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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	Obsolete
Core Processor	FT32
Core Size	32-Bit Single-Core
Speed	100MHz
Connectivity	I²C, SPI, UART/USART, USB
Peripherals	POR, PWM, WDT
Number of I/O	42
Program Memory Size	256KB (256K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	320K x 8
Voltage - Supply (Vcc/Vdd)	2.97V ~ 3.63V
Data Converters	A/D 4x10b; D/A 2x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	80-LQFP
Supplier Device Package	80-LQFP (12x12)
Purchase URL	https://www.e-xfl.com/product-detail/bridgetek/ft908l-t

- Cortex-M0 Processor core
  - ARM Cortex-M0 coprocessor capable of off-loading the main ARM Cortex-M4 application processor.
  - Running at frequencies of up to 204 MHz.
  - JTAG
  - Built-in NVIC.
- On-chip memory
  - Up to 264 kB SRAM for code and data use.
  - Multiple SRAM blocks with separate bus access. Two SRAM blocks can be powered down individually.
  - 64 kB ROM containing boot code and on-chip software drivers.
  - 64 bit general-purpose OTP memory.
  - Two banks (256 bit total) One-Time Programmable (OTP) memory for AES key storage One bank can store an encrypted key for decoding the boot image.
- AES engine for encryption and decryption of the boot image and data with DMA support and programmable via a ROM-based API.
- Clock generation unit
  - Crystal oscillator with an operating range of 1 MHz to 25 MHz.
  - 12 MHz Internal RC (IRC) oscillator trimmed to 1.5 % accuracy over temperature and voltage.
  - Ultra-low power Real-Time Clock (RTC) crystal oscillator.
  - Three PLLs allow CPU operation up to the maximum CPU rate without the need for a high-frequency crystal. The second PLL is dedicated to the High-speed USB, the third PLL can be used as audio PLL.
  - Clock output.
- Configurable digital peripherals
  - Serial GPIO (SGPIO) interface.
  - State Configurable Timer (SCTimer/PWM) subsystem on AHB.
  - Global Input Multiplexer Array (GIMA) allows to cross-connect multiple inputs and outputs to event driven peripherals like the timers, SCTimer/PWM, and ADC0/1.
- Serial interfaces
  - Quad SPI Flash Interface (SPIFI) with 1-, 2-, or 4-bit data at rates of up to 52 MB per second.
  - 10/100T Ethernet MAC with RMII and MII interfaces and DMA support for high throughput at low CPU load. Support for IEEE 1588 time stamping/advanced time stamping (IEEE 1588-2008 v2).
  - One High-speed USB 2.0 Host/Device/OTG interface with DMA support and on-chip high-speed PHY (USB0).
  - One High-speed USB 2.0 Host/Device interface with DMA support, on-chip full-speed PHY and ULPI interface to external high-speed PHY (USB1).
  - USB interface electrical test software included in ROM USB stack.
  - Four 550 UARTs with DMA support: one UART with full modem interface; one UART with IrDA interface; three USARTs support UART synchronous mode and a smart card interface conforming to ISO7816 specification.
  - Up to two C_CAN 2.0B controllers with one channel each. Use of C_CAN controller excludes operation of all other peripherals connected to the same bus bridge See Figure 1 and Ref. 2.

Table 3. Pin description *…continued*

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

Symbol	LBGA256	TFBGA180	TFBGA100	LQFP144		Reset state [1]	Type	Description
P4_9	L2	J2	-	33	[2]	N; PU	-	**R —** Function reserved.
							I	**CTIN_6 —** SCTimer/PWM input 6. Capture input 1 of timer 3.
							O	**LCD_VD11 —** LCD data.
							-	**R —** Function reserved.
							I/O	**GPIO5[13] —** General purpose digital input/output pin.
							O	**LCD_VD15 —** LCD data.
							I	**CAN1_RD —** CAN1 receiver input.
							I/O	**SGPIO14 —** General purpose digital input/output pin.
P4_10	M3	L3	-	35	[2]	N; PU	-	**R —** Function reserved.
							I	**CTIN_2 —** SCTimer/PWM input 2. Capture input 2 of timer 0.
							O	**LCD_VD10 —** LCD data.
							-	**R —** Function reserved.
							I/O	**GPIO5[14] —** General purpose digital input/output pin.
							O	**LCD_VD14 —** LCD data.
							-	**R —** Function reserved.
							I/O	**SGPIO15 —** General purpose digital input/output pin.
P5_0	N3	L2	-	37	[2]	N; PU	I/O	**GPIO2[9] —** General purpose digital input/output pin.
							O	**MCOB2 —** Motor control PWM channel 2, output B.
							I/O	**EMC_D12 —** External memory data line 12.
							-	**R —** Function reserved.
							I	**U1_DSR —** Data Set Ready input for UART 1.
							I	**T1_CAP0 —** Capture input 0 of timer 1.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
P5_1	P3	M1	-	39	[2]	N; PU	I/O	**GPIO2[10] —** General purpose digital input/output pin.
							I	**MCI2 —** Motor control PWM channel 2, input.
							I/O	**EMC_D13 —** External memory data line 13.
							-	**R —** Function reserved.
							O	**U1_DTR —** Data Terminal Ready output for UART 1. Can also be configured to be an RS-485/EIA-485 output enable signal for UART 1.
							I	**T1_CAP1 —** Capture input 1 of timer 1.
							-	**R —** Function reserved.
							-	**R —** Function reserved.

