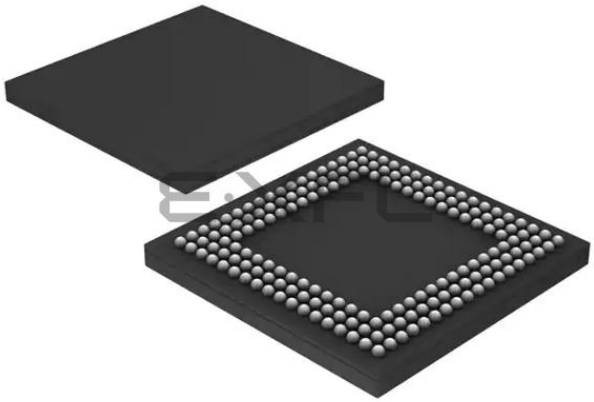

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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	ARM® Cortex®-M3
Core Size	32-Bit Single-Core
Speed	180MHz
Connectivity	CANbus, EBI/EMI, Ethernet, I²C, IrDA, Microwire, QEI, SD, SPI, SSI, SSP, UART/USART, USB, USB OTG
Peripherals	Brown-out Detect/Reset, DMA, I²S, POR, PWM, WDT
Number of I/O	118
Program Memory Size	-
Program Memory Type	ROMless
EEPROM Size	-
RAM Size	200K x 8
Voltage - Supply (Vcc/Vdd)	2.2V ~ 3.6V
Data Converters	A/D 8x10b; D/A 1x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	180-TFBGA
Supplier Device Package	180-TFBGA (12x12)
Purchase URL	https://www.e-xfl.com/product-detail/nxp-semiconductors/lpc1830fet180-551

Table 3. Pin description *…continued*

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

Symbol	LBGA256	TFBGA180	TFBGA100	LQFP144		Reset state [1]	Type	Description
P4_3	C2	B2	-	7	[5]	N; PU	I/O	**GPIO2[3] —** General purpose digital input/output pin.
							O	**CTOUT_3 —** SCTimer/PWM 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	-	9	[5]	N; PU	I/O	**GPIO2[4] —** General purpose digital input/output pin.
							O	**CTOUT_2 —** SCTimer/PWM 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.
P4_5	D2	C2	-	10	[2]	N; PU	I/O	**GPIO2[5] —** General purpose digital input/output pin.
							O	**CTOUT_5 —** SCTimer/PWM 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.

Table 3. Pin description *…continued*

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

Symbol	LBGA256	TFBGA180	TFBGA100	LQFP144		Reset state [1]	Type	Description
P8_7	K1	J1	-	-	[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	-	-	[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	-	-	[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.
P9_1	N6	P4	-	-	[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.

Table 3. Pin description *…continued*

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

Symbol	LBGA256	TFBGA180	TFBGA100	LQFP144		Reset state [1]	Type	Description
PD_0	N2	-	-	-	[2]	N; PU	-	**R —** Function reserved.
							O	**CTOUT_15 —** SCTimer/PWM 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 —** SCTimer/PWM 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.
PD_3	P4	-	-	-	[2]	N; PU	-	**R —** Function reserved.
							O	**CTOUT_6 —** SCTimer/PWM 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.

Table 3. Pin description *…continued*

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

Symbol	LBGA256	TFBGA180	TFBGA100	LQFP144		Reset state [1]	Type	Description
PE_7	F15	-	-	-	[2]	N; PU	-	**R —** Function reserved.
							O	**CTOUT_5 —** SCTimer/PWM 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	-	-	-	[2]	N; PU	-	**R —** Function reserved.
							O	**CTOUT_4 —** SCTimer/PWM 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	-	-	-	[2]	N; PU	-	**R —** Function reserved.
							I	**CTIN_4 —** SCTimer/PWM 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.
PE_10	E14	-	-	-	[2]	N; PU	-	**R —** Function reserved.
							I	**CTIN_3 —** SCTimer/PWM 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.

