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What is "Embedded - Microcontrollers"?

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

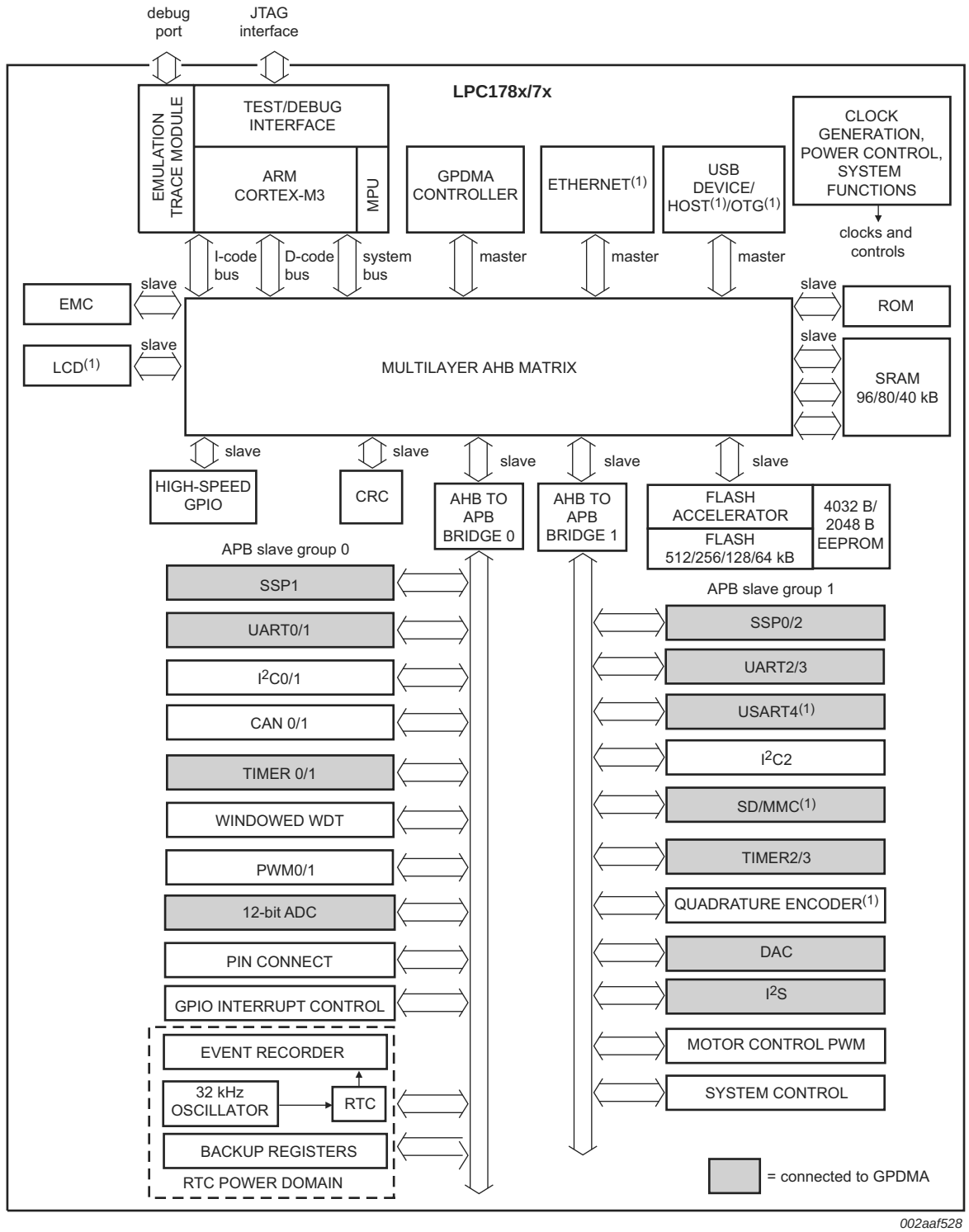
Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	ARM® Cortex®-M3
Core Size	32-Bit Single-Core
Speed	120MHz
Connectivity	CANbus, EBI/EMI, I²C, Microwire, Memory Card, SPI, SSI, SSP, UART/USART, USB OTG
Peripherals	Brown-out Detect/Reset, DMA, I²S, LCD, Motor Control PWM, POR, PWM, WDT
Number of I/O	165
Program Memory Size	256KB (256K x 8)
Program Memory Type	FLASH
EEPROM Size	4K x 8
RAM Size	80K x 8
Voltage - Supply (Vcc/Vdd)	2.4V ~ 3.6V
Data Converters	A/D 8x12b; D/A 1x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	208-LQFP
Supplier Device Package	208-LQFP (28x28)
Purchase URL	https://www.e-xfl.com/product-detail/nxp-semiconductors/lpc1785fbd208k

- Three enhanced I^2C-bus interfaces, one with a true open-drain output supporting the full I^2C-bus specification and Fast-mode Plus with data rates of 1 Mbit/s, two with standard port pins. Enhancements include multiple address recognition and monitor mode.
- I^2S-bus (Inter-IC Sound) interface for digital audio input or output. It can be used with the GPDMA.
- CAN controller with two channels.

- Digital peripherals:
  - SD/MMC memory card interface.
  - Up to 165 General Purpose I/O (GPIO) pins depending on the packaging with configurable pull-up/down resistors, open-drain mode, and repeater mode. All GPIOs are located on an AHB bus for fast access and support Cortex-M3 bit-banding. GPIOs can be accessed by the General Purpose DMA Controller. Any pin of ports 0 and 2 can be used to generate an interrupt.
  - Two external interrupt inputs configurable as edge/level sensitive. All pins on port 0 and port 2 can be used as edge sensitive interrupt sources.
  - Four general purpose timers/counters with a total of eight capture inputs and ten compare outputs. Each timer block has an external count input. Specific timer events can be selected to generate DMA requests.
  - Quadrature encoder interface that can monitor one external quadrature encoder.
  - Two standard PWM/timer blocks with external count input option.
  - One motor control PWM with support for three-phase motor control.
  - Real-Time Clock (RTC) with a separate power domain. The RTC is clocked by a dedicated RTC oscillator. The RTC block includes 20 bytes of battery-powered backup registers, allowing system status to be stored when the rest of the chip is powered off. Battery power can be supplied from a standard 3 V lithium button cell. The RTC will continue working when the battery voltage drops to as low as 2.1 V. An RTC interrupt can wake up the CPU from any reduced power mode.
  - Event Recorder that can capture the clock value when an event occurs on any of three inputs. The event identification and the time it occurred are stored in registers. The Event Recorder is located in the RTC power domain and can therefore operate as long as there is RTC power.
  - Windowed Watchdog Timer (WWDT). Windowed operation, dedicated internal oscillator, watchdog warning interrupt, and safety features.
  - CRC Engine block can calculate a CRC on supplied data using one of three standard polynomials. The CRC engine can be used in conjunction with the DMA controller to generate a CRC without CPU involvement in the data transfer.
- Analog peripherals:
  - 12-bit Analog-to-Digital Converter (ADC) with input multiplexing among eight pins, conversion rates up to 400 kHz, and multiple result registers. The 12-bit ADC can be used with the GPDMA controller.
  - 10-bit Digital-to-Analog Converter (DAC) with dedicated conversion timer and GPDMA support.
- Power control:
  - Four reduced power modes: Sleep, Deep-sleep, Power-down, and Deep power-down.

