%      |
|                |          | —        | PG[15] | 8%                   | 11%     | 9%           | 10%     | 8%           | 11%     | 9%           | 10%     |
|                |          | —        | PE[14] | 8%                   | —       | 9%           | —       | 8%           | —       | 9%           | —       |
|                |          | —        | PE[15] | 8%                   | 11%     | 9%           | 10%     | 8%           | 11%     | 9%           | 10%     |
|                | —        | PG[10]   | 8%     | —                    | 9%      | —            | 8%      | —            | 9%      | —            |         |
|                | —        | PG[11]   | 7%     | 11%                  | 9%      | 9%           | 7%      | 11%          | 9%      | 9%           |         |
|                | —        | —        | —      | PH[11]               | 7%      | 10%          | 9%      | 9%           | —       | —            | —       |
|                | —        | —        | —      | PH[12]               | 7%      | 10%          | 8%      | 9%           | —       | —            | —       |
|                | —        | —        | —      | PI[5]                | 7%      | —            | 8%      | —            | —       | —            | —       |
|                | —        | —        | —      | PI[4]                | 7%      | —            | 8%      | —            | —       | —            | —       |
|                | 3        | 3        | PC[3]  | 6%                   | —       | 8%           | —       | 6%           | —       | 8%           | —       |
| PC[2]          |          |          | 6%     | 8%                   | 7%      | 7%           | 6%      | 8%           | 7%      | 7%           |         |
| PA[5]          |          |          | 6%     | 8%                   | 7%      | 7%           | 6%      | 8%           | 7%      | 7%           |         |
| PA[6]          |          |          | 5%     | —                    | 6%      | —            | 5%      | —            | 6%      | —            |         |
| PH[10]         |          |          | 5%     | 7%                   | 6%      | 6%           | 5%      | 7%           | 6%      | 6%           |         |
| PC[1]          |          |          | 5%     | 19%                  | 5%      | 13%          | 5%      | 19%          | 5%      | 13%          |         |

Table 23. I/O weight<sup>1</sup> (continued)

| Supply segment |          |          | Pad    | 176 LQFP             |         |              |         | 144/100 LQFP |         |              |         |     |
|----------------|----------|----------|--------|----------------------|---------|--------------|---------|--------------|---------|--------------|---------|-----|
|                |          |          |        | Weight 5 V           |         | Weight 3.3 V |         | Weight 5 V   |         | Weight 3.3 V |         |     |
| 176 LQFP       | 144 LQFP | 100 LQFP |        | SRC <sup>2</sup> = 0 | SRC = 1 | SRC = 0      | SRC = 1 | SRC = 0      | SRC = 1 | SRC = 0      | SRC = 1 |     |
| 6              | 4        | 4        | PC[0]  | 6%                   | 9%      | 7%           | 8%      | 7%           | 10%     | 8%           | 8%      |     |
|                |          |          | PH[9]  | 7%                   | —       | 8%           | —       | 7%           | —       | 9%           | —       |     |
|                |          |          | PE[2]  | 7%                   | 10%     | 8%           | 9%      | 8%           | 11%     | 9%           | 10%     |     |
|                |          |          | PE[3]  | 7%                   | 10%     | 9%           | 9%      | 8%           | 12%     | 10%          | 10%     |     |
|                |          |          | PC[5]  | 7%                   | 11%     | 9%           | 9%      | 8%           | 12%     | 10%          | 11%     |     |
|                |          |          | PC[4]  | 8%                   | 11%     | 9%           | 10%     | 9%           | 13%     | 10%          | 11%     |     |
|                |          |          | PE[4]  | 8%                   | 11%     | 9%           | 10%     | 9%           | 13%     | 11%          | 12%     |     |
|                |          |          | PE[5]  | 8%                   | 11%     | 10%          | 10%     | 9%           | 14%     | 11%          | 12%     |     |
|                |          | —        | —      | PH[4]                | 8%      | 12%          | 10%     | 10%          | 10%     | 14%          | 12%     | 12% |
|                |          | —        | —      | PH[5]                | 8%      | —            | 10%     | —            | 10%     | —            | 12%     | —   |
|                |          | —        | —      | PH[6]                | 8%      | 12%          | 10%     | 11%          | 10%     | 15%          | 12%     | 13% |
|                |          | —        | —      | PH[7]                | 9%      | 12%          | 10%     | 11%          | 11%     | 15%          | 13%     | 13% |
|                |          | —        | —      | PH[8]                | 9%      | 12%          | 10%     | 11%          | 11%     | 16%          | 13%     | 14% |
|                |          | —        | 4      | PE[6]                | 9%      | 12%          | 10%     | 11%          | 11%     | 16%          | 13%     | 14% |
|                |          | —        | 4      | PE[7]                | 9%      | 12%          | 10%     | 11%          | 11%     | 16%          | 14%     | 14% |
|                |          | —        | —      | PI[3]                | 9%      | —            | 10%     | —            | —       | —            | —       | —   |
|                |          | —        | —      | PI[2]                | 9%      | —            | 10%     | —            | —       | —            | —       | —   |
|                |          | —        | —      | PI[1]                | 9%      | —            | 10%     | —            | —       | —            | —       | —   |
|                |          | —        | —      | PI[0]                | 9%      | —            | 10%     | —            | —       | —            | —       | —   |
|                |          | —        | 4      | 4                    | PC[12]  | 8%           | 12%     | 10%          | 11%     | 12%          | 18%     | 15% |
| —              | 4        | 4        | PC[13] | 8%                   | —       | 10%          | —       | 13%          | —       | 15%          | —       |     |
| —              | 4        | 4        | PC[8]  | 8%                   | —       | 10%          | —       | 13%          | —       | 15%          | —       |     |
| —              | 4        | 4        | PB[2]  | 8%                   | 11%     | 9%           | 10%     | 13%          | 18%     | 15%          | 16%     |     |

<sup>1</sup> V<sub>DD</sub> = 3.3 V ± 10% / 5.0 V ± 10%, T<sub>A</sub> = -40 to 125 °C, unless otherwise specified

<sup>2</sup> SRC: “Slew Rate Control” bit in SIU\_PCRx

#### 4.6.6 RESET electrical characteristics

The device implements a dedicated bidirectional RESET pin.

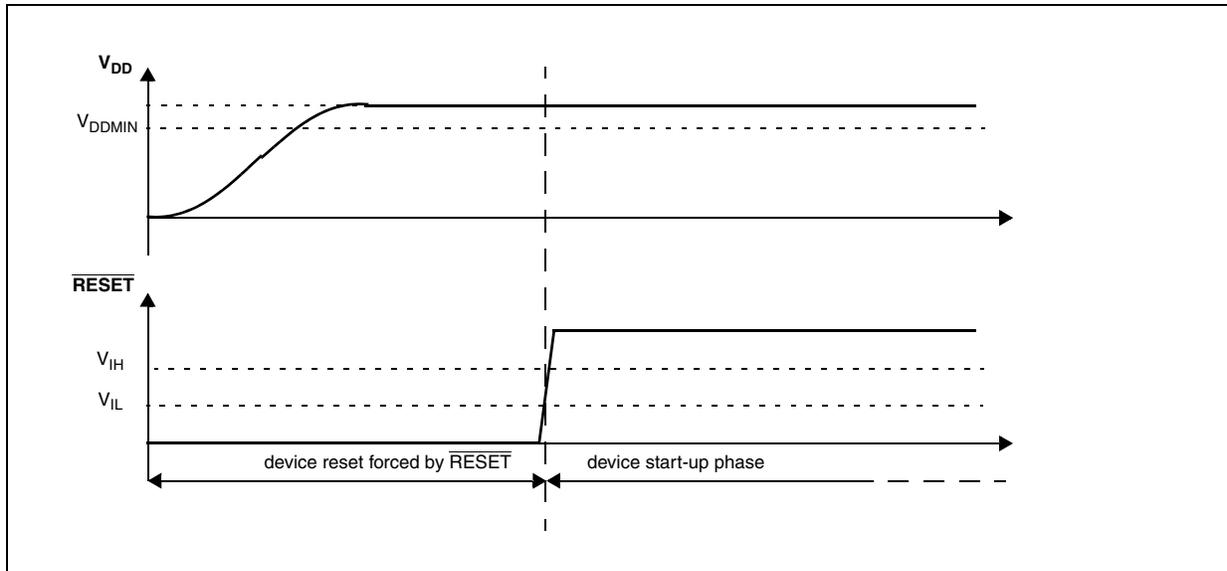


Figure 7. Start-up reset requirements

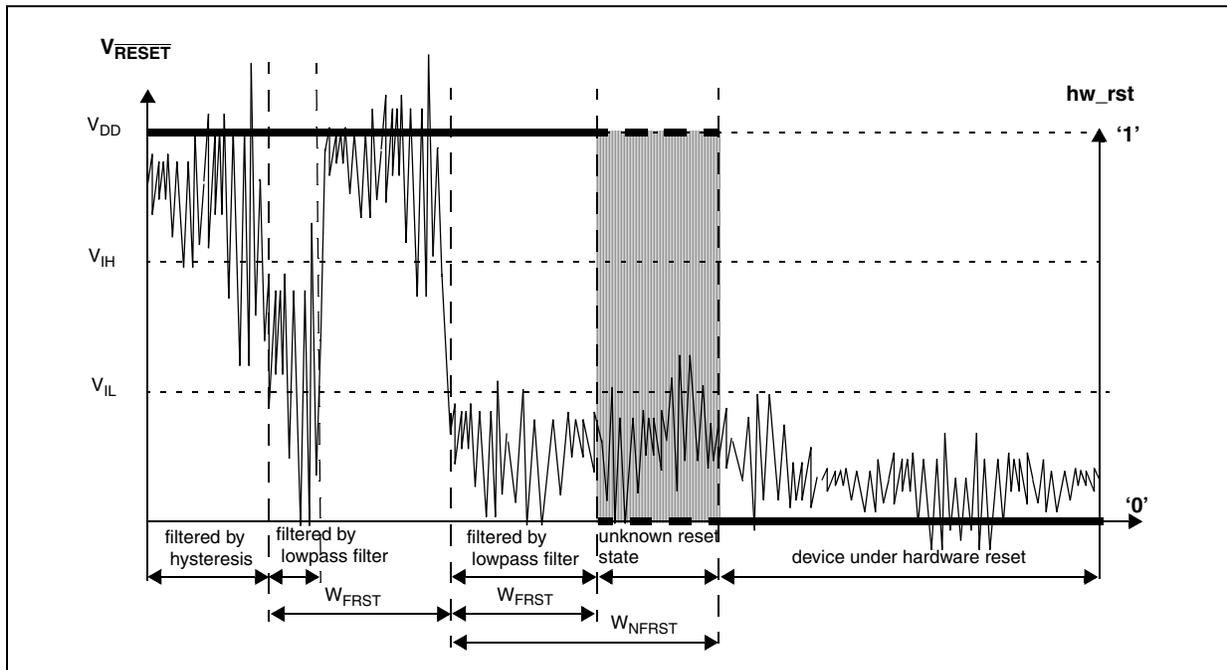


Figure 8. Noise filtering on reset signal

Table 24. Reset electrical characteristics

| Symbol          | C    | Parameter                               | Conditions <sup>1</sup> | Value               |     |                       | Unit |
|-----------------|------|---|-------------------------|---------------------|-----|-----------------------|------|
|                 |      |   |                         | Min                 | Typ | Max                   |      |
| V <sub>IH</sub> | SR P | Input High Level CMOS (Schmitt Trigger) | —                       | 0.65V <sub>DD</sub> | —   | V <sub>DD</sub> + 0.4 | V    |

Table 24. Reset electrical characteristics (continued)

| Symbol             | C  | Parameter | Conditions <sup>1</sup>   | Value   |      |                     | Unit               |    |
|--------------------|----|-----------|---|---|------|---------------------|--------------------|----|
|                    |    |           |   | Min   | Typ  | Max                 |                    |    |
| V <sub>IL</sub>    | SR | P         | Input low Level CMOS (Schmitt Trigger)                              | —   | —    | 0.35V <sub>DD</sub> | V                  |    |
| V <sub>HYS</sub>   | CC | C         | Input hysteresis CMOS (Schmitt Trigger)                             | —   | —    | 0.1V <sub>DD</sub>  | V                  |    |
| V <sub>OL</sub>    | CC | P         | Output low level  | Push Pull, I <sub>OL</sub> = 2 mA, V <sub>DD</sub> = 5.0 V ± 10%, PAD3V5V = 0 (recommended) | —    | —                   | 0.1V <sub>DD</sub> | V  |
|                    |    |           |   | Push Pull, I <sub>OL</sub> = 1 mA, V <sub>DD</sub> = 5.0 V ± 10%, PAD3V5V = 1 <sup>2</sup>  | —    | —                   | 0.1V <sub>DD</sub> |    |
|                    |    |           |   | Push Pull, I <sub>OL</sub> = 1 mA, V <sub>DD</sub> = 3.3 V ± 10%, PAD3V5V = 1 (recommended) | —    | —                   | 0.5                |    |
| t <sub>tr</sub>    | CC | D         | Output transition time output pin <sup>3</sup> MEDIUM configuration | C <sub>L</sub> = 25 pF, V <sub>DD</sub> = 5.0 V ± 10%, PAD3V5V = 0                          | —    | —                   | 10                 | ns |
|                    |    |           |   | C <sub>L</sub> = 50 pF, V <sub>DD</sub> = 5.0 V ± 10%, PAD3V5V = 0                          | —    | —                   | 20                 |    |
|                    |    |           |   | C <sub>L</sub> = 100 pF, V <sub>DD</sub> = 5.0 V ± 10%, PAD3V5V = 0                         | —    | —                   | 40                 |    |
|                    |    |           |   | C <sub>L</sub> = 25 pF, V <sub>DD</sub> = 3.3 V ± 10%, PAD3V5V = 1                          | —    | —                   | 12                 |    |
|                    |    |           |   | C <sub>L</sub> = 50 pF, V <sub>DD</sub> = 3.3 V ± 10%, PAD3V5V = 1                          | —    | —                   | 25                 |    |
|                    |    |           |   | C <sub>L</sub> = 100 pF, V <sub>DD</sub> = 3.3 V ± 10%, PAD3V5V = 1                         | —    | —                   | 40                 |    |
| W <sub>FRST</sub>  | SR | P         | $\overline{\text{RESET}}$ input filtered pulse                      | —   | —    | 40                  | ns                 |    |
| W <sub>NFRST</sub> | SR | P         | $\overline{\text{RESET}}$ input not filtered pulse                  | —   | 1000 | —                   | ns                 |    |
| I <sub>WPU</sub>   | CC | P         | Weak pull-up current absolute value                                 | V <sub>DD</sub> = 3.3 V ± 10%, PAD3V5V = 1  | 10   | —                   | 150                | μA |
|                    |    |           |   | V <sub>DD</sub> = 5.0 V ± 10%, PAD3V5V = 0  | 10   | —                   | 150                |    |
|                    |    |           |   | V <sub>DD</sub> = 5.0 V ± 10%, PAD3V5V = 1 <sup>4</sup>                                     | 10   | —                   | 250                |    |

<sup>1</sup> V<sub>DD</sub> = 3.3 V ± 10% / 5.0 V ± 10%, T<sub>A</sub> = -40 to 125 °C, unless otherwise specified

<sup>2</sup> This is a transient configuration during power-up, up to the end of reset PHASE2 (refer to RGM module section of the device reference manual).

<sup>3</sup> C<sub>L</sub> includes device and package capacitance (C<sub>PKG</sub> < 5 pF).

<sup>4</sup> The configuration PAD3V5 = 1 when V<sub>DD</sub> = 5 V is only transient configuration during power-up. All pads but RESET and Nexus output (MDOx, EVTO, MCKO) are configured in input or in high impedance state.

## 4.7 Power management electrical characteristics

### 4.7.1 Voltage regulator electrical characteristics

The device implements an internal voltage regulator to generate the low voltage core supply  $V_{DD\_LV}$  from the high voltage ballast supply  $V_{DD\_BV}$ . The regulator itself is supplied by the common I/O supply  $V_{DD}$ . The following supplies are involved:

- HV: High voltage external power supply for voltage regulator module. This must be provided externally through  $V_{DD}$  power pin.
- BV: High voltage external power supply for internal ballast module. This must be provided externally through  $V_{DD\_BV}$  power pin. Voltage values should be aligned with  $V_{DD}$ .
- LV: Low voltage internal power supply for core, FMPLL and Flash digital logic. This is generated by the internal voltage regulator but provided outside to connect stability capacitor. It is further split into four main domains to ensure noise isolation between critical LV modules within the device:
  - LV\_COR: Low voltage supply for the core. It is also used to provide supply for FMPLL through double bonding.
  - LV\_CFLA: Low voltage supply for code flash module. It is supplied with dedicated ballast and shorted to LV\_COR through double bonding.
  - LV\_DFLA: Low voltage supply for data flash module. It is supplied with dedicated ballast and shorted to LV\_COR through double bonding.
  - LV\_PLL: Low voltage supply for FMPLL. It is shorted to LV\_COR through double bonding.

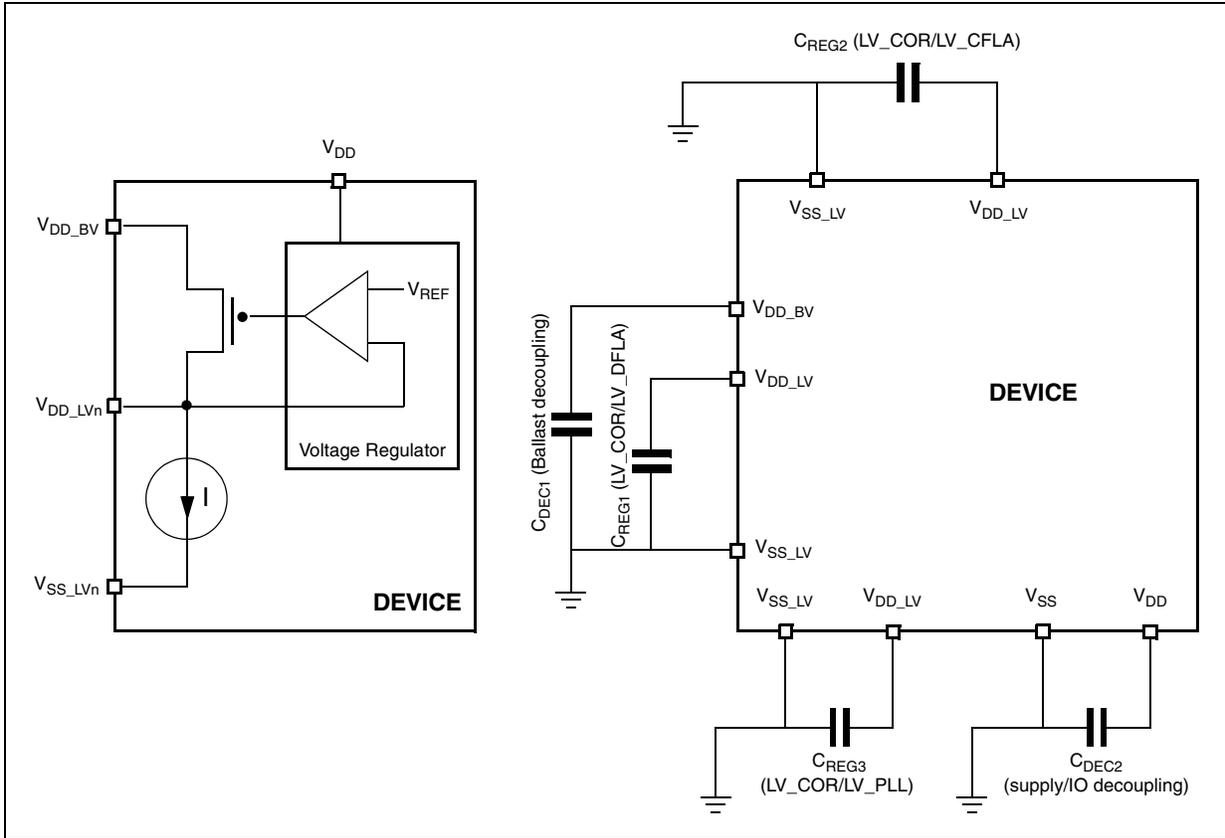


Figure 9. Voltage regulator capacitance connection

The internal voltage regulator requires external capacitance ( $C_{REGn}$ ) to be connected to the device in order to provide a stable low voltage digital supply to the device. Capacitances should be placed on the board as near as possible to the associated pins. Care should also be taken to limit the serial inductance of the board to less than 5 nH.

Each decoupling capacitor must be placed between each of the three  $V_{DD\_LV}/V_{SS\_LV}$  supply pairs to ensure stable voltage (see 4.4, Recommended operating conditions).

Table 25. Voltage regulator electrical characteristics

| Symbol     | C  | Parameter  | Conditions <sup>1</sup>  | Value   |         |     | Unit     |
|------------|----|--|--|---------|---------|-----|----------|
|            |    |  |  | Min     | Typ     | Max |          |
| $C_{REGn}$ | SR | Internal voltage regulator external capacitance  | —  | 200     | —       | 500 | nF       |
| $R_{REG}$  | SR | Stability capacitor equivalent serial resistance | Range:<br>10 kHz to 20 MHz   | —       | —       | 0.2 | $\Omega$ |
| $C_{DEC1}$ | SR | Decoupling capacitance <sup>2</sup> ballast      | $V_{DD\_BV}/V_{SS\_LV}$ pair:<br>$V_{DD\_BV} = 4.5\text{ V to }5.5\text{ V}$ | $100^3$ | $470^4$ | —   | nF       |
|            |    |  | $V_{DD\_BV}/V_{SS\_LV}$ pair:<br>$V_{DD\_BV} = 3\text{ V to }3.6\text{ V}$   | 400     |         | —   |          |

Table 25. Voltage regulator electrical characteristics (continued)

| Symbol                 | C  | Parameter | Conditions <sup>1</sup>  | Value   |      |      | Unit             |     |    |
|------------------------|----|-----------|--|---|------|------|------------------|-----|----|
|                        |    |           |  | Min   | Typ  | Max  |                  |     |    |
| C <sub>DEC2</sub>      | SR | —         | Decoupling capacitance regulator supply                                    | V <sub>DD</sub> /V <sub>SS</sub> pair                 | 10   | 100  | —                | nF  |    |
| V <sub>MREG</sub>      | CC | T         | Main regulator output voltage  | Before exiting from reset                             | —    | 1.32 | —                | V   |    |
|                        |    |           |  | After trimming  | 1.16 | 1.28 | —                |     |    |
| I <sub>MREG</sub>      | SR | —         | Main regulator current provided to V <sub>DD_LV</sub> domain               | —   | —    | —    | 150              | mA  |    |
| I <sub>MREGINT</sub>   | CC | D         | Main regulator module current consumption                                  | I <sub>MREG</sub> = 200 mA                            | —    | —    | —                | 2   | mA |
|                        |    |           |  | I <sub>MREG</sub> = 0 mA                              | —    | —    | —                |     |    |
| V <sub>LPREG</sub>     | CC | P         | Low-power regulator output voltage   | After trimming  | 1.16 | 1.28 | —                | V   |    |
| I <sub>LPREG</sub>     | SR | —         | Low-power regulator current provided to V <sub>DD_LV</sub> domain          | —   | —    | —    | 15               | mA  |    |
| I <sub>LPREGINT</sub>  | CC | D         | Low-power regulator module current consumption                             | I <sub>LPREG</sub> = 15 mA;<br>T <sub>A</sub> = 55 °C | —    | —    | —                | 600 | μA |
|                        |    |           |  | I <sub>LPREG</sub> = 0 mA;<br>T <sub>A</sub> = 55 °C  | —    | 5    | —                |     |    |
| V <sub>ULPREG</sub>    | CC | P         | Ultra low power regulator output voltage                                   | After trimming  | 1.16 | 1.28 | —                | V   |    |
| I <sub>ULPREG</sub>    | SR | —         | Ultra low power regulator current provided to V <sub>DD_LV</sub> domain    | —   | —    | —    | 5                | mA  |    |
| I <sub>ULPREGINT</sub> | CC | D         | Ultra low power regulator module current consumption                       | I <sub>ULPREG</sub> = 5 mA;<br>T <sub>A</sub> = 55 °C | —    | —    | —                | 100 | μA |
|                        |    |           |  | I <sub>ULPREG</sub> = 0 mA;<br>T <sub>A</sub> = 55 °C | —    | 2    | —                |     |    |
| I <sub>DD_BV</sub>     | CC | D         | In-rush average current on V <sub>DD_BV</sub> during power-up <sup>5</sup> | —   | —    | —    | 300 <sup>6</sup> | mA  |    |

<sup>1</sup> V<sub>DD</sub> = 3.3 V ± 10% / 5.0 V ± 10%, T<sub>A</sub> = -40 to 125 °C, unless otherwise specified

<sup>2</sup> This capacitance value is driven by the constraints of the external voltage regulator supplying the V<sub>DD\_BV</sub> voltage. A typical value is in the range of 470 nF.

<sup>3</sup> This value is acceptable to guarantee operation from 4.5 V to 5.5 V

<sup>4</sup> External regulator and capacitance circuitry must be capable of providing I<sub>DD\_BV</sub> while maintaining supply V<sub>DD\_BV</sub> in operating range.

<sup>5</sup> In-rush average current is seen only for short time during power-up and on standby exit (maximum 20 μs, depending on external capacitances to be loaded).

<sup>6</sup> The duration of the in-rush current depends on the capacitance placed on LV pins. BV decoupling capacitors must be sized accordingly. Refer to I<sub>MREG</sub> value for minimum amount of current to be provided in cc.

