# LPC1850/30/20/10

## 32-bit ARM Cortex-M3 MCU; up to 200 kB SRAM; Ethernet, two High-speed USB, LCD, and external memory controller

Rev. 6.1 — 7 February 2013 Product data sheet

## 1. General description

The LPC1850/30/20/10 are ARM Cortex-M3 based microcontrollers for embedded applications. The ARM Cortex-M3 is a next generation core that offers system enhancements such as low power consumption, enhanced debug features, and a high level of support block integration.

The LPC1850/30/20/10 operate at CPU frequencies of up to 180 MHz. The ARM Cortex-M3 CPU incorporates a 3-stage pipeline and uses a Harvard architecture with separate local instruction and data buses as well as a third bus for peripherals. The ARM Cortex-M3 CPU also includes an internal prefetch unit that supports speculative branching.

The LPC1850/30/20/10 include up to 200 kB of on-chip SRAM, a quad SPI Flash Interface (SPIFI), a State Configurable Timer (SCT) subsystem, two High-speed USB controllers, Ethernet, LCD, an external memory controller, and multiple digital and analog peripherals.

## 2. Features and benefits

- Processor core
  - ARM Cortex-M3 processor, running at frequencies of up to 180 MHz.
  - ARM Cortex-M3 built-in Memory Protection Unit (MPU) supporting eight regions.
  - ARM Cortex-M3 built-in Nested Vectored Interrupt Controller (NVIC).
  - Non-maskable Interrupt (NMI) input.
  - JTAG and Serial Wire Debug, serial trace, eight breakpoints, and four watch points.
  - Enhanced Trace Module (ETM) and Enhanced Trace Buffer (ETB) support.
  - System tick timer.
- On-chip memory
  - 200 kB SRAM for code and data use.
  - Multiple SRAM blocks with separate bus access.
  - 64 kB ROM containing boot code and on-chip software drivers.
  - 32-bit One-Time Programmable (OTP) memory for general-purpose use.
- Clock generation unit
  - Crystal oscillator with an operating range of 1 MHz to 25 MHz.
  - 12 MHz internal RC oscillator trimmed to 1 % accuracy over temperature and voltage.
  - Ultra-low power RTC crystal oscillator.

- Three PLLs allow CPU operation up to the maximum CPU rate without the need for a high-frequency crystal. The second PLL is dedicated to the High-speed USB, the third PLL can be used as audio PLL.
- Clock output.

- Configurable digital peripherals:
  - State Configurable Timer (SCT) subsystem on AHB.
  - Global Input Multiplexer Array (GIMA) allows to cross-connect multiple inputs and outputs to event driven peripherals like timers, SCT, and ADC0/1.
- Serial interfaces:
  - Quad SPI Flash Interface (SPIFI) with 1-, 2-, or 4-bit data at rates of up to 52 MB per second.
  - 10/100T Ethernet MAC with RMII and MII interfaces and DMA support for high throughput at low CPU load. Support for IEEE 1588 time stamping/advanced time stamping (IEEE 1588-2008 v2).
  - One High-speed USB 2.0 Host/Device/OTG interface with DMA support and on-chip high-speed PHY (USB0).
  - One High-speed USB 2.0 Host/Device interface with DMA support, on-chip full-speed PHY and ULPI interface to an external high-speed PHY (USB1).
  - USB interface electrical test software included in ROM USB stack.
  - Four 550 UARTs with DMA support: one UART with full modem interface; one UART with IrDA interface; three USARTs support UART synchronous mode and a smart card interface conforming to ISO7816 specification.
  - Up to two C_CAN 2.0B controllers with one channel each. Use of C_CAN controller excludes operation of all other peripherals connected to the same bus bridge See Figure 1 and Ref. 1.
  - Two SSP controllers with FIFO and multi-protocol support. Both SSPs with DMA support.
  - One Fast-mode Plus $I^2C$-bus interface with monitor mode and with open-drain I/O pins conforming to the full $I^2C$-bus specification. Supports data rates of up to 1 Mbit/s.
  - One standard $I^2C$-bus interface with monitor mode and standard I/O pins.
  - Two $I^2S$ interfaces with DMA support, each with one input and one output.
- Digital peripherals:
  - External Memory Controller (EMC) supporting external SRAM, ROM, NOR flash, and SDRAM devices.
  - LCD controller with DMA support and a programmable display resolution of up to 1024 H $\times$ 768 V. Supports monochrome and color STN panels and TFT color panels; supports 1/2/4/8 bpp Color Look-Up Table (CLUT) and 16/24-bit direct pixel mapping.
  - Secure Digital Input Output (SD/MMC) card interface.
  - Eight-channel General-Purpose DMA controller can access all memories on the AHB and all DMA-capable AHB slaves.
  - Up to 164 General-Purpose Input/Output (GPIO) pins with configurable pull-up/pull-down resistors.
  - GPIO registers are located on the AHB for fast access. GPIO ports have DMA support.

- Up to eight GPIO pins can be selected from all GPIO pins as edge and level sensitive interrupt sources.
- Two GPIO group interrupt modules enable an interrupt based on a programmable pattern of input states of a group of GPIO pins.
- Four general-purpose timer/counters with capture and match capabilities.
- One motor control PWM for three-phase motor control.
- One Quadrature Encoder Interface (QEI).
- Repetitive Interrupt timer (RI timer).
- Windowed watchdog timer.
- Ultra-low power Real-Time Clock (RTC) on separate power domain with 256 bytes of battery powered backup registers.
- Alarm timer; can be battery powered.

- Analog peripherals:
  - One 10-bit DAC with DMA support and a data conversion rate of 400 kSamples/s.
  - Two 10-bit ADCs with DMA support and a data conversion rate of 400 kSamples/s. Up to eight input channels per ADC.
  - Unique ID for each device.
- Power:
  - Single 3.3 V (2.2 V to 3.6 V) power supply with on-chip internal voltage regulator for the core supply and the RTC power domain.
  - RTC power domain can be powered separately by a 3 V battery supply.
  - Four reduced power modes: Sleep, Deep-sleep, Power-down, and Deep power-down.
  - Processor wake-up from Sleep mode via wake-up interrupts from various peripherals.
  - Wake-up from Deep-sleep, Power-down, and Deep power-down modes via external interrupts and interrupts generated by battery powered blocks in the RTC power domain.
  - Brownout detect with four separate thresholds for interrupt and forced reset.
  - Power-On Reset (POR).
- Available as 208-pin and 144-pin LQFP packages and as 256-pin, 180-pin, and 100-pin BGA packages.

## 3. Applications

- Industrial
- Consumer
- White goods
- RFID readers
- e-Metering

# 4. Ordering information

**Table 1. Ordering information**

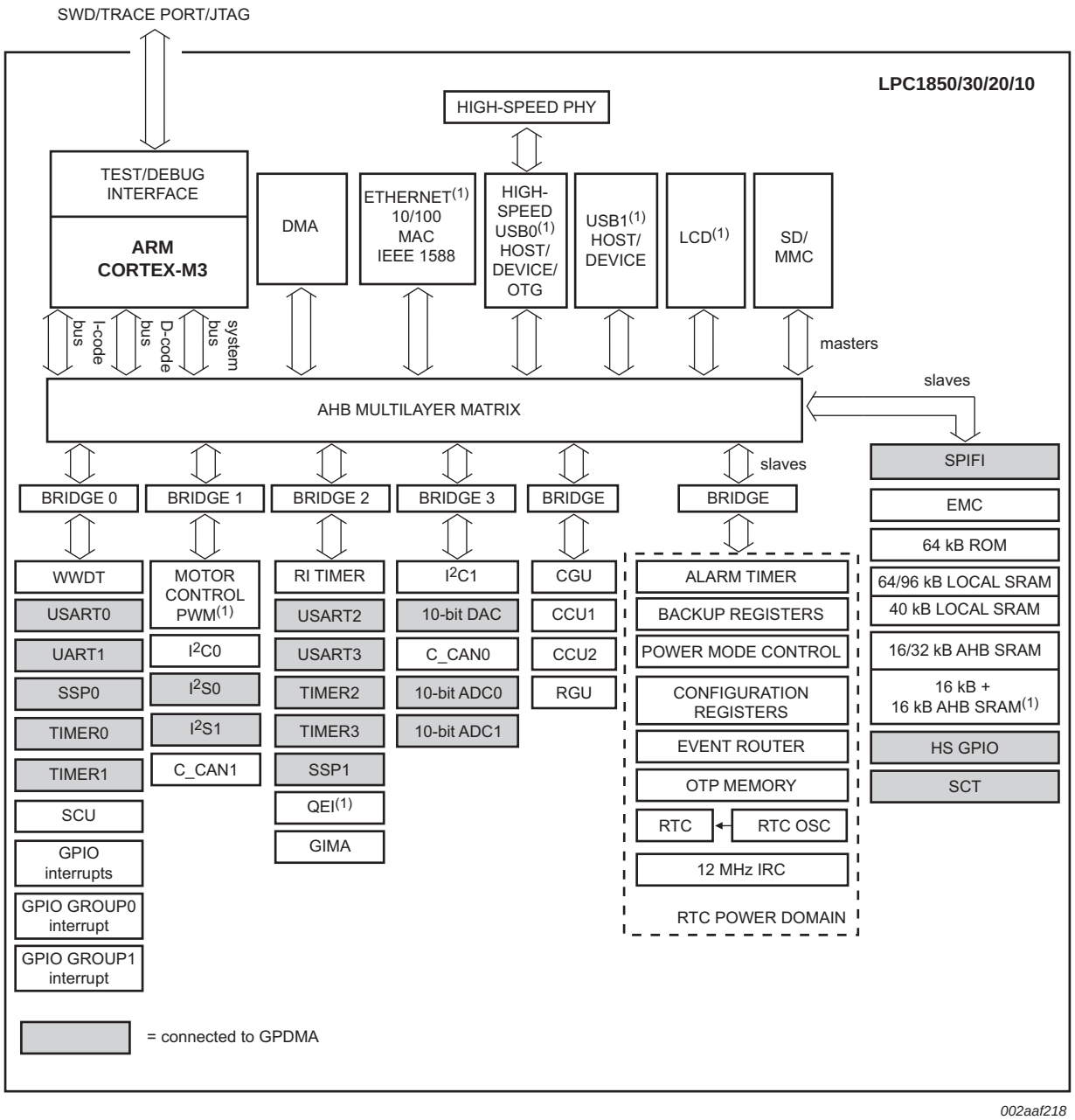
| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| LPC1850FET256 | LBGA256 | Plastic low profile ball grid array package; 256 balls; body 17 × 17 × 1 mm | SOT740-2 |
| LPC1850FET180 | TFBGA180 | Thin fine-pitch ball grid array package; 180 balls | SOT570-3 |
| LPC1850FBD208 | LQFP208 | Plastic low profile quad flat package; 208 leads; body 28 × 28 × 1.4 mm | SOT459-1 |
| LPC1830FET256 | LBGA256 | Plastic low profile ball grid array package; 256 balls; body 17 × 17 × 1 mm | SOT740-2 |
| LPC1830FET180 | TFBGA180 | Thin fine-pitch ball grid array package; 180 balls | SOT570-3 |
| LPC1830FET100 | TFBGA100 | Plastic thin fine-pitch ball grid array package; 100 balls; body 9 × 9 × 0.7 mm | SOT926-1 |
| LPC1830FBD144 | LQFP144 | Plastic low profile quad flat package; 144 leads; body 20 × 20 × 1.4 mm | SOT486-1 |
| LPC1820FET100 | TFBGA100 | Plastic thin fine-pitch ball grid array package; 100 balls; body 9 × 9 × 0.7 mm | SOT926-1 |
| LPC1820FBD144 | LQFP144 | Plastic low profile quad flat package; 144 leads; body 20 × 20 × 1.4 mm | SOT486-1 |
| LPC1810FET100 | TFBGA100 | Plastic thin fine-pitch ball grid array package; 100 balls; body 9 × 9 × 0.7 mm | SOT926-1 |
| LPC1810FBD144 | LQFP144 | Plastic low profile quad flat package; 144 leads; body 20 × 20 × 1.4 mm | SOT486-1 |

## 4.1 Ordering options

**Table 2. Ordering options**

| Type number | Total SRAM | LCD | Ethernet | USB0 (Host, Device, OTG) | USB1 (Host, Device)/ ULPI interface | ADC channels | PWM | QEI | GPIO | Package |
|---|---|---|---|---|---|---|---|---|---|---|
| LPC1850FET256 | 200 kB | yes | yes | yes | yes/yes | 8 | yes | yes | 164 | LBGA256 |
| LPC1850FET180 | 200 kB | yes | yes | yes | yes/yes | 8 | yes | yes | 118 | TFBGA180 |
| LPC1850FBD208 | 200 kB | yes | yes | yes | yes/yes | 8 | yes | yes | 142 | LQFP208 |
| LPC1830FET256 | 200 kB | no | yes | yes | yes/yes | 8 | yes | yes | 164 | LBGA256 |
| LPC1830FET180 | 200 kB | no | yes | yes | yes/yes | 8 | yes | yes | 118 | TFBGA180 |
| LPC1830FET100 | 200 kB | no | yes | yes | yes/no | 4 | no | no | 49 | TFBGA100 |
| LPC1830FBD144 | 200 kB | no | yes | yes | yes/no | 8 | yes | no | 83 | LQFP144 |
| LPC1820FET100 | 168 kB | no | no | yes | no | 4 | no | no | 49 | TFBGA100 |
| LPC1820FBD144 | 168 kB | no | no | yes | no | 8 | yes | no | 83 | LQFP144 |
| LPC1810FET100 | 136 kB | no | no | no | no | 4 | no | no | 49 | TFBGA100 |
| LPC1810FBD144 | 136 kB | no | no | no | no | 8 | yes | no | 83 | LQFP144 |

# 5. Block diagram




(1) Not available on all parts (see Table 2).

**Fig 1. LPC1850/30/20/10 block diagram**

# 6. Pinning information

## 6.1 Pinning

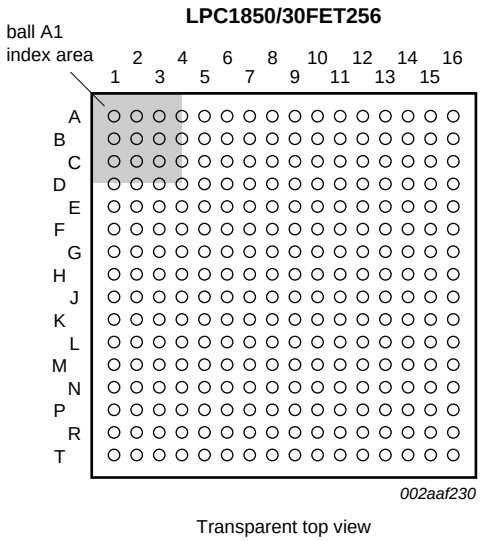



Fig 2. Pin configuration LBGA256 package

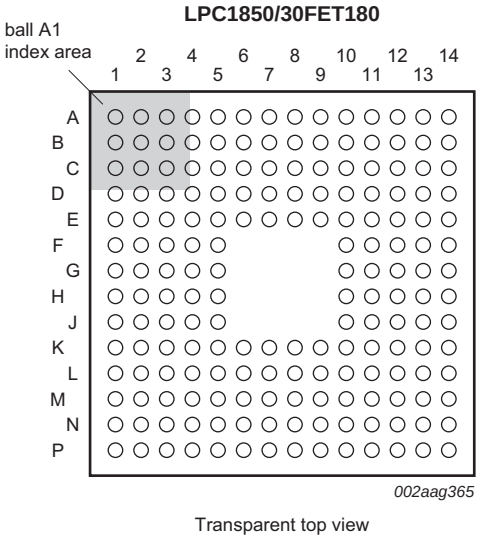



Fig 3. Pin configuration TFBGA180 package

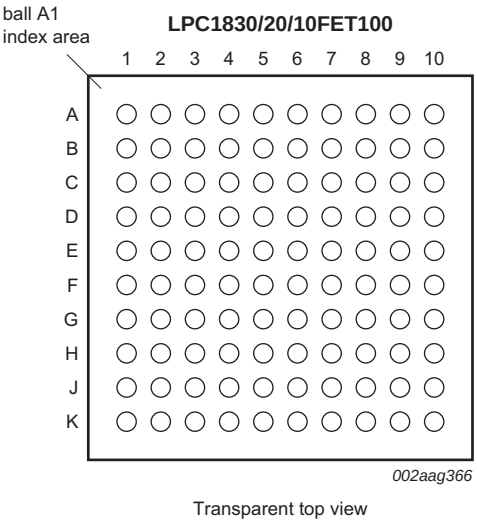



Fig 4. Pin configuration TFBGA100 package

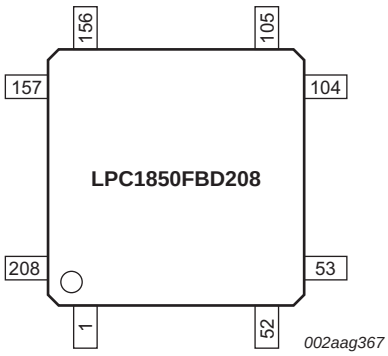



Fig 5. Pin configuration LQFP208 package

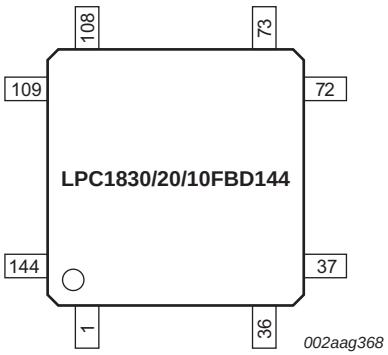



Fig 6. Pin configuration LQFP144 package

## 6.2 Pin description

On the LPC1850/30/20/10, digital pins are grouped into 16 ports, named P0 to P9 and PA to PF, with up to 20 pins used per port. Each digital pin can support up to eight different digital functions, including General-Purpose I/O (GPIO), selectable through the System Configuration Unit (SCU) registers. The pin name is not indicative of the GPIO port assigned to it.

Not all functions listed in Table 3 are available on all packages. See Table 2 for availability of USB0, USB1, Ethernet, and LCD functions.