5. Block diagram



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

Fig 1. Block diagram

Table 3. Pin description *…continued*

Not all functions are available on all parts. See Table 2 (Ethernet, USB, LCD, QEI, SD/MMC, DAC pins) and Table 7 (EMC pins).

Symbol	Pin LQFP208	Ball TFBGA208	Ball TFBGA180	Pin LQFP144		Reset state[1]	Type[2]	Description
P2[23]	64	U5	-	-	[3]	I; PU	I/O	**P2[23] —** General purpose digital input/output pin.
							O	**EMC_DYCS3 —** SDRAM chip select 3.
							I/O	**SSP0_SSEL —** Slave Select for SSP0.
							I	**T3_CAP1 —** Capture input for Timer 3, channel 1.
P2[24]	53	P5	P1	-	[3]	I; PU	I/O	**P2[24] —** General purpose digital input/output pin.
							O	**EMC_CKE0 —** SDRAM clock enable 0.
P2[25]	54	R4	P2	-	[3]	I; PU	I/O	**P2[25] —** General purpose digital input/output pin.
							O	**EMC_CKE1 —** SDRAM clock enable 1.
P2[26]	57	T4	-	-	[3]	I; PU	I/O	**P2[26] —** General purpose digital input/output pin.
							O	**EMC_CKE2 —** SDRAM clock enable 2.
							I/O	**SSP0_MISO —** Master In Slave Out for SSP0.
							O	**T3_MAT0 —** Match output for Timer 3, channel 0.
P2[27]	47	P3	-	-	[3]	I; PU	I/O	**P2[27] —** General purpose digital input/output pin.
							O	**EMC_CKE3 —** SDRAM clock enable 3.
							I/O	**SSP0_MOSI —** Master Out Slave In for SSP0.
							O	**T3_MAT1 —** Match output for Timer 3, channel 1.
P2[28]	49	P4	M2	-	[3]	I; PU	I/O	**P2[28] —** General purpose digital input/output pin.
							O	**EMC_DQM0 —** Data mask 0 used with SDRAM and static devices.
P2[29]	43	N3	L1	-	[3]	I; PU	I/O	**P2[29] —** General purpose digital input/output pin.
							O	**EMC_DQM1 —** Data mask 1 used with SDRAM and static devices.
P2[30]	31	L4	-	-	[3]	I; PU	I/O	**P2[30] —** General purpose digital input/output pin.
							O	**EMC_DQM2 —** Data mask 2 used with SDRAM and static devices.
							I/O	**I2C2_SDA —** I^2C2 data input/output (this pin does not use a specialized I2C pad).
							O	**T3_MAT2 —** Match output for Timer 3, channel 2.
P2[31]	39	N2	-	-	[3]	I; PU	I/O	**P2[31] —** General purpose digital input/output pin.
							O	**EMC_DQM3 —** Data mask 3 used with SDRAM and static devices.
							I/O	**I2C2_SCL —** I^2C2 clock input/output (this pin does not use a specialized I2C pad).
							O	**T3_MAT3 —** Match output for Timer 3, channel 3.
P3[0] to P3[31]							I/O	**Port 3:** Port 3 is a 32-bit I/O port with individual direction controls for each bit. The operation of port 3 pins depends upon the pin function selected via the pin connect block.

Table 5. Pin allocation table TFBGA180

Not all functions are available on all parts. See Table 2 and Table 7 (EMC pins).

Ball	Symbol	Ball	Symbol	Ball	Symbol	Ball	Symbol
Row J							
1	$\overline{\text{RESET}}$	2	RTCX1	3	RTCX2	4	P0[12]
5	P0[13]	6	-	7	-	8	-
9	-	10	P0[19]	11	P4[8]	12	P0[17]
13	P0[18]	14	$V_{DD(3V3)}$		-		-
Row K							
1	VBAT	2	P1[31]	3	P1[30]	4	XTAL2
5	P0[29]	6	P1[20]	7	P3[26]	8	$V_{DD(3V3)}$
9	P4[3]	10	P4[6]	11	P0[21]	12	P4[7]
13	P4[26]	14	P0[20]		-		-
Row L							
1	P2[29]	2	XTAL1	3	P0[27]	4	$V_{DD(3V3)}$
5	P1[18]	6	P4[0]	7	P1[25]	8	V_{SSREG}
9	V_{SS}	10	P0[10]	11	$V_{DD(3V3)}$	12	P5[2]
13	V_{SS}	14	P0[22]		-		-
Row M							
1	P0[28]	2	P2[28]	3	P3[25]	4	P3[23]
5	P0[14]	6	P1[22]	7	P4[1]	8	P4[2]
9	P1[27]	10	P0[0]	11	P2[13]	12	P2[11]
13	P2[10]	14	P4[19]		-		-
Row N							
1	P0[31]	2	USB_D-2	3	P3[24]	4	P0[30]
5	P2[19]	6	P1[21]	7	P1[23]	8	P2[21]
9	$V_{DD(REG)(3V3)}$	10	P1[29]	11	P0[1]	12	P4[16]
13	P4[17]	14	P2[12]		-		-
Row P							
1	P2[24]	2	P2[25]	3	P2[18]	4	V_{SS}
5	P1[19]	6	P2[20]	7	P1[24]	8	P1[26]
9	P2[16]	10	P1[28]	11	P2[17]	12	P0[11]
13	P4[4]	14	P4[18]		-		-

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 are faster than the system bus and are used similarly to Tightly Coupled Memory (TCM) interfaces: one bus dedicated for instruction fetch (I-code) and one bus for data access (D-code). The use of two core buses allows for simultaneous operations if concurrent operations target different devices.

