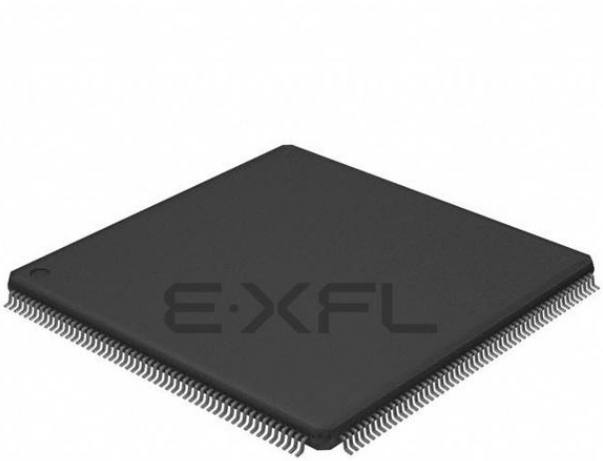

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What is "Embedded - Microcontrollers"?

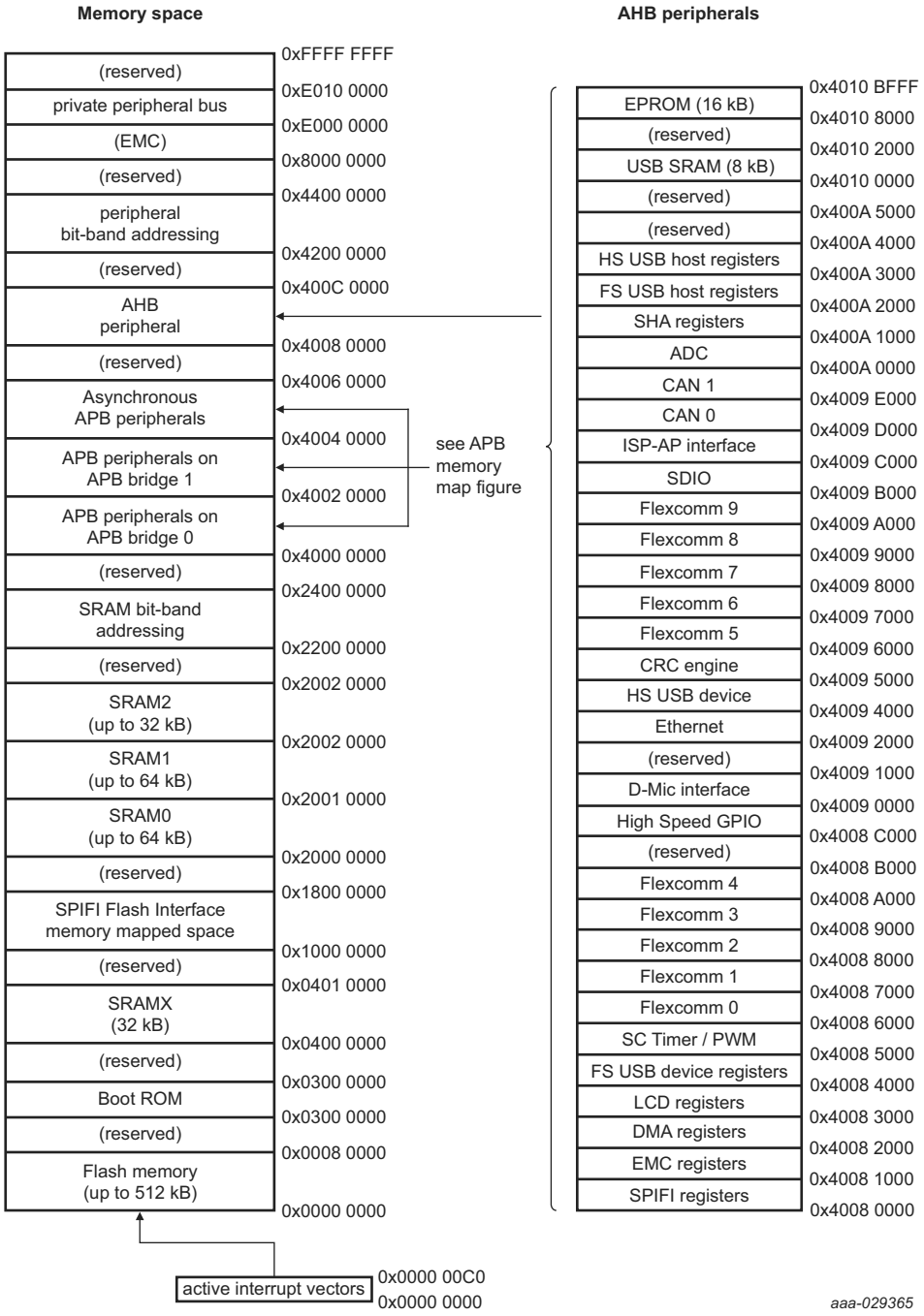
"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" 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	Discontinued at Digi-Key
Core Processor	ARM® Cortex®-M4
Core Size	32-Bit Single-Core
Speed	180MHz
Connectivity	CANbus, Ethernet, I²C, SPI, UART/USART, USB
Peripherals	Brown-out Detect/Reset, DMA, I²S, LCD, POR, PWM, WDT
Number of I/O	171
Program Memory Size	512KB (512K x 8)
Program Memory Type	FLASH
EEPROM Size	16K x 8
RAM Size	200K x 8
Voltage - Supply (Vcc/Vdd)	1.71V ~ 3.6V
Data Converters	A/D 12x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 105°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/lpc54608j512bd208e