**Table 3. Pin description**

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| **Multiplexed digital pins** | | | | | | | | | |
| P0_0 | L3 | K3 | G2 | 47 | 32 | [2] | N; PU | I/O | **GPIO0[0] —** General purpose digital input/output pin. |
| | | | | | | | | I/O | **SSP1_MISO —** Master In Slave Out for SSP1. |
| | | | | | | | | I | **ENET_RXD1 —** Ethernet receive data 1 (RMII/MII interface). |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **I2S0_TX_WS —** Transmit Word Select. It is driven by the master and received by the slave. Corresponds to the signal WS in the *I²S-bus specification*. |
| | | | | | | | | I/O | **I2S1_TX_WS —** Transmit Word Select. It is driven by the master and received by the slave. Corresponds to the signal WS in the *I²S-bus specification*. |
| P0_1 | M2 | K2 | G1 | 50 | 34 | [2] | N; PU | I/O | **GPIO0[1] —** General purpose digital input/output pin. |
| | | | | | | | | I/O | **SSP1_MOSI —** Master Out Slave in for SSP1. |
| | | | | | | | | I | **ENET_COL —** Ethernet Collision detect (MII interface). |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | | **ENET_TX_EN —** Ethernet transmit enable (RMII/MII interface). |
| | | | | | | | | I/O | **I2S1_TX_SDA —** I²S1 transmit data. It is driven by the transmitter and read by the receiver. Corresponds to the signal SD in the *I²S-bus specification*. |
| P1_0 | P2 | L1 | H1 | 54 | 38 | [2] | N; PU | I/O | **GPIO0[4] —** General purpose digital input/output pin. |
| | | | | | | | | I | **CTIN_3 —** SCT input 3. Capture input 1 of timer 1. |
| | | | | | | | | I/O | **EMC_A5 —** External memory address line 5. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SSP0_SSEL —** Slave Select for SSP0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P1_1 | R2 | N1 | K2 | 58 | 42 | [2] | N; PU | I/O | **GPIO0[8] —** General purpose digital input/output pin. Boot pin (see Table 5). |
| | | | | | | | | O | **CTOUT_7 —** SCT output 7. Match output 3 of timer 1. |
| | | | | | | | | I/O | **EMC_A6 —** External memory address line 6. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SSP0_MISO —** Master In Slave Out for SSP0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P1_2 | R3 | N2 | K1 | 60 | 43 | [2] | N; PU | I/O | **GPIO0[9] —** General purpose digital input/output pin. Boot pin (see Table 5). |
| | | | | | | | | O | **CTOUT_6 —** SCT output 6. Match output 2 of timer 1. |
| | | | | | | | | I/O | **EMC_A7 —** External memory address line 7. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SSP0_MOSI —** Master Out Slave in for SSP0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P1_3 | P5 | M2 | J1 | 61 | 44 | [2] | N; PU | I/O | **GPIO0[10] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_8 —** SCT output 8. Match output 0 of timer 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **$\overline{\text{EMC\_OE}}$ —** LOW active Output Enable signal. |
| | | | | | | | | O | **USB0_IND1 —** USB0 port indicator LED control output 1. |
| | | | | | | | | I/O | **SSP1_MISO —** Master In Slave Out for SSP1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **SD_RST —** SD/MMC reset signal for MMC4.4 card. |
| P1_4 | T3 | P2 | J2 | 64 | 47 | [2] | N; PU | I/O | **GPIO0[11] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_9 —** SCT output 9. Match output 3 of timer 3. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **$\overline{\text{EMC\_BLS0}}$ —** LOW active Byte Lane select signal 0. |
| | | | | | | | | O | **USB0_IND0 —** USB0 port indicator LED control output 0. |
| | | | | | | | | I/O | **SSP1_MOSI —** Master Out Slave in for SSP1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **SD_VOLT1 —** SD/MMC bus voltage select output 1. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P1_5 | R5 | N3 | J4 | 65 | 48 | [2] | N; PU | I/O | **GPIO1[8] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_10 —** SCT output 10. Match output 3 of timer 3. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **$\overline{\text{EMC\_CS0}}$ —** LOW active Chip Select 0 signal. |
| | | | | | | | | I | **USB0_PWR_FAULT —** Port power fault signal indicating overcurrent condition; this signal monitors over-current on the USB bus (external circuitry required to detect over-current condition). |
| | | | | | | | | I/O | **SSP1_SSEL —** Slave Select for SSP1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **SD_POW —** SD/MMC card power monitor output. |
| P1_6 | T4 | P3 | K4 | 67 | 49 | [2] | N; PU | I/O | **GPIO1[9] —** General purpose digital input/output pin. |
| | | | | | | | | I | **CTIN_5 —** SCT input 5. Capture input 2 of timer 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **$\overline{\text{EMC\_WE}}$ —** LOW active Write Enable signal. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SD_CMD —** SD/MMC command signal. |
| P1_7 | T5 | N4 | G4 | 69 | 50 | [2] | N; PU | I/O | **GPIO1[0] —** General purpose digital input/output pin. |
| | | | | | | | | I | **U1_DSR —** Data Set Ready input for UART1. |
| | | | | | | | | O | **CTOUT_13 —** SCT output 13. Match output 3 of timer 3. |
| | | | | | | | | I/O | **EMC_D0 —** External memory data line 0. |
| | | | | | | | | O | **USB0_PPWR —** VBUS drive signal (towards external charge pump or power management unit); indicates that VBUS must be driven (active HIGH).<br>Add a pull-down resistor to disable the power switch at reset. This signal has opposite polarity compared to the USB_PPWR used on other NXP LPC parts. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P1_8 | R7 | M5 | H5 | 71 | 51 | [2] | N; PU | I/O | **GPIO1[1] —** General purpose digital input/output pin. |
| | | | | | | | | O | **U1_DTR —** Data Terminal Ready output for UART1. |
| | | | | | | | | O | **CTOUT_12 —** SCT output 12. Match output 3 of timer 3. |
| | | | | | | | | I/O | **EMC_D1 —** External memory data line 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **SD_VOLT0 —** SD/MMC bus voltage select output 0. |
| P1_9 | T7 | N5 | J5 | 73 | 52 | [2] | N; PU | I/O | **GPIO1[2] —** General purpose digital input/output pin. |
| | | | | | | | | O | **U1_RTS —** Request to Send output for UART1. |
| | | | | | | | | O | **CTOUT_11 —** SCT output 11. Match output 3 of timer 2. |
| | | | | | | | | I/O | **EMC_D2 —** External memory data line 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SD_DAT0 —** SD/MMC data bus line 0. |
| P1_10 | R8 | N6 | H6 | 75 | 53 | [2] | N; PU | I/O | **GPIO1[3] —** General purpose digital input/output pin. |
| | | | | | | | | I | **U1_RI —** Ring Indicator input for UART1. |
| | | | | | | | | O | **CTOUT_14 —** SCT output 14. Match output 2 of timer 3. |
| | | | | | | | | I/O | **EMC_D3 —** External memory data line 3. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SD_DAT1 —** SD/MMC data bus line 1. |
| P1_11 | T9 | P8 | J7 | 77 | 55 | [2] | N; PU | I/O | **GPIO1[4] —** General purpose digital input/output pin. |
| | | | | | | | | I | **U1_CTS —** Clear to Send input for UART1. |
| | | | | | | | | O | **CTOUT_15 —** SCT output 15. Match output 3 of timer 3. |
| | | | | | | | | I/O | **EMC_D4 —** External memory data line 4. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SD_DAT2 —** SD/MMC data bus line 2. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P1_12 | R9 | P7 | K7 | 78 | 56 | [2] | N; PU | I/O | **GPIO1[5] —** General purpose digital input/output pin. |
| | | | | | | | | I | **U1_DCD —** Data Carrier Detect input for UART1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **EMC_D5 —** External memory data line 5. |
| | | | | | | | | I | **T0_CAP1 —** Capture input 1 of timer 0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SD_DAT3 —** SD/MMC data bus line 3. |
| P1_13 | R10 | L8 | H8 | 83 | 60 | [2] | N; PU | I/O | **GPIO1[6] —** General purpose digital input/output pin. |
| | | | | | | | | O | **U1_TXD —** Transmitter output for UART1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **EMC_D6 —** External memory data line 6. |
| | | | | | | | | I | **T0_CAP0 —** Capture input 0 of timer 0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **SD_CD —** SD/MMC card detect input. |
| P1_14 | R11 | K7 | J8 | 85 | 61 | [2] | N; PU | I/O | **GPIO1[7] —** General purpose digital input/output pin. |
| | | | | | | | | I | **U1_RXD —** Receiver input for UART1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **EMC_D7 —** External memory data line 7. |
| | | | | | | | | O | **T0_MAT2 —** Match output 2 of timer 0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P1_15 | T12 | P11 | K8 | 87 | 62 | [2] | N; PU | I/O | **GPIO0[2] —** General purpose digital input/output pin. |
| | | | | | | | | O | **U2_TXD —** Transmitter output for USART2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **ENET_RXD0 —** Ethernet receive data 0 (RMII/MII interface). |
| | | | | | | | | O | **T0_MAT1 —** Match output 1 of timer 0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P1_16 | M7 | L5 | H9 | 90 | 64 | [2] | N; PU | I/O | **GPIO0[3] —** General purpose digital input/output pin. |
| | | | | | | | | I | **U2_RXD —** Receiver input for USART2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **ENET_CRS —** Ethernet Carrier Sense (MII interface). |
| | | | | | | | | O | **T0_MAT0 —** Match output 0 of timer 0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **ENET_RX_DV —** Ethernet Receive Data Valid (RMII/MII interface). |
| P1_17 | M8 | L6 | H10 | 93 | 66 | [3] | N; PU | I/O | **GPIO0[12] —** General purpose digital input/output pin. |
| | | | | | | | | I/O | **U2_UCLK —** Serial clock input/output for USART2 in synchronous mode. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **ENET_MDIO —** Ethernet MIIM data input and output. |
| | | | | | | | | I | **T0_CAP3 —** Capture input 3 of timer 0. |
| | | | | | | | | O | **CAN1_TD —** CAN1 transmitter output. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P1_18 | N12 | N10 | J10 | 95 | 67 | [2] | N; PU | I/O | **GPIO0[13] —** General purpose digital input/output pin. |
| | | | | | | | | I/O | **U2_DIR —** RS-485/EIA-485 output enable/direction control for USART2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **ENET_TXD0 —** Ethernet transmit data 0 (RMII/MII interface). |
| | | | | | | | | O | **T0_MAT3 —** Match output 3 of timer 0. |
| | | | | | | | | I | **CAN1_RD —** CAN1 receiver input. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P1_19 | M11 | N9 | K9 | 96 | 68 | [2] | N; PU | I | **ENET_TX_CLK (ENET_REF_CLK) —** Ethernet Transmit Clock (MII interface) or Ethernet Reference Clock (RMII interface). |
| | | | | | | | | I/O | **SSP1_SCK —** Serial clock for SSP1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **CLKOUT —** Clock output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **I2S0_RX_MCLK —** $I^2S$ receive master clock. |
| | | | | | | | | I/O | **I2S1_TX_SCK —** Transmit Clock. It is driven by the master and received by the slave. Corresponds to the signal SCK in the *$I^2S$-bus specification*. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P1_20 | M10 | J10 | K10 | 100 | 70 | [2] | N; PU | I/O | **GPIO0[15] —** General purpose digital input/output pin. |
| | | | | | | | | I/O | **SSP1_SSEL —** Slave Select for SSP1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **ENET_TXD1 —** Ethernet transmit data 1 (RMII/MII interface). |
| | | | | | | | | I | **T0_CAP2 —** Capture input 2 of timer 0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P2_0 | T16 | N14 | G10 | 108 | 75 | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **U0_TXD —** Transmitter output for USART0. |
| | | | | | | | | I/O | **EMC_A13 —** External memory address line 13. |
| | | | | | | | | O | **USB0_PPWR —** VBUS drive signal (towards external charge pump or power management unit); indicates that VBUS must be driven (active high).<br>Add a pull-down resistor to disable the power switch at reset. This signal has opposite polarity compared to the USB_PPWR used on other NXP LPC parts. |
| | | | | | | | | I/O | **GPIO5[0] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **T3_CAP0 —** Capture input 0 of timer 3. |
| | | | | | | | | O | **ENET_MDC —** Ethernet MIIM clock. |
| P2_1 | N15 | M13 | G7 | 116 | 81 | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I | **U0_RXD —** Receiver input for USART0. |
| | | | | | | | | I/O | **EMC_A12 —** External memory address line 12. |
| | | | | | | | | I | **USB0_PWR_FAULT —** Port power fault signal indicating overcurrent condition; this signal monitors over-current on the USB bus (external circuitry required to detect over-current condition). |
| | | | | | | | | I/O | **GPIO5[1] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **T3_CAP1 —** Capture input 1 of timer 3. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P2_2 | M15 | L13 | F5 | 121 | 84 | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I/O | **U0_UCLK —** Serial clock input/output for USART0 in synchronous mode. |
| | | | | | | | | I/O | **EMC_A11 —** External memory address line 11. |
| | | | | | | | | O | **USB0_IND1 —** USB0 port indicator LED control output 1. |
| | | | | | | | | I/O | **GPIO5[2] —** General purpose digital input/output pin. |
| | | | | | | | | I | **CTIN_6 —** SCT input 6. Capture input 1 of timer 3. |
| | | | | | | | | I | **T3_CAP2 —** Capture input 2 of timer 3. |
| | | | | | | | | - | **R —** Function reserved. |
| P2_3 | J12 | G11 | D8 | 127 | 87 | [3] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I/O | **I2C1_SDA —** $I^2C1$ data input/output (this pin does not use a specialized $I^2C$ pad). |
| | | | | | | | | O | **U3_TXD —** Transmitter output for USART3. |
| | | | | | | | | I | **CTIN_1 —** SCT input 1. Capture input 1 of timer 0. Capture input 1 of timer 2. |
| | | | | | | | | I/O | **GPIO5[3] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **T3_MAT0 —** Match output 0 of timer 3. |
| | | | | | | | | O | **USB0_PPWR —** VBUS drive signal (towards external charge pump or power management unit); indicates that VBUS must be driven (active HIGH).<br>Add a pull-down resistor to disable the power switch at reset. This signal has opposite polarity compared to the USB_PPWR used on other NXP LPC parts. |
| P2_4 | K11 | L9 | D9 | 128 | 88 | [3] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I/O | **I2C1_SCL —** $I^2C1$ clock input/output (this pin does not use a specialized $I^2C$ pad). |
| | | | | | | | | I | **U3_RXD —** Receiver input for USART3. |
| | | | | | | | | I | **CTIN_0 —** SCT input 0. Capture input 0 of timer 0, 1, 2, 3. |
| | | | | | | | | I/O | **GPIO5[4] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **T3_MAT1 —** Match output 1 of timer 3. |
| | | | | | | | | I | **USB0_PWR_FAULT —** Port power fault signal indicating overcurrent condition; this signal monitors over-current on the USB bus (external circuitry required to detect over-current condition). |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P2_5 | K14 | J12 | D10 | 131 | 91 | [3] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I | **CTIN_2 —** SCT input 2. Capture input 2 of timer 0. |
| | | | | | | | | I | **USB1_VBUS —** Monitors the presence of USB1 bus power.<br>**Note:** This signal must be HIGH for USB reset to occur. |
| | | | | | | | | I | **ADCTRIG1 —** ADC trigger input 1. |
| | | | | | | | | I/O | **GPIO5[5] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **T3_MAT2 —** Match output 2 of timer 3. |
| | | | | | | | | O | **USB0_IND0 —** USB0 port indicator LED control output 0. |
| P2_6 | K16 | J14 | G9 | 137 | 95 | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I/O | **U0_DIR —** RS-485/EIA-485 output enable/direction control for USART0. |
| | | | | | | | | I/O | **EMC_A10 —** External memory address line 10. |
| | | | | | | | | O | **USB0_IND0 —** USB0 port indicator LED control output 0. |
| | | | | | | | | I/O | **GPIO5[6] —** General purpose digital input/output pin. |
| | | | | | | | | I | **CTIN_7 —** SCT input 7. |
| | | | | | | | | I | **T3_CAP3 —** Capture input 3 of timer 3. |
| | | | | | | | | - | **R —** Function reserved. |
| P2_7 | H14 | G12 | C10 | 138 | 96 | [2] | N; PU | I/O | **GPIO0[7] —** General purpose digital input/output pin. ISP entry pin. If this pin is pulled LOW at reset, the part enters ISP mode using USART0. |
| | | | | | | | | O | **CTOUT_1 —** SCT output 1. Match output 3 of timer 3. |
| | | | | | | | | I/O | **U3_UCLK —** Serial clock input/output for USART3 in synchronous mode. |
| | | | | | | | | I/O | **EMC_A9 —** External memory address line 9. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **T3_MAT3 —** Match output 3 of timer 3. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P2_8 | J16 | H14 | C6 | 140 | 98 | [2] | N; PU | - | **R —** Function reserved. Boot pin (see Table 5) |
| | | | | | | | | O | **CTOUT_0 —** SCT output 0. Match output 0 of timer 0. |
| | | | | | | | | I/O | **U3_DIR —** RS-485/EIA-485 output enable/direction control for USART3. |
| | | | | | | | | I/O | **EMC_A8 —** External memory address line 8. |
| | | | | | | | | I/O | **GPIO5[7] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P2_9 | H16 | G14 | B10 | 144 | 102 | [2] | N; PU | I/O | **GPIO1[10] —** General purpose digital input/output pin. Boot pin (see Table 5). |
| | | | | | | | | O | **CTOUT_3 —** SCT output 3. Match output 3 of timer 0. |
| | | | | | | | | I/O | **U3_BAUD —** Baud pin for USART3. |
| | | | | | | | | I/O | **EMC_A0 —** External memory address line 0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P2_10 | G16 | F14 | E8 | 146 | 104 | [2] | N; PU | I/O | **GPIO0[14] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_2 —** SCT output 2. Match output 2 of timer 0. |
| | | | | | | | | O | **U2_TXD —** Transmitter output for USART2. |
| | | | | | | | | I/O | **EMC_A1 —** External memory address line 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P2_11 | F16 | E13 | A9 | 148 | 105 | [2] | N; PU | I/O | **GPIO1[11] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_5 —** SCT output 5. Match output 3 of timer 3. |
| | | | | | | | | I | **U2_RXD —** Receiver input for USART2. |
| | | | | | | | | I/O | **EMC_A2 —** External memory address line 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P2_12 | E15 | D13 | B9 | 153 | 106 | [2] | N; PU | I/O | **GPIO1[12] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_4 —** SCT output 4. Match output 3 of timer 3. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **EMC_A3 —** External memory address line 3. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **U2_UCLK —** Serial clock input/output for USART2 in synchronous mode. |
| P2_13 | C16 | E14 | A10 | 156 | 108 | [2] | N; PU | I/O | **GPIO1[13] —** General purpose digital input/output pin. |
| | | | | | | | | I | **CTIN_4 —** SCT input 4. Capture input 2 of timer 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **EMC_A4 —** External memory address line 4. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **U2_DIR —** RS-485/EIA-485 output enable/direction control for USART2. |
| P3_0 | F13 | D12 | A8 | 161 | 112 | [2] | N; PU | I/O | **I2S0_RX_SCK —** $I^2S$ receive clock. It is driven by the master and received by the slave. Corresponds to the signal SCK in the *$I^2S$-bus specification*. |
| | | | | | | | | O | **I2S0_RX_MCLK —** $I^2S$ receive master clock. |
| | | | | | | | | I/O | **I2S0_TX_SCK —** Transmit Clock. It is driven by the master and received by the slave. Corresponds to the signal SCK in the *$I^2S$-bus specification*. |
| | | | | | | | | O | **I2S0_TX_MCLK —** $I^2S$ transmit master clock. |
| | | | | | | | | I/O | **SSP0_SCK —** Serial clock for SSP0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P3_1 | G11 | D10 | F7 | 163 | 114 | [2] | N; PU | I/O | **I2S0_TX_WS —** Transmit Word Select. It is driven by the master and received by the slave. Corresponds to the signal WS in the *I²S-bus specification*. |
| | | | | | | | | I/O | **I2S0_RX_WS —** Receive Word Select. It is driven by the master and received by the slave. Corresponds to the signal WS in the *I²S-bus specification*. |
| | | | | | | | | I | **CAN0_RD —** CAN receiver input. |
| | | | | | | | | O | **USB1_IND1 —** USB1 Port indicator LED control output 1. |
| | | | | | | | | I/O | **GPIO5[8] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **LCD_VD15 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| P3_2 | F11 | D9 | G6 | 166 | 116 | [2] | OL; PU | I/O | **I2S0_TX_SDA —** I²S transmit data. It is driven by the transmitter and read by the receiver. Corresponds to the signal SD in the *I²S-bus specification*. |
| | | | | | | | | I/O | **I2S0_RX_SDA —** I²S receive data. It is driven by the transmitter and read by the receiver. Corresponds to the signal SD in the *I²S-bus specification*. |
| | | | | | | | | O | **CAN0_TD —** CAN transmitter output. |
| | | | | | | | | O | **USB1_IND0 —** USB1 Port indicator LED control output 0. |
| | | | | | | | | I/O | **GPIO5[9] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **LCD_VD14 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| P3_3 | B14 | B13 | A7 | 169 | 118 | [4] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SSP0_SCK —** Serial clock for SSP0. |
| | | | | | | | | O | **SPIFI_SCK —** Serial clock for SPIFI. |
| | | | | | | | | O | **CGU_OUT1 —** CGU spare clock output 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **I2S0_TX_MCLK —** I²S transmit master clock. |
| | | | | | | | | I/O | **I2S1_TX_SCK —** Transmit Clock. It is driven by the master and received by the slave. Corresponds to the signal SCK in the *I²S-bus specification*. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P3_4 | A15 | C14 | B8 | 171 | 119 | [2] | N; PU | I/O | **GPIO1[14] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SPIFI_SIO3 —** I/O lane 3 for SPIFI. |
| | | | | | | | | O | **U1_TXD —** Transmitter output for UART1. |
| | | | | | | | | I/O | **I2S0_TX_WS —** Transmit Word Select. It is driven by the master and received by the slave. Corresponds to the signal WS in the *I²S-bus specification*. |
| | | | | | | | | I/O | **I2S1_RX_SDA —** I²S1 receive data. It is driven by the transmitter and read by the receiver. Corresponds to the signal SD in the *I²S-bus specification*. |
| | | | | | | | | O | **LCD_VD13 —** LCD data. |
| P3_5 | C12 | C11 | B7 | 173 | 121 | [2] | N; PU | I/O | **GPIO1[15] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SPIFI_SIO2 —** I/O lane 2 for SPIFI. |
| | | | | | | | | I | **U1_RXD —** Receiver input for UART1. |
| | | | | | | | | I/O | **I2S0_TX_SDA —** I²S transmit data. It is driven by the transmitter and read by the receiver. Corresponds to the signal SD in the *I²S-bus specification*. |
| | | | | | | | | I/O | **I2S1_RX_WS —** Receive Word Select. It is driven by the master and received by the slave. Corresponds to the signal WS in the *I²S-bus specification*. |
| | | | | | | | | O | **LCD_VD12 —** LCD data. |
| P3_6 | B13 | B12 | C7 | 174 | 122 | [2] | N; PU | I/O | **GPIO0[6] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SSP0_SSEL —** Slave Select for SSP0. |
| | | | | | | | | I/O | **SPIFI_MISO —** Input 1 in SPIFI quad mode; SPIFI output IO1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SSP0_MISO —** Master In Slave Out for SSP0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P3_7 | C11 | C10 | D7 | 176 | 123 | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SSP0_MISO —** Master In Slave Out for SSP0. |
| | | | | | | | | I/O | **SPIFI_MOSI —** Input 0 in SPIFI quad mode; SPIFI output IO0. |
| | | | | | | | | I/O | **GPIO5[10] —** General purpose digital input/output pin. |
| | | | | | | | | I/O | **SSP0_MOSI —** Master Out Slave in for SSP0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P3_8 | C10 | C9 | E7 | 179 | 124 | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SSP0_MOSI —** Master Out Slave in for SSP0. |
| | | | | | | | | I/O | **SPIFI_CS —** SPIFI serial flash chip select. |
| | | | | | | | | I/O | **GPIO5[11] —** General purpose digital input/output pin. |
| | | | | | | | | I/O | **SSP0_SSEL —** Slave Select for SSP0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P4_0 | D5 | D4 | - | 1 | 1 | [2] | N; PU | I/O | **GPIO2[0] —** General purpose digital input/output pin. |
| | | | | | | | | O | **MCOA0 —** Motor control PWM channel 0, output A. |
| | | | | | | | | I | **NMI —** External interrupt input to NMI. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **LCD_VD13 —** LCD data. |
| | | | | | | | | I/O | **U3_UCLK —** Serial clock input/output for USART3 in synchronous mode. |
| | | | | | | | | - | **R —** Function reserved. |
| P4_1 | A1 | D3 | - | 3 | 3 | [5] | N; PU | I/O | **GPIO2[1] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_1 —** SCT output 3. Match output 3 of timer 3. |
| | | | | | | | | O | **LCD_VD0 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **LCD_VD19 —** LCD data. |
| | | | | | | | | O | **U3_TXD —** Transmitter output for USART3. |
| | | | | | | | | I | **ENET_COL —** Ethernet Collision detect (MII interface). |
| | | | | | | | | AI | **ADC0_1 —** ADC0 and ADC1, input channel 1. Configure the pin as GPIO input and use the ADC function select register in the SCU to select the ADC. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P4_2 | D3 | A2 | - | 12 | 8 | [2] | N; PU | I/O | **GPIO2[2] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_0 —** SCT output 0. Match output 0 of timer 0. |
| | | | | | | | | O | **LCD_VD3 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **LCD_VD12 —** LCD data. |
| | | | | | | | | I | **U3_RXD —** Receiver input for USART3. |
| | | | | | | | | - | **R —** Function reserved. |
| P4_3 | C2 | B2 | - | 10 | 7 | [5] | N; PU | I/O | **GPIO2[3] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_3 —** SCT output 3. Match output 3 of timer 0. |
| | | | | | | | | O | **LCD_VD2 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **LCD_VD21 —** LCD data. |
| | | | | | | | | I/O | **U3_BAUD —** Baud pin for USART3. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | AI | **ADC0_0 —** ADC0 and ADC1, input channel shared with DAC output. Configure the pin as GPIO input and use the ADC function select register in the SCU to select the ADC. |
| P4_4 | B1 | A1 | - | 14 | 9 | [5] | N; PU | I/O | **GPIO2[4] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_2 —** SCT output 2. Match output 2 of timer 0. |
| | | | | | | | | O | **LCD_VD1 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **LCD_VD20 —** LCD data. |
| | | | | | | | | I/O | **U3_DIR —** RS-485/EIA-485 output enable/direction control for USART3. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | AO | **DAC —** DAC output. Shared between 10-bit ADC0/1 and DAC. Configure the pin as GPIO input and use the analog function select register in the SCU to select the DAC. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P4_5 | D2 | C2 | - | 15 | 10 | [2] | N; PU | I/O | **GPIO2[5] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_5 —** SCT output 5. Match output 3 of timer 3. |
| | | | | | | | | O | **LCD_FP —** Frame pulse (STN). Vertical synchronization pulse (TFT). |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P4_6 | C1 | B1 | - | 17 | 11 | [2] | N; PU | I/O | **GPIO2[6] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_4 —** SCT output 4. Match output 3 of timer 3. |
| | | | | | | | | O | **LCD_ENAB/LCDM —** STN AC bias drive or TFT data enable input. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P4_7 | H4 | F4 | - | 21 | 14 | [2] | O; PU | O | **LCD_DCLK —** LCD panel clock. |
| | | | | | | | | I | **GP_CLKIN —** General-purpose clock input to the CGU. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **I2S1_TX_SCK —** Transmit Clock. It is driven by the master and received by the slave. Corresponds to the signal SCK in the *$I^2S$-bus specification*. |
| | | | | | | | | I/O | **I2S0_TX_SCK —** Transmit Clock. It is driven by the master and received by the slave. Corresponds to the signal SCK in the *$I^2S$-bus specification*. |
| P4_8 | E2 | D2 | - | 23 | 15 | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I | **CTIN_5 —** SCT input 5. Capture input 2 of timer 2. |
| | | | | | | | | O | **LCD_VD9 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO5[12] —** General purpose digital input/output pin. |
| | | | | | | | | O | **LCD_VD22 —** LCD data. |
| | | | | | | | | O | **CAN1_TD —** CAN1 transmitter output. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P4_9 | L2 | J2 | - | 48 | 33 | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I | **CTIN_6 —** SCT input 6. Capture input 1 of timer 3. |
| | | | | | | | | O | **LCD_VD11 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO5[13] —** General purpose digital input/output pin. |
| | | | | | | | | O | **LCD_VD15 —** LCD data. |
| | | | | | | | | I | **CAN1_RD —** CAN1 receiver input. |
| | | | | | | | | - | **R —** Function reserved. |
| P4_10 | M3 | L3 | - | 51 | 35 | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I | **CTIN_2 —** SCT input 2. Capture input 2 of timer 0. |
| | | | | | | | | O | **LCD_VD10 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO5[14] —** General purpose digital input/output pin. |
| | | | | | | | | O | **LCD_VD14 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P5_0 | N3 | L2 | - | 53 | 37 | [2] | N; PU | I/O | **GPIO2[9] —** General purpose digital input/output pin. |
| | | | | | | | | O | **MCOB2 —** Motor control PWM channel 2, output B. |
| | | | | | | | | I/O | **EMC_D12 —** External memory data line 12. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **U1_DSR —** Data Set Ready input for UART1. |
| | | | | | | | | I | **T1_CAP0 —** Capture input 0 of timer 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P5_1 | P3 | M1 | - | 55 | 39 | [2] | N; PU | I/O | **GPIO2[10] —** General purpose digital input/output pin. |
| | | | | | | | | I | **MCI2 —** Motor control PWM channel 2, input. |
| | | | | | | | | I/O | **EMC_D13 —** External memory data line 13. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **U1_DTR —** Data Terminal Ready output for UART1. Can also be configured to be an RS-485/EIA-485 output enable signal for UART1. |
| | | | | | | | | I | **T1_CAP1 —** Capture input 1 of timer 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P5_2 | R4 | M3 | - | 63 | 46 | [2] | N; PU | I/O | **GPIO2[11] —** General purpose digital input/output pin. |
| | | | | | | | | I | **MCI1 —** Motor control PWM channel 1, input. |
| | | | | | | | | I/O | **EMC_D14 —** External memory data line 14. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **U1_RTS —** Request to Send output for UART1. Can also be configured to be an RS-485/EIA-485 output enable signal for UART1. |
| | | | | | | | | I | **T1_CAP2 —** Capture input 2 of timer 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P5_3 | T8 | P6 | - | 76 | 54 | [2] | N; PU | I/O | **GPIO2[12] —** General purpose digital input/output pin. |
| | | | | | | | | I | **MCI0 —** Motor control PWM channel 0, input. |
| | | | | | | | | I/O | **EMC_D15 —** External memory data line 15. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **U1_RI —** Ring Indicator input for UART1. |
| | | | | | | | | I | **T1_CAP3 —** Capture input 3 of timer 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P5_4 | P9 | N7 | - | 80 | 57 | [2] | N; PU | I/O | **GPIO2[13] —** General purpose digital input/output pin. |
| | | | | | | | | O | **MCOB0 —** Motor control PWM channel 0, output B. |
| | | | | | | | | I/O | **EMC_D8 —** External memory data line 8. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **U1_CTS —** Clear to Send input for UART1. |
| | | | | | | | | O | **T1_MAT0 —** Match output 0 of timer 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P5_5 | P10 | N8 | - | 81 | 58 | [2] | N; PU | I/O | **GPIO2[14] —** General purpose digital input/output pin. |
| | | | | | | | | O | **MCOA1 —** Motor control PWM channel 1, output A. |
| | | | | | | | | I/O | **EMC_D9 —** External memory data line 9. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **U1_DCD —** Data Carrier Detect input for UART1. |
| | | | | | | | | O | **T1_MAT1 —** Match output 1 of timer 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P5_6 | T13 | M11 | - | 89 | 63 | [2] | N; PU | I/O | **GPIO2[15] —** General purpose digital input/output pin. |
| | | | | | | | | O | **MCOB1 —** Motor control PWM channel 1, output B. |
| | | | | | | | | I/O | **EMC_D10 —** External memory data line 10. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **U1_TXD —** Transmitter output for UART1. |
| | | | | | | | | O | **T1_MAT2 —** Match output 2 of timer 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P5_7 | R12 | N11 | - | 91 | 65 | [2] | N; PU | I/O | **GPIO2[7] —** General purpose digital input/output pin. |
| | | | | | | | | O | **MCOA2 —** Motor control PWM channel 2, output A. |
| | | | | | | | | I/O | **EMC_D11 —** External memory data line 11. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **U1_RXD —** Receiver input for UART1. |
| | | | | | | | | O | **T1_MAT3 —** Match output 3 of timer 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P6_0 | M12 | M10 | H7 | 105 | 73 | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **I2S0_RX_MCLK —** $I^2S$ receive master clock. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **I2S0_RX_SCK —** Receive Clock. It is driven by the master and received by the slave. Corresponds to the signal SCK in the *$I^2S$-bus specification*. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P6_1 | R15 | P14 | G5 | 107 | 74 | [2] | N; PU | I/O | **GPIO3[0] —** General purpose digital input/output pin. |
| | | | | | | | | O | **$\overline{\text{EMC\_DYCS1}}$ —** SDRAM chip select 1. |
| | | | | | | | | I/O | **U0_UCLK —** Serial clock input/output for USART0 in synchronous mode. |
| | | | | | | | | I/O | **I2S0_RX_WS —** Receive Word Select. It is driven by the master and received by the slave. Corresponds to the signal WS in the *$I^2S$-bus specification*. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **T2_CAP0 —** Capture input 2 of timer 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P6_2 | L13 | K11 | J9 | 111 | 78 | [2] | N; PU | I/O | **GPIO3[1] —** General purpose digital input/output pin. |
| | | | | | | | | O | **EMC_CKEOUT1 —** SDRAM clock enable 1. |
| | | | | | | | | I/O | **U0_DIR —** RS-485/EIA-485 output enable/direction control for USART0. |
| | | | | | | | | I/O | **I2S0_RX_SDA —** $I^2S$ Receive data. It is driven by the transmitter and read by the receiver. Corresponds to the signal SD in the *$I^2S$-bus specification*. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **T2_CAP1 —** Capture input 1 of timer 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P6_3 | P15 | N13 | - | 113 | 79 | [2] | N; PU | I/O | **GPIO3[2] —** General purpose digital input/output pin. |
| | | | | | | | | O | **USB0_PPWR —** VBUS drive signal (towards external charge pump or power management unit); indicates that the VBUS signal must be driven (active HIGH).<br>Add a pull-down resistor to disable the power switch at reset. This signal has opposite polarity compared to the USB_PPWR used on other NXP LPC parts. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **$\overline{\text{EMC\_CS1}}$ —** LOW active Chip Select 1 signal. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **T2_CAP2 —** Capture input 2 of timer 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P6_4 | R16 | M14 | F6 | 114 | 80 | [2] | N; PU | I/O | **GPIO3[3] —** General purpose digital input/output pin. |
| | | | | | | | | I | **CTIN_6 —** SCT input 6. Capture input 1 of timer 3. |
| | | | | | | | | O | **U0_TXD —** Transmitter output for USART0. |
| | | | | | | | | O | **$\overline{\text{EMC\_CAS}}$ —** LOW active SDRAM Column Address Strobe. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P6_5 | P16 | L14 | F9 | 117 | 82 | [2] | N; PU | I/O | **GPIO3[4] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_6 —** SCT output 6. Match output 2 of timer 1. |
| | | | | | | | | I | **U0_RXD —** Receiver input for USART0. |
| | | | | | | | | O | **$\overline{\text{EMC\_RAS}}$ —** LOW active SDRAM Row Address Strobe. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P6_6 | L14 | K12 | - | 119 | 83 | [2] | N; PU | I/O | **GPIO0[5] —** General purpose digital input/output pin. |
| | | | | | | | | O | **$\overline{\text{EMC\_BLS1}}$ —** LOW active Byte Lane select signal 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **USB0_PWR_FAULT —** Port power fault signal indicating overcurrent condition; this signal monitors over-current on the USB bus (external circuitry required to detect over-current condition). |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **T2_CAP3 —** Capture input 3 of timer 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P6_7 | J13 | H11 | - | 123 | 85 | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I/O | **EMC_A15 —** External memory address line 15. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **USB0_IND1 —** USB0 port indicator LED control output 1. |
| | | | | | | | | I/O | **GPIO5[15] —** General purpose digital input/output pin. |
| | | | | | | | | O | **T2_MAT0 —** Match output 0 of timer 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P6_8 | H13 | F12 | - | 125 | 86 | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I/O | **EMC_A14 —** External memory address line 14. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **USB0_IND0 —** USB0 port indicator LED control output 0. |
| | | | | | | | | I/O | **GPIO5[16] —** General purpose digital input/output pin. |
| | | | | | | | | O | **T2_MAT1 —** Match output 1 of timer 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P6_9 | J15 | H13 | F8 | 139 | 97 | [2] | N; PU | I/O | **GPIO3[5] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **$\overline{\text{EMC\_DYCS0}}$ —** SDRAM chip select 0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **T2_MAT2 —** Match output 2 of timer 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P6_10 | H15 | G13 | - | 142 | 100 | [2] | N; PU | I/O | **GPIO3[6] —** General purpose digital input/output pin. |
| | | | | | | | | O | **$\overline{\text{MCABORT}}$ —** Motor control PWM, LOW-active fast abort. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **EMC_DQMOUT1 —** Data mask 1 used with SDRAM and static devices. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P6_11 | H12 | F11 | C9 | 143 | 101 | [2] | N; PU | I/O | **GPIO3[7] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **EMC_CKEOUT0 —** SDRAM clock enable 0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **T2_MAT3 —** Match output 3 of timer 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P6_12 | G15 | F13 | - | 145 | 103 | [2] | N; PU | I/O | **GPIO2[8] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_7 —** SCT output 7. Match output 3 of timer 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **EMC_DQMOUT0 —** Data mask 0 used with SDRAM and static devices. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P7_0 | B16 | B14 | - | 158 | 110 | [2] | N; PU | I/O | **GPIO3[8] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_14 —** SCT output 14. Match output 2 of timer 3. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **LCD_LE —** Line end signal. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| P7_1 | C14 | C13 | - | 162 | 113 | [2] | N; PU | I/O | **GPIO3[9] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_15 —** SCT output 15. Match output 3 of timer 3. |
| | | | | | | | | I/O | **I2S0_TX_WS —** Transmit Word Select. It is driven by the master and received by the slave. Corresponds to the signal WS in the *$I^2S$-bus specification*. |
| | | | | | | | | O | **LCD_VD19 —** LCD data. |
| | | | | | | | | O | **LCD_VD7 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **U2_TXD —** Transmitter output for USART2. |
| | | | | | | | | - | **R —** Function reserved. |
| P7_2 | A16 | A14 | - | 165 | 115 | [2] | N; PU | I/O | **GPIO3[10] —** General purpose digital input/output pin. |
| | | | | | | | | I | **CTIN_4 —** SCT input 4. Capture input 2 of timer 1. |
| | | | | | | | | I/O | **I2S0_TX_SDA —** $I^2S$ transmit data. It is driven by the transmitter and read by the receiver. Corresponds to the signal SD in the *$I^2S$-bus specification*. |
| | | | | | | | | O | **LCD_VD18 —** LCD data. |
| | | | | | | | | O | **LCD_VD6 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **U2_RXD —** Receiver input for USART2. |
| | | | | | | | | - | **R —** Function reserved. |
| P7_3 | C13 | C12 | - | 167 | 117 | [2] | N; PU | I/O | **GPIO3[11] —** General purpose digital input/output pin. |
| | | | | | | | | I | **CTIN_3 —** SCT input 3. Capture input 1 of timer 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **LCD_VD17 —** LCD data. |
| | | | | | | | | O | **LCD_VD5 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P7_4 | C8 | C6 | - | 189 | 132 | [5] | N; PU | I/O | **GPIO3[12] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_13 —** SCT output 13. Match output 3 of timer 3. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **LCD_VD16 —** LCD data. |
| | | | | | | | | O | **LCD_VD4 —** LCD data. |
| | | | | | | | | O | **TRACEDATA[0] —** Trace data, bit 0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | AI | **ADC0_4 —** ADC0 and ADC1, input channel 4. Configure the pin as GPIO input and use the ADC function select register in the SCU to select the ADC. |
| P7_5 | A7 | A7 | - | 191 | 133 | [5] | N; PU | I/O | **GPIO3[13] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_12 —** SCT output 12. Match output 3 of timer 3. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **LCD_VD8 —** LCD data. |
| | | | | | | | | O | **LCD_VD23 —** LCD data. |
| | | | | | | | | O | **TRACEDATA[1] —** Trace data, bit 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | AI | **ADC0_3 —** ADC0 and ADC1, input channel 3. Configure the pin as GPIO input and use the ADC function select register in the SCU to select the ADC. |
| P7_6 | C7 | F5 | - | 194 | 134 | [2] | N; PU | I/O | **GPIO3[14] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_11 —** SCT output 1. Match output 3 of timer 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **LCD_LP —** Line synchronization pulse (STN). Horizontal synchronization pulse (TFT). |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **TRACEDATA[2] —** Trace data, bit 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P7_7 | B6 | D5 | - | 201 | 140 | [5] | N; PU | I/O | **GPIO3[15] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_8 —** SCT output 8. Match output 0 of timer 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **LCD_PWR —** LCD panel power enable. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **TRACEDATA[3] —** Trace data, bit 3. |
| | | | | | | | | O | **ENET_MDC —** Ethernet MIIM clock. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | AI | **ADC1_6 —** ADC1 and ADC0, input channel 6. Configure the pin as GPIO input and use the ADC function select register in the SCU to select the ADC. |
| P8_0 | E5 | E4 | - | 2 | - | [3] | N; PU | I/O | **GPIO4[0] —** General purpose digital input/output pin. |
| | | | | | | | | I | **USB0_PWR_FAULT —** Port power fault signal indicating overcurrent condition; this signal monitors over-current on the USB bus (external circuitry required to detect over-current condition). |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **MCI2 —** Motor control PWM channel 2, input. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **T0_MAT0 —** Match output 0 of timer 0. |
| P8_1 | H5 | G4 | - | 34 | - | [3] | N; PU | I/O | **GPIO4[1] —** General purpose digital input/output pin. |
| | | | | | | | | O | **USB0_IND1 —** USB0 port indicator LED control output 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **MCI1 —** Motor control PWM channel 1, input. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **T0_MAT1 —** Match output 1 of timer 0. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P8_2 | K4 | J4 | - | 36 | - | [3] | N; PU | I/O | **GPIO4[2] —** General purpose digital input/output pin. |
| | | | | | | | | O | **USB0_IND0 —** USB0 port indicator LED control output 0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **MCI0 —** Motor control PWM channel 0, input. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **T0_MAT2 —** Match output 2 of timer 0. |
| P8_3 | J3 | H3 | - | 37 | - | [2] | N; PU | I/O | **GPIO4[3] —** General purpose digital input/output pin. |
| | | | | | | | | I/O | **USB1_ULPI_D2 —** ULPI link bidirectional data line 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **LCD_VD12 —** LCD data. |
| | | | | | | | | O | **LCD_VD19 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **T0_MAT3 —** Match output 3 of timer 0. |
| P8_4 | J2 | H2 | - | 39 | - | [2] | N; PU | I/O | **GPIO4[4] —** General purpose digital input/output pin. |
| | | | | | | | | I/O | **USB1_ULPI_D1 —** ULPI link bidirectional data line 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **LCD_VD7 —** LCD data. |
| | | | | | | | | O | **LCD_VD16 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **T0_CAP0 —** Capture input 0 of timer 0. |
| P8_5 | J1 | H1 | - | 40 | - | [2] | N; PU | I/O | **GPIO4[5] —** General purpose digital input/output pin. |
| | | | | | | | | I/O | **USB1_ULPI_D0 —** ULPI link bidirectional data line 0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **LCD_VD6 —** LCD data. |
| | | | | | | | | O | **LCD_VD8 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **T0_CAP1 —** Capture input 1 of timer 0. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P8_6 | K3 | J3 | - | 43 | - | [2] | N; PU | I/O | **GPIO4[6] —** General purpose digital input/output pin. |
| | | | | | | | | I | **USB1_ULPI_NXT —** ULPI link NXT signal. Data flow control signal from the PHY. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **LCD_VD5 —** LCD data. |
| | | | | | | | | O | **LCD_LP —** Line synchronization pulse (STN). Horizontal synchronization pulse (TFT). |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **T0_CAP2 —** Capture input 2 of timer 0. |
| P8_7 | K1 | J1 | - | 45 | - | [2] | N; PU | I/O | **GPIO4[7] —** General purpose digital input/output pin. |
| | | | | | | | | O | **USB1_ULPI_STP —** ULPI link STP signal. Asserted to end or interrupt transfers to the PHY. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **LCD_VD4 —** LCD data. |
| | | | | | | | | O | **LCD_PWR —** LCD panel power enable. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **T0_CAP3 —** Capture input 3 of timer 0. |
| P8_8 | L1 | K1 | - | 49 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I | **USB1_ULPI_CLK —** ULPI link CLK signal. 60 MHz clock generated by the PHY. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **CGU_OUT0 —** CGU spare clock output 0. |
| | | | | | | | | O | **I2S1_TX_MCLK —** $I^2S1$ transmit master clock. |
| P9_0 | T1 | P1 | - | 59 | - | [2] | N; PU | I/O | **GPIO4[12] —** General purpose digital input/output pin. |
| | | | | | | | | O | **$\overline{\text{MCABORT}}$ —** Motor control PWM, LOW-active fast abort. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **ENET_CRS —** Ethernet Carrier Sense (MII interface). |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SSP0_SSEL —** Slave Select for SSP0. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P9_1 | N6 | P4 | - | 66 | - | [2] | N; PU | I/O | **GPIO4[13] —** General purpose digital input/output pin. |
| | | | | | | | | O | **MCOA2 —** Motor control PWM channel 2, output A. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **I2S0_TX_WS —** Transmit Word Select. It is driven by the master and received by the slave. Corresponds to the signal WS in the *$I^2S$-bus specification*. |
| | | | | | | | | I | **ENET_RX_ER —** Ethernet receive error (MII interface). |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SSP0_MISO —** Master In Slave Out for SSP0. |
| P9_2 | N8 | M6 | - | 70 | - | [2] | N; PU | I/O | **GPIO4[14] —** General purpose digital input/output pin. |
| | | | | | | | | O | **MCOB2 —** Motor control PWM channel 2, output B. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **I2S0_TX_SDA —** $I^2S$ transmit data. It is driven by the transmitter and read by the receiver. Corresponds to the signal SD in the *$I^2S$-bus specification*. |
| | | | | | | | | I | **ENET_RXD3 —** Ethernet receive data 3 (MII interface). |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SSP0_MOSI —** Master Out Slave in for SSP0. |
| P9_3 | M6 | P5 | - | 79 | - | [2] | N; PU | I/O | **GPIO4[15] —** General purpose digital input/output pin. |
| | | | | | | | | O | **MCOA0 —** Motor control PWM channel 0, output A. |
| | | | | | | | | O | **USB1_IND1 —** USB1 Port indicator LED control output 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **ENET_RXD2 —** Ethernet receive data 2 (MII interface). |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **U3_TXD —** Transmitter output for USART3. |
| P9_4 | N10 | M8 | - | 92 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **MCOB0 —** Motor control PWM channel 0, output B. |
| | | | | | | | | O | **USB1_IND0 —** USB1 Port indicator LED control output 0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO5[17] —** General purpose digital input/output pin. |
| | | | | | | | | O | **ENET_TXD2 —** Ethernet transmit data 2 (MII interface). |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **U3_RXD —** Receiver input for USART3. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| P9_5 | M9 | L7 | - | 98 | 69 | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **MCOA1 —** Motor control PWM channel 1, output A. |
| | | | | | | | | O | **USB1_PPWR —** VBUS drive signal (towards external charge pump or power management unit); indicates that VBUS must be driven (active HIGH).<br>Add a pull-down resistor to disable the power switch at reset. This signal has opposite polarity compared to the USB_PPWR used on other NXP LPC parts. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO5[18] —** General purpose digital input/output pin. |
| | | | | | | | | O | **ENET_TXD3 —** Ethernet transmit data 3 (MII interface). |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **U0_TXD —** Transmitter output for USART0. |
| P9_6 | L11 | M9 | - | 103 | 72 | [2] | N; PU | I/O | **GPIO4[11] —** General purpose digital input/output pin. |
| | | | | | | | | O | **MCOB1 —** Motor control PWM channel 1, output B. |
| | | | | | | | | I | **USB1_PWR_FAULT —** USB1 Port power fault signal indicating over-current condition; this signal monitors over-current on the USB1 bus (external circuitry required to detect over-current condition). |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **ENET_COL —** Ethernet Collision detect (MII interface). |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **U0_RXD —** Receiver input for USART0. |
| PA_0 | L12 | L10 | - | 126 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **I2S1_RX_MCLK —** $I^2S1$ receive master clock. |
| | | | | | | | | O | **CGU_OUT1 —** CGU spare clock output 1. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| PA_1 | J14 | H12 | - | 134 | - | [3] | N; PU | I/O | **GPIO4[8] —** General purpose digital input/output pin. |
| | | | | | | | | I | **QEI_IDX —** Quadrature Encoder Interface INDEX input. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **U2_TXD —** Transmitter output for USART2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PA_2 | K15 | J13 | - | 136 | - | [3] | N; PU | I/O | **GPIO4[9] —** General purpose digital input/output pin. |
| | | | | | | | | I | **QEI_PHB —** Quadrature Encoder Interface PHB input. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **U2_RXD —** Receiver input for USART2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PA_3 | H11 | E10 | - | 147 | - | [3] | N; PU | I/O | **GPIO4[10] —** General purpose digital input/output pin. |
| | | | | | | | | I | **QEI_PHA —** Quadrature Encoder Interface PHA input. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PA_4 | G13 | E12 | - | 151 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **CTOUT_9 —** SCT output 9. Match output 3 of timer 3. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **EMC_A23 —** External memory address line 23. |
| | | | | | | | | I/O | **GPIO5[19] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| PB_0 | B15 | D14 | - | 164 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **CTOUT_10 —** SCT output 10. Match output 3 of timer 3. |
| | | | | | | | | O | **LCD_VD23 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO5[20] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PB_1 | A14 | A13 | - | 175 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I | **USB1_ULPI_DIR —** ULPI link DIR signal. Controls the ULP data line direction. |
| | | | | | | | | O | **LCD_VD22 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO5[21] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_6 —** SCT output 6. Match output 2 of timer 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PB_2 | B12 | B11 | - | 177 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I/O | **USB1_ULPI_D7 —** ULPI link bidirectional data line 7. |
| | | | | | | | | O | **LCD_VD21 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO5[22] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_7 —** SCT output 7. Match output 3 of timer 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PB_3 | A13 | A12 | - | 178 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I/O | **USB1_ULPI_D6 —** ULPI link bidirectional data line 6. |
| | | | | | | | | O | **LCD_VD20 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO5[23] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CTOUT_8 —** SCT output 8. Match output 0 of timer 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| PB_4 | B11 | B10 | - | 180 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I/O | **USB1_ULPI_D5 —** ULPI link bidirectional data line 5. |
| | | | | | | | | O | **LCD_VD15 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO5[24] —** General purpose digital input/output pin. |
| | | | | | | | | I | **CTIN_5 —** SCT input 5. Capture input 2 of timer 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PB_5 | A12 | A11 | - | 181 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I/O | **USB1_ULPI_D4 —** ULPI link bidirectional data line 4. |
| | | | | | | | | O | **LCD_VD14 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO5[25] —** General purpose digital input/output pin. |
| | | | | | | | | I | **CTIN_7 —** SCT input 7. |
| | | | | | | | | O | **LCD_PWR —** LCD panel power enable. |
| | | | | | | | | - | **R —** Function reserved. |
| PB_6 | A6 | C5 | - | - | - | [5] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I/O | **USB1_ULPI_D3 —** ULPI link bidirectional data line 3. |
| | | | | | | | | O | **LCD_VD13 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO5[26] —** General purpose digital input/output pin. |
| | | | | | | | | I | **CTIN_6 —** SCT input 6. Capture input 1 of timer 3. |
| | | | | | | | | O | **LCD_VD19 —** LCD data. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | AI | **ADC0_6 —** ADC0 and ADC1, input channel 6. Configure the pin as GPIO input and use the ADC function select register in the SCU to select the ADC. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| PC_0 | D4 | - | - | 7 | - | [5] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I | **USB1_ULPI_CLK —** ULPI link CLK signal. 60 MHz clock generated by the PHY. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | **I/O** | **ENET_RX_CLK —** Ethernet Receive Clock (MII interface). |
| | | | | | | | | O | **LCD_DCLK —** LCD panel clock. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SD_CLK —** SD/MMC card clock. |
| | | | | | | | | AI | **ADC1_1 —** ADC1 and ADC0, input channel 1. Configure the pin as GPIO input and use the ADC function select register in the SCU to select the ADC. |
| PC_1 | E4 | - | - | 9 | - | [2] | N; PU | I/O | **USB1_ULPI_D7 —** ULPI link bidirectional data line 7. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **U1_RI —** Ring Indicator input for UART1. |
| | | | | | | | | O | **ENET_MDC —** Ethernet MIIM clock. |
| | | | | | | | | I/O | **GPIO6[0] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **T3_CAP0 —** Capture input 0 of timer 3. |
| | | | | | | | | O | **SD_VOLT0 —** SD/MMC bus voltage select output 0. |
| PC_2 | F6 | - | - | 13 | - | [2] | N; PU | I/O | **USB1_ULPI_D6 —** ULPI link bidirectional data line 6. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **U1_CTS —** Clear to Send input for UART1. |
| | | | | | | | | O | **ENET_TXD2 —** Ethernet transmit data 2 (MII interface). |
| | | | | | | | | I/O | **GPIO6[1] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **SD_RST —** SD/MMC reset signal for MMC4.4 card. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| PC_3 | F5 | - | - | 11 | - | [5] | N; PU | I/O | **USB1_ULPI_D5 —** ULPI link bidirectional data line 5. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **U1_RTS —** Request to Send output for UART1. Can also be configured to be an RS-485/EIA-485 output enable signal for UART1. |
| | | | | | | | | O | **ENET_TXD3 —** Ethernet transmit data 3 (MII interface). |
| | | | | | | | | I/O | **GPIO6[2] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **SD_VOLT1 —** SD/MMC bus voltage select output 1. |
| | | | | | | | | AI | **ADC1_0 —** ADC1 and ADC0, input channel shared with DAC output. Configure the pin as GPIO input and use the ADC function select register in the SCU to select the ADC. |
| PC_4 | F4 | - | - | 16 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I/O | **USB1_ULPI_D4 —** ULPI link bidirectional data line 4. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | | **ENET_TX_EN —** Ethernet transmit enable (RMII/MII interface). |
| | | | | | | | | I/O | **GPIO6[3] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **T3_CAP1 —** Capture input 1 of timer 3. |
| | | | | | | | | I/O | **SD_DAT0 —** SD/MMC data bus line 0. |
| PC_5 | G4 | - | - | 20 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I/O | **USB1_ULPI_D3 —** ULPI link bidirectional data line 3. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **ENET_TX_ER —** Ethernet Transmit Error (MII interface). |
| | | | | | | | | I/O | **GPIO6[4] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **T3_CAP2 —** Capture input 2 of timer 3. |
| | | | | | | | | I/O | **SD_DAT1 —** SD/MMC data bus line 1. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| PC_6 | H6 | - | - | 22 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I/O | **USB1_ULPI_D2 —** ULPI link bidirectional data line 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **ENET_RXD2 —** Ethernet receive data 2 (MII interface). |
| | | | | | | | | I/O | **GPIO6[5] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **T3_CAP3 —** Capture input 3 of timer 3. |
| | | | | | | | | I/O | **SD_DAT2 —** SD/MMC data bus line 2. |
| PC_7 | G5 | - | - | - | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I/O | **USB1_ULPI_D1 —** ULPI link bidirectional data line 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **ENET_RXD3 —** Ethernet receive data 3 (MII interface). |
| | | | | | | | | I/O | **GPIO6[6] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **T3_MAT0 —** Match output 0 of timer 3. |
| | | | | | | | | I/O | **SD_DAT3 —** SD/MMC data bus line 3. |
| PC_8 | N4 | - | - | - | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I/O | **USB1_ULPI_D0 —** ULPI link bidirectional data line 0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **ENET_RX_DV —** Ethernet Receive Data Valid (RMII/MII interface). |
| | | | | | | | | I/O | **GPIO6[7] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **T3_MAT1 —** Match output 1 of timer 3. |
| | | | | | | | | I | **SD_CD —** SD/MMC card detect input. |
| PC_9 | K2 | - | - | - | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I | **USB1_ULPI_NXT —** ULPI link NXT signal. Data flow control signal from the PHY. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **ENET_RX_ER —** Ethernet receive error (MII interface). |
| | | | | | | | | I/O | **GPIO6[8] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **T3_MAT2 —** Match output 2 of timer 3. |
| | | | | | | | | O | **SD_POW —** SD/MMC power monitor output. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| PC_10 | M5 | - | - | - | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **USB1_ULPI_STP —** ULPI link STP signal. Asserted to end or interrupt transfers to the PHY. |
| | | | | | | | | I | **U1_DSR —** Data Set Ready input for UART1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[9] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **T3_MAT3 —** Match output 3 of timer 3. |
| | | | | | | | | I/O | **SD_CMD —** SD/MMC command signal. |
| PC_11 | L5 | - | - | - | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I | **USB1_ULPI_DIR —** ULPI link DIR signal. Controls the ULP data line direction. |
| | | | | | | | | I | **U1_DCD —** Data Carrier Detect input for UART1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[10] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SD_DAT4 —** SD/MMC data bus line 4. |
| PC_12 | L6 | - | - | - | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **U1_DTR —** Data Terminal Ready output for UART1. Can also be configured to be an RS-485/EIA-485 output enable signal for UART1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[11] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **I2S0_TX_SDA —** $I^2S$ transmit data. It is driven by the transmitter and read by the receiver. Corresponds to the signal SD in the *$I^2S$-bus specification*. |
| | | | | | | | | I/O | **SD_DAT5 —** SD/MMC data bus line 5. |
| PC_13 | M1 | - | - | - | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **U1_TXD —** Transmitter output for UART1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[12] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **I2S0_TX_WS —** Transmit Word Select. It is driven by the master and received by the slave. Corresponds to the signal WS in the *$I^2S$-bus specification*. |
| | | | | | | | | I/O | **SD_DAT6 —** SD/MMC data bus line 6. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| PC_14 | N1 | - | - | - | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **U1_RXD —** Receiver input for UART1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[13] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **ENET_TX_ER —** Ethernet Transmit Error (MII interface). |
| | | | | | | | | I/O | **SD_DAT7 —** SD/MMC data bus line 7. |
| PD_0 | N2 | - | - | - | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **CTOUT_15 —** SCT output 15. Match output 3 of timer 3. |
| | | | | | | | | O | **EMC_DQMOUT2 —** Data mask 2 used with SDRAM and static devices. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[14] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PD_1 | P1 | - | - | - | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **EMC_CKEOUT2 —** SDRAM clock enable 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[15] —** General purpose digital input/output pin. |
| | | | | | | | | O | **SD_POW —** SD/MMC power monitor output. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PD_2 | R1 | - | - | - | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **CTOUT_7 —** SCT output 7. Match output 3 of timer 1. |
| | | | | | | | | I/O | **EMC_D16 —** External memory data line 16. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[16] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| PD_3 | P4 | - | - | - | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **CTOUT_6 —** SCT output 7. Match output 2 of timer 1. |
| | | | | | | | | I/O | **EMC_D17 —** External memory data line 17. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[17] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PD_4 | T2 | - | - | - | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **CTOUT_8 —** SCT output 8. Match output 0 of timer 2. |
| | | | | | | | | I/O | **EMC_D18 —** External memory data line 18. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[18] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PD_5 | P6 | - | - | - | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **CTOUT_9 —** SCT output 9. Match output 3 of timer 3. |
| | | | | | | | | I/O | **EMC_D19 —** External memory data line 19. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[19] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PD_6 | R6 | - | - | 68 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **CTOUT_10 —** SCT output 10. Match output 3 of timer 3. |
| | | | | | | | | I/O | **EMC_D20 —** External memory data line 20. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[20] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| PD_7 | T6 | - | - | 72 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I | **CTIN_5 —** SCT input 5. Capture input 2 of timer 2. |
| | | | | | | | | I/O | **EMC_D21 —** External memory data line 21. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[21] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PD_8 | P8 | - | - | 74 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I | **CTIN_6 —** SCT input 6. Capture input 1 of timer 3. |
| | | | | | | | | I/O | **EMC_D22 —** External memory data line 22. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[22] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PD_9 | T11 | - | - | 84 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **CTOUT_13 —** SCT output 13. Match output 3 of timer 3. |
| | | | | | | | | I/O | **EMC_D23 —** External memory data line 23. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[23] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PD_10 | P11 | - | - | 86 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I | **CTIN_1 —** SCT input 1. Capture input 1 of timer 0. Capture input 1 of timer 2. |
| | | | | | | | | O | **$\overline{\text{EMC\_BLS3}}$ —** LOW active Byte Lane select signal 3. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[24] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| PD_11 | N9 | M7 | - | 88 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **$\overline{\text{EMC\_CS3}}$ —** LOW active Chip Select 3 signal. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[25] —** General purpose digital input/output pin. |
| | | | | | | | | I/O | **USB1_ULPI_D0 —** ULPI link bidirectional data line 0. |
| | | | | | | | | O | **CTOUT_14 —** SCT output 14. Match output 2 of timer 3. |
| | | | | | | | | - | **R —** Function reserved. |
| PD_12 | N11 | P9 | - | 94 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **$\overline{\text{EMC\_CS2}}$ —** LOW active Chip Select 2 signal. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[26] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **CTOUT_10 —** SCT output 10. Match output 3 of timer 3. |
| | | | | | | | | - | **R —** Function reserved. |
| PD_13 | T14 | - | - | 97 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I | **CTIN_0 —** SCT input 0. Capture input 0 of timer 0, 1, 2, 3. |
| | | | | | | | | O | **$\overline{\text{EMC\_BLS2}}$ —** LOW active Byte Lane select signal 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[27] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **CTOUT_13 —** SCT output 13. Match output 3 of timer 3. |
| | | | | | | | | - | **R —** Function reserved. |
| PD_14 | R13 | L11 | - | 99 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **$\overline{\text{EMC\_DYCS2}}$ —** SDRAM chip select 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[28] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **CTOUT_11 —** SCT output 11. Match output 3 of timer 2. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| PD_15 | T15 | P13 | - | 101 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **EMC_A17 —** External memory address line 17. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[29] —** General purpose digital input/output pin. |
| | | | | | | | | I | **SD_WP —** SD/MMC card write protect input. |
| | | | | | | | | O | **CTOUT_8 —** SCT output 8. Match output 0 of timer 2. |
| | | | | | | | | - | **R —** Function reserved. |
| PD_16 | R14 | P12 | - | 104 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **EMC_A16 —** External memory address line 16. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO6[30] —** General purpose digital input/output pin. |
| | | | | | | | | O | **SD_VOLT2 —** SD/MMC bus voltage select output 2. |
| | | | | | | | | O | **CTOUT_12 —** SCT output 12. Match output 3 of timer 3. |
| | | | | | | | | - | **R —** Function reserved. |
| PE_0 | P14 | N12 | - | 106 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **EMC_A18 —** External memory address line 18. |
| | | | | | | | | I/O | **GPIO7[0] —** General purpose digital input/output pin. |
| | | | | | | | | O | **CAN1_TD —** CAN1 transmitter output. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PE_1 | N14 | M12 | - | 112 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **EMC_A19 —** External memory address line 19. |
| | | | | | | | | I/O | **GPIO7[1] —** General purpose digital input/output pin. |
| | | | | | | | | I | **CAN1_RD —** CAN1 receiver input. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| PE_2 | M14 | L12 | - | 115 | - | [2] | N; PU | I | **ADCTRIG0 —** ADC trigger input 0. |
| | | | | | | | | I | **CAN0_RD —** CAN receiver input. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **EMC_A20 —** External memory address line 20. |
| | | | | | | | | I/O | **GPIO7[2] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PE_3 | K12 | K10 | - | 118 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **CAN0_TD —** CAN transmitter output. |
| | | | | | | | | I | **ADCTRIG1 —** ADC trigger input 1. |
| | | | | | | | | I/O | **EMC_A21 —** External memory address line 21. |
| | | | | | | | | I/O | **GPIO7[3] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PE_4 | K13 | J11 | - | 120 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I | **NMI —** External interrupt input to NMI. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **EMC_A22 —** External memory address line 22. |
| | | | | | | | | I/O | **GPIO7[4] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PE_5 | N16 | - | - | 122 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **CTOUT_3 —** SCT output 3. Match output 3 of timer 0. |
| | | | | | | | | O | **U1_RTS —** Request to Send output for UART1. Can also be configured to be an RS-485/EIA-485 output enable signal for UART1. |
| | | | | | | | | I/O | **EMC_D24 —** External memory data line 24. |
| | | | | | | | | I/O | **GPIO7[5] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| PE_6 | M16 | - | - | 124 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **CTOUT_2 —** SCT output 2. Match output 2 of timer 0. |
| | | | | | | | | I | **U1_RI —** Ring Indicator input for UART1. |
| | | | | | | | | I/O | **EMC_D25 —** External memory data line 25. |
| | | | | | | | | I/O | **GPIO7[6] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PE_7 | F15 | - | - | 149 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **CTOUT_5 —** SCT output 5. Match output 3 of timer 3. |
| | | | | | | | | I | **U1_CTS —** Clear to Send input for UART1. |
| | | | | | | | | I/O | **EMC_D26 —** External memory data line 26. |
| | | | | | | | | I/O | **GPIO7[7] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PE_8 | F14 | - | - | 150 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **CTOUT_4 —** SCT output 4. Match output 3 of timer 3. |
| | | | | | | | | I | **U1_DSR —** Data Set Ready input for UART1. |
| | | | | | | | | I/O | **EMC_D27 —** External memory data line 27. |
| | | | | | | | | I/O | **GPIO7[8] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PE_9 | E16 | - | - | 152 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I | **CTIN_4 —** SCT input 4. Capture input 2 of timer 1. |
| | | | | | | | | I | **U1_DCD —** Data Carrier Detect input for UART1. |
| | | | | | | | | I/O | **EMC_D28 —** External memory data line 28. |
| | | | | | | | | I/O | **GPIO7[9] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| PE_10 | E14 | - | - | 154 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I | **CTIN_3 —** SCT input 3. Capture input 1 of timer 1. |
| | | | | | | | | O | **U1_DTR —** Data Terminal Ready output for UART1. Can also be configured to be an RS-485/EIA-485 output enable signal for UART1. |
| | | | | | | | | I/O | **EMC_D29 —** External memory data line 29. |
| | | | | | | | | I/O | **GPIO7[10] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PE_11 | D16 | - | - | - | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **CTOUT_12 —** SCT output 12. Match output 3 of timer 3. |
| | | | | | | | | O | **U1_TXD —** Transmitter output for UART1. |
| | | | | | | | | I/O | **EMC_D30 —** External memory data line 30. |
| | | | | | | | | I/O | **GPIO7[11] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PE_12 | D15 | - | - | - | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **CTOUT_11 —** SCT output 11. Match output 3 of timer 2. |
| | | | | | | | | I | **U1_RXD —** Receiver input for UART1. |
| | | | | | | | | I/O | **EMC_D31 —** External memory data line 31. |
| | | | | | | | | I/O | **GPIO7[12] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PE_13 | G14 | - | - | - | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **CTOUT_14 —** SCT output 14. Match output 2 of timer 3. |
| | | | | | | | | I/O | **I2C1_SDA —** $I^2C1$ data input/output (this pin does not use a specialized $I^2C$ pad). |
| | | | | | | | | O | **EMC_DQMOUT3 —** Data mask 3 used with SDRAM and static devices. |
| | | | | | | | | I/O | **GPIO7[13] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| PE_14 | C15 | - | - | - | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **EMC_DYCS3 —** SDRAM chip select 3. |
| | | | | | | | | I/O | **GPIO7[14] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PE_15 | E13 | - | - | - | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **CTOUT_0 —** SCT output 0. Match output 0 of timer 0. |
| | | | | | | | | I/O | **I2C1_SCL —** $I^2C1$ clock input/output (this pin does not use a specialized $I^2C$ pad). |
| | | | | | | | | O | **EMC_CKEOUT3 —** SDRAM clock enable 3. |
| | | | | | | | | I/O | **GPIO7[15] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PF_0 | D12 | - | - | 159 | - | [2] | OL; PU | I/O | **SSP0_SCK —** Serial clock for SSP0. |
| | | | | | | | | I | **GP_CLKIN —** General-purpose clock input to the CGU. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **I2S1_TX_MCLK —** $I^2S1$ transmit master clock. |
| PF_1 | E11 | - | - | - | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SSP0_SSEL —** Slave Select for SSP0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO7[16] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| PF_2 | D11 | - | - | 168 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **U3_TXD —** Transmitter output for USART3. |
| | | | | | | | | I/O | **SSP0_MISO —** Master In Slave Out for SSP0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO7[17] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PF_3 | E10 | - | - | 170 | - | [2] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I | **U3_RXD —** Receiver input for USART3. |
| | | | | | | | | I/O | **SSP0_MOSI —** Master Out Slave in for SSP0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO7[18] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| PF_4 | D10 | D6 | H4 | 172 | 120 | [2] | OL; PU | I/O | **SSP1_SCK —** Serial clock for SSP1. |
| | | | | | | | | I | **GP_CLKIN —** General-purpose clock input to the CGU. |
| | | | | | | | | O | **TRACECLK —** Trace clock. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **I2S0_TX_MCLK —** $I^2S$ transmit master clock. |
| | | | | | | | | I/O | **I2S0_RX_SCK —** $I^2S$ receive clock. It is driven by the master and received by the slave. Corresponds to the signal SCK in the *$I^2S$-bus specification*. |
| PF_5 | E9 | - | - | 190 | - | [5] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I/O | **U3_UCLK —** Serial clock input/output for USART3 in synchronous mode. |
| | | | | | | | | I/O | **SSP1_SSEL —** Slave Select for SSP1. |
| | | | | | | | | O | **TRACEDATA[0] —** Trace data, bit 0. |
| | | | | | | | | I/O | **GPIO7[19] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | AI | **ADC1_4 —** ADC1 and ADC0, input channel 4. Configure the pin as GPIO input and use the ADC function select register in the SCU to select the ADC. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| PF_6 | E7 | - | - | 192 | - | [5] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I/O | **U3_DIR —** RS-485/EIA-485 output enable/direction control for USART3. |
| | | | | | | | | I/O | **SSP1_MISO —** Master In Slave Out for SSP1. |
| | | | | | | | | O | **TRACEDATA[1] —** Trace data, bit 1. |
| | | | | | | | | I/O | **GPIO7[20] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **I2S1_TX_SDA —** $I^2S1$ transmit data. It is driven by the transmitter and read by the receiver. Corresponds to the signal SD in the *$I^2S$-bus specification*. |
| | | | | | | | | AI | **ADC1_3 —** ADC1 and ADC0, input channel 3. Configure the pin as GPIO input and use the ADC function select register in the SCU to select the ADC. |
| PF_7 | B7 | - | - | 193 | - | [5] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I/O | **U3_BAUD —** Baud pin USART3. |
| | | | | | | | | I/O | **SSP1_MOSI —** Master Out Slave in for SSP1. |
| | | | | | | | | O | **TRACEDATA[2] —** Trace data, bit 2. |
| | | | | | | | | I/O | **GPIO7[21] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **I2S1_TX_WS —** Transmit Word Select. It is driven by the master and received by the slave. Corresponds to the signal WS in the *$I^2S$-bus specification*. |
| | | | | | | | | AI/O | **ADC1_7 —** ADC1 and ADC0, input channel 7 or band gap output. Configure the pin as GPIO input and use the ADC function select register in the SCU to select the ADC. |
| PF_8 | E6 | - | - | - | - | [5] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I/O | **U0_UCLK —** Serial clock input/output for USART0 in synchronous mode. |
| | | | | | | | | I | **CTIN_2 —** SCT input 2. Capture input 2 of timer 0. |
| | | | | | | | | O | **TRACEDATA[3] —** Trace data, bit 3. |
| | | | | | | | | I/O | **GPIO7[22] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | AI | **ADC0_2 —** ADC0 and ADC1, input channel 2. Configure the pin as GPIO input and use the ADC function select register in the SCU to select the ADC. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| PF_9 | D6 | - | - | 203 | - | [5] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I/O | **U0_DIR —** RS-485/EIA-485 output enable/direction control for USART0. |
| | | | | | | | | O | **CTOUT_1 —** SCT output 1. Match output 3 of timer 3. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO7[23] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | AI | **ADC1_2 —** ADC1 and ADC0, input channel 2. Configure the pin as GPIO input and use the ADC function select register in the SCU to select the ADC. |
| PF_10 | A3 | - | - | 205 | - | [5] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | O | **U0_TXD —** Transmitter output for USART0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO7[24] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I | **SD_WP —** SD/MMC card write protect input. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | AI | **ADC0_5 —** ADC0 and ADC1, input channel 5. Configure the pin as GPIO input and use the ADC function select register in the SCU to select the ADC. |
| PF_11 | A2 | - | - | 207 | - | [5] | N; PU | - | **R —** Function reserved. |
| | | | | | | | | I | **U0_RXD —** Receiver input for USART0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **GPIO7[25] —** General purpose digital input/output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **SD_VOLT2 —** SD/MMC bus voltage select output 2. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | AI | **ADC1_5 —** ADC1 and ADC0, input channel 5. Configure the pin as GPIO input and use the ADC function select register in the SCU to select the ADC. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| **Clock pins** | | | | | | | | | |
| CLK0 | N5 | M4 | K3 | 62 | 45 | [4] | O; PU | O | **EMC_CLK0 —** SDRAM clock 0. |
| | | | | | | | | O | **CLKOUT —** Clock output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SD_CLK —** SD/MMC card clock. |
| | | | | | | | | O | **EMC_CLK01 —** SDRAM clock 0 and clock 1 combined. |
| | | | | | | | | I/O | **SSP1_SCK —** Serial clock for SSP1. |
| | | | | | | | | I | **ENET_TX_CLK (ENET_REF_CLK) —** Ethernet Transmit Clock (MII interface) or Ethernet Reference Clock (RMII interface). |
| CLK1 | T10 | - | - | - | - | [4] | O; PU | O | **EMC_CLK1 —** SDRAM clock 1. |
| | | | | | | | | O | **CLKOUT —** Clock output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **CGU_OUT0 —** CGU spare clock output 0. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **I2S1_TX_MCLK —** $I^2S$1 transmit master clock. |
| CLK2 | D14 | P10 | K6 | 141 | 99 | [4] | O; PU | O | **EMC_CLK3 —** SDRAM clock 3. |
| | | | | | | | | O | **CLKOUT —** Clock output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **SD_CLK —** SD/MMC card clock. |
| | | | | | | | | O | **EMC_CLK23 —** SDRAM clock 2 and clock 3 combined. |
| | | | | | | | | O | **I2S0_TX_MCLK —** $I^2S$ transmit master clock. |
| | | | | | | | | I/O | **I2S1_RX_SCK —** Receive Clock. It is driven by the master and received by the slave. Corresponds to the signal SCK in the *$I^2S$-bus specification*. |
| CLK3 | P12 | - | - | - | - | [4] | O; PU | O | **EMC_CLK2 —** SDRAM clock 2. |
| | | | | | | | | O | **CLKOUT —** Clock output pin. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | O | **CGU_OUT1 —** CGU spare clock output 1. |
| | | | | | | | | - | **R —** Function reserved. |
| | | | | | | | | I/O | **I2S1_RX_SCK —** Receive Clock. It is driven by the master and received by the slave. Corresponds to the signal SCK in the *$I^2S$-bus specification*. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| **Debug pins** | | | | | | | | | |
| DBGEN | L4 | K4 | A6 | 41 | 28 | [2] | I | I | JTAG interface control signal. Also used for boundary scan. |
| TCK/SWDCLK | J5 | G5 | H2 | 38 | 27 | [2] | I; F | I | Test Clock for JTAG interface (default) or Serial Wire (SW) clock. |
| $\overline{\text{TRST}}$ | M4 | L4 | B4 | 42 | 29 | [2] | I; PU | I | Test Reset for JTAG interface. |
| TMS/SWDIO | K6 | K5 | C4 | 44 | 30 | [2] | I; PU | I | Test Mode Select for JTAG interface (default) or SW debug data input/output. |
| TDO/SWO | K5 | J5 | H3 | 46 | 31 | [2] | O | O | Test Data Out for JTAG interface (default) or SW trace output. |
| TDI | J4 | H4 | G3 | 35 | 26 | [2] | I; PU | I | Test Data In for JTAG interface. |
| **USB0 pins** | | | | | | | | | |
| USB0_DP | F2 | E2 | E1 | 26 | 18 | [6] | - | I/O | USB0 bidirectional D+ line. Do not add an external series resistor. |
| USB0_DM | G2 | F2 | E2 | 28 | 20 | [6] | - | I/O | USB0 bidirectional D− line. Do not add an external series resistor. |
| USB0_VBUS | F1 | E1 | E3 | 29 | 21 | [6] [7] | - | I/O | VBUS pin (power on USB cable). This pin includes an internal pull-down resistor of 64 kΩ (typical) ± 16 kΩ. |
| USB0_ID | H2 | G2 | F1 | 30 | 22 | [8] | - | I | Indicates to the transceiver whether connected as an A-device (USB0_ID LOW) or B-device (USB0_ID HIGH). For OTG, this pin has an internal pull-up resistor. |
| USB0_RREF | H1 | G1 | F3 | 32 | 24 | [8] | - | | 12.0 kΩ (accuracy 1 %) on-board resistor to ground for current reference. |
| **USB1 pins** | | | | | | | | | |
| USB1_DP | F12 | D11 | E9 | 129 | 89 | [9] | - | I/O | USB1 bidirectional D+ line. Add an external series resistor of 33 Ω +/- 2 %. |
| USB1_DM | G12 | E11 | E10 | 130 | 90 | [9] | - | I/O | USB1 bidirectional D− line. Add an external series resistor of 33 Ω +/- 2 %. |
| **$I^2C$-bus pins** | | | | | | | | | |
| I2C0_SCL | L15 | K13 | D6 | 132 | 92 | [10] | I; F | I/O | $I^2C$ clock input/output. Open-drain output (for $I^2C$-bus compliance). |
| I2C0_SDA | L16 | K14 | E6 | 133 | 93 | [10] | I; F | I/O | $I^2C$ data input/output. Open-drain output (for $I^2C$-bus compliance). |
| **Reset and wake-up pins** | | | | | | | | | |
| $\overline{\text{RESET}}$ | D9 | C7 | B6 | 185 | 128 | [11] | I; IA | I | External reset input: A LOW on this pin resets the device, causing I/O ports and peripherals to take on their default states, and processor execution to begin at address 0. |
| WAKEUP0 | A9 | A9 | A4 | 187 | 130 | [11] | I; IA | I | External wake-up input; can raise an interrupt and can cause wake-up from any of the low-power modes. A pulse with a duration of at least 45 ns wakes up the part. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| WAKEUP1 | A10 | C8 | - | - | - | [11] | I; IA | I | External wake-up input; can raise an interrupt and can cause wake-up from any of the low-power modes. A pulse with a duration of at least 45 ns wakes up the part. |
| WAKEUP2 | C9 | E5 | - | - | - | [11] | I; IA | I | External wake-up input; can raise an interrupt and can cause wake-up from any of the low-power modes. A pulse with a duration of at least 45 ns wakes up the part. |
| WAKEUP3 | D8 | - | - | - | - | [11] | I; IA | I | External wake-up input; can raise an interrupt and can cause wake-up from any of the low-power modes. A pulse with a duration of at least 45 ns wakes up the part. |
| **ADC pins** | | | | | | | | | |
| ADC0_0/ ADC1_0/DAC | E3 | B6 | A2 | 8 | 6 | [8] | AI/O; IA | I | ADC input channel 0. Shared between 10-bit ADC0/1 and DAC. |
| ADC0_1/ ADC1_1 | C3 | C4 | A1 | 4 | 2 | [8] | AI; IA | I | ADC input channel 1. Shared between 10-bit ADC0/1. |
| ADC0_2/ ADC1_2 | A4 | B3 | B3 | 206 | 143 | [8] | AI; IA | I | ADC input channel 2. Shared between 10-bit ADC0/1. |
| ADC0_3/ ADC1_3 | B5 | B4 | A3 | 200 | 139 | [8] | AI; IA | I | ADC input channel 3. Shared between 10-bit ADC0/1. |
| ADC0_4/ ADC1_4 | C6 | A5 | - | 199 | 138 | [8] | AI; IA | I | ADC input channel 4. Shared between 10-bit ADC0/1. |
| ADC0_5/ ADC1_5 | B3 | C3 | - | 208 | 144 | [8] | AI; IA | I | ADC input channel 5. Shared between 10-bit ADC0/1. |
| ADC0_6/ ADC1_6 | A5 | A4 | - | 204 | 142 | [8] | AI; IA | I | ADC input channel 6. Shared between 10-bit ADC0/1. |
| ADC0_7/ ADC1_7 | C5 | B5 | - | 197 | 136 | [8] | AI; IA | I | ADC input channel 7. Shared between 10-bit ADC0/1. |
| **RTC** | | | | | | | | | |
| RTC_ALARM | A11 | A10 | C3 | 186 | 129 | [11] | - | O | RTC controlled output. |
| RTCX1 | A8 | A8 | A5 | 182 | 125 | [8] | - | I | Input to the RTC 32 kHz ultra-low power oscillator circuit. |
| RTCX2 | B8 | B7 | B5 | 183 | 126 | [8] | - | O | Output from the RTC 32 kHz ultra-low power oscillator circuit. |
| **Crystal oscillator pins** | | | | | | | | | |
| XTAL1 | D1 | C1 | B1 | 18 | 12 | [8] | - | I | Input to the oscillator circuit and internal clock generator circuits. |
| XTAL2 | E1 | D1 | C1 | 19 | 13 | [8] | - | O | Output from the oscillator amplifier. |
| **Power and ground pins** | | | | | | | | | |
| USB0_VDDA 3V3_DRIVER | F3 | E3 | D1 | 24 | 16 | | - | - | Separate analog 3.3 V power supply for driver. |
| USB0 _VDDA3V3 | G3 | F3 | D2 | 25 | 17 | | - | - | USB 3.3 V separate power supply voltage. |
| USB0_VSSA _TERM | H3 | G3 | D3 | 27 | 19 | | - | - | Dedicated analog ground for clean reference for termination resistors. |