Table 3. Pin description *…continued*

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

Symbol	LBGA256	TFBGA180	TFBGA100	LQFP144		Reset state [1]	Type	Description
PE_15	E13	-	-	-	[2]	N; PU	-	**R —** Function reserved.
							O	**CTOUT_0 —** SCTimer/PWM output 0. Match output 0 of timer 0.
							I/O	**I2C1_SCL —** I^2C1 clock input/output (this pin does not use a specialized I2C 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	-	-	-	[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.
PF_2	D11	-	-	-	[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.

Table 3. Pin description *…continued*

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

Symbol	LBGA256	TFBGA180	TFBGA100	LQFP144		Reset state [1]	Type	Description
Debug pins								
DBGEN	L4	K4	A6	28	[2]	I; PU	I	JTAG interface control signal. Also used for boundary scan. To use the part in functional mode, connect this pin in one of the following ways: • Leave DBGEN open. The DBGEN pin is pulled up internally by a 50 kΩ resistor. • Tie DBGEN to VDDIO. • Pull DBGEN up to VDDIO with an external pull-up resistor.
TCK/SWDCLK	J5	G5	H2	27	[2]	I; F	I	Test Clock for JTAG interface (default) or Serial Wire (SW) clock.
$\overline{\text{TRST}}$	M4	L4	B4	29	[2]	I; PU	I	Test Reset for JTAG interface.
TMS/SWDIO	K6	K5	C4	30	[2]	I; PU	I	Test Mode Select for JTAG interface (default) or SW debug data input/output.
TDO/SWO	K5	J5	H3	31	[2]	O	O	Test Data Out for JTAG interface (default) or SW trace output.
TDI	J4	H4	G3	26	[2]	I; PU	I	Test Data In for JTAG interface.
USB0 pins								
USB0_DP	F2	E2	E1	18	[6]	-	I/O	USB0 bidirectional D+ line. Do not add an external series resistor.
USB0_DM	G2	F2	E2	20	[6]	-	I/O	USB0 bidirectional D− line. Do not add an external series resistor.
USB0_VBUS	F1	E1	E3	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	22	[8]	-	I	Indicates to the transceiver whether connected as an A-device (USB0_ID LOW) or B-device (USB0_ID HIGH). For use with OTG, this pin has an internal pull-up resistor.
USB0_RREF	H1	G1	F3	24	[8]	-		12.0 kΩ (accuracy 1 %) on-board resistor to ground for current reference.
USB1 pins								
USB1_DP	F12	D11	E9	89	[9]	-	I/O	USB1 bidirectional D+ line. Add an external series resistor of 33 Ω +/- 2 %.
USB1_DM	G12	E11	E10	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	92	[10]	I; F	I/O	I^2C clock input/output. Open-drain output (for I^2C-bus compliance).
I2C0_SDA	L16	K14	E6	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	128	[11]	I; IA	I	External reset input: 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 does not have an internal pull-up.

- 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.

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 1.5 % 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 1 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.

10. Static characteristics

Table 10. Static characteristics

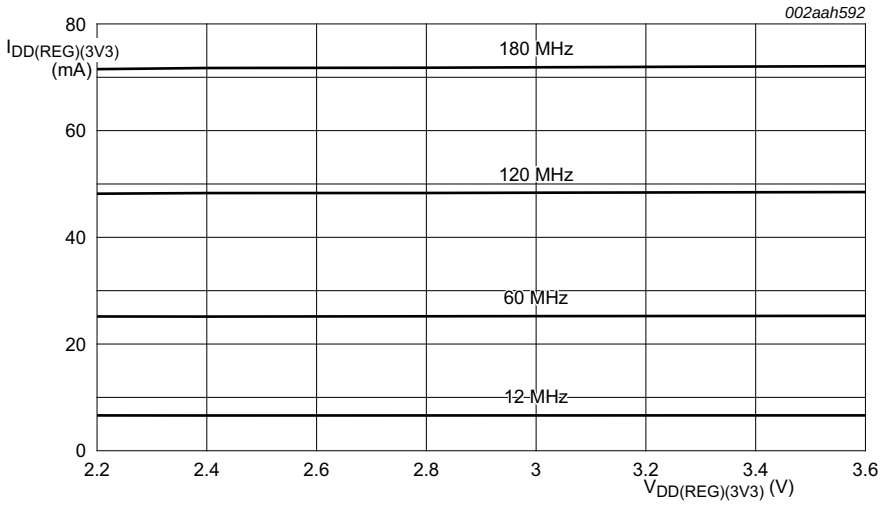
T_{amb} = −40 °C to +85 °C unless otherwise specified.

