

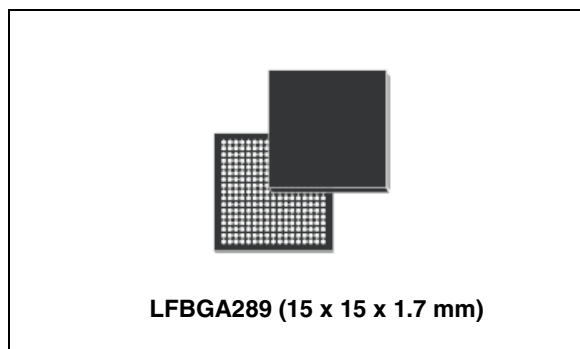


SPEAr300

Embedded MPU with ARM926 core, flexible memory support, powerful connectivity features and human machine interface

Features

- ARM926EJ-S core up to 333 MHz
- High-performance 8-channel DMA
- Dynamic power-saving features
- Configurable peripheral functions multiplexed on 102 shared I/Os
- Memory
 - 32 KB ROM and 57 KB internal SRAM
 - LPDDR-333/DDR2-666 external memory interface
 - Flexible static memory controller (FSMC) up to 16-bit data bus width, supporting external SRAM, NAND/NOR Flash and FPGAs
 - Serial SPI Flash interface
 - SDIO/MMC card interface
- Connectivity
 - 2 x USB 2.0 Host
 - USB 2.0 Device
 - Fast Ethernet (MII port)
 - SPI, I²C, I²S, UART and IrDA interfaces
 - TDM bus (512 timeslots)
 - Up to 8 additional I²C/SPI chip selects
- Security
 - C3 cryptographic accelerator
- Peripherals supported
 - Camera interface (ITU-601/656 and CSI2 support)
 - TFT/STN LCD controller (resolution up to 1024 x 768 and up to 24 bpp)
 - Touchscreen support
 - 9 x 9 keyboard controller
 - Glueless management of up to 8 SLICs/CODECs
- Miscellaneous functions
 - Integrated real time clock, watchdog, and system controller



- 8-channel 10-bit ADC, 1 Msps
- 1-bit DAC
- JPEG codec accelerator
- Six 16-bit general purpose timers with capture mode and programmable prescaler
- Up to 44 GPIOs

Applications

- SPEAr300 embedded MPU is configurable in 13 sets of peripheral functions targeting a range of applications:
 - General purpose NAND Flash or NOR Flash based devices
 - Digital photo frames
 - WiFi or IP phones (low end or high end)
 - ATA PABX systems (with or without I²S)
 - 8-bit or 14-bit camera (with or without LCD)

Table 1. Device summary

Order code	Temp range, °C	Package	Packing
SPEAR300-2	- 40 to 85 °C	LFBGA289 (15x15 mm) pitch 0.8 mm	Tray

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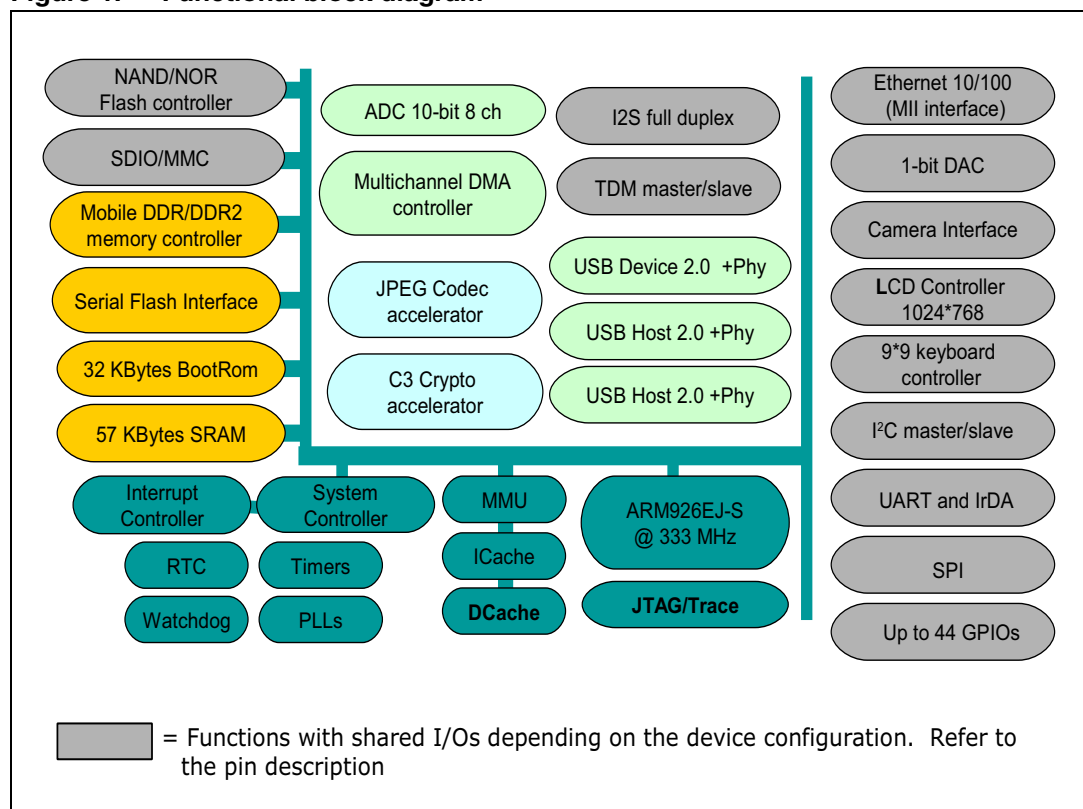
1 Description

The SPEAr300 is a member of the SPEAr family of embedded MPUs for networked devices. It is based on the powerful ARM926EJ-S processor (up to 333 MHz), widely used in applications where high computation performance is required.

In addition, SPEAr300 has an MMU that allows virtual memory management -- making the system compliant with Linux operating system. It also offers 16 KB of data cache, 16 KB of instruction cache, JTAG and ETM (embedded trace macro-cell) for debug operations.

A full set of peripherals allows the system to be used in many applications, some typical applications being HMI, Security and VoIP phones.

Figure 1. Functional block diagram



Main features:

- ARM926EJ-S 32-bit RISC CPU, up to 333 MHz
 - 16 Kbytes of instruction cache, 16 Kbytes of data cache
 - 3 instruction sets: 32-bit for high performance, 16-bit (Thumb) for efficient code density, byte Java mode (Jazelle™) for direct execution of Java code.
 - Tightly Coupled Memory
 - AMBA bus interface
- 32-KByte on-chip BootRom
- 57-KByte on-chip SRAM
- 16-bit mobile DDR/DDR2 memory controller (up to 333 MHz)
- Serial memory interface
- SDIO/MMC interface supporting SPI, SD1, SD4 and SD8 mode with card detect, write protect, LED
- 8/16-bits NOR Flash/NAND Flash controller
- Boot capability from NAND Flash, serial/parallel NOR Flash, Ethernet and UART
- Boot and field upgrade capability from USB
- Multichannel DMA controller
- Color LCD Controller for STN/TFT display panels
 - up to 1024 x 768 resolution
 - 24 bpp true color
- Up to 44 GPIOs (muxed with peripheral I/Os), up to 22 with interrupt capability
- JPEG CODEC accelerator, 1 clock/pixel
- Camera interface ITU-601 with external or embedded synchronization (ITU-656 or CSI2). Picture limit is given by the line length that must be stored in a 2048 x 32 buffer
- C3 Crypto accelerator (DES/3DES/AES/SHA1)
- TDM master/slave
 - Up to 512 timeslots
 - Any input timeslot can be switched to any output timeslot, and/or can be buffered for computation
 - Up to 16 channels of 1 to 4 timeslots buffered during 32 ms
 - Up to 16 buffers can be played in output timeslots
- I²S interface, full duplex with data buffer for left and right channels allowing up to 64 ms of voice buffer (for 32 bit samples).
- 10-bit ADC, 1 Msps, 8 inputs/1-bit DAC
- 9 x 9 keyboard controller
- Ethernet MAC 10/100 Mbps (MII PHY interface)
- Two USB2.0 host (high-full-low speed) with integrated PHY transceiver
- One USB2.0 device (high-full-low speed) with integrated PHY transceiver
- SPI master/slave (Motorola, Texas instruments, National semiconductor protocols) up to 50 Mbps
- I²C (slow- fast-high speed, up to 1.2 Mb/s) master/slave
- I/O peripherals
 - UART (speed rate up to 460.8 kbps)

SPEAr300**Description**

- IrDA (FIR/MIR/SIR) 9.6 kbps to 4 Mbps speed-rate
- Advanced power saving features
 - Normal, Slow, Doze and Sleep modes CPU clock with software-programmable frequency
 - Enhanced dynamic power-domain management
 - Clock gating functionality
 - Low frequency operating mode
 - Automatic power saving controlled from application activity demands
- Vectored interrupt controller
- System and peripheral controller
 - 3 pairs of 16-bit general purpose timers with programmable prescaler.
 - RTC with separate power supply allowing battery connection
 - Watchdog timer
 - Miscellaneous registers array for embedded MPU configuration
- Programmable PLL for CPU and system clocks
- JTAG IEEE 1149.1 boundary scan
- ETM9 interface and embedded ICE-RT
- ETM functionality multiplexed on primary pins
- Supply voltages
 - 1.2 V core, 1.8 V to 3.3 V I/Os
- Operating temperature: - 40 to 85 °C
- LFBGA289 (15 x15 mm, pitch 0.8 mm)

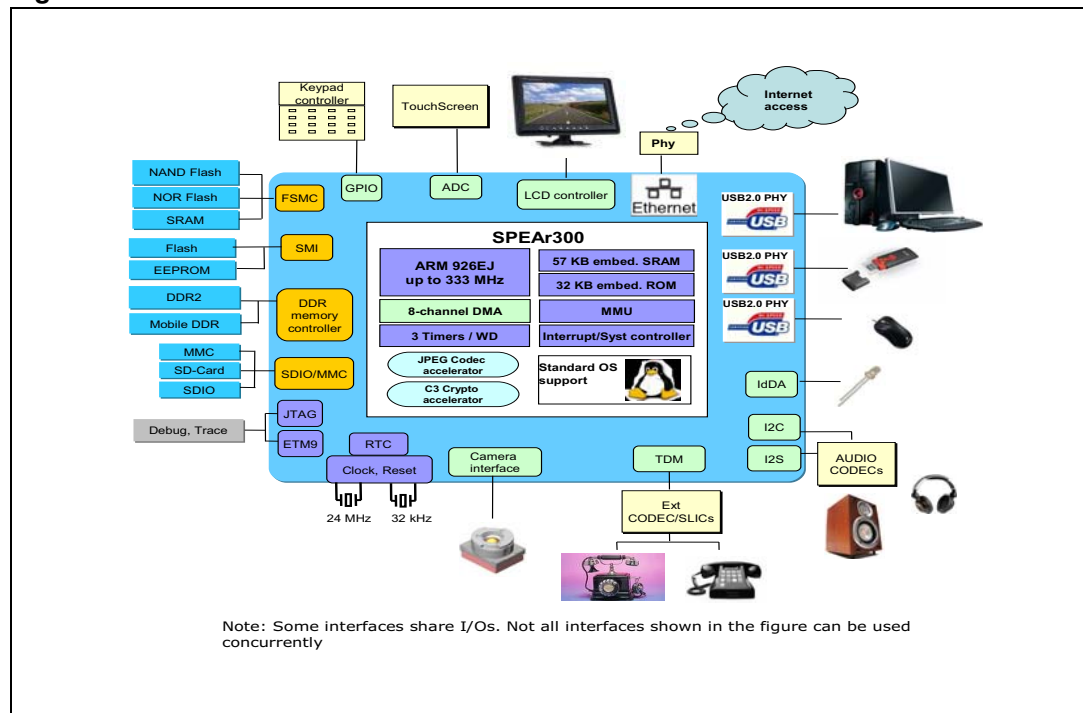
2 Architecture overview

The SPEAr300 internal architecture is based on several shared subsystem logic blocks interconnected through a multilayer interconnection matrix.

The switch matrix structure allows different subsystem dataflow to be executed in parallel improving the core platform efficiency.

High performance master agents are directly interconnected with the memory controller reducing the memory access latency. The overall memory bandwidth assigned to each master port can be programmed and optimized through an internal efficient weighted round-robin arbitration mechanism.

Figure 2. SPEAr300 overview



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2.1 ARM 926EJ-S CPU

The SPEAr300 CPU is an ARM926EJ reduced instruction set computer (RISC) processor.

It supports the 32-bit ARM and 16-bit Thumb instruction sets, enabling the user to trade off between high performance and high code density and includes features for efficient execution of Java byte codes.

The ARM CPU and is clocked at a frequency up to 333 MHz. It has a 16-Kbyte instruction cache, a 16-Kbyte data cache, and features a memory management unit (MMU) which makes it fully compliant with Linux and VxWorks operating systems.

It also includes an embedded trace module (ETM Medium+) for real-time CPU activity tracing and debugging. It supports 4-bit and 8-bit normal trace mode and 4-bit demultiplexed trace mode, with normal or half-rate clock.