**Table 3. Pin description** *...continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| USB0_VSSA_REF | G1 | F1 | F2 | 31 | 23 | | - | - | Dedicated clean analog ground for generation of reference currents and voltages. |
| VDDA | B4 | A6 | B2 | 198 | 137 | | - | - | Analog power supply and ADC reference voltage. |
| VBAT | B10 | B9 | C5 | 184 | 127 | | - | - | RTC power supply: 3.3 V on this pin supplies power to the RTC. |
| VDDREG | F10, F9, L8, L7 | D8, E8 | E4, E5, F4 | 135, 188, 195, 82, 33 | 94, 131, 59, 25 | | | - | Main regulator power supply. Tie the VDDREG and VDDIO pins to a common power supply to ensure the same ramp-up time for both supply voltages. |
| VPP | E8 | - | - | - | - | [12] | - | - | OTP programming voltage. |
| VDDIO | D7, E12, F7, F8, G10, H10, J6, J7, K7, L9, L10, N7, N13 | H5, H10, K8, G10 | F10, K5 | 6, 52, 57, 102, 110, 155, 160, 202 | 5, 36, 41, 71, 77, 107, 111, 141 | [12] | - | - | I/O power supply. Tie the VDDREG and VDDIO pins to a common power supply to ensure the same ramp-up time for both supply voltages. |
| VSS | G9, H7, J10, J11, K8 | F10, D7, E6, E7, E9, K6, K9 | C8, D4, D5, G8, J3, J6 | - | - | [13] | - | - | Ground. |
| VSSIO | C4, D13, G6, G7, G8, H8, H9, J8, J9, K9, K10, M13, P7, P13 | - | - | 5, 56, 109, 157 | 4, 40, 76, 109 | [13] | - | - | Ground. |

**Table 3. Pin description** *…continued*

*LCD, Ethernet, USB0, and USB1 functions are not available on all parts. See Table 2.*

| Symbol | LBGA256 | TFBGA180 | TFBGA100 | LQFP208 | LQFP144 | Reset state [1] | Type | Description |
|---|---|---|---|---|---|---|---|---|
| VSSA | B2 | A3 | C2 | 196 | 135 | - | - | Analog ground. |
| **Not connected** | | | | | | | | |
| - | B9 | B8 | - | - | - | - | - | n.c. |

[1] N = neutral, input buffer disabled; no extra VDDIO current consumption if the input is driven midway between supplies; set the EZI bit in the SFS register to enable the input buffer; I = input; OL = output driving LOW; OH = output driving HIGH; AI/O = analog input/output; IA = inactive; PU = pull-up enabled (weak pull-up resistor pulls up pin to VDDIO; F = floating. Reset state reflects the pin state at reset without boot code operation.

[2] 5 V tolerant pad with 15 ns glitch filter (5 V tolerant if VDDIO present; if VDDIO not present, do not exceed 3.6 V); provides digital I/O functions with TTL levels and hysteresis; normal drive strength (see Figure 45).

[3] 5 V tolerant pad with 15 ns glitch filter (5 V tolerant if VDDIO present; if VDDIO not present, do not exceed 3.6 V); provides digital I/O functions with TTL levels, and hysteresis; high drive strength (see Figure 45).

[4] 5 V tolerant pad with 15 ns glitch filter (5 V tolerant if VDDIO present; if VDDIO not present, do not exceed 3.6 V); provides high-speed digital I/O functions with TTL levels and hysteresis (see Figure 45).

[5] 5 V tolerant pad providing digital I/O functions (with TTL levels and hysteresis) and analog input or output (5 V tolerant if VDDIO present; if VDDIO not present, do not exceed 3.6 V). When configured as an ADC input or DAC output, the pin is not 5 V tolerant and the digital section of the pad must be disabled by setting the pin to an input function and disabling the pull-up resistor through the pin's SFSP register.

[6] 5 V tolerant transparent analog pad.

[7] For maximum load $C_L$ = 6.5 μF and maximum pull-down resistance $R_{pd}$ = 80 kΩ, the VBUS signal takes about 2 s to fall from VBUS = 5 V to VBUS = 0.2 V when it is no longer driven.

[8] Transparent analog pad. Not 5 V tolerant.

[9] Pad provides USB functions. It is designed in accordance with the USB specification, revision 2.0 (Full-speed and Low-speed mode only).

[10] Open-drain 5 V tolerant digital I/O pad, compatible with $I^2C$-bus Fast Mode Plus specification. This pad requires an external pull-up to provide output functionality. When power is switched off, this pin connected to the $I^2C$-bus is floating and does not disturb the $I^2C$ lines.

[11] 5 V tolerant pad with 20 ns glitch filter; provides digital I/O functions with open-drain output with weak pull-up resistor and hysteresis (see Figure 46).

[12] If not pinned out, VPP is internally connected to VDDIO.

[13] On the TFBGA100 and LQFP208 packages, VSS is internally connected to VSSIO.

# 7. Functional description

## 7.1 Architectural overview

The ARM Cortex-M3 includes three AHB-Lite buses: the system bus, the I-code bus, and the D-code bus. The I-code and D-code core buses allow for concurrent code and data accesses from different slave ports.

The LPC1850/30/20/10 use a multi-layer AHB matrix to connect the ARM Cortex-M3 buses and other bus masters to peripherals. Flexible connections allow different bus masters to access peripherals that are on different slave ports of the matrix simultaneously.

## 7.2 ARM Cortex-M3 processor

The ARM Cortex-M3 is a general purpose, 32-bit microprocessor, which offers high performance and low-power consumption. The ARM Cortex-M3 offers many new features, including a Thumb-2 instruction set, low interrupt latency, hardware division, hardware single-cycle multiply, interruptable/continuable multiple load and store instructions, automatic state save and restore for interrupts, tightly integrated interrupt controller with wake-up interrupt controller, and multiple core buses capable of simultaneous accesses.

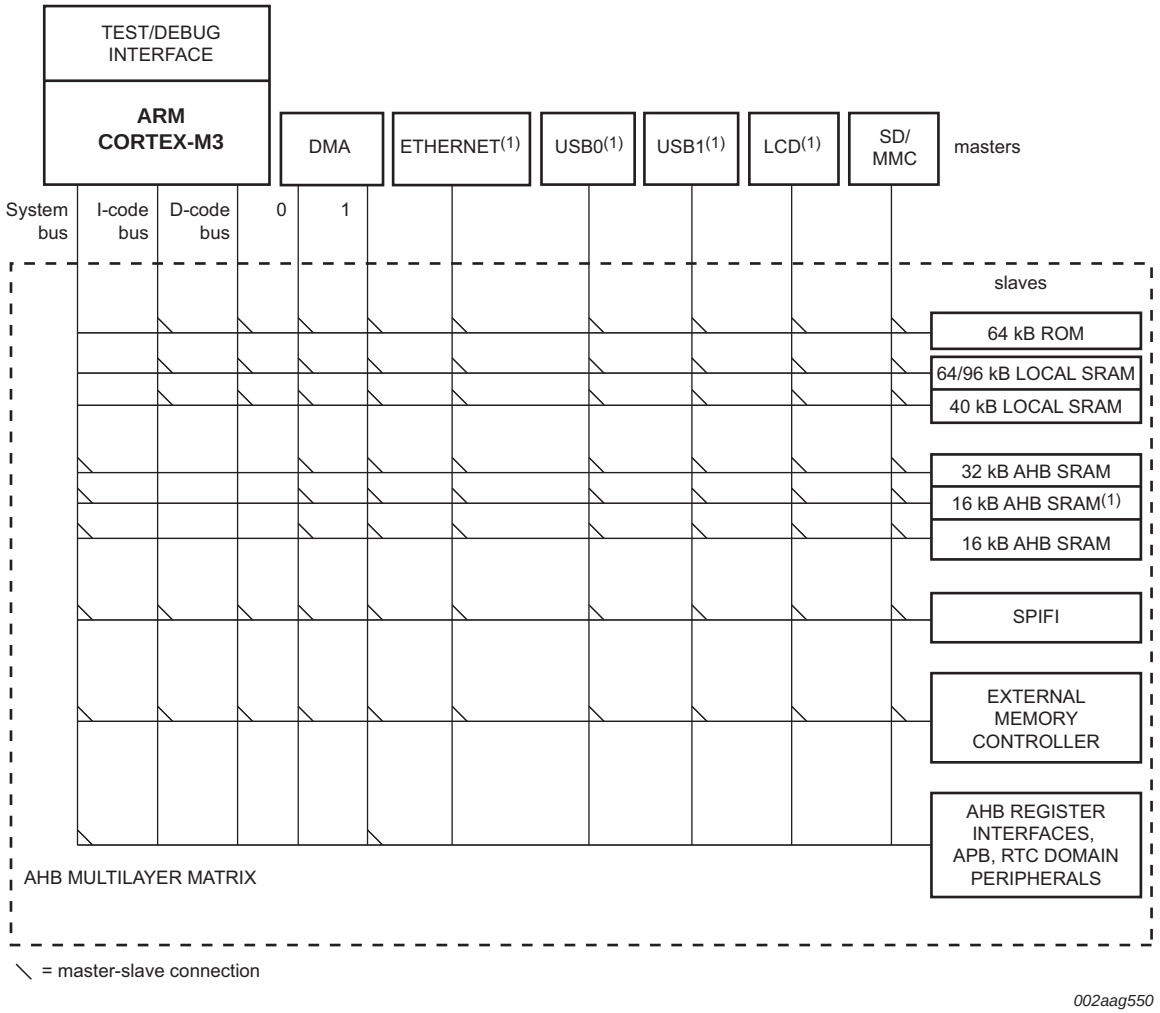
Pipeline techniques are employed so that all parts of the processing and memory systems can operate continuously. Typically, while one instruction is being executed, its successor is being decoded, and a third instruction is being fetched from memory.

The ARM Cortex-M3 processor is described in detail in the Cortex-M3 Technical Reference Manual.

## 7.3 System Tick timer (SysTick)

The ARM Cortex-M3 includes a system tick timer (SYSTICK) that is intended to generate a dedicated SYSTICK exception at a 10 ms interval.

## 7.4 AHB multilayer matrix




(1) Not available on all parts (see Table 2).

**Fig 7. AHB multilayer matrix master and slave connections**

## 7.5 Nested Vectored Interrupt Controller (NVIC)

The NVIC is part of the Cortex-M3. The tight coupling to the CPU allows for low interrupt latency and efficient processing of late arriving interrupts.

### 7.5.1 Features

- Controls system exceptions and peripheral interrupts.
- On the LPC1850/30/20/10, the NVIC supports 53 vectored interrupts.
- Eight programmable interrupt priority levels, with hardware priority level masking.
- Relocatable vector table.
- Non-Maskable Interrupt (NMI).
- Software interrupt generation.

### 7.5.2 Interrupt sources

Each peripheral device has one interrupt line connected to the NVIC but can have several interrupt flags. Individual interrupt flags can also represent more than one interrupt source.

## 7.6 Event router

The event router combines various internal signals, interrupts, and the external interrupt pins (WAKEUP[3:0]) to create an interrupt in the NVIC, if enabled. In addition, the event router creates a wake-up signal to the ARM core and the CCU for waking up from Sleep, Deep-sleep, Power-down, and Deep power-down modes. Individual events can be configured as edge or level sensitive and can be enabled or disabled in the event router. The event router can be battery powered.

The following events if enabled in the event router can create a wake-up signal from sleep, deep-sleep, power-down, and deep power-down modes and/or create an interrupt:

- External pins WAKEUP0/1/2/3 and $\overline{\text{RESET}}$
- Alarm timer, RTC (32 kHz oscillator running)

The following events if enabled in the event router can create a wake-up signal from sleep mode only and/or create an interrupt:

- WWDT, BOD interrupts
- C_CAN0/1 and QEI interrupts
- Ethernet, USB0, USB1 signals
- Selected outputs of combined timers (SCT and timer0/1/3)

**Remark:** Any interrupt can wake up the ARM Cortex-M3 from sleep mode if enabled in the NVIC.

## 7.7 Global Input Multiplexer Array (GIMA)

The GIMA routes internal and external signals to event-driven peripheral targets like the SCT, timers, event router, or the ADCs.

### 7.7.1 Features

- Single selection of a source.
- Signal inversion.
- Can capture a pulse if the input event source is faster than the target clock.
- Synchronization of input event and target clock.
- Single-cycle pulse generation for target.

## 7.8 On-chip static RAM

The LPC1850/30/20/10 support up to 200 kB SRAM with separate bus master access for higher throughput and individual power control for low-power operation.

### 7.8.1 ISP (In-System Programming) mode

In-System Programming (ISP) means programming or reprogramming the on-chip SRAM memory, using the boot loader software and the USART0 serial port. ISP can be performed when the part resides in the end-user board. ISP loads data into on-chip SRAM and execute code from on-chip SRAM.

## 7.9 Boot ROM

The internal ROM memory is used to store the boot code of the LPC1850/30/20/10. After a reset, the ARM processor will start its code execution from this memory.

The boot ROM memory includes the following features:

- The ROM memory size is 64 kB.
- Supports booting from external static memory such as NOR flash, SPI flash, quad SPI flash, USB0, and USB1.
- Includes API for OTP programming.
- Includes a flexible USB device stack that supports Human Interface Device (HID), Mass Storage Class (MSC), and Device Firmware Upgrade (DFU) drivers.

Several boot modes are available depending on the values of the OTP bits BOOT_SRC. If the OTP memory is not programmed or the BOOT_SRC bits are all zero, the boot mode is determined by the states of the boot pins P2_9, P2_8, P1_2, and P1_1.

**Table 4. Boot mode when OTP BOOT_SRC bits are programmed**

| Boot mode | BOOT_SRC bit 3 | BOOT_SRC bit 2 | BOOT_SRC bit 1 | BOOT_SRC bit 0 | Description |
|---|---|---|---|---|---|
| Pin state | 0 | 0 | 0 | 0 | Boot source is defined by the reset state of P1_1, P1_2, P2_8, and P2_9 pins. See Table 5. |
| USART0 | 0 | 0 | 0 | 1 | Boot from device connected to USART0 using pins P2_0 and P2_1. |
| SPIFI | 0 | 0 | 1 | 0 | Boot from Quad SPI flash connected to the SPIFI interface using pins P3_3 to P3_8. |
| EMC 8-bit | 0 | 0 | 1 | 1 | Boot from external static memory (such as NOR flash) using CS0 and an 8-bit data bus. |
| EMC 16-bit | 0 | 1 | 0 | 0 | Boot from external static memory (such as NOR flash) using CS0 and a 16-bit data bus. |
| EMC 32-bit | 0 | 1 | 0 | 1 | Boot from external static memory (such as NOR flash) using CS0 and a 32-bit data bus. |
| USB0 | 0 | 1 | 1 | 0 | Boot from USB0. |
| USB1 | 0 | 1 | 1 | 1 | Boot from USB1. |
| SPI (SSP0) | 1 | 0 | 0 | 0 | Boot from SPI flash connected to the SSP0 interface on P3_3 (function SSP0_SCK), P3_6 (function SSP0_SSEL), P3_7 (function SSP0_MISO), and P3_8 (function SSP0_MOSI)[1]. |
| USART3 | 1 | 0 | 0 | 1 | Boot from device connected to USART3 using pins P2_3 and P2_4. |

[1] The boot loader programs the appropriate pin function at reset to boot using either SSP0 or SPIFI.
**Remark:** Pin functions for SPIFI and SSP0 boot are different.

**Table 5. Boot mode when OPT BOOT_SRC bits are zero**

| Boot mode | Pins | | | | Description |
|---|---|---|---|---|---|
| | P2_9 | P2_8 | P1_2 | P1_1 | |
| USART0 | LOW | LOW | LOW | LOW | Boot from device connected to USART0 using pins P2_0 and P2_1. |
| SPIFI | LOW | LOW | LOW | HIGH | Boot from Quad SPI flash connected to the SPIFI interface on P3_3 to P3_8[1]. |
| EMC 8-bit | LOW | LOW | HIGH | LOW | Boot from external static memory (such as NOR flash) using CS0 and an 8-bit data bus. |
| EMC 16-bit | LOW | LOW | HIGH | HIGH | Boot from external static memory (such as NOR flash) using CS0 and a 16-bit data bus. |
| EMC 32-bit | LOW | HIGH | LOW | LOW | Boot from external static memory (such as NOR flash) using CS0 and a 32-bit data bus. |
| USB0 | LOW | HIGH | LOW | HIGH | Boot from USB0 |
| USB1 | LOW | HIGH | HIGH | LOW | Boot from USB1. |
| SPI (SSP0) | LOW | HIGH | HIGH | HIGH | Boot from SPI flash connected to the SSP0 interface on P3_3 (function SSP0_SCK), P3_6 (function SSP0_SSEL), P3_7 (function SSP0_MISO), and P3_8 (function SSP0_MOSI)[1]. |
| USART3 | HIGH | LOW | LOW | LOW | Boot from device connected to USART3 using pins P2_3 and P2_4. |

[1] The boot loader programs the appropriate pin function at reset to boot using the SSP0 or SPIFI.
**Remark:** Pin functions for SPIFI and SSP0 boot are different.

## 7.10 Memory mapping

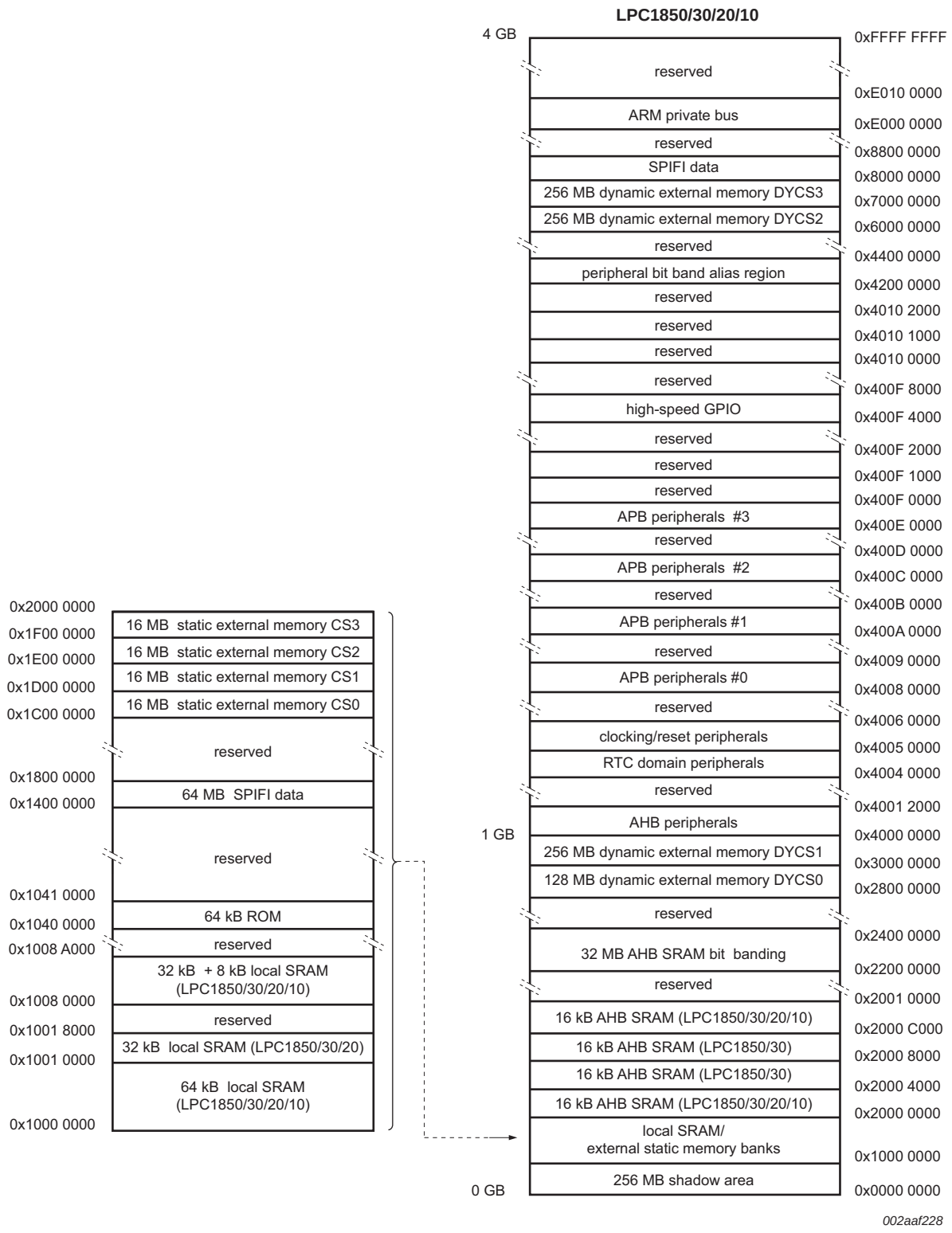



**Fig 8. LPC1850/30/20/10 Memory mapping (overview)**

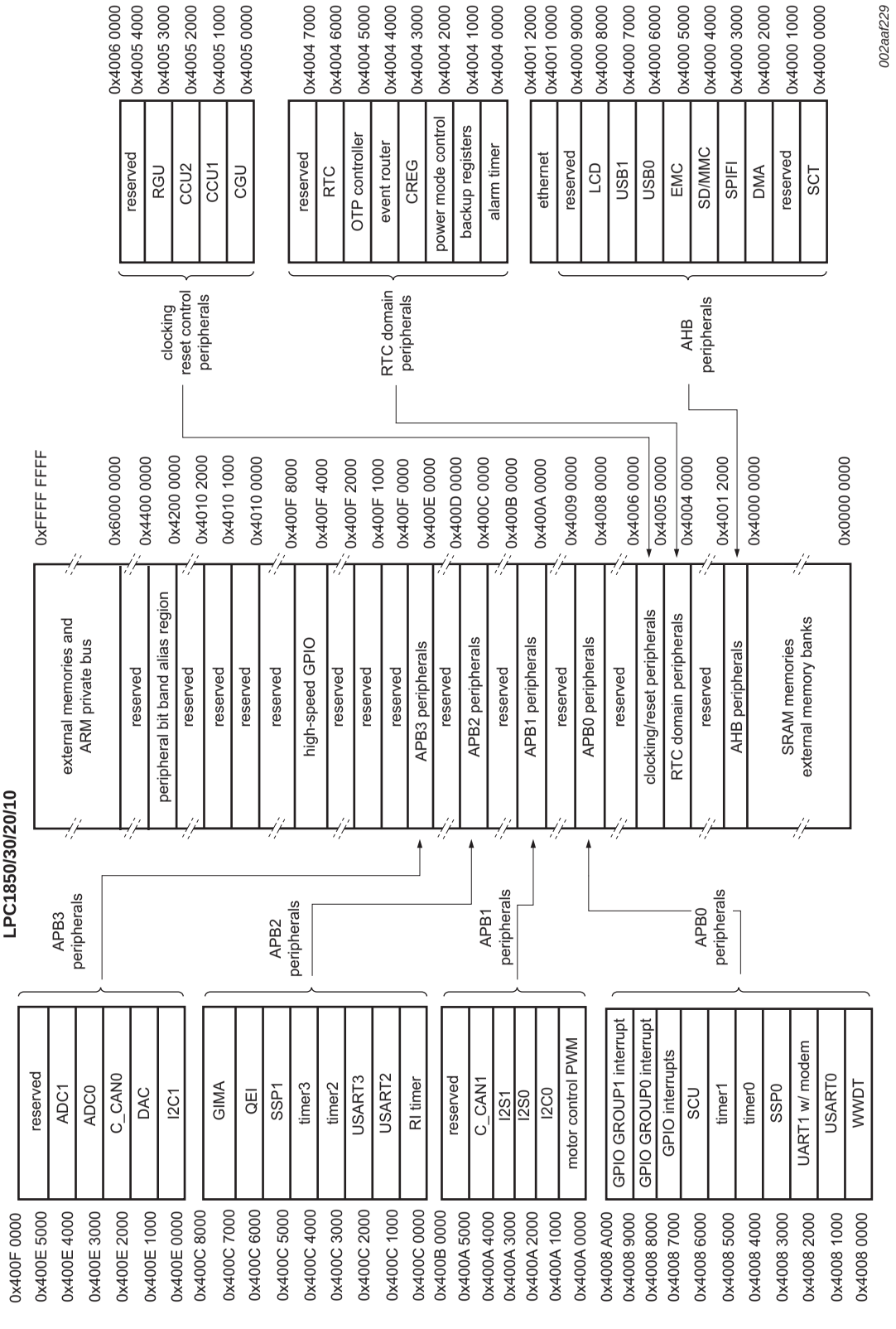



**Fig 9. LPC1850/30/20/10 Memory mapping (peripherals)**

## 7.11 One-Time Programmable (OTP) memory

The OTP provides 32 bit of memory for general-purpose use.

## 7.12 General-Purpose I/O (GPIO)

The LPC1850/30/20/10 provides eight GPIO ports with up to 31 GPIO pins each.

Device pins that are not connected to a specific peripheral function are controlled by the GPIO registers. Pins may be dynamically configured as inputs or outputs. Separate registers allow setting or clearing any number of outputs simultaneously. The value of the output register may be read back as well as the current state of the port pins.

All GPIO pins default to inputs with pull-up resistors enabled and input buffer disabled on reset. The input buffer must be turned on in the system control block SFS register before the GPIO input can be read.

### 7.12.1 Features

- Accelerated GPIO functions:
  - GPIO registers are located on the AHB so that the fastest possible I/O timing can be achieved.
  - Mask registers allow treating sets of port bits as a group, leaving other bits unchanged.
  - All GPIO registers are byte and half-word addressable.
  - Entire port value can be written in one instruction.
- Bit-level set and clear registers allow a single instruction set or clear of any number of bits in one port.
- Direction control of individual bits.
- Up to eight GPIO pins can be selected from all GPIO pins to create an edge- or level-sensitive GPIO interrupt request.
- Two GPIO group interrupts can be triggered by any pin or pins in each port.

## 7.13 AHB peripherals

### 7.13.1 State Configurable Timer (SCT) subsystem

The SCT allows a wide variety of timing, counting, output modulation, and input capture operations. The inputs and outputs of the SCT are shared with the capture and match inputs/outputs of the 32-bit general-purpose counter/timers.

The SCT can be configured as two 16-bit counters or a unified 32-bit counter. In the two-counter case, in addition to the counter value the following operational elements are independent for each half:

- State variable
- Limit, halt, stop, and start conditions
- Values of Match/Capture registers, plus reload or capture control values

In the two-counter case, the following operational elements are global to the SCT, but the last three can use match conditions from either counter:

- Clock selection
- Inputs
- Events
- Outputs
- Interrupts

#### 7.13.1.1 Features

- Two 16-bit counters or one 32-bit counter.
- Counters clocked by bus clock or selected input.
- Counters can be configured as up counters or up-down counters.
- State variable allows sequencing across multiple counter cycles.
- Event combines input or output condition and/or counter match in a specified state.
- Events control outputs and interrupts.
- Selected events can limit, halt, start, or stop a counter.
- Supports:
  - up to 8 inputs
  - up to 16 outputs
  - 16 match/capture registers
  - 16 events
  - 32 states

### 7.13.2 General-purpose DMA

The DMA controller allows peripheral-to memory, memory-to-peripheral, peripheral-to-peripheral, and memory-to-memory transactions. Each DMA stream provides unidirectional serial DMA transfers for a single source and destination. For example, a bidirectional port requires one stream for transmit and one for receives. The source and destination areas can each be either a memory region or a peripheral for master 1, but only memory for master 0.

#### 7.13.2.1 Features

- Eight DMA channels. Each channel can support a unidirectional transfer.
- 16 DMA request lines.
- Single DMA and burst DMA request signals. Each peripheral connected to the DMA Controller can assert either a burst DMA request or a single DMA request. The DMA burst size is set by programming the DMA Controller.
- Memory-to-memory, memory-to-peripheral, peripheral-to-memory, and peripheral-to-peripheral transfers are supported.
- Scatter or gather DMA is supported through the use of linked lists. This means that the source and destination areas do not have to occupy contiguous areas of memory.
- Hardware DMA channel priority.
- AHB slave DMA programming interface. The DMA Controller is programmed by writing to the DMA control registers over the AHB slave interface.

- Two AHB bus masters for transferring data. These interfaces transfer data when a DMA request goes active. Master 1 can access memories and peripherals, master 0 can access memories only.
- 32-bit AHB master bus width.
- Incrementing or non-incrementing addressing for source and destination.
- Programmable DMA burst size. The DMA burst size can be programmed to more efficiently transfer data.
- Internal four-word FIFO per channel.
- Supports 8, 16, and 32-bit wide transactions.
- Big-endian and little-endian support. The DMA Controller defaults to little-endian mode on reset.
- An interrupt to the processor can be generated on a DMA completion or when a DMA error has occurred.
- Raw interrupt status. The DMA error and DMA count raw interrupt status can be read prior to masking.

### 7.13.3 SPI Flash Interface (SPIFI)

The SPI Flash Interface allows low-cost serial flash memories to be connected to the ARM Cortex-M3 processor with little performance penalty compared to parallel flash devices with higher pin count.

After a few commands configure the interface at startup, the entire flash content is accessible as normal memory using byte, halfword, and word accesses by the processor and/or DMA channels. Simple sequences of commands handle erasing and programming.

Many serial flash devices use a half-duplex command-driven SPI protocol for device setup and initialization and then move to a half-duplex, command-driven 4-bit protocol for normal operation. Different serial flash vendors and devices accept or require different commands and command formats. SPIFI provides sufficient flexibility to be compatible with common flash devices and includes extensions to help insure compatibility with future devices.

#### 7.13.3.1 Features

- Interfaces to serial flash memory in the main memory map.
- Supports classic and 4-bit bidirectional serial protocols.
- Half-duplex protocol compatible with various vendors and devices.
- Quad SPI Flash Interface (SPIFI) with 1-, 2-, or 4-bit data at rates of up to 52 MB per second.
- Supports DMA access.

### 7.13.4 SD/MMC card interface

The SD/MMC card interface supports the following modes:

- Secure Digital memory (SD version 3.0)
- Secure Digital I/O (SDIO version 2.0)
- Consumer Electronics Advanced Transport Architecture (CE-ATA version 1.1)

- MultiMedia Cards (MMC version 4.4)

### 7.13.5 External Memory Controller (EMC)

The LPC1850/30/20/10 EMC is a Memory Controller peripheral offering support for asynchronous static memory devices such as RAM, ROM, and NOR flash. In addition, it can be used as an interface with off-chip memory-mapped devices and peripherals.

#### 7.13.5.1 Features

- Dynamic memory interface support including single data rate SDRAM.
- Asynchronous static memory device support including RAM, ROM, and NOR flash, with or without asynchronous page mode.
- Low transaction latency.
- Read and write buffers to reduce latency and to improve performance.
- 8/16/32 data and 24 address lines-wide static memory support. On parts LPC1820/10 only 8/16 data lines are available.
- 16-bit and 32-bit wide chip select SDRAM memory support.
- Static memory features include:
  - Asynchronous page mode read
  - Programmable Wait States
  - Bus turnaround delay
  - Output enable and write enable delays
  - Extended wait
- Four chip selects for synchronous memory and four chip selects for static memory devices.
- Power-saving modes dynamically control EMC_CKEOUT and EMC_CLK signals to SDRAMs.
- Dynamic memory self-refresh mode controlled by software.
- Controller supports 2048 (A0 to A10), 4096 (A0 to A11), and 8192 (A0 to A12) row address synchronous memory parts. Those are typically 512 MB, 256 MB, and 128 MB parts, with 4, 8, 16, or 32 data bits per device.
- Separate reset domains allow auto-refresh through a chip reset if desired.