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
		on pins USB0_VDDA3V3_DRIVER and USB0_VDDA3V3		3.0	3.3	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	[9]			-	
		deep-sleep mode		-	2		µA
		power-down mode	[9]	-	2	-	µA
		deep power-down mode	[9]	-	2	-	µA

Table 10. Static characteristics *…continued*
T_{amb} = −40 °C to +85 °C unless otherwise specified.

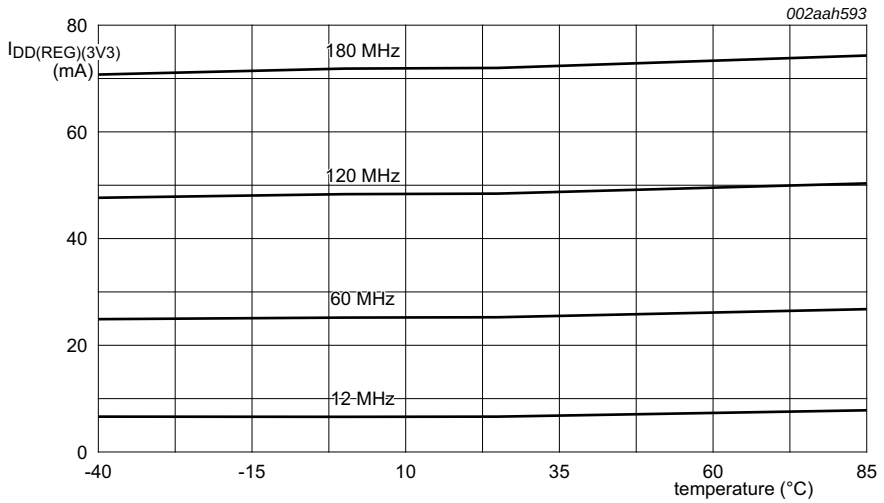
Symbol	Parameter	Conditions		Min	Typ[1]	Max	Unit
I/O pins - high drive strength: standard drive mode							
I_{OH}	HIGH-level output current	$V_{OH} = V_{DD(IO)} - 0.4$ V		−4	-	-	mA
I_{OL}	LOW-level output current	$V_{OL} = 0.4$ V		4	-	-	mA
I_{OHS}	HIGH-level short-circuit output current	drive HIGH; connected to ground	[12]	-	-	32	mA
I_{OLS}	LOW-level short-circuit output current	drive LOW; connected to $V_{DD(IO)}$	[12]	-	-	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	[12]	-	-	65	mA
I_{OLS}	LOW-level short-circuit output current	drive LOW; connected to $V_{DD(IO)}$	[12]	-	-	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	[12]	-	-	113	mA
I_{OLS}	LOW-level short-circuit output current	drive LOW; connected to $V_{DD(IO)}$	[12]	-	-	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	[12]	-	-	165	mA
I_{OLS}	LOW-level short-circuit output current	drive LOW; connected to $V_{DD(IO)}$	[12]	-	-	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		-	-	20	nA

