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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, Ethernet, 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	109
Program Memory Size	512KB (512K x 8)
Program Memory Type	FLASH
EEPROM Size	4K x 8
RAM Size	96K 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	144-LQFP
Supplier Device Package	144-LQFP (20x20)
Purchase URL	https://www.e-xfl.com/product-detail/nxp-semiconductors/lpc1788fbd144-551

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[5]	140	F16	F12	97	[3]	I; PU	I/O	**P2[5] —** General purpose digital input/output pin.
							O	**PWM1[6] —** Pulse Width Modulator 1, channel 6 output.
							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.
							O	**T2_MAT0 —** Match output for Timer 2, channel 0.
							-	**R —** Function reserved.
							O	**TRACEDATA[0] —** Trace data, bit 0.
							-	**R —** Function reserved.
							O	**LCD_LP —** Line synchronization pulse (STN). Horizontal synchronization pulse (TFT).
P2[6]	138	E17	F13	96	[3]	I; PU	I/O	**P2[6] —** General purpose digital input/output pin.
							I	**PWM1_CAP0 —** Capture input for PWM1, channel 0.
							I	**U1_RI —** Ring Indicator input for UART1.
							I	**T2_CAP0 —** Capture input for Timer 2, channel 0.
							O	**U2_OE —** RS-485/EIA-485 output enable signal for UART2.
							O	**TRACECLK —** Trace clock.
							O	**LCD_VD[0] —** LCD data.
							O	**LCD_VD[4] —** LCD data.
P2[7]	136	G16	G11	95	[3]	I; PU	I/O	**P2[7] —** General purpose digital input/output pin.
							I	**CAN_RD2 —** CAN2 receiver input.
							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.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
							O	**LCD_VD[1] —** LCD data.
							O	**LCD_VD[5] —** LCD data.
P2[8]	134	H15	G14	93	[3]	I; PU	I/O	**P2[8] —** General purpose digital input/output pin.
							O	**CAN_TD2 —** CAN2 transmitter output.
							O	**U2_TXD —** Transmitter output for UART2.
							I	**U1_CTS —** Clear to Send input for UART1.
							O	**ENET_MDC —** Ethernet MIIM clock.
							-	**R —** Function reserved.
							O	**LCD_VD[2] —** LCD data.
							O	**LCD_VD[6] —** LCD data.

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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
P4[1]	79	U10	M7	55	[3]	I; PU	I/O	**P4[1] —** General purpose digital input/output pin.
							I/O	**EMC_A[1] —** External memory address line 1.
P4[2]	83	T11	M8	58	[3]	I; PU	I/O	**P4[2] —** General purpose digital input/output pin.
							I/O	**EMC_A[2] —** External memory address line 2.
P4[3]	97	U16	K9	68	[3]	I; PU	I/O	**P4[3] —** General purpose digital input/output pin.
							I/O	**EMC_A[3] —** External memory address line 3.
P4[4]	103	R15	P13	72	[3]	I; PU	I/O	**P4[4] —** General purpose digital input/output pin.
							I/O	**EMC_A[4] —** External memory address line 4.
P4[5]	107	R16	H10	74	[3]	I; PU	I/O	**P4[5] —** General purpose digital input/output pin.
							I/O	**EMC_A[5] —** External memory address line 5.
P4[6]	113	M14	K10	78	[3]	I; PU	I/O	**P4[6] —** General purpose digital input/output pin.
							I/O	**EMC_A[6] —** External memory address line 6.
P4[7]	121	L16	K12	84	[3]	I; PU	I/O	**P4[7] —** General purpose digital input/output pin.
							I/O	**EMC_A[7] —** External memory address line 7.
P4[8]	127	J17	J11	88	[3]	I; PU	I/O	**P4[8] —** General purpose digital input/output pin.
							I/O	**EMC_A[8] —** External memory address line 8.
P4[9]	131	H17	H12	91	[3]	I; PU	I/O	**P4[9] —** General purpose digital input/output pin.
							I/O	**EMC_A[9] —** External memory address line 9.
P4[10]	135	G17	G12	94	[3]	I; PU	I/O	**P4[10] —** General purpose digital input/output pin.
							I/O	**EMC_A[10] —** External memory address line 10.
P4[11]	145	F14	F11	101	[3]	I; PU	I/O	**P4[11] —** General purpose digital input/output pin.
							I/O	**EMC_A[11] —** External memory address line 11.
P4[12]	149	C16	F10	104	[3]	I; PU	I/O	**P4[12] —** General purpose digital input/output pin.
							I/O	**EMC_A[12] —** External memory address line 12.
P4[13]	155	B16	B14	108	[3]	I; PU	I/O	**P4[13] —** General purpose digital input/output pin.
							I/O	**EMC_A[13] —** External memory address line 13.
P4[14]	159	B15	E8	110	[3]	I; PU	I/O	**P4[14] —** General purpose digital input/output pin.
							I/O	**EMC_A[14] —** External memory address line 14.
P4[15]	173	A11	C10	120	[3]	I; PU	I/O	**P4[15] —** General purpose digital input/output pin.
							I/O	**EMC_A[15] —** External memory address line 15.
P4[16]	101	U17	N12	-	[3]	I; PU	I/O	**P4[16] —** General purpose digital input/output pin.
							I/O	**EMC_A[16] —** External memory address line 16.
P4[17]	104	P14	N13	-	[3]	I; PU	I/O	**P4[17] —** General purpose digital input/output pin.
							I/O	**EMC_A[17] —** External memory address line 17.
P4[18]	105	P15	P14	-	[3]	I; PU	I/O	**P4[18] —** General purpose digital input/output pin.
							I/O	**EMC_A[18] —** External memory address line 18.