2.2 Embedded memory units

32 Kbytes of BootROM

57 Kbytes of SRAM

2.3 Mobile DDR/DDR2 memory controller

SPEAr300 integrates a high performances multi-channel memory controller able to support low power Mobile DDR and DDR2 double data rate memory devices. The multi-port architecture ensures memory is shared efficiently among different high-bandwidth client modules.

It offers 6 internal ports. One of them is reserved for register access during the controller initialization while the other five are used to access the external memory.

It also include the physical layer (PHY) and some DLLs that allow fine tuning of all the timing parameters to maximize the data valid windows at any frequency in the allowed range.

2.4 Serial memory interface

The main features of SMI are listed below:

- Supports the following SPI-compatible Flash and EEPROM devices:
 - STMicroelectronics M25Pxxx, M45Pxxx
 - STMicroelectronics M95xxx, except M95040, M95020 and M95010
 - ATMEL AT25Fxx
 - YMC Y25Fxx
 - SST SST25LFxx
- Acts always as a SPI master and up to 2 SPI slave memory devices are supported (through as many chip select signals), with up to 16 MB address space each
- SMI clock signal (SMICK) is generated by SMI (and input to all slaves) using a clock provided by the AHB bus
- SMICK can be up to 50 MHz in fast read mode (or 20 MHz in normal mode). It can be controlled by 7 programmable bits.

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2.5 SDIO/MMC

SPEAr300 provides an SDIO host controller that has an AMBA compatible interface and conforms to the SD host controller standard specification version 2.0. It handles SD/SDIO protocol at transmission level, packing data, adding cyclic redundancy check (CRC), start/end bit, and checking for transaction format correctness.

Main features:

- Meets the following standard specifications:
 - SD host controller standard specification version 2.0
 - SDIO card specification version 2.0
 - SD memory card specification draft version 2.0
 - SD memory card security specification version 1.01
 - MMC specification version 3.31 and 4.2
- Supports both DMA and non-DMA mode of operation
- Supports MMC plus and MMC mobile
- Card detection (insertion/removal)
- Password protection of cards
- Host clock rate variable between 0 and 48 MHz
- Supports 1-bit, 4-bit and 8-bit SD modes and SPI mode
- Supports MultiMedia Card interrupt mode
- Allows card to interrupt host in 1-bit, 4-bit, 8-bit SD modes and SPI mode.
- Up to 100 Mbit/s data rate using 4 parallel data lines (sd4-bit mode)
- Up to 416 Mbit/s data rate using 8-bit parallel data lines (sd8-bit mode)
- Cyclic redundancy check CRC7 for command and CRC16 for data integrity
- Designed to work with I/O cards, read-only cards and read/write cards
- Error correction code (ECC) support for MMC4.2 cards
- Supports read wait control, suspend/resume operation
- Supports FIFO overrun and underrun condition by stopping the SD clock
- Conforms to AMBA specification AHB (2.0)

2.6 Flexible static memory controller

SPEAr300 provides a Flexible Static Memory Controller (FSMC) which interface the AHB bus to external NAND/NOR Flash memories and to asynchronous SRAM memories.

Main features:

- Provides an interface between AHB system bus and external parallel memory devices
- Interfaces static memory-mapped devices including RAM, ROM and synchronous burst Flash.
- For SRAM and Flash 8/16-bit wide, external memory and data paths are provided
- FSMC performs only one access at a time and only one external device is accessed.
- Supports little-endian and big-endian memory architectures
- AHB burst transfer handling to reduce access time to external devices
- Supplies an independent configuration for each memory bank
- Programmable timings to support a wide range of devices
- Programmable wait states (up to 31)
- Programmable bus turnaround cycles (up to 15)
- Programmable output enable and write enable delays (up to 15)
- Provides independent chip select control for each memory bank
- Shares the address bus and the data bus with all the external peripherals. Only the chip selects are unique for each peripheral
- External asynchronous wait control
- Boot memory bank configurable at reset using external control pins

2.7 Multichannel DMA controller

Within its basic subsystem, SPEAr300 provides an DMA controller (DMAC) able to service up to 8 independent DMA channels for serial data transfers between single source and destination (i.e., memory-to-memory, memory-to-peripheral, peripheral to- memory, and peripheral-to-peripheral).

Each DMA channel can support a unidirectional transfer, with internal four-word FIFO per channel.

2.8 CLCD controller

SPEAr300 has a color liquid crystal display controller (CLCDC) that provides all the necessary control signals to interface directly to a variety of color and monochrome LCD panels.

Main features:

- Resolution programmable up to 1024 x 768
- 16-bpp true-color non-palletized, for color STN and TFT
- 24-bpp true-color non-palletized, for color TFT
- Supports single and dual panel mono super twisted nematic (STN) displays with 4 or 8-bit interfaces
- Supports single and dual-panel color and monochrome STN displays
- Supports thin film transistor (TFT) color displays
- 15 gray-level mono, 3375 color STN, and 32 K color TFT support
- 1, 2, or 4 bits per pixel (bpp) palletized displays for mono STN
- 1, 2, 4 or 8-bpp palletized color displays for color STN and TFT
- Programmable timing for different display panels
- 256 entry, 16-bit palette RAM, arranged as a 128 x 32-bit RAM physically frame, line and pixel clock signals
- AC bias signal for STN and data enable signal for TFT panels patented gray scale algorithm
- Supports little and big-endian

2.9 GPIOs

The General Purpose Input/Outputs (GPIOs) provide programmable inputs or outputs.

Each input/output can be controlled in two distinct modes:

- Software mode, through an APB interface
- Hardware mode, through a hardware control interface.

Main features:

- Up to 44 individually programmable input/output pins implemented in 4 blocks:
 - Up to 6 base GPIOs in the basic subsystem (basGPIO)
 - Up to 18 GPIOs in the telecom subsystem (G10 and G8)
 - Up to 8 GPIOs in the independent GPIO block (GPIO[7:0])
 - Other GPIOs available on free PL_GPIO pins in the RAS block.
- Programmable interrupt generation capability up to 22 pins.
- Base GPIOs and independent GPIOs support bit masking in both read and write operation through address lines.

2.10 JPEG (CODEC)

SPEAr300 provides a JPEG CODEC with header processing (JPGC), able to decode (or encode) image data contained in the RAM memory, from the JPEG (or BMP) format to the BMP (or JPEG) format.

Main features:

- Compliance with the baseline JPEG standard (ISO/IEC 10918-1)
- Single-clock per pixel encoding/decoding
- Support for up to four channels of component color
- 8-bit/channel pixel depths
- Programmable quantization tables (up to four)
- Programmable Huffman tables (two AC and two DC)
- Programmable minimum coded unit (MCU)
- Configurable JPEG headers processing
- Support for restart marker insertion
- Use of two DMA channels and of two 8 x 32-bits FIFO's (local to the JPEG) for efficient transferring and buffering of encoded/decoded data from/to the CODEC core.

2.11 Camera interface

The camera interface receives data from a sensor in parallel mode (8 to 14-bits) by storing a full line in a buffer memory, then requesting a DMA transfer or interrupting the processor.

When all the lines of a frame are transferred, a frame sync interrupt is generated.

Main features:

- Supports both hardware synchronization (HSYNC and VSYNC signals) and embedded synchronization (ITU656 or CSI2).
- Data carried by the bus can be:
 - Raw Bayer10 (10-14 bits/pixel – 2 Bytes), Raw Bayer8 (8 bits/pixel – 1 Byte),
 - YCbCr400 (1 Byte/pixel – 1 Byte), YCbCr422 (4 Bytes/ 2 pixels – 2*2 Bytes), YCbCr444 (3 Bytes/ pixel – 4 Bytes)
 - RGB444 (2 Bytes/ pixel – 2 Bytes), RGB565 (2 Bytes/ pixel – 2 Bytes), RGB888 (3 Bytes/ pixel – 4 Bytes)
 - JPEG compressed
- Data is stored in a 2048 x 32 buffer memory
- The camera interface can be assigned to two different set of pins. When using data greater than 8-bits, it is not possible to use the MII interface.
- Max pixel clock frequency is 100 MHz

2.12 Cryptographic co-processor (C3)

Main features:

- Supported cryptographic algorithms:
 - Advanced encryption standard (AES) cipher in ECB, CBC, CTR modes
 - Data encryption standard (DES) cipher in ECB and CBC modes.
 - SHA-1, HMAC-SHA-1, MD5, HMAC-MD5 digests.
- Instruction driven DMA based programmable engine.
- AHB master port for data access from/to system memory.
- AHB slave port for co-processor register accesses and initial engine-setup
- The co-processor is fully autonomous (DMA input reading, cryptographic operation execution, DMA output writing) after being set up by the host processor
- The co-processor executes programs written by the host in memory, it can execute an unlimited list of programs.
- The co-processor supports hardware chaining of cryptographic blocks for optimized execution of data-flow requiring multiple algorithms processing over the same set of data (for example encryption + hashing on the fly)

2.13 TDM interface

The TDM block implements time division multiplexing.

Main features:

- TDM interface with 512 timeslots and up to 16 bufferization channels.
- 32 ms bufferization for 16 channels (of 4 bytes each)
- Supports master and slave mode operation
- Programmable clock and synchronization signal generation in master mode
- Clock & synchronization signal recovery in slave mode
- 8 programmable synchronization signals for CODECs
- Uses 11 pins:
 - SYNC7-0 are dedicated frame syncs for CODECs without timeslot recognition
 - CLK is the TDM clock
 - DIN is the TDM input and receives the data
 - DOUT is the TDM output and transmits the data. It can be high impedance on a unused timeslot
- The TDM interface can be the master or a slave of the CLK or SYNC0 signals.
- Timeslots can be used for switching or bufferization purposes:
 - Switching and bufferization can be used concurrently for different timeslots on the same TDM
 - The only limitation is that an output timeslot can not be switched and bufferized at the same time.
 - Timeslot switching: any of the output time slots can receive any input timeslot of the previous frame. The connection memory is part of the action memory, indicating which timeslot has to be output.
 - Timeslot bufferization: data from DIN is stored in an input buffer and data from an output buffer is played on DOUT. When the number of samples stored/played reaches the buffer size, the processor is interrupted in order to read the input buffer and prepare a new output buffer (or a DMA request is generated).

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2.14 I²S interface

The I²S interface is very similar to the TDM block, but the frame sync is limited to Philips I²S definition. It is composed of 4 signals:

- I2S_LRCK; Left and right channels synchronization (Master/slave)
- I2S_CLK: I²S clock (Master/slave)
- I2S_DIN: I²S clock (Master/slave)
- I2S DOUT: I²S output (tri-state)

The DOUT line can be high impedance when out of samples. Data is always stored in 32 bit format in the buffer. A shift left operation is possible to left align the data.

Main features:

- Can be master or slave for the clock and sync signals
- Buffering of up to 1024 samples (512 left and 512 right samples representing 64 ms of voice). Data is stored always on 32 bits.
- Left and right channels are stored in two different buffers.
- Two banks are used to exchange data with the processor.
- In master mode, LRCK can be adjusted for 8, 16 or 32 bits width.
- Data width can be less than LRCK width. Input (received on I2S_DIN) and output (transmitted on DOUT) can be 8, 16 or 32 bits.

2.15 8-channel ADC**Main features:**

- Successive approximation conversion method
- 10-bit resolution @1 Msps
- Hardware supporting up to 13.5 bits resolution at 8 ksps by oversampling and accumulation
- Eight analog input (AIN) channels, ranging from 0 to 2.5 V
- $INL \pm 1$ LSB, $DNL \pm 1$ LSB
- Programmable conversion speed, (min. conversion time is 1 s)
- Programmable average results from 1 (no averaging) up to 128
- Programmable auto scan for all the eight channels.
- Normal or enhanced mode;
 - In normal mode the conversion start upon CPU request
 - In enhanced mode the ADC converts continuously the selected channels inserting a selectable amount of time between two conversions.

2.16 1-bit DAC

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The one-bit DAC is a second-order noise shaper based on the TDM hardware. The action memory determines whether a new sample needs to be sent to the DAC during the next byte. Samples are read from the buffer memory.

Main features:

- Input data must be 32-bits wide, either in 2's complement or binary form.
- Oversampling min 32, max 256
- S/N ratio is 82 dB, THD is 72 dB (Measured on a 1 kHz sine wave x64 over sampled by the processor and x32 by the DAC)
- Dynamic: 80% of full scale
- Optionally, the order of the noise shaper can be set to 1

2.17 Keyboard controller

SPEAr300 provides a GPIO/keyboard block which is a two-mode input and output port.

Main features:

- The selection between the two modes is an APB Bus programmable bit.
- Keyboard interface uses 18 pins
- 18-bit general-purpose parallel port with input or output single pin programmability
- Pins can be either used as standard GPIOs or to drive a 9 x 9 keyboard (81 keys)
- Keyboard scan period can be adjusted between 10 ms and 80 ms
- Supports auto-scanning with debouncing.