Table 3. Pin description *…continued*

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

Symbol	LBGA256	TFBGA180	TFBGA100	LQFP144		Reset state [1]	Type	Description
P5_6	T13	M11	-	63	[2]	N; PU	I/O	**GPIO2[15] —** General purpose digital input/output pin.
							O	**MCOB1 —** Motor control PWM channel 1, output B.
							I/O	**EMC_D10 —** External memory data line 10.
							-	**R —** Function reserved.
							O	**U1_TXD —** Transmitter output for UART 1.
							O	**T1_MAT2 —** Match output 2 of timer 1.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
P5_7	R12	N11	-	65	[2]	N; PU	I/O	**GPIO2[7] —** General purpose digital input/output pin.
							O	**MCOA2 —** Motor control PWM channel 2, output A.
							I/O	**EMC_D11 —** External memory data line 11.
							-	**R —** Function reserved.
							I	**U1_RXD —** Receiver input for UART 1.
							O	**T1_MAT3 —** Match output 3 of timer 1.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
P6_0	M12	M10	H7	73	[2]	N; PU	-	**R —** Function reserved.
							O	**I2S0_RX_MCLK —** I2S receive master clock.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
							I/O	**I2S0_RX_SCK —** Receive Clock. It is driven by the master and received by the slave. Corresponds to the signal SCK in the *I^2S-bus specification*.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
P6_1	R15	P14	G5	74	[2]	N; PU	I/O	**GPIO3[0] —** General purpose digital input/output pin.
							O	**EMC_DYCS1 —** SDRAM chip select 1.
							I/O	**U0_UCLK —** Serial clock input/output for USART0 in synchronous mode.
							I/O	**I2S0_RX_WS —** Receive Word Select. It is driven by the master and received by the slave. Corresponds to the signal WS in the *I^2S-bus specification*.
							-	**R —** Function reserved.
							I	**T2_CAP0 —** Capture input 2 of timer 2.
							-	**R —** Function reserved.
							-	**R —** Function reserved.

Table 3. Pin description *…continued*

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

Symbol	LBGA256	TFBGA180	TFBGA100	LQFP144		Reset state [1]	Type	Description
P6_5	P16	L14	F9	82	[2]	N; PU	I/O	**GPIO3[4] —** General purpose digital input/output pin.
							O	**CTOUT_6 —** SCTimer/PWM output 6. Match output 2 of timer 1.
							I	**U0_RXD —** Receiver input for USART0.
							O	**EMC_RAS —** LOW active SDRAM Row Address Strobe.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
P6_6	L14	K12	-	83	[2]	N; PU	I/O	**GPIO0[5] —** General purpose digital input/output pin.
							O	**EMC_BLS1 —** LOW active Byte Lane select signal 1.
							I/O	**SGPIO5 —** General purpose digital input/output pin.
							I	**USB0_PWR_FAULT —** Port power fault signal indicating overcurrent condition; this signal monitors over-current on the USB bus (external circuitry required to detect over-current condition).
							-	**R —** Function reserved.
							I	**T2_CAP3 —** Capture input 3 of timer 2.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
P6_7	J13	H11	-	85	[2]	N; PU	-	**R —** Function reserved.
							I/O	**EMC_A15 —** External memory address line 15.
							I/O	**SGPIO6 —** General purpose digital input/output pin.
							O	**USB0_IND1 —** USB0 port indicator LED control output 1.
							I/O	**GPIO5[15] —** General purpose digital input/output pin.
							O	**T2_MAT0 —** Match output 0 of timer 2.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
P6_8	H13	F12	-	86	[2]	N; PU	-	**R —** Function reserved.
							I/O	**EMC_A14 —** External memory address line 14.
							I/O	**SGPIO7 —** General purpose digital input/output pin.
							O	**USB0_IND0 —** USB0 port indicator LED control output 0.
							I/O	**GPIO5[16] —** General purpose digital input/output pin.
							O	**T2_MAT1 —** Match output 1 of timer 2.
							-	**R —** Function reserved.
							-	**R —** Function reserved.

Table 3. Pin description *…continued*

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

Symbol	LBGA256	TFBGA180	TFBGA100	LQFP144		Reset state [1]	Type	Description
PA_3	H11	E10	-	-	[3]	N; PU	I/O	**GPIO4[10] —** General purpose digital input/output pin.
							I	**QEI_PHA —** Quadrature Encoder Interface PHA input.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
PA_4	G13	E12	-	-	[2]	N; PU	-	**R —** Function reserved.
							O	**CTOUT_9 —** SCTimer/PWM output 9. Match output 3 of timer 3.
							-	**R —** Function reserved.
							I/O	**EMC_A23 —** External memory address line 23.
							I/O	**GPIO5[19] —** General purpose digital input/output pin.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
PB_0	B15	D14	-	-	[2]	N; PU	-	**R —** Function reserved.
							O	**CTOUT_10 —** SCTimer/PWM output 10. Match output 3 of timer 3.
							O	**LCD_VD23 —** LCD data.
							-	**R —** Function reserved.
							I/O	**GPIO5[20] —** General purpose digital input/output pin.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
PB_1	A14	A13	-	-	[2]	N; PU	-	**R —** Function reserved.
							I	**USB1_ULPI_DIR —** ULPI link DIR signal. Controls the ULP data line direction.
							O	**LCD_VD22 —** LCD data.
							-	**R —** Function reserved.
							I/O	**GPIO5[21] —** General purpose digital input/output pin.
							O	**CTOUT_6 —** SCTimer/PWM output 6. Match output 2 of timer 1.
							-	**R —** Function reserved.
							-	**R —** Function reserved.