**Note:** Synchronous static memory devices (synchronous burst mode) are not supported.

### 7.13.6 High-speed USB Host/Device/OTG interface (USB0)

**Remark:** USB0 is available on parts LPC1850/30/20 (see Table 2).

The USB OTG module allows the part to connect directly to a USB host such as a PC (in device mode) or to a USB device in host mode.

#### 7.13.6.1 Features

- On-chip UTMI+ compliant high-speed transceiver (PHY).
- Complies with *Universal Serial Bus specification 2.0*.
- Complies with *USB On-The-Go supplement*.
- Complies with *Enhanced Host Controller Interface Specification*.

- Supports auto USB 2.0 mode discovery.
- Supports all high-speed USB-compliant peripherals.
- Supports all full-speed USB-compliant peripherals.
- Supports software Host Negotiation Protocol (HNP) and Session Request Protocol (SRP) for OTG peripherals.
- Supports interrupts.
- This module has its own, integrated DMA engine.
- USB interface electrical test software included in ROM USB stack.

### 7.13.7 High-speed USB Host/Device interface with ULPI (USB1)

**Remark:** USB1 is available on parts LPC1850/30 (see Table 2).

The USB1 interface can operate as a full-speed USB host/device interface or can connect to an external ULPI PHY for High-speed operation.

#### 7.13.7.1 Features

- Complies with *Universal Serial Bus specification 2.0*.
- Complies with *Enhanced Host Controller Interface Specification*.
- Supports auto USB 2.0 mode discovery.
- Supports all high-speed USB-compliant peripherals if connected to external ULPI PHY.
- Supports all full-speed USB-compliant peripherals.
- Supports interrupts.
- This module has its own, integrated DMA engine.
- USB interface electrical test software included in ROM USB stack.

### 7.13.8 LCD controller

**Remark:** The LCD controller is available on LPC1850 only.

The LCD controller provides all of the necessary control signals to interface directly to various color and monochrome LCD panels. Both STN (single and dual panel) and TFT panels can be operated. The display resolution is selectable and can be up to 1024 × 768 pixels. Several color modes are provided, up to a 24-bit true-color non-palettized mode. An on-chip 512 byte color palette allows reducing bus utilization (that is, memory size of the displayed data) while still supporting many colors.

The LCD interface includes its own DMA controller to allow it to operate independently of the CPU and other system functions. A built-in FIFO acts as a buffer for display data, providing flexibility for system timing. Hardware cursor support can further reduce the amount of CPU time required to operate the display.

#### 7.13.8.1 Features

- AHB master interface to access frame buffer.
- Setup and control via a separate AHB slave interface.
- Dual 16-deep programmable 64-bit wide FIFOs for buffering incoming display data.

- Supports single and dual-panel monochrome Super Twisted Nematic (STN) displays with 4-bit or 8-bit interfaces.
- Supports single and dual-panel color STN displays.
- Supports Thin Film Transistor (TFT) color displays.
- Programmable display resolution including, but not limited to: 320 × 200, 320 × 240, 640 × 200, 640 × 240, 640 × 480, 800 × 600, and 1024 × 768.
- Hardware cursor support for single-panel displays.
- 15 gray-level monochrome, 3375 color STN, and 32 K color palettized TFT support.
- 1, 2, or 4 bits-per-pixel (bpp) palettized displays for monochrome STN.
- 1, 2, 4, or 8 bpp palettized color displays for color STN and TFT.
- 16 bpp true-color non-palettized for color STN and TFT.
- 24 bpp true-color non-palettized for color TFT.
- Programmable timing for different display panels.
- 256 entry, 16-bit palette RAM, arranged as a 128 × 32-bit RAM.
- Frame, line, and pixel clock signals.
- AC bias signal for STN, data enable signal for TFT panels.
- Supports little and big-endian, and Windows CE data formats.
- LCD panel clock can be generated from the peripheral clock, or from a clock input pin.

### 7.13.9 Ethernet

**Remark:** Ethernet is available on parts LPC1850/30 (see Table 2).

#### 7.13.9.1 Features

- 10/100 Mbit/s
- DMA support
- Power management remote wake-up frame and magic packet detection
- Supports both full-duplex and half-duplex operation
  - Supports CSMA/CD Protocol for half-duplex operation.
  - Supports IEEE 802.3x flow control for full-duplex operation.
  - Optional forwarding of received pause control frames to the user application in full-duplex operation.
  - Back-pressure support for half-duplex operation.
  - Automatic transmission of zero-quanta pause frame on deassertion of flow control input in full-duplex operation.
- Support for IEEE 1588 time stamping and IEEE 1588 advanced time stamping (IEEE 1588-2008 v2).

## 7.14 Digital serial peripherals

### 7.14.1 UART

The LPC1850/30/20/10 contain one UART with standard transmit and receive data lines. UART1 also provides a full modem control handshake interface and support for RS-485/9-bit mode allowing both software address detection and automatic address detection using 9-bit mode.

UART1 includes a fractional baud rate generator. Standard baud rates such as 115200 Bd can be achieved with any crystal frequency above 2 MHz.

#### 7.14.1.1 Features

- Maximum UART data bit rate of 8 MBit/s.
- 16 B Receive and Transmit FIFOs.
- Register locations conform to 16C550 industry standard.
- Receiver FIFO trigger points at 1 B, 4 B, 8 B, and 14 B.
- Built-in fractional baud rate generator covering wide range of baud rates without a need for external crystals of particular values.
- Auto baud capabilities and FIFO control mechanism that enables software flow control implementation.
- Equipped with standard modem interface signals. This module also provides full support for hardware flow control (auto-CTS/RTS).
- Support for RS-485/9-bit/EIA-485 mode (UART1).
- DMA support.

### 7.14.2 USART

**Remark:** The LPC1850/30/20/10 contain three USARTs. In addition to standard transmit and receive data lines, the USARTs support a synchronous mode and a smart card mode.

The USARTs include a fractional baud rate generator. Standard baud rates such as 115200 Bd can be achieved with any crystal frequency above 2 MHz.

#### 7.14.2.1 Features

- Maximum UART data bit rate of 8 MBit/s.
- 16 B Receive and Transmit FIFOs.
- Register locations conform to 16C550 industry standard.
- Receiver FIFO trigger points at 1 B, 4 B, 8 B, and 14 B.
- Built-in fractional baud rate generator covering wide range of baud rates without a need for external crystals of particular values.
- Auto baud capabilities and FIFO control mechanism that enables software flow control implementation.
- Support for RS-485/9-bit/EIA-485 mode.
- USART3 includes an IrDA mode to support infrared communication.
- All USARTs have DMA support.
- Support for synchronous mode at a data bit rate of up to 8 Mbit/s.

- Smart card mode conforming to ISO7816 specification

### 7.14.3 SSP serial I/O controller

**Remark:** The LPC1850/30/20/10 contain two SSP controllers.

The SSP controller can operate on a SPI, 4-wire SSI, or Microwire bus. It can interact with multiple masters and slaves on the bus. Only a single master and a single slave can communicate on the bus during a given data transfer. The SSP supports full-duplex transfers, with frames of 4 bit to 16 bit of data flowing from the master to the slave and from the slave to the master. In practice, often only one of these data flows carries meaningful data.

#### 7.14.3.1 Features

- Maximum SSP speed in full-duplex mode of 25 Mbit/s; for transmit only 50 Mbit/s (master) and 15 Mbit/s (slave).
- Compatible with Motorola SPI, 4-wire Texas Instruments SSI, and National Semiconductor Microwire buses
- Synchronous serial communication
- Master or slave operation
- Eight-frame FIFOs for both transmit and receive
- 4-bit to 16-bit frame
- Connected to the GPDMA

### 7.14.4 $I^2C$-bus interface

**Remark:** The LPC1850/30/20/10 contain two $I^2C$-bus interfaces.

The $I^2C$-bus is bidirectional for inter-IC control using only two wires: a Serial Clock line (SCL) and a Serial Data line (SDA). Each device is recognized by a unique address and can operate as either a receiver-only device (for example an LCD driver) or a transmitter with the capability to both receive and send information (such as memory). Transmitters and/or receivers can operate in either master or slave mode, depending on whether the chip has to initiate a data transfer or is only addressed. The $I^2C$ is a multi-master bus and can be controlled by more than one bus master connected to it.

#### 7.14.4.1 Features

- $I^2C0$ is a standard $I^2C$-compliant bus interface with open-drain pins. $I^2C0$ also supports Fast mode plus with bit rates up to 1 Mbit/s.
- $I^2C1$ uses standard I/O pins with bit rates of up to 400 kbit/s (Fast $I^2C$-bus).
- Easy to configure as master, slave, or master/slave.
- Programmable clocks allow versatile rate control.
- Bidirectional data transfer between masters and slaves.
- Multi-master bus (no central master).
- Arbitration between simultaneously transmitting masters without corruption of serial data on the bus.
- Serial clock synchronization allows devices with different bit rates to communicate via one serial bus.

- Serial clock synchronization can be used as a handshake mechanism to suspend and resume serial transfer.
- The I²C-bus can be used for test and diagnostic purposes.
- All I²C-bus controllers support multiple address recognition and a bus monitor mode.

### 7.14.5 I²S interface

**Remark:** The LPC1850/30/20/10 contain two I²S interfaces.

The I²S-bus provides a standard communication interface for digital audio applications.

The *I²S-bus specification* defines a 3-wire serial bus using one data line, one clock line, and one word select signal. The basic I²S-bus connection has one master, which is always the master, and one slave. The I²S-bus interface provides a separate transmit and receive channel, each of which can operate as either a master or a slave.

#### 7.14.5.1 Features

- The interface has separate input/output channels each of which can operate in master or slave mode.
- Capable of handling 8-bit, 16-bit, and 32-bit word sizes.
- Mono and stereo audio data supported.
- The sampling frequency can range from 16 kHz to 192 kHz (16, 22.05, 32, 44.1, 48, 96, 192) kHz.
- Support for an audio master clock.
- Configurable word select period in master mode (separately for I²S-bus input and output).
- Two 8-word FIFO data buffers are provided, one for transmit and one for receive.
- Generates interrupt requests when buffer levels cross a programmable boundary.
- Two DMA requests, controlled by programmable buffer levels. The DMA requests are connected to the GPDMA block.
- Controls include reset, stop and mute options separately for I²S-bus input and I²S-bus output.

### 7.14.6 C_CAN

**Remark:** The LPC1850/30/20/10 contain two C_CAN controllers.

Controller Area Network (CAN) is the definition of a high performance communication protocol for serial data communication. The C_CAN controller is designed to provide a full implementation of the CAN protocol according to the CAN Specification Version 2.0B. The C_CAN controller can build powerful local networks with low-cost multiplex wiring by supporting distributed real-time control with a high level of reliability.

#### 7.14.6.1 Features

- Conforms to protocol version 2.0 parts A and B.
- Supports bit rate of up to 1 Mbit/s.
- Supports 32 Message Objects.
- Each Message Object has its own identifier mask.

- Provides programmable FIFO mode (concatenation of Message Objects).
- Provides maskable interrupts.
- Supports Disabled Automatic Retransmission (DAR) mode for time-triggered CAN applications.
- Provides programmable loop-back mode for self-test operation.

## 7.15 Counter/timers and motor control

### 7.15.1 General purpose 32-bit timers/external event counter

**Remark:** The LPC1850/30/20/10 include four 32-bit timer/counters.

The timer/counter is designed to count cycles of the system derived clock or an externally-supplied clock. It can optionally generate interrupts, generate timed DMA requests, or perform other actions at specified timer values, based on four match registers. Each timer/counter also includes two capture inputs to trap the timer value when an input signal transitions, optionally generating an interrupt.

#### 7.15.1.1 Features

- A 32-bit timer/counter with a programmable 32-bit prescaler.
- Counter or timer operation.
- Two 32-bit capture channels per timer, that can take a snapshot of the timer value when an input signal transitions. A capture event can also generate an interrupt.
- Four 32-bit match registers that allow:
  - Continuous operation with optional interrupt generation on match.
  - Stop timer on match with optional interrupt generation.
  - Reset timer on match with optional interrupt generation.
- Up to four external outputs corresponding to match registers, with the following capabilities:
  - Set LOW on match.
  - Set HIGH on match.
  - Toggle on match.
  - Do nothing on match.
- Up to two match registers can be used to generate timed DMA requests.

### 7.15.2 Motor control PWM

The motor control PWM is a specialized PWM supporting 3-phase motors and other combinations. Feedback inputs are provided to automatically sense rotor position and use that information to ramp speed up or down. An abort input causes the PWM to release all motor drive outputs immediately . At the same time, the motor control PWM is highly configurable for other generalized timing, counting, capture, and compare applications.

### 7.15.3 Quadrature Encoder Interface (QEI)

A quadrature encoder, also known as a 2-channel incremental encoder, converts angular displacement into two pulse signals. By monitoring both the number of pulses and the relative phase of the two signals, the user code can track the position, direction of rotation,

and velocity. In addition, a third channel, or index signal, can be used to reset the position counter. The quadrature encoder interface decodes the digital pulses from a quadrature encoder wheel to integrate position over time and determine direction of rotation. In addition, the QEI can capture the velocity of the encoder wheel.

#### 7.15.3.1 Features

- Tracks encoder position.
- Increments/decrements depending on direction.
- Programmable for 2× or 4× position counting.
- Velocity capture using built-in timer.
- Velocity compare function with “less than” interrupt.
- Uses 32-bit registers for position and velocity.
- Three position-compare registers with interrupts.
- Index counter for revolution counting.
- Index compare register with interrupts.
- Can combine index and position interrupts to produce an interrupt for whole and partial revolution displacement.
- Digital filter with programmable delays for encoder input signals.
- Can accept decoded signal inputs (clk and direction).

### 7.15.4 Repetitive Interrupt (RI) timer

The repetitive interrupt timer provides a free-running 32-bit counter which is compared to a selectable value, generating an interrupt when a match occurs. Any bits of the timer compare function can be masked such that they do not contribute to the match detection. The repetitive interrupt timer can be used to create an interrupt that repeats at predetermined intervals.

#### 7.15.4.1 Features

- 32-bit counter. Counter can be free-running or be reset by a generated interrupt.
- 32-bit compare value.
- 32-bit compare mask. An interrupt is generated when the counter value equals the compare value, after masking. This mechanism allows for combinations not possible with a simple compare.

### 7.15.5 Windowed WatchDog Timer (WWDT)

The purpose of the watchdog is to reset the controller if software fails to periodically service it within a programmable time window.

#### 7.15.5.1 Features

- Internally resets chip if not periodically reloaded during the programmable time-out period.
- Optional windowed operation requires reload to occur between a minimum and maximum time period, both programmable.

- Optional warning interrupt can be generated at a programmable time prior to watchdog time-out.
- Enabled by software but requires a hardware reset or a watchdog reset/interrupt to be disabled.
- Incorrect feed sequence causes reset or interrupt if enabled.
- Flag to indicate watchdog reset.
- Programmable 24-bit timer with internal prescaler.
- Selectable time period from ($T_{cy(WDCLK)} \times 256 \times 4$) to ($T_{cy(WDCLK)} \times 2^{24} \times 4$) in multiples of $T_{cy(WDCLK)} \times 4$.
- The Watchdog Clock (WDCLK) uses the IRC as the clock source.

## 7.16 Analog peripherals

### 7.16.1 Analog-to-Digital Converter

**Remark:** The LPC1850/30/20/10 contain two 10-bit ADCs.

#### 7.16.1.1 Features

- 10-bit successive approximation analog to digital converter.
- Input multiplexing among 8 pins.
- Power-down mode.
- Measurement range 0 to VDDA.
- Sampling frequency up to 400 kSamples/s.
- Burst conversion mode for single or multiple inputs.
- Optional conversion on transition on ADCTRIG0 or ADCTRIG1 pins, combined timer outputs 8 or 15, or the PWM output MCOA2.
- Individual result registers for each A/D channel to reduce interrupt overhead.
- DMA support.

### 7.16.2 Digital-to-Analog Converter (DAC)

#### 7.16.2.1 Features

- 10-bit resolution
- Monotonic by design (resistor string architecture)
- Controllable conversion speed
- Low-power consumption

## 7.17 Peripherals in the RTC power domain

### 7.17.1 RTC

The Real-Time Clock (RTC) is a set of counters for measuring time when system power is on, and optionally when it is off. It uses little power when the CPU does not access its registers, especially in the reduced power modes. A separate 32 kHz oscillator clocks the RTC. The oscillator produces a 1 Hz internal time reference and is powered by its own power supply pin, VBAT.

#### 7.17.1.1 Features

- Measures the passage of time to maintain a calendar and clock. Provides seconds, minutes, hours, day of month, month, year, day of week, and day of year.
- Ultra-low power design to support battery powered systems. Uses power from the CPU power supply when it is present.
- Dedicated battery power supply pin.
- RTC power supply is isolated from the rest of the chip.
- Calibration counter allows adjustment to better than ±1 sec/day with 1 sec resolution.
- Periodic interrupts can be generated from increments of any field of the time registers.
- Alarm interrupt can be generated for a specific date/time.

### 7.17.2 Alarm timer

The alarm timer is a 16-bit timer and counts down at 1 kHz from a preset value generating alarms in intervals of up to 1 min. The counter triggers a status bit when it reaches 0x00 and asserts an interrupt if enabled.

The alarm timer is part of the RTC power domain and can be battery powered.

## 7.18 System control

### 7.18.1 Configuration registers (CREG)

The following settings are controlled in the configuration register block:

- BOD trip settings
- Oscillator output
- DMA-to-peripheral muxing
- Ethernet mode
- Memory mapping
- Timer/USART inputs
- Enabling the USB controllers

In addition, the CREG block contains the part identification and part configuration information.

### 7.18.2 System Control Unit (SCU)

The system control unit determines the function and electrical mode of the digital pins. By default function 0 is selected for all pins with pull-up enabled. For pins that support a digital and analog function, the ADC function select registers in the SCU enable the analog function.

A separate set of analog I/Os for the ADCs and the DAC as well as most USB pins are located on separate pads and are not controlled through the SCU.

In addition, the clock delay register for the SDRAM EMC_CLK pins and the registers that select the pin interrupts are located in the SCU.

### 7.18.3 Clock Generation Unit (CGU)

The Clock Generator Unit (CGU) generates several base clocks. The base clocks can be unrelated in frequency and phase and can have different clock sources within the CGU. One CGU base clock is routed to the CLKOUT pins. The base clock that generates the CPU clock is referred to as CCLK.

Multiple branch clocks are derived from each base clock. The branch clocks offer flexible control for power-management purposes. All branch clocks are outputs of one of two Clock Control Units (CCUs) and can be controlled independently. Branch clocks derived from the same base clock are synchronous in frequency and phase.

### 7.18.4 Internal RC oscillator (IRC)

The IRC is used as the clock source for the WWDT and/or as the clock that drives the PLLs and the CPU. The nominal IRC frequency is 12 MHz. The IRC is trimmed to 1 % accuracy over the entire voltage and temperature range.

Upon power-up or any chip reset, the LPC1850/30/20/10 use the IRC as the clock source. The boot loader then configures the PLL1 to provide a 96 MHz clock for the core and the PLL0USB or PLL0AUDIO as needed if an external boot source is selected.

### 7.18.5 PLL0USB (for USB0)

PLL0 is a dedicated PLL for the USB0 High-speed controller.

PLL0 accepts an input clock frequency from an external oscillator in the range of 14 kHz to 25 MHz. The input frequency is multiplied up to a high frequency with a Current Controlled Oscillator (CCO). The CCO operates in the range of 4.3 MHz to 550 MHz.

### 7.18.6 PLL0AUDIO (for audio)

The audio PLL PLL0AUDIO is a general-purpose PLL with a small step size. This PLL accepts an input clock frequency derived from an external oscillator or internal IRC. The input frequency is multiplied up to a high frequency with a Current Controlled Oscillator (CCO). A sigma-delta converter modulates the PLL divider ratios to obtain the desired output frequency. The output frequency can be set as a multiple of the sampling frequency $f_s$ to $32 \times f_s$, $64 \times f_s$, $128 \times f_s$, $256 \times f_s$, $384 \times f_s$, $512 \times f_s$ and the sampling frequency $f_s$ can range from 16 kHz to 192 kHz (16, 22.05, 32, 44.1, 48, 96,192) kHz. Many other frequencies are possible as well using the integrated fractional divider.

### 7.18.7 System PLL1

The PLL1 accepts an input clock frequency from an external oscillator in the range of 10 MHz to 25 MHz. The input frequency is multiplied up to a high frequency with a Current Controlled Oscillator (CCO). The multiplier can be an integer value from 1 to 32. The CCO operates in the range of 156 MHz to 320 MHz. This range is possible through an additional divider in the loop to keep the CCO within its frequency range while the PLL is providing the desired output frequency. The output divider can be set to divide by 2, 4, 8, or 16 to produce the output clock. Since the minimum output divider value is 2, it is insured that the PLL output has a 50 % duty cycle. The PLL is turned off and bypassed following a chip reset. After reset, software can enable the PLL. The program must configure and activate the PLL, wait for the PLL to lock, and then connect to the PLL as a clock source. The PLL settling time is 100 μs.

### 7.18.8 Reset Generation Unit (RGU)

The RGU allows generation of independent reset signals for individual blocks and peripherals.

### 7.18.9 Power control

The LPC1850/30/20/10 feature several independent power domains to control power to the core and the peripherals (see Figure 10). The RTC and its associated peripherals (the alarm timer, the CREG block, the OTP controller, the back-up registers, and the event router) are located in the RTC power-domain. The main regulator or a battery supply can power the RTC. A power selector switch ensures that the RTC block is always powered on.

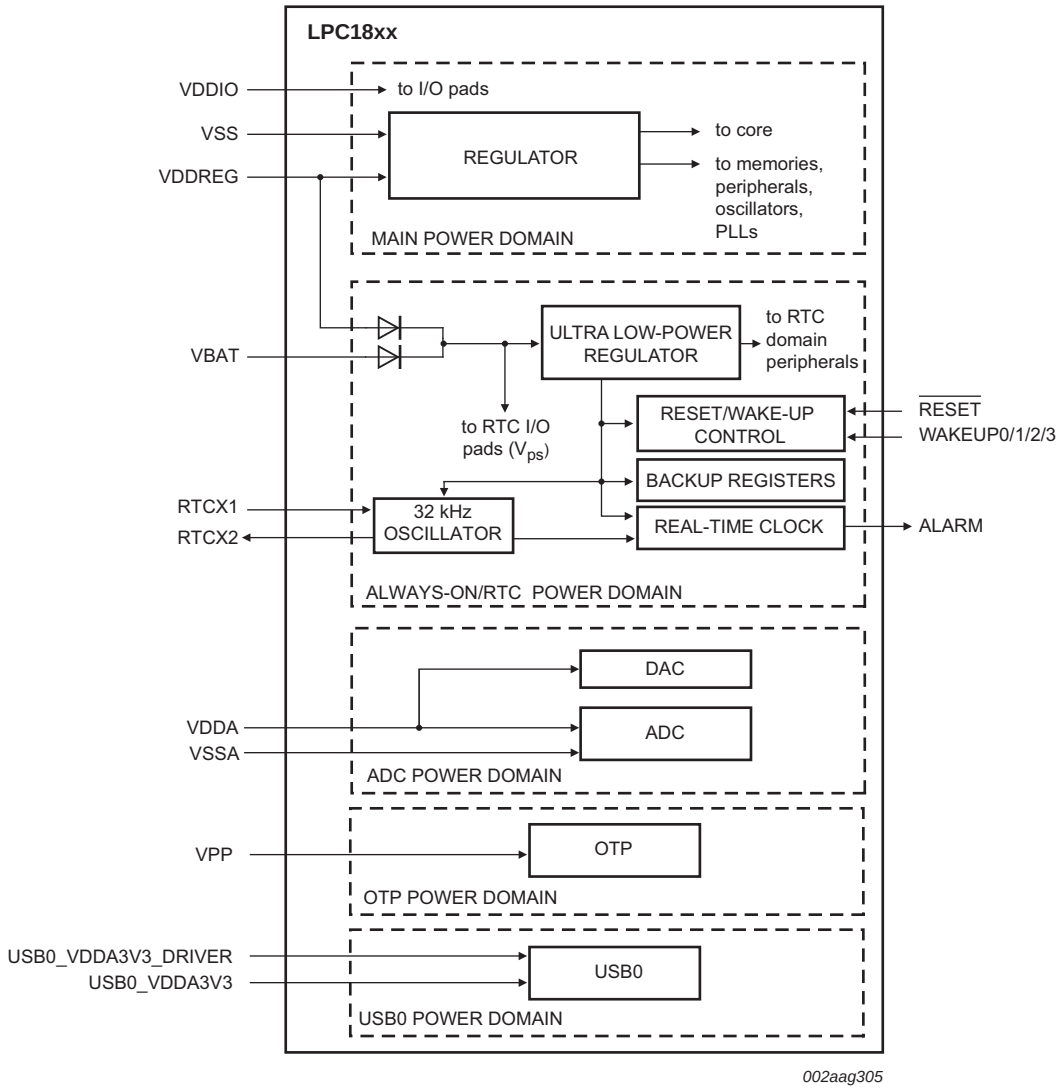



**Fig 10. LPC1850/30/20/10 power domains**

The LPC1850/30/20/10 support four reduced power modes: Sleep, Deep-sleep, Power-down, and Deep power-down.

The LPC1850/30/20/10 can wake up from Deep-sleep, Power-down, and Deep power-down modes via the WAKEUP[3:0] pins and interrupts generated by battery powered blocks in the RTC power domain.

## 7.19 Emulation and debugging

Debug and trace functions are integrated into the ARM Cortex-M3. Serial wire debug and trace functions are supported in addition to a standard JTAG debug and parallel trace functions. The ARM Cortex-M3 is configured to support up to eight breakpoints and four watch points.

# 8. Limiting values

**Table 6. Limiting values**

*In accordance with the Absolute Maximum Rating System (IEC 60134).*[1]

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{DD(REG)(3V3)}$ | regulator supply voltage (3.3 V) | on pin VDDREG | | –0.5 | 3.6 | V |
| $V_{DD(IO)}$ | input/output supply voltage | on pin VDDIO | | –0.5 | 3.6 | V |
| $V_{DDA(3V3)}$ | analog supply voltage (3.3 V) | on pin VDDA | | –0.5 | 3.6 | V |
| $V_{BAT}$ | battery supply voltage | on pin VBAT | | –0.5 | 3.6 | V |
| $V_{prog(pf)}$ | polyfuse programming voltage | on pin VPP | | –0.5 | 3.6 | V |
| $V_I$ | input voltage | only valid when the $V_{DD(IO)} \geq 2.2$ V | [2] | | | |
| | | 5 V tolerant I/O pins | | –0.5 | 5.5 | V |
| | | ADC/DAC pins and digital I/O pins configured for an analog function | | –0.5 | $V_{DDA(3V3)}$ | V |
| | | USB0 pins USB0_DP; USB0_DM;USB0_VBUS | | –0.3 | 5.2 | V |
| | | USB0 pins USB0_ID; USB0_RREF | | –0.3 | 3.6 | V |
| | | USB1 pins USB1_DP and USB1_DM | | –0.3 | 5.2 | V |
| $I_{DD}$ | supply current | per supply pin | [3] | - | 100 | mA |
| $I_{SS}$ | ground current | per ground pin | [3] | - | 100 | mA |
| $I_{latch}$ | I/O latch-up current | $-(0.5V_{DD(IO)}) < V_I < (1.5V_{DD(IO)})$; $T_j < 125$ °C | | - | 100 | mA |
| $T_{stg}$ | storage temperature | | [4] | –65 | +150 | °C |
| $P_{tot(pack)}$ | total power dissipation (per package) | based on package heat transfer, not device power consumption | | - | 1.5 | W |
| $V_{ESD}$ | electrostatic discharge voltage | human body model; all pins | [5] | –2000 | +2000 | V |

[1] The following applies to the limiting values:

a) This product includes circuitry designed for the protection of its internal devices from the damaging effects of excessive static charge. Nonetheless, it is suggested that conventional precautions be taken to avoid applying greater than the rated maximum.

b) Parameters are valid over operating temperature range unless otherwise specified. All voltages are with respect to $V_{SS}$ unless otherwise noted.

[2] Including voltage on outputs in 3-state mode.

[3] The peak current is limited to 25 times the corresponding maximum current.

[4] Dependent on package type.

[5] Human body model: equivalent to discharging a 100 pF capacitor through a 1.5 kΩ series resistor.

# 9. Thermal characteristics

The average chip junction temperature, $T_j$ (°C), can be calculated using the following equation:

$$T_j = T_{amb} + (P_D \times R_{th(j-a)}) \quad (1)$$

- $T_{amb}$ = ambient temperature (°C),
- $R_{th(j-a)}$ = the package junction-to-ambient thermal resistance (°C/W)
- $P_D$ = sum of internal and I/O power dissipation

The internal power dissipation is the product of $I_{DD(REG)(3V3)}$ and $V_{DD(REG)(3V3)}$. The I/O power dissipation of the I/O pins is often small and many times can be negligible. However it can be significant in some applications.

**Table 7. Thermal characteristics**

| Symbol | Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| $T_{j(max)}$ | maximum junction temperature | - | - | 125 | °C |

**Table 8. Thermal resistance (LQFP packages)**

| Symbol | Parameter | Conditions | Thermal resistance in °C/W ±15 % |
|---|---|---|---|
| | | | LQFP144 |
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | JEDEC (4.5 in × 4 in); still air | 38 |
| | | Single-layer (4.5 in × 3 in); still air | 50 |
| $R_{th(j-c)}$ | thermal resistance from junction to case | | 11 |

**Table 9. Thermal resistance value (BGA packages)**

| Symbol | Parameter | Conditions | Thermal resistance in °C/W ±15 % | | |
|---|---|---|---|---|---|
| | | | LBGA256 | TFBGA180 | TFBGA100 |
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | JEDEC (4.5 in × 4 in); still air | 29 | 38 | 46 |
| | | 8-layer (4.5 in × 3 in); still air | 24 | 30 | 37 |
| $R_{th(j-c)}$ | thermal resistance from junction to case | | 14 | 11 | 11 |

# 10. Static characteristics

**Table 10. Static characteristics**

*$T_{amb}$ = −40 °C to +85 °C, unless otherwise specified.*

| Symbol | Parameter | Conditions | | Min | Typ[1] | Max | Unit |
|---|---|---|---|---|---|---|---|
| **Supply pins** | | | | | | | |
| $V_{DD(IO)}$ | input/output supply voltage | | | 2.2 | - | 3.6 | V |
| $V_{DD(REG)(3V3)}$ | regulator supply voltage (3.3 V) | | [2] | 2.2 | - | 3.6 | V |
| $V_{DDA(3V3)}$ | analog supply voltage (3.3 V) | on pin VDDA | | 2.2 | - | 3.6 | V |
| $V_{BAT}$ | battery supply voltage | | [2] | 2.2 | - | 3.6 | V |
| $V_{prog(pf)}$ | polyfuse programming voltage | on pin VPP (for OTP) | [3] | 2.7 | - | 3.6 | V |
| $I_{prog(pf)}$ | polyfuse programming current | on pin VPP; OTP programming time ≤ 1.6 ms | | - | - | 30 | mA |
| $I_{DD(REG)(3V3)}$ | regulator supply current (3.3 V) | Active mode; code `while(1){}` executed from RAM; all peripherals disabled; PLL1 enabled | | | | | |
| | | CCLK = 12 MHz | [4] | - | 6.6 | - | mA |
| | | CCLK = 60 MHz | [4] | | 25.3 | - | mA |
| | | CCLK = 120 MHz | [4] | - | 48.4 | - | mA |
| | | CCLK = 180 MHz | [4] | - | 72.0 | - | mA |
| $I_{DD(REG)(3V3)}$ | regulator supply current (3.3 V) | after WFE/WFI instruction executed from RAM; all peripherals disabled | | | | | |
| | | sleep mode | [4][5] | - | 5.0 | - | mA |
| | | deep-sleep mode | [4] | - | 30 | - | µA |
| | | power-down mode | [4] | - | 15 | - | µA |
| | | deep power-down mode | [4][6] | - | 0.03 | - | µA |
| | | deep power-down mode; VBAT floating | [4] | - | 2 | - | µA |
| $I_{BAT}$ | battery supply current | active mode; $V_{BAT}$ = 3.2 V; $V_{DD(REG)(3V3)}$ = 3.6 V. | [7] | - | 0 | - | nA |
| $I_{BAT}$ | battery supply current | $V_{DD(REG)(3V3)}$ = 3.3 V; $V_{BAT}$ = 3.6 V | [8] | | | - | |
| | | deep-sleep mode | | - | 2 | | µA |
| | | power-down mode | [8] | - | 2 | - | µA |
| | | deep power-down mode | [8] | - | 2 | - | µA |

**Table 10. Static characteristics** *...continued*

*$T_{amb}$ = −40 °C to +85 °C, unless otherwise specified.*

| Symbol | Parameter | Conditions | | Min | Typ[1] | Max | Unit |
|---|---|---|---|---|---|---|---|
| $I_{DD(IO)}$ | I/O supply current | deep sleep mode | | - | 1 | - | µA |
| | | power-down mode | | - | 1 | - | µA |
| | | deep power-down mode | | - | 0.05 | - | µA |
| $I_{DDA}$ | Analog supply current | deep sleep mode | [10] | - | 0.4 | - | µA |
| | | power-down mode | [10] | - | 0.4 | - | µA |
| | | deep power-down mode | [10] | - | 0.007 | - | µA |
| **RESET pin** | | | | | | | |
| $V_{IH}$ | HIGH-level input voltage | | [9] | $0.8 \times (V_{ps} - 0.35)$ | - | 5.5 | V |
| $V_{IL}$ | LOW-level input voltage | | [9] | 0 | - | $0.3 \times (V_{ps} - 0.1)$ | V |
| $V_{hys}$ | hysteresis voltage | | [9] | $0.05 \times (V_{ps} - 0.35)$ | - | - | V |
| **Standard I/O pins - normal drive strength** | | | | | | | |
| $C_I$ | input capacitance | | | - | - | 2 | pF |
| $I_{LL}$ | LOW-level leakage current | $V_I$ = 0 V; on-chip pull-up resistor disabled | | - | 3 | - | nA |
| $I_{LH}$ | HIGH-level leakage current | $V_I = V_{DD(IO)}$; on-chip pull-down resistor disabled | | - | 3 | - | nA |
| | | $V_I$ = 5 V | | - | 1 | - | nA |
| $I_{OZ}$ | OFF-state output current | $V_O$ = 0 V to $V_{DD(IO)}$; on-chip pull-up/down resistors disabled; absolute value | | - | 3 | - | nA |
| $V_I$ | input voltage | pin configured to provide a digital function; $V_{DD(IO)} \geq 2.2$ V | | 0 | - | 5.5 | V |
| | | $V_{DD(IO)}$ = 0 V | | 0 | - | 3.6 | V |
| $V_O$ | output voltage | output active | | 0 | - | $V_{DD(IO)}$ | V |
| $V_{IH}$ | HIGH-level input voltage | | | $0.7 \times V_{DD(IO)}$ | - | 5.5 | V |
| $V_{IL}$ | LOW-level input voltage | | | 0 | - | $0.3 \times V_{DD(IO)}$ | V |
| $V_{hys}$ | hysteresis voltage | | | $0.1 \times V_{DD(IO)}$ | - | - | V |
| $V_{OH}$ | HIGH-level output voltage | $I_{OH}$ = −6 mA | | $V_{DD(IO)} - 0.4$ | - | - | V |
| $V_{OL}$ | LOW-level output voltage | $I_{OL}$ = 6 mA | | - | - | 0.4 | V |
| $I_{OH}$ | HIGH-level output current | $V_{OH} = V_{DD(IO)} - 0.4$ V | | −6 | - | - | mA |
| $I_{OL}$ | LOW-level output current | $V_{OL}$ = 0.4 V | | 6 | - | - | mA |

**Table 10. Static characteristics** *...continued*

*$T_{amb}$ = −40 °C to +85 °C, unless otherwise specified.*

| Symbol | Parameter | Conditions | | Min | Typ[1] | Max | Unit |
|---|---|---|---|---|---|---|---|
| $I_{OHS}$ | HIGH-level short-circuit output current | drive HIGH; connected to ground | [11] | - | - | 86.5 | mA |
| $I_{OLS}$ | LOW-level short-circuit output current | drive LOW; connected to $V_{DD(IO)}$ | [11] | - | - | 76.5 | mA |
| $I_{pd}$ | pull-down current | $V_I$ = 5 V | [13] [14] [15] | - | 93 | - | µA |
| $I_{pu}$ | pull-up current | $V_I$ = 0 V | [13] [14] [15] | - | −62 | - | µA |
| | | $V_{DD(IO)} < V_I \leq 5$ V | | - | 10 | - | µA |
| $R_S$ | series resistance | on I/O pins with analog function; analog function enabled | | | 200 | | Ω |
| **I/O pins - high drive strength** | | | | | | | |
| $C_I$ | input capacitance | | | - | - | 2 | pF |
| $I_{LL}$ | LOW-level leakage current | $V_I$ = 0 V; on-chip pull-up resistor disabled | | - | 3 | - | nA |
| $I_{LH}$ | HIGH-level leakage current | $V_I = V_{DD(IO)}$; on-chip pull-down resistor disabled | | - | 3 | - | nA |
| | | $V_I$ = 5 V | | - | 1 | - | nA |
| $I_{OZ}$ | OFF-state output current | $V_O$ = 0 V to $V_{DD(IO)}$; on-chip pull-up/down resistors disabled; absolute value | | - | 3 | - | nA |
| $V_I$ | input voltage | pin configured to provide a digital function; | | | | | |
| | | $V_{DD(IO)} \geq 2.2$ V | | 0 | - | 5.5 | V |
| | | $V_{DD(IO)}$ = 0 V | | 0 | - | 3.6 | V |
| $V_O$ | output voltage | output active | | 0 | - | $V_{DD(IO)}$ | V |
| $V_{IH}$ | HIGH-level input voltage | | | 0.7 × $V_{DD(IO)}$ | - | 5.5 | V |
| $V_{IL}$ | LOW-level input voltage | | | 0 | - | 0.3 × $V_{DD(IO)}$ | V |
| $V_{hys}$ | hysteresis voltage | | | 0.1 × $V_{DD(IO)}$ | - | - | V |
| $I_{pd}$ | pull-down current | $V_I = V_{DD(IO)}$ | [13] [14] [15] | - | 62 | - | µA |
| $I_{pu}$ | pull-up current | $V_I$ = 0 V | [13] [14] [15] | - | −62 | - | µA |
| | | $V_{DD(IO)} < V_I \leq 5$ V | | - | 10 | - | µA |

**Table 10. Static characteristics** *...continued*

*$T_{amb}$ = −40 °C to +85 °C, unless otherwise specified.*

| Symbol | Parameter | Conditions | | Min | Typ[1] | Max | Unit |
|---|---|---|---|---|---|---|---|
| I/O pins - high drive strength: standard drive mode | | | | | | | |
| $I_{OH}$ | HIGH-level output current | $V_{OH} = V_{DD(IO)} - 0.4$ V | | −4 | - | - | mA |
| $I_{OL}$ | LOW-level output current | $V_{OL} = 0.4$ V | | 4 | - | - | mA |
| $I_{OHS}$ | HIGH-level short-circuit output current | drive HIGH; connected to ground | [11] | - | - | 32 | mA |
| $I_{OLS}$ | LOW-level short-circuit output current | drive LOW; connected to $V_{DD(IO)}$ | [11] | - | - | 32 | mA |
| I/O pins - high drive strength: medium drive mode | | | | | | | |
| $I_{OH}$ | HIGH-level output current | $V_{OH} = V_{DD(IO)} - 0.4$ V | | −8 | - | - | mA |
| $I_{OL}$ | LOW-level output current | $V_{OL} = 0.4$ V | | 8 | - | - | mA |
| $I_{OHS}$ | HIGH-level short-circuit output current | drive HIGH; connected to ground | [11] | - | - | 65 | mA |
| $I_{OLS}$ | LOW-level short-circuit output current | drive LOW; connected to $V_{DD(IO)}$ | [11] | - | - | 63 | mA |
| I/O pins - high drive strength: high drive mode | | | | | | | |
| $I_{OH}$ | HIGH-level output current | $V_{OH} = V_{DD(IO)} - 0.4$ V | | −14 | - | - | mA |
| $I_{OL}$ | LOW-level output current | $V_{OL} = 0.4$ V | | 14 | - | - | mA |
| $I_{OHS}$ | HIGH-level short-circuit output current | drive HIGH; connected to ground | [11] | - | - | 113 | mA |
| $I_{OLS}$ | LOW-level short-circuit output current | drive LOW; connected to $V_{DD(IO)}$ | [11] | - | - | 110 | mA |
| I/O pins - high drive strength: ultra-high drive mode | | | | | | | |
| $I_{OH}$ | HIGH-level output current | $V_{OH} = V_{DD(IO)} - 0.4$ V | | −20 | - | - | mA |
| $I_{OL}$ | LOW-level output current | $V_{OL} = 0.4$ V | | 20 | - | - | mA |
| $I_{OHS}$ | HIGH-level short-circuit output current | drive HIGH; connected to ground | [11] | - | - | 165 | mA |
| $I_{OLS}$ | LOW-level short-circuit output current | drive LOW; connected to $V_{DD(IO)}$ | [11] | - | - | 156 | mA |
| **I/O pins - high-speed** | | | | | | | |
| $C_I$ | input capacitance | | | - | - | 2 | pF |
| $I_{LL}$ | LOW-level leakage current | $V_I = 0$ V; on-chip pull-up resistor disabled | | - | 3 | - | nA |
| $I_{LH}$ | HIGH-level leakage current | $V_I = V_{DD(IO)}$; on-chip pull-down resistor disabled | | - | 3 | - | nA |
| | | $V_I = 5$ V | | - | 1 | - | nA |

**Table 10. Static characteristics** *...continued*

*$T_{amb}$ = −40 °C to +85 °C, unless otherwise specified.*

| Symbol | Parameter | Conditions | | Min | Typ[1] | Max | Unit |
|---|---|---|---|---|---|---|---|
| $I_{OZ}$ | OFF-state output current | $V_O$ = 0 V to $V_{DD(IO)}$; on-chip pull-up/down resistors disabled; absolute value | | - | 3 | - | nA |
| $V_I$ | input voltage | pin configured to provide a digital function; | | | | | |
| | | $V_{DD(IO)} \geq 2.2$ V | | 0 | - | 5.5 | V |
| | | $V_{DD(IO)}$ = 0 V | | 0 | - | 3.6 | V |
| $V_O$ | output voltage | output active | | 0 | - | $V_{DD(IO)}$ | V |
| $V_{IH}$ | HIGH-level input voltage | | | 0.7 × $V_{DD(IO)}$ | - | 5.5 | V |
| $V_{IL}$ | LOW-level input voltage | | | 0 | - | 0.3 × $V_{DD(IO)}$ | V |
| $V_{hys}$ | hysteresis voltage | | | 0.1 × $V_{DD(IO)}$ | - | - | V |
| $V_{OH}$ | HIGH-level output voltage | $I_{OH}$ = −8 mA | | $V_{DD(IO)}$ − 0.4 | - | - | V |
| $V_{OL}$ | LOW-level output voltage | $I_{OL}$ = 8 mA | | - | - | 0.4 | V |
| $I_{OH}$ | HIGH-level output current | $V_{OH} = V_{DD(IO)} - 0.4$ V | | −8 | - | - | mA |
| $I_{OL}$ | LOW-level output current | $V_{OL}$ = 0.4 V | | 8 | - | - | mA |
| $I_{OHS}$ | HIGH-level short-circuit output current | drive HIGH; connected to ground | [11] | - | - | 86 | mA |
| $I_{OLS}$ | LOW-level short-circuit output current | drive LOW; connected to $V_{DD(IO)}$ | [11] | - | - | 76 | mA |
| $I_{pd}$ | pull-down current | $V_I = V_{DD(IO)}$ | [13] [14] [15] | - | 62 | - | µA |
| $I_{pu}$ | pull-up current | $V_I$ = 0 V | [13] [14] [15] | - | −62 | - | µA |
| | | $V_{DD(IO)} < V_I \leq 5$ V | | - | 0 | - | µA |
| **Open-drain I²C0-bus pins** | | | | | | | |
| $V_{IH}$ | HIGH-level input voltage | | | 0.7 × $V_{DD(IO)}$ | - | - | V |
| $V_{IL}$ | LOW-level input voltage | | | 0 | 0.14 | 0.3 × $V_{DD(IO)}$ | V |
| $V_{hys}$ | hysteresis voltage | | | 0.1 × $V_{DD(IO)}$ | - | - | V |
| $V_{OL}$ | LOW-level output voltage | $I_{OLS}$ = 3 mA | | - | - | 0.4 | V |
| $I_{LI}$ | input leakage current | $V_I = V_{DD(IO)}$ | [12] | - | 4.5 | - | µA |
| | | $V_I$ = 5 V | | - | - | 10 | µA |

**Table 10. Static characteristics** *...continued*

*$T_{amb}$ = −40 °C to +85 °C, unless otherwise specified.*

| Symbol | Parameter | Conditions | | Min | Typ[1] | Max | Unit |
|---|---|---|---|---|---|---|---|
| **Oscillator pins** | | | | | | | |
| $V_{i(XTAL1)}$ | input voltage on pin XTAL1 | | | −0.5 | - | 1.2 | V |
| $V_{o(XTAL2)}$ | output voltage on pin XTAL2 | | | −0.5 | - | 1.2 | V |
| $C_{io}$ | input/output capacitance | | [16] | - | - | 0.8 | pF |
| **USB0 pins**[17] | | | | | | | |
| $V_I$ | input voltage | on pins USB0_DP; USB0_DM; USB0_VBUS | | | | | |
| | | $V_{DD(IO)} \geq 2.2$ V | | 0 | - | 5.5 | V |
| | | $V_{DD(IO)}$ = 0 V | | 0 | - | 3.6 | V |
| $R_{pd}$ | pull-down resistance | on pin USB0_VBUS | | 48 | 64 | 80 | kΩ |
| $V_{IC}$ | common-mode input voltage | high-speed mode | | −50 | 200 | 500 | mV |
| | | full-speed/low-speed mode | | 800 | - | 2500 | mV |
| | | chirp mode | | −50 | - | 600 | mV |
| $V_{i(dif)}$ | differential input voltage | | | 100 | 400 | 1100 | mV |
| **USB1 pins (USB1_DP/USB1_DM)**[17] | | | | | | | |
| $I_{OZ}$ | OFF-state output current | 0 V < $V_I$ < 3.3 V | [17] | - | - | ±10 | μA |
| $V_{BUS}$ | bus supply voltage | | [18] | - | - | 5.25 | V |
| $V_{DI}$ | differential input sensitivity voltage | \|(D+) − (D−)\| | | 0.2 | - | - | V |
| $V_{CM}$ | differential common mode voltage range | includes $V_{DI}$ range | | 0.8 | - | 2.5 | V |
| $V_{th(rs)se}$ | single-ended receiver switching threshold voltage | | | 0.8 | - | 2.0 | V |
| $V_{OL}$ | LOW-level output voltage for low-/full-speed | $R_L$ of 1.5 kΩ to 3.6 V | | - | - | 0.18 | V |
| $V_{OH}$ | HIGH-level output voltage (driven) for low-/full-speed | $R_L$ of 15 kΩ to GND | | 2.8 | - | 3.5 | V |
| $C_{trans}$ | transceiver capacitance | pin to GND | | - | - | 20 | pF |
| $Z_{DRV}$ | driver output impedance for driver which is not high-speed capable | with 33 Ω series resistor; steady state drive | [19] | 36 | - | 44.1 | Ω |

[1] Typical ratings are not guaranteed. The values listed are at room temperature (25 °C), nominal supply voltages.