Table 4. Pin description *…continued*

Symbol	100-pin, TFBGA	180-pin, TFBGA	208-pin, LQFP	100-pin, LQFP		Reset state [1]	Type	Description
PIO0_3/ TCK	A6	A10	178	85	[2]	PU	I/O	**PIO0_3 —** General-purpose digital input/output pin. In boundary scan mode: TCK (Test Clock In). **Remark:** In ISP mode, this pin is set to the Flexcomm 3 SPI MOSI function.
							I/O	**FC3_RXD_SDA_MOSI —** Flexcomm 3: USART receiver, I2C data I/O, SPI master-out/slave-in data.
							O	**CT0_MAT1 —** Match output 1 from Timer 0.
							O	**SCT0_OUT1 —** SCTimer/PWM output 1.
							I	**SCT0_GPI3 —** Pin input 3 to SCTimer/PWM.
								R — Reserved.
							I/O	**EMC_D[1] —** External Memory interface data [1].
PIO0_4/ TMS	B6	C8	185	87	[2]	PU	I/O	**PIO0_4 —** General-purpose digital input/output pin. In boundary scan mode: TMS (Test Mode Select). **Remark:** The state of this pin at Reset in conjunction with PIO0_5 and PIO0_6 will determine the boot source for the part or if ISP handler is invoked. See the Boot Process chapter in UM10912 for more details.
							I	**CAN0_RD —** Receiver input for CAN 0.
							I/O	**FC4_SCK —** Flexcomm 4: USART or SPI clock.
							I	**CT3_CAP0 —** Capture input 0 to Timer 3.
							I	**SCT0_GPI4 —** Pin input 4 to SCTimer/PWM.
								R — Reserved.
							I/O	**EMC_D[2] —** External Memory interface data [2].
							O	**ENET_MDC —** Ethernet management data clock.
PIO0_5/ TDI	A5	E7	189	89	[2]	PU	I/O	**PIO0_5 —** General-purpose digital input/output pin. In boundary scan mode: TDI (Test Data In). **Remark:** The state of this pin at Reset in conjunction with PIO0_4 and PIO0_6 will determine the boot source for the part or if ISP handler is invoked. See the Boot Process chapter in UM10912 for more details.
							O	**CAN0_TD —** Transmitter output for CAN 0.
							I/O	**FC4_RXD_SDA_MOSI —** Flexcomm 4: USART receiver, I2C data I/O, SPI master-out/slave-in data.
							O	**CT3_MAT0 —** Match output 0 from Timer 3.
							I	**SCT0_GPI5 —** Pin input 5 to SCTimer/PWM.
								R — Reserved.
							I/O	**EMC_D[3] —** External Memory interface data [3].
							I/O	**ENET_MDIO —** Ethernet management data I/O.



The private peripheral bus includes CPU peripherals such as the NVIC, SysTick, and the core control registers.

Fig 9. LPC546xx Memory mapping

Table 9 shows wake-up sources for reduced power modes.

Table 9. Wake-up sources for reduced power modes

Power mode	Wake-up source	Conditions
Sleep	Any interrupt	Enable interrupt in NVIC.
	HWWAKE	Certain Flexcomm Interface and DMIC subsystem activity.
Deep-sleep	Pin interrupts	Enable pin interrupts in NVIC and STARTER0 and/or STARTER1 registers.
	BOD interrupt	• Enable interrupt in NVIC and STARTER0 registers. • Enable interrupt in BODCTRL register. • Configure the BOD to keep running in this mode with the power API.
	BOD reset	Enable reset in BODCTRL register.
	Watchdog interrupt	• Enable the watchdog oscillator in the PDRUNCFG0 register. • Enable the watchdog interrupt in NVIC and STARTER0 registers. • Enable the watchdog in the WWDT MOD register and feed. • Enable interrupt in WWDT MOD register. • Configure the WDTOSC to keep running in this mode with the power API.
	Watchdog reset	• Enable the watchdog oscillator in the PDRUNCFG0 register. • Enable the watchdog and watchdog reset in the WWDT MOD register and feed.
	Reset pin	Always available.
	RTC 1 Hz alarm timer	• Enable the RTC 1 Hz oscillator in the RTCOSCCTRL register. • Enable the RTC bus clock in the AHBCLKCTRL0 register. • Start RTC alarm timer by writing a time-out value to the RTC COUNT register. • Enable the RTCALARM interrupt in the STARTER0 register.
	RTC 1 kHz timer time-out and alarm	• Enable the RTC 1 Hz oscillator and the RTC 1 kHz oscillator in the RTC CTRL register. • Start RTC 1 kHz timer by writing a value to the WAKE register of the RTC. • Enable the RTC wake-up interrupt in the STARTER0 register.
	Micro-tick timer (intended for ultra-low power wake-up from deep-sleep mode	• Enable the watchdog oscillator in the PDRUNCFG0 register. • Enable the Micro-tick timer clock by writing to the AHBCLKCTRL1 register. • Start the Micro-tick timer by writing UTICK CTRL register. • Enable the Micro-tick timer interrupt in the STARTER0 register.
	I2C interrupt	Interrupt from I2C in slave mode.
	SPI interrupt	Interrupt from SPI in slave mode.
	USART interrupt	Interrupt from USART in slave or 32 kHz mode.
	USB0 need clock interrupt	Interrupt from USB0 when activity is detected that requires a clock.
	USB1 need clock interrupt	Interrupt from USB1 when activity is detected that requires a clock.
	Ethernet interrupt	Interrupt from ethernet.
	DMA interrupt	Interrupt from DMA.
	HWWAKE	Certain Flexcomm Interface and DMIC subsystem activity.

7.17.3 Ethernet AVB

The Ethernet block enables a host to transmit and receive data over Ethernet in compliance with the IEEE 802.3-2008 standard. The Ethernet interface contains a full featured 10 Mbps or 100 Mbps Ethernet MAC (Media Access Controller) designed to provide optimized performance through the use of DMA hardware acceleration.

7.17.3.1 Features

- 10/100 Mbit/s
- DMA support
- Power management remote wake-up frame and magic packet detection
- Supports both full-duplex and half-duplex operation
  - Supports CSMA/CD Protocol for half-duplex operation.
  - Supports IEEE 802.3x flow control for full-duplex operation.
  - Optional forwarding of received pause control frames to the user application in full-duplex operation.
  - Supports IEEE 802.1AS-2011 and 802.1-Qav-2009 for Audio Video (AV) traffic.
  - Software support for AVB feature is available from NXP Professional Services. See nxp.com for more details.
  - Back-pressure support for half-duplex operation.
  - Automatic transmission of zero-quanta pause frame on deassertion of flow control input in full-duplex operation.
- Supports IEEE1588 time stamping and IEEE 1588 advanced time stamping (IEEE 1588-2008 v2).