Table 3. Pin description *…continued*

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

Symbol	LBGA256	TFBGA180	TFBGA100	LQFP144		Reset state [1]	Type	Description
PD_8	P8	-	-	-	[2]	N; PU	-	**R —** Function reserved.
							I	**CTIN_6 —** SCTimer/PWM input 6. Capture input 1 of timer 3.
							I/O	**EMC_D22 —** External memory data line 22.
							-	**R —** Function reserved.
							I/O	**GPIO6[22] —** General purpose digital input/output pin.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
							I/O	**SGPIO12 —** General purpose digital input/output pin.
PD_9	T11	-	-	-	[2]	N; PU	-	**R —** Function reserved.
							O	**CTOUT_13 —** SCTimer/PWM output 13. Match output 3 of timer 3.
							I/O	**EMC_D23 —** External memory data line 23.
							-	**R —** Function reserved.
							I/O	**GPIO6[23] —** General purpose digital input/output pin.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
							I/O	**SGPIO13 —** General purpose digital input/output pin.
PD_10	P11	-	-	-	[2]	N; PU	-	**R —** Function reserved.
							I	**CTIN_1 —** SCTimer/PWM input 1. Capture input 1 of timer 0. Capture input 1 of timer 2.
							O	**$\overline{\text{EMC\_BLS3}}$ —** LOW active Byte Lane select signal 3.
							-	**R —** Function reserved.
							I/O	**GPIO6[24] —** General purpose digital input/output pin.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
							-	**R —** Function reserved.
PD_11	N9	M7	-	-	[2]	N; PU	-	**R —** Function reserved.
							-	**R —** Function reserved.
							O	**$\overline{\text{EMC\_CS3}}$ —** LOW active Chip Select 3 signal.
							-	**R —** Function reserved.
							I/O	**GPIO6[25] —** General purpose digital input/output pin.
							I/O	**USB1_ULPI_D0 —** ULPI link bidirectional data line 0.
							O	**CTOUT_14 —** SCTimer/PWM output 14. Match output 2 of timer 3.
							-	**R —** Function reserved.

Table 3. Pin description *…continued*

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

Symbol	LBGA256	TFBGA180	TFBGA100	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]	O; 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 —** I2S1 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.
							I/O	**SGPIO0 —** General purpose digital input/output pin.
							-	**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.
							I/O	**SGPIO1 —** General purpose digital input/output pin.
							-	**R —** Function reserved.

7.9.1 Features

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

7.10 On-chip static RAM

The LPC43S50/S30/S20 support up to 200 kB local SRAM and an additional 64 kB AHB SRAM with separate bus master access for higher throughput and individual power control for low-power operation.

7.11 In-System Programming (ISP)

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

7.12 Boot ROM

The internal ROM memory is used to store the boot code of the LPC43S50/S30/S20. After a reset, the ARM processor will start its code execution from this memory.

The boot ROM memory includes the following features:

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

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

Table 4. Boot mode when OTP BOOT_SRC bits are programmed

Boot mode	BOOT_SRC bit 3	BOOT_SRC bit 2	BOOT_SRC bit 1	BOOT_SRC bit 0	Description
Pin state	0	0	0	0	Boot source is defined by the reset state of P1_1, P1_2, P2_8, and P2_9 pins. See Table 5.
USART0	0	0	0	1	Boot from device connected to USART0 using pins P2_0 and P2_1.
SPIFI	0	0	1	0	Boot from Quad SPI flash connected to the SPIFI interface using pins P3_3 to P3_8.
EMC 8-bit	0	0	1	1	Boot from external static memory (such as NOR flash) using CS0 and an 8-bit data bus.