## 4.7.2 Low voltage detector electrical characteristics

The device implements a power-on reset (POR) module to ensure correct power-up initialization, as well as five low voltage detectors (LVDs) to monitor the V<sub>DD</sub> and the V<sub>DD\_LV</sub> voltage while device is supplied:

## Electrical characteristics

- POR monitors  $V_{DD}$  during the power-up phase to ensure device is maintained in a safe reset state (refer to RGM Destructive Event Status (RGM\_DES) Register flag F\_POR in device reference manual)
- LVDHV3 monitors  $V_{DD}$  to ensure device reset below minimum functional supply (refer to RGM Destructive Event Status (RGM\_DES) Register flag F\_LVD27 in device reference manual)
- LVDHV3B monitors  $V_{DD\_BV}$  to ensure device reset below minimum functional supply (refer to RGM Destructive Event Status (RGM\_DES) Register flag F\_LVD27\_VREG in device reference manual)
- LVDHV5 monitors  $V_{DD}$  when application uses device in the  $5.0\text{ V} \pm 10\%$  range (refer to RGM Functional Event Status (RGM\_FES) Register flag F\_LVD45 in device reference manual)
- LVDLVCOR monitors power domain No. 1 (refer to RGM Destructive Event Status (RGM\_DES) Register flag F\_LVD12\_PD1 in device reference manual)
- LVDLVBKP monitors power domain No. 0 (refer to RGM Destructive Event Status (RGM\_DES) Register flag F\_LVD12\_PD0 in device reference manual)

### NOTE

When enabled, power domain No. 2 is monitored through LVDLVBKP.

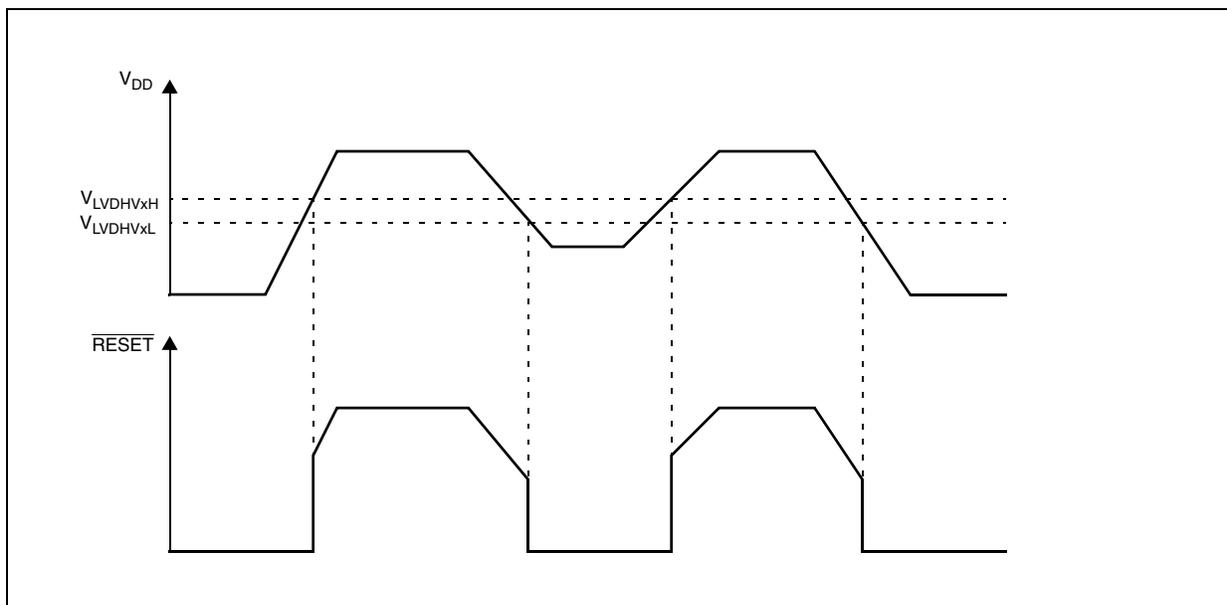


Figure 10. Low voltage detector vs reset

Table 26. Low voltage detector electrical characteristics

| Symbol                 | C  | Parameter | Conditions <sup>1</sup>                   | Value                                       |      |     | Unit |      |
|------------------------|----|-----------|---|---|------|-----|------|------|
|                        |    |           |   | Min   | Typ  | Max |      |      |
| V <sub>PORUP</sub>     | SR | P         | T <sub>A</sub> = 25 °C,<br>after trimming | 1.0   | —    | 5.5 | V    |      |
| V <sub>PORH</sub>      | CC | P         |   | Power-on reset threshold                    | 1.5  | —   |      | 2.6  |
| V <sub>LVDHV3H</sub>   | CC | T         |   | LVDHV3 low voltage detector high threshold  | —    | —   |      | 2.95 |
| V <sub>LVDHV3L</sub>   | CC | P         |   | LVDHV3 low voltage detector low threshold   | 2.6  | —   |      | 2.9  |
| V <sub>LVDHV3BH</sub>  | CC | P         |   | LVDHV3B low voltage detector high threshold | —    | —   |      | 2.95 |
| V <sub>LVDHV3BL</sub>  | CC | P         |   | LVDHV3B low voltage detector low threshold  | 2.6  | —   |      | 2.9  |
| V <sub>LVDHV5H</sub>   | CC | T         |   | LVDHV5 low voltage detector high threshold  | —    | —   |      | 4.5  |
| V <sub>LVDHV5L</sub>   | CC | P         |   | LVDHV5 low voltage detector low threshold   | 3.8  | —   |      | 4.4  |
| V <sub>LVDLVCORL</sub> | CC | P         |   | LVDLVCOR low voltage detector low threshold | 1.08 | —   |      | 1.16 |
| V <sub>LVDLVBKPL</sub> | CC | P         |   | LVDLVBKP low voltage detector low threshold | 1.08 | —   |      | 1.16 |

<sup>1</sup> V<sub>DD</sub> = 3.3 V ± 10% / 5.0 V ± 10%, T<sub>A</sub> = -40 to 125 °C, unless otherwise specified

## 4.8 Power consumption

Table 27 provides DC electrical characteristics for significant application modes. These values are indicative values; actual consumption depends on the application.

Table 27. Power consumption on VDD\_BV and VDD\_HV

| Symbol                          | C  | Parameter | Conditions <sup>1</sup>                       | Value   |                         |                  | Unit |                  |    |
|---------------------------------|----|-----------|---|---|-------------------------|------------------|------|------------------|----|
|                                 |    |           |   | Min   | Typ                     | Max              |      |                  |    |
| I <sub>DDMAX</sub> <sup>2</sup> | CC | D         | RUN mode maximum average current              | —   | 115                     | 140 <sup>3</sup> | mA   |                  |    |
| I <sub>DDRUN</sub> <sup>4</sup> | CC | T         | RUN mode typical average current <sup>5</sup> | f <sub>CPU</sub> = 8 MHz                      | —                       | 12               | —    | mA               |    |
|                                 |    |           |   | f <sub>CPU</sub> = 16 MHz                     | —                       | 27               | —    |                  |    |
|                                 |    |           |   | f <sub>CPU</sub> = 32 MHz                     | —                       | 43               | —    |                  |    |
|                                 |    |           |   | f <sub>CPU</sub> = 48 MHz                     | —                       | 56               | 100  |                  |    |
|                                 |    |           |   | f <sub>CPU</sub> = 64 MHz                     | —                       | 70               | 125  |                  |    |
| I <sub>DDHALT</sub>             | CC | C         | HALT mode current <sup>6</sup>                | Slow internal RC oscillator (128 kHz) running | T <sub>A</sub> = 25 °C  | —                | 10   | 18               | mA |
|                                 |    |           |   |   | T <sub>A</sub> = 125 °C | —                | 17   | 28               |    |
| I <sub>DDSTOP</sub>             | CC | P         | STOP mode current <sup>7</sup>                | Slow internal RC oscillator (128 kHz) running | T <sub>A</sub> = 25 °C  | —                | 350  | 900 <sup>8</sup> | μA |
|                                 |    |           |   |   | T <sub>A</sub> = 55 °C  | —                | 750  | —                |    |
|                                 |    |           |   |   | T <sub>A</sub> = 85 °C  | —                | 2    | 7                | mA |
|                                 |    |           |   |   | T <sub>A</sub> = 105 °C | —                | 4    | 10               |    |
|                                 |    |           |   |   | T <sub>A</sub> = 125 °C | —                | 7    | 14               |    |

Table 27. Power consumption on VDD\_BV and VDD\_HV (continued)

| Symbol                | C  | Parameter                           | Conditions <sup>1</sup>                       | Value                   |     |     | Unit |    |
|-----------------------|----|-------------------------------------|---|-------------------------|-----|-----|------|----|
|                       |    |                                     |   | Min                     | Typ | Max |      |    |
| I <sub>DDSTDBY2</sub> | CC | STANDBY2 mode current <sup>9</sup>  | Slow internal RC oscillator (128 kHz) running | T <sub>A</sub> = 25 °C  | —   | 30  | 100  | μA |
|                       |    |                                     |   | T <sub>A</sub> = 55 °C  | —   | 75  | —    |    |
|                       |    |                                     |   | T <sub>A</sub> = 85 °C  | —   | 180 | 700  |    |
|                       |    |                                     |   | T <sub>A</sub> = 105 °C | —   | 315 | 1000 |    |
|                       |    |                                     |   | T <sub>A</sub> = 125 °C | —   | 560 | 1700 |    |
| I <sub>DDSTDBY1</sub> | CC | STANDBY1 mode current <sup>10</sup> | Slow internal RC oscillator (128 kHz) running | T <sub>A</sub> = 25 °C  | —   | 20  | 60   | μA |
|                       |    |                                     |   | T <sub>A</sub> = 55 °C  | —   | 45  | —    |    |
|                       |    |                                     |   | T <sub>A</sub> = 85 °C  | —   | 100 | 350  |    |
|                       |    |                                     |   | T <sub>A</sub> = 105 °C | —   | 165 | 500  |    |
|                       |    |                                     |   | T <sub>A</sub> = 125 °C | —   | 280 | 900  |    |

<sup>1</sup> V<sub>DD</sub> = 3.3 V ± 10% / 5.0 V ± 10%, T<sub>A</sub> = -40 to 125 °C, unless otherwise specified

<sup>2</sup> Running consumption does not include I/Os toggling which is highly dependent on the application. The given value is thought to be a worst case value with all peripherals running, and code fetched from code flash while modify operation ongoing on data flash. Notice that this value can be significantly reduced by application: switch off not used peripherals (default), reduce peripheral frequency through internal prescaler, fetch from RAM most used functions, use low power mode when possible.

<sup>3</sup> Higher current may be sunk by device during power-up and standby exit. Please refer to in-rush average current in Table 25.

<sup>4</sup> RUN current measured with typical application with accesses on both Flash and RAM.

<sup>5</sup> 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.

<sup>6</sup> 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 clocks gated. LINFlex: instances: 0, 1, 2 ON (clocked but not reception or transmission), instance: 3 to 9 clocks 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), instance: 1 to 5 clocks gated. RTC/API ON. PIT ON. STM ON. ADC1 OFF. ADC0 ON but no conversion except two analog watchdogs.

<sup>7</sup> 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.

<sup>8</sup> 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.

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

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

## 4.9 Flash memory electrical characteristics

### 4.9.1 Program/erase characteristics

Table 28 shows the program and erase characteristics.

Table 28. Program and erase specifications

| Symbol            | C  | Parameter                                       | Conditions | Value |                  |                          |                  | Unit    |
|-------------------|----|---|------------|-------|------------------|--------------------------|------------------|---------|
|                   |    |   |            | Min   | Typ <sup>1</sup> | Initial max <sup>2</sup> | Max <sup>3</sup> |         |
| $t_{dwprogram}$   | CC | Double word (64 bits) program time <sup>4</sup> | Code Flash | —     | 18               | 50                       | 500              | $\mu$ s |
|                   |    |   | Data Flash |       | 22               |                          |                  |         |
| $t_{16Kpperase}$  |    | 16 KB block preprogram and erase time           | Code Flash | —     | 200              | 500                      | 5000             | ms      |
|                   |    |   | Data Flash |       | 300              |                          |                  |         |
| $t_{32Kpperase}$  |    | 32 KB block preprogram and erase time           | Code Flash | —     | 300              | 600                      | 5000             | ms      |
|                   |    |   | Data Flash |       | 400              |                          |                  |         |
| $t_{128Kpperase}$ |    | 128 KB block preprogram and erase time          | Code Flash | —     | 600              | 1300                     | 7500             | ms      |
|                   |    |   | Data Flash |       | 800              |                          |                  |         |
| $t_{esus}$        | D  | Erase Suspend Latency                           | —          | —     | 30               | 30                       | $\mu$ s          |         |
| $t_{ESRT}$        | C  | Erase Suspend Request Rate <sup>5</sup>         | Code Flash | 20    | —                | —                        | —                | ms      |
|                   |    |   | Data Flash | 10    | —                | —                        | —                |         |

<sup>1</sup> Typical program and erase times assume nominal supply values and operation at 25 °C. All times are subject to change pending device characterization.

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

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

<sup>4</sup> Actual hardware programming times. This does not include software overhead.

<sup>5</sup> Time between erase suspend resume and the next erase suspend request

**Table 29. Flash module life**

| Symbol    | C  | Parameter | Conditions  | Value                                 |         |     | Unit   |       |
|-----------|----|-----------|---|---------------------------------------|---------|-----|--------|-------|
|           |    |           |   | Min                                   | Typ     | Max |        |       |
| P/E       | CC | C         | Number of program/erase cycles per block for 16 KB blocks over the operating temperature range (T <sub>J</sub> )  | 100,000                               | —       | —   | cycles |       |
| P/E       | CC | C         | Number of program/erase cycles per block for 32 KB blocks over the operating temperature range (T <sub>J</sub> )  | 10,000                                | 100,000 | —   | cycles |       |
| P/E       | CC | C         | Number of program/erase cycles per block for 128 KB blocks over the operating temperature range (T <sub>J</sub> ) | 1,000                                 | 100,000 | —   | cycles |       |
| Retention | CC | C         | Minimum data retention at 85 °C average ambient temperature <sup>1</sup>  | Blocks with 0–1,000 P/E cycles        | 20      | —   | —      | years |
|           |    |           |   | Blocks with 1,001–10,000 P/E cycles   | 10      | —   | —      | years |
|           |    |           |   | Blocks with 10,001–100,000 P/E cycles | 5       | —   | —      | years |

<sup>1</sup> Ambient temperature averaged over duration of application, not to exceed recommended product operating temperature range.

ECC circuitry provides correction of single bit faults and is used to improve further automotive reliability results. Some units will experience single bit corrections throughout the life of the product with no impact to product reliability.

**Table 30. Flash read access timing**

| Symbol            | C  | Parameter | Conditions <sup>1</sup>             | Max           | Unit |     |
|-------------------|----|-----------|-------------------------------------|---------------|------|-----|
| f <sub>READ</sub> | CC | P         | Maximum frequency for Flash reading | 2 wait states | 64   | MHz |
|                   |    |           |                                     | 1 wait state  | 40   |     |
|                   |    |           |                                     | 0 wait states | 20   |     |

<sup>1</sup> V<sub>DD</sub> = 3.3 V ± 10% / 5.0 V ± 10%, T<sub>A</sub> = –40 to 125 °C, unless otherwise specified

### 4.9.2 Flash power supply DC characteristics

Table 31 shows the power supply DC characteristics on external supply.

Table 31. Flash power supply DC electrical characteristics

| Symbol              | Parameter   | Conditions <sup>1</sup>   | Value      |     |     | Unit |    |
|---------------------|---|---|------------|-----|-----|------|----|
|                     |   |   | Min        | Typ | Max |      |    |
| I <sub>CFREAD</sub> | CC Sum of the current consumption on V <sub>DD_HV</sub> and V <sub>DD_BV</sub> on read access                         | Flash module read<br>f <sub>CPU</sub> = 64 MHz                                    | Code Flash | —   | —   | 33   | mA |
| I <sub>DFREAD</sub> |   |   | Data Flash | —   | —   | 33   |    |
| I <sub>CFMOD</sub>  | CC Sum of the current consumption on V <sub>DD_HV</sub> and V <sub>DD_BV</sub> on matrix modification (program/erase) | Program/Erase on-going while reading Flash registers<br>f <sub>CPU</sub> = 64 MHz | Code Flash | —   | —   | 52   | mA |
| I <sub>DFMOD</sub>  |   |   | Data Flash | —   | —   | 33   |    |
| I <sub>CFLPW</sub>  | CC Sum of the current consumption on V <sub>DD_HV</sub> and V <sub>DD_BV</sub> during Flash low power mode            | —   | Code Flash | —   | —   | 1.1  | mA |
| I <sub>DFLPW</sub>  |   |   | Data Flash | —   | —   | 900  |    |
| I <sub>CFPWD</sub>  | CC Sum of the current consumption on V <sub>DD_HV</sub> and V <sub>DD_BV</sub> during Flash power down mode           | —   | Code Flash | —   | —   | 150  | μA |
| I <sub>DFPWD</sub>  |   |   | Data Flash | —   | —   | 150  |    |

<sup>1</sup> V<sub>DD</sub> = 3.3 V ± 10% / 5.0 V ± 10%, T<sub>A</sub> = -40 to 125 °C, unless otherwise specified

### 4.9.3 Start-up/Switch-off timings

Table 32. Start-up time/Switch-off time

| Symbol                  | C  | Parameter   | Conditions <sup>1</sup> | Value |     |     | Unit |
|-------------------------|----|---|-------------------------|-------|-----|-----|------|
|                         |    |   |                         | Min   | Typ | Max |      |
| t <sub>FLARSTEXIT</sub> | CC | T Delay for Flash module to exit reset mode       | —                       | —     | —   | 125 | μs   |
| t <sub>FLALPEXIT</sub>  | CC | T Delay for Flash module to exit low-power mode   | —                       | —     | —   | 0.5 |      |
| t <sub>FLAPDEXIT</sub>  | CC | T Delay for Flash module to exit power-down mode  | —                       | —     | —   | 30  |      |
| t <sub>FLALPENTRY</sub> | CC | T Delay for Flash module to enter low-power mode  | —                       | —     | —   | 0.5 |      |
| t <sub>FLAPDENTRY</sub> | CC | T Delay for Flash module to enter power-down mode | —                       | —     | —   | 1.5 |      |

<sup>1</sup> V<sub>DD</sub> = 3.3 V ± 10% / 5.0 V ± 10%, T<sub>A</sub> = -40 to 125 °C, unless otherwise specified

## 4.10 Electromagnetic compatibility (EMC) characteristics

Susceptibility tests are performed on a sample basis during product characterization.

### 4.10.1 Designing hardened software to avoid noise problems

EMC characterization and optimization are performed at component level with a typical application environment and simplified MCU software. It should be noted that good EMC performance is highly dependent on the user application and the software in particular.

Therefore it is recommended that the user apply EMC software optimization and prequalification tests in relation with the EMC level requested for the application.

## Electrical characteristics

- Software recommendations – The software flowchart must include the management of runaway conditions such as:
  - Corrupted program counter
  - Unexpected reset
  - Critical data corruption (control registers...)
- Prequalification trials – Most of the common failures (unexpected reset and program counter corruption) can be reproduced by manually forcing a low state on the reset pin or the oscillator pins for 1 second.

To complete these trials, ESD stress can be applied directly on the device. When unexpected behavior is detected, the software can be hardened to prevent unrecoverable errors occurring.

### 4.10.2 Electromagnetic interference (EMI)

The product is monitored in terms of emission based on a typical application. This emission test conforms to the IEC61967-1 standard, which specifies the general conditions for EMI measurements.

**Table 33. EMI radiated emission measurement<sup>1,2</sup>**

| Symbol             | C  | Parameter | Conditions            | Value   |                             |      | Unit |      |      |
|--------------------|----|-----------|-----------------------|---|-----------------------------|------|------|------|------|
|                    |    |           |                       | Min   | Typ                         | Max  |      |      |      |
| —                  | SR | —         | Scan range            | 0.150   |                             | 1000 | MHz  |      |      |
| f <sub>CPU</sub>   | SR | —         | Operating frequency   | —   | 64                          | —    | MHz  |      |      |
| V <sub>DD_LV</sub> | SR | —         | LV operating voltages | —   | 1.28                        | —    | V    |      |      |
| S <sub>EMI</sub>   | CC | T         | Peak level            | V <sub>DD</sub> = 5 V, T <sub>A</sub> = 25 °C, LQFP144 package<br>Test conforming to IEC 61967-2,<br>f <sub>OSC</sub> = 8 MHz/f <sub>CPU</sub> = 64 MHz | No PLL frequency modulation | —    | —    | 18   | dBμV |
|                    |    |           |                       | ± 2% PLL frequency modulation   | —                           | —    | 14   | dBμV |      |

<sup>1</sup> EMI testing and I/O port waveforms per IEC 61967-1, -2, -4

<sup>2</sup> For information on conducted emission and susceptibility measurement (norm IEC 61967-4), please contact your local marketing representative.

### 4.10.3 Absolute maximum ratings (electrical sensitivity)

Based on two different tests (ESD and LU) using specific measurement methods, the product is stressed in order to determine its performance in terms of electrical sensitivity.

#### 4.10.3.1 Electrostatic discharge (ESD)

Electrostatic discharges (a positive then a negative pulse separated by 1 second) are applied to the pins of each sample according to each pin combination. The sample size depends on the number of supply pins in the device (3 parts×(n + 1) supply pin). This test conforms to the AEC-Q100-002/-003/-011 standard.

**Table 34. ESD absolute maximum ratings<sup>1,2</sup>**

| Symbol         | Ratings  | Conditions   | Class | Max value <sup>3</sup> | Unit |
|----------------|--|--|-------|------------------------|------|
| $V_{ESD(HBM)}$ | Electrostatic discharge voltage (Human Body Model)     | $T_A = 25\text{ °C}$<br>conforming to AEC-Q100-002 | H1C   | 2000                   | V    |
| $V_{ESD(MM)}$  | Electrostatic discharge voltage (Machine Model)        | $T_A = 25\text{ °C}$<br>conforming to AEC-Q100-003 | M2    | 200                    |      |
| $V_{ESD(CDM)}$ | Electrostatic discharge voltage (Charged Device Model) | $T_A = 25\text{ °C}$<br>conforming to AEC-Q100-011 | C3A   | 500<br>750 (corners)   |      |

<sup>1</sup> All ESD testing is in conformity with CDF-AEC-Q100 Stress Test Qualification for Automotive Grade Integrated Circuits.

<sup>2</sup> A device will be defined as a failure if after exposure to ESD pulses the device no longer meets the device specification requirements. Complete DC parametric and functional testing shall be performed per applicable device specification at room temperature followed by hot temperature, unless specified otherwise in the device specification.

<sup>3</sup> Data based on characterization results, not tested in production

### 4.10.3.2 Static latch-up (LU)

Two complementary static tests are required on six parts to assess the latch-up performance:

- A supply overvoltage is applied to each power supply pin.
- A current injection is applied to each input, output and configurable I/O pin.

These tests are compliant with the EIA/JESD 78 IC latch-up standard.

**Table 35. Latch-up results**

| Symbol | Parameter             | Conditions                                     | Class      |
|--------|-----------------------|--|------------|
| LU     | Static latch-up class | $T_A = 125\text{ °C}$<br>conforming to JESD 78 | II level A |

## 4.11 Fast external crystal oscillator (4 to 16 MHz) electrical characteristics

The device provides an oscillator/resonator driver. [Figure 11](#) describes a simple model of the internal oscillator driver and provides an example of a connection for an oscillator or a resonator.

[Table 36](#) provides the parameter description of 4 MHz to 16 MHz crystals used for the design simulations.

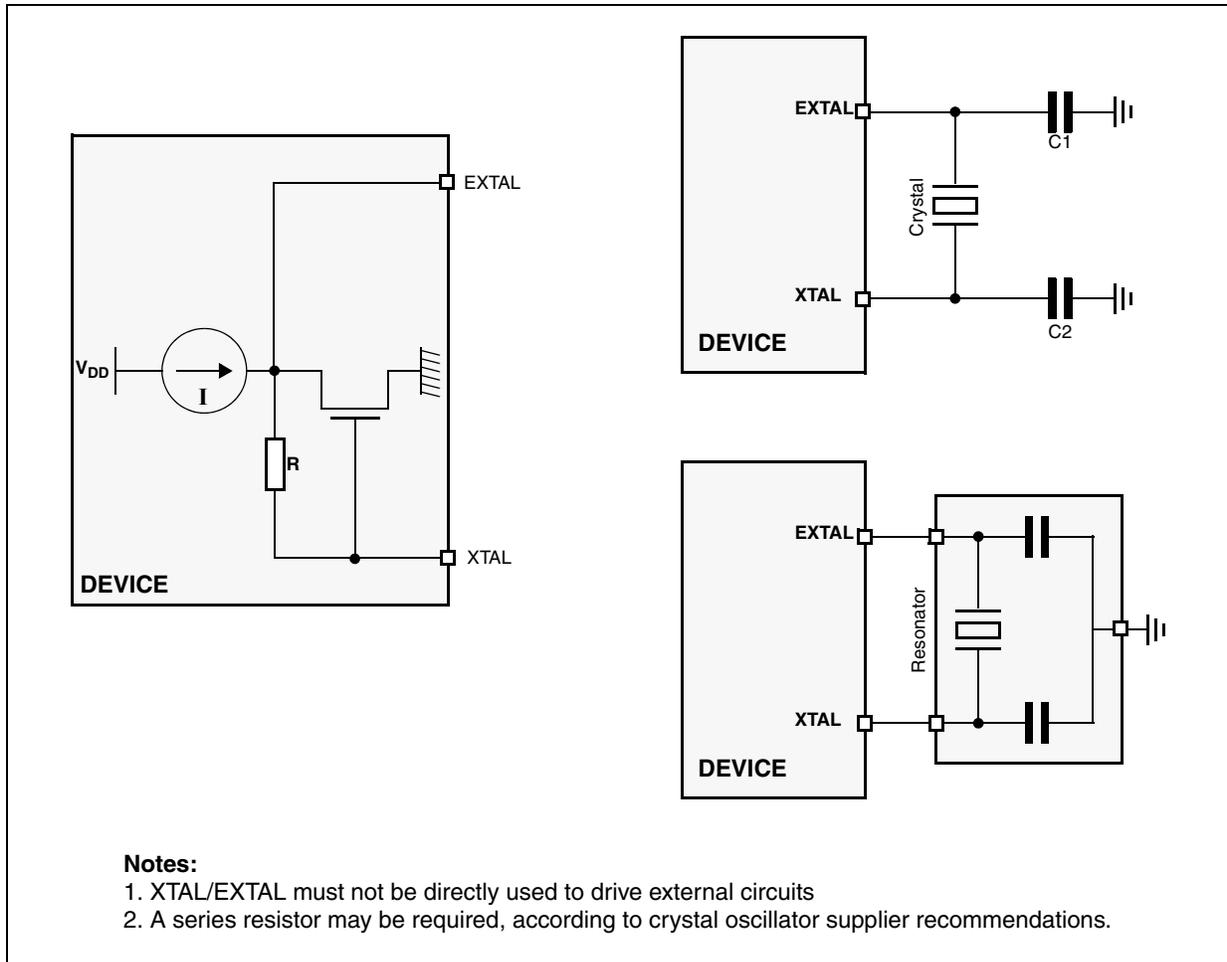


Figure 11. Crystal oscillator and resonator connection scheme

Table 36. Crystal description

| Nominal frequency (MHz) | NDK crystal reference | Crystal equivalent series resistance ESR $\Omega$ | Crystal motional capacitance ( $C_m$ ) fF | Crystal motional inductance ( $L_m$ ) mH | Load on xtalin/xtalout $C1 = C2$ (pF) <sup>1</sup> | 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   |

<sup>1</sup> 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.