7.17.4 SPI Flash Interface (SPIFI)

The SPI Flash Interface allows low-cost serial flash memories to be connected to the LPC546xx microcontroller with little performance penalty compared to parallel flash devices with higher pin count.

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

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

7.17.4.1 Features

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

7.18.4 DMA controller

The DMA controller allows peripheral-to memory, memory-to-peripheral, and memory-to-memory transactions. Each DMA stream provides unidirectional DMA transfers for a single source and destination.

7.18.4.1 Features

- One channel per on-chip peripheral direction: typically one for input and one for output for most peripherals.
- DMA operations can optionally be triggered by on- or off-chip events.
- Priority is user selectable for each channel.
- Continuous priority arbitration.
- Address cache.
- Efficient use of data bus.
- Supports single transfers up to 1,024 words.
- Address increment options allow packing and/or unpacking data.

7.19 Counter/timers

7.19.1 General-purpose 32-bit timers/external event counter

The LPC546xx includes five general-purpose 32-bit timer/counters.

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

7.19.1.1 Features

- A 32-bit timer/counter with a programmable 32-bit prescaler.
- Counter or timer operation.
- Up to four 32-bit captures can take a snapshot of the timer value when an input signal transitions. A capture event may also optionally generate an interrupt. The number of capture inputs for each timer that are actually available on device pins may vary by device.
- Four 32-bit match registers that allow:
  - Continuous operation with optional interrupt generation on match.
  - Stop timer on match with optional interrupt generation.
  - Reset timer on match with optional interrupt generation.
  - Shadow registers are added for glitch-free PWM output.
- For each timer, up to four external outputs corresponding to match registers with the following capabilities (the number of match outputs for each timer that are actually available on device pins may vary by device):
  - Set LOW on match.
  - Set HIGH on match.

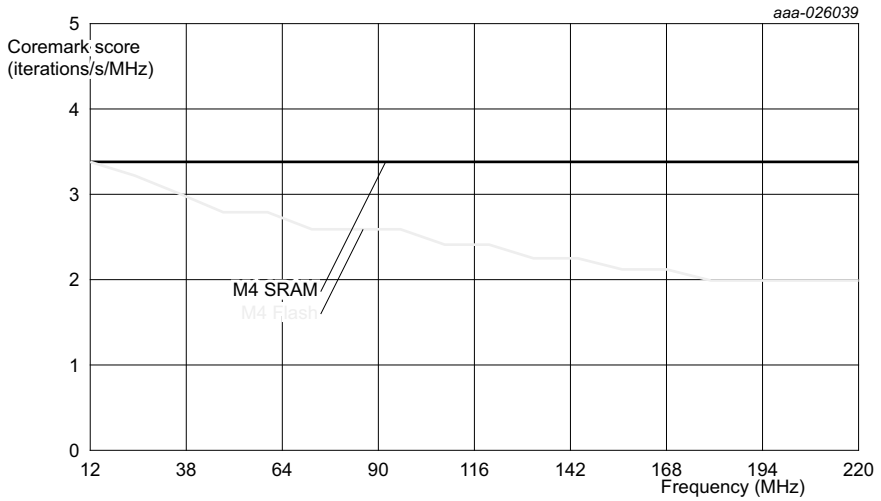
[9] It is recommended to connect an overvoltage protection diode between the analog input pin and the voltage supply pin.

[10] Dependent on package type.

[11] JEDEC (4.5 in × 4 in); still air.

[12] Single layer (4.5 in × 3 in); still air.

[13] 8-layer (4.5 in × 3 in); still air.



Conditions: V_{DD} = 3.3 V; T_{amb} = 25 °C; active mode; all peripherals disabled; BOD disabled; See the FLASHCFG register in the LPC546xx. User Manual for system clock flash access time settings. Acceleration enable bit in the FLASCFG register is set to 1. Measured with IAR ver 8.22.2. Optimization level 3, optimized for time ON. Coremark score is based on the power API library from the SDK software package available on nxp.com.

12 MHz, 24 MHz, 48 MHz, and 96 MHz: FRO enabled; PLL disabled.
36 MHz, 60 MHz, 72 MHz, 84 MHz, 108 MHz, 120 MHz, 132 MHz, 144 MHz, 156 MHz, 168 MHz, 180 MHz, 192 MHz, 204 MHz, 216 MHz, and 220 MHz: FRO enabled; PLL enabled.
CoreMark score from flash: SRAM1, SRAM2, SRAM3, and USB SRAM powered down. SRAM0 and SRAMX powered.
CoreMark score from SRAMX: SRAM0 is powered; flash is powered down.

Fig 14. Typical CoreMark score (iterations/s/MHz) vs. Frequency (MHz) from flash and SRAMX

[3] Tested in production. VDD = 1.71 V. At hot temperature and below 2.0 V, the supply current could increase slightly because of reduction of available RBB (reverse body bias) voltage.

Table 17. Static characteristics: Power consumption in deep-sleep and deep power-down modes

T_{amb} = −40 °C to +105 °C, unless otherwise specified, 2.7 V ≤ V_{DD} ≤ 3.6 V.

Symbol	Parameter	Conditions		Min	Typ[1][2]	Max[3]	Unit
I_{DD}	supply current	Deep-sleep mode; Flash is powered down					
		SRAMX (32 KB) powered T_{amb} = 25 °C		-	23	69	μA
		SRAMX (32 KB) powered T_{amb} = 105 °C		-	-	1150	μA
		Deep power-down mode					
		RTC oscillator input grounded (RTC oscillator disabled) *T_{amb} = 25 °C*		-	464	1500	nA
		RTC oscillator input grounded (RTC oscillator disabled) *T_{amb} = 105 °C*		-	-	42	μA
		RTC oscillator running with external crystal VDD = VDDA= VREFP = 3.3 V, VBAT = 3.0 V		-	550	-	nA

[1] Typical ratings are not guaranteed. Typical values listed are at room temperature (25 °C), VDD = 3.3 V.

[2] Characterized through bench measurements using typical samples.