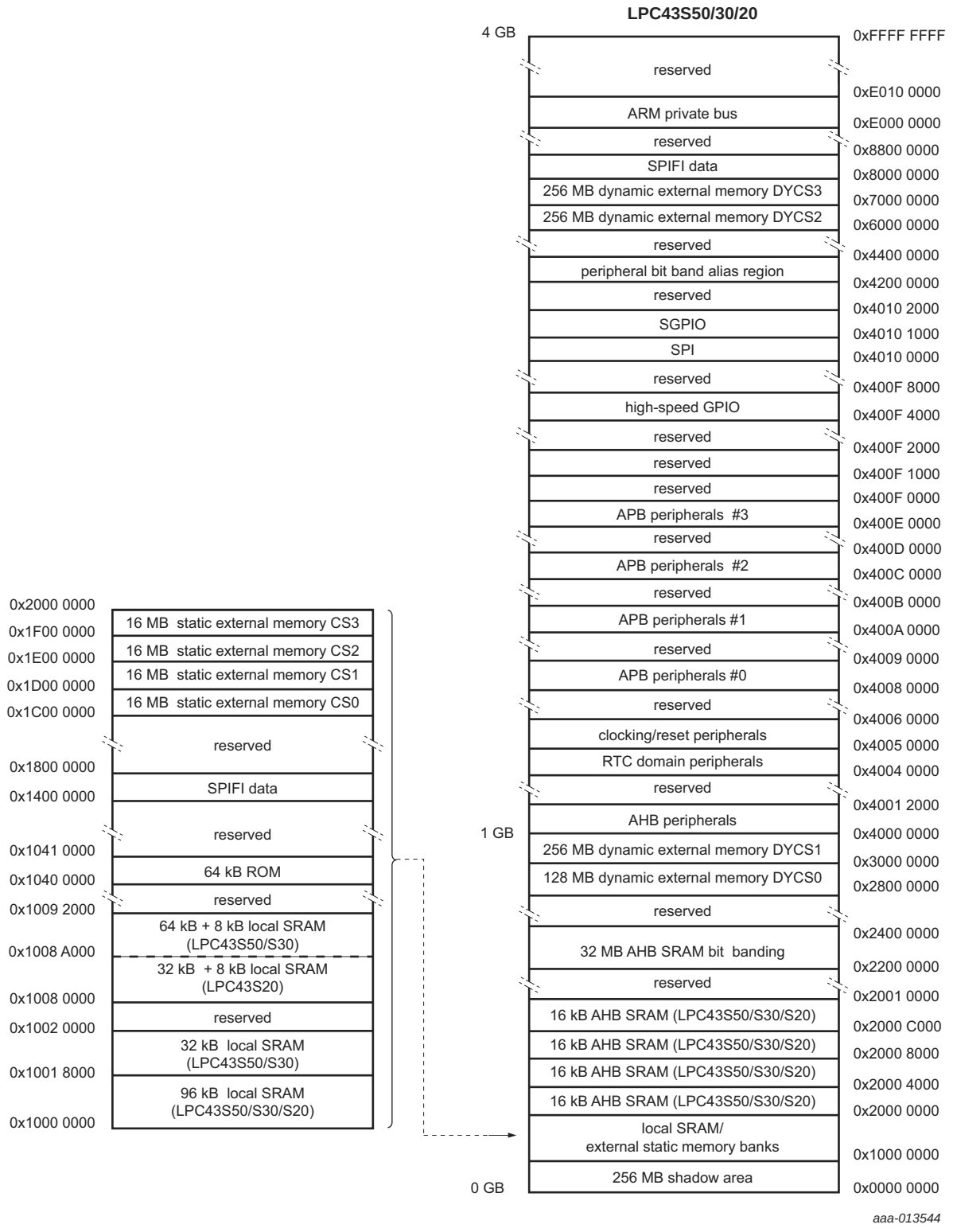


Fig 7. LPC43S50/S30/S20 Memory mapping (overview)