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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
P4[19]	111	P16	M14	-	[3]	I; PU	I/O	**P4[19] —** General purpose digital input/output pin.
							I/O	**EMC_A[19] —** External memory address line 19.
P4[20]	109	R17	-	-	[3]	I; PU	I/O	**P4[20] —** General purpose digital input/output pin.
							I/O	**EMC_A[20] —** External memory address line 20.
							I/O	**I2C2_SDA —** I^2C2 data input/output (this pin does not use a specialized I2C pad).
							I/O	**SSP1_SCK —** Serial Clock for SSP1.
P4[21]	115	M15	-	-	[3]	I; PU	I/O	**P4[21] —** General purpose digital input/output pin.
							I/O	**EMC_A[21] —** External memory address line 21.
							I/O	**I2C2_SCL —** I^2C2 clock input/output (this pin does not use a specialized I2C pad).
							I/O	**SSP1_SSEL —** Slave Select for SSP1.
P4[22]	123	K14	-	-	[3]	I; PU	I/O	**P4[22] —** General purpose digital input/output pin.
							I/O	**EMC_A[22] —** External memory address line 22.
							O	**U2_TXD —** Transmitter output for UART2.
							I/O	**SSP1_MISO —** Master In Slave Out for SSP1.
P4[23]	129	J15	-	-	[3]	I; PU	I/O	**P4[23] —** General purpose digital input/output pin.
							I/O	**EMC_A[23] —** External memory address line 23.
							I	**U2_RXD —** Receiver input for UART2.
							I/O	**SSP1_MOSI —** Master Out Slave In for SSP1.
P4[24]	183	B8	C8	127	[3]	I; PU	I/O	**P4[24] —** General purpose digital input/output pin.
							O	**$\overline{\text{EMC\_OE}}$ —** LOW active Output Enable signal.
P4[25]	179	B9	D9	124	[3]	I; PU	I/O	**P4[25] —** General purpose digital input/output pin.
							O	**$\overline{\text{EMC\_WE}}$ —** LOW active Write Enable signal.
P4[26]	119	L15	K13	-	[3]	I; PU	I/O	**P4[26] —** General purpose digital input/output pin.
							O	**$\overline{\text{EMC\_BLS0}}$ —** LOW active Byte Lane select signal 0.
P4[27]	139	G15	F14	-	[3]	I; PU	I/O	**P4[27] —** General purpose digital input/output pin.
							O	**$\overline{\text{EMC\_BLS1}}$ —** LOW active Byte Lane select signal 1.
P4[28]	170	C11	D10	118	[3]	I; PU	I/O	**P4[28] —** General purpose digital input/output pin.
							O	**$\overline{\text{EMC\_BLS2}}$ —** LOW active Byte Lane select signal 2.
							O	**U3_TXD —** Transmitter output for UART3.
							O	**T2_MAT0 —** Match output for Timer 2, channel 0.
							-	**R —** Function reserved.
							O	**LCD_VD[6] —** LCD data.
							O	**LCD_VD[10] —** LCD data.
							O	**LCD_VD[2] —** LCD data.

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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
P4[29]	176	B10	B9	122	[3]	I; PU	I/O	**P4[29] —** General purpose digital input/output pin.
							O	**EMC_BLS3 —** LOW active Byte Lane select signal 3.
							I	**U3_RXD —** Receiver input for UART3.
							O	**T2_MAT1 —** Match output for Timer 2, channel 1.
							I/O	**I2C2_SCL —** I^2C2 clock input/output (this pin does not use a specialized I2C pad).
							O	**LCD_VD[7] —** LCD data.
							O	**LCD_VD[11] —** LCD data.
							O	**LCD_VD[3] —** LCD data.
P4[30]	187	B7	C7	130	[3]	I; PU	I/O	**P4[30] —** General purpose digital input/output pin.
							O	**EMC_CS0 —** LOW active Chip Select 0 signal.
P4[31]	193	A4	E7	134	[3]	I; PU	I/O	**P4[31] —** General purpose digital input/output pin.
							O	**EMC_CS1 —** LOW active Chip Select 1 signal.
P5[0] to P5[4]							I/O	**Port 5:** Port 5 is a 5-bit I/O port with individual direction controls for each bit. The operation of port 5 pins depends upon the pin function selected via the pin connect block.
P5[0]	9	F4	E5	6	[3]	I; PU	I/O	**P5[0] —** General purpose digital input/output pin.
							I/O	**EMC_A[24] —** External memory address line 24.
							I/O	**SSP2_MOSI —** Master Out Slave In for SSP2.
							O	**T2_MAT2 —** Match output for Timer 2, channel 2.
P5[1]	30	J4	H1	21	[3]	I; PU	I/O	**P5[1] —** General purpose digital input/output pin.
							I/O	**EMC_A[25] —** External memory address line 25.
							I/O	**SSP2_MISO —** Master In Slave Out for SSP2.
							O	**T2_MAT3 —** Match output for Timer 2, channel 3.
P5[2]	117	L14	L12	81	[11]	I	I/O	**P5[2] —** General purpose digital input/output pin.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
							O	**T3_MAT2 —** Match output for Timer 3, channel 2.
							-	**R —** Function reserved.
							I/O	**I2C0_SDA —** I^2C0 data input/output (this pin uses a specialized I^2C pad that supports I^2C Fast Mode Plus).