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

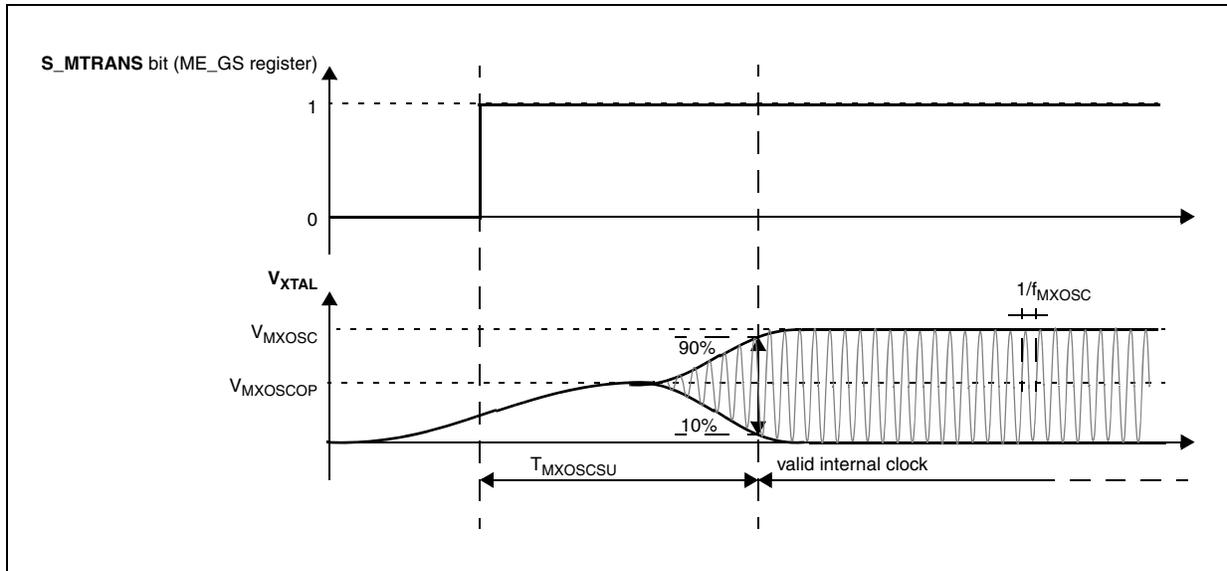


Figure 12. Fast external crystal oscillator (4 to 16 MHz) timing diagram

Table 37. Fast external crystal oscillator (4 to 16 MHz) electrical characteristics

| Symbol        | C  | Parameter | Conditions <sup>1</sup>                           | Value  |     |      | Unit |     |
|---------------|----|-----------|---|--|-----|------|------|-----|
|               |    |           |   | Min  | Typ | Max  |      |     |
| $f_{FXOSC}$   | SR | —         | Fast external crystal oscillator frequency        | —  | —   | —    | —    |     |
| $g_{mFXOSC}$  | CC | C         | Fast external crystal oscillator transconductance | $V_{DD} = 3.3\text{ V} \pm 10\%$ ,<br>PAD3V5V = 1<br>OSCILLATOR_MARGIN = 0 | 2.2 | —    | 8.2  | mAV |
|               | CC | P         |   | $V_{DD} = 5.0\text{ V} \pm 10\%$ ,<br>PAD3V5V = 0<br>OSCILLATOR_MARGIN = 0 | 2.0 | —    | 7.4  |     |
|               | CC | C         |   | $V_{DD} = 3.3\text{ V} \pm 10\%$ ,<br>PAD3V5V = 1<br>OSCILLATOR_MARGIN = 1 | 2.7 | —    | 9.7  |     |
|               | CC | C         |   | $V_{DD} = 5.0\text{ V} \pm 10\%$ ,<br>PAD3V5V = 0<br>OSCILLATOR_MARGIN = 1 | 2.5 | —    | 9.2  |     |
| $V_{FXOSC}$   | CC | T         | Oscillation amplitude at EXTAL                    | $f_{OSC} = 4\text{ MHz}$ ,<br>OSCILLATOR_MARGIN = 0                        | 1.3 | —    | —    | V   |
|               |    |           |   | $f_{OSC} = 16\text{ MHz}$ ,<br>OSCILLATOR_MARGIN = 1                       | 1.3 | —    | —    |     |
| $V_{FXOSCO}$  | CC | C         | Oscillation operating point                       | —  | —   | 0.95 | —    | V   |
| $I_{FXOSC}^2$ | CC | T         | Fast external crystal oscillator consumption      | —  | —   | 2    | 3    | mA  |

**Table 37. Fast external crystal oscillator (4 to 16 MHz) electrical characteristics (continued)**

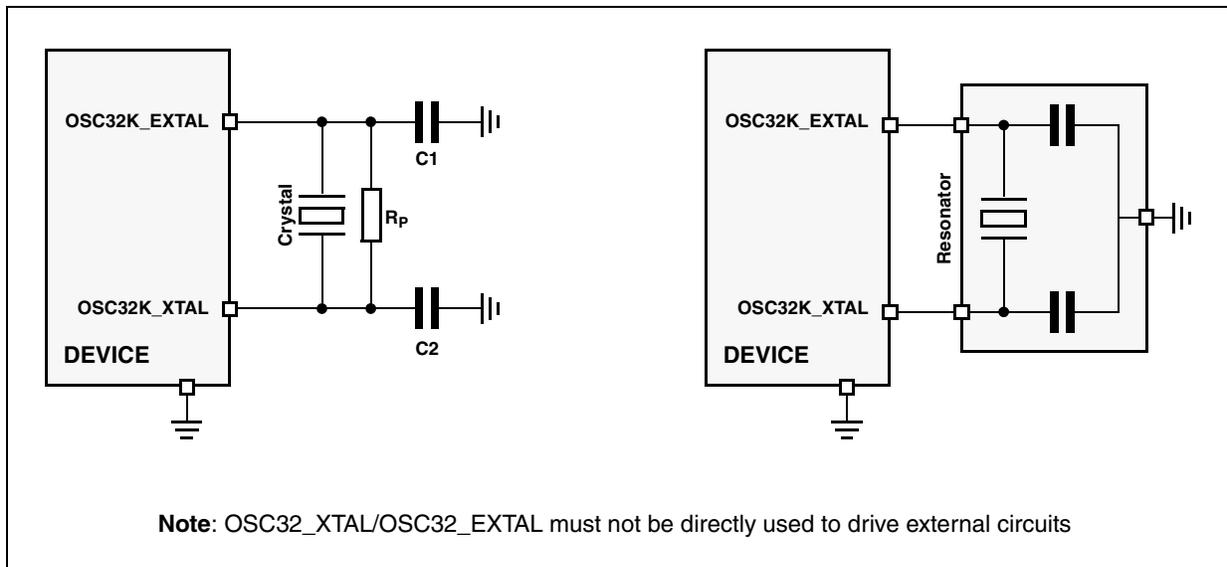
| Symbol               | C  | Parameter                                      | Conditions <sup>1</sup>                          | Value               |     |                       | Unit |
|----------------------|----|--|--|---------------------|-----|-----------------------|------|
|                      |    |  |  | Min                 | Typ | Max                   |      |
| t <sub>FXOSCSU</sub> | CC | Fast external crystal oscillator start-up time | f <sub>OSC</sub> = 4 MHz, OSCILLATOR_MARGIN = 0  | —                   | —   | 6                     | ms   |
|                      |    |  | f <sub>OSC</sub> = 16 MHz, OSCILLATOR_MARGIN = 1 | —                   | —   | 1.8                   |      |
| V <sub>IH</sub>      | SR | Input high level CMOS (Schmitt Trigger)        | Oscillator bypass mode                           | 0.65V <sub>DD</sub> | —   | V <sub>DD</sub> + 0.4 | V    |
| V <sub>IL</sub>      | SR | Input low level CMOS (Schmitt Trigger)         | Oscillator bypass mode                           | -0.4                | —   | 0.35V <sub>DD</sub>   | V    |

<sup>1</sup> V<sub>DD</sub> = 3.3 V ± 10% / 5.0 V ± 10%, T<sub>A</sub> = -40 to 125 °C, unless otherwise specified.

<sup>2</sup> Stated values take into account only analog module consumption but not the digital contributor (clock tree and enabled peripherals).

## 4.12 Slow external crystal oscillator (32 kHz) electrical characteristics

The device provides a low power oscillator/resonator driver.



**Figure 13. Crystal oscillator and resonator connection scheme**

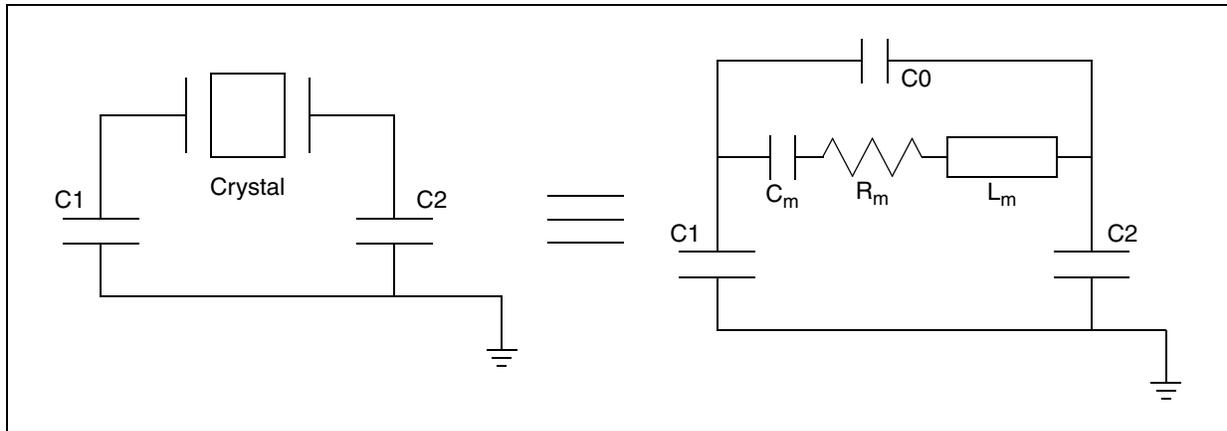


Figure 14. Equivalent circuit of a quartz crystal

Table 38. Crystal motional characteristics<sup>1</sup>

| Symbol             | Parameter  | Conditions                              | Value |        |     | Unit       |
|--------------------|--|---|-------|--------|-----|------------|
|                    |  |   | Min   | Typ    | Max |            |
| $L_m$              | Motional inductance  | —                                       | —     | 11.796 | —   | KH         |
| $C_m$              | Motional capacitance   | —                                       | —     | 2      | —   | fF         |
| C1/C2              | Load capacitance at OSC32K_XTAL and OSC32K_EXTAL with respect to ground <sup>2</sup> | —                                       | 18    | —      | 28  | pF         |
| $R_m$ <sup>3</sup> | Motional resistance  | AC coupled at $C_0 = 2.85 \text{ pF}^4$ | —     | —      | 65  | k $\Omega$ |
|                    |  | AC coupled at $C_0 = 4.9 \text{ pF}^4$  | —     | —      | 50  |            |
|                    |  | AC coupled at $C_0 = 7.0 \text{ pF}^4$  | —     | —      | 35  |            |
|                    |  | AC coupled at $C_0 = 9.0 \text{ pF}^4$  | —     | —      | 30  |            |

<sup>1</sup> The crystal used is Epson Toyocom MC306.

<sup>2</sup> 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.

<sup>3</sup> Maximum ESR ( $R_m$ ) of the crystal is 50 k $\Omega$

<sup>4</sup>  $C_0$  Includes a parasitic capacitance of 2.0 pF between OSC32K\_XTAL and OSC32K\_EXTAL pins.

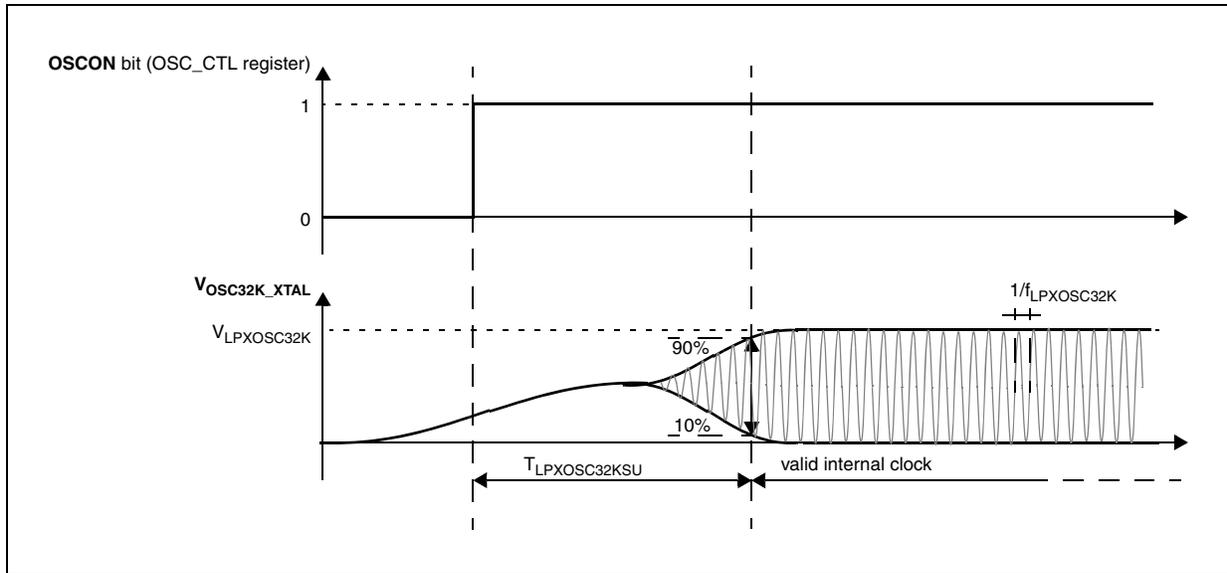


Figure 15. Slow external crystal oscillator (32 kHz) timing diagram

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

| Symbol                 | C  | Parameter | Conditions <sup>1</sup>                        | Value |        |                | Unit |
|------------------------|----|-----------|--|-------|--------|----------------|------|
|                        |    |           |  | Min   | Typ    | Max            |      |
| f <sub>SXOSC</sub>     | SR | —         | Slow external crystal oscillator frequency     | 32    | 32.768 | 40             | kHz  |
| V <sub>SXOSC</sub>     | CC | T         | Oscillation amplitude                          | —     | 2.1    | —              | V    |
| I <sub>SXOSCBIAS</sub> | CC | T         | Oscillation bias current                       | —     | 2.5    |                | μA   |
| I <sub>SXOSC</sub>     | CC | T         | Slow external crystal oscillator consumption   | —     | —      | 8              | μA   |
| t <sub>SXOSCSU</sub>   | CC | T         | Slow external crystal oscillator start-up time | —     | —      | 2 <sup>2</sup> | s    |

<sup>1</sup> V<sub>DD</sub> = 3.3 V ± 10% / 5.0 V ± 10%, T<sub>A</sub> = -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.

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

### 4.13 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.

Table 40. FMPLL electrical characteristics

| Symbol             | C  | Parameter | Conditions <sup>1</sup>            | Value |     |     | Unit |
|--------------------|----|-----------|------------------------------------|-------|-----|-----|------|
|                    |    |           |                                    | Min   | Typ | Max |      |
| f <sub>PLLIN</sub> | SR | —         | FMPLL reference clock <sup>2</sup> | 4     | —   | 64  | MHz  |

Table 40. FMPLL electrical characteristics (continued)

| Symbol                 | C  | Parameter | Conditions <sup>1</sup>                       | Value                                     |     |     | Unit |         |
|------------------------|----|-----------|---|---|-----|-----|------|---------|
|                        |    |           |   | Min                                       | Typ | Max |      |         |
| $\Delta_{PLLIN}$       | SR | —         | FMPLL reference clock duty cycle <sup>2</sup> | —   | —   | —   | %    |         |
| $f_{PULLOUT}$          | CC | P         | FMPLL output clock frequency                  | —   | —   | —   | MHz  |         |
| $f_{VCO}$ <sup>3</sup> | CC | P         | VCO frequency without frequency modulation    | —   | —   | —   | MHz  |         |
|                        |    | P         | VCO frequency with frequency modulation       | —   | —   | —   |      |         |
| $f_{CPU}$              | SR | —         | System clock frequency                        | —   | —   | —   | MHz  |         |
| $f_{FREE}$             | CC | P         | Free-running frequency                        | —   | —   | —   | MHz  |         |
| $t_{LOCK}$             | CC | P         | FMPLL lock time                               | Stable oscillator ( $f_{PLLIN} = 16$ MHz) |     |     | —    | $\mu$ s |
| $\Delta t_{STJIT}$     | CC | —         | FMPLL short term jitter <sup>4</sup>          | $f_{sys}$ maximum                         |     |     | —    | %       |
| $\Delta t_{LTJIT}$     | CC | —         | FMPLL long term jitter                        | $f_{PLLCLK}$ at 64 MHz, 4000 cycles       |     |     | —    | ns      |
| $I_{PLL}$              | CC | C         | FMPLL consumption                             | $T_A = 25$ °C                             |     |     | —    | mA      |

<sup>1</sup>  $V_{DD} = 3.3$  V  $\pm$  10% / 5.0 V  $\pm$  10%,  $T_A = -40$  to 125 °C, unless otherwise specified

<sup>2</sup> PLLIN clock retrieved directly from FXOSC clock. Input characteristics are granted when oscillator is used in functional mode. When bypass mode is used, oscillator input clock should verify  $f_{PLLIN}$  and  $\Delta_{PLLIN}$ .

<sup>3</sup> Frequency modulation is considered  $\pm$  4%.

<sup>4</sup> Short term jitter is measured on the clock rising edge at cycle n and n+4.

## 4.14 Fast internal RC oscillator (16 MHz) electrical characteristics

The device provides a 16 MHz main internal RC oscillator. This is used as the default clock at the power-up of the device.

Table 41. Fast internal RC oscillator (16 MHz) electrical characteristics

| Symbol                      | C  | Parameter                                  | Conditions <sup>1</sup>   | Value                  |     |     | Unit    |
|-----------------------------|----|--|---|------------------------|-----|-----|---------|
|                             |    |  |   | Min                    | Typ | Max |         |
| $f_{FIRC}$                  | CC | Fast internal RC oscillator high frequency | $T_A = 25$ °C, trimmed  | —                      | 16  | —   | MHz     |
|                             | SR |  |   | —                      | —   | 20  |         |
| $I_{FIRC RUN}$ <sup>2</sup> | CC | T  | Fast internal RC oscillator high frequency current in running mode    | $T_A = 25$ °C, trimmed |     |     | $\mu$ A |
| $I_{FIRC PWD}$              | CC | D  | Fast internal RC oscillator high frequency current in power down mode | $T_A = 25$ °C          |     |     | $\mu$ A |

Table 41. Fast internal RC oscillator (16 MHz) electrical characteristics (continued)

| Symbol                 | C  | Parameter | Conditions <sup>1</sup>   | Value                         |                 |     | Unit |    |    |
|------------------------|----|-----------|---|-------------------------------|-----------------|-----|------|----|----|
|                        |    |           |   | Min                           | Typ             | Max |      |    |    |
| I <sub>FIRCSTOP</sub>  | CC | T         | Fast internal RC oscillator high frequency and system clock current in stop mode  | T <sub>A</sub> = 25 °C        | sysclk = off    | —   | 500  | —  | μA |
|                        |    |           |   |                               | sysclk = 2 MHz  | —   | 600  | —  |    |
|                        |    |           |   |                               | sysclk = 4 MHz  | —   | 700  | —  |    |
|                        |    |           |   |                               | sysclk = 8 MHz  | —   | 900  | —  |    |
|                        |    |           |   |                               | sysclk = 16 MHz | —   | 1250 | —  |    |
| t <sub>FIRCSU</sub>    | CC | C         | Fast internal RC oscillator start-up time   | V <sub>DD</sub> = 5.0 V ± 10% | —               | 1.1 | 2.0  | μs |    |
| Δ <sub>FIRC</sub> PRE  | CC | C         | Fast internal RC oscillator precision after software trimming of f <sub>FIRC</sub>  | T <sub>A</sub> = 25 °C        | -1              | —   | 1    | %  |    |
| Δ <sub>FIRC</sub> TRIM | CC | C         | Fast internal RC oscillator trimming step   | T <sub>A</sub> = 25 °C        | —               | 1.6 | —    | %  |    |
| Δ <sub>FIRC</sub> VAR  | CC | C         | Fast internal RC oscillator variation over temperature and supply with respect to f <sub>FIRC</sub> at T <sub>A</sub> = 25 °C in high-frequency configuration | —                             | -5              | —   | 5    | %  |    |

<sup>1</sup> V<sub>DD</sub> = 3.3 V ± 10% / 5.0 V ± 10%, T<sub>A</sub> = -40 to 125 °C, unless otherwise specified

<sup>2</sup> This does not include consumption linked to clock tree toggling and peripherals consumption when RC oscillator is ON.

## 4.15 Slow internal RC oscillator (128 kHz) electrical characteristics

The device provides a 128 kHz low power internal RC oscillator. This can be used as the reference clock for the RTC module.

Table 42. Slow internal RC oscillator (128 kHz) electrical characteristics

| Symbol                         | C  | Parameter | Conditions <sup>1</sup>  | Value   |     |     | Unit |     |
|--------------------------------|----|-----------|--|---|-----|-----|------|-----|
|                                |    |           |  | Min   | Typ | Max |      |     |
| f <sub>SIRC</sub>              | CC | P         | Slow internal RC oscillator low frequency  | T <sub>A</sub> = 25 °C, trimmed                       | —   | 128 | —    | kHz |
|                                | SR |           |  |   | —   | 100 | —    |     |
| I <sub>SIRC</sub> <sup>2</sup> | CC | C         | Slow internal RC oscillator low frequency current                                  | T <sub>A</sub> = 25 °C, trimmed                       | —   | —   | 5    | μA  |
| t <sub>SIRCSU</sub>            | CC | P         | Slow internal RC oscillator start-up time  | T <sub>A</sub> = 25 °C, V <sub>DD</sub> = 5.0 V ± 10% | —   | 8   | 12   | μs  |
| Δ <sub>SIRC</sub> PRE          | CC | C         | Slow internal RC oscillator precision after software trimming of f <sub>SIRC</sub> | T <sub>A</sub> = 25 °C                                | -2  | —   | 2    | %   |
| Δ <sub>SIRC</sub> TRIM         | CC | C         | Slow internal RC oscillator trimming step  | —   | —   | 2.7 | —    |     |

Table 42. Slow internal RC oscillator (128 kHz) electrical characteristics (continued)

| Symbol                    | C  | Parameter | Conditions <sup>1</sup>   | Value                        |     |     | Unit |   |
|---------------------------|----|-----------|---|------------------------------|-----|-----|------|---|
|                           |    |           |   | Min                          | Typ | Max |      |   |
| $\Delta_{\text{SIRCVAR}}$ | CC | C         | Slow internal RC oscillator variation in temperature and supply with respect to $f_{\text{SIRC}}$ at $T_A = 55\text{ °C}$ in high frequency configuration | High frequency configuration | -10 | —   | 10   | % |

<sup>1</sup>  $V_{\text{DD}} = 3.3\text{ V} \pm 10\% / 5.0\text{ V} \pm 10\%$ ,  $T_A = -40$  to  $125\text{ °C}$ , unless otherwise specified

<sup>2</sup> This does not include consumption linked to clock tree toggling and peripherals consumption when RC oscillator is ON.

## 4.16 ADC electrical characteristics

### 4.16.1 Introduction

The device provides two Successive Approximation Register (SAR) analog-to-digital converters (10-bit and 12-bit).