10.1 Power consumption



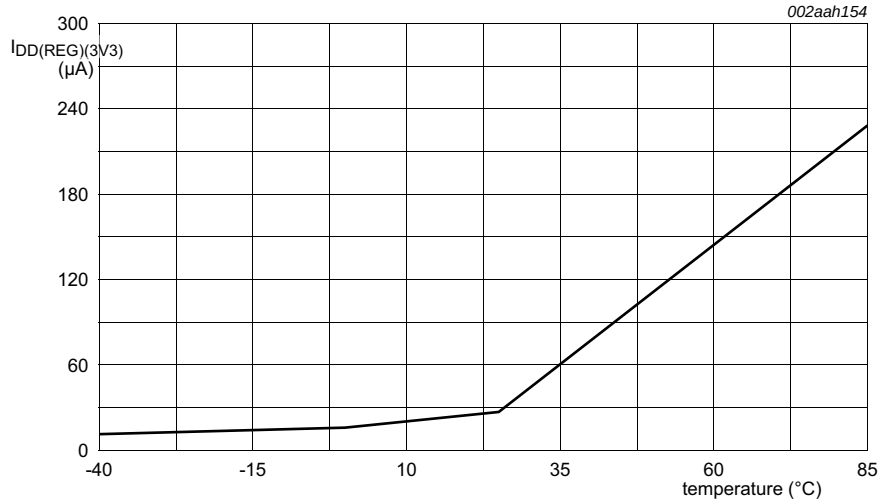
Conditions: T_{amb} = 25 °C; active mode entered executing code while(1){} from SRAM; internal pull-up resistors disabled; PLL1 enabled; IRC enabled; all peripherals disabled; all peripheral clocks disabled.

Fig 10. Typical supply current versus regulator supply voltage $V_{DD(REG)(3V3)}$ in active mode



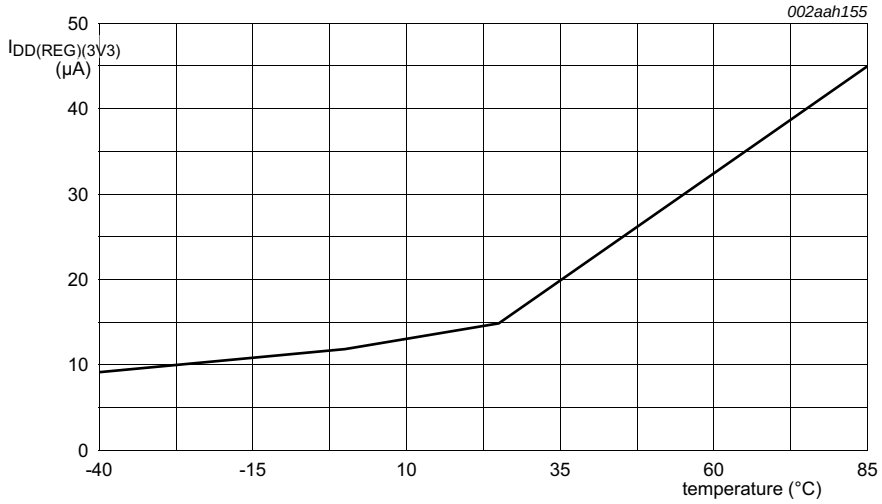
Conditions: $V_{DD(REG)(3V3)}$ = 3.3 V, Active mode entered executing code while(1){} from SRAM; internal pull-up resistors disabled; PLL1 enabled; IRC enabled; all peripherals disabled; all peripheral clocks disabled.

Fig 11. Typical supply current versus temperature in Active mode



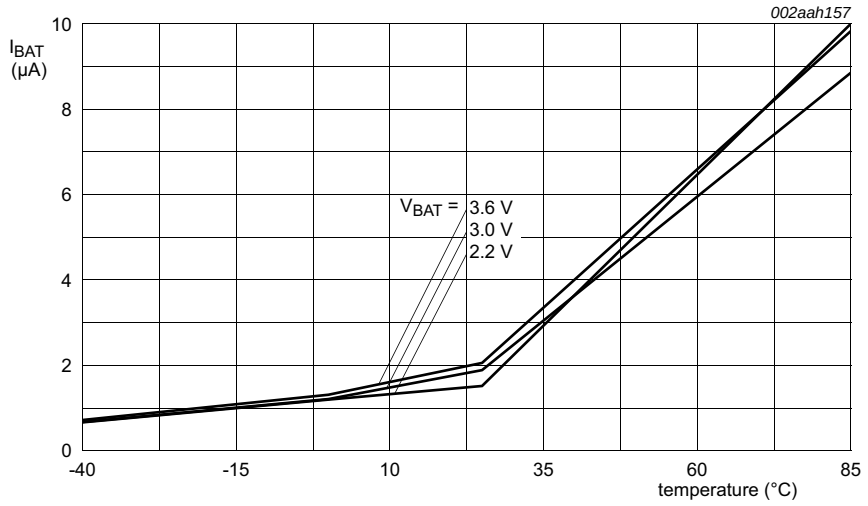
Conditions: $V_{DD(REG)(3V3)}$ = 3.3 V; V_{BAT} floating; $V_{DD(IO)}$ = 3.3 V.