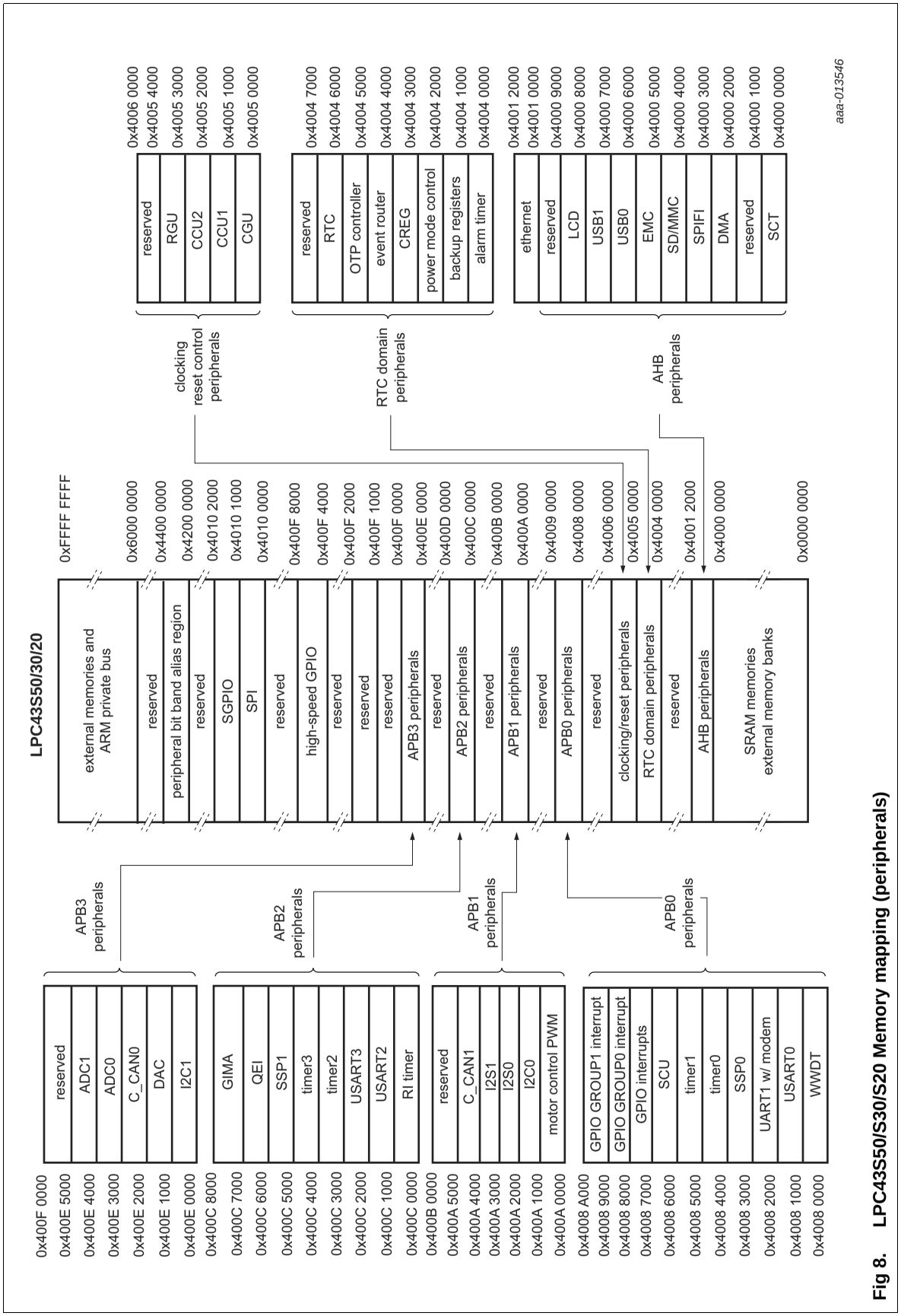


Fig 8. LPC43S50/S30/S20 Memory mapping (peripherals)

7.19.4 Repetitive Interrupt (RI) timer

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

7.19.4.1 Features

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

7.19.5 Windowed WatchDog Timer (WWDT)

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

7.19.5.1 Features

- Internally resets chip if not periodically reloaded during the programmable time-out period.
- Optional windowed operation requires reload to occur between a minimum and maximum time period, both programmable.
- Optional warning interrupt can be generated at a programmable time prior to watchdog time-out.
- Enabled by software but requires a hardware reset or a watchdog reset/interrupt to be disabled.
- Incorrect feed sequence causes reset or interrupt if enabled.
- Flag to indicate watchdog reset.
- Programmable 24-bit timer with internal prescaler.
- Selectable time period from ($T_{cy(WDCLK)} \times 256 \times 4$) to ($T_{cy(WDCLK)} \times 2^{24} \times 4$) in multiples of $T_{cy(WDCLK)} \times 4$.
- The Watchdog Clock (WDCLK) uses the IRC as the clock source.

7.20 Analog peripherals

7.20.1 Analog-to-Digital Converter (ADC0/1)

7.20.1.1 Features

- 10-bit successive approximation analog to digital converter.
- Input multiplexing among 8 pins.
- Power-down mode.
- Measurement range 0 to VDDA.
- Sampling frequency up to 400 kSamples/s.

9. Thermal characteristics

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

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

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

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

Table 7. Thermal characteristics

V_{DD} = 2.2 V to 3.6 V; T_{amb} = −40 °C to +85 °C unless otherwise specified;

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

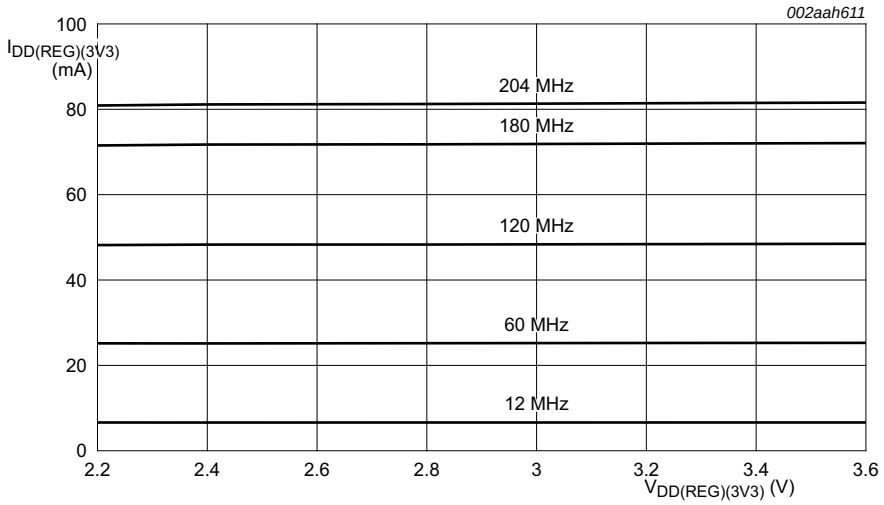
Table 8. Thermal resistance (LQFP packages)

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

Table 9. Thermal resistance value (BGA packages)

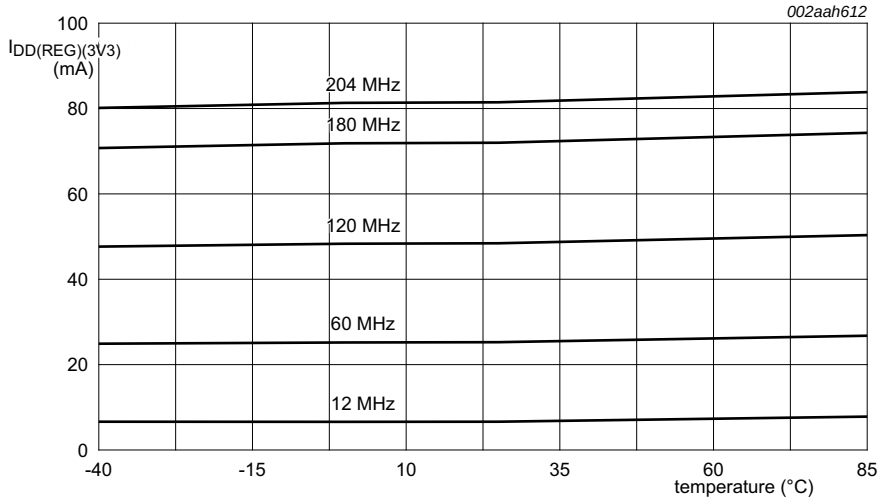
Symbol	Parameter	Conditions	Thermal resistance in °C/W ±15 %		
			LBGA256	TFBGA180	TFBGA100
$R_{th(j-a)}$	thermal resistance from junction to ambient	JEDEC (4.5 in × 4 in); still air	29	38	46
		8-layer (4.5 in × 3 in); still air	24	30	37
$R_{th(j-c)}$	thermal resistance from junction to case		14	11	11

10.1 Power consumption



Conditions: T_{amb} = 25 °C; active mode entered executing code while(1){} from SRAM; M0-core in reset; internal pull-up resistors disabled; PLL1 enabled; IRC enabled; all peripherals disabled; all peripheral clocks disabled.