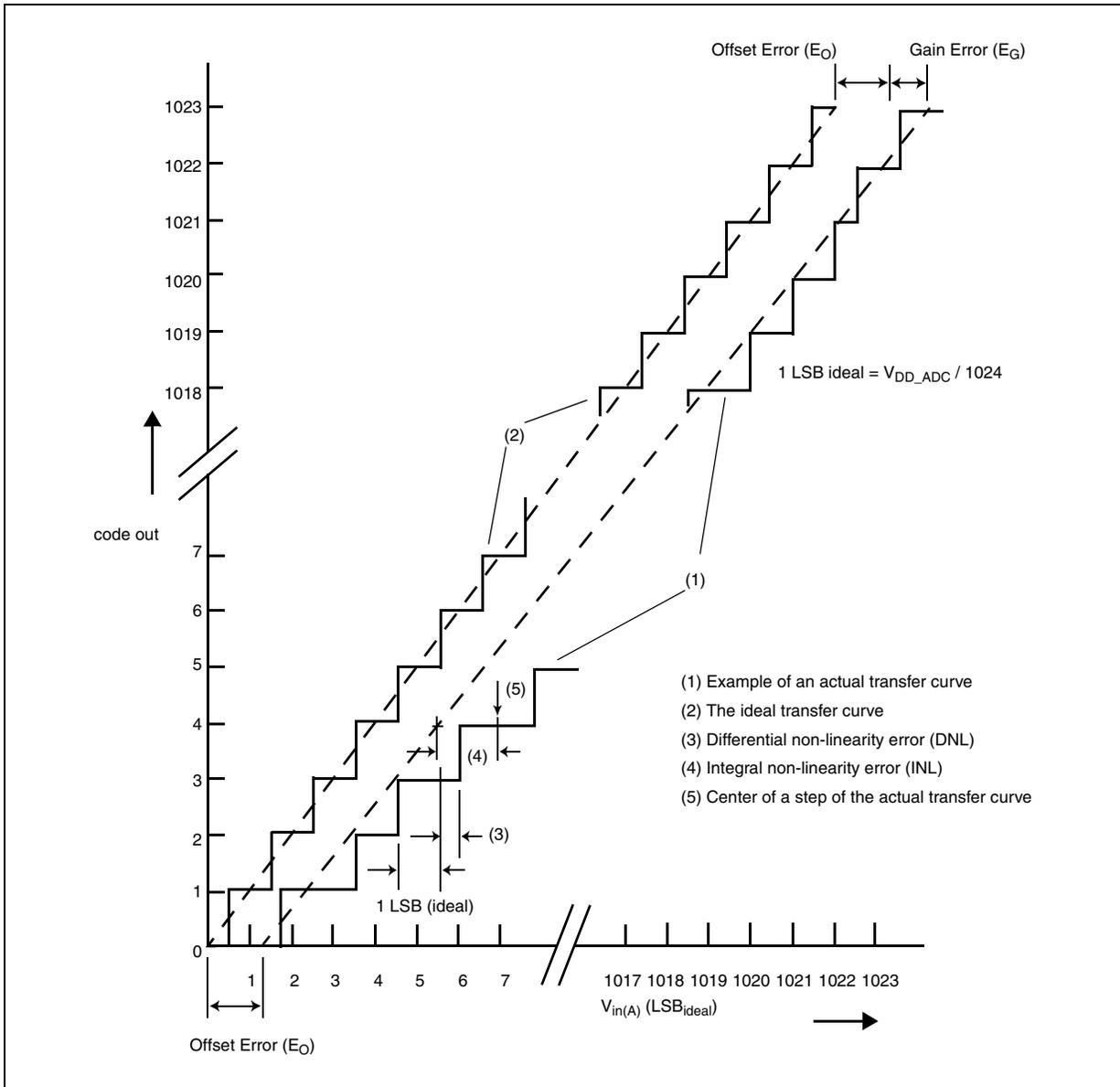


Figure 16. ADC\_0 characteristic and error definitions

### 4.16.2 Input impedance and ADC accuracy

In the following analysis, the input circuit corresponding to the precise channels is considered.

To preserve the accuracy of the A/D converter, it is necessary that analog input pins have low AC impedance. Placing a capacitor with good high frequency characteristics at the input pin of the device can 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 k $\Omega$  is obtained ( $R_{EQ} = 1 / (f_c \times (C_S + C_{P2}))$ ), 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

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

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

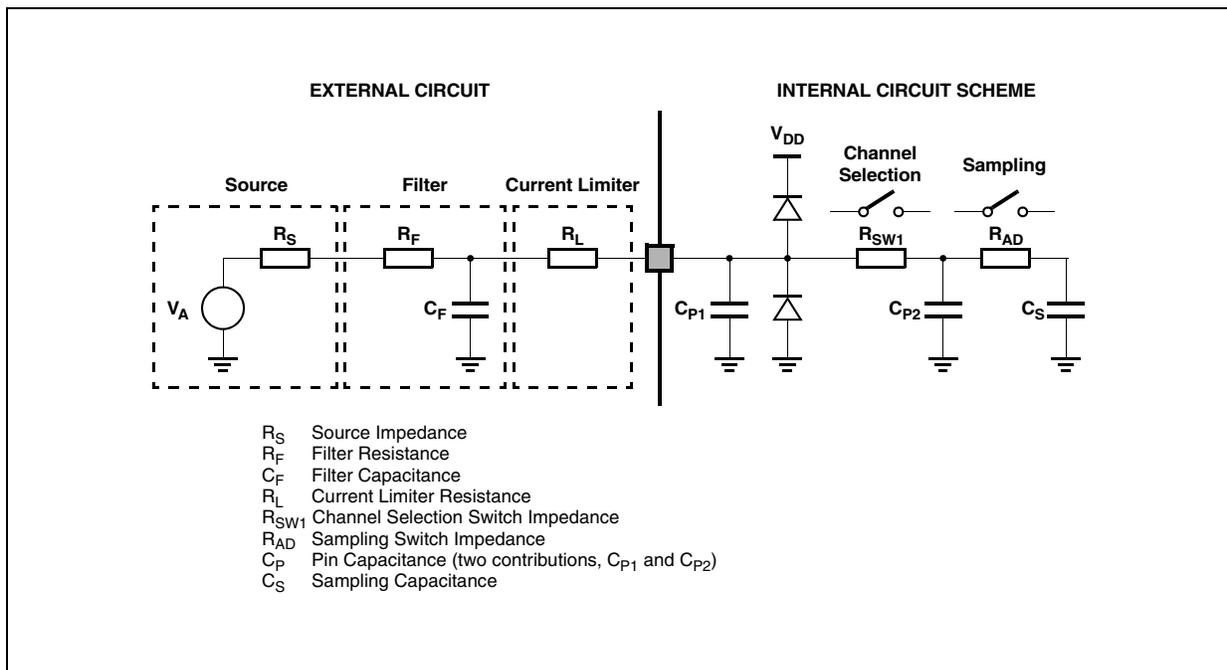


Figure 17. Input equivalent circuit (precise channels)

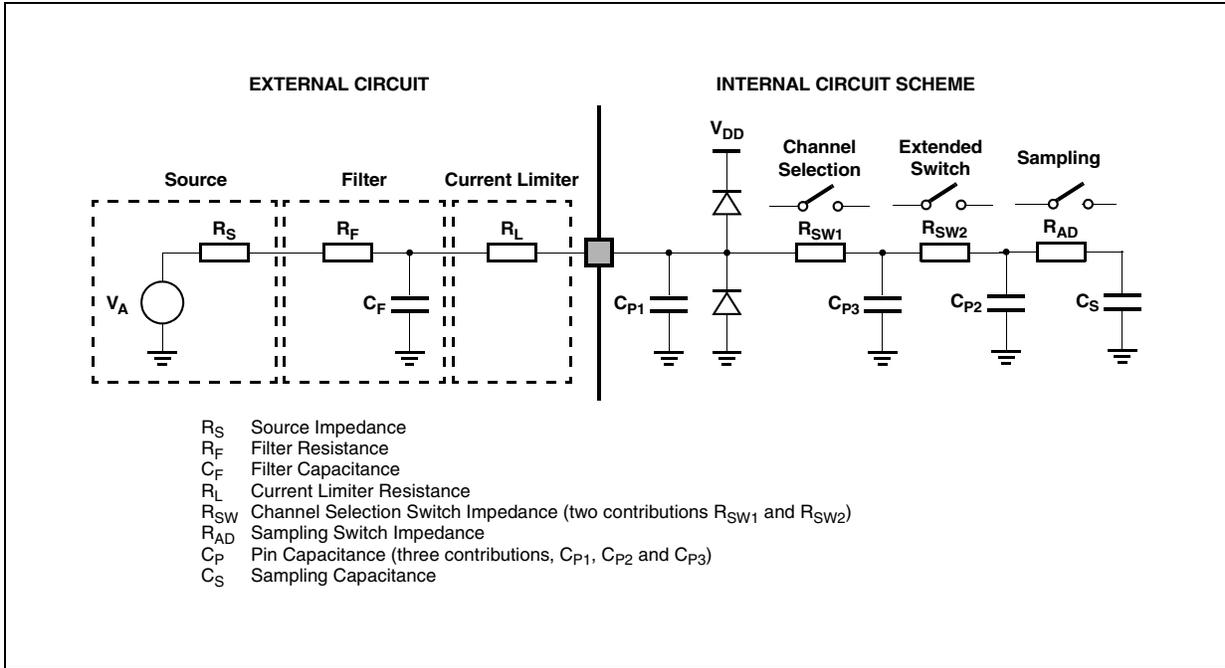


Figure 18. Input equivalent circuit (extended channels)

A second aspect involving the capacitance network shall be considered. Assuming the three capacitances  $C_F$ ,  $C_{P1}$  and  $C_{P2}$  are initially charged at the source voltage  $V_A$  (refer to the equivalent circuit reported in Figure 17): A charge sharing phenomenon is installed when the sampling phase is started (A/D switch close).

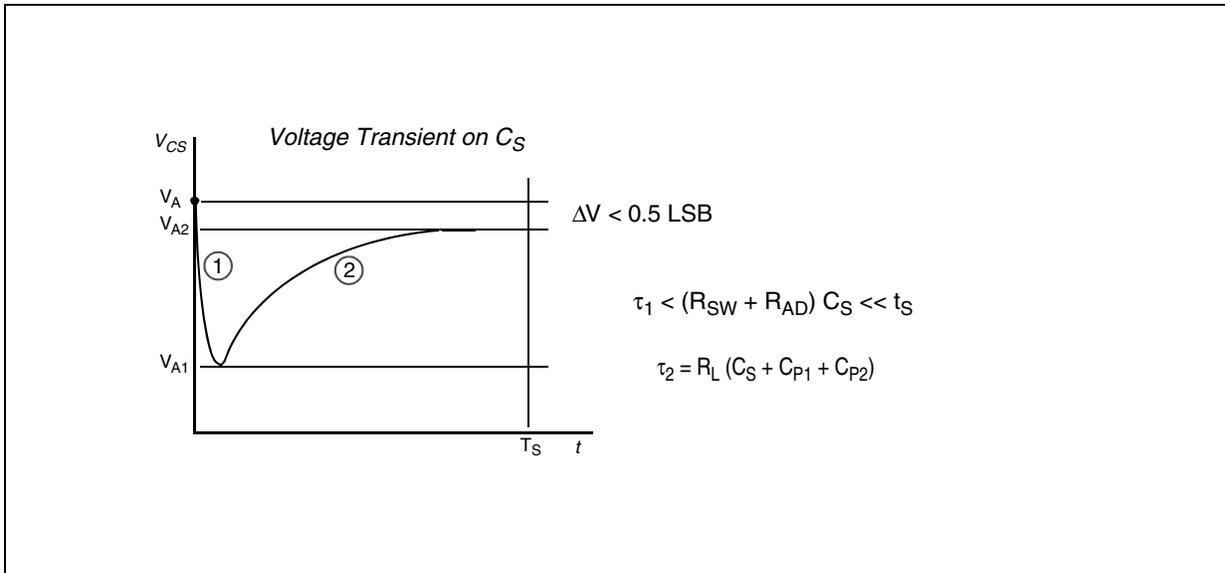


Figure 19. Transient behavior during sampling phase

In particular two different transient periods can be distinguished:

1. A first and quick charge transfer from the internal capacitance  $C_{P1}$  and  $C_{P2}$  to the sampling capacitance  $C_S$  occurs ( $C_S$  is supposed initially completely discharged): considering a worst case (since the time constant in reality would be faster) in which  $C_{P2}$  is reported in parallel to  $C_{P1}$  (call  $C_P = C_{P1} + C_{P2}$ ), the two capacitances  $C_P$  and  $C_S$  are in series, and the time constant is

$$\tau_1 = (R_{SW} + R_{AD}) \cdot \frac{C_P \cdot C_S}{C_P + C_S}$$

**Eqn. 5**

Equation 5 can again be simplified considering only  $C_S$  as an additional worst condition. In reality, the transient is faster, but the A/D converter circuitry has been designed to be robust also in the very worst case: the sampling time  $t_s$  is always much longer than the internal time constant:

$$\tau_1 < (R_{SW} + R_{AD}) \cdot C_S \ll t_s$$

**Eqn. 6**

The charge of  $C_{P1}$  and  $C_{P2}$  is redistributed also on  $C_S$ , determining a new value of the voltage  $V_{A1}$  on the capacitance according to Equation 7:

$$V_{A1} \cdot (C_S + C_{P1} + C_{P2}) = V_A \cdot (C_{P1} + C_{P2})$$

**Eqn. 7**

2. A second charge transfer involves also  $C_F$  (that is typically bigger than the on-chip capacitance) through the resistance  $R_L$ : again considering the worst case in which  $C_{P2}$  and  $C_S$  were in parallel to  $C_{P1}$  (since the time constant in reality would be faster), the time constant is:

$$\tau_2 < R_L \cdot (C_S + C_{P1} + C_{P2})$$

**Eqn. 8**

In this case, the time constant depends on the external circuit: in particular imposing that the transient is completed well before the end of sampling time  $t_s$ , a constraints on  $R_L$  sizing is obtained:

**ADC\_0 (10-bit)**

$$8.5 \cdot \tau_2 = 8.5 \cdot R_L \cdot (C_S + C_{P1} + C_{P2}) < t_s$$

**Eqn. 9**

**ADC\_1 (12-bit)**

$$10 \cdot \tau_2 = 10 \cdot R_L \cdot (C_S + C_{P1} + C_{P2}) < t_s$$

**Eqn. 10**

Of course,  $R_L$  shall be sized also according to the current limitation constraints, in combination with  $R_S$  (source impedance) and  $R_F$  (filter resistance). Being  $C_F$  definitively bigger than  $C_{P1}$ ,  $C_{P2}$  and  $C_S$ , then the final voltage  $V_{A2}$  (at the end of the charge transfer transient) will be much higher than  $V_{A1}$ . Equation 11 must be respected (charge balance assuming now  $C_S$  already charged at  $V_{A1}$ ):

$$V_{A2} \cdot (C_S + C_{P1} + C_{P2} + C_F) = V_A \cdot C_F + V_{A1} \cdot (C_{P1} + C_{P2} + C_S)$$

The two transients above are not influenced by the voltage source that, due to the presence of the  $R_F C_F$  filter, is not able to provide the extra charge to compensate the voltage drop on  $C_S$  with respect to the ideal source  $V_A$ ; the time constant  $R_F C_F$  of the filter is very high with respect to the sampling time ( $t_s$ ). The filter is typically designed to act as antialiasing.

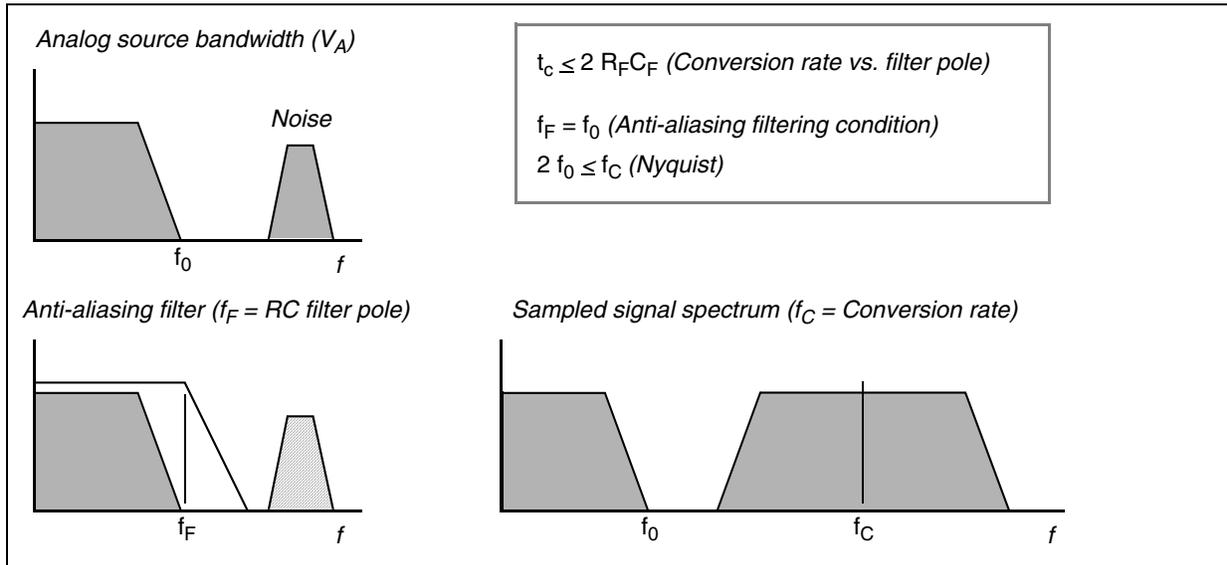


Figure 20. Spectral representation of input signal

Calling  $f_0$  the bandwidth of the source signal (and as a consequence the cut-off frequency of the antialiasing filter,  $f_F$ ), according to the Nyquist theorem the conversion rate  $f_C$  must be at least  $2f_0$ ; it means that the constant time of the filter is greater than or at least equal to twice the conversion period ( $t_c$ ). Again the conversion period  $t_c$  is longer than the sampling time  $t_s$ , which is just a portion of it, even when fixed channel continuous conversion mode is selected (fastest conversion rate at a specific channel): in conclusion it is evident that the time constant of the filter  $R_F C_F$  is definitively much higher than the sampling time  $t_s$ , so the charge level on  $C_S$  cannot be modified by the analog signal source during the time in which the sampling switch is closed.

The considerations above lead to impose new constraints on the external circuit, to reduce the accuracy error due to the voltage drop on  $C_S$ ; from the two charge balance equations above, it is simple to derive [Equation 12](#) between the ideal and real sampled voltage on  $C_S$ :

$$\frac{V_{A2}}{V_A} = \frac{C_{P1} + C_{P2} + C_F}{C_{P1} + C_{P2} + C_F + C_S}$$

From this formula, in the worst case (when  $V_A$  is maximum, that is for instance 5 V), assuming to accept a maximum error of half a count, a constraint is evident on  $C_F$  value:

## ADC\_0 (10-bit)

Eqn. 13

$$C_F > 2048 \cdot C_S$$

## ADC\_1 (12-bit)

Eqn. 14

$$C_F > 8192 \cdot C_S$$

## 4.16.3 ADC electrical characteristics

Table 43. ADC input leakage current

| Symbol           | C  | Parameter | Conditions            | Value                   |                                      |     | Unit |     |    |
|------------------|----|-----------|-----------------------|-------------------------|--------------------------------------|-----|------|-----|----|
|                  |    |           |                       | Min                     | Typ                                  | Max |      |     |    |
| I <sub>LKG</sub> | CC | D         | Input leakage current | T <sub>A</sub> = -40 °C | No current injection on adjacent pin | —   | 1    | 70  | nA |
|                  |    |           |                       | T <sub>A</sub> = 25 °C  |                                      | —   | 1    | 70  |    |
|                  |    |           |                       | T <sub>A</sub> = 85 °C  |                                      | —   | 3    | 100 |    |
|                  |    |           |                       | T <sub>A</sub> = 105 °C |                                      | —   | 8    | 200 |    |
|                  |    |           |                       | T <sub>A</sub> = 125 °C |                                      | —   | 45   | 400 |    |

Table 44. ADC\_0 conversion characteristics (10-bit ADC\_0)

| Symbol                | C  | Parameter | Conditions <sup>1</sup>   | Value                                      |     |                            | Unit |
|-----------------------|----|-----------|---|--|-----|----------------------------|------|
|                       |    |           |   | Min  | Typ | Max                        |      |
| V <sub>SS_ADC0</sub>  | SR | —         | Voltage on VSS_HV_ADC0 (ADC_0 reference) pin with respect to ground (V <sub>SS</sub> ) <sup>2</sup> | —  | —   | 0.1                        | V    |
| V <sub>DD_ADC0</sub>  | SR | —         | Voltage on VDD_HV_ADC pin (ADC reference) with respect to ground (V <sub>SS</sub> )                 | —  | —   | V <sub>DD</sub> + 0.1      | V    |
| V <sub>AINx</sub>     | SR | —         | Analog input voltage <sup>3</sup>   | —  | —   | V <sub>DD_ADC0</sub> + 0.1 | V    |
| I <sub>ADC0pwd</sub>  | SR | —         | ADC_0 consumption in power down mode  | —  | —   | 50                         | μA   |
| I <sub>ADC0run</sub>  | SR | —         | ADC_0 consumption in running mode   | —  | —   | 5                          | mA   |
| f <sub>ADC0</sub>     | SR | —         | ADC_0 analog frequency  | —  | —   | 32 + 4%                    | MHz  |
| Δ <sub>ADC0_SYS</sub> | SR | —         | ADC_0 digital clock duty cycle (ipg_clk)  | ADCLKSEL = 1 <sup>4</sup>                  | —   | 55                         | %    |
| t <sub>ADC0_PU</sub>  | SR | —         | ADC_0 power up delay  | —  | —   | 1.5                        | μs   |
| t <sub>ADC0_S</sub>   | CC | T         | Sampling time <sup>5</sup>  | f <sub>ADC</sub> = 32 MHz,<br>INPSAMP = 17 | —   | —                          | μs   |
|                       |    |           |   | f <sub>ADC</sub> = 6 MHz,<br>INPSAMP = 255 | —   | —                          |      |

Table 44. ADC\_0 conversion characteristics (10-bit ADC\_0) (continued)

| Symbol        | C  | Parameter | Conditions <sup>1</sup>   | Value  |                                   |     | Unit |               |    |
|---------------|----|-----------|---|--|-----------------------------------|-----|------|---------------|----|
|               |    |           |   | Min  | Typ                               | Max |      |               |    |
| $t_{ADC0\_C}$ | CC | P         | Conversion time <sup>6</sup>  | $f_{ADC} = 32 \text{ MHz}$ ,<br>$INPCMP = 2$                           | 0.625                             | —   | —    | $\mu\text{s}$ |    |
| $C_S$         | CC | D         | ADC_0 input sampling capacitance  | —  | —                                 | —   | 3    | pF            |    |
| $C_{P1}$      | CC | D         | ADC_0 input pin capacitance 1   | —  | —                                 | —   | 3    | pF            |    |
| $C_{P2}$      | CC | D         | ADC_0 input pin capacitance 2   | —  | —                                 | —   | 1    | pF            |    |
| $C_{P3}$      | CC | D         | ADC_0 input pin capacitance 3   | —  | —                                 | —   | 1    | pF            |    |
| $R_{SW1}$     | CC | D         | Internal resistance of analog source                                      | —  | —                                 | —   | 3    | k $\Omega$    |    |
| $R_{SW2}$     | CC | D         | Internal resistance of analog source                                      | —  | —                                 | —   | 2    | k $\Omega$    |    |
| $R_{AD}$      | CC | D         | Internal resistance of analog source                                      | —  | —                                 | —   | 2    | k $\Omega$    |    |
| $I_{INJ}$     | SR | —         | Input current Injection   | Current injection on one ADC_0 input, different from the converted one | $V_{DD} = 3.3 \text{ V} \pm 10\%$ | —5  | —    | 5             | mA |
|               |    |           |   |  | $V_{DD} = 5.0 \text{ V} \pm 10\%$ | —5  | —    | 5             |    |
| $ INL $       | CC | T         | Absolute integral nonlinearity  | No overload  | —                                 | 0.5 | 1.5  | LSB           |    |
| $ DNL $       | CC | T         | Absolute differential nonlinearity  | No overload  | —                                 | 0.5 | 1.0  | LSB           |    |
| $ E_O $       | CC | T         | Absolute offset error   | —  | —                                 | 0.5 | —    | LSB           |    |
| $ E_G $       | CC | T         | Absolute gain error   | —  | —                                 | 0.6 | —    | LSB           |    |
| TUEP          | CC | P         | Total unadjusted error <sup>7</sup> for precise channels, input only pins | Without current injection  | —2                                | 0.6 | 2    | LSB           |    |
|               |    |           |   | With current injection   | —3                                | —   | 3    |               |    |
| TUEX          | CC | T         | Total unadjusted error <sup>7</sup> for extended channel                  | Without current injection  | —3                                | 1   | 3    | LSB           |    |
|               |    |           |   | With current injection   | —4                                | —   | 4    |               |    |

<sup>1</sup>  $V_{DD} = 3.3 \text{ V} \pm 10\% / 5.0 \text{ V} \pm 10\%$ ,  $T_A = -40$  to  $125 \text{ }^\circ\text{C}$ , unless otherwise specified.

<sup>2</sup> Analog and digital  $V_{SS}$  **must** be common (to be tied together externally).

<sup>3</sup>  $V_{AINx}$  may exceed  $V_{SS\_ADC0}$  and  $V_{DD\_ADC0}$  limits, remaining on absolute maximum ratings, but the results of the conversion will be clamped respectively to 0x000 or 0x3FF.

<sup>4</sup> Duty cycle is ensured by using system clock without prescaling. When  $ADCLKSEL = 0$ , the duty cycle is ensured by internal divider by 2.

<sup>5</sup> During the sampling time the input capacitance  $C_S$  can be charged/discharged by the external source. The internal resistance of the analog source must allow the capacitance to reach its final voltage level within  $t_{ADC0\_S}$ . After the end of the sampling time  $t_{ADC0\_S}$ , changes of the analog input voltage have no effect on the conversion result. Values for the sampling clock  $t_{ADC0\_S}$  depend on programming.

<sup>6</sup> This parameter does not include the sampling time  $t_{ADC0\_S}$ , but only the time for determining the digital result and the time to load the result's register with the conversion result.

<sup>7</sup> Total Unadjusted Error: The maximum error that occurs without adjusting Offset and Gain errors. This error is a combination of Offset, Gain and Integral Linearity errors.