[3] Tested in production, VDD = 3.6 V.

Table 18. Static characteristics: Power consumption in deep power-down mode

T_{amb} = −40 °C to +105 °C, unless otherwise specified, 2.7 V ≤ V_{DD} ≤ 3.6 V.

Symbol	Parameter	Conditions		Min	Typ[1][2]	Max	Unit
I_{BAT}	battery supply current	deep power-down mode; RTC oscillator running with external crystal					
		VDD = VDDA= VREFP = 3.3 V, VBAT = 3.0 V		-	0	-	nA
		VDD = VDDA= VREFP = 0 V or tied to ground, VBAT = 3.0 V		-	340[3]	-	nA

[1] Typical ratings are not guaranteed. Typical values listed are at room temperature (25 °C).

[2] Characterized through bench measurements using typical samples.

[3] If VBAT> VDD, the external reset pin must be floating to prevent high VBAT leakage.

Table 27. Dynamic characteristics: Static external memory interface *…continued*

C_L = 20 pF balanced loading on all pins, T_{amb} = −40 °C to 105 °C, V_{DD} = 2.7 V to 3.6 V. Max EMC clock = 100 MHz. Input slew = 1 ns; SLEW set to fast-mode. Parameters sampled at the 90 % and 10 % level of the rising or falling edge. Excluding delays introduced by external device and PCB; Values based on simulation.

Symbol	Parameter[1]	Conditions[1]		Min	Typ	Max	Unit
$t_{h(D)}$	data input hold time	RD_6	[2][4]	−5.5	-	-	ns
$t_{CSHBLSH}$	$\overline{CS}$ HIGH to $\overline{BLS}$ HIGH time	PB = 1	[6]	0.7	-	1.5	ns
t_{CSHOEH}	$\overline{CS}$ HIGH to $\overline{OE}$ HIGH time		[2]	0.5	-	0.9	ns
t_{OEHANV}	$\overline{OE}$ HIGH to address invalid time	RD_8	[2]	−0.4	-	0	ns
t_{deact}	deactivation time	RD_7	[2]	0.5	-	0.9	ns
Write cycle parameters[2]							
t_{CSLAV}	$\overline{CS}$ LOW to address valid time	WR_1		0.1	-	0.5	ns
t_{CSLDV}	$\overline{CS}$ LOW to data valid time	WR_2		1	-	2.2	ns
t_{CSLWEL}	$\overline{CS}$ LOW to $\overline{WE}$ LOW time	WR_3; PB =1	[2][6]	−0.5 + (WAITWEN + 1) × $T_{cy(clk)}$	-	(WAITWEN + 1) × $T_{cy(clk)}$	ns
$t_{CSLBLSL}$	$\overline{CS}$ LOW to $\overline{BLS}$ LOW time	WR_4; PB = 1	[2][6]	−1.9	-	0	ns
t_{WELWEH}	$\overline{WE}$ LOW to $\overline{WE}$ HIGH time	WR_5; PB =1	[2][6]	−0.1 + (WAITWEN + 1) × $T_{cy(clk)}$	-	(WAITWEN + 1) × $T_{cy(clk)}$	ns
$t_{BLSLBLSH}$	$\overline{BLS}$ LOW to $\overline{BLS}$ HIGH time	PB = 1	[2][6]	3.1	-	6.7	ns
t_{WEHDNV}	$\overline{WE}$ HIGH to data invalid time	WR_6; PB =1	[2][6]	1.6 + $T_{cy(clk)}$	-	2.8 + $T_{cy(clk)}$	ns
t_{WEHEOW}	$\overline{WE}$ HIGH to end of write time	WR_7; PB = 1	[2][5][6]	0.5 +$T_{cy(clk)}$	-	0.8 + $T_{cy(clk)}$	ns
$t_{BLSHDNV}$	$\overline{BLS}$ HIGH to data invalid time	PB = 1	[6]	−0.8	-	0	ns
t_{WEHANV}	$\overline{WE}$ HIGH to address invalid time	PB = 1	[6]	0.5	-	0.8	ns
t_{deact}	deactivation time	WR_8; PB = 0; PB = 1	[2][6]	−0.8	-	0	ns
$t_{CSLBLSL}$	$\overline{CS}$ LOW to $\overline{BLS}$ LOW	WR_9; PB = 0	[2][6]	−1.9 + (WAITWEN + 1) × $T_{cy(clk)}$	-	(WAITWEN + 1) × $T_{cy(clk)}$	ns
$t_{BLSLBLSH}$	$\overline{BLS}$ LOW to $\overline{BLS}$ HIGH time	WR_{10}; PB = 0	[2][6]	3.1+ (WAITWR − WAITWEN + 1) × $T_{cy(clk)}$	-	6.7+ (WAITWR − WAITWEN + 1) × $T_{cy(clk)}$	ns
$t_{BLSHEOW}$	$\overline{BLS}$ HIGH to end of write time	WR_{11}; PB = 0	[2][5][6]	−0.8 + $T_{cy(clk)}$	-	$T_{cy(clk)}$	ns
$t_{BLSHDNV}$	$\overline{BLS}$ HIGH to data invalid time	WR12; PB = 0	[2][6]	0.2 + $T_{cy(clk)}$	-	0.5 + $T_{cy(clk)}$	ns

[1] Parameters are shown as RD_n or WD_n in Figure 24 as indicated in the Conditions column.

Table 28. Dynamic characteristics: Dynamic external memory interface, read strategy bits (RD bits) = 01 [2]

C_L = 10 pF balanced loading on all pins, T_{amb} = −40 °C to 105 °C, V_{DD} = 2.7 V to 3.6 V. Max EMC clock = 100 MHz. Input slew = 1 ns; SLEW set to fast-mode. Parameters sampled at the 90 % and 10 % level of the rising or falling edge. Excluding delays introduced by external device and PCB. Values based on simulation. t_{cmddly} is programmable delay value for EMC command outputs in command delayed mode; t_{fbdly} is programmable delay value for the feedback clock that controls input data sampling.