[2] Dynamic characteristics for peripherals are provided for $V_{DD(REG)(3V3)} \geq 2.7$ V.

[3] Pin VPP should either be not connected (when OTP does not need to be programmed) or tied to pins VDDIO and VDDREG to ensure the same ramp-up time for both supply voltages.

[4] $V_{DD(REG)(3V3)}$ = 3.3 V; $V_{DD(IO)}$ = 3.3 V; $T_{amb}$ = 25 °C.

[5] PLL1 disabled; IRC running; CCLK = 12 MHz.

[6] $V_{BAT}$ = 3.6 V.

[7] $V_{DD(IO)} = V_{DDA}$ = 3.6 V; over entire frequency range CCLK = 12 MHz to 180 MHz.

[8] On pin VBAT; $T_{amb}$ = 25 °C.

[9] $V_{ps}$ corresponds to the output of the power switch (see Figure 10) which is determined by the greater of $V_{BAT}$ and $V_{DD(Reg)(3V3)}$.

[10] $V_{DDA(3V3)}$ = 3.3 V; $T_{amb}$ = 25 °C.

[11] Allowed as long as the current limit does not exceed the maximum current allowed by the device.

[12] To $V_{SS}$.

[13] The values specified are simulated and absolute values.

[14] The weak pull-up resistor is connected to the $V_{DD(IO)}$ rail and pulls up the I/O pin to the $V_{DD(IO)}$ level.

[15] The input cell disables the weak pull-up resistor when the applied input voltage exceeds $V_{DD(IO)}$.

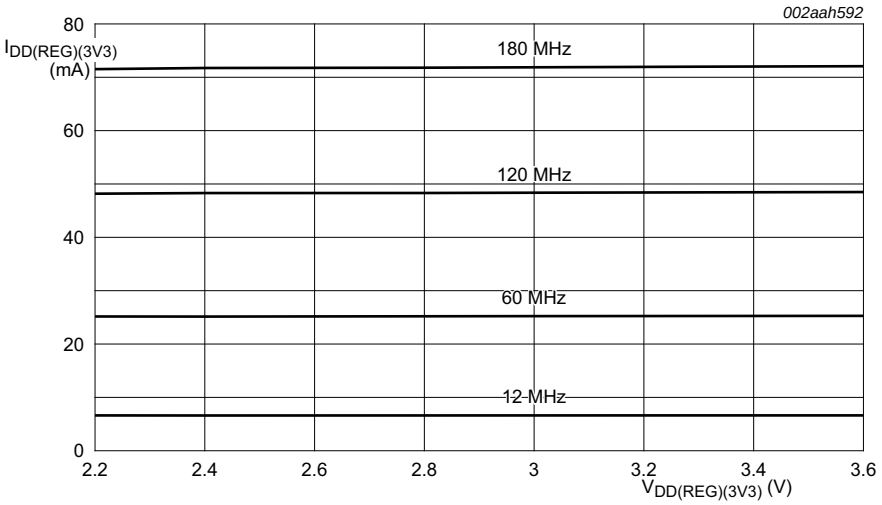
[16] The parameter value specified is a simulated value excluding bond capacitance.

[17] For USB operation 3.0 V $\leq V_{DD((IO)} \leq$ 3.6 V. Guaranteed by design.

[18] $V_{DD(IO)}$ present.

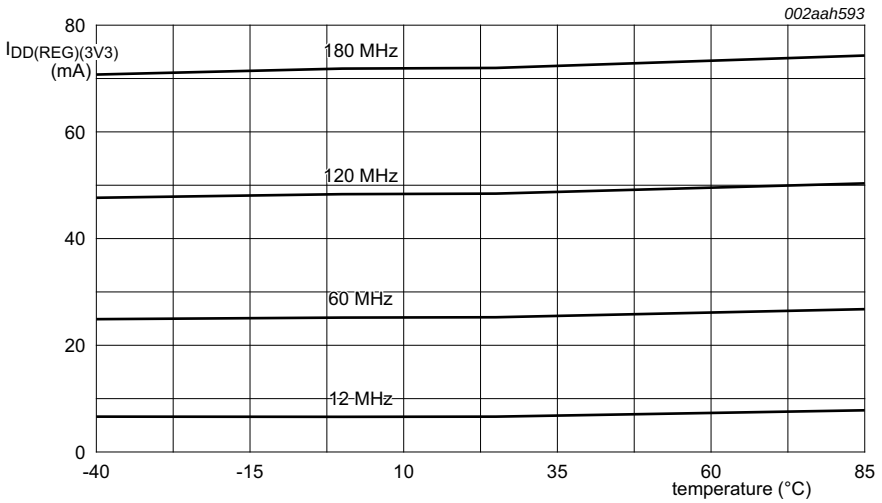
[19] Includes external resistors of 33 Ω ± 1 % on D+ and D−.

## 10.1 Power consumption



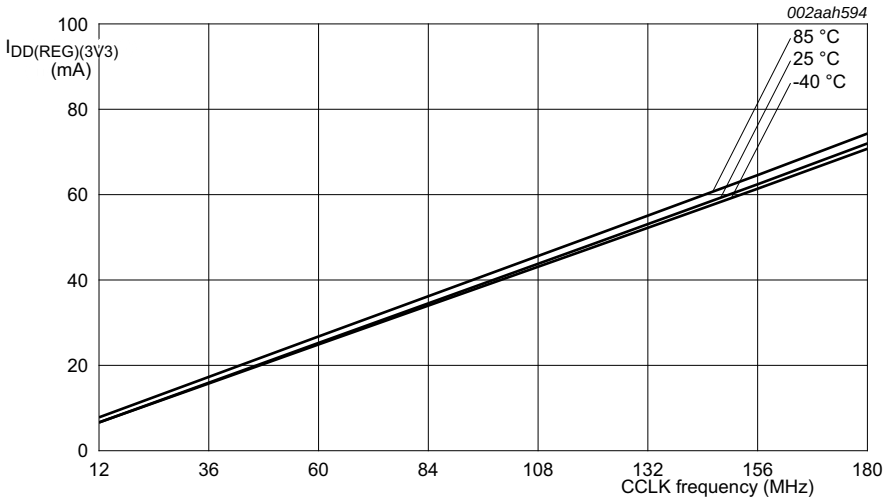

Conditions: $T_{amb}$ = 25 °C; active mode entered executing code while(1){} from SRAM; internal pull-up resistors disabled; PLL1 enabled; IRC enabled; all peripherals disabled; all peripheral clocks disabled.

**Fig 11. Typical supply current versus regulator supply voltage $V_{DD(REG)(3V3)}$ in active mode**



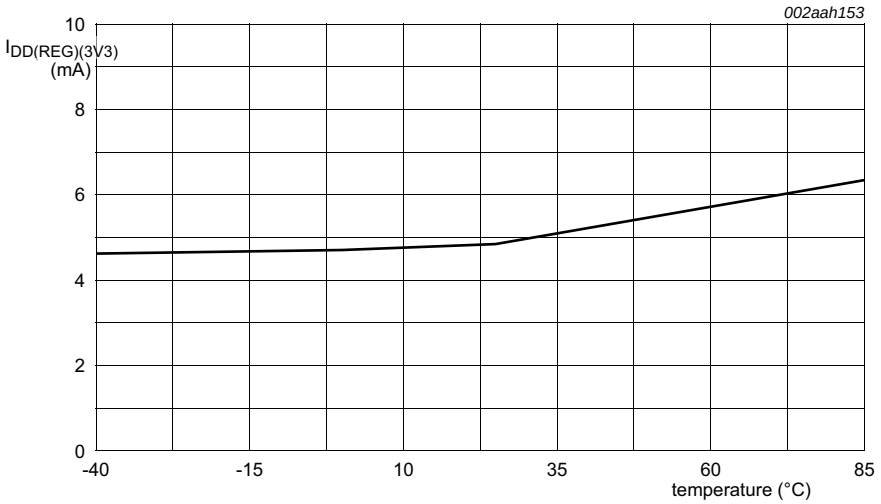

Conditions: $V_{DD(REG)(3V3)}$ = 3.3 V, Active mode entered executing code while(1){} from SRAM; internal pull-up resistors disabled; PLL1 enabled; IRC enabled; all peripherals disabled; all peripheral clocks disabled.

**Fig 12. Typical supply current versus temperature in Active mode**



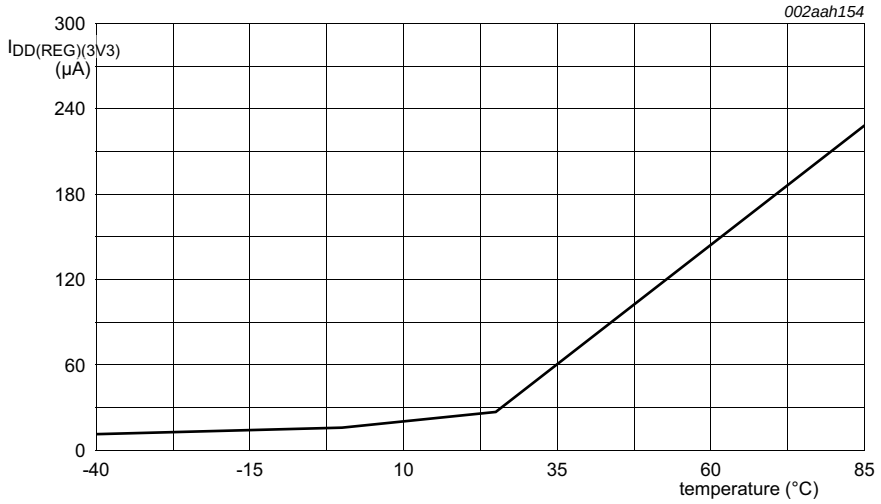

Conditions: $V_{DD(REG)(3V3)}$ = 3.3 V; Active mode entered executing code while(1){} from SRAM; internal pull-up resistors disabled; PLL1 enabled; IRC enabled; all peripherals disabled; all peripheral clocks disabled.

**Fig 13. Typical supply current versus frequency in Active mode**



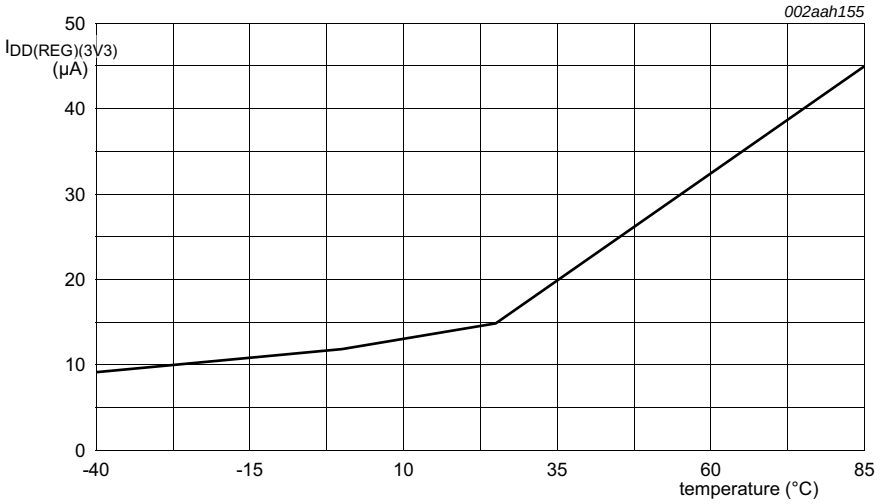

Conditions: $V_{DD(REG)(3V3)}$ = 3.3 V; internal pull-up resistors disabled; PLL1 enabled; IRC enabled; all peripherals disabled; all peripheral clocks disabled; core clock CCLK = 12 MHz.

**Fig 14. Typical supply current versus temperature in Sleep mode**



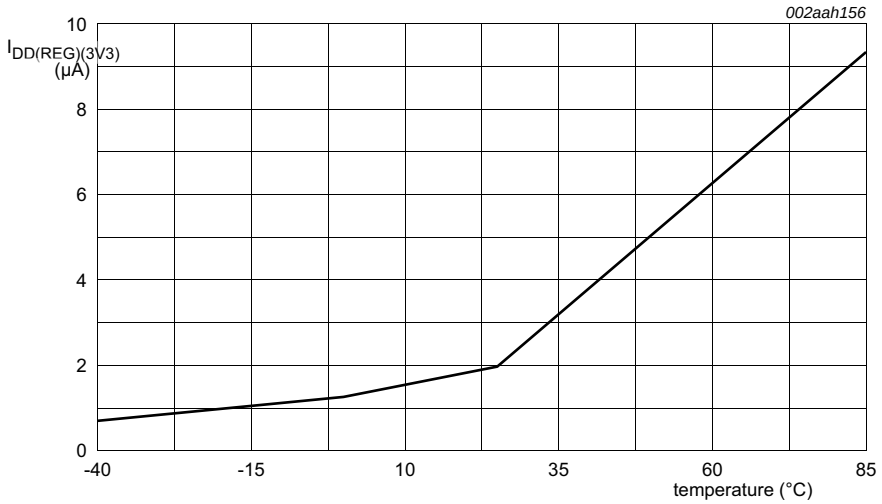

Conditions: $V_{DD(REG)(3V3)}$ = 3.3 V; $V_{BAT}$ floating; $V_{DD(IO)}$ = 3.3 V.

**Fig 15. Typical supply current versus temperature in Deep-sleep mode**



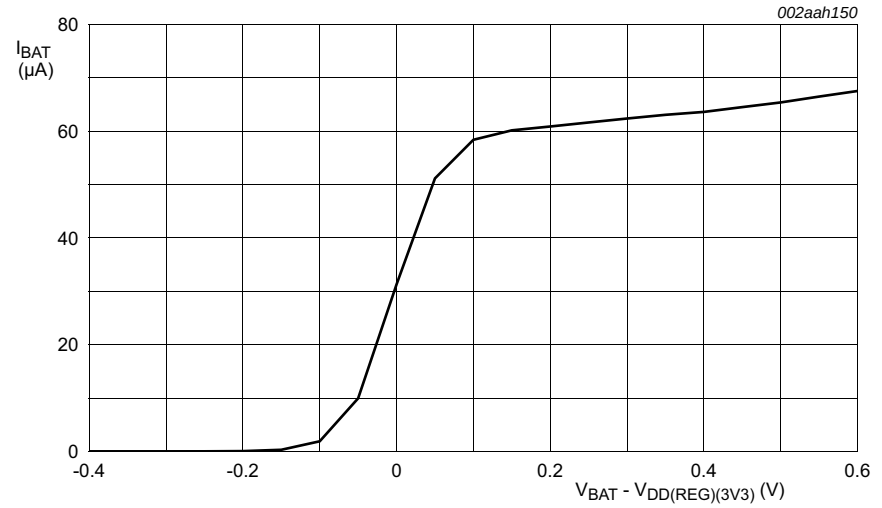

Conditions: $V_{DD(REG)(3V3)}$ = 3.3 V; $V_{BAT}$ floating; $V_{DD(IO)}$ = 3.3 V.

**Fig 16. Typical supply current versus temperature in Power-down mode**



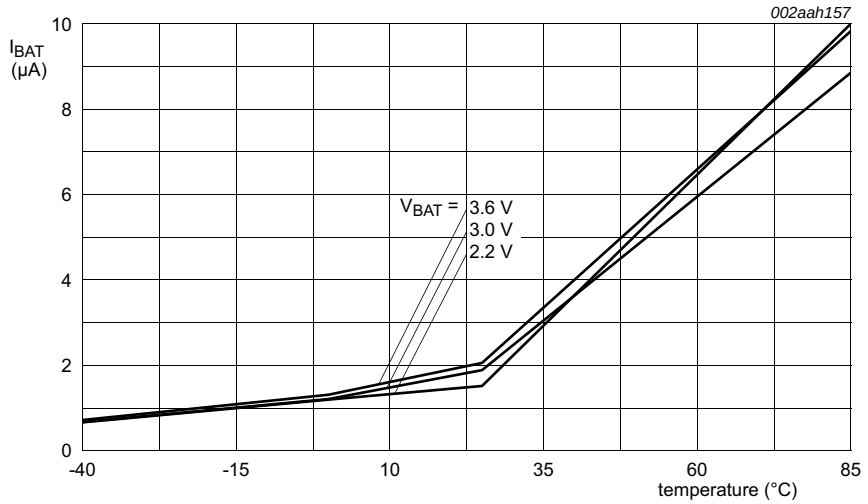

Conditions: $V_{DD(REG)(3V3)}$ = 3.3 V; $V_{BAT}$ floating; $V_{DD(IO)}$ = 3.3 V.

**Fig 17. Typical supply current versus temperature in Deep power-down mode**




Conditions: $V_{DD(REG)(3V3)}$ = 3.0 V; CCLK = 12 MHz.

**Fig 18. Typical battery supply current in Active mode**




Conditions: $V_{DD(REG)(3V3)}$, $V_{DD(IO)}$ floating.

**Fig 19. Typical battery supply versus temperature in Deep power-down mode**

## 10.2 Peripheral power consumption

The typical power consumption at T = 25 °C for each individual peripheral is measured as follows:

1. Enable all branch clocks and measure the current $I_{DD(REG)(3V3)}$.
2. Disable the branch clock to the peripheral to be measured and keep all other branch clocks enabled.
3. Calculate the difference between measurement 1 and 2. The result is the peripheral power consumption.

**Table 11. Peripheral power consumption**

| Peripheral | Branch clock | $I_{DD(REG)(3V3)}$ in mA | |
|---|---|---|---|
| | | Branch clock frequency = 48 MHz | Branch clock frequency = 96 MHz |
| I2C1 | CLK_APB3_I2C1 | 0.01 | 0.02 |
| I2C0 | CLK_APB1_I2C0 | 0.02 | 0.01 |
| DAC | CLK_APB3_DAC | 0.01 | 0.02 |
| ADC0 | CLK_APB3_ADC0 | 0.05 | 0.05 |
| ADC1 | CLK_APB3_ADC1 | 0.04 | 0.04 |
| CAN0 | CLK_APB3_CAN0 | 0.17 | 0.17 |
| CAN1 | CLK_APB1_CAN1 | 0.17 | 0.17 |
| MOTOCON | CLK_APB1_MOTOCON | 0.05 | 0.05 |
| I2S | CLK_APB1_I2S | 0.11 | 0.11 |
| SPIFI | CLK_SPIFI, CLK_M3_SPIFI | 0.95 | 1.85 |
| GPIO | CLK_M3_GPIO | 0.66 | 1.31 |
| LCD | CLK_M3_LCD | 0.85 | 1.72 |

**Table 11. Peripheral power consumption**

| Peripheral | Branch clock | $I_{DD(REG)(3V3)}$ in mA | |
|---|---|---|---|
| | | Branch clock frequency = 48 MHz | Branch clock frequency = 96 MHz |
| ETHERNET | CLK_M3_ETHERNET | 1.05 | 2.09 |
| UART0 | CLK_M3_UART0, CLK_APB0_UART0 | 0.3 | 0.38 |
| UART1 | CLK_M3_UART1, CLK_APB0_UART1 | 0.27 | 0.48 |
| UART2 | CLK_M3_UART2, CLK_APB2_UART2 | 0.27 | 0.47 |
| UART3 | CLK_M3_USART3, CLK_APB2_UART3 | 0.29 | 0.49 |
| TIMER0 | CLK_M3_TIMER0 | 0.07 | 0.14 |
| TIMER1 | CLK_M3_TIMER1 | 0.07 | 0.14 |
| TIMER2 | CLK_M3_TIMER2 | 0.07 | 0.15 |
| TIMER3 | CLK_M3_TIMER3 | 0.06 | 0.11 |
| SDIO | CLK_M3_SDIO, CLK_SDIO | 0.79 | 1.37 |
| SCT | CLK_M3_SCT | 0.52 | 1.05 |
| SSP0 | CLK_M3_SSP0, CLK_APB0_SSP0 | 0.12 | 0.21 |
| SSP1 | CLK_M3_SSP1, CLK_APB2_SSP1 | 0.15 | 0.28 |
| DMA | CLK_M3_DMA | 1.88 | 3.71 |
| WWDT | CLK_M3_WWDT | 0.05 | 0.08 |
| QEI | CLK_M3_QEI | 0.33 | 0.68 |
| USB0 | CLK_M3_USB0, CLK_USB0 | 1.46 | 3.32 |
| USB1 | CLK_M3_USB1, CLK_USB1 | 2.83 | 5.03 |
| RITIMER | CLK_M3_RITIMER | 0.04 | 0.08 |
| EMC | CLK_M3_EMC, CLK_M3_EMC_DIV | 3.6 | 6.97 |
| SCU | CLK_M3_SCU | 0.09 | 0.23 |
| CREG | CLK_M3_CREG | 0.37 | 0.72 |

## 10.3 BOD and band gap static characteristics

**Table 12. BOD static characteristics[1]**

*$T_{amb}$ = 25 °C; typical data.*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{th}$ | threshold voltage | interrupt level 0 | | | | |
| | | assertion | - | 2.75 | - | V |
| | | de-assertion | - | 2.92 | - | V |
| | | interrupt level 1 | | | | |
| | | assertion | - | 2.85 | - | V |
| | | de-assertion | - | 3.00 | - | V |
| | | interrupt level 2 | | | | |
| | | assertion | - | 2.95 | - | V |
| | | de-assertion | - | 3.12 | - | V |
| | | interrupt level 3 | | | | |
| | | assertion | - | 3.05 | - | V |
| | | de-assertion | - | 3.19 | - | V |
| | | reset level 0 | | | | |
| | | assertion | - | 1.70 | - | V |
| | | de-assertion | - | 1.85 | - | V |
| | | reset level 1 | | | | |
| | | assertion | - | 1.80 | - | V |
| | | de-assertion | - | 1.95 | - | V |
| | | reset level 2 | | | | |
| | | assertion | - | 1.90 | - | V |
| | | de-assertion | - | 2.05 | - | V |
| | | reset level 3 | | | | |
| | | assertion | - | 2.00 | - | V |
| | | de-assertion | - | 2.15 | - | V |

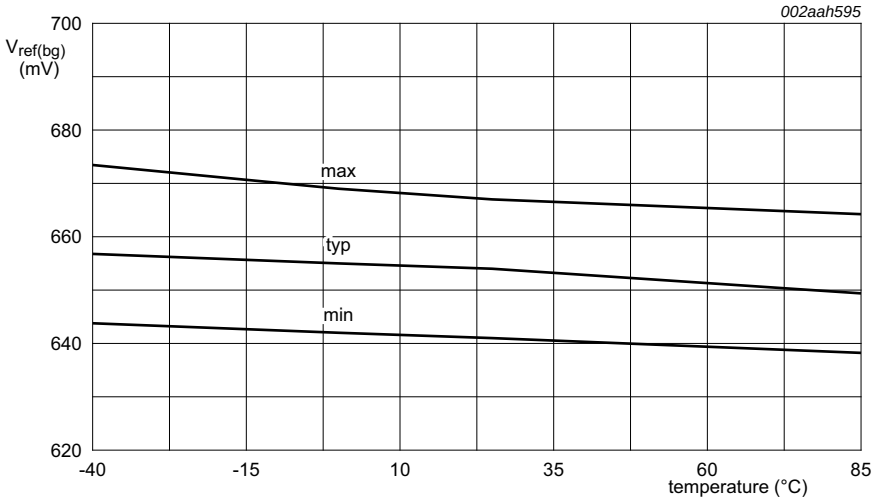
[1] Interrupt and reset levels are selected by writing to the BODLV1/2 bits in the control register CREGE0, see *the LPC18xx user manual*.

**Table 13. Band gap characteristics**

*$V_{DD(REG)(3V3)}$ over specified ranges; $T_{amb}$ = −40 °C to +85 °C; unless otherwise specified*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{ref(bg)}$ | band gap reference voltage | $T_{amb}$ = -40 °C to +85 °C | [1] | - | 654 ± 1 % | - | mV |

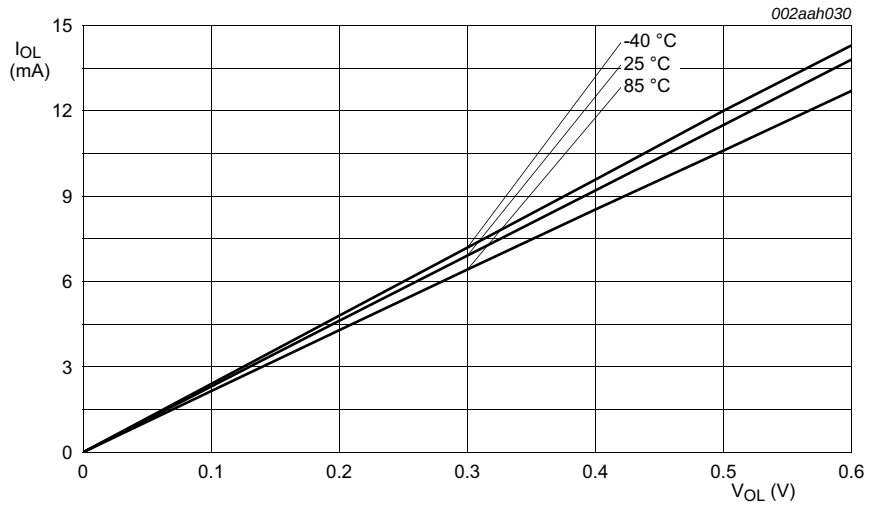
[1] Characterized for typical samples.




On pin ADC1_7. For typical, maximum, and minimum process conditions.

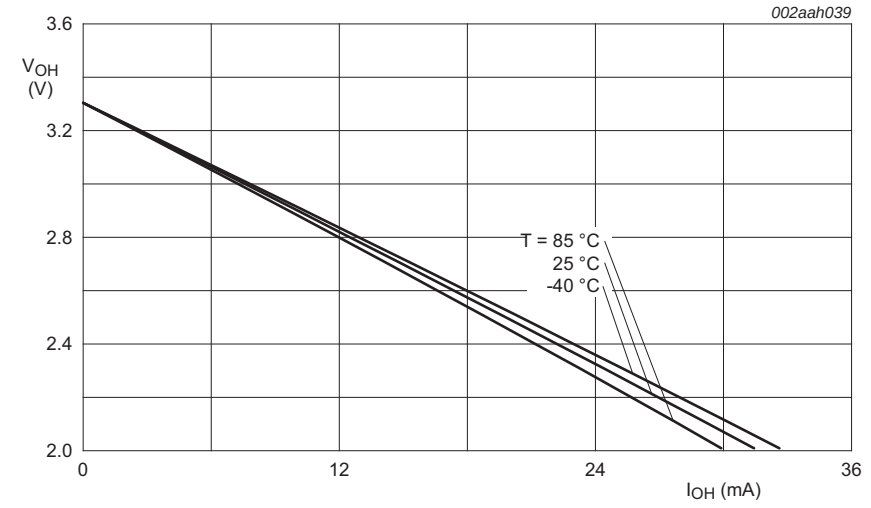
**Fig 20. Band gap voltage for different temperatures and process conditions**

## 10.4 Electrical pin characteristics



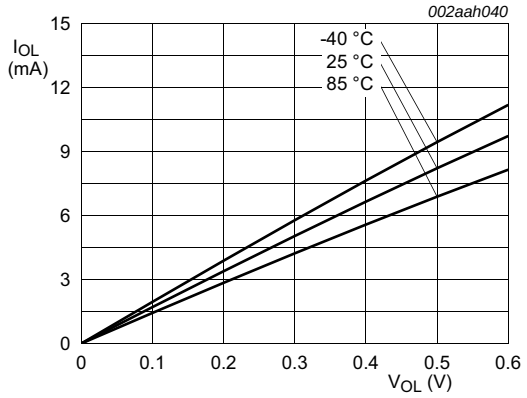

Conditions: $V_{DD(REG)(3V3)} = V_{DD(IO)} = 3.3$ V.

**Fig 21. Normal-drive pins and high-speed pins; typical LOW level output current $I_{OL}$ versus LOW level output voltage $V_{OL}$**

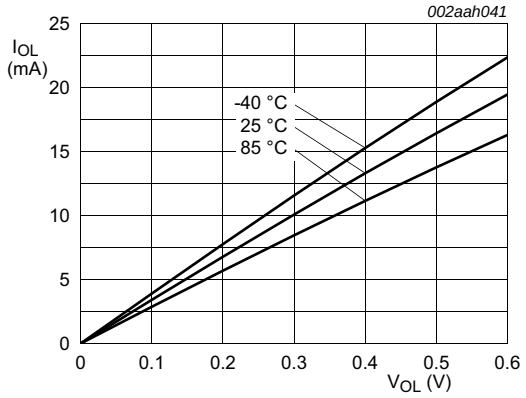



Conditions: $V_{DD(REG)(3V3)} = V_{DD(IO)} = 3.3$ V.

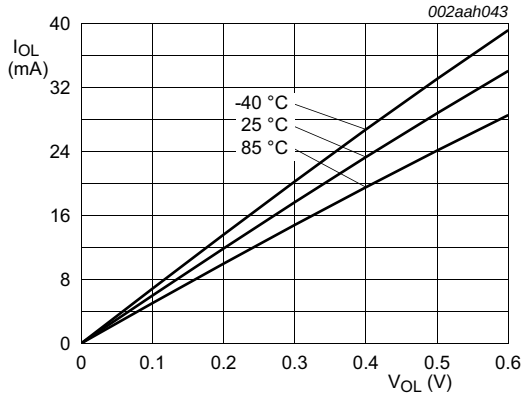
**Fig 22. Normal-drive pins and high-speed pins; typical HIGH level output voltage $V_{OL}$ versus HGH level output current $I_{OH}$**



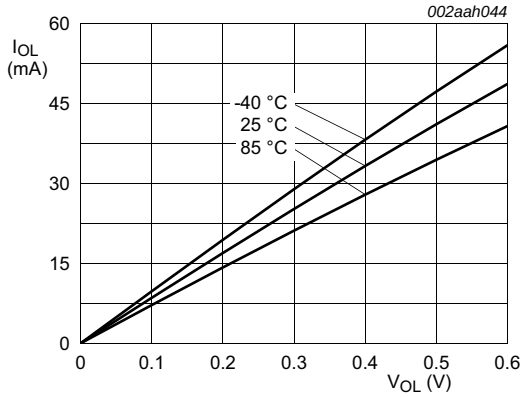

Conditions: $V_{DD(REG)(3V3)} = V_{DD(IO)} = 3.3$ V; normal-drive; EHD = 0x0.




Conditions: $V_{DD(REG)(3V3)} = V_{DD(IO)} = 3.3$ V; medium-drive; EHD = 0x1.

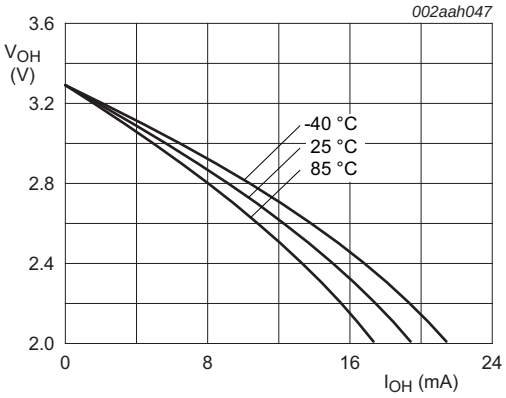



Conditions: $V_{DD(REG)(3V3)} = V_{DD(IO)} = 3.3$ V; high-drive; EHD = 0x2.

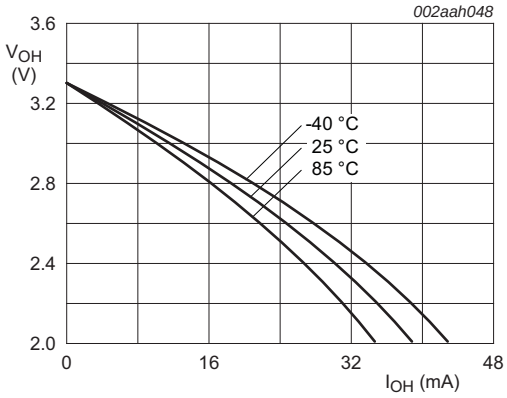



Conditions: $V_{DD(REG)(3V3)} = V_{DD(IO)} = 3.3$ V; ultra high-drive; EHD = 0x3.

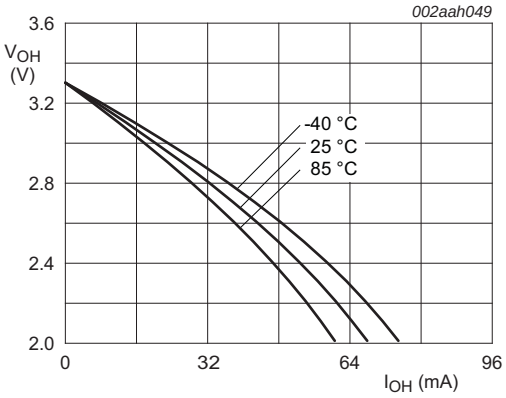
**Fig 23. High-drive pins; typical LOW level output current $I_{OL}$ versus LOW level output voltage $V_{OL}$**



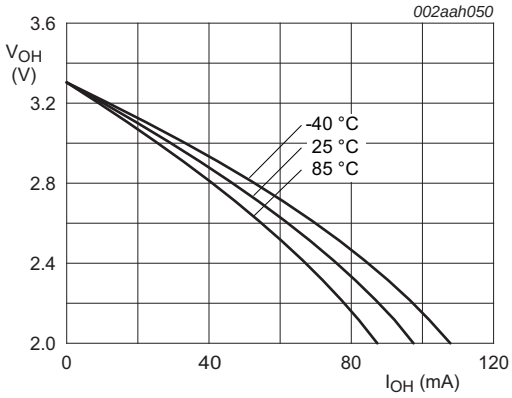

Conditions: $V_{DD(REG)(3V3)} = V_{DD(IO)} = 3.3$ V; normal-drive; EHD = 0x0.




Conditions: $V_{DD(REG)(3V3)} = V_{DD(IO)} = 3.3$ V; medium-drive; EHD = 0x1.

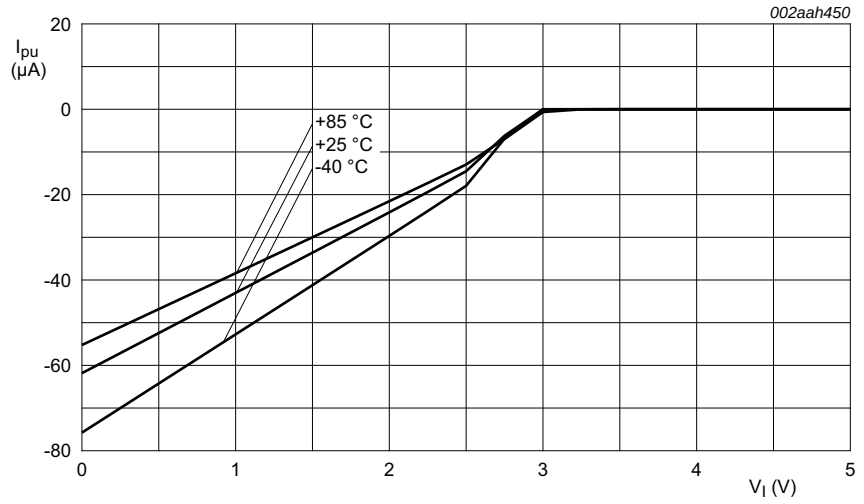



Conditions: $V_{DD(REG)(3V3)} = V_{DD(IO)} = 3.3$ V; high-drive; EHD = 0x2.



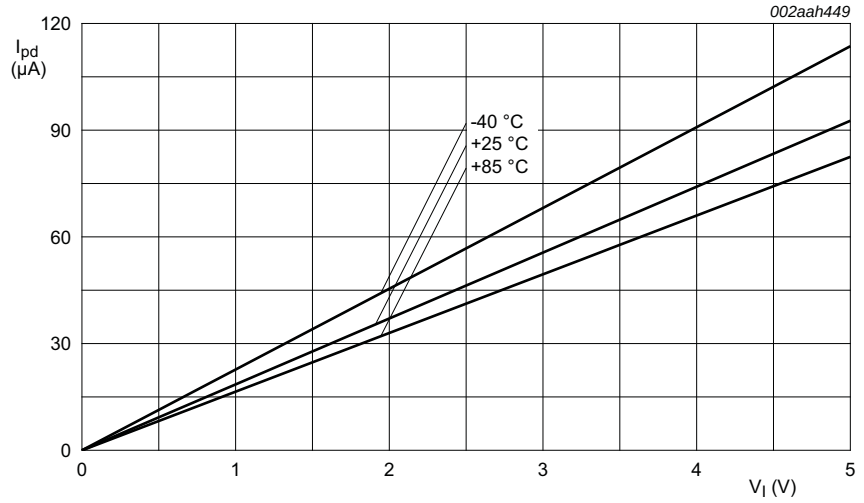

Conditions: $V_{DD(REG)(3V3)} = V_{DD(IO)} = 3.3$ V; ultra high-drive; EHD = 0x3.

**Fig 24. High-drive pins; typical HIGH level output voltage $V_{OH}$ versus HGH level output current $I_{OH}$**




Conditions: $V_{DD(IO)}$ = 3.3 V. Simulated values.

**Fig 25. Typical pull-up current $I_{pu}$ versus input voltage $V_I$**




Conditions: $V_{DD(IO)}$ = 3.3 V. Simulated values.

**Fig 26. Typical pull-down current $I_{pd}$ versus input voltage $V_I$**

# 11. Dynamic characteristics

## 11.1 Wake-up times

**Table 14. Dynamic characteristic: Wake-up from Deep-sleep, Power-down, and Deep power-down modes**

$T_{amb}$ = −40 °C to +85 °C

| Symbol | Parameter | Conditions | | Min | Typ[1] | Max | Unit |
|---|---|---|---|---|---|---|---|
| $t_{wake}$ | wake-up time | from Sleep mode | [2] | 3 × $T_{cy(clk)}$ | 5 × $T_{cy(clk)}$ | - | ns |
| | | from Deep-sleep and Power-down mode | | 12 | 51 | - | µs |
| | | from Deep power-down mode | | - | 250 | - | µs |
| | | after reset | | - | 250 | - | µs |

[1] Typical ratings are not guaranteed. The values listed are at room temperature (25 °C), nominal supply voltages.

[2] $T_{cy(clk)}$ = 1/CCLK with CCLK = CPU clock frequency.

## 11.2 External clock for oscillator in slave mode

**Remark:** The input voltage on the XTAL1/2 pins must be ≤ 1.2 V (see Table 10). For connecting the oscillator to the XTAL pins, also see Section 13.2 and Section 13.4.

**Table 15. Dynamic characteristic: external clock**

$T_{amb}$ = −40 °C to +85 °C; $V_{DD(IO)}$ over specified ranges.[3]

| Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| $f_{osc}$ | oscillator frequency | 1 | 25 | MHz |
| $T_{cy(clk)}$ | clock cycle time | 40 | 1000 | ns |
| $t_{CHCX}$ | clock HIGH time | $T_{cy(clk)}$ × 0.4 | $T_{cy(clk)}$ × 0.6 | ns |
| $t_{CLCX}$ | clock LOW time | $T_{cy(clk)}$ × 0.4 | $T_{cy(clk)}$ × 0.6 | ns |

[3] Parameters are valid over operating temperature range unless otherwise specified.

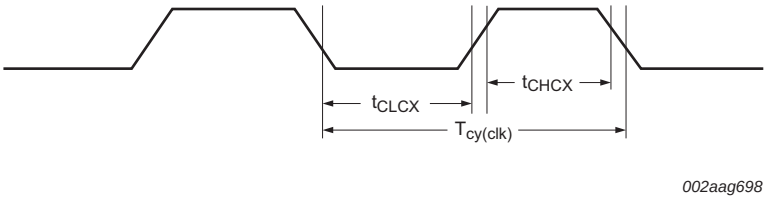



**Fig 27. External clock timing (with an amplitude of at least $V_{i(RMS)}$ = 200 mV)**

## 11.3 Crystal oscillator

**Table 16. Dynamic characteristic: oscillator**

*$T_{amb}$ = −40 °C to +85 °C; $V_{DD(IO)}$ over specified ranges; 2.2 V ≤ $V_{DD(REG)(3V3)}$ ≤ 3.6 V.*[1]

| Symbol | Parameter | Conditions | | Min | Typ[2] | Max | Unit |
|---|---|---|---|---|---|---|---|
| **Low-frequency mode (1 MHz - 20 MHz)**[5] | | | | | | | |
| $t_{jit(per)}$ | period jitter time | 5 MHz crystal | [3][4] | - | 13.2 | - | ps |
| | | 10 MHz crystal | | - | 6.6 | - | ps |
| | | 15 MHz crystal | | - | 4.8 | - | ps |
| **High-frequency mode (20 MHz - 25 MHz)**[6] | | | | | | | |
| $t_{jit(per)}$ | period jitter time | 20 MHz crystal | [3][4] | - | 4.3 | - | ps |
| | | 25 MHz crystal | | - | 3.7 | - | ps |

[1] Parameters are valid over operating temperature range unless otherwise specified.