Table 7. External memory controller pin configuration

Part	Data bus pins	Address bus pins	Control pins	
			SRAM	SDRAM
LPC1788FBD208	EMC_D[31:0]	EMC_A[25:0]	EMC_BLS[3:0], EMC_CS[3:0], EMC_OE, EMC_WE	EMC_RAS, EMC_CAS, EMC_DYCS[3:0], EMC_CLK[1:0], EMC_CKE[3:0], EMC_DQM[3:0]
LPC1788FET208	EMC_D[31:0]	EMC_A[25:0]	EMC_BLS[3:0], EMC_CS[3:0], EMC_OE, EMC_WE	EMC_RAS, EMC_CAS, EMC_DYCS[3:0], EMC_CLK[1:0], EMC_CKE[3:0], EMC_DQM[3:0]
LPC1788FET180	EMC_D[15:0]	EMC_A[19:0]	EMC_BLS[1:0], EMC_CS[1:0], EMC_OE, EMC_WE	EMC_RAS, EMC_CAS, EMC_DYCS[1:0], EMC_CLK[1:0], EMC_CKE[1:0], EMC_DQM[1:0]
LPC1788FBD144	EMC_D[7:0]	EMC_A[15:0]	EMC_BLS[3:2], EMC_CS[1:0], EMC_OE, EMC_WE	not available
LPC1787FBD208	EMC_D[31:0]	EMC_A[25:0]	EMC_BLS[3:0], EMC_CS_[3:0], EMC_OE, EMC_WE	EMC_RAS, EMC_CAS, EMC_DYCS[3:0], EMC_CLK[1:0], EMC_CKE[3:0], EMC_DQM[3:0]
LPC1786FBD208	EMC_D[31:0]	EMC_A[25:0]	EMC_BLS[3:0], EMC_CS[3:0], EMC_OE, EMC_WE	EMC_RAS, EMC_CAS, EMC_DYCS[3:0], EMC_CLK[1:0], EMC_CKE[3:0], EMC_DQM[3:0]
LPC1785FBD208	EMC_D[31:0]	EMC_A[25:0]	EMC_BLS[3:0], EMC_CS[3:0], EMC_OE, EMC_WE	EMC_RAS, EMC_CAS, EMC_DYCS[3:0], EMC_CLK[1:0], EMC_CKE[3:0], EMC_DQM[3:0]
LPC1778FBD208	EMC_D[31:0]	EMC_A[25:0]	EMC_BLS[3:0], EMC_CS[3:0], EMC_OE, EMC_WE	EMC_RAS, EMC_CAS, EMC_DYCS[3:0], EMC_CLK[1:0], EMC_CKE[3:0], EMC_DQM[3:0]
LPC1778FET208	EMC_D[31:0]	EMC_A[25:0]	EMC_BLS[3:0], EMC_CS[3:0], EMC_OE, EMC_WE	EMC_RAS, EMC_CAS, EMC_DYCS[3:0], EMC_CLK[1:0], EMC_CKE[3:0], EMC_DQM[3:0]
LPC1778FET180	EMC_D[15:0]	EMC_A[19:0]	EMC_BLS[1:0], EMC_CS[1:0], EMC_OE, EMC_WE	EMC_RAS, EMC_CAS, EMC_DYCS[1:0], EMC_CLK[1:0], EMC_CKE[1:0], EMC_DQM[1:0]
LPC1778FBD144	EMC_D[7:0]	EMC_A[15:0]	EMC_CS[1:0], EMC_OE, EMC_WE	not available
LPC1777FBD208	EMC_D[31:0]	EMC_A[25:0]	EMC_BLS[3:0], EMC_CS[3:0], EMC_OE, EMC_WE	EMC_RAS, EMC_CAS, EMC_DYCS[3:0], EMC_CLK[1:0], EMC_CKE[3:0], EMC_DQM[3:0]
LPC1776FBD208	EMC_D[31:0]	EMC_A[25:0]	EMC_BLS[3:0], EMC_CS[3:0], EMC_OE, EMC_WE	EMC_RAS, EMC_CAS, EMC_DYCS[3:0], EMC_CLK[1:0], EMC_CKE[3:0], EMC_DQM[3:0]
LPC1776FET180	EMC_D[15:0]	EMC_A[19:0]	EMC_BLS[3:0], EMC_CS[3:0], EMC_OE, EMC_WE	EMC_RAS, EMC_CAS, EMC_DYCS[1:0], EMC_CLK[1:0], EMC_CKE[1:0], EMC_DQM[1:0]
LPC1774FBD208	EMC_D[31:0]	EMC_A[25:0]	EMC_BLS[3:0], EMC_CS[3:0], EMC_OE, EMC_WE	EMC_RAS, EMC_CAS, EMC_DYCS[3:0], EMC_CLK[1:0], EMC_CKE[3:0], EMC_DQM[3:0]
LPC1774FBD144	EMC_D[7:0]	EMC_A[15:0]	EMC_CS[1:0], EMC_OE, EMC_WE	not available

The LPC178x/7x EMC is an ARM PrimeCell MultiPort Memory Controller peripheral offering support for asynchronous static memory devices such as RAM, ROM, and flash. In addition, it can be used as an interface with off-chip memory-mapped devices and peripherals. The EMC is an Advanced Microcontroller Bus Architecture (AMBA) compliant peripheral.

See Table 6 for EMC memory access.

7.10.1 Features

- Dynamic memory interface support including single data rate SDRAM.
- Asynchronous static memory device support including RAM, ROM, and 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 16/20/26 address lines wide static memory support.
- 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_CKE and EMC_CLK outputs 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. That is typical 512 MB, 256 MB, and 128 MB parts, with 4, 8, 16, or 32 data bits per device.
- Separate reset domains allow the for auto-refresh through a chip reset if desired.

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

7.11 General purpose DMA controller

The GPDMA is an AMBA AHB compliant peripheral allowing selected peripherals to have DMA support.

The GPDMA enables peripheral-to-memory, memory-to-peripheral, peripheral-to-peripheral, and memory-to-memory transactions. The source and destination areas can each be either a memory region or a peripheral and can be accessed through the AHB master. The GPDMA controller allows data transfers between the various on-chip SRAM areas and supports the SD/MMC card interface, all SSPs, the I^2S, all UARTs, the A/D Converter, and the D/A Converter peripherals. DMA can also be triggered by selected timer match conditions. Memory-to-memory transfers and transfers to or from GPIO are supported.

during a given data transfer. The SSP supports full duplex transfers, with frames of 4 bits to 16 bits 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.

7.21.1 Features

- Maximum SSP speed of 33 Mbit/s (master) or 10 Mbit/s (slave).
- Compatible with Motorola SPI, 4-wire Texas Instruments SSI, and National Semiconductor Microwire buses.
- Synchronous serial communication.
- Master or slave operation.
- 8-frame FIFOs for both transmit and receive.
- 4-bit to 16-bit frame.
- DMA transfers supported by GPDMA.

7.22 I^2C-bus serial I/O controllers

The LPC178x/7x contain three I^2C-bus controllers.

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 (e.g., 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.

7.22.1 Features

- All I^2C-bus controllers can use standard GPIO pins with bit rates of up to 400 kbit/s (Fast I^2C-bus). The I^2C0-bus interface uses special open-drain pins with bit rates of up to 400 kbit/s.
- The I^2C-bus interface supports Fast-mode Plus with bit rates up to 1 Mbit/s for I2C0 using pins P5[2] and P5[3].
- 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 I^2C-bus can be used for test and diagnostic purposes.
- Both I^2C-bus controllers support multiple address recognition and a bus monitor mode.

7.34 System control

7.34.1 Reset

Reset has four sources on the LPC178x/7x: the $\overline{\text{RESET}}$ pin, the Watchdog reset, Power-On Reset (POR), and the BrownOut Detection (BOD) circuit. The $\overline{\text{RESET}}$ pin is a Schmitt trigger input pin. Assertion of chip Reset by any source, once the operating voltage attains a usable level, starts the Wake-up timer (see description in Section 7.33.3), causing reset to remain asserted until the external Reset is de-asserted, the oscillator is running, a fixed number of clocks have passed, and the flash controller has completed its initialization.

When the internal Reset is removed, the processor begins executing at address 0, which is initially the Reset vector mapped from the boot block. At that point, all of the processor and peripheral registers have been initialized to predetermined values.