Symbol	Parameter		Min	Typ	Max	Unit
For RD = 1						
Common to read and write cycles						
$T_{cy(clk)}$	clock cycle time	[1]	10	-	-	ns
$t_{d(SV)}$	chip select valid delay time		-	-	t_{cmddly} + 3.7	ns
$t_{h(S)}$	chip select hold time		t_{cmddly} + 1.7	-	-	ns
$t_{d(RASV)}$	row address strobe valid delay time		-	-	t_{cmddly} + 4.1	ns
$t_{h(RAS)}$	row address strobe hold time		t_{cmddly} + 1.8	-	-	ns
$t_{d(CASV)}$	column address strobe valid delay time		-	-	t_{cmddly} + 4.4	ns
$t_{h(CAS)}$	column address strobe hold time		t_{cmddly} + 1.9	-	-	ns
$t_{d(WV)}$	write valid delay time		-	-	t_{cmddly} + 5.1	ns
$t_{h(W)}$	write hold time		t_{cmddly} + 2.4	-	-	ns
$t_{d(AV)}$	address valid delay time		-	-	t_{cmddly} + 4.8	ns
$t_{h(A)}$	address hold time		t_{cmddly} + 1.7	-	-	ns
Read cycle parameters						
$t_{su(D)}$	data input set-up time		0.5	-	-	ns
$t_{h(D)}$	data input hold time		2.1	-	-	ns
Write cycle parameters						
$t_{d(QV)}$	data output valid delay time		-	-	8.1	ns
$t_{h(Q)}$	data output hold time		−1.7	-	-	ns

[1] Refers to SDRAM clock signal EMC_CLKOUTn where n = 0 and 1.

[2] See Table 30 for internal programmable delay.

Table 36. Dynamic characteristics of the PLL2[1]

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Reference clock input							
F_{in}	input frequency			1	-	25	MHz
Clock output							
f_o	output frequency	for PLL2 clkout output	[2]	4.3	-	550	MHz
d_o	output duty cycle	for PLL2 clkout output		46	-	54	%
f_{CCO}	CCO frequency			275	-	550	MHz
Lock detector output							
$\Delta_{lock(PFD)}$	PFD lock criterion		[3]	1	2	4	ns
Dynamic parameters at $f_{out} = f_{CCO} = 540$ MHz; standard bandwidth settings							
$J_{rms\text{-}interval}$	RMS interval jitter	f_{ref} = 10 MHz	[4][5]	-	15	30	ps
$J_{pp\text{-}period}$	peak-to-peak, period jitter	f_{ref} = 10 MHz	[4][5]	-	40	80	ps

[1] Data based on characterization results, not tested in production.

[2] Excluding under- and overshoot which may occur when the PLL is not in lock.

[3] A phase difference between the inputs of the PFD (clkref and clkfb) smaller than the PFD lock criterion means lock output is HIGH.

[4] Actual jitter dependent on amplitude and spectrum of substrate noise.

[5] Input clock coming from a crystal oscillator with less than 250 ps peak-to-peak period jitter.

11.9 FRO

The FRO is trimmed to ±1 % accuracy over the entire voltage and temperature range.

Table 37. Dynamic characteristic: FRO

T_{amb} = −40 °C to +105 °C; 1.71 V ≤ V_{DD} ≤ 3.6 V.

Symbol	Parameter	Conditions	Min	Typ[1]	Max	Unit
$f_{osc(RC)}$	FRO clock frequency	-	11.88	12	12.12	MHz
$f_{osc(RC)}$	FRO clock frequency	-	47.52	48	48.48	MHz
$f_{osc(RC)}$	FRO clock frequency	-	95.04	96	96.96	MHz

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

11.10 Crystal oscillator

Table 38. Dynamic characteristic: oscillator

T_{amb} = −40 °C to +105 °C; 1.71 V ≤ V_{DD} ≤ 3.6 V.[1]

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

Table 42. Dynamic characteristics: I²S-bus interface pins [1][4]

T_{amb} = −40 °C to 105 °C; V_{DD} = 1.71 V to 3.6 V; C_L = 30 pF balanced loading on all pins; Input slew = 1.0 ns, SLEW setting = standard mode for all pins; Parameters sampled at the 50 % level of the rising or falling edge.

Symbol	Parameter	Conditions		Min	Typ[3]	Max	Unit
Master; 2.7 V ≤ VDD ≤ 3.6 V							
$t_{v(Q)}$	data output valid time	on pin I2Sx_TX_SDA	[2]				
		CCLK ≤ 100 MHz		21.4	-	30.4	ns
		100 MHz < CCLK ≤ 180 MHz		20.6	-	28.7	ns
		on pin I2Sx_WS					
		CCLK ≤ 100 MHz		21.1	-	29	ns
		100 MHz < CCLK ≤ 180 MHz		20.3	-	28.3	ns
$t_{su(D)}$	data input set-up time	on pin I2Sx_RX_SDA	[2]				
		CCLK ≤ 100 MHz		1.3	-	-	ns
		100 MHz < CCLK ≤ 180 MHz		1.0	-	-	ns
$t_{h(D)}$	data input hold time	on pin I2Sx_RX_SDA	[2]				
		CCLK ≤ 100 MHz		2.9	-	-	ns
		100 MHz < CCLK ≤ 180 MHz		3.3	-	-	ns
Slave; 2.7 V ≤ VDD ≤ 3.6 V							
$t_{v(Q)}$	data output valid time	on pin I2Sx_TX_SDA	[2]				
		CCLK ≤ 100 MHz		13.8	-	23.6	ns
		100 MHz < CCLK ≤ 180 MHz		13	-	21.9	ns
$t_{su(D)}$	data input set-up time	on pin I2Sx_RX_SDA	[2]				
		CCLK ≤ 100 MHz		4.7	-	-	ns
		100 MHz < CCLK ≤ 180 MHz		4.2	-	-	ns
		on pin I2Sx_WS					
		CCLK ≤ 100 MHz		0.9	-	-	ns
		100 MHz < CCLK ≤ 180 MHz		0.7	-	-	ns
$t_{h(D)}$	data input hold time	on pin I2Sx_RX_SDA	[2]				
		CCLK ≤ 100 MHz		0	-	-	ns
		100 MHz < CCLK ≤ 180 MHz		0	-	-	ns
		on pin I2Sx_WS					
		CCLK ≤ 100 MHz		1.5	-	-	ns
		100 MHz < CCLK ≤ 180 MHz		1.3	-	-	ns

[1] Based on characterization; not tested in production.