[2] Typical ratings are not guaranteed. The values listed are at room temperature (25 °C), nominal supply voltages.

[3] Indicates RMS period jitter.

[4] PLL-induced jitter is not included.

[5] Select HF = 0 in the XTAL_OSC_CTRL register.

[6] Select HF = 1 in the XTAL_OSC_CTRL register.

## 11.4 IRC oscillator

**Table 17. Dynamic characteristic: IRC oscillator**

*$T_{amb}$ = −40 °C to +85 °C; 2.2 V ≤ $V_{DD(REG)(3V3)}$ ≤ 3.6 V.*[1]

| Symbol | Parameter | Conditions | Min | Typ[2] | Max | Unit |
|---|---|---|---|---|---|---|
| $f_{osc(RC)}$ | internal RC oscillator frequency | - | 11.88 | 12.0 | 12.12 | MHz |

[1] Parameters are valid over operating temperature range unless otherwise specified.

[2] Typical ratings are not guaranteed. The values listed are at room temperature (25 °C), nominal supply voltages.

## 11.5 RTC oscillator

**Table 18. Dynamic characteristic: RTC oscillator**

*$T_{amb}$ = −40 °C to +85 °C; 2.2 V ≤ $V_{DD(REG)(3V3)}$ ≤ 3.6 V or 2.2 V ≤ $V_{BAT}$ ≤ 3.6 V*[1]*; typical $C_{RTCX1/2}$ = 20 pF; also see Section 13.3*

| Symbol | Parameter | Conditions | Min | Typ[2] | Max | Unit |
|---|---|---|---|---|---|---|
| $f_{i(RTC)}$ | RTC input frequency | - | - | 32.768 | - | kHz |
| $I_{DD(RTC)}$ | RTC supply current | | | 280 | 800 | nA |

[1] Parameters are valid over operating temperature range unless otherwise specified.

[2] Typical ratings are not guaranteed. The values listed are at room temperature (25 °C), nominal supply voltages.

## 11.6 I²C-bus

**Table 19. Dynamic characteristic: I²C-bus pins**

*$T_{amb}$ = −40 °C to +85 °C; 2.2 V ≤ $V_{DD(REG)(3V3)}$ ≤ 3.6 V.*[1]

| Symbol | Parameter | | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|---|
| $f_{SCL}$ | SCL clock frequency | | Standard-mode | 0 | 100 | kHz |
| | | | Fast-mode | 0 | 400 | kHz |
| | | | Fast-mode Plus | 0 | 1 | MHz |
| $t_f$ | fall time | [3][4][5][6] | of both SDA and SCL signals | - | 300 | ns |
| | | | Standard-mode | | | |
| | | | Fast-mode | 20 + 0.1 × $C_b$ | 300 | ns |
| | | | Fast-mode Plus | - | 120 | ns |
| $t_{LOW}$ | LOW period of the SCL clock | | Standard-mode | 4.7 | - | µs |
| | | | Fast-mode | 1.3 | - | µs |
| | | | Fast-mode Plus | 0.5 | - | µs |
| $t_{HIGH}$ | HIGH period of the SCL clock | | Standard-mode | 4.0 | - | µs |
| | | | Fast-mode | 0.6 | - | µs |
| | | | Fast-mode Plus | 0.26 | - | µs |
| $t_{HD;DAT}$ | data hold time | [2][3][7] | Standard-mode | 0 | - | µs |
| | | | Fast-mode | 0 | - | µs |
| | | | Fast-mode Plus | 0 | - | µs |
| $t_{SU;DAT}$ | data set-up time | [8][9] | Standard-mode | 250 | - | ns |
| | | | Fast-mode | 100 | - | ns |
| | | | Fast-mode Plus | 50 | - | ns |

[1] Parameters are valid over operating temperature range unless otherwise specified. See the I²C-bus specification *UM10204* for details.

[2] tHD;DAT is the data hold time that is measured from the falling edge of SCL; applies to data in transmission and the acknowledge.

[3] A device must internally provide a hold time of at least 300 ns for the SDA signal (with respect to the $V_{IH}$(min) of the SCL signal) to bridge the undefined region of the falling edge of SCL.

[4] $C_b$ = total capacitance of one bus line in pF. If mixed with Hs-mode devices, faster fall times are allowed.

[5] The maximum $t_f$ for the SDA and SCL bus lines is specified at 300 ns. The maximum fall time for the SDA output stage $t_f$ is specified at 250 ns. This allows series protection resistors to be connected in between the SDA and the SCL pins and the SDA/SCL bus lines without exceeding the maximum specified $t_f$.

[6] In Fast-mode Plus, fall time is specified the same for both output stage and bus timing. If series resistors are used, designers should allow for this when considering bus timing.

[7] The maximum $t_{HD;DAT}$ could be 3.45 µs and 0.9 µs for Standard-mode and Fast-mode but must be less than the maximum of $t_{VD;DAT}$ or $t_{VD;ACK}$ by a transition time. This maximum must only be met if the device does not stretch the LOW period ($t_{LOW}$) of the SCL signal. If the clock stretches the SCL, the data must be valid by the set-up time before it releases the clock.

[8] tSU;DAT is the data set-up time that is measured with respect to the rising edge of SCL; applies to data in transmission and the acknowledge.

[9] A Fast-mode I²C-bus device can be used in a Standard-mode I²C-bus system but the requirement $t_{SU;DAT}$ = 250 ns must then be met. This will automatically be the case if the device does not stretch the LOW period of the SCL signal. If such a device does stretch the LOW period of the SCL signal, it must output the next data bit to the SDA line $t_{r(max)}$ + $t_{SU;DAT}$ = 1000 + 250 = 1250 ns (according to the Standard-mode I²C-bus specification) before the SCL line is released. Also the acknowledge timing must meet this set-up time.

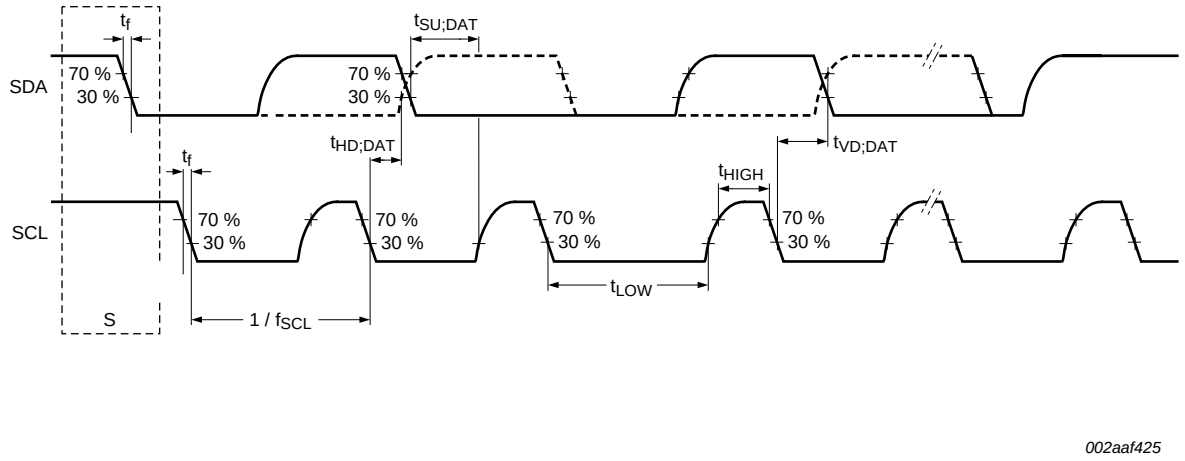



**Fig 28. I²C-bus pins clock timing**

## 11.7 I²S-bus interface

**Table 20. Dynamic characteristics: I²S-bus interface pins**

*$T_{amb}$ = 25 °C; 2.2 V ≤ $V_{DD(REG)(3V3)}$ ≤ 3.6 V; 2.7 V ≤ $V_{DD(IO)}$ ≤ 3.6 V; $C_L$ = 20 pF. Conditions and data refer to I2S0 and I2S1 pins. Simulated values.*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **common to input and output** | | | | | | | |
| $t_r$ | rise time | | | - | 4 | - | ns |
| $t_f$ | fall time | | | - | 4 | - | ns |
| $t_{WH}$ | pulse width HIGH | on pins I2Sx_TX_SCK and I2Sx_RX_SCK | | 36 | - | - | ns |
| $t_{WL}$ | pulse width LOW | on pins I2Sx_TX_SCK and I2Sx_RX_SCK | | 36 | - | - | ns |
| **output** | | | | | | | |
| $t_{v(Q)}$ | data output valid time | on pin I2Sx_TX_SDA | [1] | - | 4.4 | - | ns |
| | | on pin I2Sx_TX_WS | | - | 4.3 | - | ns |
| **input** | | | | | | | |
| $t_{su(D)}$ | data input set-up time | on pin I2Sx_RX_SDA | [1] | - | 0 | - | ns |
| | | on pin I2Sx_RX_WS | | | 0.20 | | ns |
| $t_{h(D)}$ | data input hold time | on pin I2Sx_RX_SDA | [1] | - | 3.7 | - | ns |
| | | on pin I2Sx_RX_WS | | - | 3.9 | - | ns |

[1] Clock to the I²S-bus interface BASE_APB1_CLK = 150 MHz; peripheral clock to the I²S-bus interface PCLK = BASE_APB1_CLK / 12. I²S clock cycle time $T_{cy(clk)}$ = 79.2 ns; corresponds to the SCK signal in the *I²S-bus specification*.

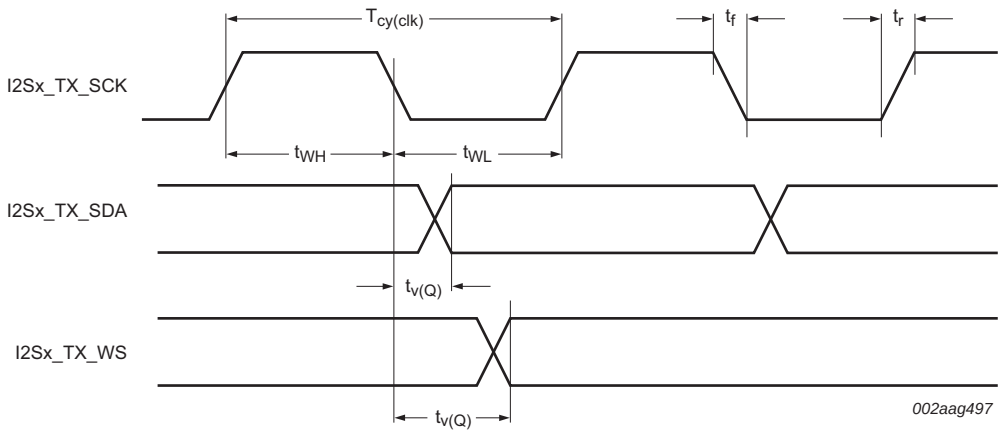



**Fig 29. I²S-bus timing (transmit)**

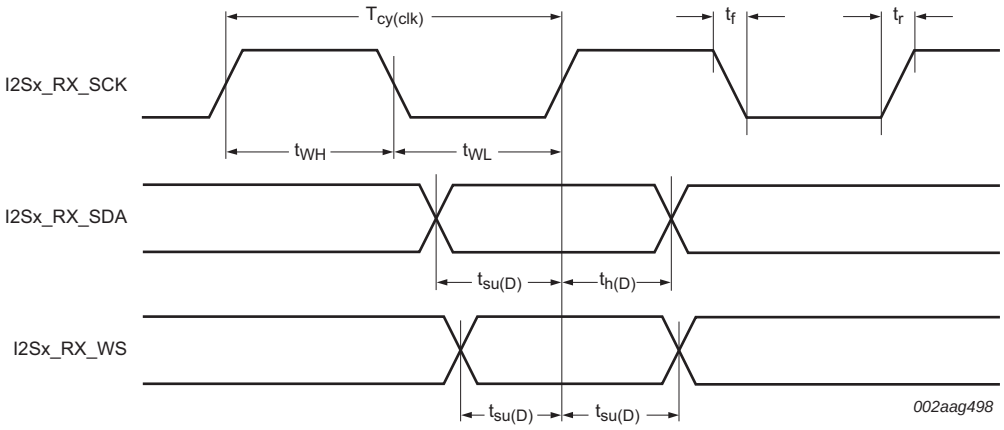



**Fig 30. I²S-bus timing (receive)**

## 11.8 USART interface

**Table 21. Dynamic characteristics: USART interface**

*$T_{amb}$ = 25 °C; 2.2 V ≤ $V_{DD(REG)(3V3)}$ ≤ 3.6 V; 2.7 V ≤ $V_{DD(IO)}$ ≤ 3.6 V; $C_L$ = 20 pF. Simulated values.*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $T_{cy(clk)}$ | clock cycle time | on pins Ux_UCLK | - | 0.1 | - | µs |
| **output** | | | | | | |
| $t_{v(Q)}$ | data output valid time | on pin Ux_TXD | - | 6.5 | - | ns |

## 11.9 SSP interface

**Table 22. Dynamic characteristics: SSP pins in SPI mode**

*$T_{amb}$ = −40 °C to 85 °C; 2.2 V ≤ $V_{DD(REG)(3V3)}$ ≤ 3.6 V; 2.7 V ≤ $V_{DD(IO)}$ ≤ 3.6 V. Simulated values.*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $T_{cy(clk)}$ | clock cycle time | full-duplex mode | [1] | - | 40 | - | ns |
| | | when only transmitting | | - | 20 | - | ns |
| **SSP master** | | | | | | | |
| $t_{DS}$ | data set-up time | in SPI mode | | 13.3 | - | - | ns |
| $t_{DH}$ | data hold time | in SPI mode | | −3.5 | - | - | ns |
| $t_{v(Q)}$ | data output valid time | in SPI mode | | - | - | 6.0 | ns |
| $t_{h(Q)}$ | data output hold time | in SPI mode | | - | - | 0 | ns |
| **SSP slave** | | | | | | | |
| $T_{cy(PCLK)}$ | PCLK cycle time | | | 10 | | | ns |
| $T_{cy(clk)}$ | clock cycle time | | [2] | 120 | - | - | ns |
| $t_{DS}$ | data set-up time | in SPI mode | | - | 10.5 | - | ns |
| $t_{DH}$ | data hold time | in SPI mode | | - | 1 | - | ns |
| $t_{v(Q)}$ | data output valid time | in SPI mode | | - | 4.0 | - | ns |
| $t_{h(Q)}$ | data output hold time | in SPI mode | | - | 0.2 | - | ns |

[1] $T_{cy(clk)} = (SSPCLKDIV \times (1 + SCR) \times CPSDVSR) / f_{main}$. The clock cycle time derived from the SPI bit rate $T_{cy(clk)}$ is a function of the main clock frequency $f_{main}$, the SSP peripheral clock divider (SSPCLKDIV), the SSP SCR parameter (specified in the SSP0CR0 register), and the SSP CPSDVSR parameter (specified in the SSP clock prescale register).

[2] $T_{cy(clk)} = 12 \times T_{cy(PCLK)}$.

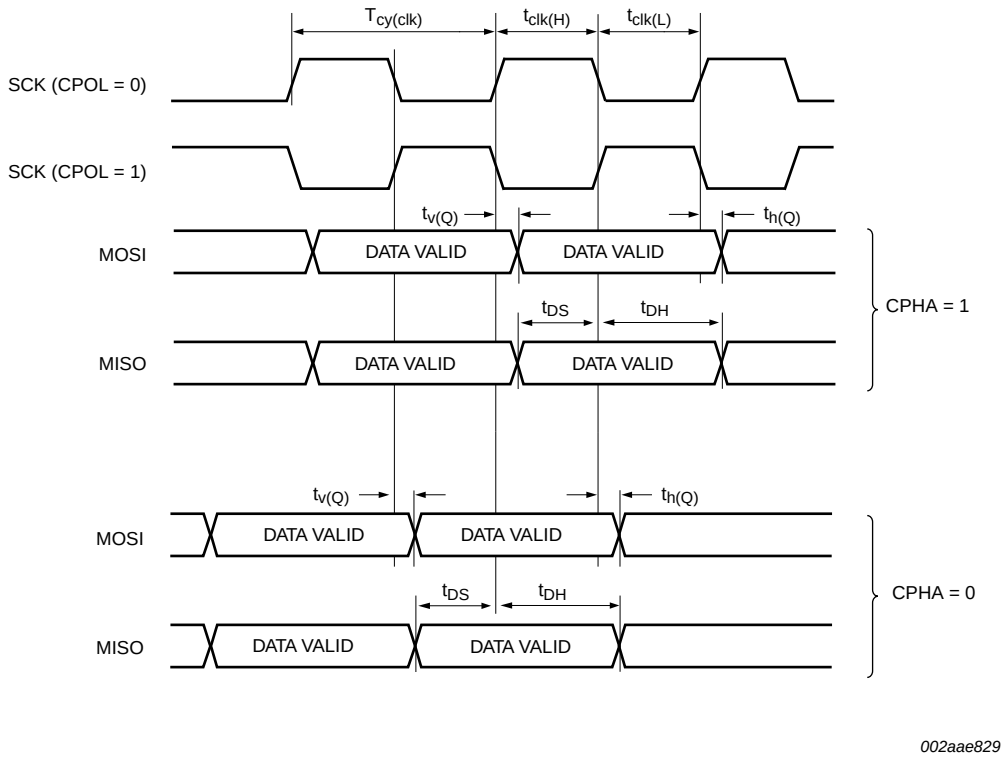



**Fig 31. SSP master timing in SPI mode**

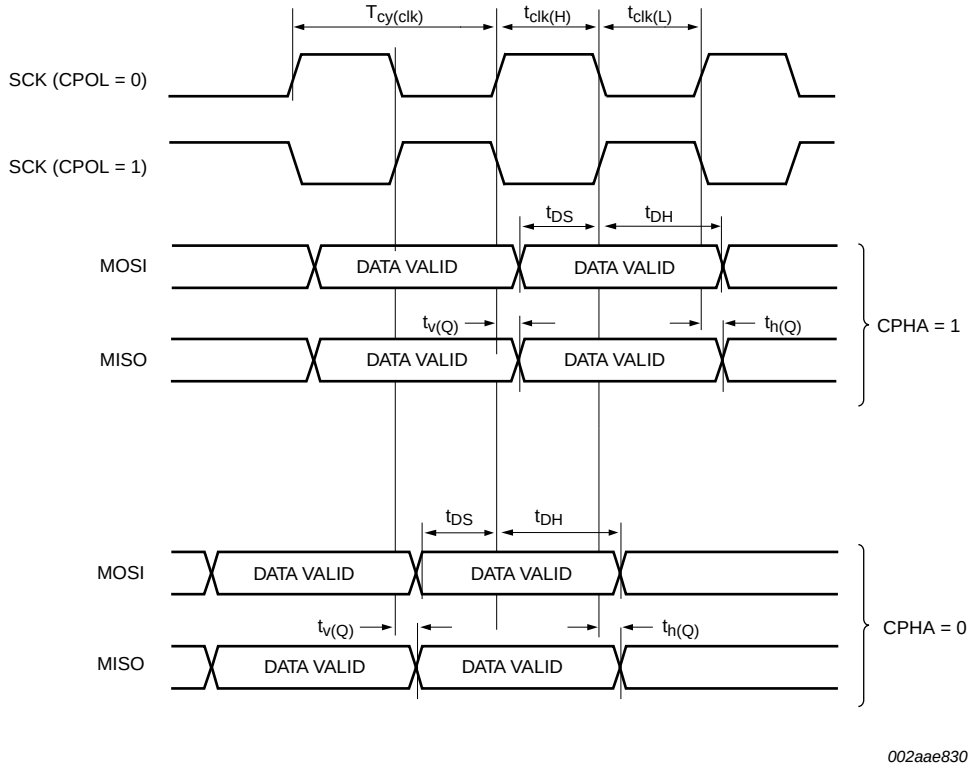



**Fig 32. SSP slave timing in SPI mode**

## 11.10 External memory interface

**Table 23. Dynamic characteristics: Static asynchronous external memory interface**

*$C_L$ = 22 pF for EMC_Dn $C_L$ = 20 pF for all others; $T_{amb}$ = −40 °C to 85 °C; 2.2 V ≤ $V_{DD(REG)(3V3)}$ ≤ 3.6 V; 2.7 V ≤ $V_{DD(IO)}$ ≤ 3.6 V; values guaranteed by design. Timing parameters are given for single memory access cycles. In a normal read operation, the EMC changes the address while CS is asserted resulting in multiple memory accesses.*

| Symbol | Parameter[1] | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **Read cycle parameters** | | | | | | | |
| $t_{CSLAV}$ | $\overline{CS}$ LOW to address valid time | | | −3.1 | - | 1.6 | ns |
| $t_{CSLOEL}$ | $\overline{CS}$ LOW to $\overline{OE}$ LOW time | | [2] | −0.6 + $T_{cy(clk)}$ × WAITOEN | - | 1.3 + $T_{cy(clk)}$ × WAITOEN | ns |
| $t_{CSLBLSL}$ | $\overline{CS}$ LOW to $\overline{BLS}$ LOW time | PB = 1 | | −0.7 | - | 1.8 | ns |
| $t_{OELOEH}$ | $\overline{OE}$ LOW to $\overline{OE}$ HIGH time | | [2] | −0.6 + (WAITRD − WAITOEN + 1) × $T_{cy(clk)}$ | - | −0.4 + (WAITRD − WAITOEN + 1) × $T_{cy(clk)}$ | ns |
| $t_{am}$ | memory access time | | | - | - | −16 + (WAITRD − WAITOEN +1) × $T_{cy(clk)}$ | ns |
| $t_{h(D)}$ | data input hold time | | | −16 | - | - | ns |
| $t_{CSHBLSH}$ | $\overline{CS}$ HIGH to $\overline{BLS}$ HIGH time | PB = 1 | | −0.4 | - | 1.9 | ns |
| $t_{CSHOEH}$ | CS HIGH to $\overline{OE}$ HIGH time | | | −0.4 | - | 1.4 | ns |
| $t_{OEHANV}$ | $\overline{OE}$ HIGH to address invalid | PB = 1 | | −2.0 | - | 2.6 | ns |
| $t_{CSHEOR}$ | $\overline{CS}$ HIGH to end of read time | | [3] | −2.0 | - | 0 | ns |
| $t_{CSLSOR}$ | $\overline{CS}$ LOW to start of read time | | [4] | 0 | - | 1.8 | ns |
| **Write cycle parameters** | | | | | | | |
| $t_{CSLAV}$ | $\overline{CS}$ LOW to address valid time | | | −3.1 | - | 1.6 | ns |
| $t_{CSLDV}$ | $\overline{CS}$ LOW to data valid time | | | −3.1 | - | 1.5 | ns |
| $t_{CSLWEL}$ | $\overline{CS}$ LOW to $\overline{WE}$ LOW time | PB = 1 | | −1.5 | - | 0.2 | ns |
| $t_{CSLBLSL}$ | $\overline{CS}$ LOW to $\overline{BLS}$ LOW time | PB = 1 | | −0.7 | - | 1.8 | ns |
| $t_{WELWEH}$ | $\overline{WE}$ LOW to $\overline{WE}$ HIGH time | PB = 1 | [2] | −0.6 + (WAITWR − WAITWEN + 1) × $T_{cy(clk)}$ | - | −0.4 + (WAITWR − WAITWEN + 1) × $T_{cy(clk)}$ | ns |
| $t_{WEHDNV}$ | $\overline{WE}$ HIGH to data invalid time | PB = 1 | [2] | −0.9 + $T_{cy(clk)}$ | - | 2.3 + $T_{cy(clk)}$ | ns |
| $t_{WEHEOW}$ | $\overline{WE}$ HIGH to end of write time | PB = 1 | [2] [5] | −0.4 + $T_{cy(clk)}$ | - | −0.3 + $T_{cy(clk)}$ | ns |
| $t_{CSLBLSL}$ | $\overline{CS}$ LOW to $\overline{BLS}$ LOW | PB = 0 | | −0.7 | - | 1.8 | ns |
| $t_{BLSLBLSH}$ | $\overline{BLS}$ LOW to $\overline{BLS}$ HIGH time | PB = 0 | [2] | −0.9 + (WAITWR − WAITWEN + 1) × $T_{cy(clk)}$ | - | −0.1 + (WAITWR − WAITWEN + 1) × $T_{cy(clk)}$ | ns |

**Table 23. Dynamic characteristics: Static asynchronous external memory interface** *...continued*

*$C_L$ = 22 pF for EMC_Dn $C_L$ = 20 pF for all others; $T_{amb}$ = −40 °C to 85 °C; 2.2 V ≤ $V_{DD(REG)(3V3)}$ ≤ 3.6 V; 2.7 V ≤ $V_{DD(IO)}$ ≤ 3.6 V; values guaranteed by design. Timing parameters are given for single memory access cycles. In a normal read operation, the EMC changes the address while CS is asserted resulting in multiple memory accesses.*

| Symbol | Parameter[1] | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $t_{BLSHEOW}$ | $\overline{BLS}$ HIGH to end of write time | PB = 0 | [2] [5] | −1.9 + $T_{cy(clk)}$ | - | −0.5 + $T_{cy(clk)}$ | ns |
| $t_{BLSHDNV}$ | $\overline{BLS}$ HIGH to data invalid time | PB = 0 | [2] | −2.5 + $T_{cy(clk)}$ | - | 1.4 + $T_{cy(clk)}$ | ns |
| $t_{CSHEOW}$ | $\overline{CS}$ HIGH to end of write time | | [5] | −2.0 | - | 0 | ns |
| $t_{BLSHDNV}$ | $\overline{BLS}$ HIGH to data invalid time | PB = 1 | | −2.5 | - | 1.4 | ns |
| $t_{WEHANV}$ | WE HIGH to address invalid time | PB = 1 | | −0.9 + $T_{cy(clk)}$ | - | 2.4 + $T_{cy(clk)}$ | ns |

[1] Parameters specified for 40 % of $V_{DD(IO)}$ for rising edges and 60 % of $V_{DD(IO)}$ for falling edges.

[2] $T_{cy(clk)}$ = 1/CCLK (see *LPC18xx User manual*).

[3] End Of Read (EOR): longest of $t_{CSHOEH}$, $t_{OEHANV}$, $t_{CSHBLSH}$.

[4] Start Of Read (SOR): longest of $t_{CSLAV}$, $t_{CSLOEL}$, $t_{CSLBLSL}$.

[5] End Of Write (EOW): earliest of address not valid or $\overline{EMC\_BLSn}$ HIGH.

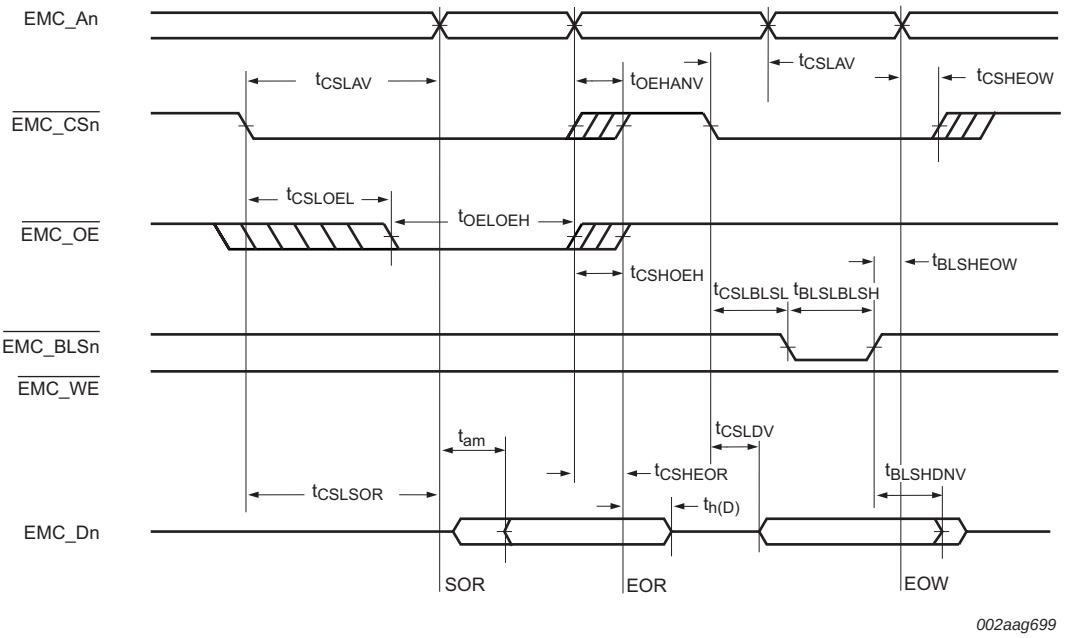



**Fig 33. External static memory read/write access (PB = 0)**

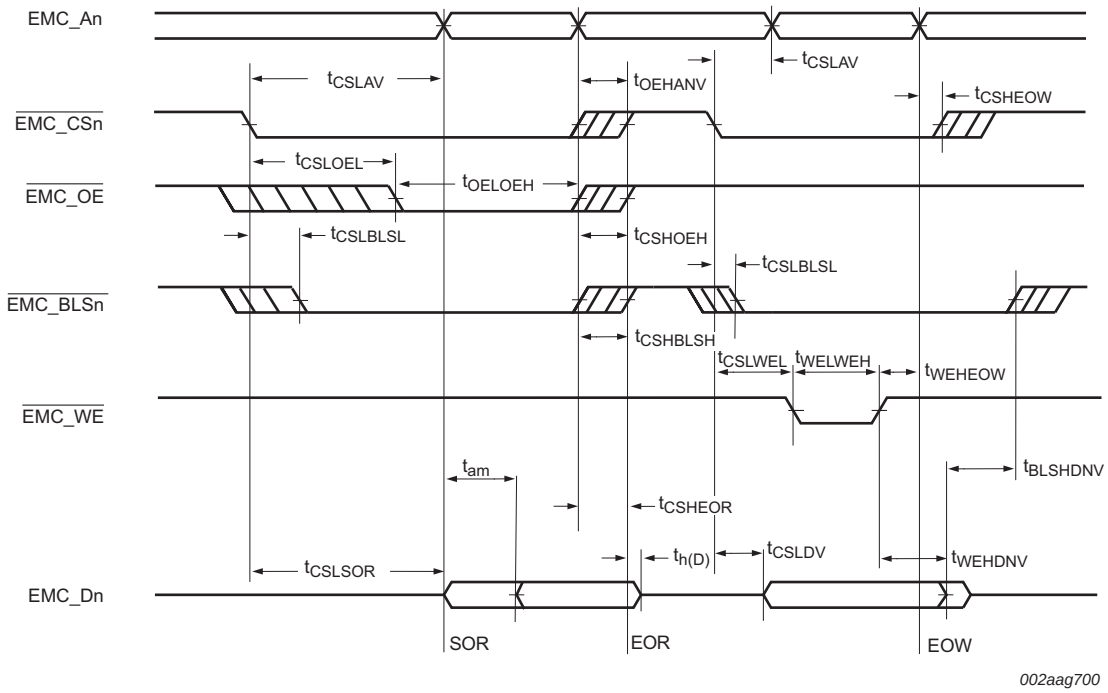



**Fig 34. External static memory read/write access (PB = 1)**

**Table 24. Dynamic characteristics: Dynamic external memory interface**

*Simulated data over temperature and process range; $C_L$ = 10 pF for $\overline{\text{EMC\_DYCSn}}$, $\overline{\text{EMC\_RAS}}$, $\overline{\text{EMC\_CAS}}$, $\overline{\text{EMC\_WE}}$, EMC_An; $C_L$ = 9 pF for EMC_Dn; $C_L$ = 5 pF for EMC_DQMOUTn, EMC_CLKn, $\overline{\text{EMC\_CKEOUTn}}$; $T_{amb}$ = −40 °C to 85 °C; 2.2 V ≤ $V_{DD(REG)(3V3)}$ ≤ 3.6 V; $V_{DD(IO)}$ = 3.3 V ± 10 %; RD = 1 (see LPC18xx User manual); EMC_CLKn delays CLK0_DELAY = CLK1_DELAY = CLK2_DELAY = CLK3_DELAY = 0.*

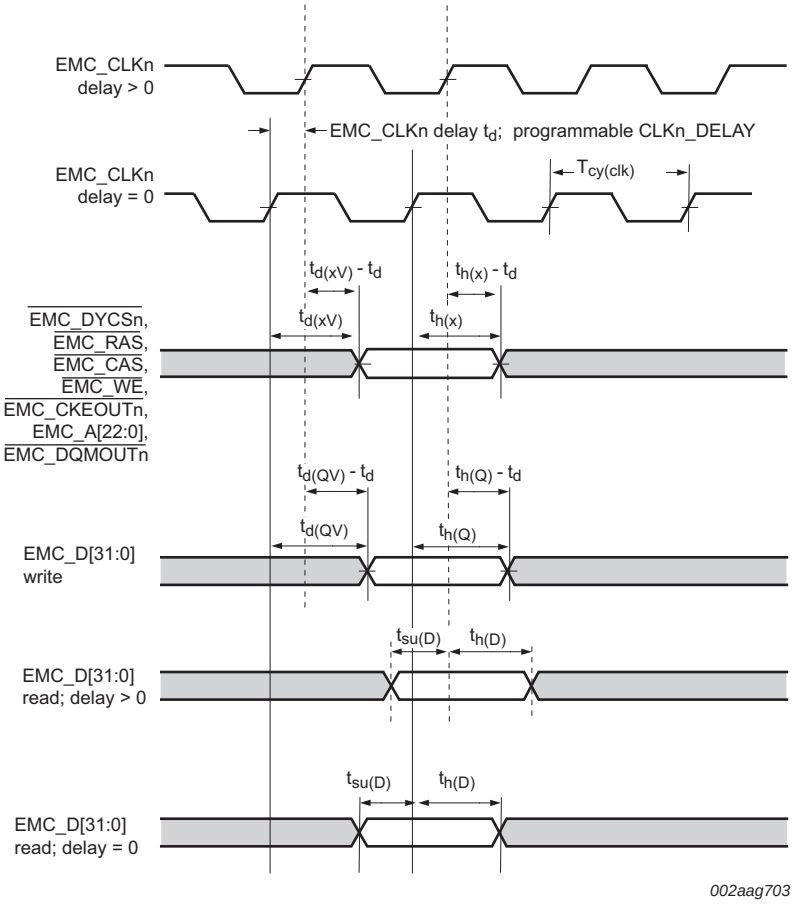
| Symbol | Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| $T_{cy(clk)}$ | clock cycle time | 8.4 | - | - | ns |
| **Common to read and write cycles** | | | | | |
| $t_{d(DYCSV)}$ | DYCS delay time | - | 3.1 + 0.5 × $T_{cy(clk)}$ | 5.1 + 0.5 × $T_{cy(clk)}$ | ns |
| $t_{h(DYCS)}$ | DYCS hold time | 0.3 + 0.5 × $T_{cy(clk)}$ | 0.9 + 0.5 × $T_{cy(clk)}$ | - | ns |
| $t_{d(RASV)}$ | row address strobe valid delay time | - | 3.1 + 0.5 × $T_{cy(clk)}$ | 4.9 + 0.5 × $T_{cy(clk)}$ | ns |
| $t_{h(RAS)}$ | row address strobe hold time | 0.5 + 0.5 × $T_{cy(clk)}$ | 1.1 + 0.5 × $T_{cy(clk)}$ | - | ns |
| $t_{d(CASV)}$ | column address strobe valid delay time | - | 2.9 + 0.5 × $T_{cy(clk)}$ | 4.6 + 0.5 × $T_{cy(clk)}$ | ns |
| $t_{h(CAS)}$ | column address strobe hold time | 0.3 + 0.5 × $T_{cy(clk)}$ | 0.9 + 0.5 × $T_{cy(clk)}$ | - | ns |
| $t_{d(WEV)}$ | $\overline{\text{WE}}$ valid delay time | - | 3.2 + 0.5 × $T_{cy(clk)}$ | 5.9 + 0.5 × $T_{cy(clk)}$ | ns |
| $t_{h(WE)}$ | $\overline{\text{WE}}$ hold time | 1.3 + 0.5 × $T_{cy(clk)}$ | 1.4 + 0.5 × $T_{cy(clk)}$ | - | ns |
| $t_{d(DQMOUTV)}$ | $\overline{\text{DQMOUT}}$ valid delay time | - | 3.1 + 0.5 × $T_{cy(clk)}$ | 5.0 + 0.5 × $T_{cy(clk)}$ | ns |
| $t_{h(DQMOUT)}$ | $\overline{\text{DQMOUT}}$ hold time | 0.2 + 0.5 × $T_{cy(clk)}$ | 0.8 + 0.5 × $T_{cy(clk)}$ | - | ns |
| $t_{d(AV)}$ | address valid delay time | - | 3.8 + 0.5 × $T_{cy(clk)}$ | 6.3 + 0.5 × $T_{cy(clk)}$ | ns |
| $t_{h(A)}$ | address hold time | 0.3 + 0.5 × $T_{cy(clk)}$ | 0.9 + 0.5 × $T_{cy(clk)}$ | - | ns |
| $t_{d(CKEOUTV)}$ | $\overline{\text{CKEOUT}}$ valid delay time | - | 3.1 + 0.5 × $T_{cy(clk)}$ | 5.1 + 0.5 × $T_{cy(clk)}$ | ns |
| $t_{h(CKEOUT)}$ | $\overline{\text{CKEOUT}}$ hold time | 0.5 × $T_{cy(clk)}$ | 0.7 + 0.5 × $T_{cy(clk)}$ | - | ns |
| **Read cycle parameters** | | | | | |
| $t_{su(D)}$ | data input set-up time | −1.5 | −0.5 | - | ns |
| $t_{h(D)}$ | data input hold time | - | 0.8 | 2.2 | ns |
| **Write cycle parameters** | | | | | |
| $t_{d(QV)}$ | data output valid delay time | - | 3.8 + 0.5 × $T_{cy(clk)}$ | 6.2 + 0.5 × $T_{cy(clk)}$ | ns |
| $t_{h(Q)}$ | data output hold time | 0.5 × $T_{cy(clk)}$ | 0.7 + 0.5 × $T_{cy(clk)}$ | - | ns |

**Table 25. Dynamic characteristics: Dynamic external memory interface; EMC_CLK[3:0] delay values**

*$T_{amb}$ = −40 °C to 85 °C; $V_{DD(IO)}$ = 3.3 V ± 10 %; 2.2 V ≤ $V_{DD(REG)(3V3)}$ ≤ 3.6 V.*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $t_d$ | delay time | delay value [1] | | | | |
| | | CLKn_DELAY = 0 | 0.0 | 0.0 | 0.0 | ns |
| | | CLKn_DELAY = 1 [1] | 0.4 | 0.5 | 0.8 | ns |
| | | CLKn_DELAY = 2 [1] | 0.7 | 1.0 | 1.7 | ns |
| | | CLKn_DELAY = 3 [1] | 1.1 | 1.6 | 2.5 | ns |
| | | CLKn_DELAY = 4 [1] | 1.4 | 2.0 | 3.3 | ns |
| | | CLKn_DELAY = 5 [1] | 1.7 | 2.6 | 4.1 | ns |
| | | CLKn_DELAY = 6 [1] | 2.1 | 3.1 | 4.9 | ns |
| | | CLKn_DELAY = 7 [1] | 2.5 | 3.6 | 5.8 | ns |

[1] Program the EMC_CLKn delay values in the EMCDELAYCLK register (see the *LPC18xx User manual*). The delay values must be the same for all SDRAM clocks EMC_CLKn: CLK0_DELAY = CLK1_DELAY = CLK2_DELAY = CLK3_DELAY.




For the programmable EMC_CLK[3:0] clock delays CLKn_DELAY, see Table 25 .

**Remark:** For SDRAM operation, set CLK0_DELAY = CLK1_DELAY = CLK2_DELAY = CLK3_DELAY in the EMCDELAYCLK register.

**Fig 35. SDRAM timing**

## 11.11 USB interface

**Table 26. Dynamic characteristics: USB0 and USB1 pins (full-speed)**
*$C_L$ = 50 pF; $R_{pu}$ = 1.5 kΩ on D+ to $V_{DD(IO)}$; 3.0 V ≤ $V_{DD(IO)}$ ≤ 3.6 V.*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $t_r$ | rise time | 10 % to 90 % | | 8.5 | - | 13.8 | ns |
| $t_f$ | fall time | 10 % to 90 % | | 7.7 | - | 13.7 | ns |
| $t_{FRFM}$ | differential rise and fall time matching | $t_r / t_f$ | | - | - | 109 | % |
| $V_{CRS}$ | output signal crossover voltage | | | 1.3 | - | 2.0 | V |
| $t_{FEOPT}$ | source SE0 interval of EOP | see Figure 36 | | 160 | - | 175 | ns |
| $t_{FDEOP}$ | source jitter for differential transition to SE0 transition | see Figure 36 | | −2 | - | +5 | ns |
| $t_{JR1}$ | receiver jitter to next transition | | | −18.5 | - | +18.5 | ns |
| $t_{JR2}$ | receiver jitter for paired transitions | 10 % to 90 % | | −9 | - | +9 | ns |
| $t_{EOPR1}$ | EOP width at receiver | must reject as EOP; see Figure 36 | [1] | 40 | - | - | ns |
| $t_{EOPR2}$ | EOP width at receiver | must accept as EOP; see Figure 36 | [1] | 82 | - | - | ns |

[1] Characterized but not implemented as production test. Guaranteed by design.

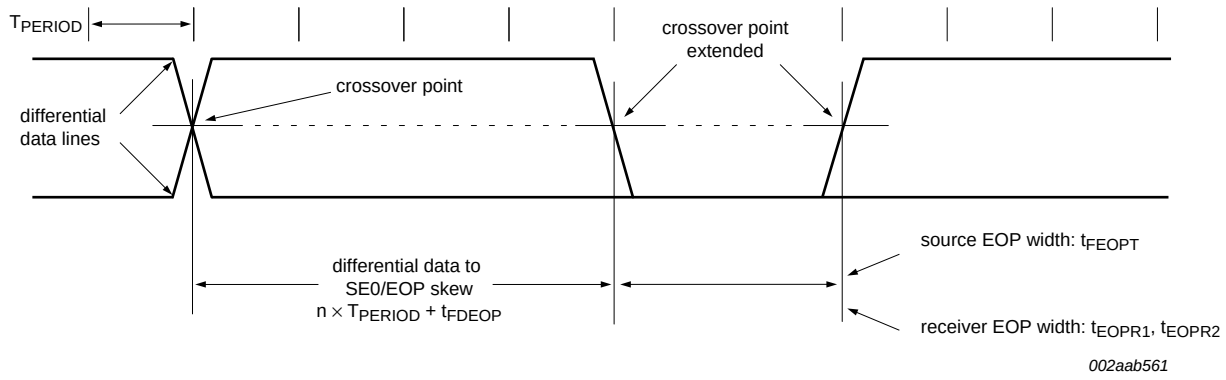



**Fig 36. Differential data-to-EOP transition skew and EOP width**

**Table 27. Static characteristics: USB0 PHY pins[1]**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **High-speed mode** | | | | | | | |
| $P_{cons}$ | power consumption | | [2] | - | 68 | - | mW |
| $I_{DDA(3V3)}$ | analog supply current (3.3 V) | on pin USB0_VDDA3V3_DRIVER; | [3] | | | | |
| | | total supply current | | - | 18 | - | mA |
| | | during transmit | | - | 31 | - | mA |
| | | during receive | | - | 14 | - | mA |
| | | with driver tri-stated | | - | 14 | - | mA |
| $I_{DDD}$ | digital supply current | | | - | 7 | - | mA |
| **Full-speed/low-speed mode** | | | | | | | |
| $P_{cons}$ | power consumption | | [2] | - | 15 | - | mW |
| $I_{DDA(3V3)}$ | analog supply current (3.3 V) | on pin USB0_VDDA3V3_DRIVER; | | | | | |
| | | total supply current | | - | 3.5 | - | mA |
| | | during transmit | | - | 5 | - | mA |
| | | during receive | | - | 3 | - | mA |
| | | with driver tri-stated | | - | 3 | - | mA |
| $I_{DDD}$ | digital supply current | | | - | 3 | - | mA |
| **Suspend mode** | | | | | | | |
| $I_{DDA(3V3)}$ | analog supply current (3.3 V) | | | - | 24 | - | µA |
| | | with driver tri-stated | | - | 24 | - | µA |
| | | with OTG functionality enabled | | - | 3 | - | mA |
| $I_{DDD}$ | digital supply current | | | - | 30 | - | µA |
| **VBUS detector outputs** | | | | | | | |
| $V_{th}$ | threshold voltage | for VBUS valid | | 4.4 | - | - | V |
| | | for session end | | 0.2 | - | 0.8 | V |
| | | for A valid | | 0.8 | - | 2 | V |
| | | for B valid | | 2 | - | 4 | V |
| $V_{hys}$ | hysteresis voltage | for session end | | - | 150 | 10 | mV |
| | | A valid | | - | 200 | 10 | mV |
| | | B valid | | - | 200 | 10 | mV |

[1] Characterized but not implemented as production test.