7.34.2 Brownout detection

The LPC178x/7x include 2-stage monitoring of the voltage on the $V_{DD(REG)(3V3)}$ pins. If this voltage falls below 2.2 V (typical), the BOD asserts an interrupt signal to the Vectored Interrupt Controller. This signal can be enabled for interrupt in the Interrupt Enable Register in the NVIC in order to cause a CPU interrupt; if not, software can monitor the signal by reading a dedicated status register.

The second stage of low-voltage detection asserts a reset to inactivate the LPC178x/7x when the voltage on the $V_{DD(REG)(3V3)}$ pins falls below 1.85 V (typical). This reset prevents alteration of the flash as operation of the various elements of the chip would otherwise become unreliable due to low voltage. The BOD circuit maintains this reset down below 1 V, at which point the power-on reset circuitry maintains the overall reset.

Both the 2.2 V and 1.85 V thresholds include some hysteresis. In normal operation, this hysteresis allows the 2.2 V detection to reliably interrupt, or a regularly executed event loop to sense the condition.

7.34.3 Code security (Code Read Protection - CRP)

This feature of the LPC178x/7x allows user to enable different levels of security in the system so that access to the on-chip flash and use of the JTAG and ISP can be restricted. When needed, CRP is invoked by programming a specific pattern into a dedicated flash location. IAP commands are not affected by the CRP.

There are three levels of the Code Read Protection.

CRP1 disables access to chip via the JTAG and allows partial flash update (excluding flash sector 0) using a limited set of the ISP commands. This mode is useful when CRP is required and flash field updates are needed but all sectors can not be erased.

CRP2 disables access to chip via the JTAG and only allows full flash erase and update using a reduced set of the ISP commands.

Running an application with level CRP3 selected fully disables any access to chip via the JTAG pins and the ISP. This mode effectively disables ISP override using P2[10] pin, too. It is up to the user's application to provide (if needed) flash update mechanism using IAP calls or call reinvoke ISP command to enable flash update via UART0.

Table 13. Static characteristics *…continued*
T_{amb} = −40 °C to +85 °C, unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ[1]	Max	Unit
V_{DI}	differential input sensitivity voltage	|(D+) − (D−)|	[20]	0.2	-	-	V
V_{CM}	differential common mode voltage range	includes V_{DI} range	[20]	0.8	-	2.5	V
$V_{th(rs)se}$	single-ended receiver switching threshold voltage		[20]	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	[20]	-	-	0.18	V
V_{OH}	HIGH-level output voltage (driven) for low-/full-speed	R_L of 15 kΩ to GND	[20]	2.8	-	3.5	V
C_{trans}	transceiver capacitance	pin to GND	[20]	-	-	20	pF
Oscillator pins (see Section 14.2)							
$V_{i(XTAL1)}$	input voltage on pin XTAL1			−0.5	1.8	1.95	V
$V_{o(XTAL2)}$	output voltage on pin XTAL2			−0.5	1.8	1.95	V
$V_{i(RTCX1)}$	input voltage on pin RTCX1			−0.5	-	3.6	V
$V_{o(RTCX2)}$	output voltage on pin RTCX2			−0.5	-	3.6	V

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

[2] For USB operation 3.0 V ≤ $V_{DD(3V3)}$ ≤ 3.6 V. Guaranteed by design.

[3] V_{DDA} and VREFP should be tied to $V_{DD(3V3)}$ if the ADC and DAC are not used.

[4] The RTC typically fails when $V_{i(VBAT)}$ drops below 1.6 V.

[5] $V_{DD(REG)(3V3)}$ = 3.3 V; T_{amb} = 25 °C for all power consumption measurements.

[6] Boost control bits in the PBOOST register set to 0x0 (see *LPC178x/7x User manual UM10470*).

[7] Boost control bits in the PBOOST register set to 0x3 (see *LPC178x/7x User manual UM10470*).

[8] IRC running at 12 MHz; main oscillator and PLL disabled; PCLK = CCLK/4.

[9] BOD disabled.

[10] On pin VBAT; $V_{DD(REG)(3V3)}$ = $V_{DD(3V3)}$ = V_{DDA} = 0; T_{amb} = 25 °C.

[11] On pin VBAT; $V_{DD(REG)(3V3)}$ = $V_{DD(3V3)}$ = V_{DDA} = 3.3 V; T_{amb} = 25 °C.

[12] All internal pull-ups disabled. All pins configured as output and driven LOW. $V_{DD(3V3)}$ = 3.3 V; T_{amb} = 25 °C.

[13] V_{DDA} = 3.3 V; T_{amb} = 25 °C.

[14] $V_{i(VREFP)}$ = 3.3 V; T_{amb} = 25 °C.

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

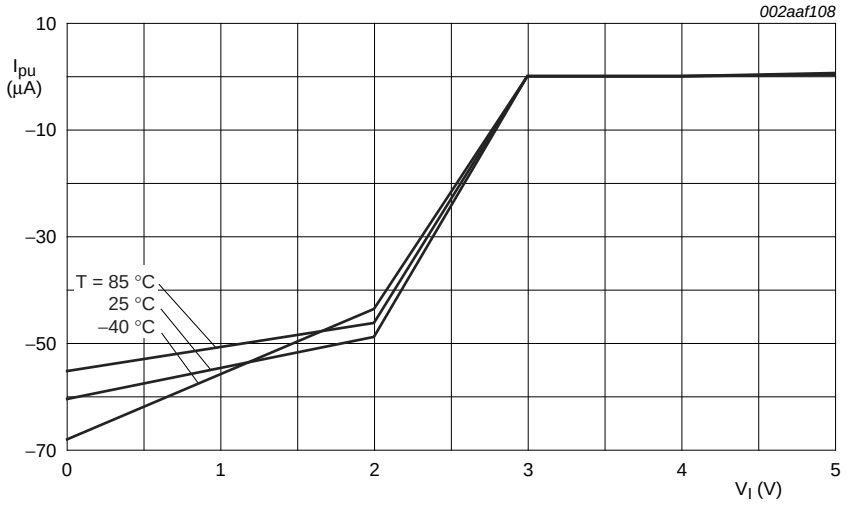
[16] $V_{DD(3V3)}$ supply voltages must be present.

[17] 3-state outputs go into 3-state mode in Deep power-down mode.

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

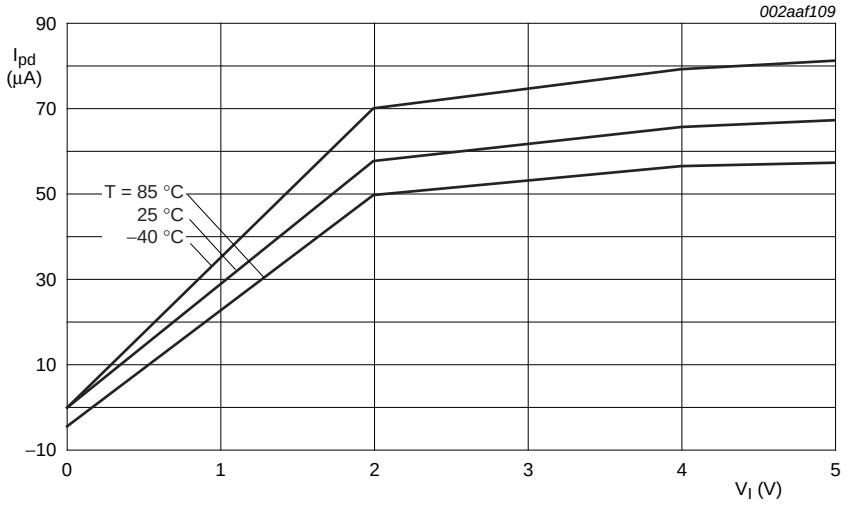
[19] To V_{SS}.