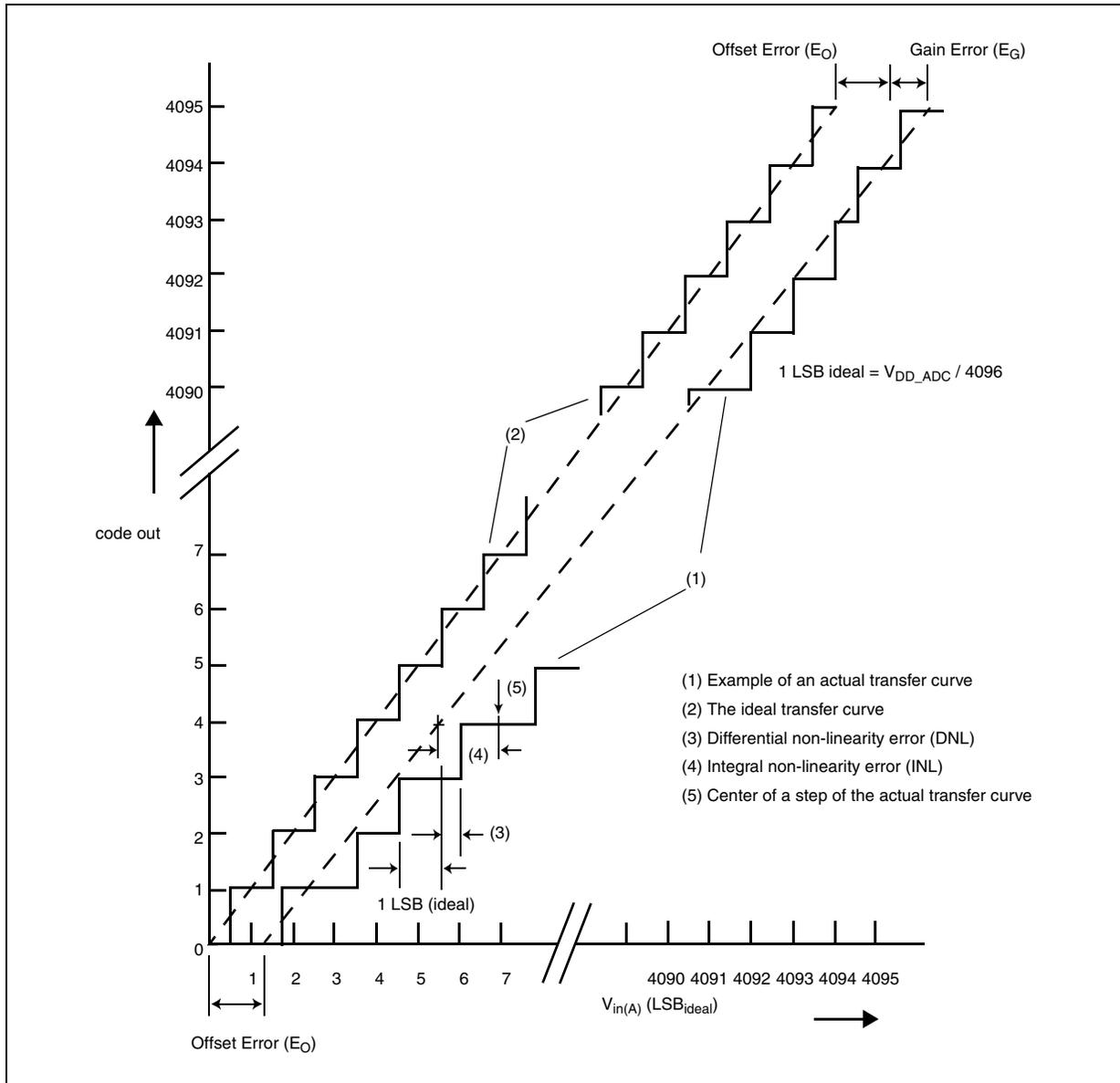


Figure 21. ADC\_1 characteristic and error definitions

Table 45. ADC\_1 conversion characteristics (12-bit ADC\_1)

| Symbol         | C  | Parameter | Conditions <sup>1</sup> | Value          |     |                | Unit |
|----------------|----|-----------|-------------------------|----------------|-----|----------------|------|
|                |    |           |                         | Min            | Typ | Max            |      |
| $V_{SS\_ADC1}$ | SR | —         | —                       | -0.1           | —   | 0.1            | V    |
| $V_{DD\_ADC1}$ | SR | —         | —                       | $V_{DD} - 0.1$ | —   | $V_{DD} + 0.1$ | V    |

Table 45. ADC\_1 conversion characteristics (12-bit ADC\_1) (continued)

| Symbol                | C  | Parameter | Conditions <sup>1</sup>                                 | Value  |      |     | Unit    |     |
|-----------------------|----|-----------|---|--|------|-----|---------|-----|
|                       |    |           |   | Min  | Typ  | Max |         |     |
| V <sub>AINx</sub>     | SR | —         | Analog input voltage <sup>3</sup>                       | —  | —    | —   | V       |     |
| I <sub>ADC1pwd</sub>  | SR | —         | ADC_1 consumption in power down mode                    | —  | —    | 50  | μA      |     |
| I <sub>ADC1run</sub>  | SR | —         | ADC_1 consumption in running mode                       | —  | —    | 6   | mA      |     |
| f <sub>ADC1</sub>     | SR | —         | ADC_1 analog frequency                                  | V <sub>DD</sub> = 3.3 V                        | 3.33 | —   | 20 + 4% | MHz |
|                       |    |           |   | V <sub>DD</sub> = 5 V                          | 3.33 | —   | 32 + 4% |     |
| t <sub>ADC1_PU</sub>  | SR | —         | ADC_1 power up delay                                    | —  | —    | 1.5 | μs      |     |
| t <sub>ADC1_S</sub>   | CC | T         | Sampling time <sup>4</sup><br>V <sub>DD</sub> = 3.3 V   | f <sub>ADC1</sub> = 20 MHz,<br>INPSAMP = 12    | 600  | —   | —       | ns  |
|                       |    |           | Sampling time <sup>4</sup><br>V <sub>DD</sub> = 5.0 V   | f <sub>ADC1</sub> = 32 MHz,<br>INPSAMP = 17    | 500  | —   | —       |     |
|                       |    |           | Sampling time <sup>4</sup><br>V <sub>DD</sub> = 3.3 V   | f <sub>ADC1</sub> = 3.33 MHz,<br>INPSAMP = 255 | —    | —   | 76.2    | μs  |
|                       |    |           | Sampling time <sup>4</sup><br>V <sub>DD</sub> = 5.0 V   | f <sub>ADC1</sub> = 3.33 MHz,<br>INPSAMP = 255 | —    | —   | 76.2    |     |
| t <sub>ADC1_C</sub>   | CC | P         | Conversion time <sup>5</sup><br>V <sub>DD</sub> = 3.3 V | f <sub>ADC1</sub> = 20 MHz,<br>INPCMP = 0      | 2.4  | —   | —       | μs  |
|                       |    |           | Conversion time <sup>5</sup><br>V <sub>DD</sub> = 5.0 V | f <sub>ADC1</sub> = 32 MHz,<br>INPCMP = 0      | 1.5  | —   | —       | μs  |
|                       |    |           | Conversion time <sup>5</sup><br>V <sub>DD</sub> = 3.3 V | f <sub>ADC1</sub> = 13.33 MHz,<br>INPCMP = 0   | —    | —   | 3.6     | μs  |
|                       |    |           | Conversion time <sup>5</sup><br>V <sub>DD</sub> = 5.0 V | f <sub>ADC1</sub> = 13.33 MHz,<br>INPCMP = 0   | —    | —   | 3.6     | μs  |
| Δ <sub>ADC1_SYS</sub> | SR | —         | ADC_1 digital clock duty cycle                          | ADCLKSEL = 1 <sup>6</sup>                      | 45   | —   | 55      | %   |
| C <sub>S</sub>        | CC | D         | ADC_1 input sampling capacitance                        | —  | —    | —   | 5       | pF  |
| C <sub>P1</sub>       | CC | D         | ADC_1 input pin capacitance 1                           | —  | —    | —   | 3       | pF  |
| C <sub>P2</sub>       | CC | D         | ADC_1 input pin capacitance 2                           | —  | —    | —   | 1       | pF  |
| C <sub>P3</sub>       | CC | D         | ADC_1 input pin capacitance 3                           | —  | —    | —   | 1.5     | pF  |
| R <sub>SW1</sub>      | CC | D         | Internal resistance of analog source                    | —  | —    | —   | 1       | kΩ  |
| R <sub>SW2</sub>      | CC | D         | Internal resistance of analog source                    | —  | —    | —   | 2       | kΩ  |
| R <sub>AD</sub>       | CC | D         | Internal resistance of analog source                    | —  | —    | —   | 0.3     | kΩ  |

Table 45. ADC\_1 conversion characteristics (12-bit ADC\_1) (continued)

| Symbol            | C  | Parameter | Conditions <sup>1</sup>                                      | Value  |                               |     | Unit |     |    |
|-------------------|----|-----------|--|--|-------------------------------|-----|------|-----|----|
|                   |    |           |  | Min  | Typ                           | Max |      |     |    |
| I <sub>INJ</sub>  | SR | —         | Input current Injection                                      | Current injection on one ADC_1 input, different from the converted one | V <sub>DD</sub> = 3.3 V ± 10% | −5  | —    | 5   | mA |
|                   |    |           |  |  | V <sub>DD</sub> = 5.0 V ± 10% | −5  | —    | 5   |    |
| INLP              | CC | T         | Absolute integral nonlinearity – Precise channels            | No overload  | —                             | 1   | 3    | LSB |    |
| INLX              | CC | T         | Absolute integral nonlinearity – Extended channels           | No overload  | —                             | 1.5 | 5    | LSB |    |
| DNL               | CC | T         | Absolute differential nonlinearity                           | No overload  | —                             | 0.5 | 1    | LSB |    |
| E <sub>O</sub>    | CC | T         | Absolute offset error  | —  | —                             | 2   | —    | LSB |    |
| E <sub>G</sub>    | CC | T         | Absolute gain error  | —  | —                             | 2   | —    | LSB |    |
| TUEP <sup>7</sup> | CC | P         | Total unadjusted error for precise channels, input only pins | Without current injection  | −6                            | —   | 6    | LSB |    |
|                   |    | T         |  | With current injection   | −8                            | —   | 8    |     |    |
| TUEX <sup>7</sup> | CC | T         | Total unadjusted error for extended channel                  | Without current injection  | −10                           | —   | 10   | LSB |    |
|                   |    | T         |  | With current injection   | −12                           | —   | 12   |     |    |

<sup>1</sup> V<sub>DD</sub> = 3.3 V ± 10% / 5.0 V ± 10%, T<sub>A</sub> = −40 to 125 °C, unless otherwise specified

<sup>2</sup> Analog and digital V<sub>SS</sub> **must** be common (to be tied together externally).

<sup>3</sup> V<sub>AINx</sub> may exceed V<sub>SS\_ADC1</sub> and V<sub>DD\_ADC1</sub> limits, remaining on absolute maximum ratings, but the results of the conversion will be clamped respectively to 0x000 or 0xFF.

<sup>4</sup> During the sampling time the input capacitance C<sub>S</sub> can be charged/discharged by the external source. The internal resistance of the analog source must allow the capacitance to reach its final voltage level within t<sub>ADC1\_S</sub>. After the end of the sampling time t<sub>ADC1\_S</sub>, changes of the analog input voltage have no effect on the conversion result. Values for the sampling clock t<sub>ADC1\_S</sub> depend on programming.

<sup>5</sup> This parameter does not include the sampling time t<sub>ADC1\_S</sub>, but only the time for determining the digital result and the time to load the result's register with the conversion result.

<sup>6</sup> Duty cycle is ensured by using system clock without prescaling. When ADCLKSEL = 0, the duty cycle is ensured by internal divider by 2.

<sup>7</sup> Total Unadjusted Error: The maximum error that occurs without adjusting Offset and Gain errors. This error is a combination of Offset, Gain and Integral Linearity errors.

## 4.17 On-chip peripherals

### 4.17.1 Current consumption

Table 46. On-chip peripherals current consumption<sup>1</sup>

| Symbol                          | C  | Parameter | Conditions   |   | Typical value <sup>2</sup>   | Unit                         |    |
|---------------------------------|----|-----------|--|---|--|------------------------------|----|
| I <sub>DD_BV(CAN)</sub>         | CC | T         | CAN (FlexCAN) supply current on V <sub>DD_BV</sub>   | Bitrate: 500 Kbyte/s  | Total (static + dynamic) consumption: <ul style="list-style-type: none"> <li>FlexCAN in loop-back mode</li> <li>XTAL at 8 MHz used as CAN engine clock source</li> <li>Message sending period is 580 μs</li> </ul> | 8 * f <sub>periph</sub> + 85 | μA |
|                                 |    |           |  | Bitrate: 125 Kbyte/s  |  | 8 * f <sub>periph</sub> + 27 |    |
| I <sub>DD_BV(eMIOS)</sub>       | CC | T         | eMIOS supply current on V <sub>DD_BV</sub>           | Static consumption: <ul style="list-style-type: none"> <li>eMIOS channel OFF</li> <li>Global prescaler enabled</li> </ul>   |  | 29 * f <sub>periph</sub>     | μA |
|                                 |    |           |  | Dynamic consumption: <ul style="list-style-type: none"> <li>It does not change varying the frequency (0.003 mA)</li> </ul>  |  | 3                            |    |
| I <sub>DD_BV(SCI)</sub>         | CC | T         | SCI (LINFlex) supply current on V <sub>DD_BV</sub>   | Total (static + dynamic) consumption: <ul style="list-style-type: none"> <li>LIN mode</li> <li>Baudrate: 20 Kbyte/s</li> </ul>  |  | 5 * f <sub>periph</sub> + 31 | μA |
| I <sub>DD_BV(SPI)</sub>         | CC | T         | SPI (DSPI) supply current on V <sub>DD_BV</sub>      | Ballast static consumption (only clocked)   |  | 1                            | μA |
|                                 |    |           |  | Ballast dynamic consumption (continuous communication): <ul style="list-style-type: none"> <li>Baudrate: 2 Mbit/s</li> <li>Transmission every 8 μs</li> <li>Frame: 16 bits</li> </ul> |  | 16 * f <sub>periph</sub>     |    |
| I <sub>DD_BV(ADC_0/ADC_1)</sub> | CC | T         | ADC_0/ADC_1 supply current on V <sub>DD_BV</sub>     | V <sub>DD</sub> = 5.5 V   | Ballast static consumption (no conversion) <sup>3</sup>  | 41 * f <sub>periph</sub>     | μA |
|                                 |    |           |  |   | Ballast dynamic consumption (continuous conversion) <sup>3</sup>   | 46 * f <sub>periph</sub>     |    |
| I <sub>DD_HV_ADC0</sub>         | CC | T         | ADC_0 supply current on V <sub>DD_HV_ADC0</sub>      | V <sub>DD</sub> = 5.5 V   | Analog static consumption (no conversion)  | 200                          | μA |
|                                 |    |           |  |   | Analog dynamic consumption (continuous conversion)   | 3                            | mA |
| I <sub>DD_HV_ADC1</sub>         | CC | T         | ADC_1 supply current on V <sub>DD_HV_ADC1</sub>      | V <sub>DD</sub> = 5.5 V   | Analog static consumption (no conversion)  | 300 * f <sub>periph</sub>    | μA |
|                                 |    |           |  |   | Analog dynamic consumption (continuous conversion)   | 4                            | mA |
| I <sub>DD_HV(FLASH)</sub>       | CC | T         | CFlash + DFlash supply current on V <sub>DD_HV</sub> | V <sub>DD</sub> = 5.5 V   | —  | 12                           | mA |
| I <sub>DD_HV(PLL)</sub>         | CC | T         | PLL supply current on V <sub>DD_HV</sub>             | V <sub>DD</sub> = 5.5 V   | —  | 30 * f <sub>periph</sub>     | μA |

- <sup>1</sup> Operating conditions:  $T_A = 25\text{ °C}$ ,  $f_{\text{periph}} = 8\text{ MHz to }64\text{ MHz}$
- <sup>2</sup>  $f_{\text{periph}}$  is an absolute value.
- <sup>3</sup> During the conversion, the total current consumption is given from the sum of the static and dynamic consumption, i.e.,  $(41 + 46) * f_{\text{periph}}$ .

## 4.17.2 DSPI characteristics

Table 47. DSPI characteristics<sup>1</sup>

| No. | Symbol           | C  | D | Parameter   | DSPI0/DSPI1/DSPI3/DSPI5 |                  |             | DSPI2/DSPI4       |                  |             | 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                |    |
| —   | $\Delta t_{CSC}$ | 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 |
| —   | $\Delta t_{ASC}$ | 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 |
|     |                  |    | 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 PCSS time   | —                       | 0                | —           | —                 | 0                | —           | —                  | ns |
| 8   | $t_{PASC}$       | SR | D | 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                | —           | —                  |    |

Table 47. DSPI characteristics<sup>1</sup> (continued)

| No. | Symbol                        | C  | Parameter | DSPI0/DSPI1/DSPI3/DSPI5    |                |     | DSPI2/DSPI4 |                |     | Unit |    |    |
|-----|-------------------------------|----|-----------|----------------------------|----------------|-----|-------------|----------------|-----|------|----|----|
|     |                               |    |           | Min                        | Typ            | Max | Min         | Typ            | Max |      |    |    |
| 10  | t <sub>HI</sub>               | SR | D         | Data hold time for inputs  | Master mode    | 0   | —           | —              | 0   | —    | —  | ns |
|     |                               |    |           | Slave mode                 | 2 <sup>6</sup> | —   | —           | 2 <sup>6</sup> | —   | —    |    |    |
| 11  | t <sub>SUO</sub> <sup>7</sup> | CC | D         | Data valid after SCK edge  | Master mode    | —   | —           | 32             | —   | —    | 50 | ns |
|     |                               |    |           | Slave mode                 | —              | —   | 52          | —              | —   | 160  |    |    |
| 12  | t <sub>HO</sub> <sup>7</sup>  | CC | D         | Data hold time for outputs | Master mode    | 0   | —           | —              | 0   | —    | —  | ns |
|     |                               |    |           | Slave mode                 | 8              | —   | —           | 13             | —   | —    |    |    |

<sup>1</sup> Operating conditions: C<sub>L</sub> = 10 to 50 pF, Slew<sub>IN</sub> = 3.5 to 15 ns

<sup>2</sup> 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.

<sup>3</sup> Maximum value is reached when CSn pad is configured as MEDIUM pad while SCK pad is configured as SLOW. A positive value means that CSn is deasserted before SCK. DSPI0 and DSPI1 have only MEDIUM SCK available.

<sup>4</sup> The t<sub>CSC</sub> delay value is configurable through a register. When configuring t<sub>CSC</sub> (using PCSSCK and CSSCK fields in DSPI\_CTARx registers), delay between internal CS and internal SCK must be higher than Δt<sub>CSC</sub> to ensure positive t<sub>CSCext</sub>.

<sup>5</sup> The t<sub>ASC</sub> delay value is configurable through a register. When configuring t<sub>ASC</sub> (using PASC and ASC fields in DSPI\_CTARx registers), delay between internal CS and internal SCK must be higher than Δt<sub>ASC</sub> to ensure positive t<sub>ASCext</sub>.

<sup>6</sup> This delay value corresponds to SMPL\_PT = 00b which is bit field 9 and 8 of DSPI\_MCR register.

<sup>7</sup> SCK and SOUT are configured as MEDIUM pad.