[2] Total average power consumption.

[3] The driver is active only 20 % of the time.

## 11.12 Ethernet

**Table 28. Dynamic characteristics: Ethernet**

*$T_{amb}$ = −40 °C to 85 °C; 2.2 V ≤ $V_{DD(REG)(3V3)}$ ≤ 3.6 V; 2.7 V ≤ $V_{DD(IO)}$ ≤ 3.6 V. Values guaranteed by design.*

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| **RMII mode** | | | | | | |
| $f_{clk}$ | clock frequency | for ENET_RX_CLK | [1] | - | 50 | MHz |
| $\delta_{clk}$ | clock duty cycle | | [1] | 50 | 50 | % |

**Table 28. Dynamic characteristics: Ethernet**

*$T_{amb}$ = −40 °C to 85 °C; 2.2 V ≤ $V_{DD(REG)(3V3)}$ ≤ 3.6 V; 2.7 V ≤ $V_{DD(IO)}$ ≤ 3.6 V. Values guaranteed by design.*

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| $t_{su}$ | set-up time | for ENET_TXDn, ENET_TX_EN, ENET_RXDn, ENET_RX_ER, ENET_RX_DV | [1][2] | 4 | - | ns |
| $t_h$ | hold time | for ENET_TXDn, ENET_TX_EN, ENET_RXDn, ENET_RX_ER, ENET_RX_DV | [1][2] | 2 | - | ns |
| **MII mode** | | | | | | |
| $f_{clk}$ | clock frequency | for ENET_TX_CLK | [1] | - | 25 | MHz |
| $\delta_{clk}$ | clock duty cycle | | [1] | 50 | 50 | % |
| $t_{su}$ | set-up time | for ENET_TXDn, ENET_TX_EN, ENET_TX_ER | [1][2] | 4 | - | ns |
| $t_h$ | hold time | for ENET_TXDn, ENET_TX_EN, ENET_TX_ER | [1][2] | 2 | - | ns |
| $f_{clk}$ | clock frequency | for ENET_RX_CLK | [1] | - | 25 | MHz |
| $\delta_{clk}$ | clock duty cycle | | [1] | 50 | 50 | % |
| $t_{su}$ | set-up time | for ENET_RXDn, ENET_RX_ER, ENET_RX_DV | [1][2] | 4 | - | ns |
| $t_h$ | hold time | for ENET_RXDn, ENET_RX_ER, ENET_RX_DV | [1][2] | 2 | - | ns |

[1] Output drivers can drive a load ≥ 25 pF accommodating over 12 inch of PCB trace and the input capacitance of the receiving device.

[2] Timing values are given from the point at which the clock signal waveform crosses 1.4 V to the valid input or output level.

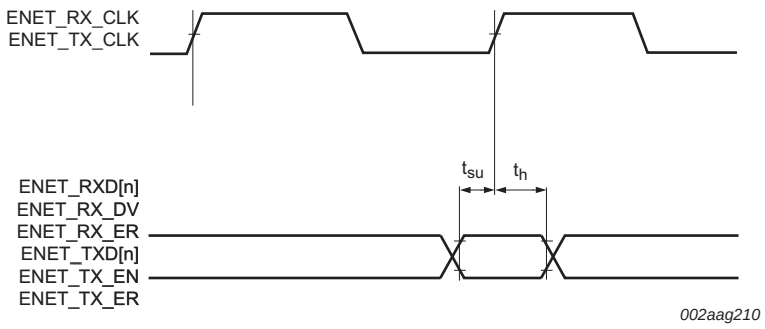



**Fig 37. Ethernet timing**

## 11.13 SD/MMC

**Table 29. Dynamic characteristics: SD/MMC**

*$T_{amb}$ = −40 °C to 85 °C, 2.2 V ≤ $V_{DD(REG)(3V3)}$ ≤ 3.6 V; 2.7 V ≤ $V_{DD(IO)}$ ≤ 3.6 V, $C_L$ = 20 pF. Simulated values.*

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $f_{clk}$ | clock frequency | on pin SD_CLK; data transfer mode | 40 | - | MHz |
| $t_{su(D)}$ | data input set-up time | on pins SD_CMD, SD_DATn as inputs | 16 | - | ns |
| $t_{h(D)}$ | data input hold time | on pins SD_CMD, SD_DATn as inputs | −2 | | ns |
| $t_{d(QV)}$ | data output valid delay time | on pins SD_CMD, SD_DATn as outputs | | 12 | ns |
| $t_{h(Q)}$ | data output hold time | on pins SD_CMD, SD_DATn as outputs | 0.3 | - | ns |

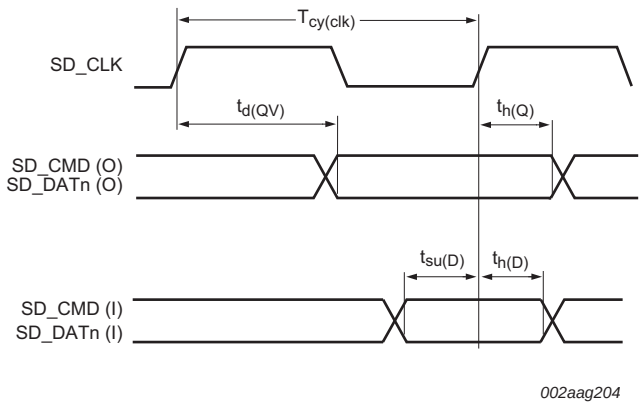



**Fig 38. SD/MMC timing**

## 11.14 LCD

**Table 30. Dynamic characteristics: LCD**

*$T_{amb}$ = −40 °C to 85 °C; 2.2 V ≤ $V_{DD(REG)(3V3)}$ ≤ 3.6 V; 2.7 V ≤ $V_{DD(IO)}$ ≤ 3.6 V; $C_L$ = 20 pF. Simulated values.*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $f_{clk}$ | clock frequency | on pin LCD_DCLK | - | 50 | - | MHz |
| $t_{d(QV)}$ | data output valid delay time | | | - | 17 | ns |
| $t_{h(Q)}$ | data output hold time | | 8.5 | - | | ns |

## 11.15 SPIFI

**Table 31. Dynamic characteristics: SPIFI**

*$T_{amb}$ = −40 °C to 85 °C; 2.2 V ≤ $V_{DD(REG)(3V3)}$ ≤ 3.6 V; 2.7 V ≤ $V_{DD(IO)}$ ≤ 3.6 V. $C_L$ = 10 pF. Simulated values.*

| Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| $T_{cy(clk)}$ | clock cycle time | 9.6 | - | ns |
| $t_{DS}$ | data set-up time | 3.4 | - | ns |
| $t_{DH}$ | data hold time | 0 | - | ns |
| $t_{v(Q)}$ | data output valid time | - | 8 | ns |
| $t_{h(Q)}$ | data output hold time | 5 | - | ns |

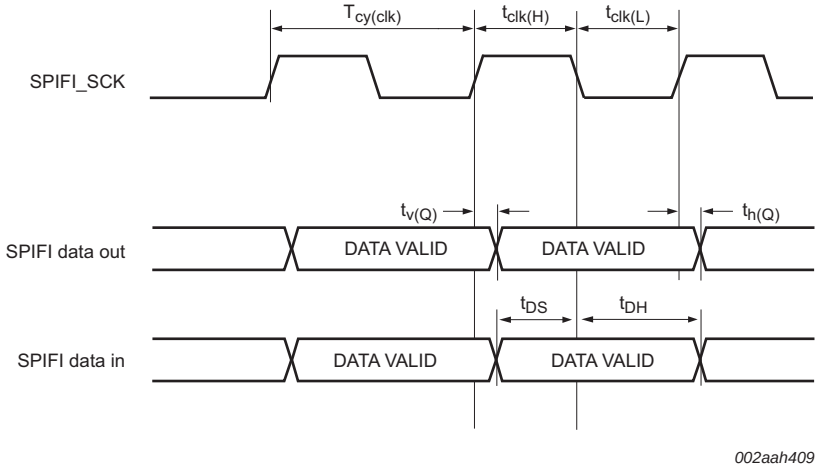



**Fig 39. SPIFI timing**

# 12. ADC/DAC electrical characteristics

**Table 32. ADC characteristics**

*$V_{DDA(3V3)}$ over specified ranges; $T_{amb}$ = −40 °C to +85 °C; unless otherwise specified.*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{IA}$ | analog input voltage | | | 0 | - | $V_{DDA(3V3)}$ | V |
| $C_{ia}$ | analog input capacitance | | | - | - | 2 | pF |
| $E_D$ | differential linearity error | 2.7 V ≤ $V_{DDA(3V3)}$ ≤ 3.6 V | [1][2] | - | ±0.8 | - | LSB |
| | | 2.2 V ≤ $V_{DDA(3V3)}$ < 2.7 V | | - | ±1.0 | - | LSB |
| $E_{L(adj)}$ | integral non-linearity | 2.7 V ≤ $V_{DDA(3V3)}$ ≤ 3.6 V | [3] | - | ±0.8 | - | LSB |
| | | 2.2 V ≤ $V_{DDA(3V3)}$ < 2.7 V | | - | ±1.5 | - | LSB |
| $E_O$ | offset error | 2.7 V ≤ $V_{DDA(3V3)}$ ≤ 3.6 V | [4] | - | ±0.15 | - | LSB |
| | | 2.2 V ≤ $V_{DDA(3V3)}$ < 2.7 V | | - | ±0.15 | - | LSB |
| $E_G$ | gain error | 2.7 V ≤ $V_{DDA(3V3)}$ ≤ 3.6 V | [5] | - | ±0.3 | - | % |
| | | 2.2 V ≤ $V_{DDA(3V3)}$ < 2.7 V | | - | ±0.35 | - | % |
| $E_T$ | absolute error | 2.7 V ≤ $V_{DDA(3V3)}$ ≤ 3.6 V | [6] | - | ±3 | - | LSB |
| | | 2.2 V ≤ $V_{DDA(3V3)}$ < 2.7 V | | - | ±4 | - | LSB |
| $R_{vsi}$ | voltage source interface resistance | see Figure 41 | | - | - | $1/(7 \times f_{clk(ADC)} \times C_{ia})$ | kΩ |
| $R_i$ | input resistance | | [7][8] | - | - | 1.2 | MΩ |
| $f_{clk(ADC)}$ | ADC clock frequency | | | - | - | 4.5 | MHz |
| $f_s$ | sampling frequency | 10-bit resolution; 11 clock cycles | | - | - | 400 | kSamples/s |
| | | 2-bit resolution; 3 clock cycles | | | | 1.5 | MSamples/s |

[1] The ADC is monotonic, there are no missing codes.

[2] The differential linearity error ($E_D$) is the difference between the actual step width and the ideal step width. See Figure 40.

[3] The integral non-linearity ($E_{L(adj)}$) is the peak difference between the center of the steps of the actual and the ideal transfer curve after appropriate adjustment of gain and offset errors. See Figure 40.

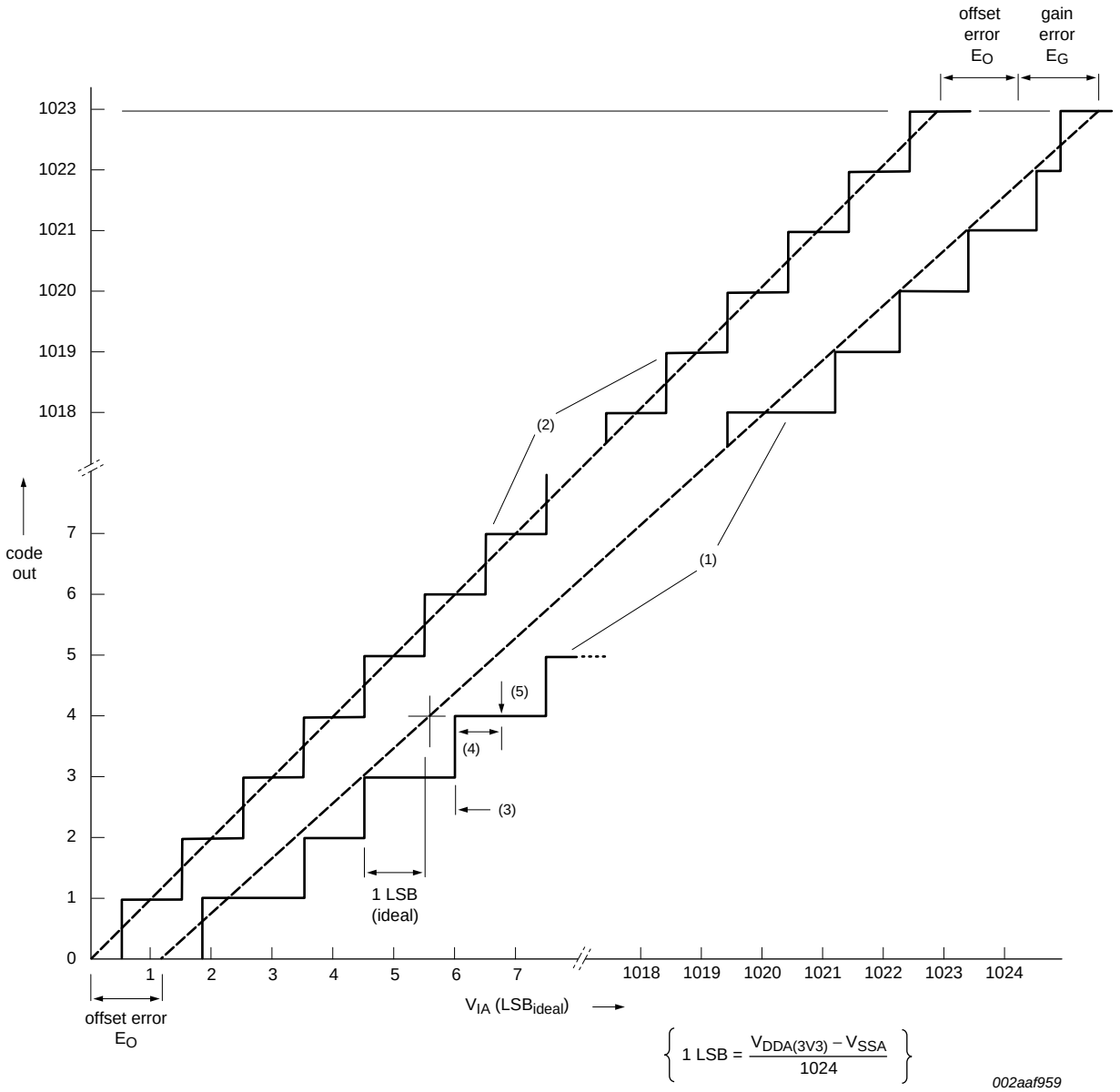
[4] The offset error ($E_O$) is the absolute difference between the straight line which fits the actual curve and the straight line which fits the ideal curve. See Figure 40.

[5] The gain error ($E_G$) is the relative difference in percent between the straight line fitting the actual transfer curve after removing offset error, and the straight line which fits the ideal transfer curve. See Figure 40.

[6] The absolute error ($E_T$) is the maximum difference between the center of the steps of the actual transfer curve of the non-calibrated ADC and the ideal transfer curve. See Figure 40.

[7] $T_{amb}$ = 25 °C.

[8] Input resistance $R_i$ depends on the sampling frequency fs: $R_i = 2\ k\Omega + 1 / (f_s \times C_{ia})$.




(1) Example of an actual transfer curve.

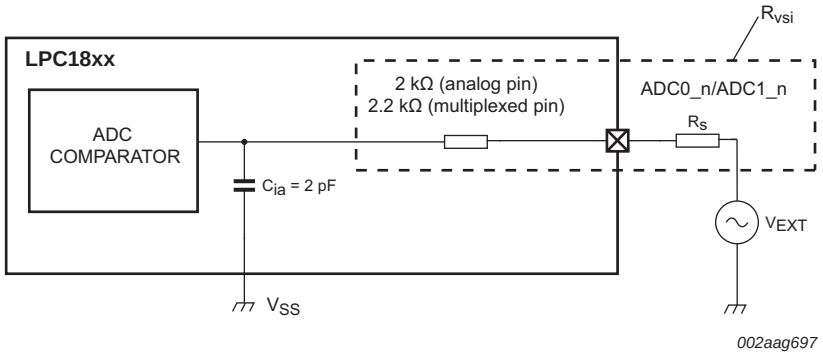
(2) The ideal transfer curve.

(3) Differential linearity error ($E_D$).

(4) Integral non-linearity ($E_{L(adj)}$).

(5) Center of a step of the actual transfer curve.

**Fig 40. 10-bit ADC characteristics**




$R_s < 1/((7 \times f_{clk(ADC)} \times C_{ia}) - 2\ k\Omega)$

**Fig 41. ADC interface to pins**

**Table 33. DAC characteristics**

*$V_{DDA(3V3)}$ over specified ranges; $T_{amb}$ = −40 °C to +85 °C; unless otherwise specified*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $E_D$ | differential linearity error | 2.7 V ≤ $V_{DDA(3V3)}$ ≤ 3.6 V | [1] | - | ±0.8 | - | LSB |
| | | 2.2 V ≤ $V_{DDA(3V3)}$ < 2.7 V | | - | ±1.0 | - | LSB |
| $E_{L(adj)}$ | integral non-linearity | code = 0 to 975 | [1] | - | ±1.0 | - | LSB |
| | | 2.7 V ≤ $V_{DDA(3V3)}$ ≤ 3.6 V | | | | | |
| | | 2.2 V ≤ $V_{DDA(3V3)}$ < 2.7 V | | - | ±1.5 | - | LSB |
| $E_O$ | offset error | 2.7 V ≤ $V_{DDA(3V3)}$ ≤ 3.6 V | [1] | - | ±0.8 | - | LSB |
| | | 2.2 V ≤ $V_{DDA(3V3)}$ < 2.7 V | | - | ±1.0 | - | LSB |
| $E_G$ | gain error | 2.7 V ≤ $V_{DDA(3V3)}$ ≤ 3.6 V | [1] | - | ±0.3 | - | % |
| | | 2.2 V ≤ $V_{DDA(3V3)}$ < 2.7 V | | - | ±1.0 | - | % |
| $C_L$ | load capacitance | | | - | - | 200 | pF |
| $R_L$ | load resistance | | | 1 | - | - | kΩ |
| $t_s$ | settling time | | [1] | | 0.4 | | µs |

[1] In the DAC CR register, bit BIAS = 0 (see the *LPC18xx user manual*).

[2] Settling time is calculated within 1/2 LSB of the final value.

# 13. Application information

## 13.1 LCD panel signal usage

**Table 34. LCD panel connections for STN single panel mode**

| External pin | 4-bit mono STN single panel | | 8-bit mono STN single panel | | Color STN single panel | |
|---|---|---|---|---|---|---|
| | LPC18xx pin used | LCD function | LPC18xx pin used | LCD function | LPC18xx pin used | LCD function |
| LCD_VD[23:8] | - | - | - | - | - | - |
| LCD_VD7 | - | - | P8_4 | UD[7] | P8_4 | UD[7] |
| LCD_VD6 | - | - | P8_5 | UD[6] | P8_5 | UD[6] |
| LCD_VD5 | - | - | P8_6 | UD[5] | P8_6 | UD[5] |
| LCD_VD4 | - | - | P8_7 | UD[4] | P8_7 | UD[4] |
| LCD_VD3 | P4_2 | UD[3] | P4_2 | UD[3] | P4_2 | UD[3] |
| LCD_VD2 | P4_3 | UD[2] | P4_3 | UD[2] | P4_3 | UD[2] |
| LCD_VD1 | P4_4 | UD[1] | P4_4 | UD[1] | P4_4 | UD[1] |
| LCD_VD0 | P4_1 | UD[0] | P4_1 | UD[0] | P4_1 | UD[0] |
| LCD_LP | P7_6 | LCDLP | P7_6 | LCDLP | P7_6 | LCDLP |
| LCD_ENAB/ LCDM | P4_6 | LCDENAB/ LCDM | P4_6 | LCDENAB/ LCDM | P4_6 | LCDENAB/ LCDM |
| LCD_FP | P4_5 | LCDFP | P4_5 | LCDFP | P4_5 | LCDFP |
| LCD_DCLK | P4_7 | LCDDCLK | P4_7 | LCDDCLK | P4_7 | LCDDCLK |
| LCD_LE | P7_0 | LCDLE | P7_0 | LCDLE | P7_0 | LCDLE |
| LCD_PWR | P7_7 | CDPWR | P7_7 | LCDPWR | P7_7 | LCDPWR |
| GP_CLKIN | PF_4 | LCDCLKIN | PF_4 | LCDCLKIN | PF_4 | LCDCLKIN |

**Table 35. LCD panel connections for STN dual panel mode**

| External pin | 4-bit mono STN dual panel | | 8-bit mono STN dual panel | | Color STN dual panel | |
|---|---|---|---|---|---|---|
| | LPC18xx pin used | LCD function | LPC18xx pin used | LCD function | LPC18xx pin used | LCD function |
| LCD_VD[23:16] | - | - | - | - | - | - |
| LCD_VD15 | - | - | PB_4 | LD[7] | PB_4 | LD[7] |
| LCD_VD14 | - | - | PB_5 | LD[6] | PB_5 | LD[6] |
| LCD_VD13 | - | - | PB_6 | LD[5] | PB_6 | LD[5] |
| LCD_VD12 | - | - | P8_3 | LD[4] | P8_3 | LD[4] |
| LCD_VD11 | P4_9 | LD[3] | P4_9 | LD[3] | P4_9 | LD[3] |
| LCD_VD10 | P4_10 | LD[2] | P4_10 | LD[2] | P4_10 | LD[2] |
| LCD_VD9 | P4_8 | LD[1] | P4_8 | LD[1] | P4_8 | LD[1] |
| LCD_VD8 | P7_5 | LD[0] | P7_5 | LD[0] | P7_5 | LD[0] |
| LCD_VD7 | - | - | | UD[7] | P8_4 | UD[7] |
| LCD_VD6 | - | - | P8_5 | UD[6] | P8_5 | UD[6] |
| LCD_VD5 | - | - | P8_6 | UD[5] | P8_6 | UD[5] |
| LCD_VD4 | - | - | P8_7 | UD[4] | P8_7 | UD[4] |
| LCD_VD3 | P4_2 | UD[3] | P4_2 | UD[3] | P4_2 | UD[3] |

**Table 35. LCD panel connections for STN dual panel mode**

| External pin | 4-bit mono STN dual panel | | 8-bit mono STN dual panel | | Color STN dual panel | |
|---|---|---|---|---|---|---|
| | LPC18xx pin used | LCD function | LPC18xx pin used | LCD function | LPC18xx pin used | LCD function |
| LCD_VD2 | P4_3 | UD[2] | P4_3 | UD[2] | P4_3 | UD[2] |
| LCD_VD1 | P4_4 | UD[1] | P4_4 | UD[1] | P4_4 | UD[1] |
| LCD_VD0 | P4_1 | UD[0] | P4_1 | UD[0] | P4_1 | UD[0] |
| LCD_LP | P7_6 | LCDLP | P7_6 | LCDLP | P7_6 | LCDLP |
| LCD_ENAB/ LCDM | P4_6 | LCDENAB/ LCDM | P4_6 | LCDENAB/ LCDM | P4_6 | LCDENAB/ LCDM |
| LCD_FP | P4_5 | LCDFP | P4_5 | LCDFP | P4_5 | LCDFP |
| LCD_DCLK | P4_7 | LCDDCLK | P4_7 | LCDDCLK | P4_7 | LCDDCLK |
| LCD_LE | P7_0 | LCDLE | P7_0 | LCDLE | P7_0 | LCDLE |
| LCD_PWR | P7_7 | LCDPWR | P7_7 | LCDPWR | P7_7 | LCDPWR |
| GP_CLKIN | PF_4 | LCDCLKIN | PF_4 | LCDCLKIN | PF_4 | LCDCLKIN |

**Table 36. LCD panel connections for TFT panels**

| External pin | TFT 12 bit (4:4:4 mode) | | TFT 16 bit (5:6:5 mode) | | TFT 16 bit (1:5:5:5 mode) | | TFT 24 bit | |
|---|---|---|---|---|---|---|---|---|
| | LPC18xx pin used | LCD function | LPC18xx pin used | LCD function | LPC18xx pin used | LCD function | LPC18xx pin used | LCD function |
| LCD_VD23 | PB_0 | BLUE3 | PB_0 | BLUE4 | PB_0 | BLUE4 | | BLUE7 |
| LCD_VD22 | PB_1 | BLUE2 | PB_1 | BLUE3 | PB_1 | BLUE3 | | BLUE6 |
| LCD_VD21 | PB_2 | BLUE1 | PB_2 | BLUE2 | PB_2 | BLUE2 | | BLUE5 |
| LCD_VD20 | PB_3 | BLUE0 | PB_3 | BLUE1 | PB_3 | BLUE1 | | BLUE4 |
| LCD_VD19 | - | - | P7_1 | BLUE0 | P7_1 | BLUE0 | | BLUE3 |
| LCD_VD18 | - | - | - | - | P7_2 | intensity | | BLUE2 |
| LCD_VD17 | - | - | - | - | - | - | P7_3 | BLUE1 |
| LCD_VD16 | - | - | - | - | - | - | P7_4 | BLUE0 |
| LCD_VD15 | PB_4 | GREEN3 | PB_4 | GREEN5 | PB_4 | GREEN4 | PB_4 | GREEN7 |
| LCD_VD14 | PB_5 | GREEN2 | PB_5 | GREEN4 | PB_5 | GREEN3 | PB_5 | GREEN6 |
| LCD_VD13 | PB_6 | GREEN1 | PB_6 | GREEN3 | PB_6 | GREEN2 | PB_6 | GREEN5 |
| LCD_VD12 | P8_3 | GREEN0 | P8_3 | GREEN2 | P8_3 | GREEN1 | P8_3 | GREEN4 |
| LCD_VD11 | - | - | P4_9 | GREEN1 | P4_9 | GREEN0 | P4_9 | GREEN3 |
| LCD_VD10 | - | - | P4_10 | GREEN0 | P4_10 | intensity | P4_10 | GREEN2 |
| LCD_VD9 | - | - | - | - | - | - | P4_8 | GREEN1 |
| LCD_VD8 | - | - | - | - | - | - | P7_5 | GREEN0 |
| LCD_VD7 | P8_4 | RED3 | P8_4 | RED4 | P8_4 | RED4 | P8_4 | RED7 |
| LCD_VD6 | P8_5 | RED2 | P8_5 | RED3 | P8_5 | RED3 | P8_5 | RED6 |
| LCD_VD5 | P8_6 | RED1 | P8_6 | RED2 | P8_6 | RED2 | P8_6 | RED5 |
| LCD_VD4 | P8_7 | RED0 | P8_7 | RED1 | P8_7 | RED1 | P8_7 | RED4 |
| LCD_VD3 | - | - | P4_2 | RED0 | P4_2 | RED0 | P4_2 | RED3 |
| LCD_VD2 | - | - | - | - | P4_3 | intensity | P4_3 | RED2 |
| LCD_VD1 | - | - | - | - | - | - | P4_4 | RED1 |

**Table 36. LCD panel connections for TFT panels**

| External pin | TFT 12 bit (4:4:4 mode) | | TFT 16 bit (5:6:5 mode) | | TFT 16 bit (1:5:5:5 mode) | | TFT 24 bit | |
|---|---|---|---|---|---|---|---|---|
| | LPC18xx pin used | LCD function | LPC18xx pin used | LCD function | LPC18xx pin used | LCD function | LPC18xx pin used | LCD function |
| LCD_VD0 | - | - | - | - | - | - | P4_1 | RED0 |
| LCD_LP | P7_6 | LCDLP | P7_6 | LCDLP | P7_6 | LCDLP | P7_6 | LCDLP |
| LCD_ENAB /LCDM | P4_6 | LCDENAB/ LCDM | P4_6 | LCDENAB/ LCDM | P4_6 | LCDENAB/ LCDM | P4_6 | LCDENAB/ LCDM |
| LCD_FP | P4_5 | LCDFP | P4_5 | LCDFP | P4_5 | LCDFP | P4_5 | LCDFP |
| LCD_DCLK | P4_7 | LCDDCLK | P4_7 | LCDDCLK | P4_7 | LCDDCLK | P4_7 | LCDDCLK |
| LCD_LE | P7_0 | LCDLE | P7_0 | LCDLE | P7_0 | LCDLE | P7_0 | LCDLE |
| LCD_PWR | P7_7 | LCDPWR | P7_7 | LCDPWR | P7_7 | LCDPWR | P7_7 | LCDPWR |
| GP_CLKIN | PF_4 | LCDCLKIN | PF_4 | LCDCLKIN | PF_4 | LCDCLKIN | PF_4 | LCDCLKIN |

## 13.2 Crystal oscillator

The crystal oscillator is controlled by the XTAL_OSC_CTRL register in the CGU (see *LPC18xx user manual*).

The crystal oscillator operates at frequencies of 1 MHz to 25 MHz. This frequency can be boosted to a higher frequency, up to the maximum CPU operating frequency, by the PLL. The oscillator can operate in one of two modes: slave mode and oscillation mode.

- In slave mode, couple the input clock signal with a capacitor of 100 pF ($C_C$ in Figure 42), with an amplitude of at least 200 mV (RMS). The XTAL2 pin in this configuration can be left unconnected.
- External components and models used in oscillation mode are shown in Figure 43, and in Table 37 and Table 38. Since the feedback resistance is integrated on chip, only a crystal and the capacitances $C_{X1}$ and $C_{X2}$ need to be connected externally in case of fundamental mode oscillation (L, $C_L$ and $R_S$ represent the fundamental frequency). Capacitance $C_P$ in Figure 43 represents the parallel package capacitance and must not be larger than 7 pF. Parameters $F_C$, $C_L$, $R_S$ and $C_P$ are supplied by the crystal manufacturer.

**Table 37. Recommended values for $C_{X1/X2}$ in oscillation mode (crystal and external components parameters) low frequency mode**

| Fundamental oscillation frequency | Maximum crystal series resistance $R_S$ | External load capacitors $C_{X1}$, $C_{X2}$ |
|---|---|---|
| 2 MHz | < 200 Ω | 33 pF, 33 pF |
| | < 200 Ω | 39 pF, 39 pF |
| | < 200 Ω | 56 pF, 56 pF |
| 4 MHz | < 200 Ω | 18 pF, 18 pF |
| | < 200 Ω | 39 pF, 39 pF |
| | < 200 Ω | 56 pF, 56 pF |
| 8 MHz | < 200 Ω | 18 pF, 18 pF |
| | < 200 Ω | 39 pF, 39 pF |

**Table 37. Recommended values for $C_{X1/X2}$ in oscillation mode (crystal and external components parameters) low frequency mode**

| Fundamental oscillation frequency | Maximum crystal series resistance $R_S$ | External load capacitors $C_{X1}$, $C_{X2}$ |
|---|---|---|
| 12 MHz | < 160 Ω | 18 pF, 18 pF |
| | < 160 Ω | 39 pF, 39 pF |
| 16 MHz | < 120 Ω | 18 pF, 18 pF |
| | < 80 Ω | 33 pF, 33 pF |
| 20 MHz | < 100 Ω | 18 pF, 18 pF |
| | < 80 Ω | 33 pF, 33 pF |

**Table 38. Recommended values for $C_{X1/X2}$ in oscillation mode (crystal and external components parameters) high frequency mode**

| Fundamental oscillation frequency | Maximum crystal series resistance $R_S$ | External load capacitors $C_{X1}$, $C_{x2}$ |
|---|---|---|
| 15 MHz | < 80 Ω | 18 pF, 18 pF |
| 20 MHz | < 80 Ω | 39 pF, 39 pF |
| | < 100 Ω | 47 pF, 47 pF |

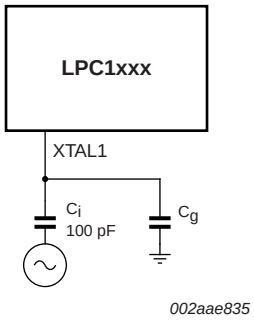



**Fig 42. Slave mode operation of the on-chip oscillator**

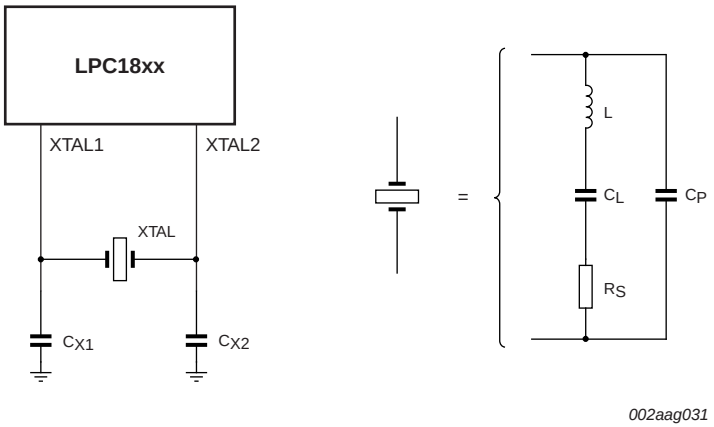



**Fig 43. Oscillator modes with external crystal model used for $C_{X1}$/$C_{X2}$ evaluation**

## 13.3 RTC oscillator

In the RTC oscillator circuit, only the crystal (XTAL) and the capacitances $C_{RTCX1}$ and $C_{RTCX2}$ need to be connected externally. Typical capacitance values for $C_{RTCX1}$ and $C_{RTCX2}$ are $C_{RTCX1/2}$ = 20 (typical) $\pm$ 4 pF.

An external clock can be connected to RTCX1 if RTCX2 is left open. The recommended amplitude of the clock signal is $V_{i(RMS)}$ = 100 mV to 200 mV with a coupling capacitance of 5 pF to 10 pF.

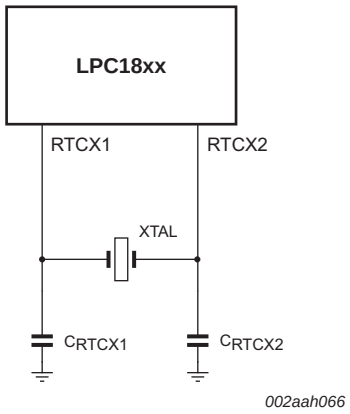



**Fig 44. RTC 32 kHz oscillator circuit**

## 13.4 XTAL and RTCX Printed Circuit Board (PCB) layout guidelines

Connect the crystal on the PCB as close as possible to the oscillator input and output pins of the chip. Take care that the load capacitors $C_{X1}$, $C_{X2}$, and $C_{X3}$ in case of third overtone crystal usage have a common ground plane. Also connect the external components to the ground plain. To keep the noise coupled in via the PCB as small as possible, make loops and parasitics as small as possible. Choose smaller values of $C_{X1}$ and $C_{X2}$ if parasitics increase in the PCB layout.

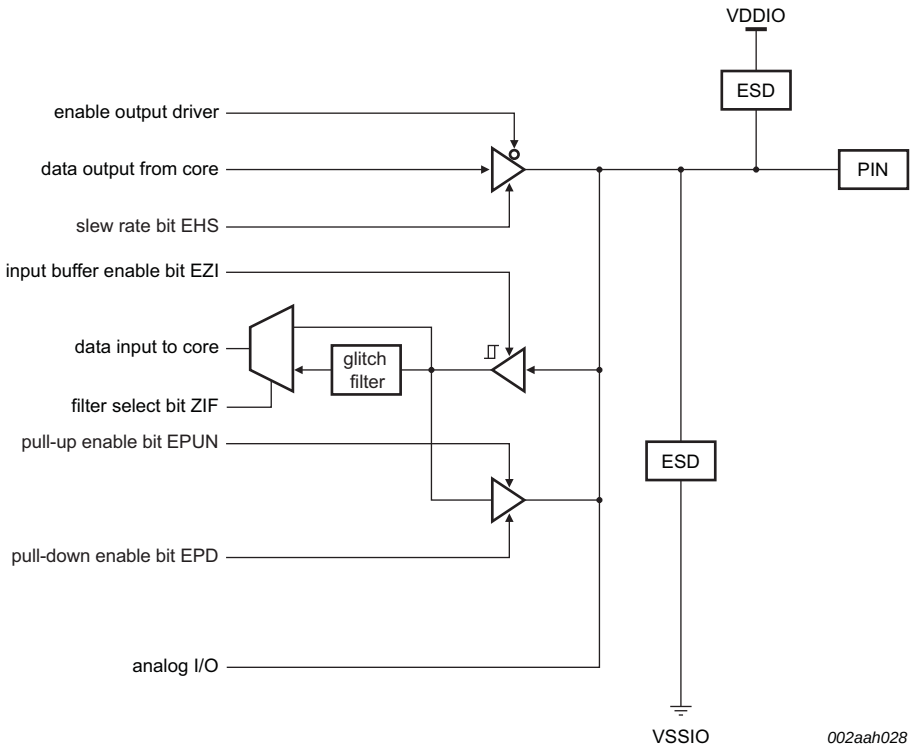
Ensure that no high-speed or high-drive signals are near the RTCX1/2 signals.

## 13.5 Standard I/O pin configuration

Figure 45 shows the possible pin modes for standard I/O pins with analog input function:

- Digital output driver enabled/disabled
- Digital input: Pull-up enabled/disabled
- Digital input: Pull-down enabled/disabled
- Digital input: Repeater mode enabled/disabled
- Digital input: Input buffer enabled/disabled
- Analog input

The default configuration for standard I/O pins is input buffer disabled and pull-up enabled. The weak MOS devices provide a drive capability equivalent to pull-up and pull-down resistors.




The glitch filter rejects pulses of typical 12 ns width.