[20] 3.0 V ≤ $V_{DD(3V3)}$ ≤ 3.6 V.



Conditions: $V_{DD(REG)(3V3)} = V_{DD(3V3)} = 3.3$ V; standard port pins.

Fig 14. Typical pull-up current I_{pu} versus input voltage V_I



Conditions: $V_{DD(REG)(3V3)} = V_{DD(3V3)} = 3.3$ V; standard port pins.

Fig 15. Typical pull-down current I_{pd} versus input voltage V_I

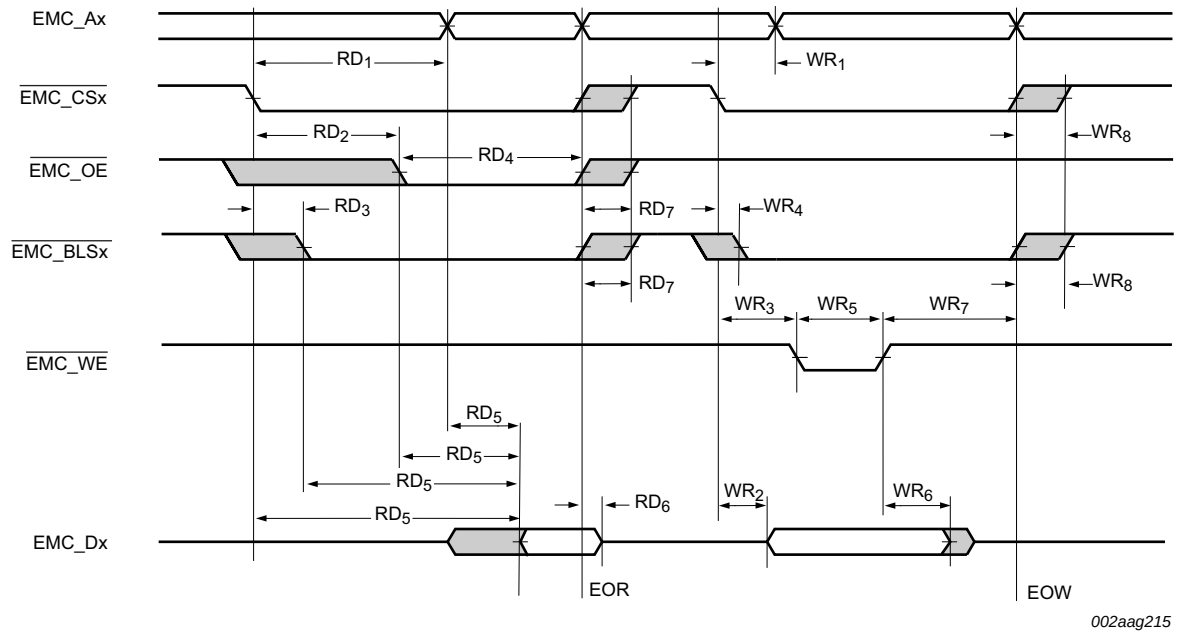


Fig 17. External static memory read/write access (PB =1)