Fig 14. 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 15. Typical supply current versus temperature in Power-down mode



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

Fig 18. 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:

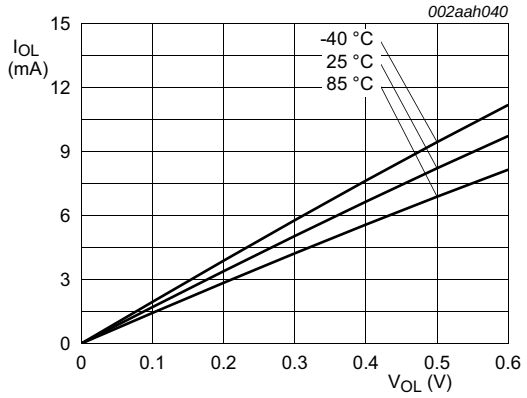
1. Enable all branch clocks and measure the current $I_{DD(REG)(3V3)}$.
2. Disable the branch clock to the peripheral to be measured and keep all other branch clocks enabled.
3. Calculate the difference between measurement 1 and 2. The result is the peripheral power consumption.

Table 11. Peripheral power consumption

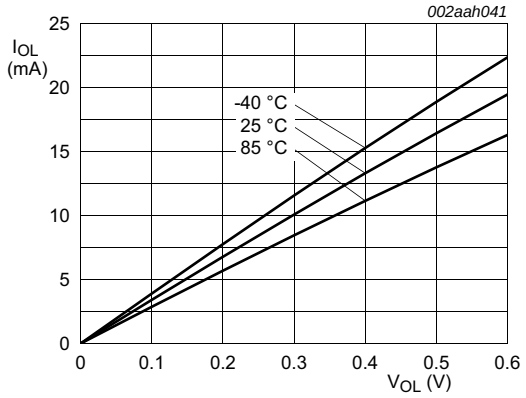
Peripheral	Branch clock	$I_{DD(REG)(3V3)}$ in mA	
		Branch clock frequency = 48 MHz	Branch clock frequency = 96 MHz
I2C1	CLK_APB3_I2C1	0.01	0.02
I2C0	CLK_APB1_I2C0	0.02	0.01
DAC	CLK_APB3_DAC	0.01	0.02
ADC0	CLK_APB3_ADC0	0.05	0.05
ADC1	CLK_APB3_ADC1	0.04	0.04
CAN0	CLK_APB3_CAN0	0.17	0.17
CAN1	CLK_APB1_CAN1	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

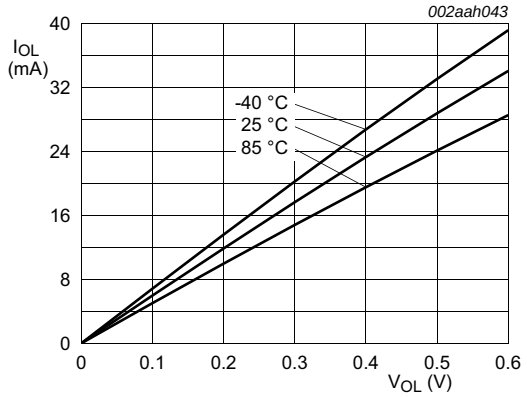
Peripheral	Branch clock	$I_{DD(REG)(3V3)}$ in mA	
		Branch clock frequency = 48 MHz	Branch clock frequency = 96 MHz
ETHERNET	CLK_M3_ETHERNET	1.05	2.09
UART0	CLK_M3_UART0, CLK_APB0_UART0	0.3	0.38
UART1	CLK_M3_UART1, CLK_APB0_UART1	0.27	0.48
UART2	CLK_M3_UART2, CLK_APB2_UART2	0.27	0.47
UART3	CLK_M3_USART3, 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
SCTimer/PWM	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