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



Conditions: $V_{DD(REG)(3V3)}$ = 3.3 V, Active mode entered executing code while(1){} from SRAM; M0-core in reset; internal pull-up resistors disabled; PLL1 enabled; IRC enabled; all peripherals disabled; all peripheral clocks disabled.

Fig 12. Typical supply current versus temperature in Active mode

[9] A Fast-mode I^2C-bus device can be used in a Standard-mode I^2C-bus system but the requirement $t_{SU;DAT}$ = 250 ns must then be met. This will automatically be the case if the device does not stretch the LOW period of the SCL signal. If such a device does stretch the LOW period of the SCL signal, it must output the next data bit to the SDA line $t_{r(max)} + t_{SU;DAT}$ = 1000 + 250 = 1250 ns (according to the Standard-mode I^2C-bus specification) before the SCL line is released. Also the acknowledge timing must meet this set-up time.

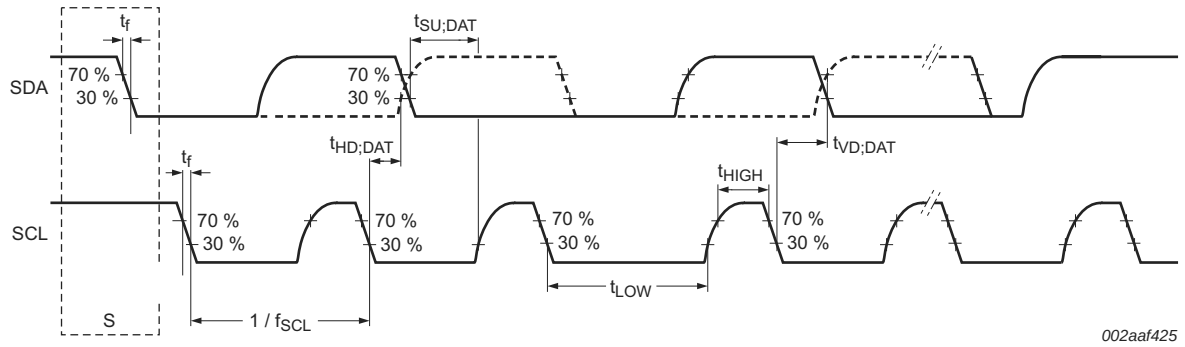


Fig 27. I^2C-bus pins clock timing

11.9 I^2S-bus interface

Table 22. Dynamic characteristics: I^2S-bus interface pins

T_{amb} = −40 °C to +85 °C ; 2.2 V ≤ $V_{DD(REG)(3V3)}$ ≤ 3.6 V; 2.7 V ≤ $V_{DD(IO)}$ ≤ 3.6 V; C_L = 20 pF. Conditions and data refer to I2S0 and I2S1 pins. Simulated values.

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

[1] Clock to the I^2S-bus interface BASE_APB1_CLK = 150 MHz; peripheral clock to the I^2S-bus interface PCLK = BASE_APB1_CLK / 12. I^2S clock cycle time $T_{cy(clk)}$ = 79.2 ns; corresponds to the SCK signal in the *I^2S-bus specification*.