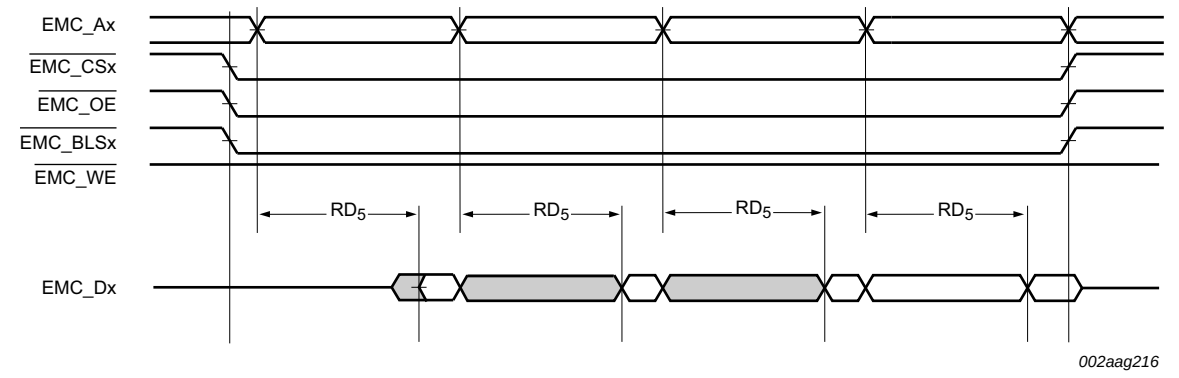


Fig 18. External static memory burst read cycle

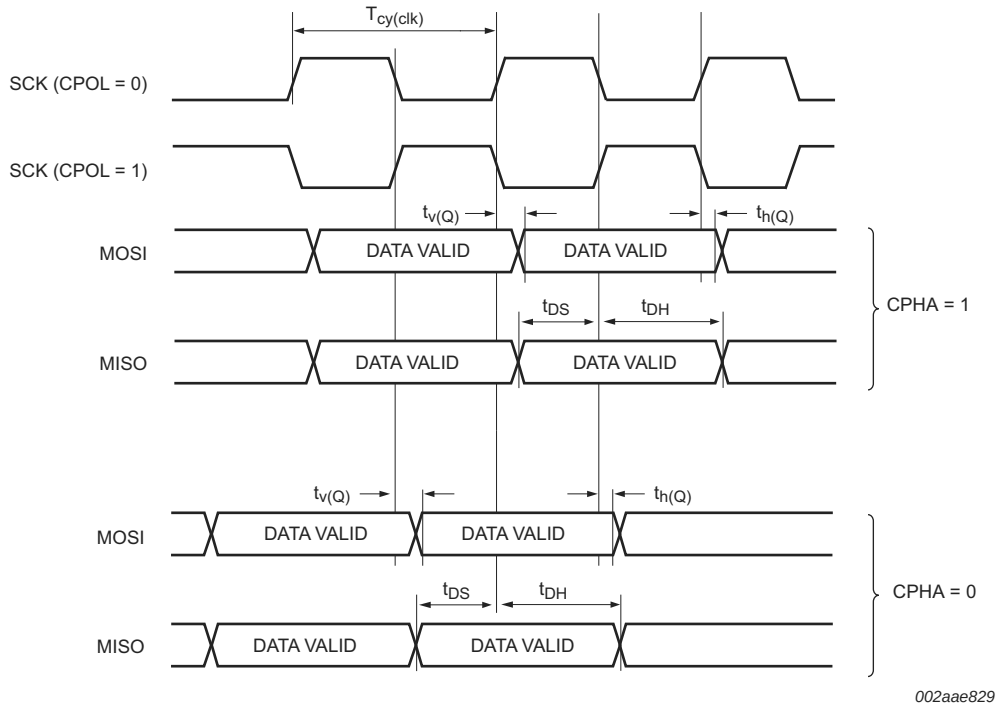


Fig 21. SSP master timing in SPI mode

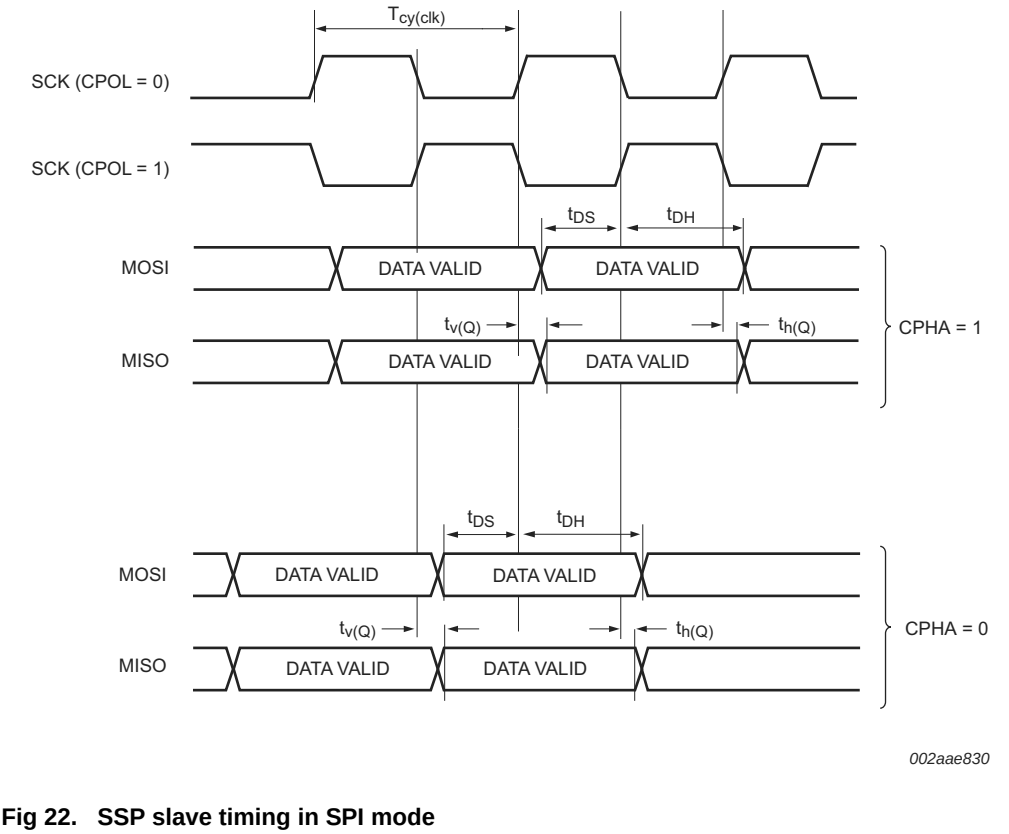


Fig 22. SSP slave timing in SPI mode

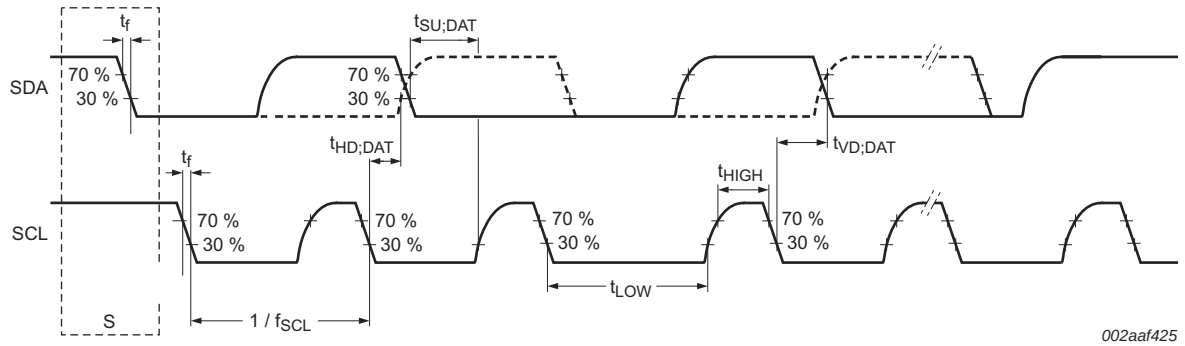


Fig 23. I²C-bus pins clock timing

11.8 I²S-bus interface

Table 28. Dynamic characteristics: I²S-bus interface pins

C_L = 10 pF; T_{amb} = −40 °C to 85 °C, $V_{DD(3V3)}$ = 3.0 V to 3.6 V. Values guaranteed by design.

Symbol	Parameter	Conditions		Min	Max	Unit
common to input and output						
t_r	rise time		[1]	-	6.7	ns
t_f	fall time		[1]	-	8.0	ns
t_{WH}	pulse width HIGH	on pins I2S_TX_SCK and I2S_RX_SCK	[1]	25	-	-
t_{WL}	pulse width LOW	on pins I2S_TX_SCK and I2S_RX_SCK	[1]	-	25	ns
output						
$t_{v(Q)}$	data output valid time	on pin I2S_TX_SDA;	[1]	-	6	ns
input						
$t_{su(D)}$	data input set-up time	on pin I2S_RX_SDA	[1]	5	-	ns
$t_{h(D)}$	data input hold time	on pin I2S_RX_SDA	[1]	2	-	ns

[1] CCLK = 100 MHz; peripheral clock to the I²S-bus interface PCLK = CCLK / 4. I²S clock cycle time $T_{cy(clk)}$ = 1600 ns, corresponds to the SCK signal in the *I²S-bus specification*.