2.18 Ethernet controller

Main features:

- Compliant with the IEEE 802.3-2002 standard
- Supports the default MII interface to the external PHY
- Supports 10/100 Mbps data transfer rates
- Local FIFO available (4 Kbyte RX, 2 Kbyte TX)
- Supports both half-duplex and full-duplex operation. In half-duplex operation, CSMA/CD protocol is provided for, as well as packet bursting and frame extension at 100 Mbps
- Programmable frame length to support both standard and jumbo Ethernet frames with size up to 16 Kbyte
- A variety of flexible addresses filtering modes are supported
- A set of control and status registers (CSRs) to control GMAC core operation
- Native DMA with single-channel transmit and receive engines, providing 32/64/128-bit data transfers
- DMA implements dual-buffer (ring) or linked-list (chained) descriptor chaining
- An AHB slave acting as programming interface to access all CSRs, for both DMA and GMAC core subsystems
- An AHB master for data transfer to system memory
- 32-bit AHB master bus width, supporting 32, 64, and 128-bit wide data transactions
- It supports both little and big endian memory architectures

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2.19 USB2 host controller

SPEAr300 has two fully independent USB 2.0 hosts. Each one is constituted by 5 major blocks:

- EHCI capable of managing high-speed transfers (HS mode, 480 Mbps)
- OHCI that manages the full and the low speed transfers (12 and 1.5 Mbps)
- Local 2-Kbyte FIFO
- Local DMA
- Integrated USB2 transceiver (PHY)

Both hosts can manage an external power switch, providing a control line to enable or disable the power, and an input line to sense any over-current condition detected by the external switch.

One host controller at time can perform high speed transfer.

2.20 USB2 device controller

The USB2 device controller provides the following features:

- Supports the 480 Mbps high-speed mode (HS) for USB 2.0, as well as the 12 Mbps full-speed (FS) and the low-speed (LS modes) for USB 1.1
- Supports 16 physical endpoints, which can be assigned to different interfaces and configurations to implement logical endpoints
- Integrated USB transceiver (PHY)
- Local 4 Kbyte FIFO shared by all endpoints
- DMA mode and slave-only mode are supported
- In DMA mode, the UDC supports descriptor-based memory structures in application memory
- In both modes, an AHB slave is provided by UDC-AHB, acting as programming interface to access to memory-mapped control and status registers (CSRs)
- An AHB master for data transfer to system memory is provided, supporting 8, 16, and 32-bit wide data transactions on the AHB bus
- A USB plug detect (UPD) which detects the connection of a cable.

2.21 SSP

SPEAr300 provides one synchronous serial port (SSP) block that offers a master or slave interface for synchronous serial communication with slave or master peripherals

Main features:

- Maximum speed of 41.5 Mbps
- Master and slave mode capability
- Programmable clock bit rate and prescale
- Separate transmit and receive first-in, first-out memory buffers, 16 bits wide, 8 locations deep
- Programmable choice of interface operation:
 - SPI (Motorola)
 - Microwire (National Semiconductor)
 - TI synchronous serial
- Programmable data frame size from 4 to 16-bit.
- Independent masking of transmit FIFO, receive FIFO, and receive overrun interrupts
- DMA interface

2.22 I²C

The I2C controller, acts as an APB slave interface to the two-wire serial I2C bus.

Main features:

- Compliance to the I2C-bus specification (Philips)
- I²C v2.0 compatible.
- Operates in three different speed modes:
 - Standard (100 kbps)
 - Fast (400 kbps)
 - High-speed (3.4 Mbps)
- Master and slave mode configuration possible
- 7-bit or 10-bit addressing
- 7-bit or 10-bit combined format transfers
- Slave bulk data transfer capability.
- Connection with general purpose DMA is provided to reduce the CPU load.
- Interrupt or polled-mode operation
- Supports APB data bus widths of 8, 16 and 32-bits

2.23 UART with IrDA

Main features:

- Can be used as UART with software flow control or as an IrDA interface
- IrDA compliant serial link (FIR/MIR/SIR) from 9.6 Kbps to 4 Mbps speed-rate.
- Separate 16x8 (16 locations deep x 8-bit wide) transmit and 16 x 12 receive FIFOs to reduce CPU interrupts
- Speed up to 460.8 kbps.

2.24 System controller

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The System Controller provides an interface for controlling the operation of the overall system.

Main features:

- Power saving system mode control
- Crystal oscillator and PLL control
- Configuration of system response to interrupts
- Reset status capture and soft reset generation
- Watchdog and timer module clock enable
- Remap control
- General purpose peripheral control r
- System and peripheral clock control and status

2.24.1 Power saving system mode control

Using three mode control bits, the system controller switch the SPEAr300 to any one of four different modes: DOZE, SLEEP, SLOW and NORMAL.

- **SLEEP mode:** In this mode the system clocks, HCLK and CLK, are disabled and the System Controller clock SCLK is driven by a low speed oscillator (nominally 32768 Hz). When either a FIQ or an IRQ interrupt is generated (through the VIC) the system enters DOZE mode. Additionally, the operating mode setting in the system control register automatically changes from SLEEP to DOZE.
- **DOZE mode:** In this mode the system clocks, HCLK and CLK, and the System Controller clock SCLK are driven by a low speed oscillator. The System Controller moves into SLEEP mode from DOZE mode only when none of the mode control bits are set and the processor is in Wait-for-interrupt state. If SLOW mode or NORMAL mode is required the system moves into the XTAL control transition state to initialize the crystal oscillator.
- **SLOW mode:** During this mode, both the system clocks and the System Controller clock are driven by the crystal oscillator. If NORMAL mode is selected, the system goes into the "PLL control" transition state. If neither the SLOW nor the NORMAL mode control bits are set, the system goes into the "Switch from XTAL" transition state.
- **NORMAL mode:** In NORMAL mode, both the system clocks and the System Controller clock are driven by the PLL output. If the NORMAL mode control bit is not set, then the system goes into the "Switch from PLL" transition state.

2.24.2 Clock and reset system

The clock system is a fully programmable block that generates all the clocks for the SPEAr300.

The default operating clock frequencies are:

- Clock @ 333 MHz for the CPU.
- Clock @ 166 MHz for AHB bus and AHB peripherals
- Clock @ 83 MHz for, APB bus and APB peripherals
- Clock @ 333 MHz for DDR memory interface.

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The above frequencies are the maximum allowed values. The clock frequencies can be modified by programming the clock system registers.

The clock system consists of 2 main parts: a multi clock generator block and two internal PLLs.

The multi clock generator block, takes a reference signal (which is usually delivered by the PLL), generates all clocks for the IPs of SPEAr300 according to dedicated programmable registers.

Each PLL uses an oscillator input of 24 MHz to generate a clock signal at a frequency corresponding to the highest of the group. This is the reference signal used by the multi clock generator block to obtain all the other required clocks for the group. Its main feature is electromagnetic interference reduction capability.

The user can set up the PLL in order to modulate the VCO with a triangular wave. The resulting signal has a spectrum (and power) spread over a small programmable range of frequencies centered on F0 (the VCO frequency), obtaining minimum electromagnetic emissions. This method replaces all the other traditional methods of EMI reduction, such as

filtering, ferrite beads, chokes, adding power layers and ground planes to PCBs, metal shielding and so on. This gives the customer appreciable cost savings.

In sleep mode the SPEAr300 runs with the PLL disabled so the available frequency is 24 MHz or a sub-multiple ($/2$, $/4$, $/8$).

2.24.3 Vectored interrupt controller (VIC)

The VIC allows the OS interrupt handler to quickly dispatch interrupt service routines in response to peripheral interrupts. There are 32 interrupt lines and the VIC uses a separate bit position for each interrupt source. Software controls each request line to generate software interrupts.

2.24.4 General purpose timers

SPEAr300 provides three general purpose timers (GPTs) acting as APB slaves.

Each GPT consists of 2 channels, each one made up of a programmable 16-bit counter and a dedicated 8-bit timer clock prescaler. The programmable 8-bit prescaler performs a clock division by 1 up to 256, and different input frequencies can be chosen through SPEAr300 configuration registers (frequencies ranging from 3.96 Hz to 48 MHz can be synthesized).

Two different modes of operation are available:

- Auto-reload mode, an interrupt source is activated, the counter is automatically cleared and then it restarts incrementing.
- Single-shot mode, an interrupt source is activated, the counter is stopped and the GPT is disabled.

2.24.5 Watchdog timer

The ARM watchdog module consists of a 32-bit down counter with a programmable timeout interval that has the capability to generate an interrupt and a reset signal on timing out. The watchdog module is intended to be used to apply a reset to a system in the event of a software failure.

2.24.6 RTC oscillator

The RTC provides a 1-second resolution clock. This keeps time when the system is inactive and can be used to wake the system up when a programmed alarm time is reached. It has a clock trimming feature to compensate for the accuracy of the 32.768 kHz crystal and a secured time update.

2.25 SPI_I2C multiple slave control

The SPI interface has only one slave select signal, SS0.

The I²C interface does not allow control of several devices with the same address, which is frequently required for CODECs.

The SPI_I2C extension allows management of up to 8 SPI devices, or 8 I²C devices at the same address (total SPI+I²C devices=8).

The SPI extension is made by generating three more slave select signals SS1, SS2 and SS3.

The I²C extension is done by replicating the I2C_SCL signal if the corresponding pin is set active. Otherwise the pin remains low, so that the start condition is not met.

Each of the 8 pins can reproduce either the SPI SS0 signal, or the I2C_SCL signal. The selection is made through a register.

3 Pin description

The following tables describe the pinout of the SPEAr300 listed by functional block.

List of abbreviations:

PU = Pull Up

PD = Pull Down

3.1 Required external components

1. DDR_COMP_1V8: place an external 121 k Ω resistor between ball P4 and ball R4
2. USB_TX_RTUNE: connect an external 43.2 k Ω pull-down resistor to ball K5
3. DIGITAL_REXT: place an external 121 k Ω resistor between ball G4 and ball F4.

3.2 Dedicated pins

Table 2. Master clock, RTC, Reset and 3.3 V comparator pin descriptions

Group	Signal name	Ball	Direction	Function	Pin type
Master Clock	MCLK_XI	P1	Input	24 MHz (typical) crystal in	Oscillator 2.5 V capable
	MCLK_XO	P2	Output	24 MHz (typical) crystal out	
RTC	RTC_XI	E2	Input	32 kHz crystal in	Oscillator 1V capable
	RTC_XO	E1	Output	32 kHz crystal out	
Reset	MRESET#	M17	Input	Main Reset	TTL Schmitt trigger input buffer, 3.3 V tolerant, PU
3.3 V Comp.	DIGITAL_REXT	G4	Output	Configuration	Analog, 3.3 V capable
	DIGITAL_GND_REX	F4	Power	Power	Power

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Table 3. Power supply pin description

Group	Signal name	Ball	Value
DIGITAL GROUND	GND	G6, G7, G8, G9, G10, G11, H6, H7, H8, H9, H10, H11, J6, J7, J8, J9, J10, J11, K6, K7, K8, K9, K10, K11, L6, L7, L8, L9, L10, M8, M9, M10	0 V
ANALOG GROUND	AGND	F2, G1, J2, L1, L3, L5, N2, N4, P3, R3, N12	0 V
I/O	VDD3	F5, F6, F7, F10, F11, F12, G5, J12, K12, L12, M12	3.3 V

Table 3. Power supply pin description

Group	Signal name	Ball	Value
CORE	VDD	F8, F9, G12, H5, H12, J5, L11, M6, M7, M11	1.2 V
USB HOST0 PHY	HOST0_VDDbc	L2	2.5 V
	HOST0_VDDb3	K4	3.3 V
	HOST0_VDDbs	M3	1.2 V
USB HOST 1 PHY	HOST1_VDDbc	K3	2.5 V
	HOST1_VDDb3	J1	3.3 V
	HOST1_VDDbs	M3	1.2 V
USB DEVICE PHY	DEVICE_VDDbc	N1	2.5 V
	DEVICE_VDDb3	N3	3.3 V
	HOST0_VDDbs	M3	1.2V
OSCI (master clock)	MCLK_VDD	R1	1.2V
	MCLK_VDD2v5	R2	2.5 V
PLL1	DITH1_AVDD	G2	2.5 V
PLL2	DITH2_AVDD	M4	2.5 V
DDR I/O	SSTL_VDDe	M5, N5, N6, N7, N8, N9, N10, N11	1.8 V
ADC	ADC_AVDD	N13	2.5 V
OSCI RTC	RTC VDD	F1	1.5 V

Table 4. Debug pin descriptions

Group	Signal name	Ball	Direction	Function	Pin type
DEBUG	TEST_0	K16	Input	Test configuration ports. For functional mode, they have to be set to zero.	TTL input buffer, 3.3 V tolerant, PD
	TEST_1	K15			
	TEST_2	K14			
	TEST_3	K13			
	TEST_4	J15			
	BOOT_SEL	J14			
	nTRST	L16	Input	Test reset input	TTL Schmitt trigger input buffer, 3.3 V tolerant, PU
	TDO	L15	Output	Test data output	TTL output buffer, 3.3 V capable 4 mA
	TCK	L17	Input	Test clock	TTL Schmitt trigger input buffer, 3.3 V tolerant, PU
	TDI	L14	Input	Test data input	
TMS	L13	Input	Test mode select		

Table 5. Serial memory interface (SMI) pin description

Group	Signal name	Ball	Direction	Function	Pin type
SMI	SMI_DATAIN	M13	Input	Serial Flash input data	TTL Input Buffer 3.3 V tolerant, PU
	SMI_DATAOUT	M14	Output	Serial Flash output data	TTL output buffer 3.3 V capable 4 mA
	SMI_CLK	N17	I/O	Serial Flash clock	
	SMI_CS_0	M15	Output	Serial Flash chip select	
	SMI_CS_1	M16			