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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
P5[3]	141	G14	G10	98	[11]	I	I/O	**P5[3] —** General purpose digital input/output pin.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
							I	**U4_RXD —** Receiver input for USART4.
							I/O	**I2C0_SCL —** I^2C0 clock input/output (this pin uses a specialized I^2C pad that supports I^2C Fast Mode Plus).
P5[4]	206	C3	C4	143	[3]	I; PU	I/O	**P5[4] —** General purpose digital input/output pin.
							O	**U0_OE —** RS-485/EIA-485 output enable signal for UART0.
							-	**R —** Function reserved.
							O	**T3_MAT3 —** Match output for Timer 3, channel 3.
							O	**U4_TXD —** Transmitter output for USART4 (input/output in smart card mode).
JTAG_TDO (SWO)	2	D3	B1	1	[3]	O	O	Test Data Out for JTAG interface. Also used as Serial wire trace output.
JTAG_TDI	4	C2	C3	3	[3]	I; PU	I	Test Data In for JTAG interface.
JTAG_TMS (SWDIO)	6	E3	C2	4	[3]	I; PU	I	Test Mode Select for JTAG interface. Also used as Serial wire debug data input/output.
JTAG_$\overline{\text{TRST}}$	8	D1	D4	5	[3]	I; PU	I	Test Reset for JTAG interface.
JTAG_TCK (SWDCLK)	10	E2	D2	7	[3]	i	I	Test Clock for JTAG interface. This clock must be slower than 1/6 of the CPU clock (CCLK) for the JTAG interface to operate. Also used as serial wire clock.
$\overline{\text{RESET}}$	35	M2	J1	24	[12]	I; PU	I	External reset input with 20 ns glitch filter. A LOW-going pulse as short as 50 ns 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. This pin also serves as the debug select input. LOW level selects the JTAG boundary scan. HIGH level selects the ARM SWD debug mode.
$\overline{\text{RSTOUT}}$	29	K3	H2	20	[3]	OH	O	Reset status output. A LOW output on this pin indicates that the device is in the reset state for any reason. This reflects the $\overline{\text{RESET}}$ input pin and all internal reset sources.
RTC_ALARM	37	N1	H5	26	[13]	OL	O	RTC controlled output. This pin has a low drive strength and is powered by VBAT. It is driven HIGH when an RTC alarm is generated.
RTCX1	34	K2	J2	23	[14] [15]	-	I	Input to the RTC 32 kHz ultra-low power oscillator circuit.
RTCX2	36	L2	J3	25	[14] [15]	-	O	Output from the RTC 32 kHz ultra-low power oscillator circuit.
USB_D−2	52	U1	N2	37	[9]	-	I/O	USB port 2 bidirectional D− line.

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The MPU separates the memory into distinct regions and implements protection by preventing disallowed accesses. The MPU supports up to eight regions each of which can be divided into eight subregions. Accesses to memory locations that are not defined in the MPU regions, or not permitted by the region setting, will cause the Memory Management Fault exception to take place.

7.7 Memory map

Table 6. LPC178x/177x memory usage and details

Address range	General Use	Address range details and description	
0x0000 0000 to 0x1FFF FFFF	On-chip non-volatile memory	0x0000 0000 - 0x0007 FFFF	For devices with 512 kB of flash memory.
		0x0000 0000 - 0x0003 FFFF	For devices with 256 kB of flash memory.
		0x0000 0000 - 0x0001 FFFF	For devices with 128 kB of flash memory.
		0x0000 0000 - 0x0000 FFFF	For devices with 64 kB of flash memory.
	On-chip main SRAM	0x1000 0000 - 0x1000 FFFF	For devices with 64 kB of main SRAM.
		0x1000 0000 - 0x1000 7FFF	For devices with 32 kB of main SRAM.
		0x1000 0000 - 0x1000 3FFF	For devices with 16 kB of main SRAM.
	Boot ROM	0x1FFF 0000 - 0x1FFF 1FFF	8 kB Boot ROM with flash services.
0x2000 0000 to 0x3FFF FFFF	On-chip SRAM (typically used for peripheral data)	0x2000 0000 - 0x2000 1FFF	Peripheral RAM - bank 0 (first 8 kB)
		0x2000 2000 - 0x2000 3FFF	Peripheral RAM - bank 0 (second 8 kB)
		0x2000 4000 - 0x2000 7FFF	Peripheral RAM - bank 1 (16 kB)
	AHB peripherals	0x2008 0000 - 0x200B FFFF	See Figure 6 for details
0x4000 0000 to 0x7FFF FFFF	APB Peripherals	0x4000 0000 - 0x4007 FFFF	APB0 Peripherals, up to 32 peripheral blocks of 16 kB each.
		0x4008 0000 - 0x400F FFFF	APB1 Peripherals, up to 32 peripheral blocks of 16 kB each.
0x8000 0000 to 0xDFFF FFFF	Off-chip Memory via the External Memory Controller	Four static memory chip selects:	
		0x8000 0000 - 0x83FF FFFF	Static memory chip select 0 (up to 64 MB)
		0x9000 0000 - 0x93FF FFFF	Static memory chip select 1 (up to 64 MB)
		0x9800 0000 - 0x9BFF FFFF	Static memory chip select 2 (up to 64 MB)
		0x9C00 0000 - 0x9FFF FFFF	Static memory chip select 3 (up to 64 MB)
		Four dynamic memory chip selects:	
		0xA000 0000 - 0xAFFF FFFF	Dynamic memory chip select 0 (up to 256MB)
		0xB000 0000 - 0xBFFF FFFF	Dynamic memory chip select 1 (up to 256MB)
		0xC000 0000 - 0xCFFF FFFF	Dynamic memory chip select 2 (up to 256MB)
		0xD000 0000 - 0xDFFF FFFF	Dynamic memory chip select 3 (up to 256MB)
0xE000 0000 to 0xE00F FFFF	Cortex-M3 Private Peripheral Bus	0xE000 0000 - 0xE00F FFFF	Cortex-M3 related functions, includes the NVIC and System Tick Timer.

The LPC178x/7x incorporate several distinct memory regions, shown in the following figures. Figure 6 shows the overall map of the entire address space from the user program viewpoint following reset. The interrupt vector area supports address remapping.

The AHB peripheral area is 2 MB in size, and is divided to allow for up to 128 peripherals. The APB peripheral area is 1 MB in size and is divided to allow for up to 64 peripherals. Each peripheral of either type is allocated 16 kB of space. This allows simplifying the address decoding for each peripheral.

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7.14 Ethernet

Remark: The Ethernet block is available on parts LPC1788/86 and LPC1778/76.

The Ethernet block contains a full featured 10 Mbit/s or 100 Mbit/s Ethernet MAC designed to provide optimized performance through the use of DMA hardware acceleration. Features include a generous suite of control registers, half or full duplex operation, flow control, control frames, hardware acceleration for transmit retry, receive packet filtering and wake-up on LAN activity. Automatic frame transmission and reception with scatter-gather DMA off-loads many operations from the CPU.

The Ethernet block and the CPU share the ARM Cortex-M3 D-code and system bus through the AHB-multilayer matrix to access the various on-chip SRAM blocks for Ethernet data, control, and status information.

The Ethernet block interfaces between an off-chip Ethernet PHY using the Media Independent Interface (MII) or Reduced MII (RMII) protocol and the on-chip Media Independent Interface Management (MIIM) serial bus.