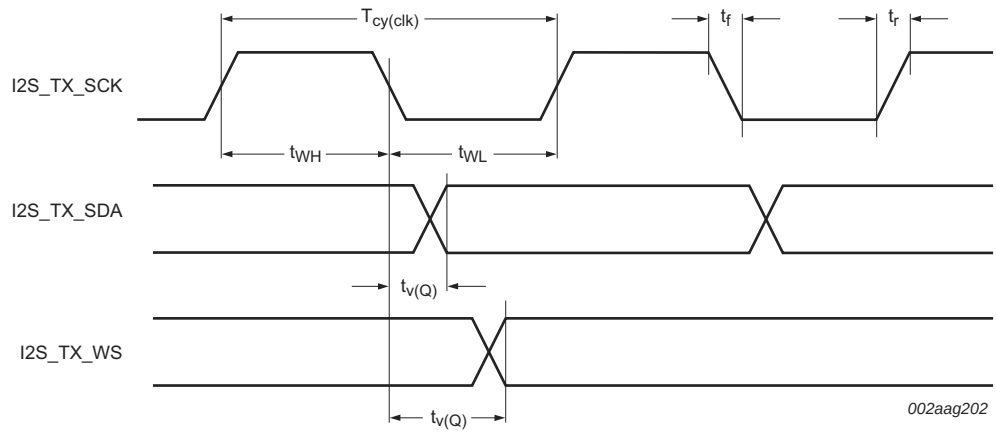


Fig 24. I²S-bus timing (transmit)

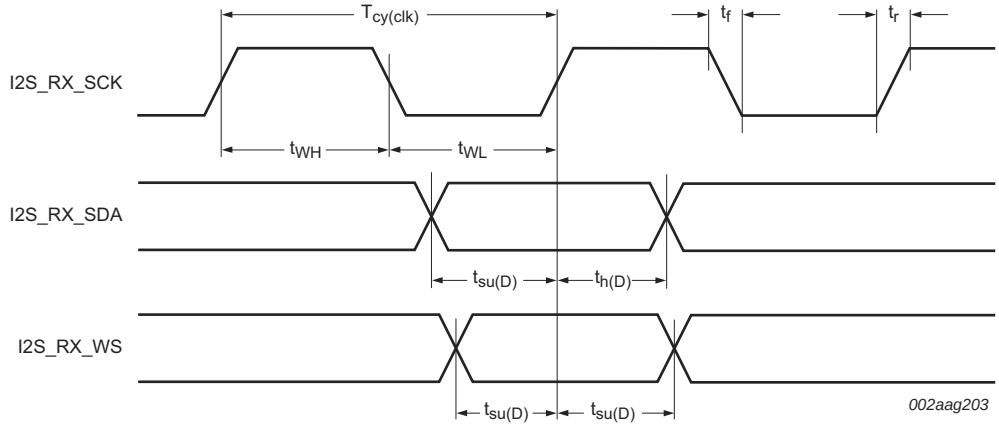


Fig 25. I²S-bus timing (receive)

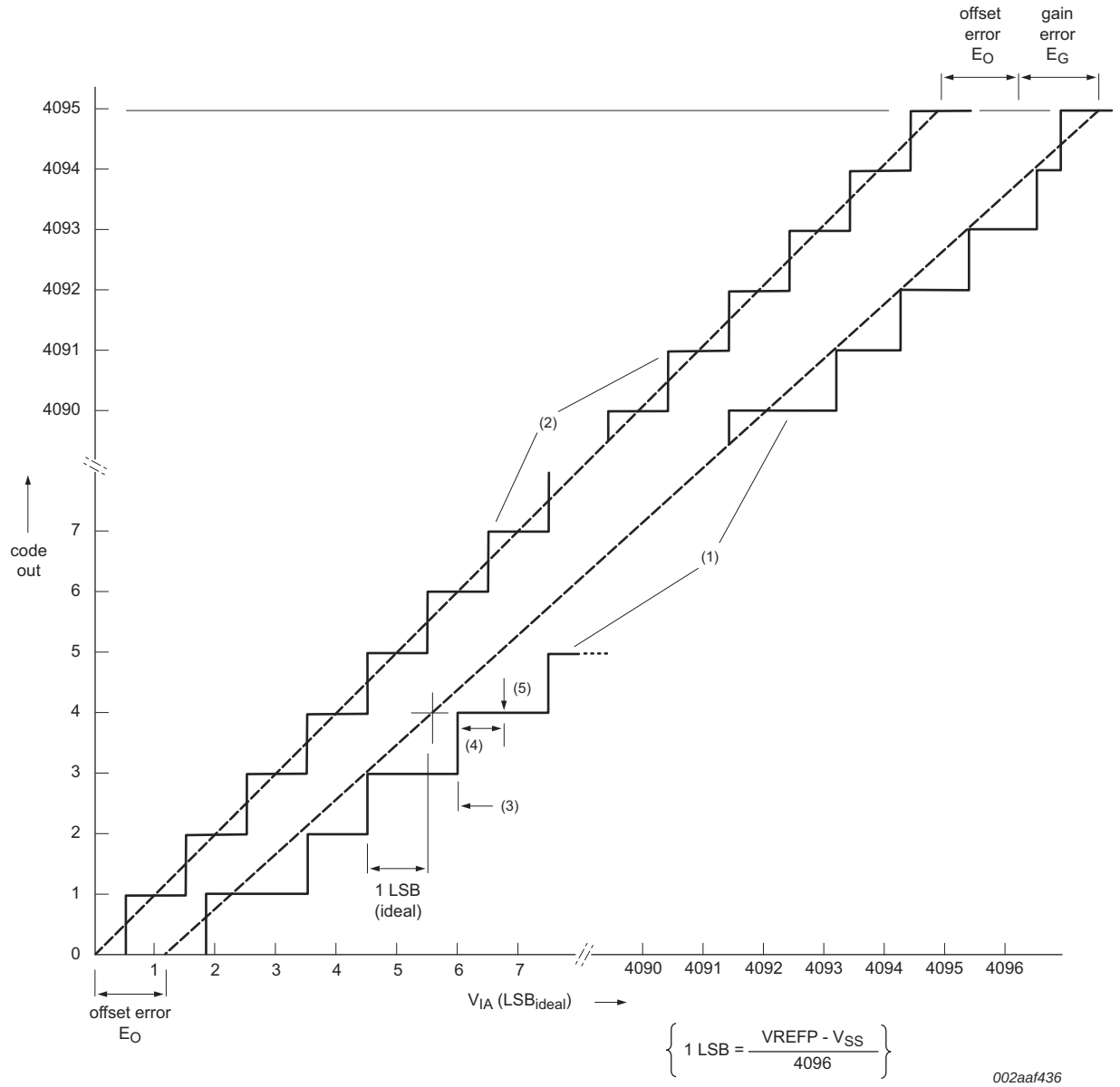
11.9 LCD

Remark: The LCD controller is available on parts LPC1788/87/86/85.

Table 29. Dynamic characteristics: LCD

C_L = 10 pF; T_{amb} = −40 °C to 85 °C, $V_{DD(3V3)}$ = 3.0 V to 3.6 V. Values guaranteed by design.