Table 6. USB pin descriptions

Group	Signal name	Ball	Direction	Function	Pin type
USB DEV	DEV_DP	M1	I/O	USB Device D+	Bidirectional analog buffer 5 V tolerant
	DEV_DM	M2		USB Device D-	
	DEV_VBUS	G3	Input	USB Device VBUS	TTL input buffer 3.3 V tolerant, PD
	HOST1_DP	H1	I/O	USB HOST1 D+	Bidirectional analog buffer 5 V tolerant
	HOST1_DM	H2		USB HOST1 D-	
USB HOST	HOST1_VBUS	H3	Output	USBHOST1 VBUS	TTL output buffer 3.3 V capable, 4 mA
	HOST1_OVRC	J4	Input	USB Host1 Over-Current	TTL input buffer 3.3 V tolerant, PD
	HOST0_DP	K1	I/O	USB HOST0 D+	Bidirectional analog buffer 5 V tolerant
	HOST0_DM	K2		USB HOST0 D-	
	HOST0_VBUS	J3	Output	USB HOST0 VBUS	TTL output buffer 3.3 V capable, 4 mA
	HOST0_OVRC	H4	Input	USB Host0 Over-current	TTL Input Buffer 3.3 V tolerant, PD
	USB_TXRTUNE	K5	Output	Reference resistor	Analog
	USB_ANALOG_T EST	L4	Output	Analog Test Output	Analog

Table 7. ADC pin description

Group	Signal name	Ball	Direction	Function	Pin type
ADC	AIN_0	N16	Input	ADC analog input channel	Analog buffer 2.5 V tolerant
	AIN_1	N15			
	AIN_2	P17			
	AIN_3	P16			
	AIN_4	P15			
	AIN_5	R17			
	AIN_6	R16			
	AIN_7	R15			
	ADC_VREFN	N14		ADC negative voltage reference	
ADC_VREFP	P14	ADC positive voltage reference			

Table 8. DDR pin description

Group	Signal name	Ball	Direction	Function	Pin type
DDR	DDR_ADD_0	T2	Output	Address Line	SSTL_2/SSTL_18
	DDR_ADD_1	T1			
	DDR_ADD_2	U1			
	DDR_ADD_3	U2			
	DDR_ADD_4	U3			
	DDR_ADD_5	U4			
	DDR_ADD_6	U5			
	DDR_ADD_7	T5			
	DDR_ADD_8	R5			
	DDR_ADD_9	P5			
	DDR_ADD_10	P6			
	DDR_ADD_11	R6			
	DDR_ADD_12	T6			
	DDR_ADD_13	U6			
	DDR_ADD_14	R7			
	DDR_BA_0	P7	Output	Bank select	SSTL_2/SSTL_18
	DDR_BA_1	P8			
	DDR_BA_2	R8			
	DDR_RAS	U8	Output	Row Add. Strobe	SSTL_2/SSTL_18
DDR_CAS	T8	Output	Col. Add. Strobe		
DDR_WE	T7	Output	Write enable		
DDR_CLKEN	U7	Output	Clock enable		
DDR_CLK_P	T9	Output	Differential clock	Differential SSTL_2/SSTL_18	
DDR_CLK_N	U9				

Table 8. DDR pin description (continued)

Group	Signal name	Ball	Direction	Function	Pin type
DDR	DDR_CS_0	P9	Output	Chip Select	SSTL_2/SSTL_18
	DDR_CS_1	R9			
	DDR_ODT_0	T3	I/O	On-Die Termination Enable lines	
	DDR_ODT_1	T4			
	DDR_DATA_0	P11	I/O	Data Lines (Lower byte)	
	DDR_DATA_1	R11			
	DDR_DATA_2	T11			
	DDR_DATA_3	U11			
	DDR_DATA_4	T12			
	DDR_DATA_5	R12			
	DDR_DATA_6	P12			
	DDR_DATA_7	P13			
	DDR_DQS_0	U10	Output	Lower Data Strobe	Differential SSTL_2/SSTL_18
	DDR_nDQS_0	T10			
	DDR_DM_0	U12	Output	Lower Data Mask	SSTL_2/SSTL_18
	DDR_GATE_0	R10	I/O	Lower Gate Open	
	DDR_DATA_8	T17	I/O	Data Lines (Upper byte)	
	DDR_DATA_9	T16			
	DDR_DATA_10	U17			
	DDR_DATA_11	U16			
	DDR_DATA_12	U14			
	DDR_DATA_13	U13			
	DDR_DATA_14	T13			
	DDR_DATA_15	R13			
	DDR_DQS_1	U15	I/O	Upper Data Strobe	Differential SSTL_2/SSTL_18
	DDR_nDQS_1	T15			
	DDR_DM_1	T14	I/O	Upper Data Mask	SSTL_2/SSTL_18
	DDR_GATE_1	R14		Upper Gate Open	
	DDR_VREF	P10	Input	Reference Voltage	Analog
	DDR_MEM_COM P_GND	R4	Power	Return for Ext. Resistors	Power
DDR_MEM_COM P_REXT	P4	Power	Ext. Resistor	Analog	
DDR2_EN	J13	Input	Configuration	TTL Input Buffer 3.3 V Tolerant, PU	

3.3 Shared I/O pins (PL_GPIOs)

The 98 PL_GPIO and 4 PL_CLK pins have the following characteristics:

- Output buffer: TTL 3.3 V capable up to 10 mA
- Input buffer: TTL, 3.3 V tolerant, selectable internal pull up/pull down (PU/PD)

Configuration modes

13 configurations are available selected by RAS control register 2. The peripherals available in each configuration are shown in [Table 9: Available peripherals in each configuration mode](#). Details of each PL_GPIO pin are given for each mode in [Table 10: PL_GPIO pin description on page 31](#).

Configuration 1 is the default mode for SPEAr300. It supports the FSMC interface for NAND Flash connectivity and boot pins used for selecting the boot mode.

Alternate functions

Other peripheral functions are listed in the Alternate Functions column of [Table 10: PL_GPIO pin description](#) and can be individually enabled/disabled via RAS control register 1. Refer to the user manual for the register descriptions.

GPIOs

Unused PL_GPIO pins can be configured individually in the RAS registers to provide additional GPIOs. The total number of GPIO can be up to 44 depending on the configuration mode and the number of alternate functions enabled.

Table 9. Available peripherals in each configuration mode

Modes	FSMC	Boot pins	SPI/I2C Multi slave control	I2S	CLCD	DAC	Camera interface	TDM No of voice devices	SDIO/MMC data lines	GPIOs	Keyboard keys	Interrupt pins
1	16-bit NAND	4										
2	16-bit NOR	4										
3	16-bit NAND				1			1	8	14 + 8 I/Os with ITs		
4			8	1		1		8	8	14	9*9	8
5			4	1	1	1		2	8	14	9*9	
6			8	1		1		8	8	14	9*9	8
7			4	1	1	1		2	8	14	9*9	
8	8-bit NOR		8					8	4	18		8
9	8-bit NAND /NOR		8	1		1		4	4	18		8
10			4	1		1	8-bit	2	8	8	9*9	
11				1	1	1	14-bit	2	8	8	7*5	
12				1		1	14-bit	2	8	8	7*5	
13			4	1	1	1	8-bit	2	8	4	9*9	

TDM interfacing using GPIOs

In some configuration modes where less than 8 TDM devices are indicated in [Table 9](#), additional TDM devices can be supported by using GPIO pins. The TDM needs a dedicated interrupt line, an SPI and an independent frame sync signal to interface each device. When enough SPI chip selects signals are not available (SPI_I2C signals), the chip select can be performed by a GPIO. In this case the number of possible TDM devices supported is:

Modes 5, 7, 8 and 9: up to 8 devices

Modes 3 and 10: up to 6 devices

Modes 11 and 12: up to 4 devices



Table 10. PL_GPIO pin description

PL / pin number	Alternate function (enabled by RAS register 1)	Configuration mode (enabled by RAS register 2)												
		1	2	3	4	5	6	7	8	9	10	11	12	13
97/H16		/E1	/E1	/E1	1	1	1	1	/E1	/E1	1	1	1	1
96/H15		D0	DQ0	D0	COL0	COL0	COL0	COL0	D0	D0	COL0	COL0	COL0	COL0
95/H14		D1	DQ1	D1	COL1	COL1	COL1	COL1	D1	D1	COL1	COL1	COL1	COL1
94/H13		D2	DQ2	D2	COL2	COL2	COL2	COL2	D2	D2	COL2	COL2	COL2	COL2
93/G17		D3	DQ3	D3	COL3	COL3	COL3	COL3	D3	D3	COL3	COL3	COL3	COL3
92/G16		D4	DQ4	D4	COL4	COL4	COL4	COL4	D4	D4	COL4	COL4	COL4	COL4
91/G15		D5	DQ5	D5	COL5	COL5	COL5	COL5	D5	D5	COL5	DIO0_1	DIO0_1	COL5
90/G14		D6	DQ6	D6	COL6	COL6	COL6	COL6	D6	D6	COL6	DIO1_1	DIO1_1	COL6
89/F17		D7	DQ7	D7	COL7	COL7	COL7	COL7	D7	D7	COL7	DIO2_1	DIO2_1	COL7
88/F16		D8	DQ8	D8	COL8	COL8	COL8	COL8	G8_0	G8_0	COL8	DIO3_1	DIO3_1	COL8
87/G13		D9	DQ9	D9	ROW0	ROW0	ROW0	ROW0	G8_1	G8_1	ROW0	ROW0	ROW0	ROW0
86/E17		D10	DQ10	D10	ROW1	ROW1	ROW1	ROW1	G8_2	G8_2	ROW1	ROW1	ROW1	ROW1
85/F15		D11	DQ11	D11	ROW2	ROW2	ROW2	ROW2	G8_3	G8_3	ROW2	ROW2	ROW2	ROW2
84/D17		D12	DQ12	D12	ROW3	ROW3	ROW3	ROW3	G8_4	G8_4	ROW3	ROW3	ROW3	ROW3
83/E16		D13	DQ13	D13	ROW4	ROW4	ROW4	ROW4	G8_5	G8_5	ROW4	ROW4	ROW4	ROW4
82/E15		D14	DQ14	D14	ROW5	ROW5	ROW5	ROW5	G8_6	G8_6	ROW5	ROW5	ROW5	ROW5
81/C17		D15	DQ15 A-1	D15	ROW6	ROW6	ROW6	ROW6	G8_7	G8_7	ROW6	ROW6	ROW6	ROW6
80/D16		0	A0	CLD0	G8_0 (out)	CLD0	0	CLD0	A0	A0	Reserved	CLD0	Reserved	CLD0
79/F14		0	A1	CLD1	G8_1 (out)	CLD1	0	CLD1	A1	A1	Reserved	CLD1	Reserved	CLD1
78/D15		0	A2	CLD2	G8_2 (out)	CLD2	0	CLD2	A2	A2	Reserved	CLD2	Reserved	CLD2
77/B17		0	A3	CLD3	G8_3 (out)	CLD3	0	CLD3	A3	A3	Reserved	CLD3	Reserved	CLD3
76/F13		0	A4	CLD4	G8_4(out)	CLD4	0	CLD4	A4	A4	Reserved	CLD4	Reserved	CLD4
75/E14		0	A5	CLD5	G8_5 (out)	CLD5	0	CLD5	A5	A5	Reserved	CLD5	Reserved	CLD5
74/C16		0	A6	CLD6	G8_6 (out)	CLD6	0	CLD6	A6	A6	Reserved	CLD6	Reserved	CLD6

Table 10. PL_GPIO pin description (continued)