7.14.1 Features

- Ethernet standards support:
  - Supports 10 Mbit/s or 100 Mbit/s PHY devices including 10 Base-T, 100 Base-TX, 100 Base-FX, and 100 Base-T4.
  - Fully compliant with IEEE standard 802.3.
  - Fully compliant with 802.3x Full Duplex Flow Control and Half Duplex back pressure.
  - Flexible transmit and receive frame options.
  - Virtual Local Area Network (VLAN) frame suppor
  - .
- Memory management:
  - Independent transmit and receive buffers memory mapped to shared SRAM.
  - DMA managers with scatter/gather DMA and arrays of frame descriptors.
  - Memory traffic optimized by buffering and pre-fetching.
- Enhanced Ethernet features:
  - Receive filtering.
  - Multicast and broadcast frame support for both transmit and receive.
  - Optional automatic Frame Check Sequence (FCS) insertion with Circular Redundancy Check (CRC) for transmit.
  - Selectable automatic transmit frame padding.
  - Over-length frame support for both transmit and receive allows any length frames.
  - Promiscuous receive mode.
  - Automatic collision back-off and frame retransmission.
  - Includes power management by clock switching.
  - Wake-on-LAN power management support allows system wake-up: using the receive filters or a magic frame detection filter.

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- Two downstream ports.
- Supports per-port power switching.

7.15.3 USB OTG controller

USB OTG is a supplement to the *USB 2.0 Specification* that augments the capability of existing mobile devices and USB peripherals by adding host functionality for connection to USB peripherals.

The OTG Controller integrates the host controller, device controller, and a master-only I^2C interface to implement OTG dual-role device functionality. The dedicated I^2C interface controls an external OTG transceiver.

7.15.3.1 Features

- Fully compliant with On-The-Go supplement to the *USB 2.0 Specification, Revision 1.0a*.
- Hardware support for Host Negotiation Protocol (HNP).
- Includes a programmable timer required for HNP and Session Request Protocol (SRP).
- Supports any OTG transceiver compliant with the *OTG Transceiver Specification (CEA-2011), Rev. 1.0*.

7.16 SD/MMC card interface

Remark: The SD/MMC card interface is available on parts LPC1788/87/86/85 and parts LPC1778/77/76.

The Secure Digital and Multimedia Card Interface (MCI) allows access to external SD memory cards. The SD card interface conforms to the *SD Multimedia Card Specification Version 2.11*.

7.16.1 Features

- The MCI provides all functions specific to the SD/MMC memory card. These include the clock generation unit, power management control, and command and data transfer.
- Conforms to *Multimedia Card Specification v2.11*.
- Conforms to *Secure Digital Memory Card Physical Layer Specification, v0.96.*
- Can be used as a multimedia card bus or a secure digital memory card bus host. The SD/MMC can be connected to several multimedia cards or a single secure digital memory card.
- DMA supported through the GPDMA controller.

7.17 Fast general purpose parallel I/O

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.

LPC178x/7x use accelerated GPIO functions:

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The alternate PLL accepts an input clock frequency from the main oscillator in the range of 10 MHz to 25 MHz only. When used as the USB clock, the input frequency is multiplied up to a multiple of 48 MHz (192 MHz or 288 MHz as described above).

7.33.3 Wake-up timer

The LPC178x/7x begin operation at power-up and when awakened from Power-down mode by using the 12 MHz IRC oscillator as the clock source. This allows chip operation to resume quickly. If the main oscillator or the PLL is needed by the application, software will need to enable these features and wait for them to stabilize before they are used as a clock source.

When the main oscillator is initially activated, the wake-up timer allows software to ensure that the main oscillator is fully functional before the processor uses it as a clock source and starts to execute instructions. This is important at power on, all types of reset, and whenever any of the aforementioned functions are turned off for any reason. Since the oscillator and other functions are turned off during Power-down mode, any wake-up of the processor from Power-down mode makes use of the wake-up Timer.

The wake-up timer monitors the crystal oscillator to check whether it is safe to begin code execution. When power is applied to the chip, or when some event caused the chip to exit Power-down mode, some time is required for the oscillator to produce a signal of sufficient amplitude to drive the clock logic. The amount of time depends on many factors, including the rate of $V_{DD(3V3)}$ ramp (in the case of power on), the type of crystal and its electrical characteristics (if a quartz crystal is used), as well as any other external circuitry (e.g., capacitors), and the characteristics of the oscillator itself under the existing ambient conditions.

7.33.4 Power control

The LPC178x/7x support a variety of power control features. There are four special modes of processor power reduction: Sleep mode, Deep-sleep mode, Power-down mode, and Deep power-down mode. The CPU clock rate may also be controlled as needed by changing clock sources, reconfiguring PLL values, and/or altering the CPU clock divider value. This allows a trade-off of power versus processing speed based on application requirements. In addition, the peripheral power control allows shutting down the clocks to individual on-chip peripherals, allowing fine tuning of power consumption by eliminating all dynamic power use in any peripherals that are not required for the application. Each of the peripherals has its own clock divider which provides even better power control.

The integrated PMU (Power Management Unit) automatically adjusts internal regulators to minimize power consumption during Sleep, Deep-sleep, Power-down, and Deep power-down modes.

The LPC178x/7x also implement a separate power domain to allow turning off power to the bulk of the device while maintaining operation of the RTC and a small set of registers for storing data during any of the power-down modes.

7.33.4.1 Sleep mode

When Sleep mode is entered, the clock to the core is stopped. Resumption from the Sleep mode does not need any special sequence other than re-enabling the clock to the ARM core.