Figure 22. DSPI classic SPI timing — master, CPHA = 0

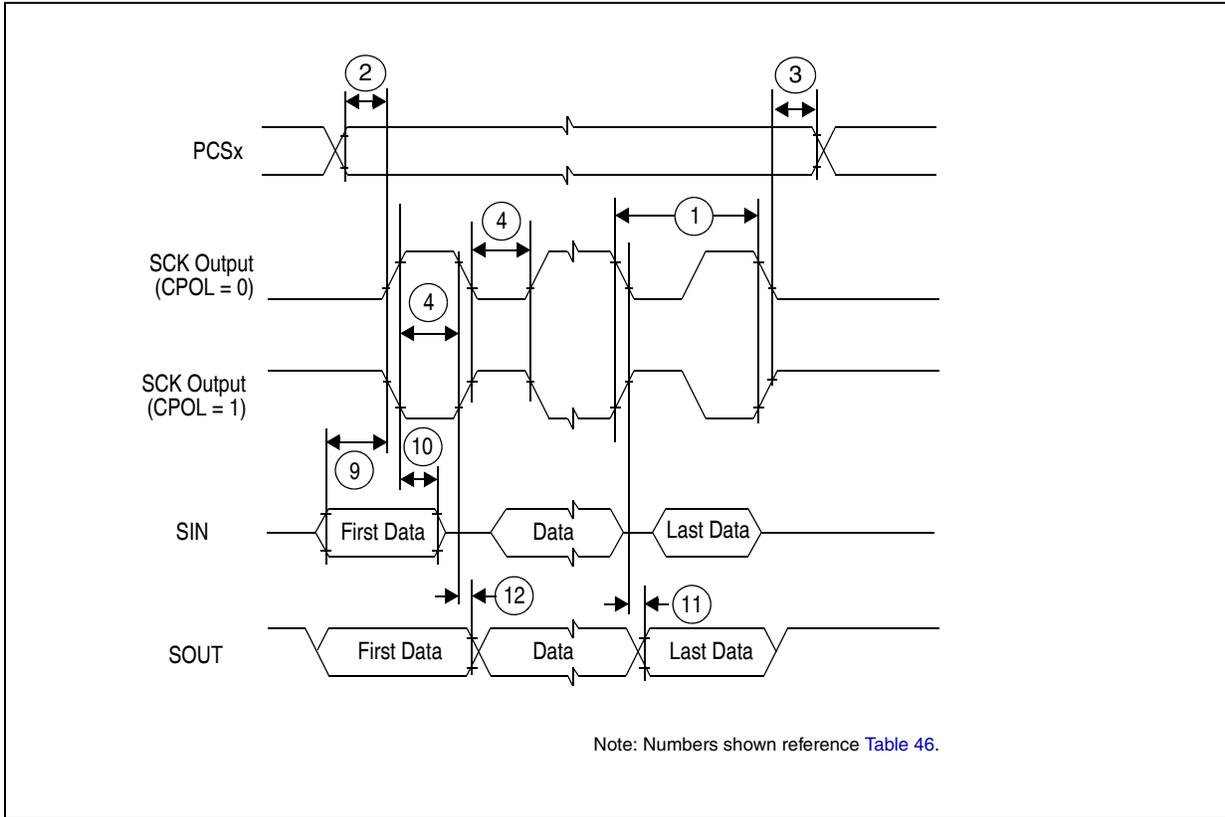


Figure 23. DSPI classic SPI timing — master, CPHA = 1

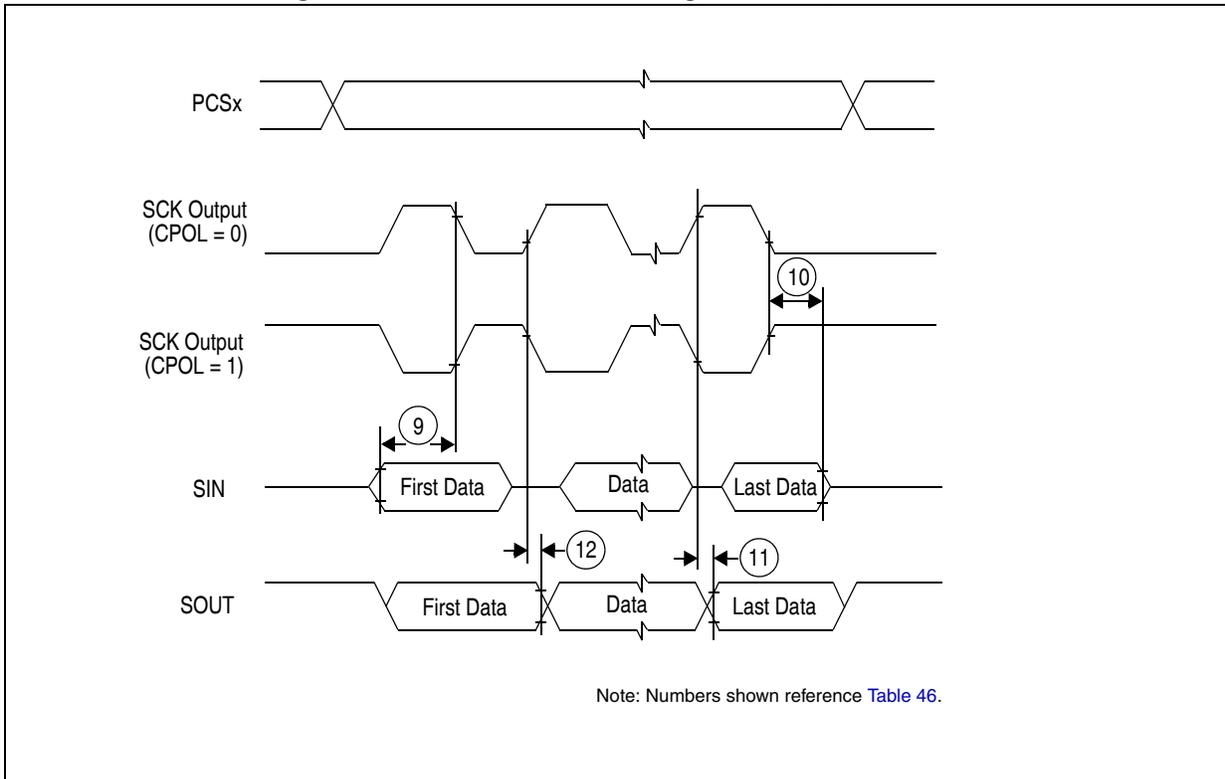


Figure 24. DSPI classic SPI timing — slave, CPHA = 0

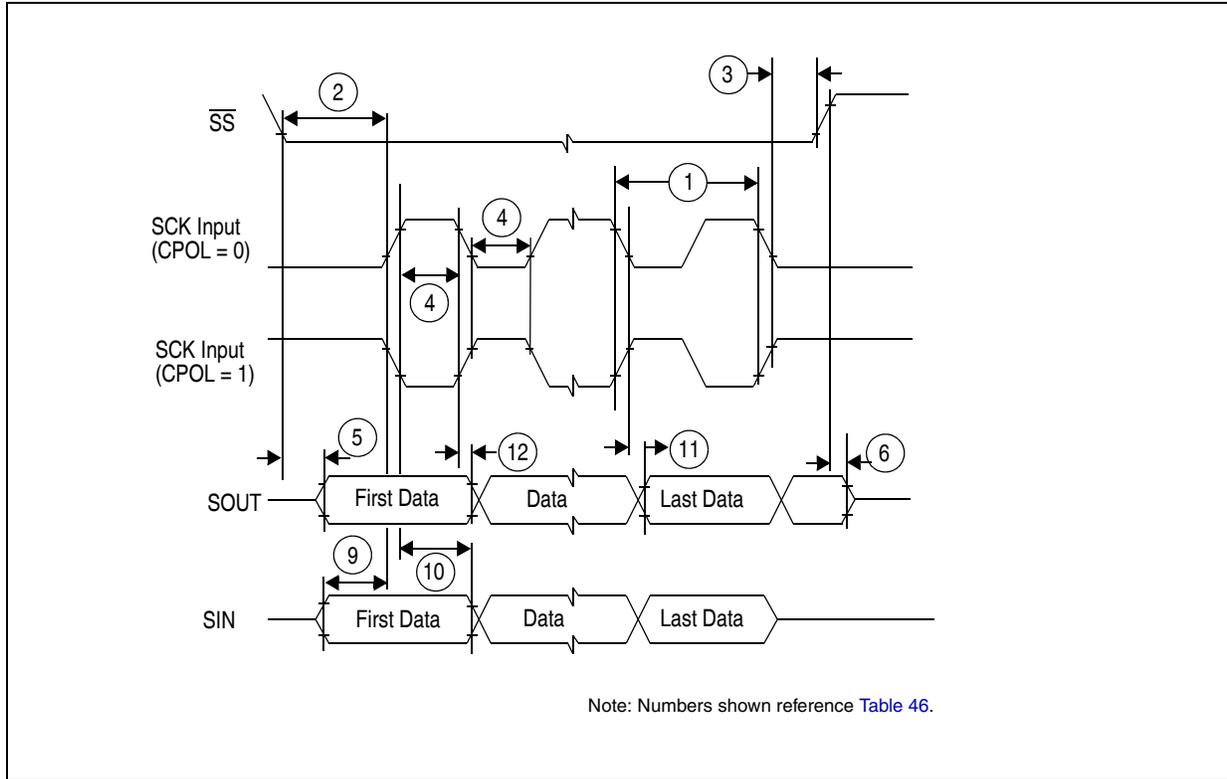
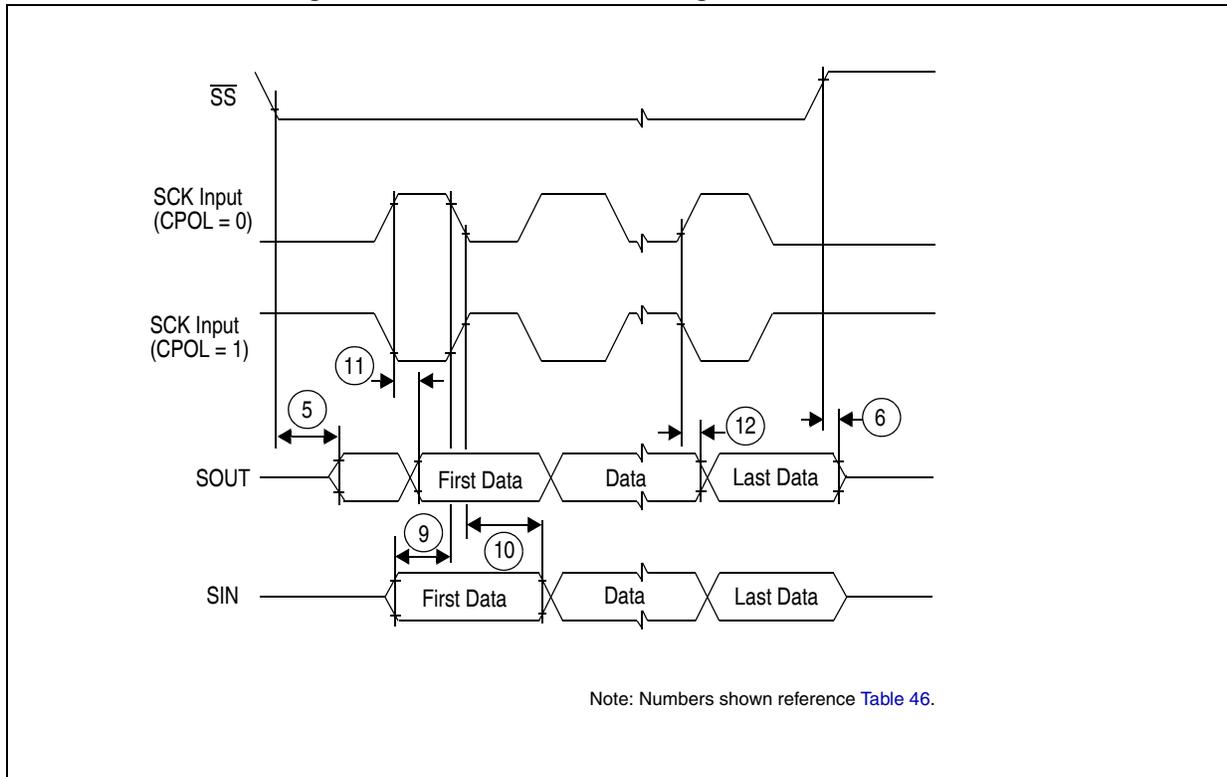
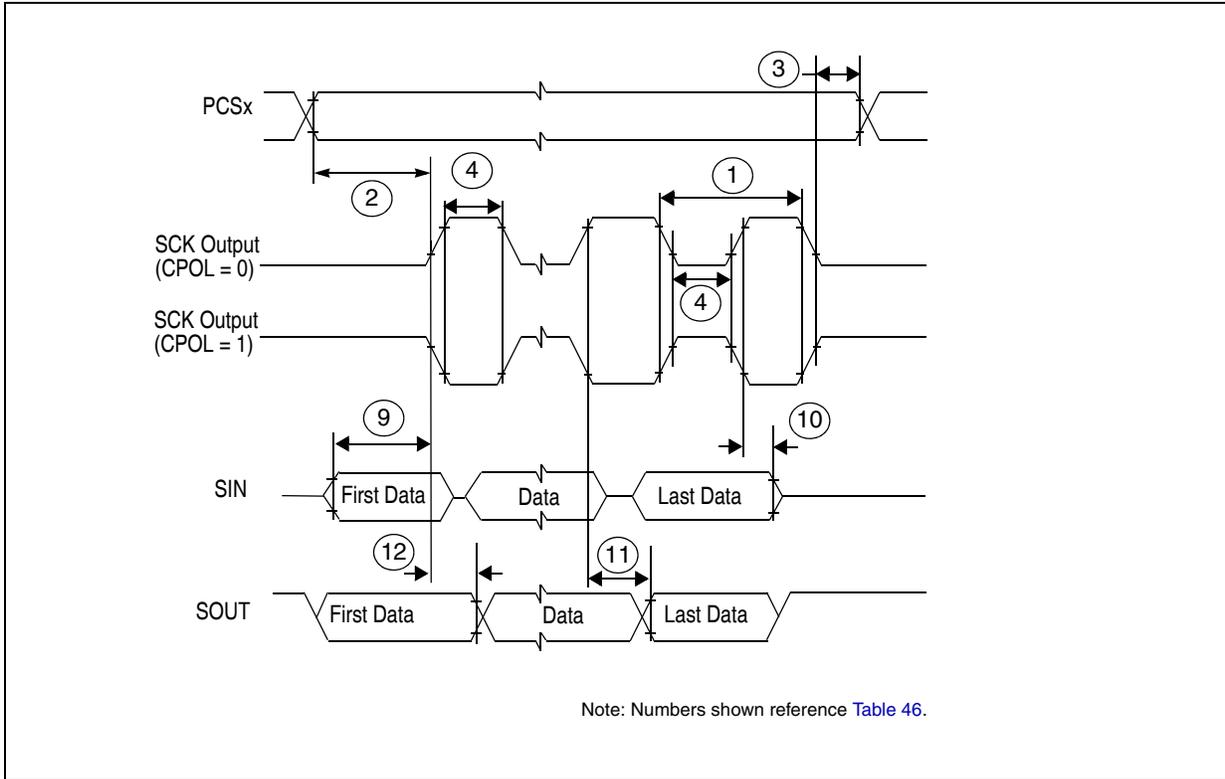


Figure 25. DSPI classic SPI timing — slave, CPHA = 1



**Figure 26. DSPI modified transfer format timing — master, CPHA = 0**



**Figure 27. DSPI modified transfer format timing — master, CPHA = 1**

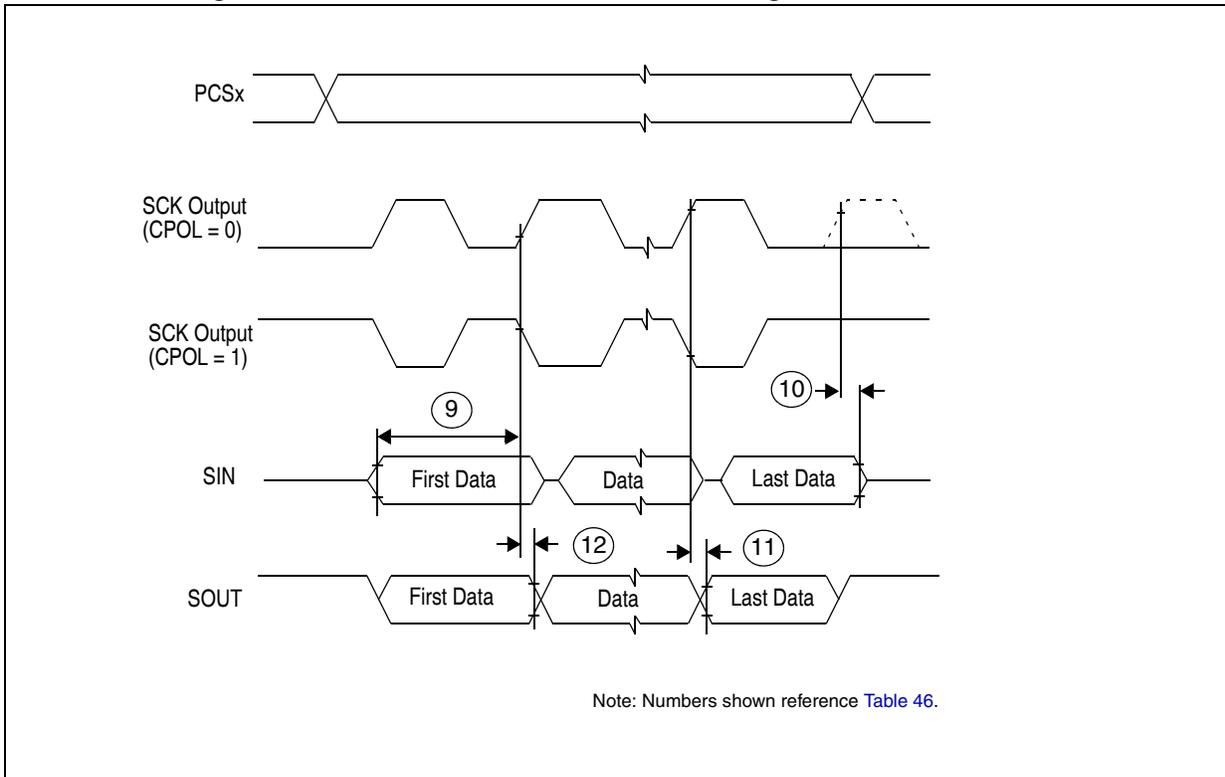


Figure 28. DSPI modified transfer format timing — slave, CPHA = 0

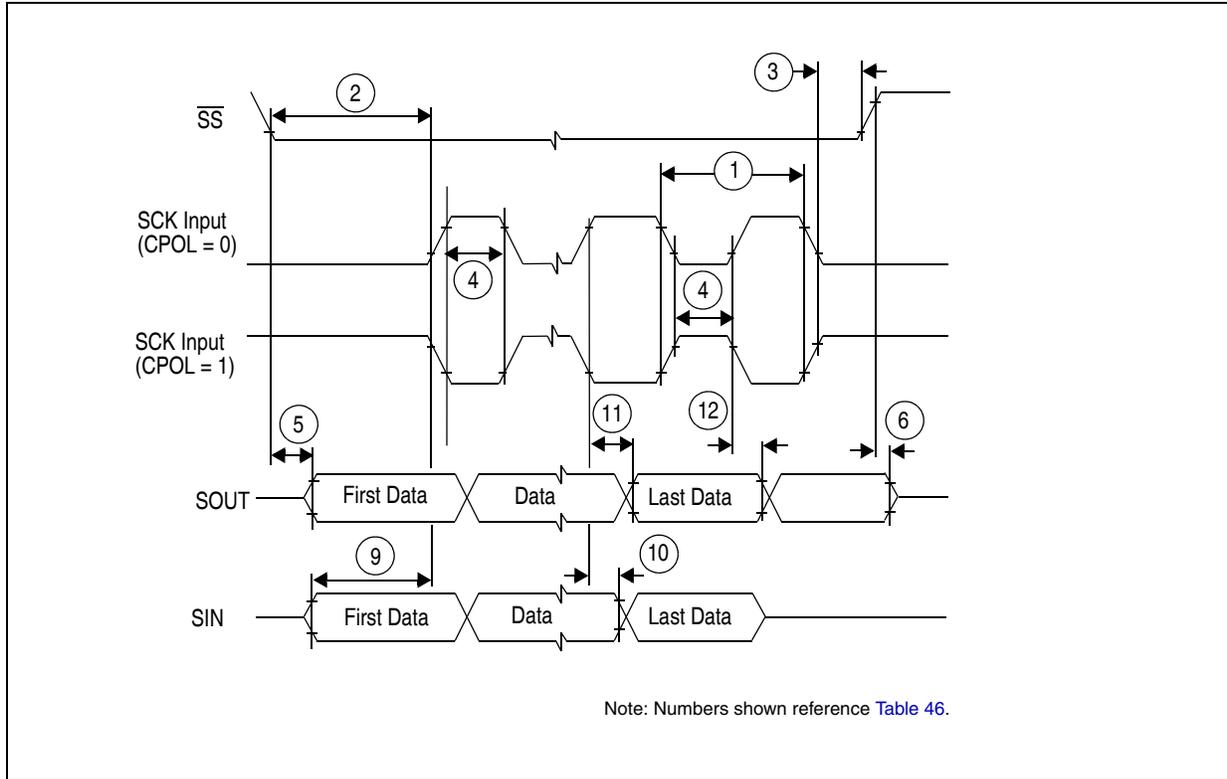
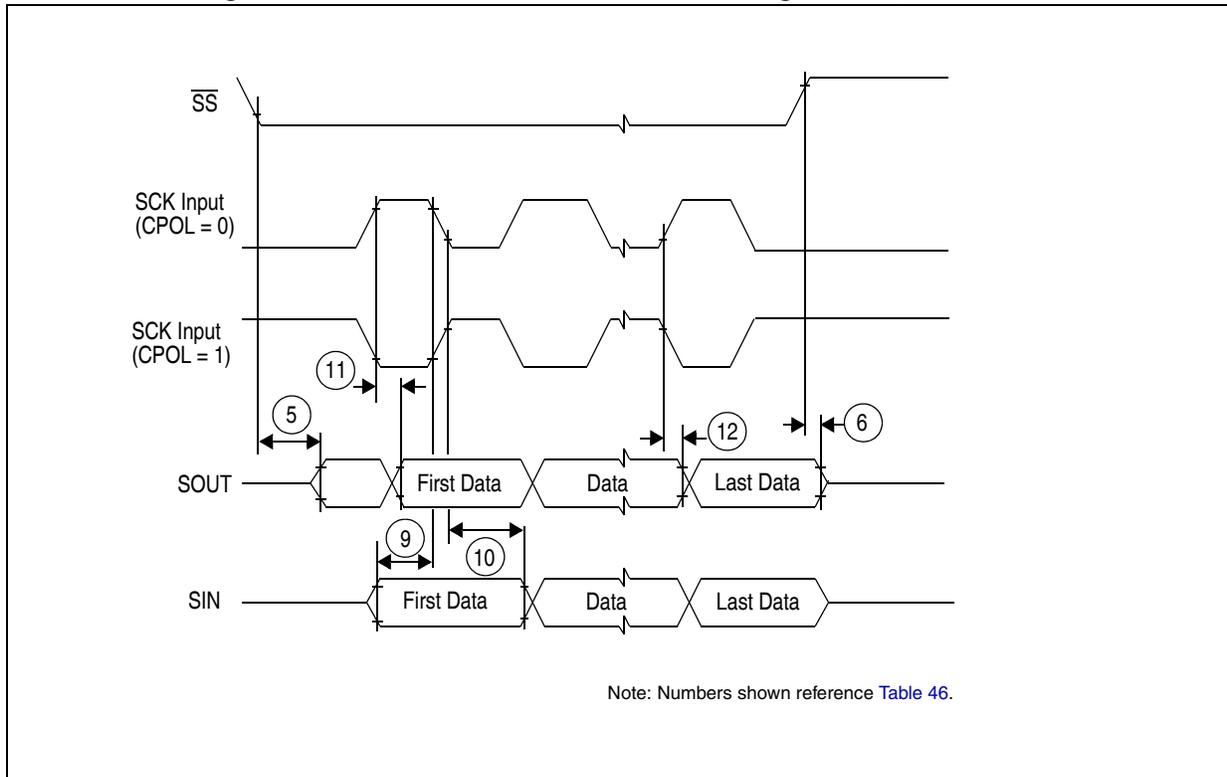


Figure 29. DSPI modified transfer format timing — slave, CPHA = 1



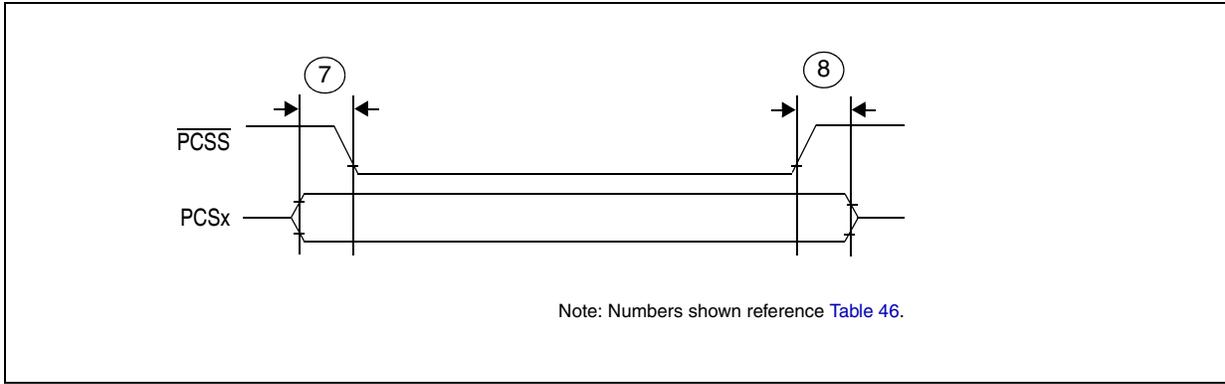


Figure 30. DSPI PCS strobe ( $\overline{\text{PCSS}}$ ) timing

### 4.17.3 Nexus characteristics

Table 48. Nexus characteristics

| No. | Symbol             | C  | Parameter | Value                         |     |     | Unit |    |
|-----|--------------------|----|-----------|-------------------------------|-----|-----|------|----|
|     |                    |    |           | Min                           | Typ | Max |      |    |
| 1   | $t_{\text{TCCY}}$  | CC | D         | TCK cycle time                | 64  | —   | —    | ns |
| 2   | $t_{\text{MCCY}}$  | CC | D         | MCKO cycle time               | 32  | —   | —    | ns |
| 3   | $t_{\text{MDOV}}$  | CC | D         | MCKO low to MDO data valid    | —   | —   | 8    | ns |
| 4   | $t_{\text{MSEOV}}$ | CC | D         | MCKO low to MSEO_b data valid | —   | —   | 8    | ns |
| 5   | $t_{\text{EVTOV}}$ | CC | D         | MCKO low to EVTO data valid   | —   | —   | 8    | ns |
| 6   | $t_{\text{NTDIS}}$ | CC | D         | TDI data setup time           | 15  | —   | —    | ns |
|     | $t_{\text{NTMSS}}$ | CC | D         | TMS data setup time           | 15  | —   | —    | ns |
| 7   | $t_{\text{NTDIH}}$ | CC | D         | TDI data hold time            | 5   | —   | —    | ns |
|     | $t_{\text{NTMSH}}$ | CC | D         | TMS data hold time            | 5   | —   | —    | ns |
| 8   | $t_{\text{TDOV}}$  | CC | D         | TCK low to TDO data valid     | 35  | —   | —    | ns |
| 9   | $t_{\text{TDOI}}$  | CC | D         | TCK low to TDO data invalid   | 6   | —   | —    | ns |

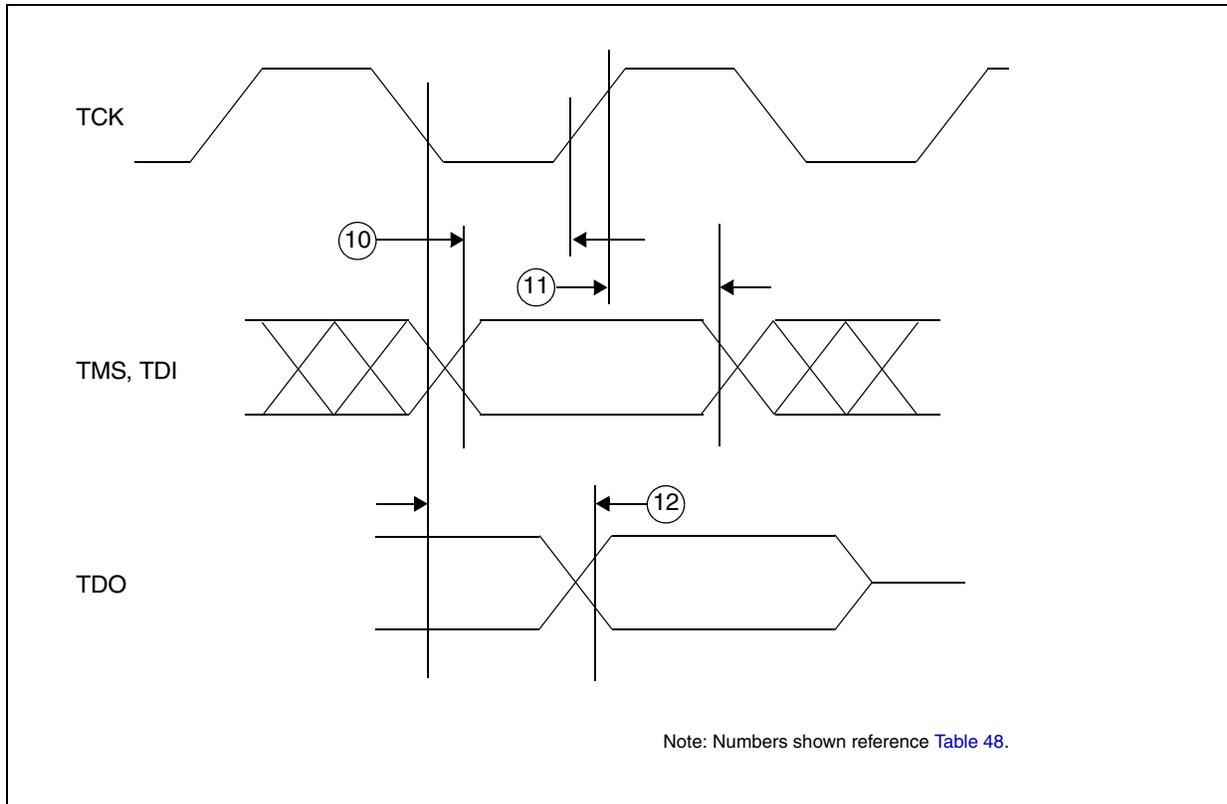


Figure 31. Nexus TDI, TMS, TDO timing

#### 4.17.4 JTAG characteristics

Table 49. JTAG characteristics

| No. | Symbol     | C  | Parameter | Value                  |     |     | Unit |    |
|-----|------------|----|-----------|------------------------|-----|-----|------|----|
|     |            |    |           | Min                    | Typ | Max |      |    |
| 1   | $t_{JCYC}$ | CC | D         | TCK cycle time         | 64  | —   | —    | ns |
| 2   | $t_{TDIS}$ | CC | D         | TDI setup time         | 15  | —   | —    | ns |
| 3   | $t_{TDIH}$ | CC | D         | TDI hold time          | 5   | —   | —    | ns |
| 4   | $t_{TMSS}$ | CC | D         | TMS setup time         | 15  | —   | —    | ns |
| 5   | $t_{TMSh}$ | CC | D         | TMS hold time          | 5   | —   | —    | ns |
| 6   | $t_{TDOV}$ | CC | D         | TCK low to TDO valid   | —   | —   | 33   | ns |
| 7   | $t_{TDOI}$ | CC | D         | TCK low to TDO invalid | 6   | —   | —    | ns |