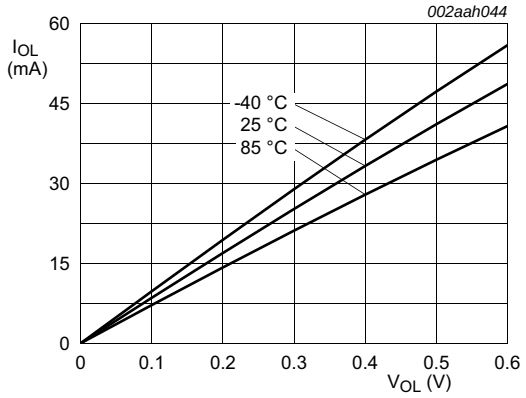
Conditions: $V_{DD(REG)(3V3)} = V_{DD(IO)} = 3.3$ V; normal-drive; EHD = 0x0.



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 21. High-drive pins; typical LOW level output current I_{OL} versus LOW level output voltage V_{OL}

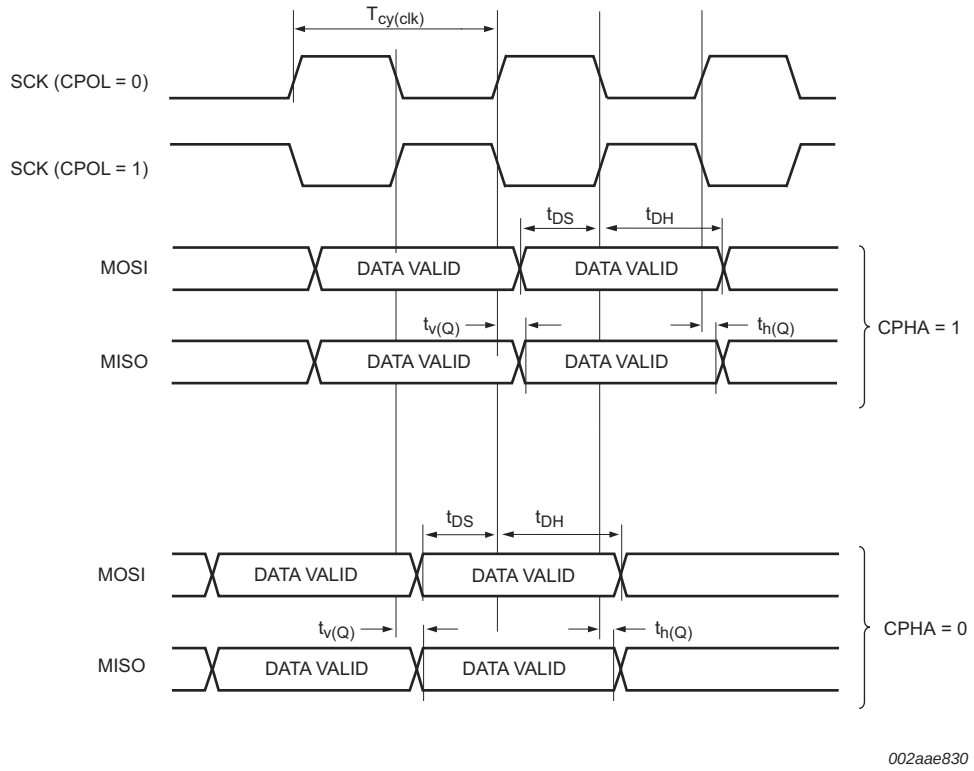


Fig 31. SSP slave timing in SPI mode

Table 25. Dynamic characteristics: Dynamic external memory interface

Simulated data over temperature and process range; C_L = 10 pF for $\overline{EMC\_DYCSn}$, $\overline{EMC\_RAS}$, $\overline{EMC\_CAS}$, $\overline{EMC\_WE}$, EMC_An; C_L = 9 pF for EMC_Dn; C_L = 5 pF for EMC_DQMOUTn, EMC_CLKn, 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
$t_{d(WEV)}$	$\overline{WE}$ valid delay time	-	3.2 + 0.5 × $T_{cy(clk)}$	5.9 + 0.5 × $T_{cy(clk)}$	ns
$t_{h(WE)}$	$\overline{WE}$ hold time	1.3 + 0.5 × $T_{cy(clk)}$	1.4 + 0.5 × $T_{cy(clk)}$	-	ns
$t_{d(DQMOUTV)}$	DQMOUT valid delay time	-	3.1 + 0.5 × $T_{cy(clk)}$	5.0 + 0.5 × $T_{cy(clk)}$	ns
$t_{h(DQMOUT)}$	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
$t_{d(CKEOUTV)}$	CKEOUT valid delay time	-	3.1 + 0.5 × $T_{cy(clk)}$	5.1 + 0.5 × $T_{cy(clk)}$	ns
$t_{h(CKEOUT)}$	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	2.2	0.8	-	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 26. 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.

11.13 USB interface

Table 27. 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 %		4.0	-	20.0	ns
t_f	fall time	10 % to 90 %		4.0	-	20.0	ns
t_{FRFM}	differential rise and fall time matching	t_r / t_f		90	-	111.11	%
V_{CRS}	output signal crossover voltage			1.3	-	2.0	V
t_{FEOPT}	source SE0 interval of EOP	see Figure 35		160	-	175	ns
t_{FDEOP}	source jitter for differential transition to SE0 transition	see Figure 35		−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 35	[1]	40	-	-	ns
t_{EOPR2}	EOP width at receiver	must accept as EOP; see Figure 35	[1]	82	-	-	ns

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

Remark: If only USB0 (HS USB) is used, VDDREG and VDDIO can be at different voltages within operating range but should have the same ramp up time. If USB1(FS USB) is used, VDDREG and VDDIO should be a minimum of 3.0 V and be tied together.