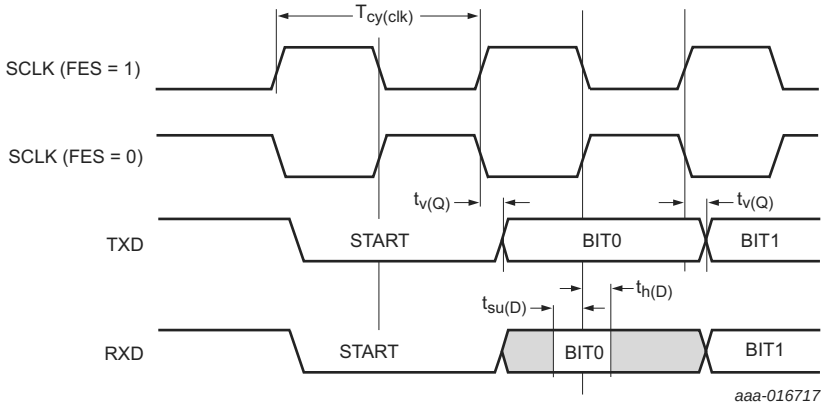


Fig 30. USART timing

11.11 SSP interface

Table 24. Dynamic characteristics: SSP pins in SPI mode

T_{amb} = −40 °C to +85 °C; 2.2 V ≤ $V_{DD(REG)(3V3)}$ ≤ 3.6 V; 2.7 V ≤ $V_{DD(IO)}$ ≤ 3.6 V; C_L = 20 pF. Sampled at 10 % and 90 % of the signal level; EHS = 1 for all pins. Simulated values.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
SSP master							
$T_{cy(clk)}$	clock cycle time	full-duplex mode	[1]	$1/(25.5 \times 10^6)$	-	-	s
		when only transmitting		$1/(51 \times 10^6)$	-	-	s
t_{DS}	data set-up time	in SPI mode		13.6	-	-	ns
t_{DH}	data hold time	in SPI mode		−3.8	-	-	ns
$t_{v(Q)}$	data output valid time	in SPI mode		-	-	6.0	ns
$t_{h(Q)}$	data output hold time	in SPI mode		−1.1	-	-	ns
t_{lead}	lead time	continuous transfer mode SPI mode; CPOL = 0; CPHA = 0		$T_{cy(clk)} + 3.2$	-	$T_{cy(clk)} + 6.1$	ns
		SPI mode; CPOL = 0; CPHA = 1		$0.5 \times T_{cy(clk)} + 3.2$	-	$0.5 \times T_{cy(clk)} + 6.1$	ns
		SPI mode; CPOL = 1; CPHA = 0		$T_{cy(clk)} + 3.2$	-	$T_{cy(clk)} + 6.1$	ns
		SPI mode; CPOL = 1; CPHA = 1		$0.5 \times T_{cy(clk)} + 3.2$	-	$0.5 \times T_{cy(clk)} + 6.1$	ns
		synchronous serial frame mode		$0.5 \times T_{cy(clk)} + 3.2$	-	$0.5 \times T_{cy(clk)} + 6.1$	ns
		microwire frame format		$T_{cy(clk)} + 3.2$	-	$T_{cy(clk)} + 6.1$	ns
t_{lag}	lag time	continuous transfer mode SPI mode; CPOL = 0; CPHA = 0		$0.5 \times T_{cy(clk)}$	-	-	ns
		SPI mode; CPOL = 0; CPHA = 1		$T_{cy(clk)}$	-	-	ns
		SPI mode; CPOL = 1; CPHA = 0		$0.5 \times T_{cy(clk)}$	-	-	ns
		SPI mode; CPOL = 1; CPHA = 1		$T_{cy(clk)}$	-	-	ns
		synchronous serial frame mode		$T_{cy(clk)}$	-	-	ns
		microwire frame format		$0.5 \times T_{cy(clk)}$	-	-	ns

Table 24. Dynamic characteristics: SSP pins in SPI mode

T_{amb} = −40 °C to +85 °C; 2.2 V ≤ $V_{DD(REG)(3V3)}$ ≤ 3.6 V; 2.7 V ≤ $V_{DD(IO)}$ ≤ 3.6 V; C_L = 20 pF. Sampled at 10 % and 90 % of the signal level; EHS = 1 for all pins. Simulated values.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
t_d	delay time	continuous transfer mode SPI mode; CPOL = 0; CPHA = 0		-	$0.5 \times T_{cy(clk)}$	-	ns
		SPI mode; CPOL = 0; CPHA = 1		-	n/a	-	ns
		SPI mode; CPOL = 1; CPHA = 0		-	$0.5 \times T_{cy(clk)}$	-	ns
		SPI mode; CPOL = 1; CPHA = 1		-	n/a	-	ns
		synchronous serial frame mode		-	$T_{cy(clk)}$	-	ns
		microwire frame format		-	n/a	-	ns
SSP slave							
PCLK	Peripheral clock frequency			-	-	204	MHz
$T_{cy(clk)}$	clock cycle time		[2]	$1/(11 \times 10^6)$	-	-	s
t_{DS}	data set-up time	in SPI mode		1.15	-	-	ns
t_{DH}	data hold time	in SPI mode		0.5	-	-	ns
$t_{v(Q)}$	data output valid time	in SPI mode		-	-	[4 × (1/PCLK)] + 3	ns
$t_{h(Q)}$	data output hold time	in SPI mode		5.1	-	-	ns
t_{lead}	lead time	continuous transfer mode SPI mode; CPOL = 0; CPHA = 0		$T_{cy(clk)} + 2.2$	-	-	ns
		SPI mode; CPOL = 0; CPHA = 1		$0.5 \times T_{cy(clk)} + 2.2$	-	-	ns
		SPI mode; CPOL = 1; CPHA = 0		$T_{cy(clk)} + 2.2$	-	-	ns
		SPI mode; CPOL = 1; CPHA = 1		$0.5 \times T_{cy(clk)} + 2.2$	-	-	ns
		synchronous serial frame mode		$0.5 \times T_{cy(clk)} + 2.2$	-	-	ns
		microwire frame format		$T_{cy(clk)} + 2.2$	-	-	ns