PL / pin number	Alternate function (enabled by RAS register 1)	Configuration mode (enabled by RAS register 2)													
		1	2	3	4	5	6	7	8	9	10	11	12	13	
73/A17		0	A7	CLD7	G8_7 (out)	CLD7	0	CLD7	A7	A7	Reserved	CLD7	Reserved	CLD7	
72/B16		0	A8	CLD8	IT0	CLD8	IT0	CLD8	IT0	IT0	Reserved	CLD8	Reserved	CLD8	
71/D14		0	A9	CLD9	IT1	CLD9	IT1	CLD9	IT1	IT1	Reserved	CLD9	Reserved	CLD9	
70/C15		0	A10	CLD10	IT2	CLD10	IT2	CLD10	IT2	IT2	Reserved	CLD10	Reserved	CLD10	
69/A16		0	A11	CLD11	IT3	CLD11	IT3	CLD11	IT3	IT3	Reserved	CLD11	Reserved	CLD11	
68/B15		0	A12	CLD12	IT4	CLD12	IT4	CLD12	IT4	IT4	Reserved	CLD12	Reserved	CLD12	
67/C14		0	A13	CLD13	IT5	CLD13	IT5	CLD13	IT5	IT5	Reserved	CLD13	Reserved	CLD13	
66/E13		0	A14	CLD14	IT6	CLD14	IT6	CLD14	IT6	IT6	Reserved	CLD14	Reserved	CLD14	
65/B14		0	A15	CLD15	IT7	CLD15	IT7	CLD15	IT7	IT7	Reserved	CLD15	Reserved	CLD15	
64/D13		0	A16	CLD16	SPI_I2C4	CLD16	SPI_I2C4	CLD16	SPI_I2C4	SPI_I2C4	Reserved	CLD16	Reserved	CLD16	
63/C13		0	A17	CLD17	SPI_I2C5	CLD17	SPI_I2C5	CLD17	SPI_I2C5	SPI_I2C5	Reserved	CLD17	Reserved	CLD17	
62/A15		0	A18	CLD18	SPI_I2C6	CLD18	SPI_I2C6	CLD18	SPI_I2C6	SPI_I2C6	Reserved	CLD18	Reserved	CLD18	
61/E12		0	A19	CLD19	SPI_I2C7	CLD19	SPI_I2C7	CLD19	SPI_I2C7 /DOUT	SPI_I2C7 /DOUT	Reserved	CLD19	Reserved	CLD19	
60/A14		0	A20	CLD20	TDM_SYNC4	CLD20	TDM_SYNC4	CLD20	TDM_SYNC4	TDM_SYNC4	Reserved	CLD20	Reserved	CLD20	
59/B13		0	A21	CLD21	TDM_SYNC5	CLD21	TDM_SYNC5	CLD21	TDM_SYNC5	TDM_SYNC5	Reserved	CLD21	Reserved	CLD21	
58/D12		CL	A22	CL	TDM_SYNC6	CLD22	TDM_SYNC6	CLD22	TDM_SYNC6	CL	Reserved	CLD22	Reserved	CLD22	
57/E11		AL	A23	AL	TDM_SYNC7	CLD23	TDM_SYNC7	CLD23	TDM_SYNC7	AL	Reserved	CLD23	Reserved	CLD23	
56/C12		/W	/W	/W	ROW7	ROW7	ROW7	ROW7	ROW7	/W	/W	ROW7	VSYNC_1	VSYNC_1	ROW7
55/A13		/R	/G	/R	ROW8	ROW8	ROW8	ROW8	ROW8	/R	/R	ROW8	HSYNC_1	HSYNC_1	ROW8
54/E10		0	0	CLAC	G10_9	CLAC	G10_9	CLAC	G10_9	G10_9	G10_9	G10_9	CLAC	G10_9	CLAC
53/D11		0	0	CLCP	G10_8	CLCP	G10_8	CLCP	G10_8	G10_8	G10_8	G10_8	CLCP	G10_8	CLCP
52/B12		0	0	CLFP	G10_7	CLFP	G10_7	CLFP	G10_7	G10_7	G10_7	G10_7	CLFP	G10_7	CLFP

Pin description

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Table 10. PL_GPIO pin description (continued)

PL / pin number	Alternate function (enabled by RAS register 1)	Configuration mode (enabled by RAS register 2)												
		1	2	3	4	5	6	7	8	9	10	11	12	13
51/D10		0	0	CLLP	G10_6	CLLP	G10_6	CLLP	G10_6	G10_6	G10_6	CLLP	G10_6	CLLP
50/A12	TMR_CPTR4	0	0	CLLE	G10_5	CLLE	G10_5	CLLE	G10_5	G10_5	G10_5	CLLE	G10_5	CLLE
49/C11	TMR_CPTR3	0	0	CLPP	G10_4	CLPP	G10_4	CLPP	G10_4	G10_4	G10_4	CLPP	G10_4	CLPP
48/B11	TMR_CPTR2	B0	B0	CLD22	SPI_I2C0	SPI_I2C0	SPI_I2C0	SPI_I2C0	SPI_I2C0	SPI_I2C0	SPI_I2C0	DIO4_1	DIO4_1	SPI_I2C0
47/C10	TMR_CPTR1	B1	B1	CLD23	SPI_I2C1	SPI_I2C1	SPI_I2C1	SPI_I2C1	SPI_I2C1	SPI_I2C1	SPI_I2C1	DIO5_1	DIO5_1	SPI_I2C1
46/A11	TMR_CLK4	B2	B2	GPIO7	SPI_I2C2	SPI_I2C2	SPI_I2C2	SPI_I2C2	SPI_I2C2	SPI_I2C2	SPI_I2C2	DIO6_1	DIO6_1	SPI_I2C2
45/B10	TMR_CLK3	B3	B3	GPIO6	SPI_I2C3	SPI_I2C3	SPI_I2C3	SPI_I2C3	SPI_I2C3	SPI_I2C3	SPI_I2C3	DIO7_1	DIO7_1	SPI_I2C3
44/A10	TMR_CLK2	H0	H0	GPIO5	G10_3/O0	G10_3/O0	G10_3/O0	G10_3/O0	G10_3	DAC_O0	DAC_O0	DAC_O0	DAC_O0	DAC_O0
43/E9	TMR_CLK1	H1	H1	GPIO4	G10_2/O1	G10_2/O1	G10_2/O1	G10_2/O1	G10_2	DAC_O1	DAC_O1	DAC_O1	DAC_O1	DAC_O1
42/D9	UART_DTR	H2	H2	GPIO3	I2S_DIN	I2S_DIN	I2S_DIN	AI2S_DIN	G10_1	I2S_DIN	I2S_DIN	I2S_DIN	I2S_DIN	I2S_DIN
41/C9	UART_RI	H3	H3	GPIO2	I2S_LRCK	I2S_LRCK	I2S_LRCK	I2S_LRCK	G10_0	I2S_LRCK	I2S_LRCK	I2S_LRCK	I2S_LRCK	I2S_LRCK
40/B9	UART_DSR	H4	H4	GPIO1	I2S_CLK	I2S_CLK	I2S_CLK	I2S_CLK	TDM_SYN C3	I2S_CLK	I2S_CLK	I2S_CLK	I2S_CLK	I2S_CLK
39/A9	UART_DCD	H5	H5	GPIO0	I2S_DOUT	I2S_DOUT	I2S_DOUT	I2S_DOUT	TDM_SYN C2	DOUT	I2S_DOUT	I2S_DOUT	I2S_DOUT	I2S_DOUT
38/A8	UART_CTS	H6	H6	TDM_SYNC1	TDM_SYNC1	TDM_SYNC1	TDM_SYNC1	TDM_SYNC1	TDM_SYNC1	TDM_SYNC1	TDM_SYNC1	TDM_SYNC1	TDM_SYNC1	TDM_SYNC1
37/B8	UART_RTS	H7	H7	TDM_DOUT	TDM_DOUT	TDM_DOUT	TDM_DOUT	TDM_DOUT	TDM_DOUT	TDM_DOUT	TDM_DOUT	TDM_DOUT	TDM_DOUT	TDM_DOUT
36/C8	SSP_CS4	0	0	TDM_SYNC0	TDM_SYNC0	TDM_SYNC0	TDM_SYNC0	TDM_SYNC0	TDM_SYNC0	TDM_SYNC0	TDM_SYNC0	TDM_SYNC0	TDM_SYNC0	TDM_SYNC0
35/D8	SSP_CS3	Reserved	Reserved	TDM_CLK	TDM_CLK	TDM_CLK	TDM_CLK	TDM_CLK	TDM_CLK	TDM_CLK	TDM_CLK	TDM_CLK	TDM_CLK	TDM_CLK
34/E8	SSP_CS2	0	0	TDM_DIN	TDM_DIN	TDM_DIN	TDM_DIN	TDM_DIN	TDM_DIN	TDM_DIN	TDM_DIN	TDM_DIN	TDM_DIN	TDM_DIN
33/E7	BasGPIO5	0	0	SD_CMD	SD_CMD	SD_CMD	SD_CMD	SD_CMD	SD_CMD	SD_CMD	SD_CMD	SD_CMD	SD_CMD	SD_CMD
32/D7	BasGPIO4	0	0	SD_CLK	SD_CLK	SD_CLK	SD_CLK	SD_CLK	SD_CLK	SD_CLK	SD_CLK	SD_CLK	SD_CLK	SD_CLK
31/C7	BasGPIO3	0	0	SD_DAT0	SD_DAT0	SD_DAT0	SD_DAT0	SD_DAT0	SD_DAT0	SD_DAT0	SD_DAT0	SD_DAT0	SD_DAT0	SD_DAT0
30/B7	BasGPIO2	0	0	SD_DAT1	SD_DAT1	SD_DAT1	SD_DAT1	SD_DAT1	SD_DAT1	SD_DAT1	SD_DAT1	SD_DAT1	SD_DAT1	SD_DAT1

Table 10. PL_GPIO pin description (continued)

PL / pin number	Alternate function (enabled by RAS register 1)	Configuration mode (enabled by RAS register 2)												
		1	2	3	4	5	6	7	8	9	10	11	12	13
29/A7	BasGPIO1	0	0	SD_DAT2	SD_DAT2	SD_DAT2	SD_DAT2	SD_DAT2	SD_DAT2	SD_DAT2	SD_DAT2	SD_DAT2	SD_DAT2	SD_DAT2
28/A6	BasGPIO0	0	0	SD_SDAT3	SD_SDAT3	SD_SDAT3	SD_SDAT3	SD_SDAT3	SD_SDAT3	SD_SDAT3	SD_SDAT3	SD_SDAT3	SD_SDAT3	SD_SDAT3
27/B6	MII_TX_CLK	0	0	SD_SDAT4	SD_SDAT4	SD_SDAT4	SD_SDAT4	SD_SDAT4	G8_0	G8_0	SD_SDAT4	SD_SDAT4	SD_SDAT4	SD_SDAT4
26/A5	MII_TXD0	0	0	SD_SDAT5	SD_SDAT5	SD_SDAT5	SD_SDAT5	SD_SDAT5	G8_1	G8_1	SD_SDAT5	SD_SDAT5	SD_SDAT5	SD_SDAT5
25/C6	MII_TXD1	0	0	SD_SDAT6	SD_SDAT6	SD_SDAT6	SD_SDAT6	SD_SDAT6	G8_2	G8_2	SD_SDAT6	SD_SDAT6	SD_SDAT6	SD_SDAT6
24/B5	MII_TXD2	0	0	SD_SDAT7	SD_SDAT7	SD_SDAT7	SD_SDAT7	SD_SDAT7	G8_3	G8_3	SD_SDAT7	SD_SDAT7	SD_SDAT7	SD_SDAT7
23/A4	MII_TXD3	0	0	G8_4	G8_4	G8_4	G8_4	G8_4	G8_4	G8_4	G8_4	G8_4	G8_4	G8_4
22/D6	MII_TX_EN	0	0	G8_5	G8_5	G8_5	G8_5	G8_5	G8_5	G8_5	G8_5	G8_5	G8_5	G8_5
21/C5	MII_TX_ER	0	0	G8_6	G8_6	G8_6	G8_6	G8_6	G8_6	G8_6	DIO7	DIO8_1	DIO8_1	DIO7
20/B4	MII_RX_CLK	0	0	G8_7	G8_7	G8_7	G8_7	G8_7	G8_7	G8_7	DIO6	DIO9_1	DIO9_1	DIO6
19/A3	MII_RX_DV	0	0	G10_0	G10_0	G10_0	G10_0	G10_0	G10_0	G10_0	DIO5	DIO10_1	DIO10_1	DIO5
18/D5	MII_RX_ERR	0	0	G10_1	G10_1	G10_1	G10_1	G10_1	G10_1	G10_1	DIO4	DIO11_1	DIO11_1	DIO4
17/C4	MII_RXD0	0	0	G10_2	G10_2	G10_2	G10_2	G10_2	G10_2	G10_2	DIO3	DIO12_1	DIO12_1	DIO3
16/E6	MII_RXD1	0	0	G10_3	G10_3	G10_3	G10_3	G10_3	G10_3	G10_3	DIO2	DIO13_1	DIO13_1	DIO2
15/B3	MII_RXD2	0	0	G10_4	G10_4	G10_4	G10_4	G10_4	G10_4	G10_4	DIO1	G10_4	G10_4	DIO1
14/A2	MII_RXD3	0	0	G10_5	G10_5	G10_5	G10_5	G10_5	G10_5	G10_5	DIO0	G10_5	G10_5	DIO0
13/A1	MII_COL	0	0	G10_6	G10_6	G10_6	G10_6	G10_6	G10_6	G10_6	VSYNC	G10_6	G10_6	VSYNC
12/D4	MII_CRD	0	0	G10_7	G10_7	G10_7	G10_7	G10_7	G10_7	G10_7	HSYNC	G10_7	G10_7	HSYNC
11/E5	MII_MDC	0	0	G10_8	G10_8	G10_8	G10_8	G10_8	G10_8	G10_8	G10_8	G10_8	G10_8	G10_8
10/C3	MII_MDIO	0	0	G10_9	G10_9	G10_9	G10_9	G10_9	G10_9	G10_9	G10_9	G10_9	G10_9	G10_9
9/B2	SSP_MOSI	0	0	SD_CD	SD_CD	SD_CD	SD_CD	SD_CD	SD_CD	SD_CD	SD_CD	SD_CD	SD_CD	SD_CD
8/C2	SSP_SCLK	0	0	SD_WP	SD_WP	SD_WP	SD_WP	SD_WP	SD_WP	SD_WP	SD_WP	SD_WP	SD_WP	SD_WP
7/D3	SSP_SS	0	0	0	0	0	0	0	0	0	0	0	0	0
6/B1	SSP_MISO	0	0	SD_LED	SD_LED	SD_LED	SD_LED	SD_LED	SD_LED	SD_LED	SD_LED	SD_LED	SD_LED	SD_LED
5/D2	I2C_SDA	0	0	0	0	0	0	0	0	0	0	0	0	0

Pin description

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Table 10. PL_GPIO pin description (continued)