[2] Clock Divider register (DIV) = 0x0.

[3] Typical ratings are not guaranteed.

[4] The Flexcomm Interface function clock frequency should not be above 48 MHz. See the data rates section in the I²S chapter (UM10912) to calculate clock and sample rates.

[5] Based on simulation. Not tested in production.

11.18 Smart card interface

Table 46. Dynamic characteristics[1]

T_{amb} = −40 °C to 105 °C; V_{DD} = 1.71 V to 3.6 V; C_L = 30 pF balanced loading on all pins; Input slew = 1 ns, SLEW setting = standard mode for all pins; Parameters sampled at the 90 % and 10 % level of the rising or falling edge.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
2.7 V ≤ VDD ≤ 3.6 V						
t_{DS}	data set-up time	CCLK ≤ 100 MHz	2.1	-	-	ns
		100 MHz < CCLK ≤ 180 MHz	2.1	-	-	ns
t_{DH}	data hold time	CCLK ≤ 100 MHz	0	-	-	ns
		100 MHz < CCLK ≤ 180 MHz	0	-	-	ns
$t_{v(Q)}$	data output valid time	CCLK ≤ 100 MHz	11.0	-	22.5	ns
		100 MHz < CCLK ≤ 180 MHz	11.0	-	22.5	ns

[1] Based on simulated values. V_{DD} = 2.7 V - 3.6 V.

12. Analog characteristics

12.1 BOD

Table 53. BOD static characteristics

T_{amb} = 25 °C; based on characterization; not tested in production.

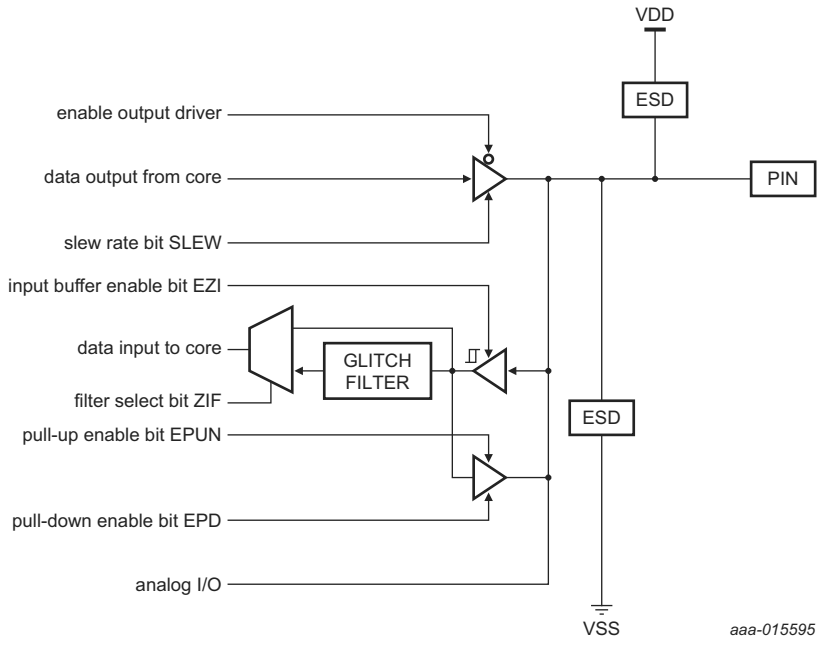
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{th}	threshold voltage	interrupt level 0					
		assertion		1.5	-	1.63	V
		de-assertion		1.55	-	1.69	V
		reset level 0					
		assertion		1.5	-	1.62	V
		de-assertion		1.55	-	1.69	V
V_{th}	threshold voltage	interrupt level 1					
		assertion		1.54	-	1.68	V
		de-assertion		1.6	-	1.75	V
		reset level 1					
		assertion		1.55	-	1.68	V
		de-assertion		1.61	-	1.74	V
V_{th}	threshold voltage	interrupt level 2					
		assertion		1.79	-	1.95	V
		de-assertion		1.85	-	2.02	V
		reset level 2					
		assertion		2.04	-	2.21	V
		de-assertion		2.19	-	2.38	V
V_{th}	threshold voltage	interrupt level 3					
		assertion		2.62	-	2.86	V
		de-assertion		2.77	-	3.03	V
		reset level 3					
		assertion		2.62	-	2.85	V
		de-assertion		2.78	-	3.02	V

13.2 Standard I/O pin configuration

Figure 44 shows the possible pin modes for standard I/O pins:

- Digital output driver: enabled/disabled.
- Digital input: Pull-up enabled/disabled.
- Digital input: Pull-down enabled/disabled.
- Digital input: Repeater mode enabled/disabled.
- Z mode; High impedance (no cross-bar currents for floating inputs).

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



The glitch filter rejects pulses of typical 12 ns width.

Fig 44. Standard I/O and $\overline{\text{RESET}}$ pin configuration

13.6 XTAL oscillator

In the XTAL oscillator circuit, only the crystal (XTAL) and the capacitances C_{X1} and C_{X2} need to be connected externally on XTALIN and XTALOUT. See Figure 47.