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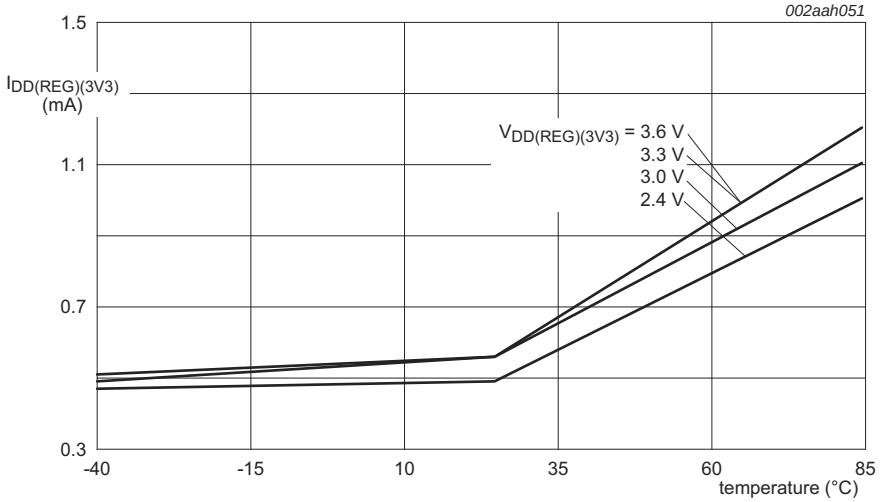
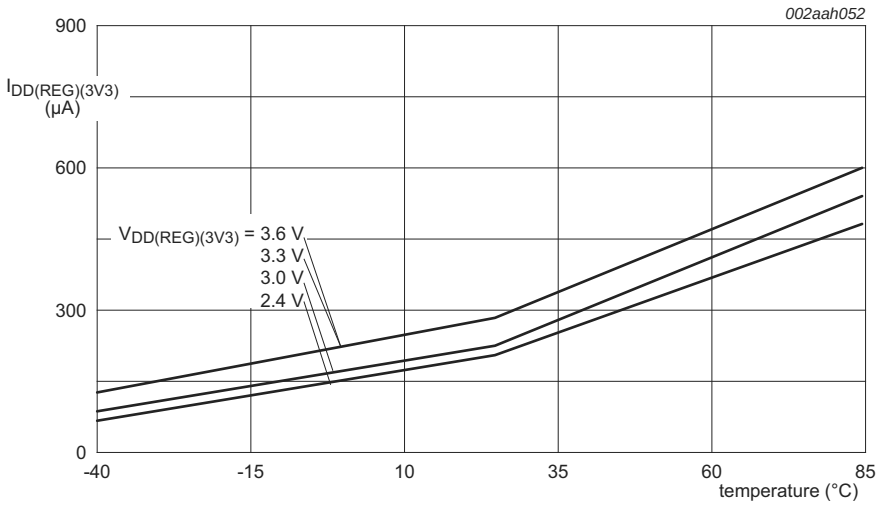
10.1 Power consumption



Conditions: BOD disabled.

Fig 9. Deep-sleep mode: Typical regulator supply current $I_{DD(REG)(3V3)}$ versus temperature



Conditions: BOD disabled.

Fig 10. Power-down mode: Typical regulator supply current $I_{DD(REG)(3V3)}$ versus temperature

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Table 17. Dynamic characteristics: Static external memory interface *…continued*

C_L = 30 pF, T_{amb} = −40 °C to 85 °C, $V_{DD(3V3)}$ = 3.0 V to 3.6 V. Values guaranteed by design.

Symbol	Parameter[1]	Conditions[1]		Min	Typ	Max	Unit
t_{deact}	deactivation time	WR_8; PB = 0; PB = 1	[3]	−2.7	−3.4	−4.7	ns
$t_{CSLBLSL}$	$\overline{CS}$ LOW to $\overline{BLS}$ LOW	WR_9; PB = 0	[3]	2.8 + $T_{cy(clk)}$ × (1 + WAITWEN)	3.7 + $T_{cy(clk)}$ × (1 + WAITWEN)	5.1 + $T_{cy(clk)}$ × (1 + WAITWEN)	ns
$t_{BLSLBLSH}$	$\overline{BLS}$ LOW to $\overline{BLS}$ HIGH time	WR_{10}; PB = 0	[3]	(WAITWR − WAITWEN + 3) × $T_{cy(clk)}$ − 2.6	(WAITWR − WAITWEN + 3) × $T_{cy(clk)}$ − 3.4	(WAITWR − WAITWEN + 3) × $T_{cy(clk)}$ − 4.9	ns
$t_{BLSHEOW}$	$\overline{BLS}$ HIGH to end of write time	WR_{11}; PB = 0	[3][6]	2.6 + $T_{cy(clk)}$	3.3 + $T_{cy(clk)}$	4.4 + $T_{cy(clk)}$	ns
$t_{BLSHDNV}$	$\overline{BLS}$ HIGH to data invalid time	WR12; PB = 0	[3]	2.7 + $T_{cy(clk)}$	3.6 + $T_{cy(clk)}$	4.8 + $T_{cy(clk)}$	ns

[1] Parameters are shown as RD_n or WD_n in Figure 16 as indicated in the Conditions column.

[2] Parameters specified for 40 % of $V_{DD(3V3)}$ for rising edges and 60 % of $V_{DD(3V3)}$ for falling edges.

[3] $T_{cy(clk)}$ = 1/EMC_CLK (see *LPC178x/7x User manual UM10470*).

[4] Latest of address valid, $\overline{EMC\_CSx}$ LOW, $\overline{EMC\_OE}$ LOW, $\overline{EMC\_BLSx}$ LOW (PB = 1).

[5] After End Of Read (EOR): Earliest of $\overline{EMC\_CSx}$ HIGH, $\overline{EMC\_OE}$ HIGH, $\overline{EMC\_BLSx}$ HIGH (PB = 1), address invalid.

[6] End Of Write (EOW): Earliest of address invalid, $\overline{EMC\_CSx}$ HIGH, $\overline{EMC\_BLSx}$ HIGH (PB = 1).