PL / pin number	Alternate function (enabled by RAS register 1)	Configuration mode (enabled by RAS register 2)												
		1	2	3	4	5	6	7	8	9	10	11	12	13
4/C1	I2C_SCL	0	0	0	0	0	0	0	0	0	0	0	0	0
3/D1	UART_RX	/E4	/E4	/E4	1	1	1	1	1	1	1	1	1	1
2/E4	UART_TX	/E3	/E3	/E3	1	1	1	1	1	1	1	1	1	1
1/E3	IrDA_RX	/E2	/E2	/E2	1	1	1	1	1	1	1	1	1	1
0/F3	IrDA_TX	R/B	R/B	R/B	1	1	1	1	R/B	R/B	1	1	1	1
CK1/K17	PL_CLK1	TCLK*	TCLK*	CCLK/TCLK*	TCLK*	CCLK/TCLK*	TCLK*	CCLK/TCLK*	TCLK*	TCLK*	TCLK*	CCLK/TCLK*	TCLK*	CCLK/TCLK*
CK2/J17	PL_CLK2	Reserved	Reserved	int_CLK	int_CLK	int_CLK	int_CLK	int_CLK	int_CLK	int_CLK	int_CLK	int_CLK	int_CLK	int_CLK
CK3/J16	PL_CLK3	Reserved	Reserved	\int_CLK	\int_CLK	\int_CLK	\int_CLK	\int_CLK	\int_CLK	\int_CLK	CLK	CLK	CLK	CLK
CK4/H17	PL_CLK4	Reserved	Reserved	2.048 MHz	2.048 MHz	2.048 MHz	2.048 MHz	2.048 MHz	2.048 MHz	2.048 MHz	PCLK	PCLK	PCLK	PCLK

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Notes/legend for Table 10:

GPIO (General purpose I/O):

basGPIO: Base GPIOs in the basic subsystem

G10 and G8: GPIOs in the telecom subsystem

GPIOx: GPIOs in the independent GPIO block

TDM_ : TDM interface signals

SD_ : SDIO interface

IT pins: interrupts

Table cells filled with '0' or '1' are unused and unless otherwise configured as Alternate function or GPIO, the corresponding pin is held at low or high level respectively by the internal logic.

Table cells filled with 'Reserved' denote pins that must be left unconnected.

Table shading:

FSMC	FSMC pins: NAND or NOR Flash
Keyboard	Keyboard pins ROWs are outputs, COLs are inputs
CLCD	Color LCD controller pins
CAMERA	Camera pins

4 Memory mapping

Table 11. Memory mapping

Start address	End address	Peripheral	Description
0x0000.0000	0x3FFF.FFFF	External DRAM	Low power DDR or DDR2
0x4000.0000	0x4FFF.FFFF	C3	
0x5000.0000	0x5000.FFFF	Telecom register	
0x5001.0000	0x5001.0FFF	TDM	Action memory
0x5003.0000	0x5003.7FFF	TDM	Buffer memory
0x5004.0000	0x5004.0FFF	TDM	Sync memory
0x5005.0000	0x5005.0FFF	I2S	I2S memory bank 1
0x5005.1000	0x5005.1FFF	I2S	I2S memory bank 2
0x6000.0000	0x6FFF.FFFF	CLCD	
0x7000.0000	0x7FFF.FFFF	SDIO	
0x8000.0000	0x83FF.FFFF	Static memory controller	NAND bank0
0x8400.0000	0x87FF.FFFF	Static memory controller	NAND bank1
0x8800.0000	0x8BFF.FFFF	Static memory controller	NAND bank2
0x8C00.0000	0x8FFF.FFFF	Static memory controller	NAND bank3
0x9000.0000	0x90FF.FFFF	Static memory controller	NOR bank0
0x9100.0000	0x91FF.FFFF	Static memory controller	NOR bank1
0x9200.0000	0x91FF.FFFF	Static memory controller	NOR bank2
0x9300.0000	0x93FF.FFFF	Static memory controller	NOR bank3
0x9400.0000	0x98FF.FFFF	Static memory controller	Register
0x9900.0000	0x9FFF.FFFF	Registers	
0xA000.0000	0xA8FF.FFFF	Keyboard	
0xA900.0000	0xAFFF.FFFF	GPIO	
0xB000.0000	0xBFFF.FFFF	-	Reserved
0xC000.0000	0xCFFF.FFFF	-	Reserved
0xD000.0000	0xD007.FFFF	UART	
0xD008.0000	0xD00F.FFFF	ADC	
0xD010.0000	0xD017.FFFF	SPI	
0xD018.0000	0xD01F.FFFF	I2C	
0xD020.0000	0xD07F.FFFF	-	Reserved
0xD080.0000	0xD0FF.FFFF	JPEG CODEC	
0xD100.0000	0xD17F.FFFF	IrDA	
0xD180.0000	0xD1FF.FFFF	-	Reserved

Memory mapping

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Table 11. Memory mapping (continued)

Start address	End address	Peripheral	Description
0xD280.0000	0xD2FF.FFFF	SRAM	Static RAM shared memory (8 Kbytes)
0xD300.0000	0xE07F.FFFF	-	Reserved
0xE0800.0000	0xE0FF.FFFF	Ethernet controller	MAC
0xE100.0000	0xE10F.FFFF	USB 2.0 device	FIFO
0xE110.0000	0xE11F.FFFF	USB 2.0 device	Configuration registers
0xE120.0000	0xE12F.FFFF	USB 2.0 device	Plug detect
0xE130.0000	0xE17F.FFFF	-	Reserved
0xE180.0000	0xE18F.FFFF	USB2.0 EHCI 0-1	
0xE190.0000	0xE19F.FFFF	USB2.0 OHCI 0	
0xE1A0.0000	0xE20F.FFFF	-	Reserved
0xE210.0000	0xE21F.FFFF	USB2.0 OHCI 1	
0xE220.0000	0xE27F.FFFF	-	Reserved
0xE280.0000	0xE28F.FFFF	ML USB ARB	Configuration register
0xE290.0000	0xE7FF.FFFF	-	Reserved
0xE800.0000	0xEFFF.FFFF	-	Reserved
0xF000.0000	0xF00F.FFFF	Timer	
0xF010.0000	0xF10F.FFFF	-	Reserved
0xF110.0000	0xF11F.FFFF	ITC primary	
0xF120.0000	0xF7FF.FFFF	-	Reserved
0xF800.0000	0xFBFF.FFFF	Serial Flash memory	
0xFC00.0000	0xFC1F.FFFF	Serial Flash controller	
0xFC20.0000	0xFC3F.FFFF	-	Reserved
0xFC40.0000	0xFC5F.FFFF	DMA controller	
0xFC60.0000	0xFC7F.FFFF	DRAM controller	
0xFC80.0000	0xFC87.FFFF	Timer 1	
0xFC88.0000	0xFC8F.FFFF	Watchdog timer	
0xFC90.0000	0xFC97.FFFF	Real-time clock	
0xFC98.0000	0xFC9F.FFFF	General purpose I/O	
0xFCA0.0000	0xFCA7.FFFF	System controller	
0xFCA8.0000	0xFCAF.FFFF	Miscellaneous registers	
0xFCB0.0000	0xFCB7.FFFF	Timer 2	
0xFCB8.0000	0xFCFF.FFFF	-	Reserved
0xFD00.0000	0xFEFF.FFFF	-	Reserved
0xFF00.0000	0xFFFF.FFFF	Internal ROM	Boot

5 Electrical characteristics

5.1 Absolute minimum and maximum ratings

This product contains devices to protect the inputs against damage due to high/low static voltages. However it is advisable to take normal precaution to avoid application of any voltage higher/lower than the specified maximum/minimum rated voltages.

The absolute minimum and maximum rating is the maximum stress that can be applied to a device without causing permanent damage. However, extended exposure to minimum/maximum ratings may affect long-term device reliability.

Table 12. Absolute minimum and maximum ratings

Symbol	Parameter	Minimum value	Maximum value	Unit
V _{DD} 1.2	Supply voltage for the core	- 0.3	1.6	V
V _{DD} 3.3	Supply voltage for the I/Os	- 0.3	4.8	V
V _{DD} 2.5	Supply voltage for the analog blocks	- 0.3	4.8	V
V _{DD} 1.8	Supply voltage for the DRAM interface	- 0.3	4.8	V
T _J	Junction temperature	-40	125	°C
T _{STG}	Storage temperature	-55	150	°C

The average chip-junction temperature, T_J, can be calculated using the following equation:

$$T_j = T_A + (P_D \cdot \Theta_{JA})$$

where:

T_A is the ambient temperature in °C

Θ_{JA} is the package junction-to-ambient thermal resistance, which is 34 °C/W

$$P_D = P_{INT} + P_{PORT}$$

– P_{INT} is the chip internal power

– P_{PORT} is the power dissipation on Input and Output pins, user determined

If P_{PORT} is neglected, an approximate relationship between P_D is:

$$P_D = K / (T_j + 273 \text{ °C})$$

And, solving first equations:

$$K = P_D \cdot (T_A + 273 \text{ °C}) + \Theta_{JA} \times P_D^2$$

K is a constant for the particular case, which can be determined through last equation by measuring P_D at equilibrium, for a known T_A.

Using this value of K, the value of P_D and T_J can be obtained by solving first and second equation, iteratively for any value of T_A.

5.2 Maximum power consumption

Note: These values take into consideration the worst cases of process variation and voltage range and must be used to design the power supply section of the board.

Table 13. Maximum power consumption

Symbol	Description	Max	Unit
V _{DD} 1.2	Supply voltage for the core ⁽¹⁾	420	mA
V _{DD} 1.8	Supply voltage for the DRAM interface ⁽²⁾	160	mA
V _{DD} 2.5	Supply voltage for the analog blocks	35	mA
V _{DD} 3.3	Supply voltage for the I/Os ⁽³⁾	15	mA
P _D	Maximum power consumption	930	mW

1. Peak current with CPU at maximum speed in asynchronous mode with DDR at maximum speed.
2. Peak current with Linux memory test (50% write and 50% read) plus DMA reading memory.
3. With 30 logic channels connected to the device and simultaneously switching at 10 MHz.

The maximum current and power values listed above are not guaranteed to be the highest obtainable. These values are dependent on many factors including the type of applications running, clock rates, use of internal functional capabilities, external interface usage, case temperature, and the power supply voltages. Your specific application can produce significantly different results. 1.2 V current and power are primarily dependent on the applications running and the use of internal chip functions (DMA, USB, Ethernet, and so on).

3.3 V current and power are primarily dependent on the capacitive loading, frequency, and utilization of the external buses.

5.3 DC electrical characteristics

The recommended operating conditions are listed in the following table:

Table 14. Recommended operating conditions

Symbol	Parameter	Min	Typ	Max	Unit
V _{DD} core	Supply voltage for the core	1.14	1.2	1.26	V
V _{DD} I/O	Supply voltage for the I/Os	3	3.3	3.6	V
V _{DD} PLL	PLL supply voltage	2.25	2.5	2.75	V
V _{DD} OSC	Oscillator supply voltage	2.25	2.5	2.75	V
V _{DD} 1.8	Supply voltage for DRAM interface	1.7	1.8	1.9	V

Table 14. Recommended operating conditions (continued)

Symbol	Parameter	Min	Typ	Max	Unit
V _{DD} RTC	RTC supply voltage	1.2	1.5	1.8	V
T _A	Operating temperature	-40		85	°C

5.4 Overshoot and undershoot

This product can support the following values of overshoot and undershoot.

Table 15. Overshoot and undershoot specifications

Parameter	3V3 I/Os	2V5 I/Os	1V8 I/Os
Amplitude	500 mV	500 mV	500 mV
Ratio of overshoot (or undershoot) duration with respect to pulse width	1/3	1/3	1/3

If the amplitude of the overshoot/undershoot increases (decreases), the ratio of Overshoot/Undershoot width to the pulse width decreases (increases). The formula relating the two is:

$$\text{Amplitude of OS/US} = 0.75 \times (1 - \text{ratio of OS (or US) duration with respect to pulse width})$$

Note: The value of overshoot/undershoot should not exceed the value of 0.5 V. However, the duration of the overshoot/undershoot can be increased by decreasing its amplitude.