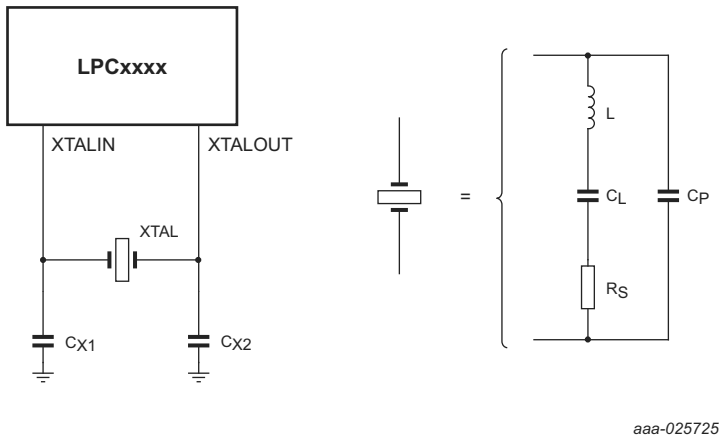


Fig 47. XTAL oscillator components

For best results, it is very critical to select a matching crystal for the on-chip oscillator. Load capacitance (CL), series resistance (RS), and drive level (DL) are important parameters to consider while choosing the crystal. After selecting the proper crystal, the external load capacitor C_{X1} and C_{X2} values can also be generally determined by the following expression:

$$C_{X1} = C_{X2} = 2C_L - (C_{Pad} + C_{Parasitic})$$

Where:

C_L - Crystal load capacitance

C_{Pad} - Pad capacitance of the XTALIN and XTALOUT pins (~3 pF).

$C_{Parasitic}$ – Parasitic or stray capacitance of external circuit.

Although $C_{Parasitic}$ can be ignored in general, the actual board layout and placement of external components influences the optimal values of external load capacitors. Therefore, it is recommended to fine tune the values of external load capacitors on actual hardware board to get the accurate clock frequency. For fine tuning, measure the clock on the XTALOUT pin and optimize the values of external load capacitors for minimum frequency deviation.

13.6.1 XTAL Printed Circuit Board (PCB) design guidelines

- Connect the crystal and external load capacitors on the PCB as close as possible to the oscillator input and output pins of the chip.
- The length of traces in the oscillation circuit should be as short as possible and must not cross other signal lines.
- Ensure that the load capacitors CX1, CX2, and CX3, in case of third overtone crystal usage, have a common ground plane.
- Loops must be made as small as possible to minimize the noise coupled in through the PCB and to keep the parasitics as small as possible.
- Lay out the ground (GND) pattern under crystal unit.
- Do not lay out other signal lines under crystal unit for multi-layered PCB.

13.7 Suggested USB interface solutions

The USB device can be connected to the USB as self-powered device (see Figure 48) or bus-powered device (see Figure 49).

On the LPC546xx, the USB_VBUS pin is 5 V tolerant only when V_{DD} is applied and at operating voltage level. Therefore, if the USB_VBUS function is connected to the USB connector and the device is self-powered, the USB_VBUS pin must be protected for situations when V_{DD} = 0 V.

If V_{DD} is always at operating level while VBUS = 5 V, the USB_VBUS pin can be connected directly to the VBUS pin on the USB connector.

For systems where V_{DD} can be 0 V and VBUS is directly applied to the VBUS pin, precautions must be taken to reduce the voltage to below 3.6 V, which is the maximum allowable voltage on the USB_VBUS pin in this case.

One method is to use a voltage divider to connect the USB_VBUS pin to the VBUS on the USB connector. The voltage divider ratio should be such that the USB_VBUS pin is greater than 0.7 V_{DD} to indicate a logic HIGH while below the 3.6 V allowable maximum voltage.

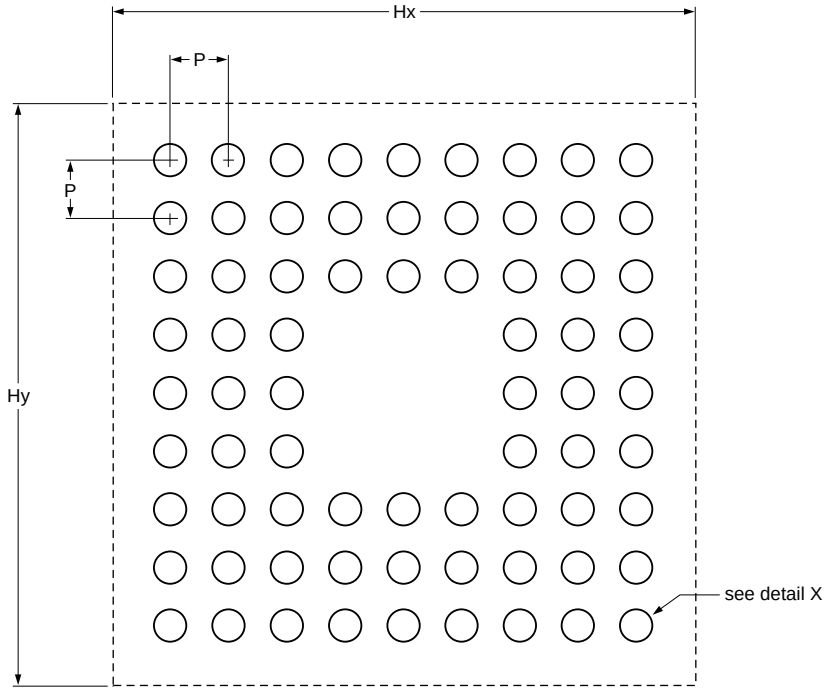
For the following operating conditions

$VBUS_{max}$ = 5.25 V

V_{DD} = 3.6 V,

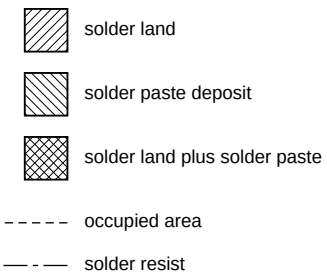
the voltage divider should provide a reduction of 3.6 V/5.25 V or ~0.686 V.