Symbol	Parameter	Conditions	Min	Max	Unit
f_{clk}	clock frequency	on pin LCD_DCLK	-	50	MHz
$t_{d(QV)}$	data output valid delay time		-	9	ns
$t_{h(Q)}$	data output hold time		−0.5	-	ns



(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 28. 12-bit ADC characteristics

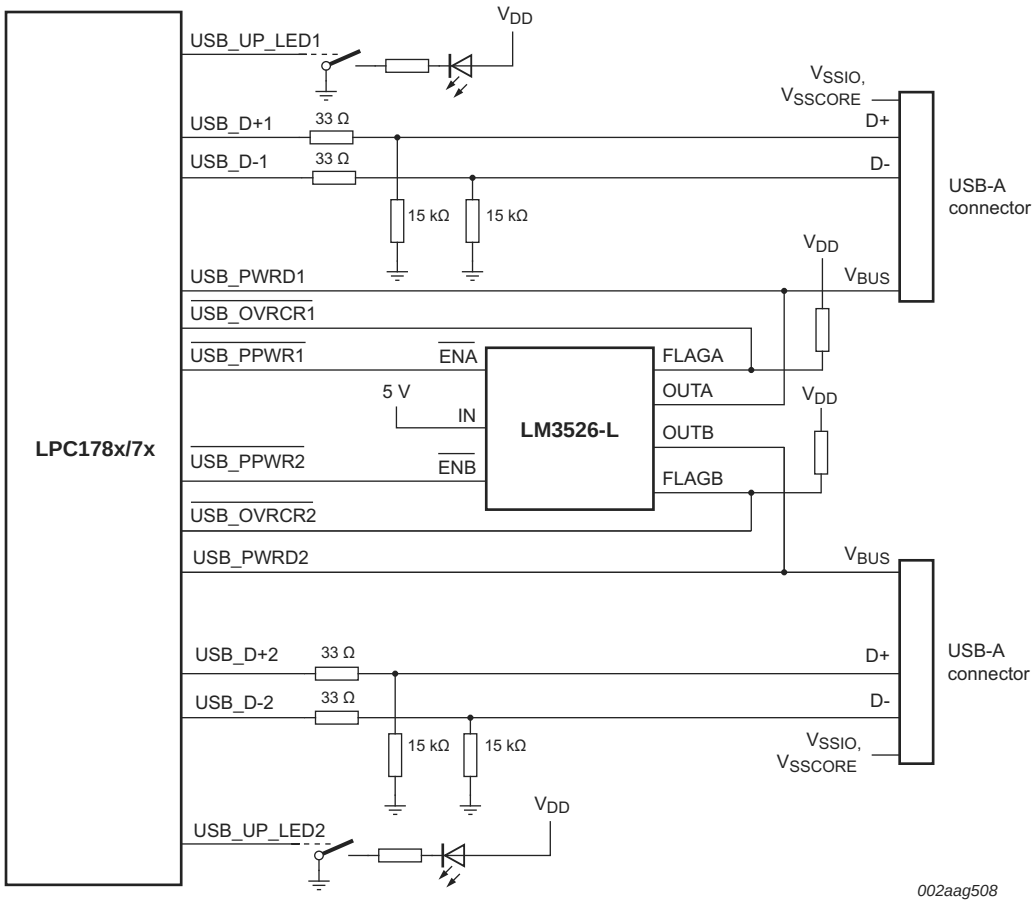


Fig 34. USB host port configuration: port 1 and port 2 as hosts

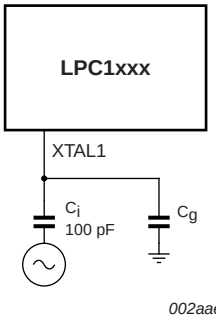


Fig 36. Slave mode operation of the on-chip oscillator

In slave mode the input clock signal should be coupled by means of a capacitor of 100 pF (Figure 36), with an amplitude between 200 mV(RMS) and 1000 mV(RMS). This corresponds to a square wave signal with a signal swing of between 280 mV and 1.4 V. The XTALOUT pin in this configuration can be left unconnected.

External components and models used in oscillation mode are shown in Figure 37 and in Table 34 and Table 35. 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 (the fundamental frequency is represented by L, C_L and R_S). Capacitance C_P in Figure 37 represents the parallel package capacitance and should not be larger than 7 pF. Parameters F_{OSC}, C_L, R_S and C_P are supplied by the crystal manufacturer.

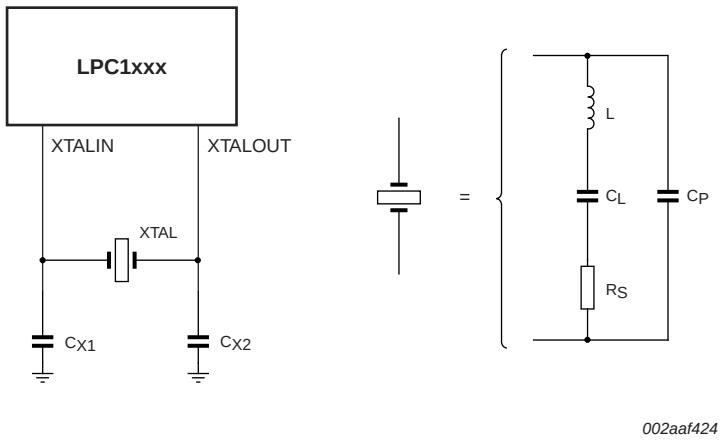


Fig 37. Oscillator modes and models: oscillation mode of operation and external crystal model used for C_{X1}/C_{X2} evaluation

Table 34. Recommended values for C_{X1}/C_{X2} in oscillation mode (crystal and external components parameters): low frequency mode

Fundamental oscillation frequency F_{OSC}	Crystal load capacitance C_L	Maximum crystal series resistance R_S	External load capacitors C_{X1}/C_{X2}
1 MHz to 5 MHz	10 pF	< 300 Ω	18 pF, 18 pF
	20 pF	< 300 Ω	39 pF, 39 pF
	30 pF	< 300 Ω	57 pF, 57 pF

To eliminate the loss of time counts in the RTC due to voltage swing or ramp rate of the $\overline{\text{RESET}}$ signal, connect an RC filter between the $\overline{\text{RESET}}$ pin and the external reset input.

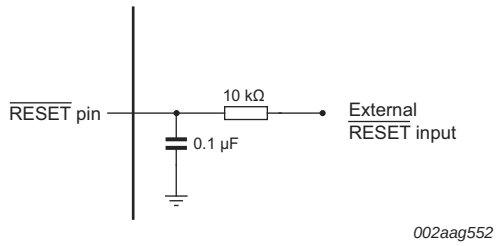


Fig 40. Reset input with RC filter

17. Abbreviations

Table 36. Abbreviations

Acronym	Description
ADC	Analog-to-Digital Converter
AHB	Advanced High-performance Bus
AMBA	Advanced Microcontroller Bus Architecture
APB	Advanced Peripheral Bus
BOD	BrownOut Detection
CAN	Controller Area Network
DAC	Digital-to-Analog Converter
DMA	Direct Memory Access
EOP	End Of Packet
ETM	Embedded Trace Macrocell
GPIO	General Purpose Input/Output
GPS	Global Positioning System
HVAC	Heating, Venting, and Air Conditioning
IRC	Internal RC
IrDA	Infrared Data Association
JTAG	Joint Test Action Group
MAC	Media Access Control
MIIM	Media Independent Interface Management
OHCI	Open Host Controller Interface
OTG	On-The-Go
PHY	Physical Layer
PLC	Programmable Logic Controller
PLL	Phase-Locked Loop
PWM	Pulse Width Modulator
RMII	Reduced Media Independent Interface
SE0	Single Ended Zero
SPI	Serial Peripheral Interface
SSI	Serial Synchronous Interface
SSP	Synchronous Serial Port
TCM	Tightly Coupled Memory
TTL	Transistor-Transistor Logic
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus

20. Legal information

20.1 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.

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