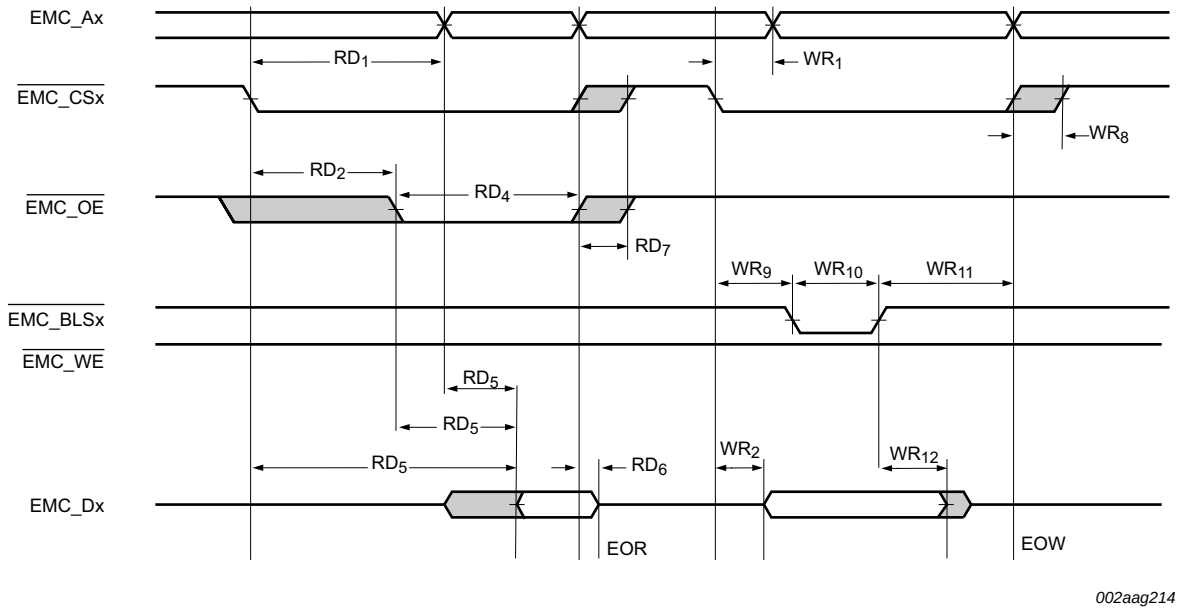

Fig 16. External static memory read/write access (PB = 0)

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11.3 External clock

Table 23. Dynamic characteristic: external clock (see Figure 36)
T_{amb} = −40 °C to +85 °C; $V_{DD(3V3)}$ over specified ranges.

Symbol	Parameter	Min	Typ	Max	Unit
f_{osc}	oscillator frequency	1	12	25	MHz
$T_{cy(clk)}$	clock cycle time	40	83.3	1000	ns
t_{CHCX}	clock HIGH time	$T_{cy(clk)} \times 0.4$	-	-	ns
t_{CLCX}	clock LOW time	$T_{cy(clk)} \times 0.4$	-	-	ns
t_{CLCH}	clock rise time	-	-	5	ns
t_{CHCL}	clock fall time	-	-	5	ns

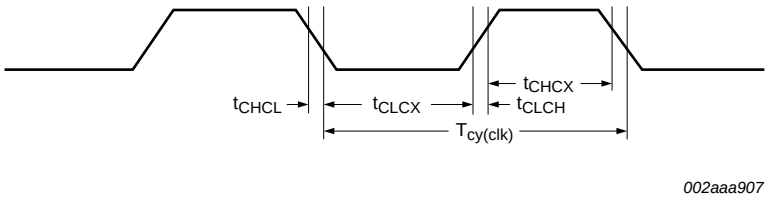

Fig 20. External clock timing (with an amplitude of at least $V_{i(RMS)}$ = 200 mV)

11.4 Internal oscillators

Table 24. Dynamic characteristic: internal oscillators
T_{amb} = −40 °C to +85 °C; 2.7 V ≤ $V_{DD(REG)(3V3)}$ ≤ 3.6 V.[1]

Symbol	Parameter	Min	Typ[2]	Max	Unit
$f_{osc(RC)}$	internal RC oscillator frequency	11.88	12	12.12	MHz
$f_{i(RTC)}$	RTC input frequency	-	32.768	-	kHz

[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 I/O pins

Table 25. Dynamic characteristic: I/O pins[1]
C_L = 10 pF; T_{amb} = −40 °C to +85 °C; $V_{DD(3V3)}$ = 3.0 V to 3.6 V.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t_r	rise time	pin configured as output	3.0	-	5.0	ns
t_f	fall time	pin configured as output	2.5	-	5.0	ns

[1] Applies to standard port pins.

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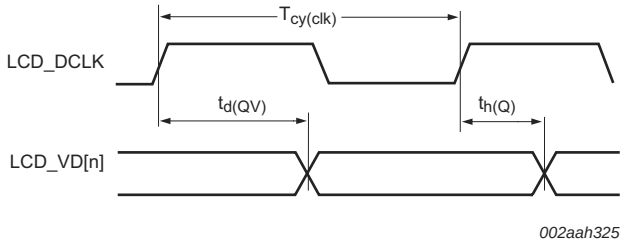

The LCD panel clock is shown with the default polarity. The clock can be inverted via the IPC bit in the LCD_POL register. Typically, the LCD panel uses the falling edge of the LCD_DCLK to sample the data.

Fig 26. LCD timing

11.10 SD/MMC

Remark: The SD/MMC card interface is available on parts LPC1788/87/86 and parts LPC1778/77/76.

Table 30. Dynamic characteristics: SD/MMC

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 SD_CLK; data transfer mode	-	25	MHz
		on pin SD_CLK; identification mode		25	MHz
$t_{su(D)}$	data input set-up time	on pins SD_CMD, SD_DAT[3:0] as inputs	6	-	ns
$t_{h(D)}$	data input hold time	on pins SD_CMD, SD_DAT[3:0] as inputs	6	-	ns
$t_{d(QV)}$	data output valid delay time	on pins SD_CMD, SD_DAT[3:0] as outputs	-	23	ns
$t_{h(Q)}$	data output hold time	on pins SD_CMD, SD_DAT[3:0] as outputs	3.5	-	ns