5.5 General purpose I/O characteristics

The 3.3 V I/Os are compliant with JEDEC standard JESD8b

Table 16. Low voltage TTL DC input specification (3 V < V_{DD} < 3.6 V)

Symbol	Parameter	Min	Max	Unit
V _{IL}	Low level input voltage		0.8	V
V _{IH}	High level input voltage	2		V
V _{hyst}	Schmitt trigger hysteresis	300	800	mV

Table 17. Low voltage TTL DC output specification (3 V < V_{DD} < 3.6 V)

Symbol	Parameter	Test condition	Min	Max	Unit
V _{OL}	Low level output voltage	I _{OL} = X mA ⁽¹⁾		0.3	V
V _{OH}	High level output voltage	I _{OH} = -X mA ⁽¹⁾	V _{DD} - 0.3		V

1. For the max current value (X mA) refer to [Section 3: Pin description](#).

Table 18. Pull-up and pull-down characteristics

Symbol	Parameter	Test condition	Min	Max	Unit
R _{PU}	Equivalent pull-up resistance	V _I = 0 V	29	67	kΩ
R _{PD}	Equivalent pull-down resistance	V _I = V _{DDE} 3V3	29	103	kΩ

5.6 LPDDR and DDR2 pin characteristics

Table 19. DC characteristics

Symbol	Parameter	Test condition	Min	Max	Unit
V _{IL}	Low level input voltage	SSTL2	-0.3	V _{REF} -0.15	V
		SSTL18	-0.3	V _{REF} -0.125	V
V _{IH}	High level input voltage	SSTL2	V _{REF} +0.15	V _{DDE} 2V5+0.3	V
		SSTL18	V _{REF} +0.125	V _{DDE} 1V8+0.3	V
V _{hyst}	Input voltage hysteresis		200		mV

Table 20. Driver characteristics

Symbol	Parameter	Min	Typ	Max	Unit
R _O	Output impedance		45		Ω

Table 21. On die termination

Symbol	Parameter	Min	Typ	Max	Unit
RT1*	Termination value of resistance for on die termination		75		Ω
RT2*	Termination value of resistance for on die termination		150		Ω

Table 22. Reference voltage

Symbol	Parameter	Min	Typ	Max	Unit
V _{REFIN}	Voltage applied to core/pad	0.49 * V _{DDE}	0.500 * V _{DDE}	0.51 * V _{DDE}	V

5.6.1 DDR2 timing characteristics

The characterization timing is done considering an output load of 10 pF on all the DDR pads. The operating conditions are in worst case V = 0.90 V T_A = 125° C and in best case V=1.10 V T_A = 40° C.

DDR2 read cycle timings

Figure 3. Read cycle waveforms

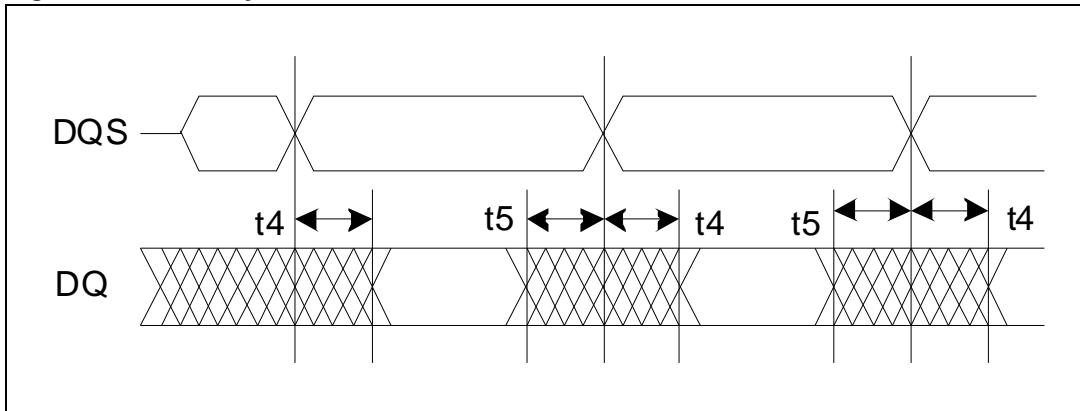


Figure 4. Read cycle path

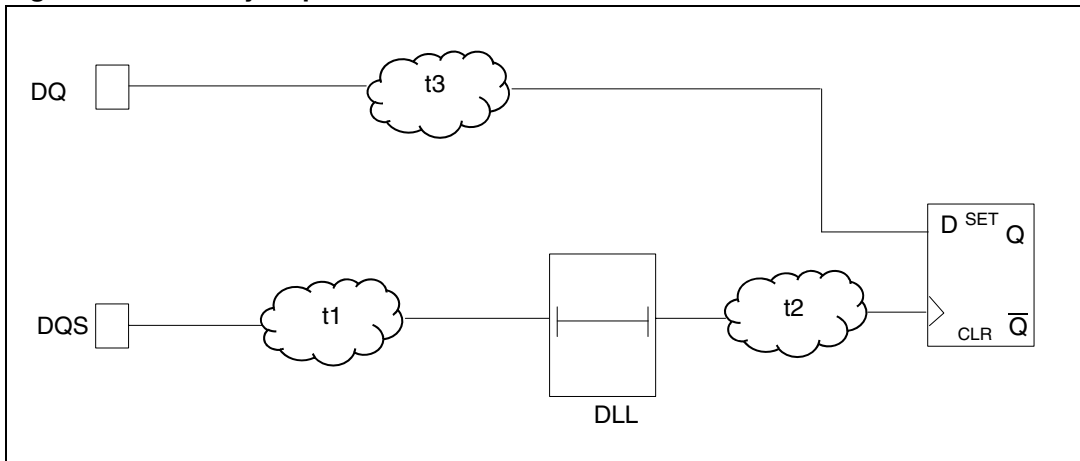


Table 23. Read cycle timings

Frequency	t4 max	t5 max	t5 max
333 MHz	1.24 ns	-495 ps	-495 ps
266 MHz	1.43 ns	-306 ps	-306 ps
200 MHz	1.74 ns	4 ps	4 ps
166 MHz	2.00 ns	260 ps	260 ps
133 MHz	2.37 ns	634 ps	634 ps

DDR2 write cycle timings

Figure 5. Write cycle waveforms

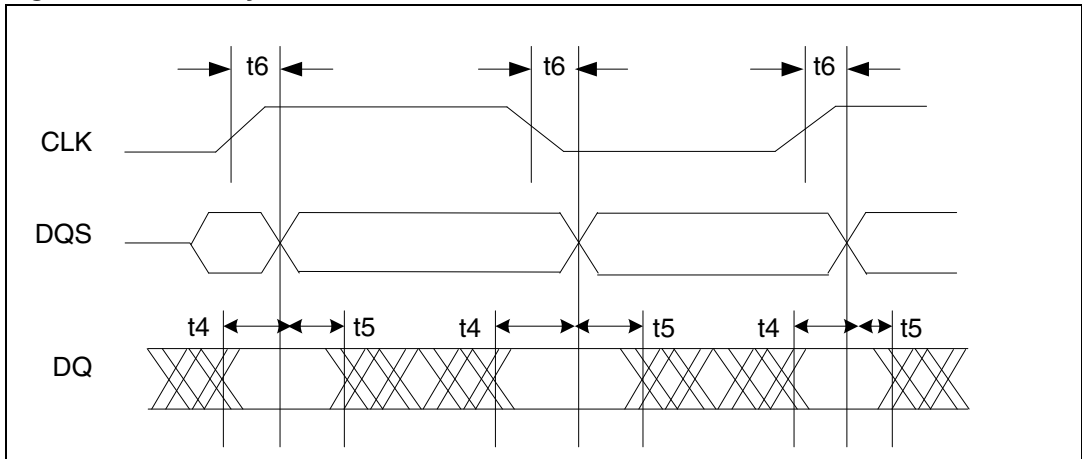
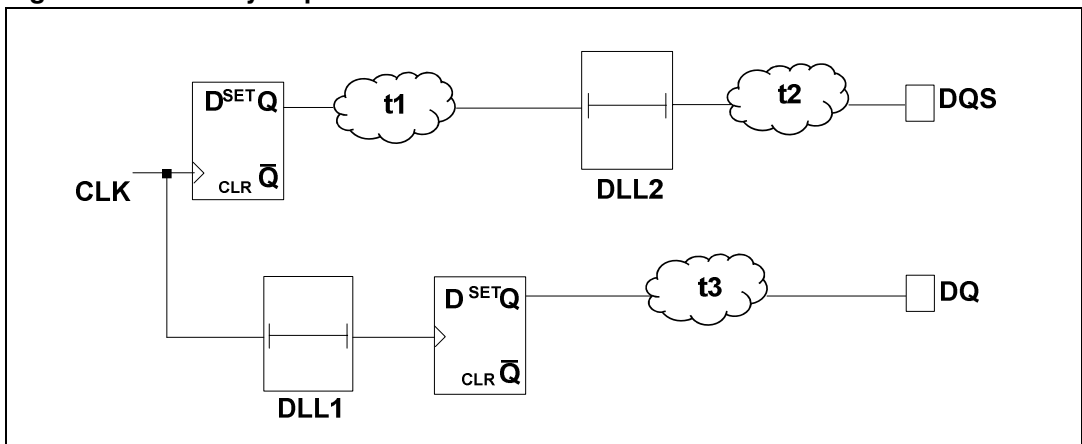


Figure 6. Write cycle path



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Table 24. Write cycle timings

Frequency	t4 max	t5 max	Unit
333 MHz	1.36	-1.55	ns
266 MHz	1.55	-1.36	ns
200 MHz	1.86	-1.05	ns
166 MHz	2.11	- 794	ns
133 MHz	2.49	-420	ns

DDR2 command timings

Figure 7. Command waveforms

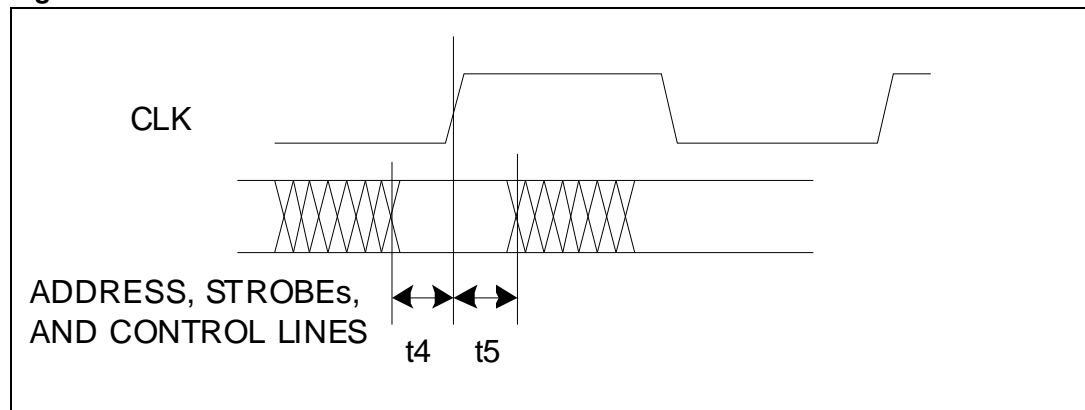


Figure 8. Command path

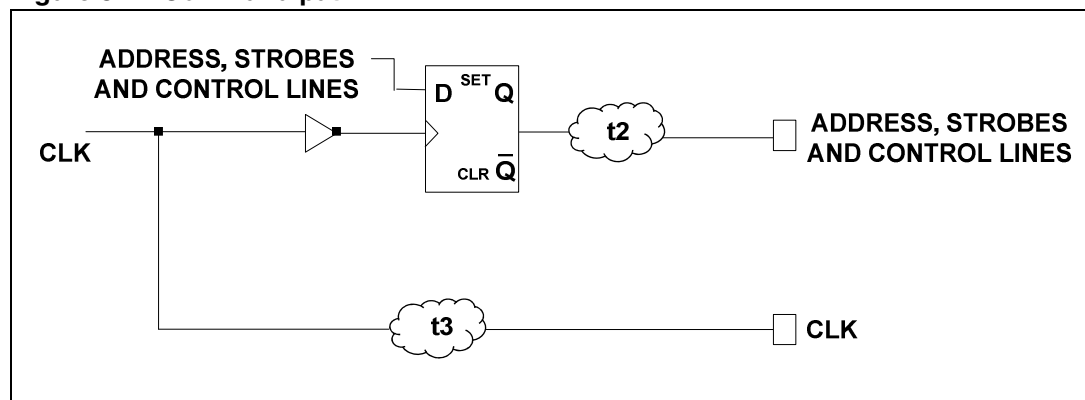


Table 25. Command timings

Frequency	t4 max	t5 max	Unit
333 MHz	1.39	1.40	ns
266 MHz	1.77	1.78	ns
200 MHz	2.39	2.40	ns
166 MHz	2.90	2.91	ns
133 MHz	3.65	3.66	ns

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5.7 CLCD timing characteristics

The characterization timing is done considering an output load of 10 pF on all the outputs. The operating conditions are in worst case $V=0.90\text{ V}$ $T=125\text{ }^{\circ}\text{C}$ and in best case $V=1.10\text{ V}$ $T=40\text{ }^{\circ}\text{C}$.

The CLCD has a wide variety of configurations and settings and the parameters change accordingly. Two main scenarios will be considered, one with direct clock to output (166 MHz), setting BCD bit to '1', and the second one with the clock passing through a clock divider (83 MHz), setting BCD bit to '0'.