Table 24. Dynamic characteristics: SSP pins in SPI mode

T_{amb} = −40 °C to +85 °C; 2.2 V ≤ $V_{DD(REG)(3V3)}$ ≤ 3.6 V; 2.7 V ≤ $V_{DD(IO)}$ ≤ 3.6 V; C_L = 20 pF. Sampled at 10 % and 90 % of the signal level; EHS = 1 for all pins. Simulated values.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
t_{lag}	lag time	continuous transfer mode SPI mode; CPOL = 0; CPHA = 0		$0.5T_{cy(clk)}$ + 0.2	-	-	ns
		SPI mode; CPOL = 0; CPHA = 1		$T_{cy(clk)}$ + 0.2	-	-	ns
		SPI mode; CPOL = 1; CPHA = 0		0.5 × $T_{cy(clk)}$ + 0.2	-	-	ns
		SPI mode; CPOL = 1; CPHA = 1		$T_{cy(clk)}$ + 0.2	-	-	ns
		synchronous serial frame mode		$T_{cy(clk)}$ + 0.2	-	-	ns
		microwire frame format		0.5 × $T_{cy(clk)}$	-	-	ns
t_d	delay time	continuous transfer mode SPI mode; CPOL = 0; CPHA = 0		-	0.5 × $T_{cy(clk)}$	-	ns
		SPI mode; CPOL = 0; CPHA = 1		-	n/a	-	ns
		SPI mode; CPOL = 1; CPHA = 0		-	0.5 × $T_{cy(clk)}$	-	ns
		SPI mode; CPOL = 1; CPHA = 1		-	n/a	-	ns
		synchronous serial frame mode		-	$T_{cy(clk)}$	-	ns
		microwire frame format		-	n/a	-	ns

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

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

11.12 SPI interface

Table 25. Dynamic characteristics: SPI

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

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$T_{cy(PCLK)}$	PCLK cycle time			5			ns
$T_{cy(clk)}$	clock cycle time		[1]	40	-	-	ns
Master							
t_{DS}	data set-up time			7.2	-	-	ns
t_{DH}	data hold time			0	-	-	ns
$t_{v(Q)}$	data output valid time			-	-	3.7	ns
$t_{h(Q)}$	data output hold time			-	-	1.2	ns
Slave							
t_{DS}	data set-up time			1.2	-	-	ns
t_{DH}	data hold time			3 x $T_{cy(PCLK)}$ + 0.54	-	-	ns
$t_{v(Q)}$	data output valid time			-	-	3 x $T_{cy(PCLK)}$ + 9.7	ns
$t_{h(Q)}$	data output hold time			-	-	2 x $T_{cy(PCLK)}$ + 7.1	ns

[1] $T_{cy(clk)}$ = 8/BASE_SPI_CLK. Tcy(PCLK) = 1/BASE_SPI_CLK.

13. Application information

13.1 LCD panel signal usage

Table 38. LCD panel connections for STN single panel mode

External pin	4-bit mono STN single panel		8-bit mono STN single panel		Color STN single panel	
	LPC43xx pin used	LCD function	LPC43xx pin used	LCD function	LPC43xx pin used	LCD function
LCD_VD[23:8]	-	-	-	-	-	-
LCD_VD7	-	-	P8_4	UD[7]	P8_4	UD[7]
LCD_VD6	-	-	P8_5	UD[6]	P8_5	UD[6]
LCD_VD5	-	-	P8_6	UD[5]	P8_6	UD[5]
LCD_VD4	-	-	P8_7	UD[4]	P8_7	UD[4]
LCD_VD3	P4_2	UD[3]	P4_2	UD[3]	P4_2	UD[3]
LCD_VD2	P4_3	UD[2]	P4_3	UD[2]	P4_3	UD[2]
LCD_VD1	P4_4	UD[1]	P4_4	UD[1]	P4_4	UD[1]
LCD_VD0	P4_1	UD[0]	P4_1	UD[0]	P4_1	UD[0]
LCD_LP	P7_6	LCDLP	P7_6	LCDLP	P7_6	LCDLP
LCD_ENAB/ LCDM	P4_6	LCDENAB/ LCDM	P4_6	LCDENAB/ LCDM	P4_6	LCDENAB/ LCDM
LCD_FP	P4_5	LCDFP	P4_5	LCDFP	P4_5	LCDFP
LCD_DCLK	P4_7	LCDDCLK	P4_7	LCDDCLK	P4_7	LCDDCLK
LCD_LE	P7_0	LCDLE	P7_0	LCDLE	P7_0	LCDLE
LCD_PWR	P7_7	CDPWR	P7_7	LCDPWR	P7_7	LCDPWR
GP_CLKIN	PF_4	LCDCLKIN	PF_4	LCDCLKIN	PF_4	LCDCLKIN

Table 39. LCD panel connections for STN dual panel mode

External pin	4-bit mono STN dual panel		8-bit mono STN dual panel		Color STN dual panel	
	LPC43xx pin used	LCD function	LPC43xx pin used	LCD function	LPC43xx pin used	LCD function
LCD_VD[23:16]	-	-	-	-	-	-
LCD_VD15	-	-	PB_4	LD[7]	PB_4	LD[7]
LCD_VD14	-	-	PB_5	LD[6]	PB_5	LD[6]
LCD_VD13	-	-	PB_6	LD[5]	PB_6	LD[5]
LCD_VD12	-	-	P8_3	LD[4]	P8_3	LD[4]
LCD_VD11	P4_9	LD[3]	P4_9	LD[3]	P4_9	LD[3]
LCD_VD10	P4_10	LD[2]	P4_10	LD[2]	P4_10	LD[2]
LCD_VD9	P4_8	LD[1]	P4_8	LD[1]	P4_8	LD[1]
LCD_VD8	P7_5	LD[0]	P7_5	LD[0]	P7_5	LD[0]
LCD_VD7	-	-		UD[7]	P8_4	UD[7]
LCD_VD6	-	-	P8_5	UD[6]	P8_5	UD[6]
LCD_VD5	-	-	P8_6	UD[5]	P8_6	UD[5]
LCD_VD4	-	-	P8_7	UD[4]	P8_7	UD[4]
LCD_VD3	P4_2	UD[3]	P4_2	UD[3]	P4_2	UD[3]