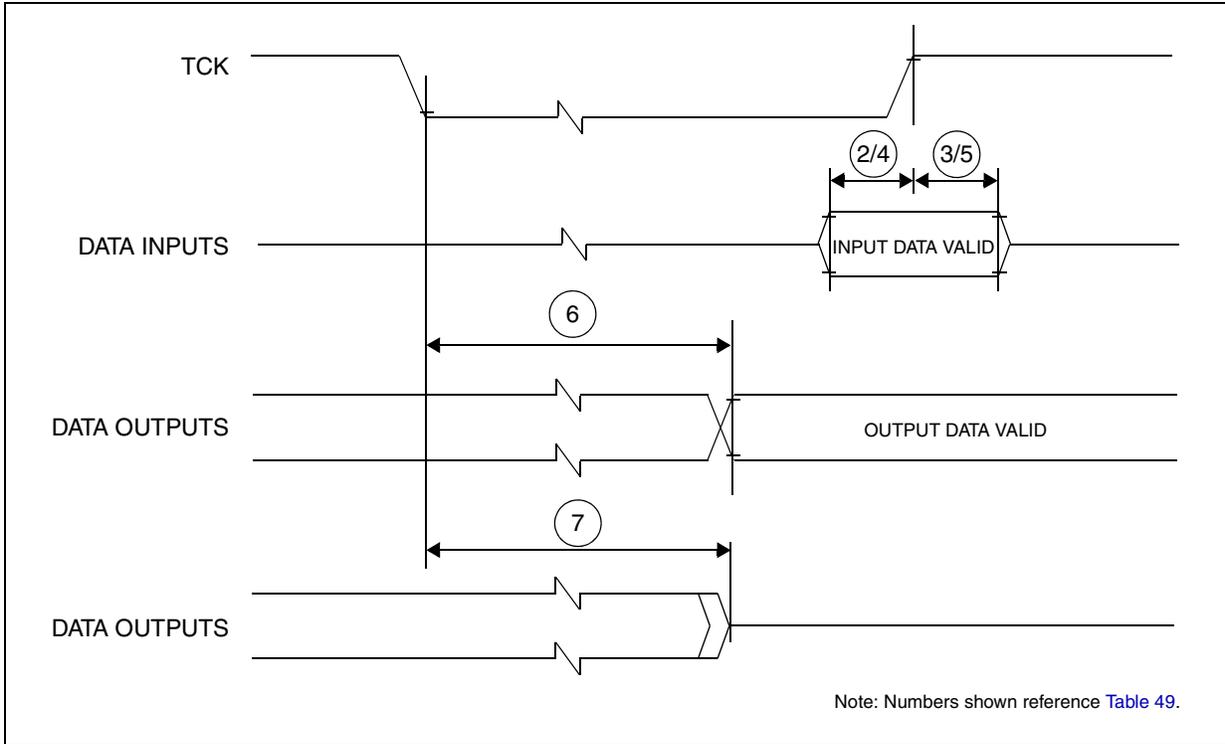


Figure 32. Timing diagram — JTAG boundary scan



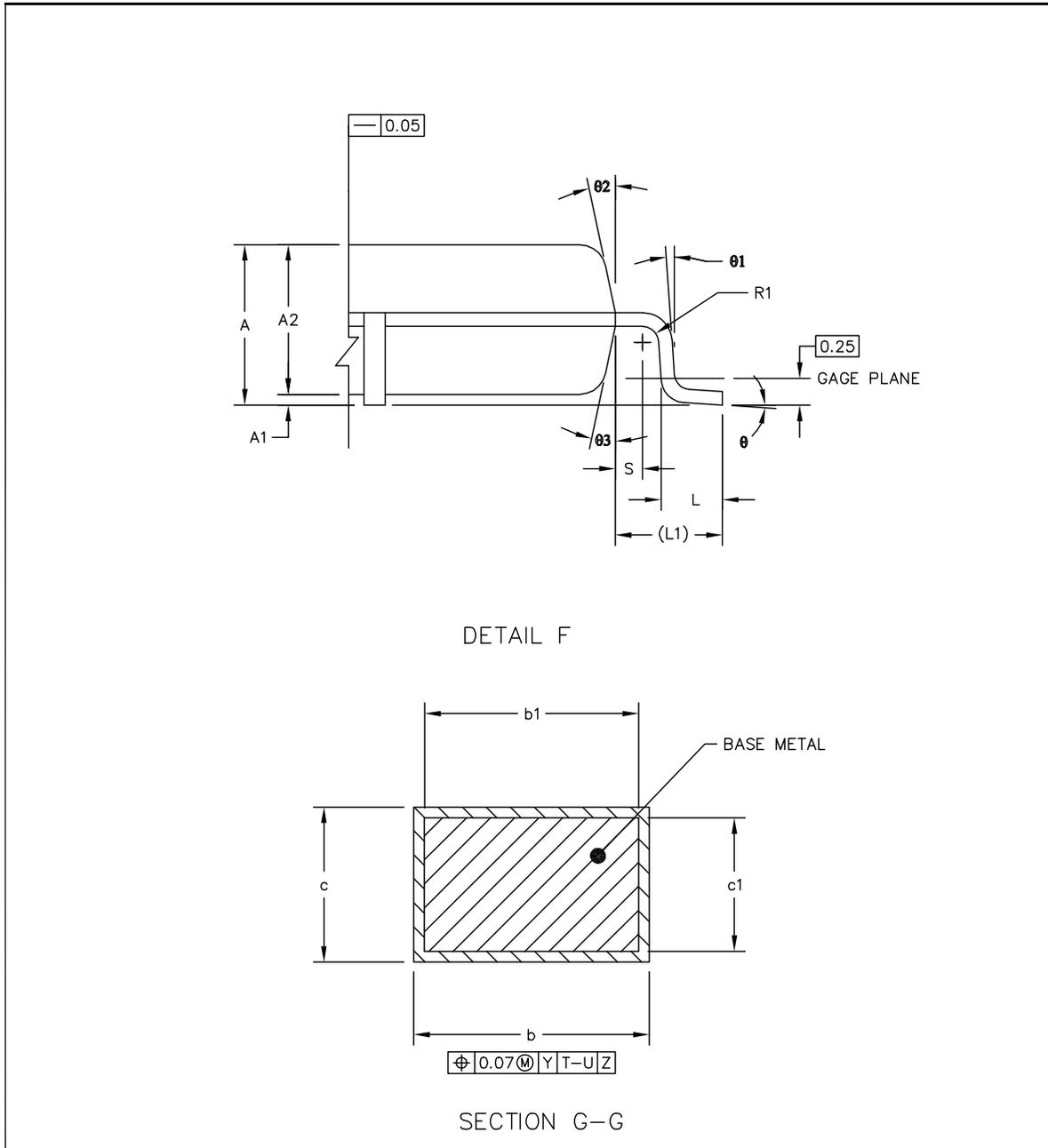


Figure 34. 176 LQFP package mechanical drawing (Part 2 of 3)

| NOTES:   |      |         |      |            |      |                          |     |     |                    |     |     |
|--|------|---------|------|------------|------|--------------------------|-----|-----|--------------------|-----|-----|
| 1. DIMENSIONS D1 AND E1 DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.25MM PER SIDE. DIMENSIONS D1 AND E1 DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE DATUM H.  |      |         |      |            |      |                          |     |     |                    |     |     |
| 2. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL NOT CAUSE THE LEAD WIDTH TO EXCEED THE MAXIMUM b DIMENSION BY MORE THEN 0.08MM. DAMBAR CAN NOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM BETWEEN PROTRUSION AND AN ADJACENT LEAD IS 0.07MM FOR 0.4MM AND 0.5MM PITCH PACKAGES. |      |         |      |            |      |                          |     |     |                    |     |     |
| DIM  | MIN  | NOM     | MAX  | DIM        | MIN  | NOM                      | MAX | DIM | MIN                | NOM | MAX |
| A  | ---  |         | 1.6  | L1         |      | 1 REF                    |     |     |                    |     |     |
| A1   | 0.05 |         | 0.15 | R1         | 0.08 |                          | --- |     |                    |     |     |
| A2   | 1.35 | 1.4     | 1.45 | R2         | 0.08 |                          | 0.2 |     |                    |     |     |
| b  | 0.17 | 0.22    | 0.27 | S          |      | 0.2 REF                  |     |     |                    |     |     |
| b1   | 0.17 | 0.2     | 0.23 | $\theta$   | 0°   | 3.5°                     | 7°  |     |                    |     |     |
| c  | 0.09 |         | 0.2  | $\theta 1$ | 0°   |                          | --- |     |                    |     |     |
| c1   | 0.09 |         | 0.16 | $\theta 2$ | 11°  | 12°                      | 13° |     |                    |     |     |
| D  |      | 26 BSC  |      | $\theta 3$ | 11°  | 12°                      | 13° |     |                    |     |     |
| D1   |      | 24 BSC  |      |            |      |                          |     |     |                    |     |     |
| e  |      | 0.5 BSC |      |            |      |                          |     |     |                    |     |     |
| E  |      | 26 BSC  |      |            |      |                          |     |     |                    |     |     |
| E1   |      | 24 BSC  |      |            |      |                          |     |     |                    |     |     |
| L  | 0.45 | 0.6     | 0.75 |            |      |                          |     |     |                    |     |     |
|  |      |         |      |            | UNIT | DIMENSION AND TOLERANCES |     |     | REFERANCE DOCUMENT |     |     |
|  |      |         |      |            | MM   | ASME Y14.5M              |     |     | 64-06-280-1392     |     |     |

Figure 35. 176 LQFP package mechanical drawing (Part 3 of 3)

### 5.1.2 144 LQFP

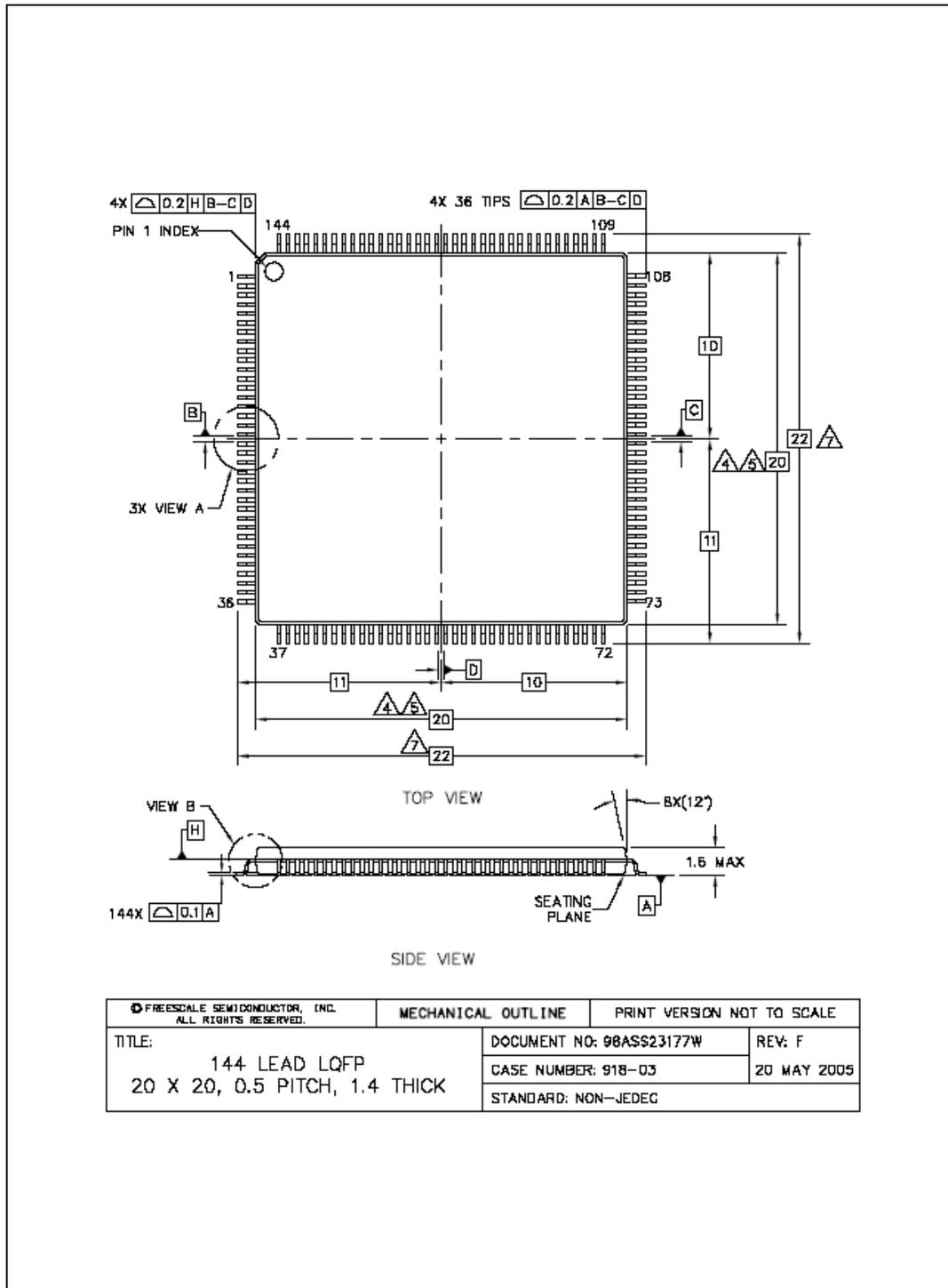


Figure 36. 144 LQFP package mechanical drawing (Part 1 of 2)

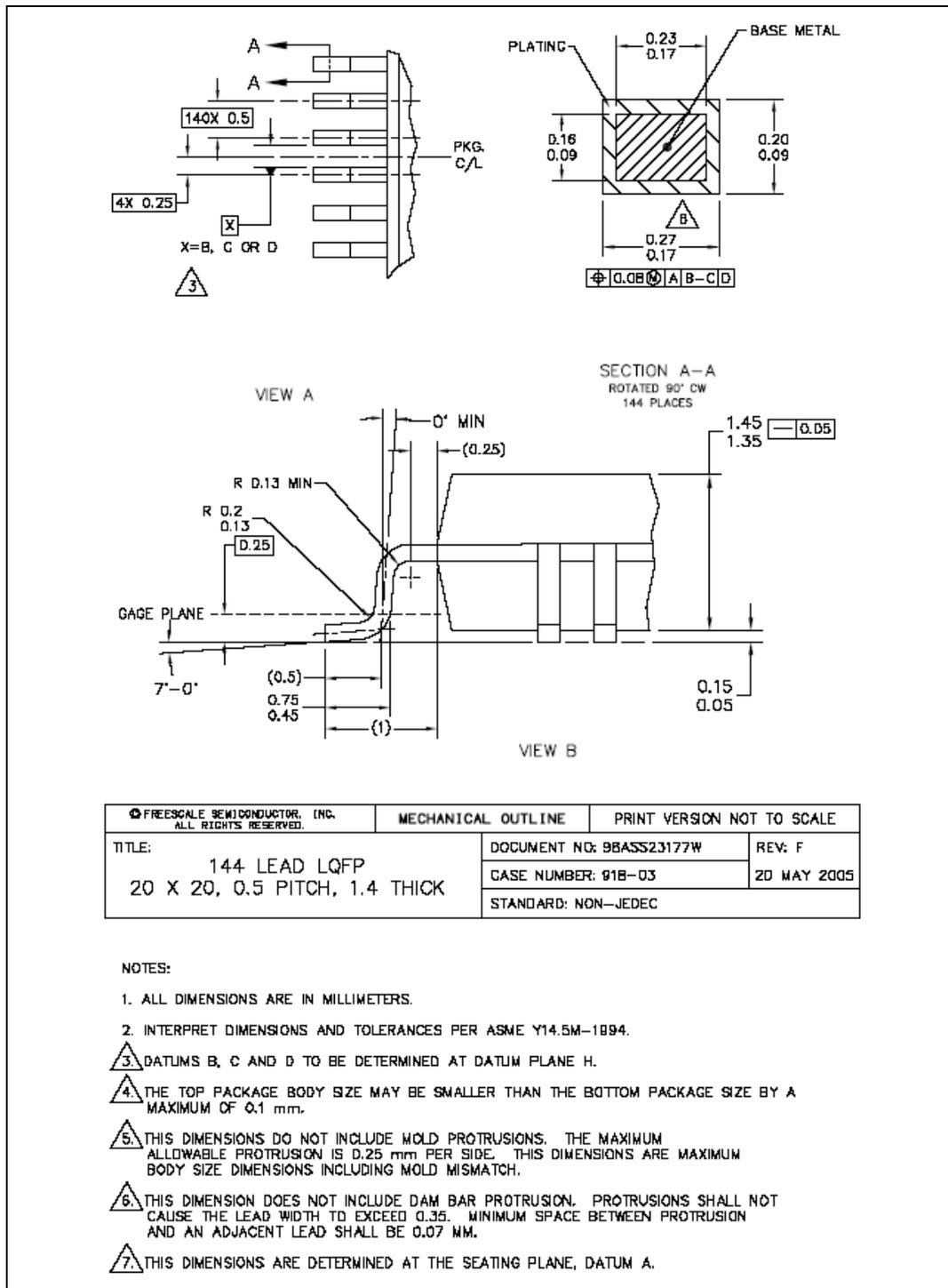


Figure 37. 144 LQFP package mechanical drawing (Part 2 of 2)

### 5.1.3 100 LQFP

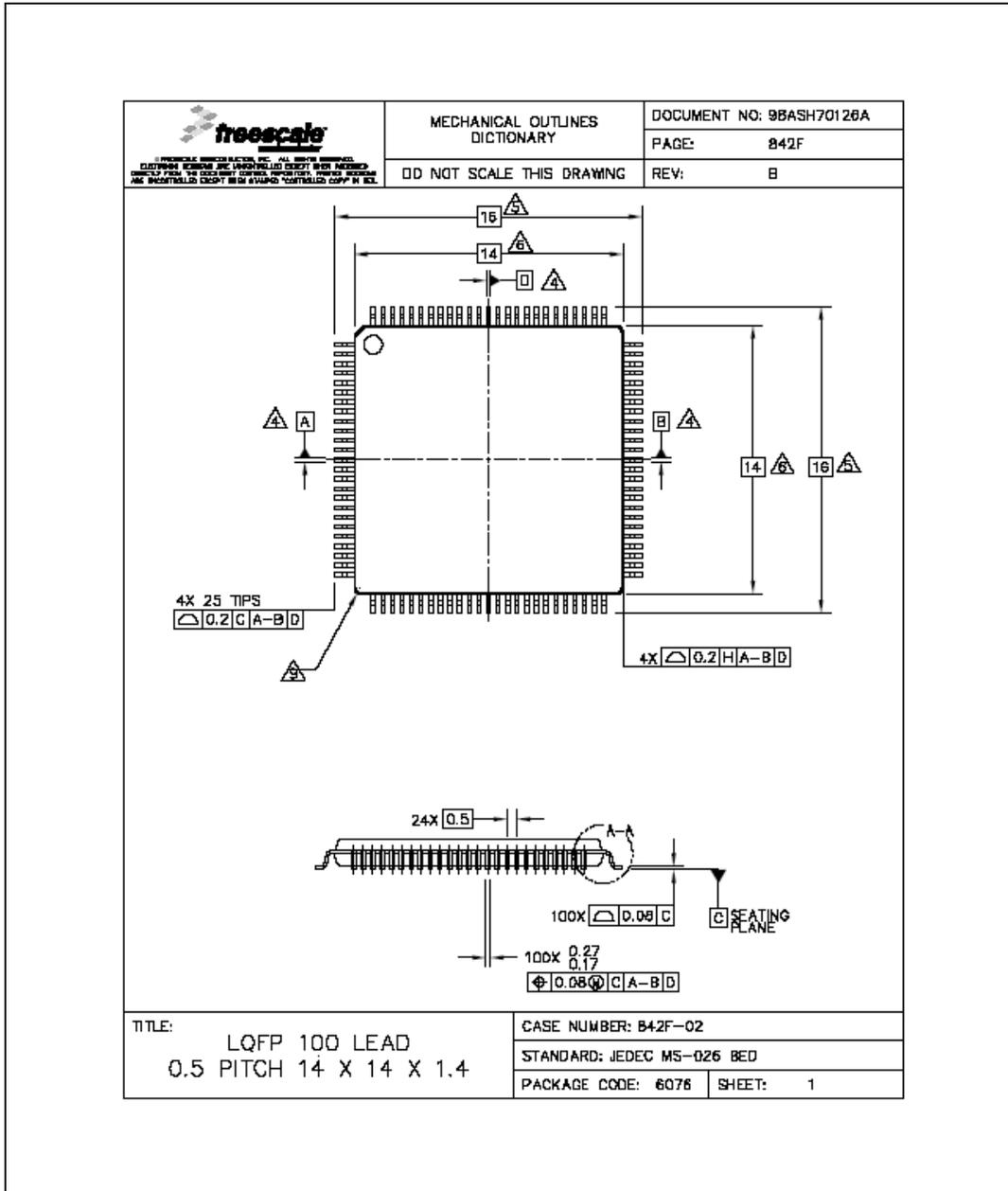


Figure 38. 100 LQFP package mechanical drawing (Part 1 of 3)

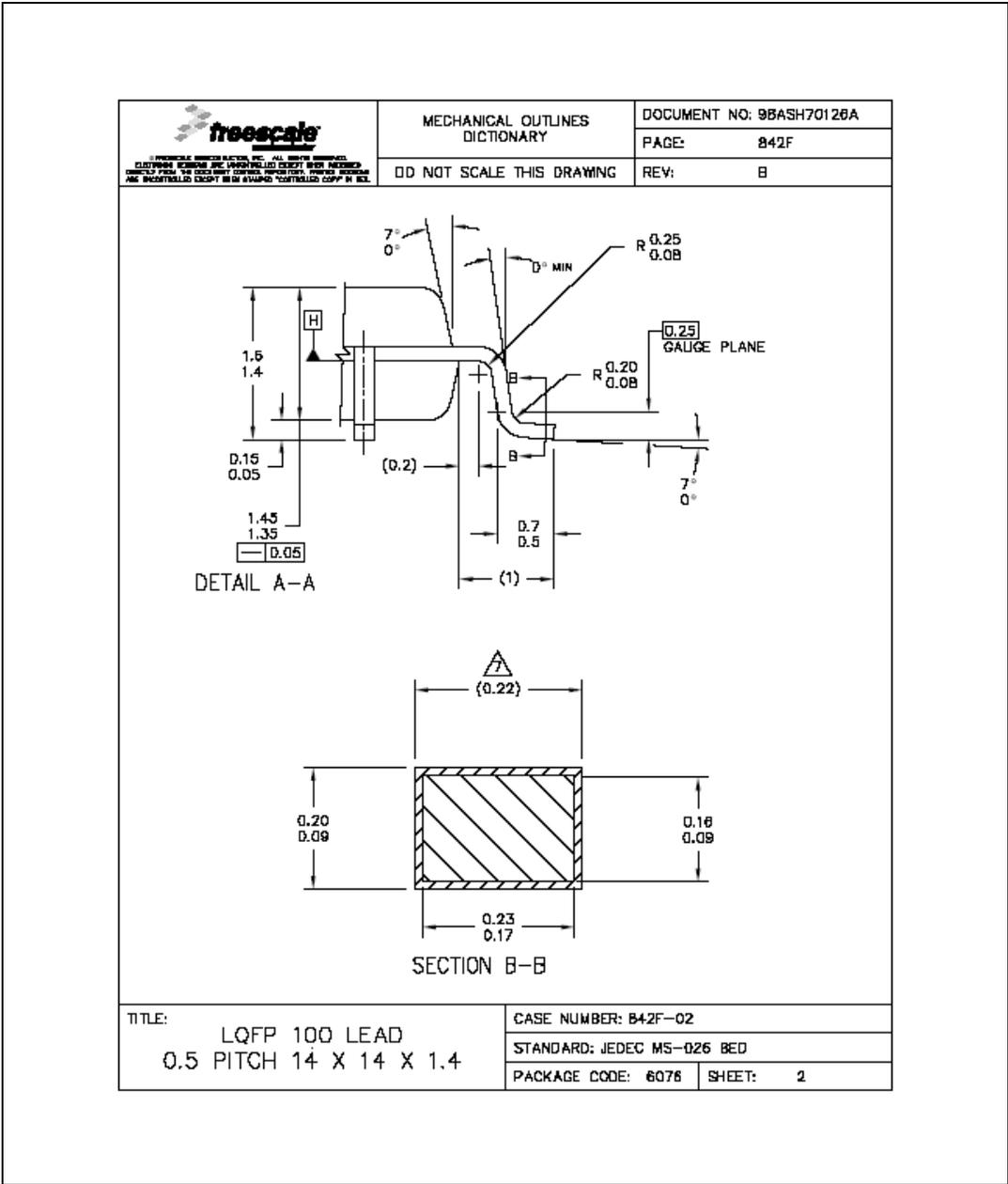


Figure 39. 100 LQFP package mechanical drawing (Part 2 of 3)

|  |                                   |                             |
|--|-----------------------------------|-----------------------------|
| <br><small>© FREESCALE SEMICONDUCTOR, INC. ALL RIGHTS RESERVED.<br/>         ELECTRONIC DRAWING AND UNCONTROLLED COPY MAY BE RELEASED<br/>         DIRECTLY FROM THE SOURCE WITH CONTROL, IMPROVEMENT, WITHOUT NOTICE,<br/>         AND UNCONTROLLED COPY MAY BE REPRODUCED "CONTROLLED COPY" BY NXP.</small>   | MECHANICAL OUTLINES<br>DICTIONARY | DOCUMENT NO: 9BASH70126A    |
|  | DO NOT SCALE THIS DRAWING         | PAGE: 842F<br>REV: 8        |
| <p>1. DIMENSIONS AND TOLERANCING PER ASME Y14.5M-1994.</p> <p>2. CONTROLLING DIMENSION: MILLIMETER</p> <p>3. DATUM PLANE H IS LOCATED AT BOTTOM OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE BOTTOM OF THE PARTING LINE.</p> <p> DATUMS A, B, AND D TO BE DETERMINED AT DATUM PLANE H.</p> <p> DIMENSIONS TO BE DETERMINED AT SEATING PLANE, DATUM C.</p> <p> DIMENSIONS DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.25 PER SIDE. DIMENSIONS DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE H.</p> <p> DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. DAMBAR PROTRUSION SHALL NOT CAUSE THE LEAD WIDTH TO EXCEED 0.35. DAMBAR CAN NOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSION AND AN ADJACENT LEAD IS 0.07.</p> <p>8. MINIMUM SOLDER PLATE THICKNESS SHALL BE 0.0076.</p> <p> EXACT SHAPE OF EACH CORNER MAY VARY FROM DEPICTION.</p> |                                   |                             |
| TITLE: LQFP 100 LEAD<br>0.5 PITCH 14 X 14 X 1.4  |                                   | CASE NUMBER: 842F-02        |
|  |                                   | STANDARD: JEDEC MS-026 BEE  |
|  |                                   | PACKAGE CODE: 6076 SHEET: 3 |

Figure 50. 100 LQFP package mechanical drawing (Part 3 of 3)