**Fig 45. Standard I/O pin configuration with analog input**

## 13.6 Reset pin configuration

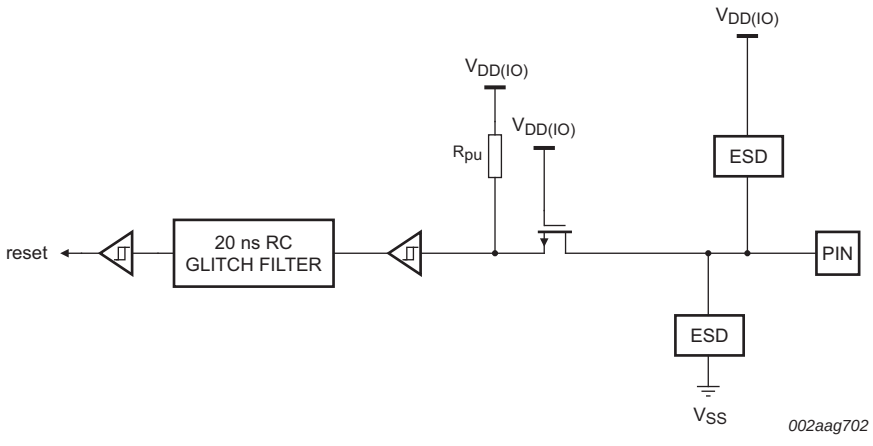
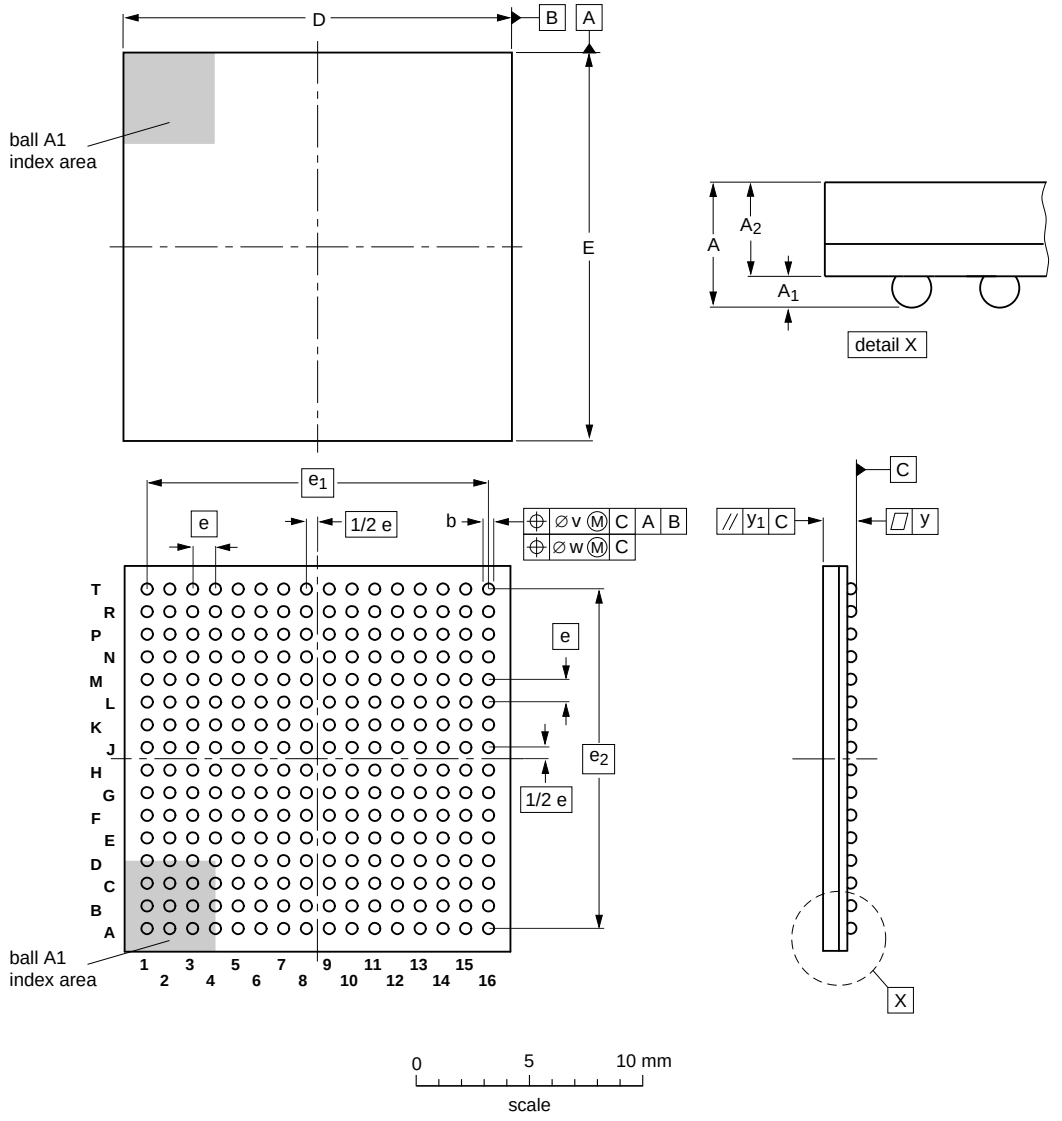



**Fig 46. Reset pin configuration**

# 14. Package outline

**LBGA256: plastic low profile ball grid array package; 256 balls; body 17 x 17 x 1 mm** **SOT740-2**



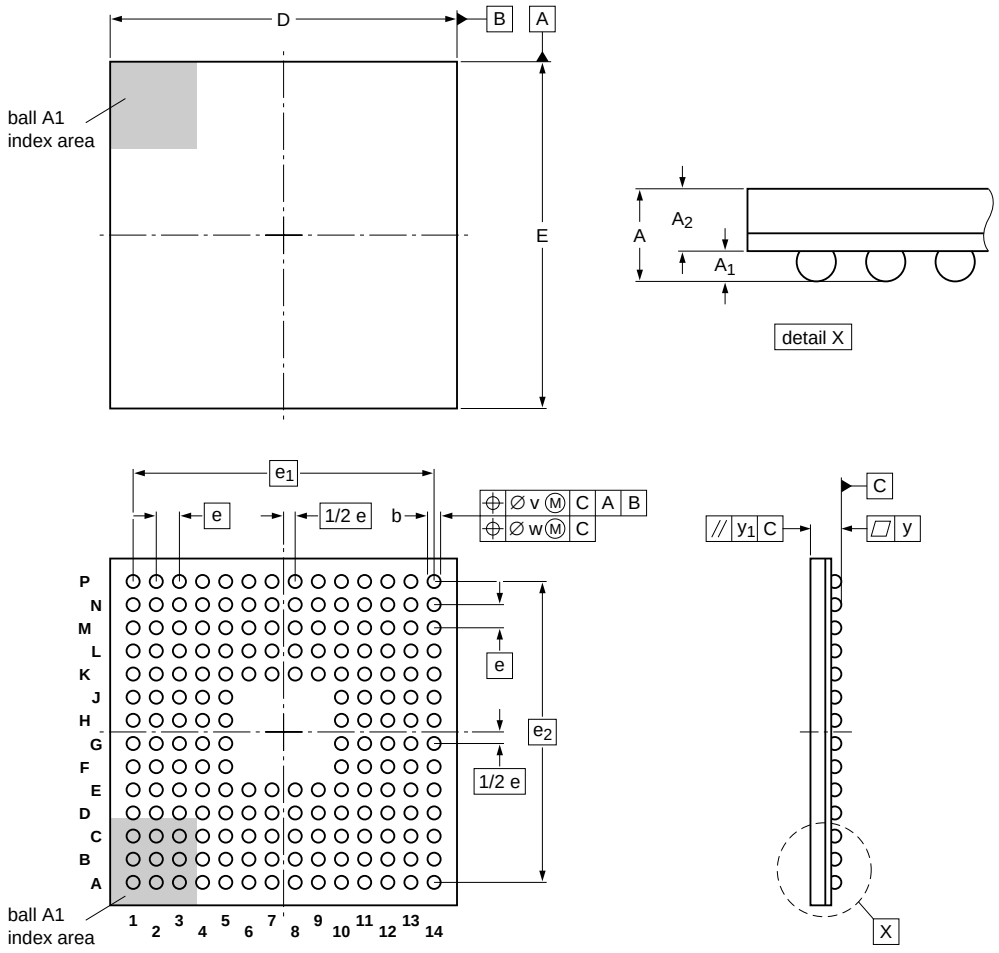

**DIMENSIONS (mm are the original dimensions)**

| UNIT | A max | $A_1$ | $A_2$ | b | D | E | e | $e_1$ | $e_2$ | v | w | y | $y_1$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.55 | 0.45<br>0.35 | 1.1<br>0.9 | 0.55<br>0.45 | 17.2<br>16.8 | 17.2<br>16.8 | 1 | 15 | 15 | 0.25 | 0.1 | 0.12 | 0.35 |

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT740-2 | - - - | MO-192 | - - - | | | ~~05-06-16~~<br>05-08-04 |

**Fig 47. Package outline of the LBGA256 package**

**TFBGA180: thin fine-pitch ball grid array package; 180 balls** **SOT570-3**



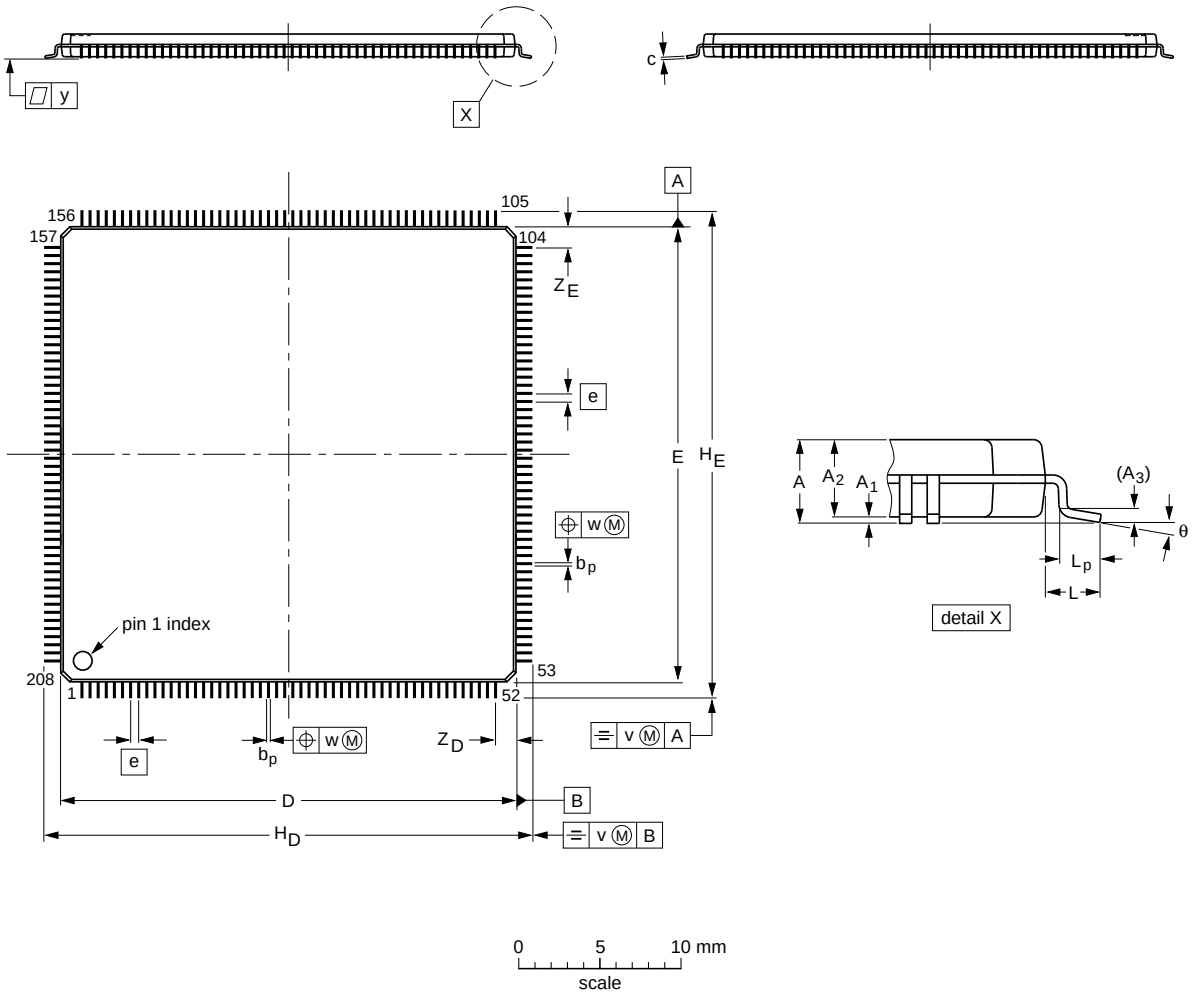

**DIMENSIONS (mm are the original dimensions)**

| UNIT | | A | $A_1$ | $A_2$ | b | D | E | e | $e_1$ | $e_2$ | v | w | y | $y_1$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | max | 1.20 | 0.40 | 0.80 | 0.50 | 12.1 | 12.1 | 0.8 | 10.4 | 10.4 | 0.15 | 0.05 | 0.12 | 0.1 |
| | nom | 1.06 | 0.35 | 0.71 | 0.45 | 12.0 | 12.0 | | | | | | | |
| | min | 0.95 | 0.30 | 0.65 | 0.40 | 11.9 | 11.9 | | | | | | | |

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT570-3 | | | | | | ~~08-07-09~~ 10-04-15 |

**Fig 48. Package outline of the TFBGA180 package**

**LQFP208; plastic low profile quad flat package; 208 leads; body 28 x 28 x 1.4 mm** **SOT459-1**




**DIMENSIONS (mm are the original dimensions)**

| UNIT | A max. | $A_1$ | $A_2$ | $A_3$ | $b_p$ | c | $D^{(1)}$ | $E^{(1)}$ | e | $H_D$ | $H_E$ | L | $L_p$ | v | w | y | $Z_D$ | $Z_E$ | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.6 | 0.15<br>0.05 | 1.45<br>1.35 | 0.25 | 0.27<br>0.17 | 0.20<br>0.09 | 28.1<br>27.9 | 28.1<br>27.9 | 0.5 | 30.15<br>29.85 | 30.15<br>29.85 | 1 | 0.75<br>0.45 | 0.12 | 0.08 | 0.08 | 1.43<br>1.08 | 1.43<br>1.08 | $7^o$<br>$0^o$ |

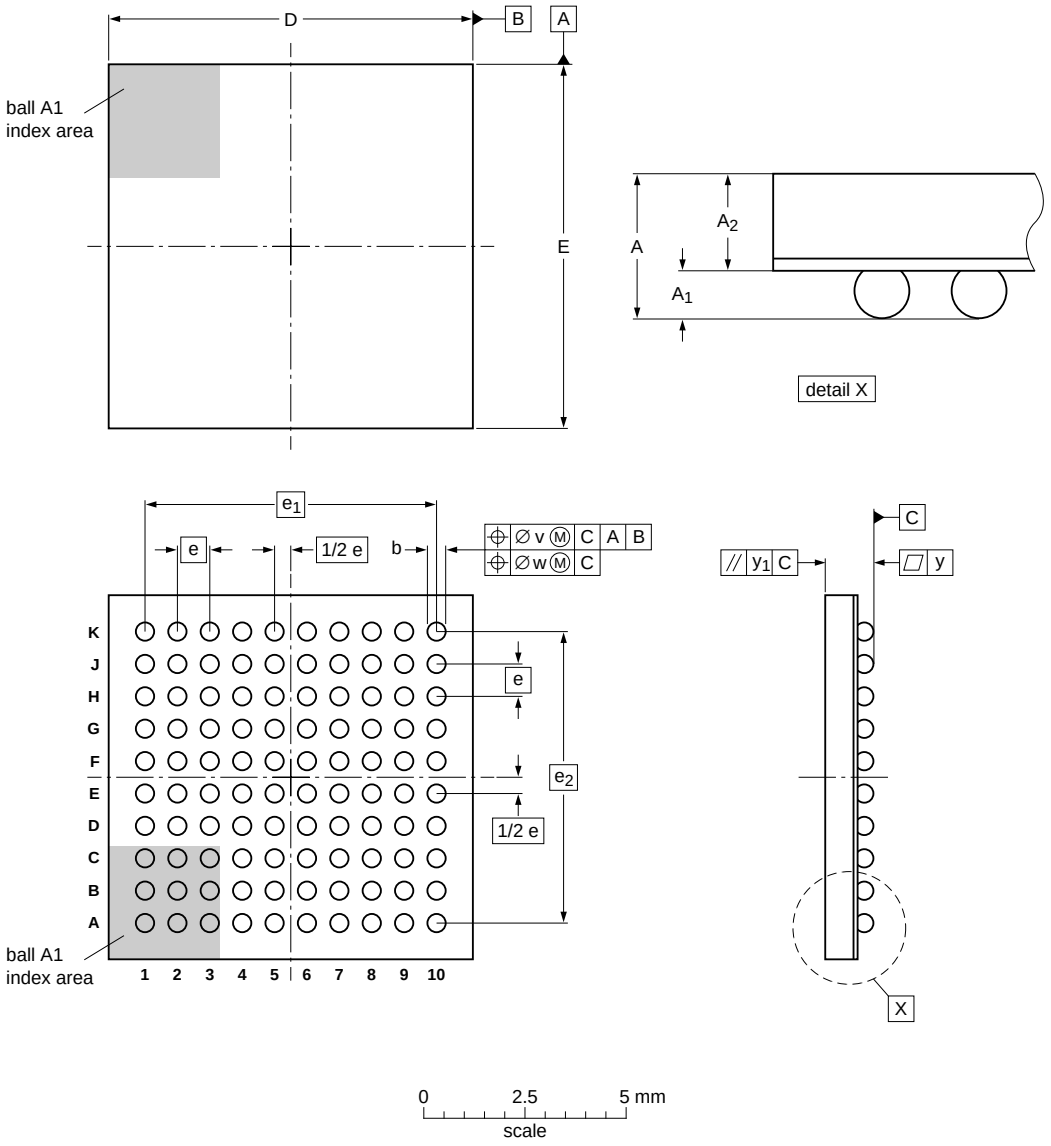
**Note**

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT459-1 | 136E30 | MS-026 | | | | ~~00-02-06~~<br>03-02-20 |

**Fig 49. Package outline of the LQFP208 package**

**TFBGA100: plastic thin fine-pitch ball grid array package; 100 balls; body 9 x 9 x 0.7 mm** **SOT926-1**



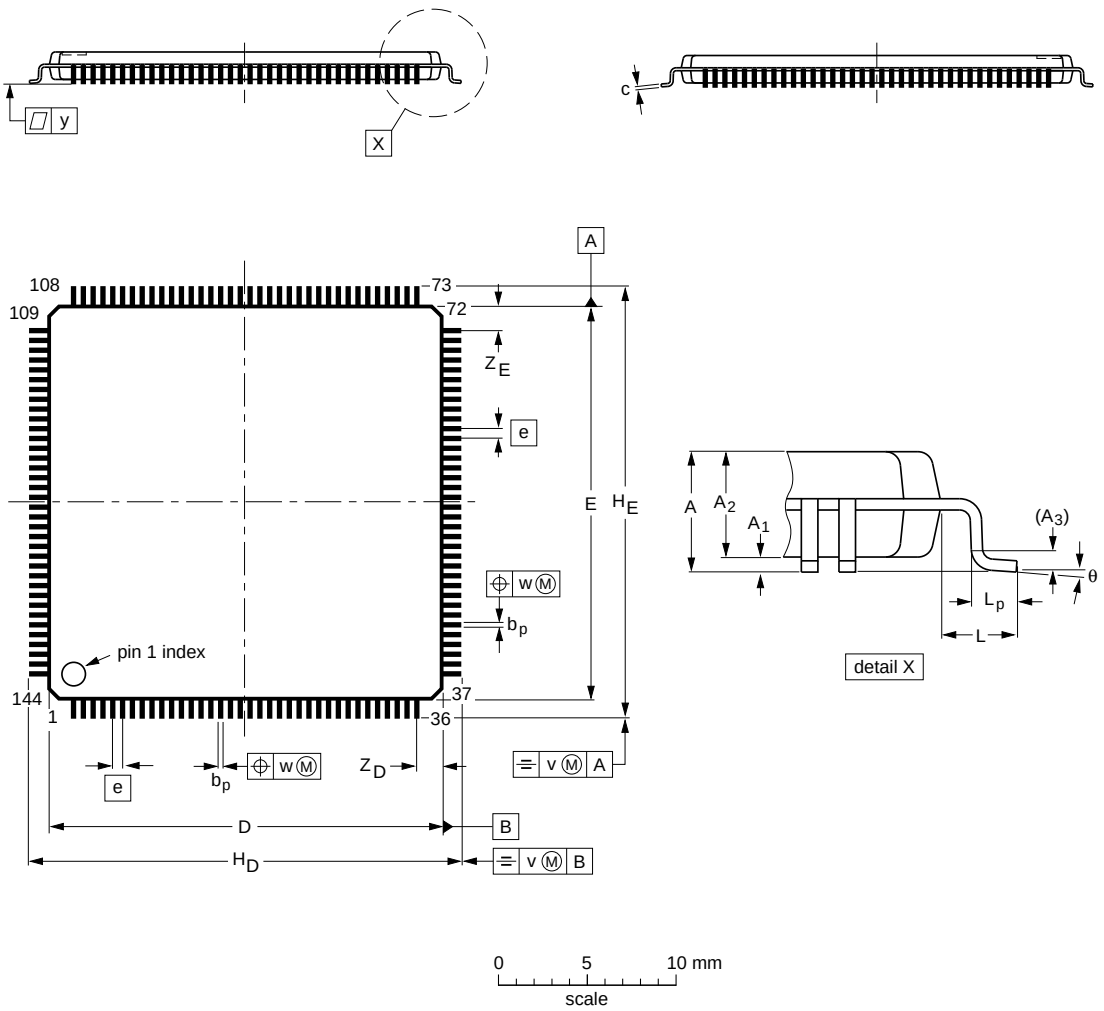

**DIMENSIONS (mm are the original dimensions)**

| UNIT | A max | $A_1$ | $A_2$ | b | D | E | e | $e_1$ | $e_2$ | v | w | y | $y_1$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.2 | 0.4<br>0.3 | 0.8<br>0.65 | 0.5<br>0.4 | 9.1<br>8.9 | 9.1<br>8.9 | 0.8 | 7.2 | 7.2 | 0.15 | 0.05 | 0.08 | 0.1 |

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT926-1 | - - - | - - - | - - - | | | ~~05-12-09~~<br>05-12-22 |

**Fig 50. Package outline of the TFBGA100 package**

**LQFP144: plastic low profile quad flat package; 144 leads; body 20 x 20 x 1.4 mm** **SOT486-1**




**DIMENSIONS (mm are the original dimensions)**

| UNIT | A max. | $A_1$ | $A_2$ | $A_3$ | $b_p$ | c | $D^{(1)}$ | $E^{(1)}$ | e | $H_D$ | $H_E$ | L | $L_p$ | v | w | y | $Z_D^{(1)}$ | $Z_E^{(1)}$ | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.6 | 0.15<br>0.05 | 1.45<br>1.35 | 0.25 | 0.27<br>0.17 | 0.20<br>0.09 | 20.1<br>19.9 | 20.1<br>19.9 | 0.5 | 22.15<br>21.85 | 22.15<br>21.85 | 1 | 0.75<br>0.45 | 0.2 | 0.08 | 0.08 | 1.4<br>1.1 | 1.4<br>1.1 | $7^o$<br>$0^o$ |

**Note**

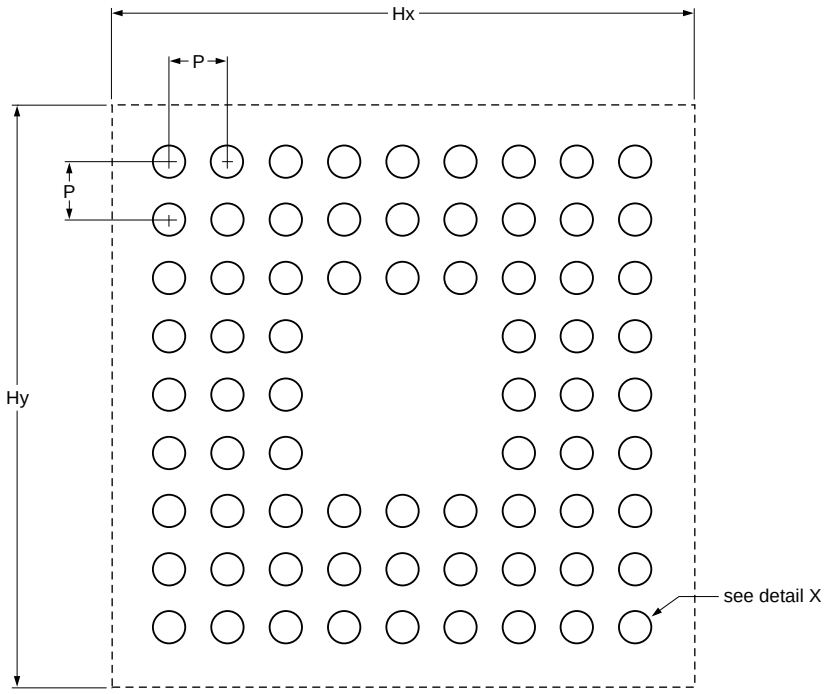
1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT486-1 | 136E23 | MS-026 | | | | ~~00-03-14~~<br>03-02-20 |

**Fig 51. Package outline for the LQFP144 package**

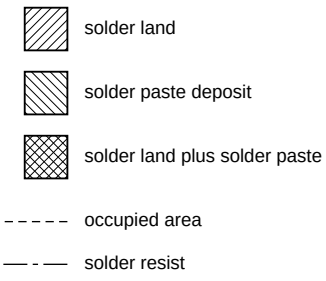
# 15. Soldering

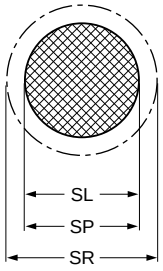
**Footprint information for reflow soldering of LBGA256 package** **SOT740-2**




Generic footprint pattern

Refer to the package outline drawing for actual layout




detail X

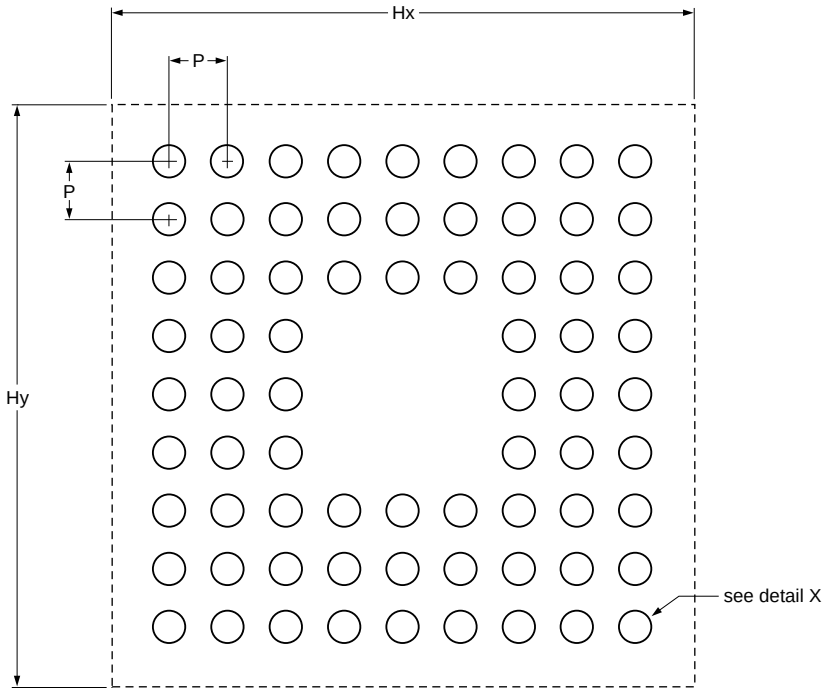
DIMENSIONS in mm

| P | SL | SP | SR | Hx | Hy |
|---|---|---|---|---|---|
| 1.00 | 0.450 | 0.450 | 0.600 | 17.500 | 17.500 |

*sot740-2_fr*

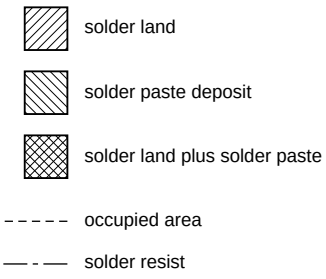
**Fig 52. Reflow soldering of the LBGA256 package**

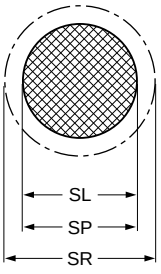
**Footprint information for reflow soldering of TFBGA180 package** **SOT570-3**




Generic footprint pattern

Refer to the package outline drawing for actual layout




detail X

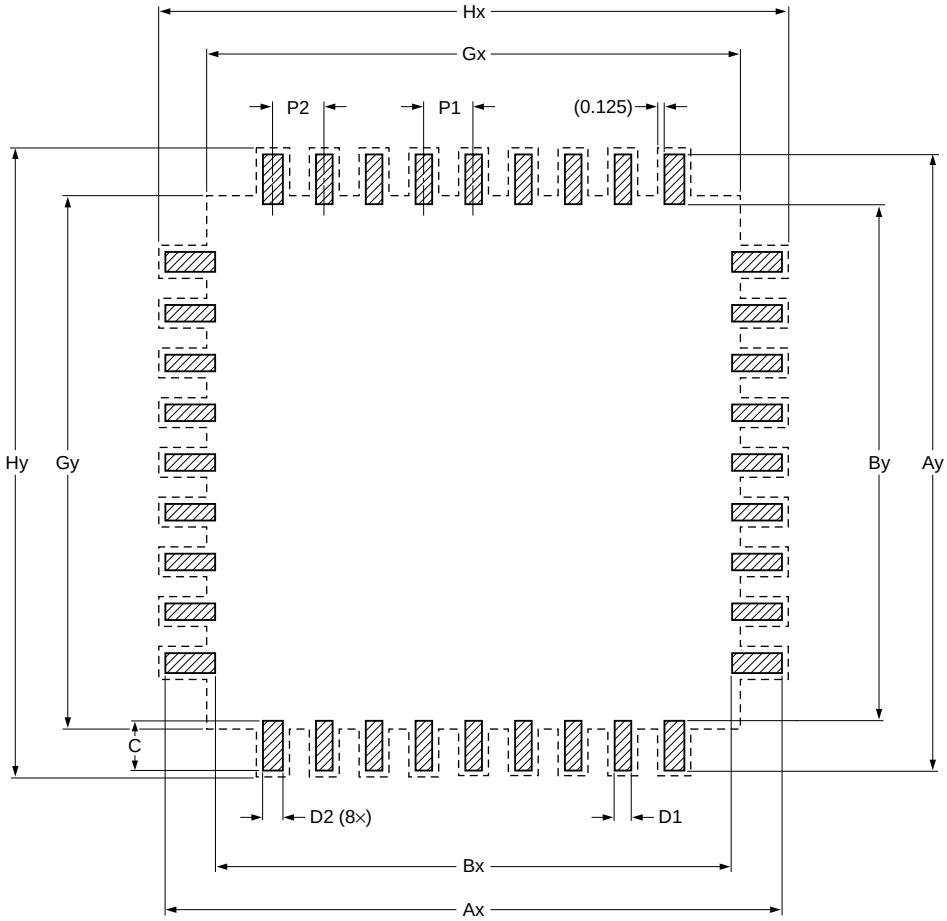
DIMENSIONS in mm

| P | SL | SP | SR | Hx | Hy |
|---|---|---|---|---|---|
| 0.80 | 0.400 | 0.400 | 0.550 | 12.575 | 12.575 |

*sot570-3_fr*

**Fig 53. Reflow soldering of the TFBGA180 package**

**Footprint information for reflow soldering of LQFP208 package** **SOT459-1**




Generic footprint pattern

Refer to the package outline drawing for actual layout

solder land

occupied area

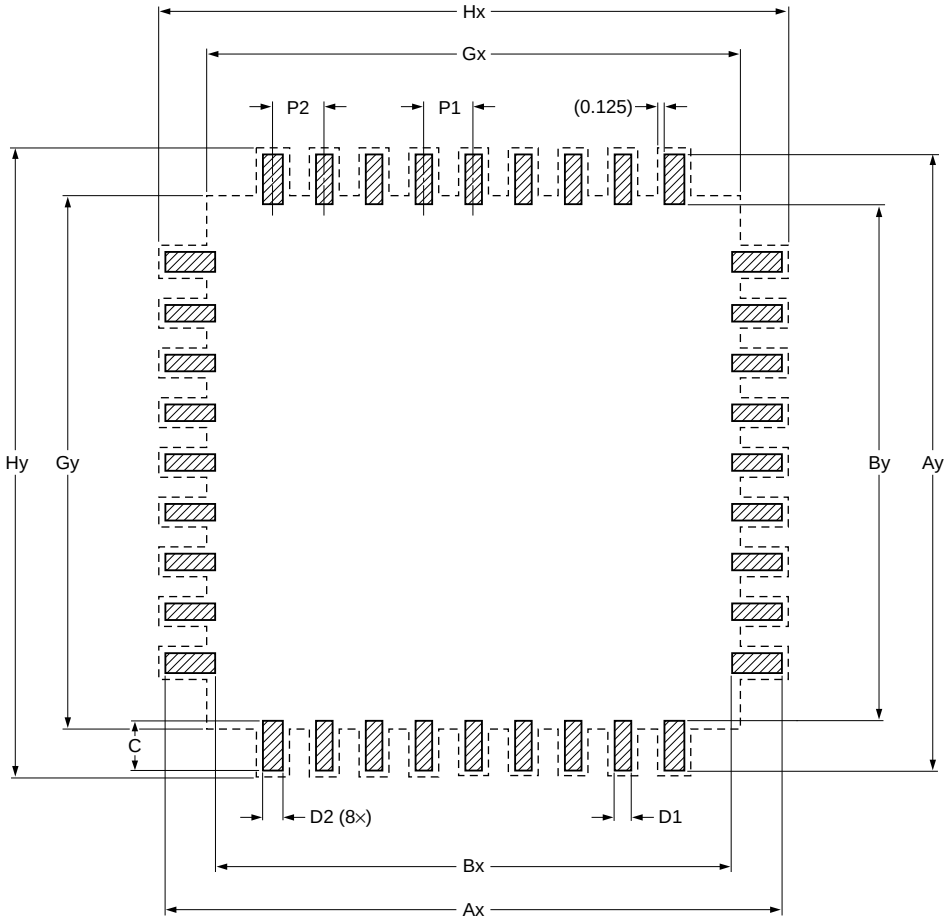
DIMENSIONS in mm

| P1 | P2 | Ax | Ay | Bx | By | C | D1 | D2 | Gx | Gy | Hx | Hy |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.500 | 0.560 | 31.300 | 31.300 | 28.300 | 28.300 | 1.500 | 0.280 | 0.400 | 28.500 | 28.500 | 31.550 | 31.550 |

*sot459-1_fr*

**Fig 54. Reflow soldering of the LQFP208 package**

**Footprint information for reflow soldering of LQFP144 package** **SOT486-1**




Generic footprint pattern

Refer to the package outline drawing for actual layout

solder land

occupied area

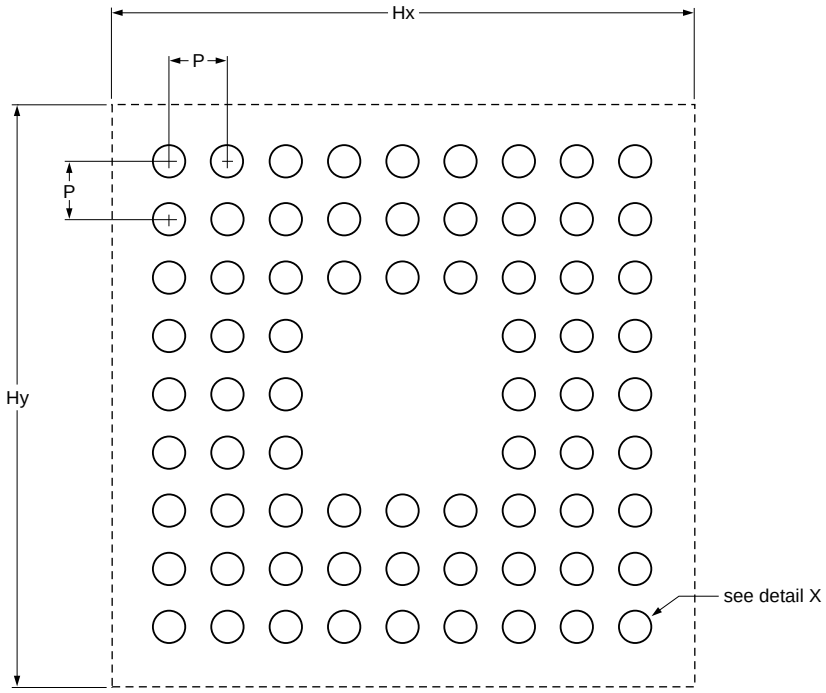
DIMENSIONS in mm

| P1 | P2 | Ax | Ay | Bx | By | C | D1 | D2 | Gx | Gy | Hx | Hy |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.500 | 0.560 | 23.300 | 23.300 | 20.300 | 20.300 | 1.500 | 0.280 | 0.400 | 20.500 | 20.500 | 23.550 | 23.550 |

*sot486-1_fr*

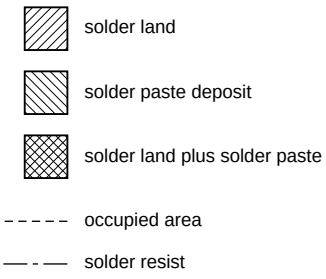
**Fig 55. Reflow soldering of the LQFP144 package**

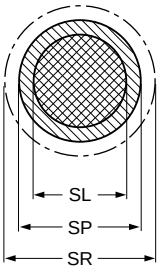
**Footprint information for reflow soldering of TFBGA100 package** **SOT926-1**




Generic footprint pattern

Refer to the package outline drawing for actual layout




detail X

DIMENSIONS in mm

| P | SL | SP | SR | Hx | Hy |
|---|---|---|---|---|---|
| 0.80 | 0.330 | 0.400 | 0.480 | 9.400 | 9.400 |

*sot926-1_fr*

**Fig 56. Reflow soldering of the TFBGA100 package**

# 16. Abbreviations

Table 39. Abbreviations

| Acronym | Description |
|---|---|
| ADC | Analog-to-Digital Converter |
| AHB | Advanced High-performance Bus |
| APB | Advanced Peripheral Bus |
| API | Application Programming Interface |
| BOD | BrownOut Detection |
| BGA | Ball Grid Array |
| CAN | Controller Area Network |
| CMAC | Cipher-based Message Authentication Code |
| CSMA/CD | Carrier Sense Multiple Access with Collision Detection |
| DAC | Digital-to-Analog Converter |
| DMA | Direct Memory Access |
| EOP | End Of Packet |
| ETB | Embedded Trace Buffer |
| ETM | Embedded Trace Macrocell |
| GPIO | General-Purpose Input/Output |
| IRC | Internal RC |
| IrDA | Infrared Data Association |
| JTAG | Joint Test Action Group |
| LCD | Liquid Crystal Display |
| LSB | Least Significant Bit |
| LQFP | Low Quad Flat Package |
| MAC | Media Access Control |
| MCU | MicroController Unit |
| MIIM | Media Independent Interface Management |
| n.c. | not connected |
| OTG | On-The-Go |
| PHY | PHYsical layer |
| PLL | Phase-Locked Loop |
| PWM | Pulse Width Modulator |
| RMII | Reduced Media Independent Interface |
| SDRAM | Synchronous Dynamic Random Access Memory |
| SPI | Serial Peripheral Interface |
| SSI | Serial Synchronous Interface |
| SSP | Synchronous Serial Port |
| TCP/IP | Transmission Control Protocol/Internet Protocol |
| TTL | Transistor-Transistor Logic |
| UART | Universal Asynchronous Receiver/Transmitter |
| ULPI | UTMI+ Low Pin Interface |

**Table 39. Abbreviations** *...continued*

| Acronym | Description |
|---|---|
| USART | Universal Synchronous Asynchronous Receiver/Transmitter |
| USB | Universal Serial Bus |
| UTMI | USB 2.0 Transceiver Macrocell Interface |

## 17. References

[1] ES_LPC18X0_A (LPC1850, LPC1830, LPC1820, LPC1810 Rev A errata).

# 18. Revision history

**Table 40. Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| LPC1850_30_20_10 v.6.1 | 20130207 | Product data sheet | - | LPC1850_30_20_10 v.6 |
| | • Table 13 “Band gap characteristics” and Figure 20 “Band gap voltage for different temperatures and process conditions” added.<br>• Table 10, added Table note 2: “Dynamic characteristics for peripherals are provided for $V_{DD(REG)(3V3)} \geq 2.7$ V.<br>• Description of ADC pins on digital/analog input pins changed. Each input to the ADC is connected to ADC0 and ADC1. See Table 3.<br>• Use of C_CAN peripheral restricted in Section 2.<br>• ADC channels limited to a total of 8 channels shared between ADC0 and ADC1.<br>• Minimum value for parameter $V_{IL}$ changed to 0 V in Table 10 “Static characteristics”.<br>• Power consumption in active mode corrected. See parameter $I_{DD(REG)(3V3)}$ in Table 10 and graphs Figure 11, Figure 12, and Figure 13.<br>• Parameter name $I_{DD(ADC)}$ changed to $I_{DDA}$ in Table 10.<br>• Added note to limit data in Table 23 “Dynamic characteristics: Static asynchronous external memory interface” to single memory accesses.<br>• Value of parameter $I_{DD(REG)(3V3)}$ in deep power-down increased to 0.03 µA in Table 10.<br>• Value of parameter $I_{DD(IO)}$ in deep power-down increased to 0.05 µA in Table 10. | | | |
| LPC1850_30_20_10 v.6 | 20121011 | Product data sheet | - | LPC1850_30_20_10 v.5.2 |
| | • Temperature range for simulated timing characteristics corrected to $T_{amb}$ = −40 °C to +85 °C in Section 11 “Dynamic characteristics”.<br>• SPIFI timing added. See Section 11.15.<br>• SPIFI maximum data rate changed to 52 MB per second.<br>• Editorial updates.<br>• Figure 24 and Figure 25 updated for full temperature range.<br>• The following changes were made to the TFBGA180 pinout in Table 3:<br>– P1_13 moved from ball D6 to L8.<br>– P7_5 moved from ball C7 to A7.<br>– PF_4 moved from ball L8 to D6.<br>– $\overline{\text{RESET}}$ moved from ball B7 to C7.<br>– RTCX2 moved from ball A7 to B7.<br>– Ball G10 changed from VSS to VDDIO.<br>• Data sheet status changed to Product data sheet. | | | |
| LPC1850_30_20_10 v.5.2 | 20120904 | Preliminary data sheet | - | LPC1850_30_20_10 v.5.1 |
| | • SSP0 boot pin functions corrected in Table 5 and Table 4. Pin P3_3 = SSP0_SCK, pin P3_6 = SSP0_SSEL, pin P3_7 = SSP0_MISO, pin P3_8 = SSP0_MOSI.<br>• Minimum value of all supply voltages changed to −0.5 V in Table 6 “Limiting values”. | | | |
| LPC1850_30_20_10 v.5.1 | 20120809 | Preliminary data sheet | - | LPC1850_30_20_10 v.5 |

**Table 40. Revision history** *...continued*

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| Modifications: | • Dynamic characteristics of the SD/MMC controller updated in Table 28.<br>• Dynamic characteristics of the LCD controller updated in Table 29.<br>• Dynamic characteristics of the SSP controller updated in Table 21.<br>• Minimum value of $V_I$ for conditions “USB0 pins USB0_DP; USB0_DM; USB0_VBUS”,“USB0 pins USB0_ID; USB0_RREF”, and “USB1 pins USB1_DP and USB1_DM” changed to −0.3 V in Table 6.<br>• Parameters $I_{IL}$ and $I_{IH}$ renamed to $I_{LL}$ and $I_{LH}$ in Table 10.<br>• AES removed. AES is available on parts LPC18Sxx only.<br>• Pin configuration diagrams corrected for LQFP packages (Figure 5 and Figure 6). | | | |
| LPC1850_30_20_10 v.5 | 20120611 | Preliminary data sheet | - | LPC1850_30_20_10 v.4 |
| LPC1850_30_20_10 v.4 | 20120516 | Preliminary data sheet | - | LPC1850_30_20_10 v.3.1 |
| LPC1850_30_20_10 v.3.1 | 20111215 | Preliminary data sheet | - | LPC1850_30_20_10 v.3 |
| LPC1850_30_20_10 v.3 | 20111206 | Preliminary data sheet | - | LPC1850_30_20_10 v.2.2 |
| LPC1850_30_20_10 v.2.2 | 20110909 | Preliminary data sheet | - | LPC1850_30_20_10 v.2.1 |
| LPC1850_30_20_10 v.2.1 | 20110822 | Preliminary data sheet | - | LPC1850_30_20_10 v.2 |
| LPC1850_30_20_10 v.2 | 20110713 | Objective data sheet | - | LPC1850_30_20_10 v.1.2 |
| LPC1850_30_20_10 v.1.2 | 20110217 | Objective data sheet | - | LPC1850_30_20_10 v.1 |
| LPC1850_30_20_10 v.1 | 20110103 | Objective data sheet | - | - |

# 19. Legal information

## 19.1 Data sheet status

| Document status[1][2] | Product status[3] | Definition |
|---|---|---|
| Objective [short] data sheet | Development | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet | Qualification | This document contains data from the preliminary specification. |
| Product [short] data sheet | Production | This document contains the product specification. |

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nxp.com.

## 19.2 Definitions

**Draft —** The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information.

**Short data sheet —** A short data sheet is an extract from a full data sheet with the same product type number(s) and title. A short data sheet is intended for quick reference only and should not be relied upon to contain detailed and full information. For detailed and full information see the relevant full data sheet, which is available on request via the local NXP Semiconductors sales office. In case of any inconsistency or conflict with the short data sheet, the full data sheet shall prevail.

**Product specification —** The information and data provided in a Product data sheet shall define the specification of the product as agreed between NXP Semiconductors and its customer, unless NXP Semiconductors and customer have explicitly agreed otherwise in writing. In no event however, shall an agreement be valid in which the NXP Semiconductors product is deemed to offer functions and qualities beyond those described in the Product data sheet.

## 19.3 Disclaimers

**Limited warranty and liability —** Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. NXP Semiconductors takes no responsibility for the content in this document if provided by an information source outside of NXP Semiconductors.

In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the *Terms and conditions of commercial sale* of NXP Semiconductors.

**Right to make changes —** NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

**Suitability for use —** NXP Semiconductors products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an NXP Semiconductors product can reasonably be expected to result in personal injury, death or severe property or environmental damage. NXP Semiconductors and its suppliers accept no liability for inclusion and/or use of NXP Semiconductors products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

**Applications —** Applications that are described herein for any of these products are for illustrative purposes only. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

**Limiting values —** Stress above one or more limiting values (as defined in the Absolute Maximum Ratings System of IEC 60134) will cause permanent damage to the device. Limiting values are stress ratings only and (proper) operation of the device at these or any other conditions above those given in the Recommended operating conditions section (if present) or the Characteristics sections of this document is not warranted. Constant or repeated exposure to limiting values will permanently and irreversibly affect the quality and reliability of the device.

**Terms and conditions of commercial sale —** NXP Semiconductors products are sold subject to the general terms and conditions of commercial sale, as published at http://www.nxp.com/profile/terms, unless otherwise agreed in a valid written individual agreement. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. NXP Semiconductors hereby expressly objects to applying the customer's general terms and conditions with regard to the purchase of NXP Semiconductors products by customer.

**No offer to sell or license —** Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights.

**Export control —** This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

**Non-automotive qualified products —** Unless this data sheet expressly states that this specific NXP Semiconductors product is automotive qualified, the product is not suitable for automotive use. It is neither qualified nor tested in accordance with automotive testing or application requirements. NXP Semiconductors accepts no liability for inclusion and/or use of non-automotive qualified products in automotive equipment or applications.

In the event that customer uses the product for design-in and use in automotive applications to automotive specifications and standards, customer (a) shall use the product without NXP Semiconductors' warranty of the product for such automotive applications, use and specifications, and (b) whenever customer uses the product for automotive applications beyond NXP Semiconductors' specifications such use shall be solely at customer's own risk, and (c) customer fully indemnifies NXP Semiconductors for any liability, damages or failed product claims resulting from customer design and use of the product for automotive applications beyond NXP Semiconductors' standard warranty and NXP Semiconductors' product specifications.

### 19.4 Trademarks

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.

**I²C-bus** — logo is a trademark of NXP B.V.

## 20. Contact information

For more information, please visit: **http://www.nxp.com**

For sales office addresses, please send an email to: **salesaddresses@nxp.com**

# 21. Contents



continued >>

For more information, please visit: http://www.nxp.com
For sales office addresses, please send an email to: salesaddresses@nxp.com

**Date of release: 7 February 2013**
**Document identifier: LPC1850_30_20_10**