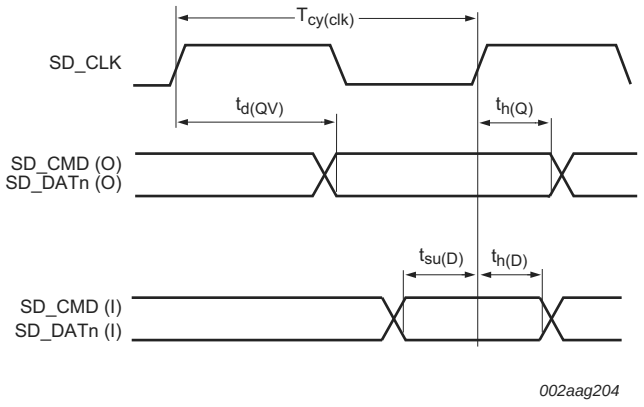

Fig 27. SD/MMC timing

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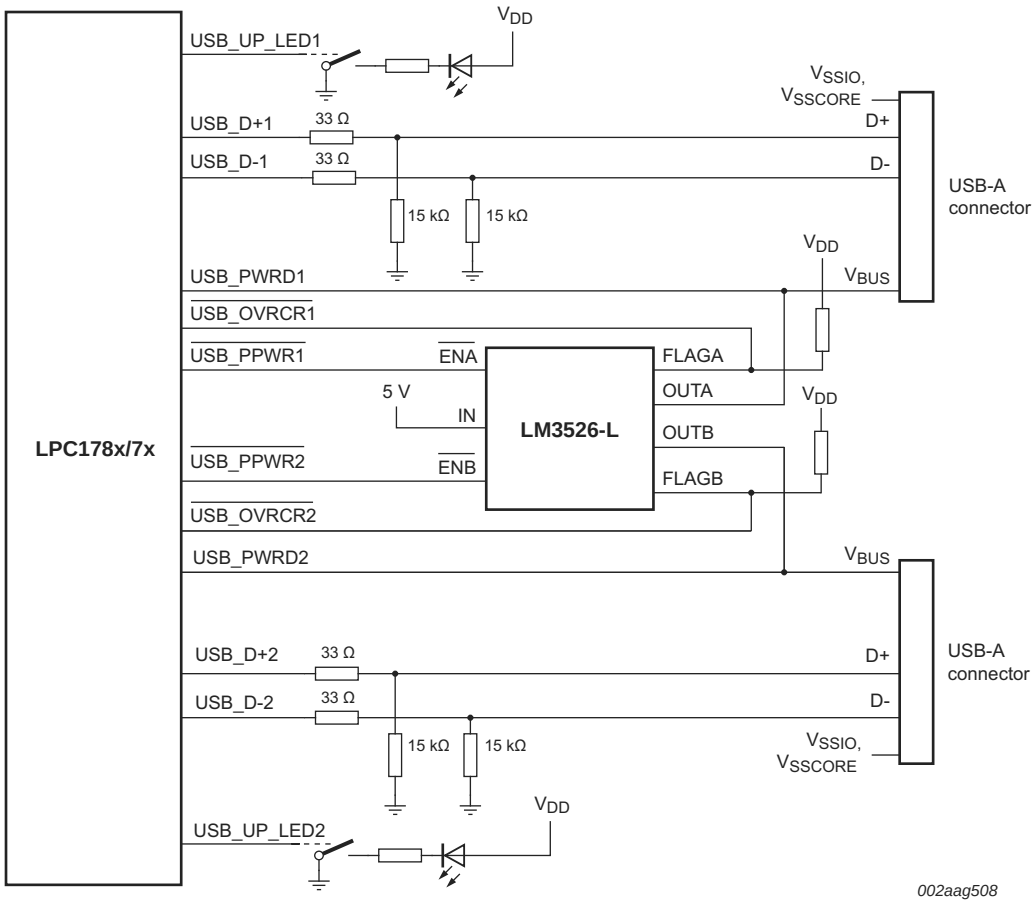

Fig 34. USB host port configuration: port 1 and port 2 as hosts

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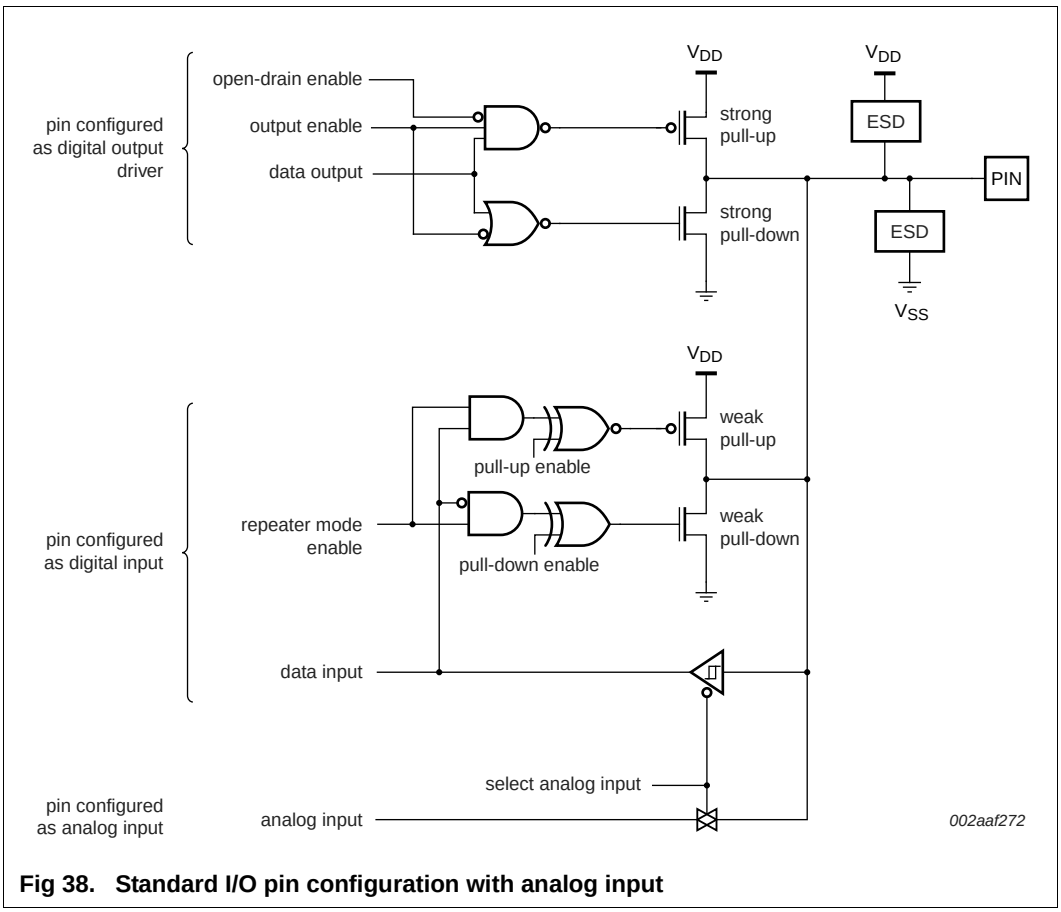