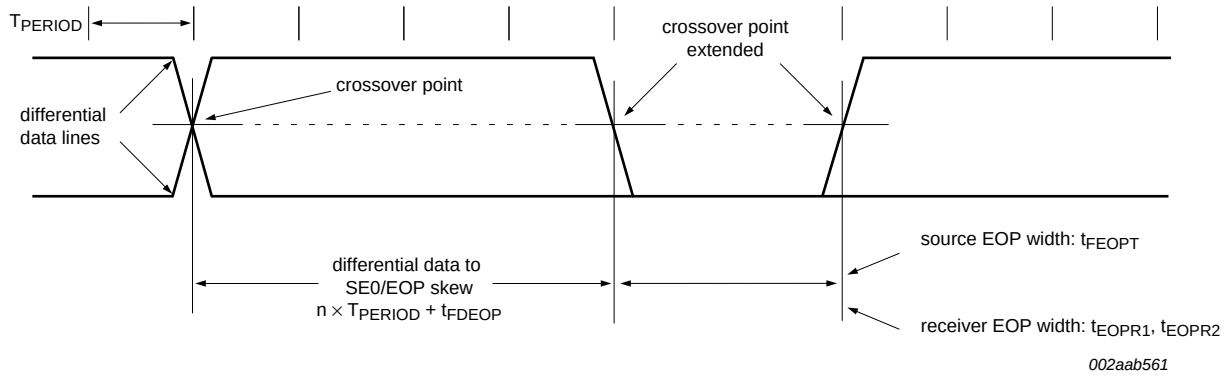
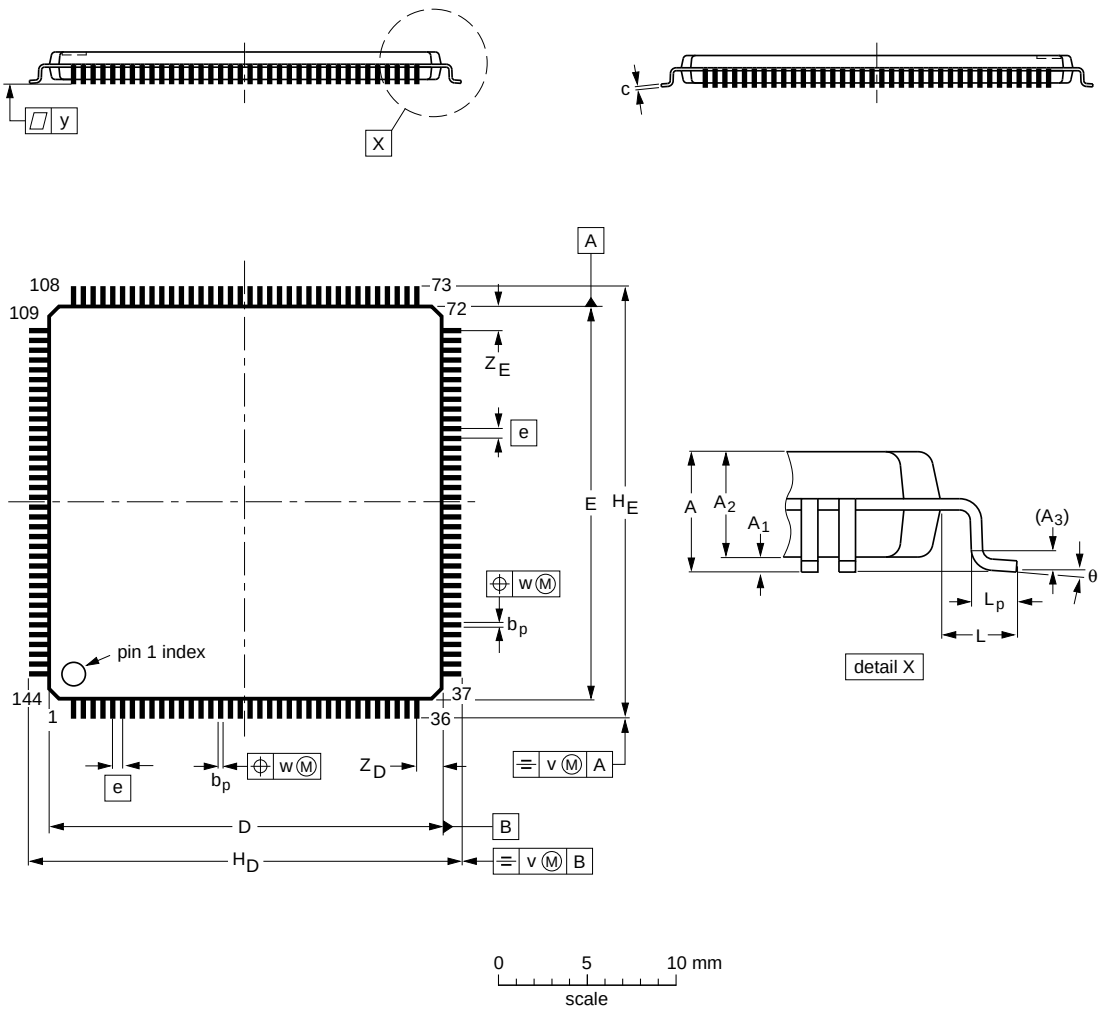


Fig 35. Differential data-to-EOP transition skew and EOP width

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 0.05	1.45 1.35	0.25	0.27 0.17	0.20 0.09	20.1 19.9	20.1 19.9	0.5	22.15 21.85	22.15 21.85	1	0.75 0.45	0.2	0.08	0.08	1.4 1.1	1.4 1.1	7^o 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~~ 03-02-20

Fig 52. Package outline for the LQFP144 package

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

Date of release: 14 March 2016
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