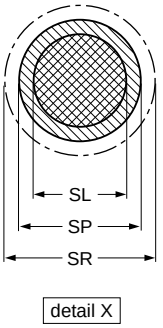
Footprint information for reflow soldering of TFBGA100 package **SOT926-1**



Generic footprint pattern

Refer to the package outline drawing for actual layout





detail X

DIMENSIONS in mm

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

sot926-1_fr

Fig 57. Reflow soldering of the TFBGA100 package

Table 60. Revision history *...continued*

Document ID	Release date	Data sheet status	Change notice	Supersedes
Modifications:	• Updated a feature in Section 7.17.8.2 “SPI serial I/O controller”: Maximum data rate of 48 Mbit/s in master mode and 14 Mbit/s in slave mode for SPI functions. Was 71 Mbit/s in master mode. • Updated Section 11.15 “SPI interfaces”: the maximum supported bit rate for SPI master mode is 48 Mbit/s. Was 71 Mbit/s. • Updated Table 4 “Pin description”: Changed restate state of PIO3_23 and PIO0_24 to Z. Added footnote True open-drain pin. I2C-bus pins compliant with the I2C-bus specification for I2C standard mode, I2C Fast-mode, and I2C Fast-mode Plus. The pin requires an external pull-up to provide output functionality. When power is switched off, this pin is floating and does not disturb the I2C lines. Open-drain configuration applies to all functions on this pin to PIO3_23 and PIO0_24.			
LPC546xx v.1.9	20171109	Product data sheet	-	LPC546xx v.1.8
Modifications:	• Updated Table 1 “Ordering information” and Table 2 “Ordering options”. Added the part numbers: LPC54605J256BD100, LPC54605J512BD100, LPC54605J256ET100, LPC54605J512ET100.			
LPC546xx v.1.8	20170614	Product data sheet	-	LPC546xx v.1.7
Modifications:	• Updated Section 13.7 “Suggested USB interface solutions”. Removed the remark. • Added LPC5462x device to the data sheet. • Updated Timer and digital peripherals of Section 2 “Features and benefits”. • Updated Section 7.19.2 “SCTimer/PWM”, Section 7.19.2.1 “Features” and Section 7.18.3 “External memory controller”. • Updated Figure 13 “Typical CoreMark score (iterations/s) vs. Frequency (MHz) from flash and SRAMX” and Figure 14 “CoreMark power consumption: typical mA/MHz vs. frequency (MHz) from flash and SRAMX”. • Updated Table 42 “Dynamic characteristics: I2S-bus interface pins [1][4]”, Table 43 “SPI dynamic characteristics[1]”, Table 44 “Dynamic characteristics: SPIFI[1]”, Table 45 “Dynamic characteristics[1]”, Table 46 “Dynamic characteristics[1]”, Table 47 “USART dynamic characteristics[1]”, Table 50 “Dynamic characteristics: Ethernet”, Table 51 “Dynamic characteristics: SD/MMC and SDIO”, and Table 52 “Dynamic characteristics: LCD”: replaced the condition, CCLK > 100 MHz with 100 MHz <CCLK ≤ 180 MHz • Updated Table 12 “General operating conditions”. Added the condition, For OTP programming only to f_{clk}. • Added Remark to Section 7.24 “Code security (enhanced Code Read Protection - eCRP)”. • Updated Table 19 “Typical peripheral power consumption[1][2]”: added SYSOSC value. • Updated Table 14 “CoreMark score[1]”. • Updated Table 15 “Static characteristics: Power consumption in active and sleep mode”: I_{DD} supply current in Active mode: CoreMark code executed from flash. • Updated Figure 13 “Typical CoreMark score (iterations/s) vs. Frequency (MHz) from flash and SRAMX” and Figure 14 “CoreMark power consumption: typical mA/MHz vs. frequency (MHz) from flash and SRAMX”.			
LPC546xx v.1.7	20170428	Product data sheet	-	LPC546xx v.1.6
Modifications:	• Updated Table 42 “Dynamic characteristics: I2S-bus interface pins [1][4]”. • Updated Table 11 “Thermal resistance”.			
LPC546xx v.1.6		Product data sheet	-	LPC546xx v.1.5
Modifications:	• Added TFBGA100 and LQFP100 packages.			

Table 60. Revision history *...continued*

Document ID	Release date	Data sheet status	Change notice	Supersedes
LPC546xx v.1.5	20170331	Product data sheet	-	LPC546xx v.1.4
Modifications:	• Updated Table 51 “Dynamic characteristics: SD/MMC and SDIO”. The max clock frequency is 50 MHz. • Updated Section 7.18.2 “SD/MMC card interface”: Supports up to a maximum of 50 MHz of interface frequency. • Updated Table 41 “Dynamic characteristic: I2C-bus pins[1]” • Updated Figure 28 “I2S-bus timing (master)” and Figure 29 “I2S-bus timing (slave)”. • Updated Table 2 “Ordering options”. Parts LPC54618J512ET180 and LPC54618J512BD208 have Classic CAN. • Added Section 11.4 “Wake-up process”.			
LPC546xx v.1.4	20170307	Product data sheet	-	LPC5460x v.1.3
Modifications:	• Changed data sheet title to LPC546xx. • Updated Table 16 “Static characteristics: Power consumption in deep-sleep and deep power-down modes” and Table 17 “Static characteristics: Power consumption in deep-sleep and deep power-down modes”.			
LPC5460x v.1.3	20170224	Product data sheet	-	LPC5460x v.1.2
Modifications:	• Removed S parts. Data sheet title renamed to LPC5460x. • Removed AES-256 engine and SHA references throughout the document. • Security peripherals renamed to Security features. • Updated Section 4 “Marking”. • Updated Section 5 “Block diagram”. • Updated Figure 6 “LPC546xx Memory mapping”. • Updated Table 20 “Typical AHB/APB peripheral power consumption [3][4][5]”.			
LPC5460x v.1.2	20170206	Product data sheet	-	LPC5460x v.1.1
Modifications:	• Updated address range details and description of the address range: 0x8000 0000 to 0xDFFF FFFF: See Table 7 “Memory usage and details”: Static memory chip select: was 0x9000 0000 - 0x93 FFFF, now, 0x9000 0000 – 0x93FF FFFF. • Updated Figure 8 “LPC5460x clock generation”. • Updated Power control in Section 2 “Features and benefits”: Ultra-low power Micro-tick Timer, running from the Watchdog oscillator that can be used to wake up the device from low power modes. • Updated Table 4 “Pin description”: PIO0_26, USB0_IDVALUE, Type is Input (I). • Updated Section 7.18.1.1 “Features”. • Updated Table 31 “Dynamic characteristics of the PLL0[1]”: Input frequency, $F_{in,}$ Max value is 25 MHZ.			
LPC5460x v.1.1	20170124	Product data sheet	-	LPC5460x v.1