Fig 38. Standard I/O pin configuration with analog input

14.5 Reset pin configuration

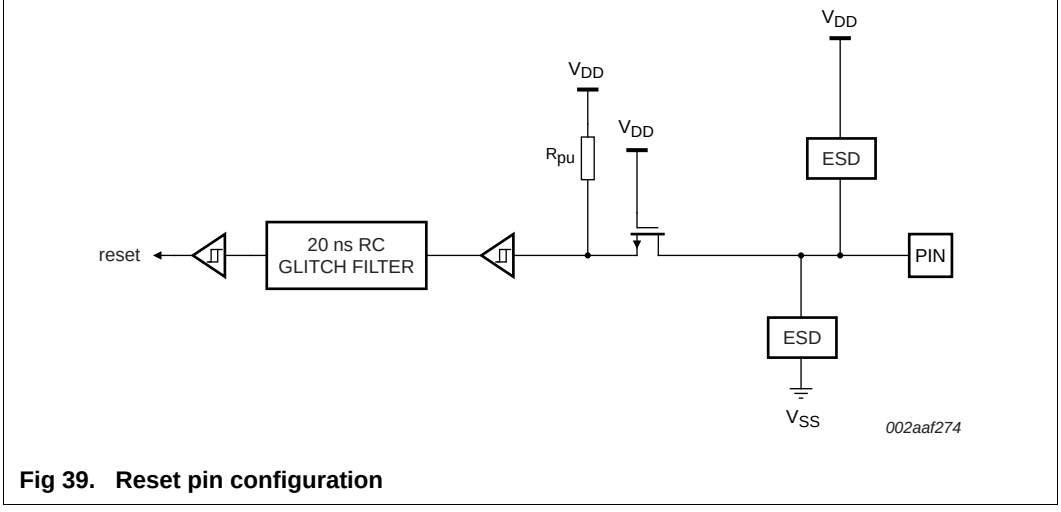

Fig 39. Reset pin configuration

14.6 Reset pin configuration for RTC operation

Under certain circumstances, the RTC may temporarily pause and lose fractions of a second during the rising and falling edges of the RESET signal.

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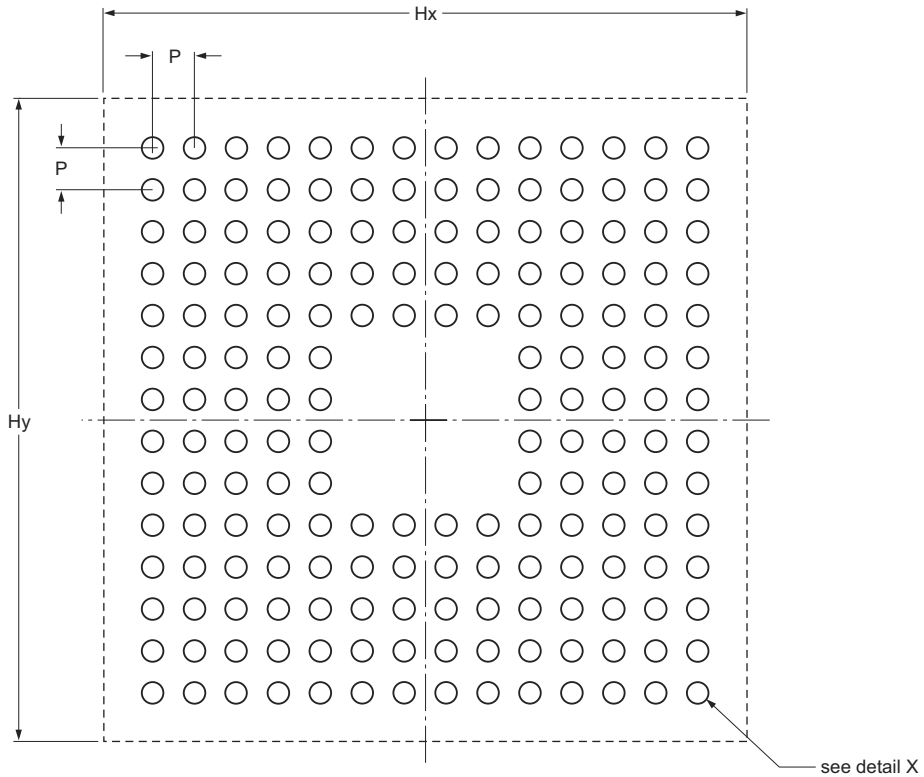
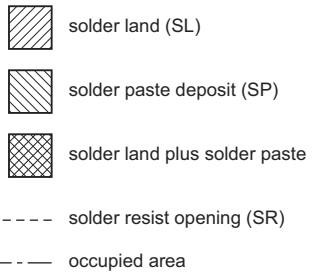
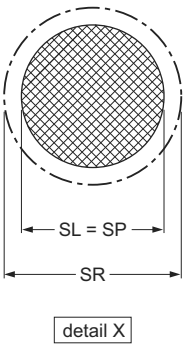
Footprint information for reflow soldering of TFBGA180 package **SOT570-3**







detail X

Dimensions in mm

P	SL	SP	SR	Hx	Hy
0.80	0.40	0.40	0.50	12.30	12.30

Issue date ~~14-01-30~~ 15-08-27

Recommend stencil thickness: 0.1 mm

sot570-3_fr

Fig 46. Reflow soldering of the TFBGA180 package

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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

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Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

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

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