5.1.4 208 MAPBGA

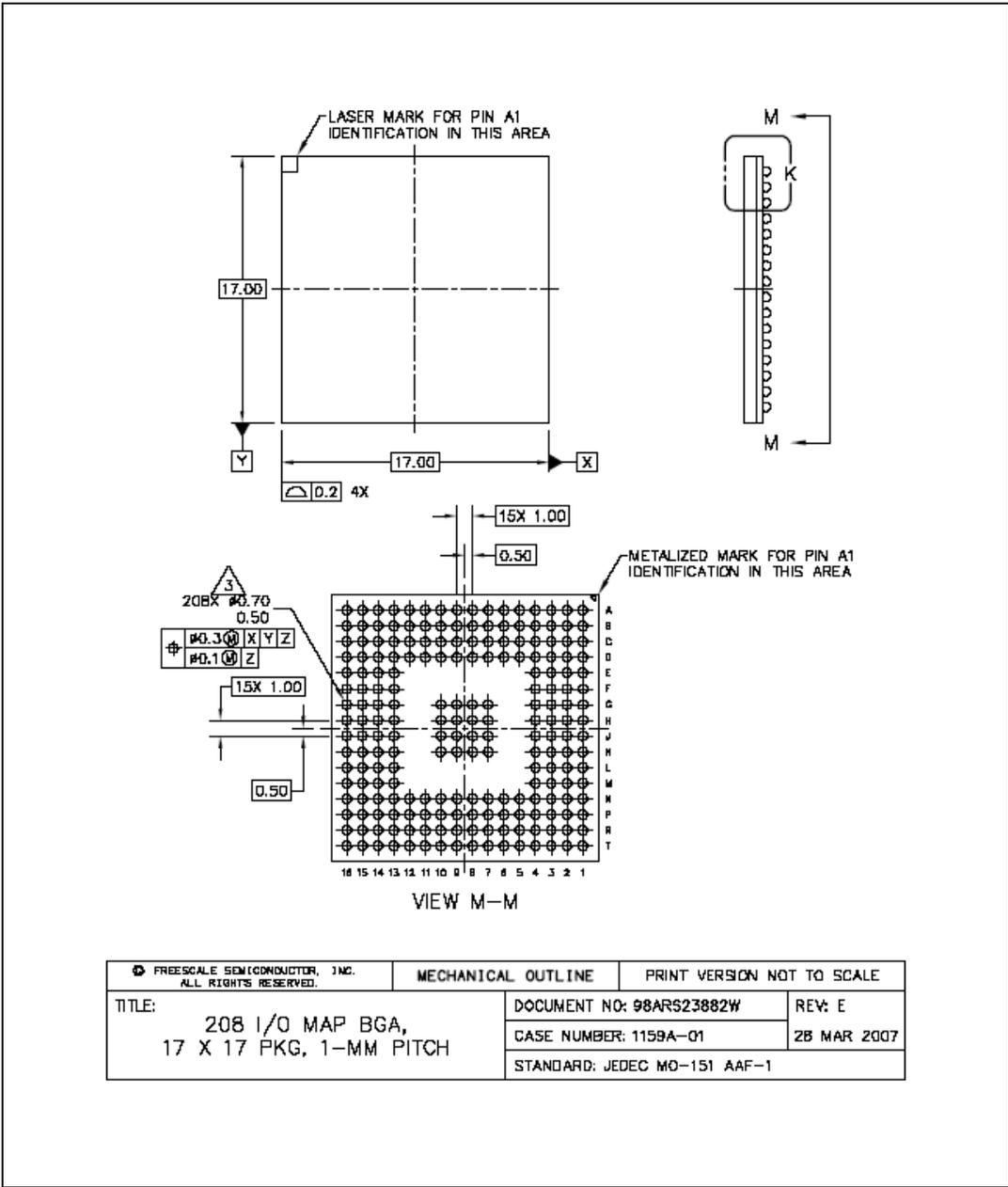


Figure 51. 208 MAPBGA package mechanical drawing (Part 1 of 2)

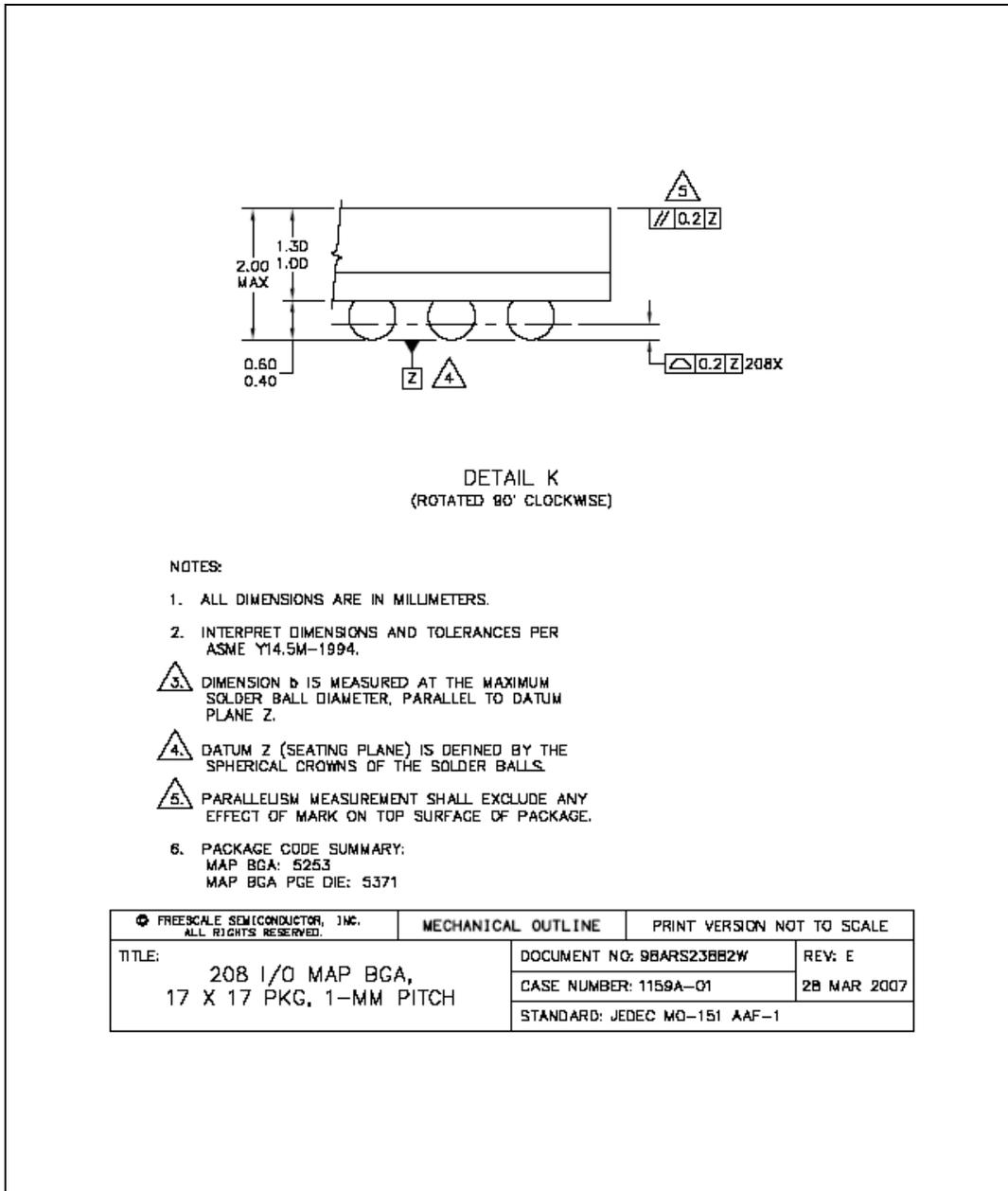
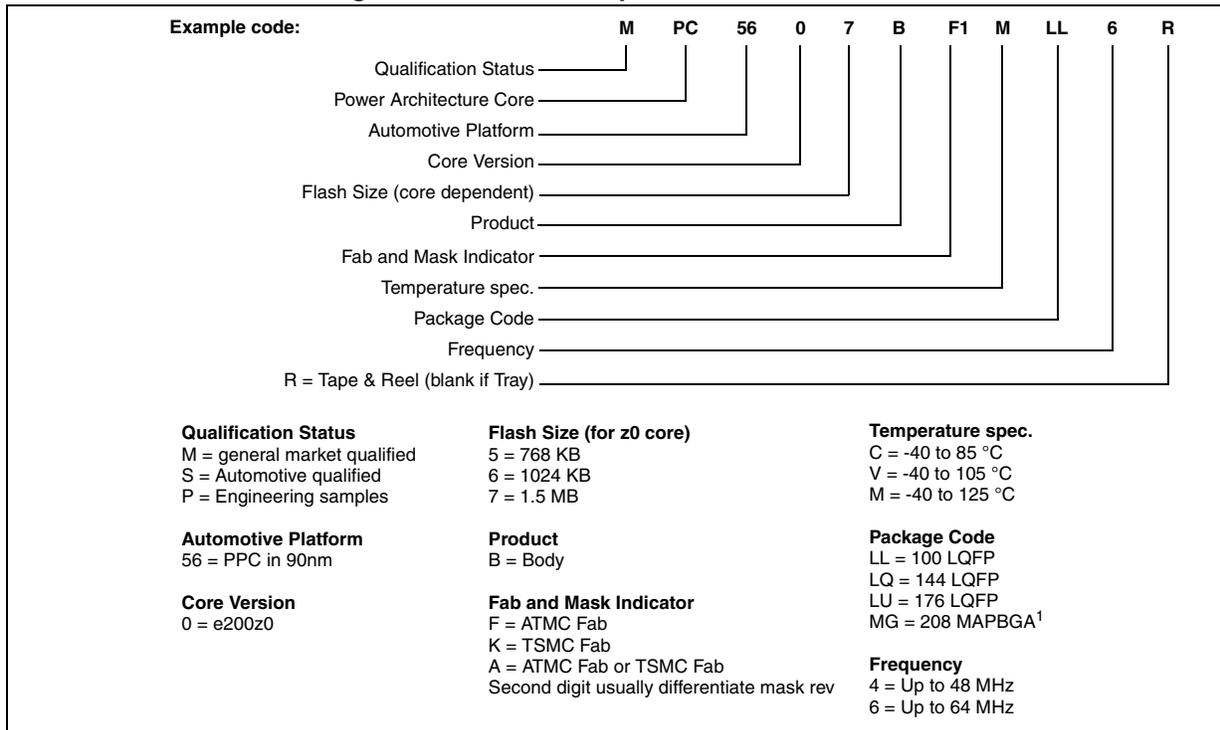


Figure 52. 208 MAPBGA package mechanical drawing (Part 2 of 2)

## 6 Ordering information

Figure 40. Commercial product code structure



Note: Not all options are available on all devices.

<sup>1</sup> 208 MAPBGA is available only as development package for Nexus2+.

## Appendix A Abbreviations

Table 53 lists abbreviations used but not defined elsewhere in this document.

Table 53. Abbreviations

| Abbreviation | Meaning                                 |
|--------------|---|
| CMOS         | Complementary metal oxide semiconductor |
| CPHA         | Clock phase                             |
| CPOL         | Clock polarity                          |
| CS           | Peripheral chip select                  |
| EVTO         | Event out                               |
| MCKO         | Message clock out                       |
| MDO          | Message data out                        |
| MSEO         | Message start/end out                   |
| MTFE         | Modified timing format enable           |
| SCK          | Serial communications clock             |
| SOUT         | Serial data out                         |

**Table 53. Abbreviations (continued)**

| <b>Abbreviation</b> | <b>Meaning</b>   |
|---------------------|------------------|
| TBD                 | To be defined    |
| TCK                 | Test clock input |
| TDI                 | Test data input  |
| TDO                 | Test data output |
| TMS                 | Test mode select |

## 7 Revision history

Table 54 summarizes revisions to this document.

**Table 54. Revision history**

| Revision | Date        | Substantive changes  |
|----------|-------------|--|
| 1        | 12-Jan-2009 | Initial release  |
| 2        | 09 Nov-2009 | <p>Updated Features</p> <p>Replaced 27 IRQs in place of 23</p> <p>ADC features</p> <p>External Ballast resistor support conditions</p> <p>Updated device summary-added 208 BGA details</p> <p>Updated block diagram to include WKUP</p> <p>Updated block diagram to include 5 ch ADC 12 -bit</p> <p>Updated Block summary table</p> <p>Updated LQFP 144, 176 and 100 pinouts. Applied new naming convention for ADC signals as ADCx_P[x] and ADCx_S[x]</p> <p>Section 1, "General description</p> <p>Updated MPC5607B device comparison table</p> <p>Updated block diagram-aligned with 512k</p> <p>Updated block summary-aligned with 512k</p> <p>Section 2, "Package pinouts</p> <p>Updated 100,144,176,208 packages according to cut2.0 changes</p> <p>Added Section 3.5.1, "External ballast resistor recommendations</p> <p>Added NVUSRO [WATCHDOG_EN] field description</p> <p>Updated Absolute maximum ratings</p> <p>Updated LQFP thermal characteristics</p> <p>Updated I/O supply segments</p> <p>Updated Voltage regulator capacitance connection</p> <p>Updated Low voltage monitor electrical characteristics</p> <p>Updated Low voltage power domain electrical characteristics</p> <p>Updated DC electrical characteristics</p> <p>Updated Program/Erase specifications</p> <p>Updated Conversion characteristics (10 bit ADC)</p> <p>Updated FMPLL electrical characteristics</p> <p>Updated Fast RC oscillator electrical characteristics-aligned with MPC5604B</p> <p>Updated On-chip peripherals current consumption</p> <p>Updated ADC characteristics and error definitions diagram</p> <p>Updated ADC conversion characteristics (10 bit and 12 bit)</p> <p>Added ADC characteristics and error definitions diagram for 12 bit ADC</p> |
| 3        | 25 Jan-2010 | <p>Updated Features</p> <p>Updated block diagram to connect peripherals to pad I/O</p> <p>Updated block summary to include ADC 12-bit</p> <p>Updated 144, 176 and 100 pinouts to adjust format issues</p> <p>Table 26 Flash module life-retention value changed from 1-5 to 5 yrs</p> <p>Minor editing changes</p>   |

Table 54. Revision history (continued)

| Revision | Date        | Substantive changes   |
|----------|-------------|---|
| 4        | 24 Aug 2010 | <p>Editorial changes and improvements.<br/> Updated “Features“ section<br/> <b>Table 1</b>: updated footnote concerning 208 MAPBGA<br/> In the block diagram:</p> <ul style="list-style-type: none"> <li>• Added “5ch 12-bit ADC“ block.</li> <li>• Updated Legend.</li> <li>• Added “Interrupt request with wakeup functionality“ as an input to the WKPU block.</li> </ul> <p><b>Figure 2</b>: removed alternate functions<br/> <b>Figure 3</b>: removed alternate functions<br/> <b>Figure 4</b>: removed alternate functions<br/> <b>Table 2</b>: added contents concerning the following blocks: CMU, eDMA, ECSM, MC_ME, MC_PCU, NMI, SSCM, SWT and WKPU<br/> Added <b>Section 3.2, Pin muxing</b><br/> <b>4, Electrical characteristics</b>: removed “Caution“ note<br/> <b>4.2, NVUSRO register</b>: removed “NVUSRO[WATCHDOG_EN] field description“ section<br/> <b>Table 11</b>: <math>V_{IN}</math>: removed min value in “relative to <math>V_{DD}</math>“ row<br/> <b>Table 12</b></p> <ul style="list-style-type: none"> <li>• <math>T_{A\ C-Grade\ Part}</math>, <math>T_{J\ C-Grade\ Part}</math>, <math>T_{A\ V-Grade\ Part}</math>, <math>T_{J\ V-Grade\ Part}</math>, <math>T_{A\ M-Grade\ Part}</math>, <math>T_{J\ M-Grade\ Part}</math>: added new rows</li> <li>• <math>T_{V_{DD}}</math>: contents merged into one row</li> <li>• <math>V_{DD\_BV}</math>: changed min value in “relative to <math>V_{DD}</math>“ row</li> </ul> <p><b>4.5, Thermal characteristics</b></p> <ul style="list-style-type: none"> <li>• <b>4.5.1, External ballast resistor recommendations</b>: added new paragraph about power supply</li> <li>• <b>Table 14</b>: added <math>R_{\theta JB}</math> and <math>R_{\theta JC}</math> rows</li> <li>• Removed “208 MAPBGA thermal characteristics“ table</li> </ul> <p><b>Table 15</b>: rewrote parameter description of <math>W_{FI}</math> and <math>W_{NFI}</math><br/> <b>4.6.5, I/O pad current specification</b></p> <ul style="list-style-type: none"> <li>• Removed <math>I_{DYNSEG}</math> information</li> <li>• Updated “I/O supply segments“ table</li> </ul> <p><b>Table 22</b>: removed <math>I_{DYNSEG}</math> row<br/> Added <b>Table 23</b><br/> <b>Table 25</b></p> <ul style="list-style-type: none"> <li>• Updated all values</li> <li>• Removed <math>I_{VREGREF}</math> and <math>I_{VREDLVD12}</math> rows</li> <li>• Added the footnote “The duration of the in-rush current depends on the capacitance placed on LV pins. BV decaps must be sized accordingly. Refer to IMREG value for minimum amount of current to be provided in cc.“ to the <math>I_{DD\_BV}</math> specification.</li> </ul> <p><b>Table 26</b></p> <ul style="list-style-type: none"> <li>• Updated <math>V_{PORH}</math> min/max value</li> <li>• Updated <math>V_{LVDLVCORL}</math> min value</li> </ul> <p>Updated <b>Table 27</b><br/> <b>Table 28</b></p> <ul style="list-style-type: none"> <li>• <math>T_{dwprogram}</math>: added initial max value</li> <li>• Inserted <math>T_{eslat}</math> row</li> </ul> <p><b>Table 29</b>: removed the “To be confirmed“ footnote<br/> In the “Crystal oscillator and resonator connection scheme“ figure, removed <math>R_P</math><br/> <b>Table 39</b></p> <ul style="list-style-type: none"> <li>• Removed <math>g_{mSXOSC}</math> row</li> <li>• <math>I_{SXOSCBIAS}</math>: added min/typ/max value</li> </ul> |

Table 54. Revision history (continued)

| Revision     | Date                   | Substantive changes   |
|--------------|------------------------|---|
| 4<br>(cont.) | 24 Aug 2010<br>(cont.) | <p><b>Table 40:</b></p> <ul style="list-style-type: none"> <li>Added <math>f_{VCO}</math> row</li> <li>Added <math>\Delta t_{STJIT}</math> row</li> </ul> <p><b>Table 41</b></p> <ul style="list-style-type: none"> <li><math>I_{FIRCPWD}</math>: removed row for <math>T_A = 55\text{ }^\circ\text{C}</math></li> <li>Updated <math>T_{FIRCSU}</math> row</li> </ul> <p><b>Table 44:</b> Added two rows: <math>I_{ADC0pwd}</math> and <math>I_{ADC0run}</math></p> <p><b>Table 45</b></p> <ul style="list-style-type: none"> <li>Added two rows: <math>I_{ADC1pwd}</math> and <math>I_{ADC1run}</math></li> <li>Updated values of <math>f_{ADC\_1}</math> and <math>t_{ADC1\_PU}</math></li> <li>Updated <math>t_{ADC1\_C}</math> row</li> </ul> <p>Updated <b>Table 46</b><br/>Updated <b>Table 47</b><br/>Updated <b>Figure 40</b><br/><b>6, Ordering information:</b> deleted “Orderable part number summary” table</p>   |
| 5            | 27 Aug 2010            | Removed “Preliminary—Subject to Change Without Notice” marking. This data sheet contains specifications based on characterization data.   |
| 6            | 08 Jul 2011            | <p>Editorial and formatting changes throughout</p> <p>Replaced instances of “e200z0” with “e200z0h”</p> <p>Device family comparison table:</p> <ul style="list-style-type: none"> <li>changed LINFlex count for 144-pin LQFP—was ‘6’; is ‘8’</li> <li>changed LINFlex count for 176-pin LQFP—was ‘8’; is ‘10’</li> <li>replaced <math>105\text{ }^\circ\text{C}</math> with <math>125\text{ }^\circ\text{C}</math> in footnote 2</li> </ul> <p>MPC5607B block diagram: added GPIO and VREG to legend</p> <p>MPC5607B series block summary: added acronym “JTAGC”; in WKPU function changed “up to 18 external sources” to “up to 27 external sources”</p> <p>144 LQFP pin configuration: for pins 37–72, restored the pin labels that existed prior to 27 July 2010</p> <p>176 LQFP pin configuration: corrected name of pin 4: was EPC[15]; is PC[15]</p> <p>Added following sections:</p> <ul style="list-style-type: none"> <li>Pad configuration during reset phases</li> <li>Pad configuration during standby mode exit</li> <li>Voltage supply pins</li> <li>Pad types</li> <li>System pins</li> <li>Functional port pins</li> <li>Nexus 2+ pins</li> </ul> <p>Section “NVUSRO register”: edited content to separate configuration into electrical parameters and digital functionality; updated footnote describing default value of ‘1’ in field descriptions NVUSRO[<math>PAD3V5V</math>] and NVUSRO[<math>OSCILLATOR\_MARGIN</math>]</p> <p>Added section “NVUSRO[<math>WATCHDOG\_EN</math>] field description”</p> <p>Tables “Absolute maximum ratings” and “Recommended operating conditions (3.3 V)”:</p> <ul style="list-style-type: none"> <li>replaced “VSS_HV_ADC0, VSS_HV_ADC1” with “VDD_HV_ADC0, VDD_HV_ADC1” in <math>V_{DD\_ADC}</math> parameter description</li> </ul> <p>“Recommended operating conditions (5.0 V)” table: replaced “VSS_HV_ADC0, VSS_HV_ADC1” with “VDD_HV_ADC0, VDD_HV_ADC1” in <math>V_{DD\_ADC}</math> parameter description; changed 3.6V to 3.0V in footnote 2</p> |

Table 54. Revision history (continued)

| Revision      | Date        | Substantive changes  |
|---------------|-------------|--|
| 6<br>(cont'd) | 08 Jul 2011 | <p>Section “External ballast resistor recommendations”: replaced “low voltage monitor” with “low voltage detector (LVD)”</p> <p>“I/O input DC electrical characteristics” table: updated <math>I_{LKG}</math> characteristics</p> <p>“MEDIUM configuration output buffer electrical characteristics” table: changed “<math>I_{OH} = 100 \mu A</math>” to “<math>I_{OL} = 100 \mu A</math>” in <math>V_{OL}</math> conditions</p> <p>I/O weight: updated table (includes replacing instances of bit “SRE” with “SRC”)</p> <p>“Reset electrical characteristics” table: updated parameter classification for <math>I_{WPU}</math></p> <p>Updated voltage regulator electrical characteristics</p> <p>Section “Low voltage detector electrical characteristics”: changed title (was “Voltage monitor electrical characteristics”); changed “as well as four low voltage detectors” to “as well as five low voltage detectors”; added event status flag names found in RGM chapter of device reference manual to POR module and LVD descriptions; replaced instances of “Low voltage monitor” with “Low voltage detector”; updated values for <math>V_{LVDLVBKPL}</math> and <math>V_{LVDLVCORL}</math></p> <p>Updated section “Power consumption”</p> <p>Section “Program/erase characteristics”: removed table “FLASH_BIU settings vs. frequency of operation” and associated introduction</p> <p>“Program and erase specifications” table: updated symbols</p> <p>PFCRn settings vs. frequency of operation: replaced “FLASH_BIU” with “PFCRn” in table title; updated field names and frequencies</p> <p>“Flash power supply DC electrical characteristics” table: deleted footnote 2</p> <p>Crystal oscillator and resonator connection scheme: inserted footnote about possibly requiring a series resistor</p> <p>Fast external crystal oscillator (4 to 16 MHz) electrical characteristics: updated parameter classification for <math>V_{FXOSCOP}</math></p> <p>Slow external crystal oscillator (32 kHz) electrical characteristics: updated footnote 1</p> <p>Section “ADC electrical characteristics”: updated symbols for offset error and gain error</p> <p>Section “Input impedance and ADC accuracy”: changed “<math>V_A/V_{A2}</math>” to “<math>V_{A2}/V_A</math>” in Equation 11</p> <p>ADC input leakage current: updated <math>I_{LKG}</math> characteristics</p> <p>ADC_0 conversion characteristics table: replaced instances of “ADCx_conf_sample_input” with “INPSAMP”; replaced instances of “ADCx_conf_comp” with “INPCMP”</p> <p>ADC_1 characteristic and error definitions: replaced “AVDD” with “<math>V_{DD\_ADC}</math>”</p> <p>ADC_1 conversion characteristics table: replaced instances of “ADCx_conf_sample_input” with “INPSAMP”; replaced instances of “ADCx_conf_comp” with “INPCMP”</p> <p>Updated “On-chip peripherals current consumption” table</p> |

Table 54. Revision history (continued)

| Revision | Date          | Substantive changes  |
|----------|---------------|--|
| 7        | 13 May 2013   | <p>In the cover feature list:<br/> added “and ECC” at the end of<br/> “Up to 1.5 MB on-chip code flash memory supported with the flash memory controller”<br/> added “with ECC” at the end of “Up to 96 KB on-chip SRAM”</p> <p><a href="#">Table 1 (MPC5607B family comparison)</a>, updated SCI (LINFlex) values, 8 channels for both MPC5605B and MPC5606B 176-pin.</p> <p><a href="#">Table 12 (Recommended operating conditions (3.3 V))</a>, updated conditions of <math>T_A</math> values and relative footnote.</p> <p><a href="#">Table 13 (Recommended operating conditions (5.0 V))</a>, updated conditions of <math>T_A</math> values and relative footnote.</p> <p><a href="#">Table 20 (Output pin transition times)</a>, replaced <math>T_{tr}</math> with <math>t_{tr}</math></p> <p><a href="#">Table 24 (Reset electrical characteristics)</a>, replaced <math>T_{tr}</math> with <math>t_{tr}</math></p> <p>Updated <a href="#">Section 4.16.2, “Input impedance and ADC accuracy”</a></p> <p><a href="#">Table 26 (Low voltage detector electrical characteristics)</a>, changed <math>V_{LVDHV3L}(\text{min})</math> and <math>V_{LVDHV3BL}(\text{min})</math> from 2.7 V to 2.6 V.</p> <p><a href="#">Table 28 (Program and erase specifications)</a>, added footnote about <math>t_{ESRT}</math></p> <p><a href="#">Table 40 (FMPLL electrical characteristics)</a>, deleted footnote relative to maximum value of <math>f_{CPU}</math></p> <p><a href="#">Table 44 (ADC_0 conversion characteristics (10-bit ADC_0))</a>, changed <math>I_{ADC0run}</math> value from 40 mA to 5 mA.</p> <p><a href="#">Table 47 (DSPI characteristics)</a>, in the heading row, replaced DSPI0/DSPI1/DSPI5/DSPI6 with DSPI0/DSPI1/DSPI3/DSPI5</p> |
| 8        | 19 Mar 2014   | <p>Added “K=TSMC Fab” against the Fab and mask indicator in <a href="#">Figure 40 (Commercial product code structure)</a>.</p>   |
| 9        | 9 Nov 2017    | <p>In <a href="#">Table 12 (Recommended operating conditions (3.3 V))</a> added Min value for <math>T_{VDD}</math>.</p> <p>In <a href="#">Table 13 (Recommended operating conditions (5.0 V))</a> added Min value for <math>T_{VDD}</math>.</p> <p>In <a href="#">6, Ordering information</a> added note “Not all options are available on all devices”.</p>   |
| 10       | 8 August 2021 | <p>In <a href="#">6, Ordering information</a>, updated Fab and Mask indicator.</p>   |