5.7.1 CLCD timing characteristics direct clock

Figure 9. CLCD waveform with CLCP direct

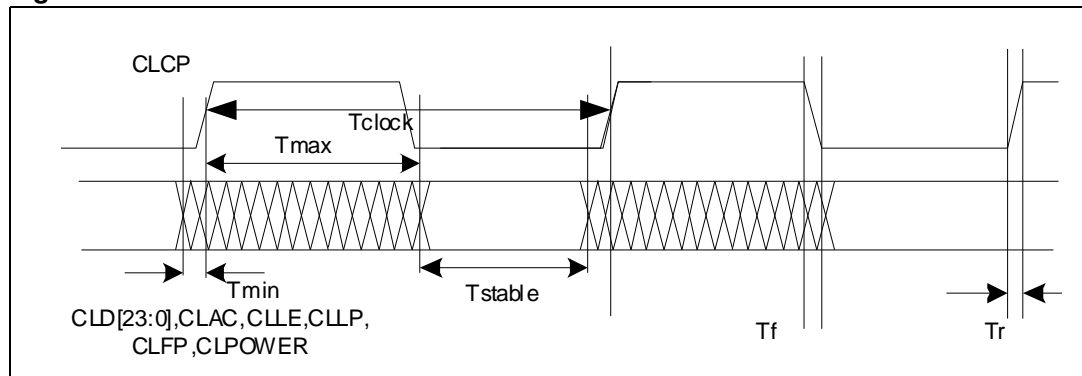


Figure 10. CLCD block diagram with CLCP direct

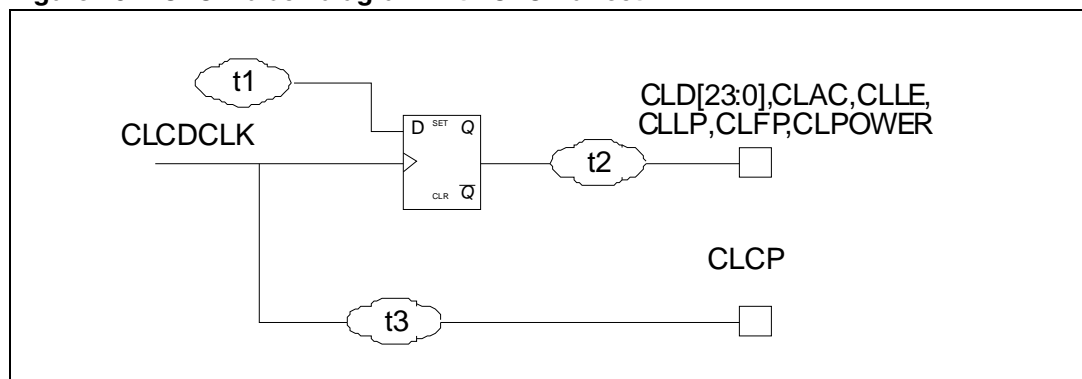


Table 26. CLCD timings with CLCP direct

Parameter	Value	Frequency
$t_{\text{CLOCK direct max}} (t_{\text{CLOCK}})$	6 ns	166 MHz
$t_{\text{CLOCK direct max rise}} (t_r)$	0.81 ns	
$t_{\text{CLOCK direct max}} (t_f)$	0.87 ns	
t_{min}	-0.04 ns	
t_{max}	3.62 ns	
t_{STABLE}	2.34 ns	

- Note:
- $t_{\text{STABLE}} = t_{\text{CLOCK direct max}} - (t_{\text{max}} + t_{\text{min}})$
 - For t_{max} the maximum value is taken from the worst case and best case, while for t_{min} the minimum value is taken from the worst case and best case.
 - CLCP should be delayed by $\{t_{\text{max}} + [t_{\text{CLOCK direct max}} - (t_{\text{max}} + t_{\text{min}})]/2\} = 4.7915 \text{ ns}$

5.7.2 CLCD timing characteristics divided clock

Figure 11. CLCD waveform with CLCP divided

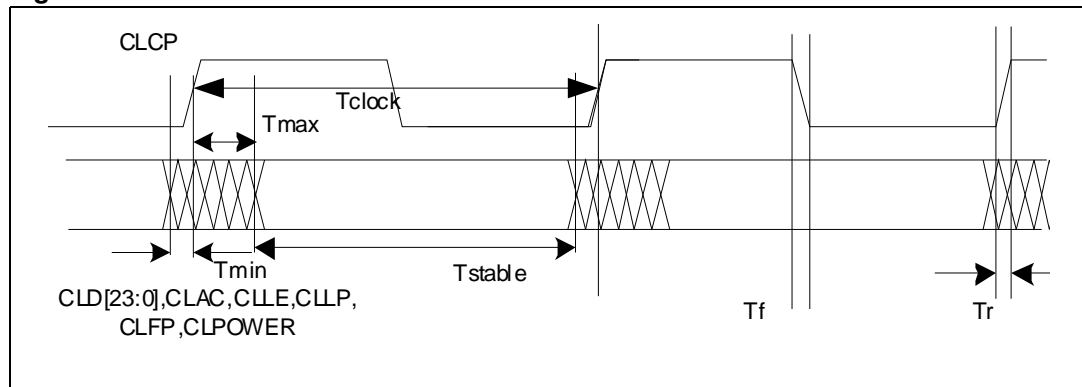


Figure 12. CLCD block diagram with CLCP divided

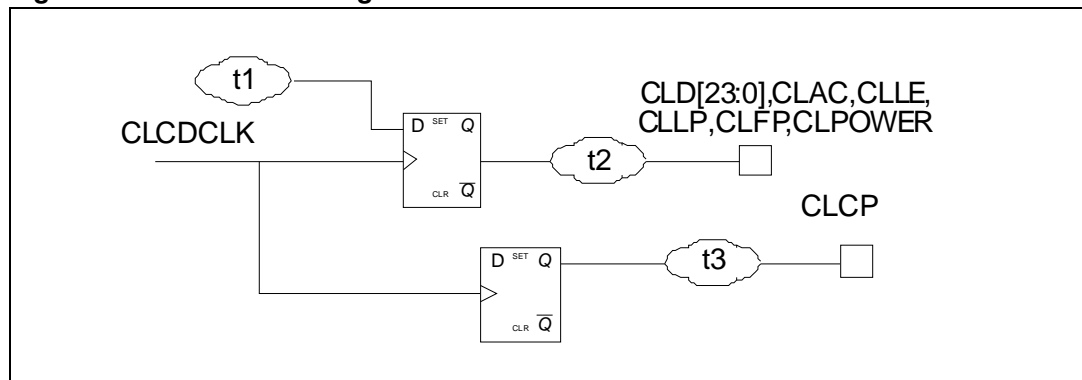


Table 27. CLCD timings with CLCP divided

Parameter	Value	Frequency
$t_{\text{CLOCK divided max}}$	12 ns	83.3 MHz
$t_{\text{CLOCK divided max rise (tr)}}$	0.81 ns	
$t_{\text{CLOCK divided max (tf)}}$	0.87 ns	
t_{min}	-0.49 ns	
t_{max}	2.38 ns	
t_{STABLE}	9.13 ns	

- Note:
- $t_{\text{STABLE}} = t_{\text{CLOCK direct max}} - (t_{\text{max}} + t_{\text{min}})$
 - For t_{max} the maximum value is taken from the worst case and for t_{min} the minimum value is taken from the best case.
 - CLCP should be delayed by $\{t_{\text{max}} + [t_{\text{CLOCK direct max}} - (t_{\text{max}} + t_{\text{min}})]/2\} = 6.945 \text{ ns}$

5.8 I²C timing characteristics

The characterization timing is done using primetime considering an output load of 10 pF on SCL and SDA. The operating conditions are $V = 0.90\text{ V}$, $T_A = 125^\circ\text{ C}$ in worst case and $V = 1.10\text{ V}$, $T_A = 40^\circ\text{ C}$ in best case.

Figure 13. I²C output pins

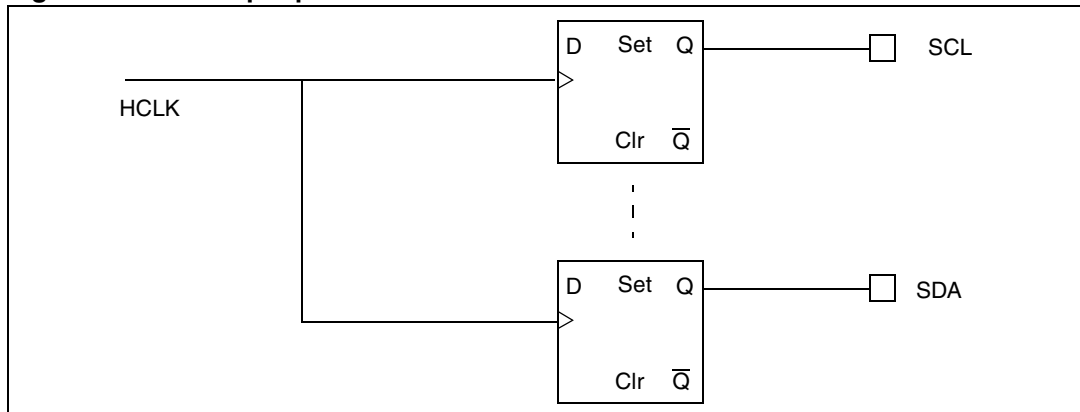
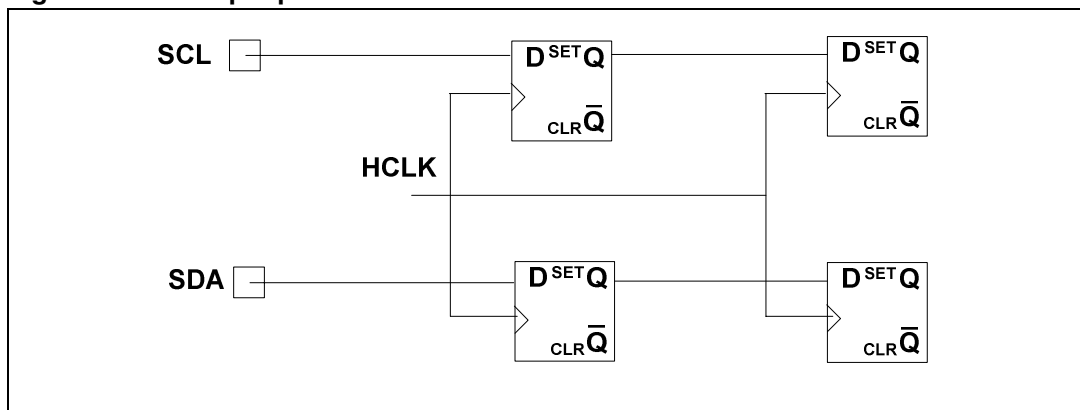


Figure 14. I²C input pins



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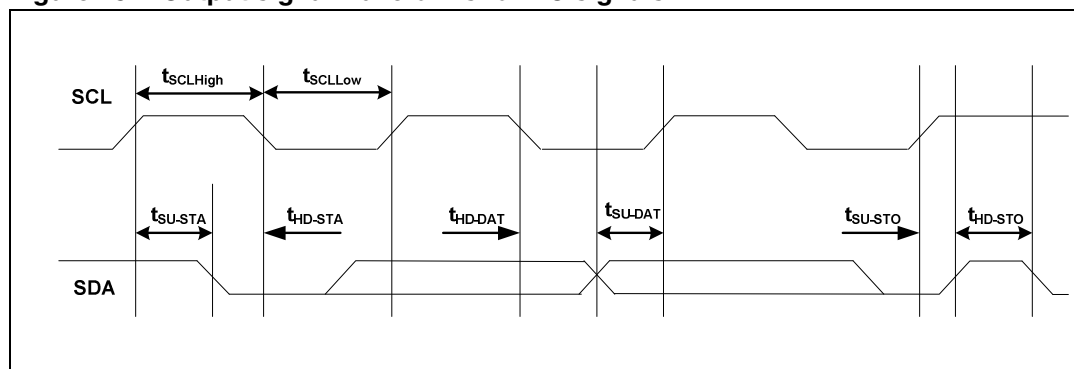
The flip-flops used to capture the incoming signals are re-synchronized with the AHB clock: so, no input delay calculation is required.

Table 28. Output delays for I²C signals

Parameter	Min	Max	Unit
$t_{\text{HCLK} \rightarrow \text{SCLH}}$	8.1067	11.8184	ns
$t_{\text{HCLK} \rightarrow \text{SCLL}}$	7.9874	12.6269	ns
$t_{\text{HCLK} \rightarrow \text{SDAH}}$	7.5274	11.2453	ns
$t_{\text{HCLK} \rightarrow \text{SDAL}}$	7.4081	12.0530	ns

Those values are referred to the common internal source clock which has a period of:

$$t_{\text{HCLK}} = 6\text{ ns.}$$

Figure 15. Output signal waveforms for I²C signals

The timing of high and low level of SCL ($t_{SCLHigh}$ and t_{SCLLow}) are programmable.

Table 29. Time characteristics for I²C in high-speed mode

Parameter	Min	Unit
t_{SU-STA}	157.5897	ns
t_{HD-STA}	325.9344	
t_{SU-DAT}	314.0537	
t_{HD-DAT}	0.7812	
t_{SU-STO}	637.709	
t_{HD-STO}	4742.1628	

Table 30. Time characteristics for I²C in fast speed mode

Parameter	Min	Unit
t_{SU-STA}	637.5897	ns
t_{HD-STA}	602.169	
t_{SU-DAT}	1286.0537	
t_{HD-DAT}	0.7812	
t_{SU-STO}	637.709	
t_{HD-STO}	4742.1628	

Table 31. Time characteristics for I²C in standard speed mode

Parameter	Min	Unit
t_{SU-STA}	4723.5897	ns
t_{HD-STA}	3991.9344	
t_{SU-DAT}	4676.0537	
t_{HD-DAT}	0.7812	
t_{SU-STO}	4027.709	
t_{HD-STO}	4742.1628	

Note: 1 The timings shown in Figure 15. depend on the programmed value of $T_{SCLHigh}$ and T_{SCLLow} , so the values present in the three tables here above have been calculated using the minimum programmable values of :

$IC_{HS_SCL_HCNT}=19$ and $IC_{HS_SCL_LCNT}=53$ registers (for High-Speed mode);

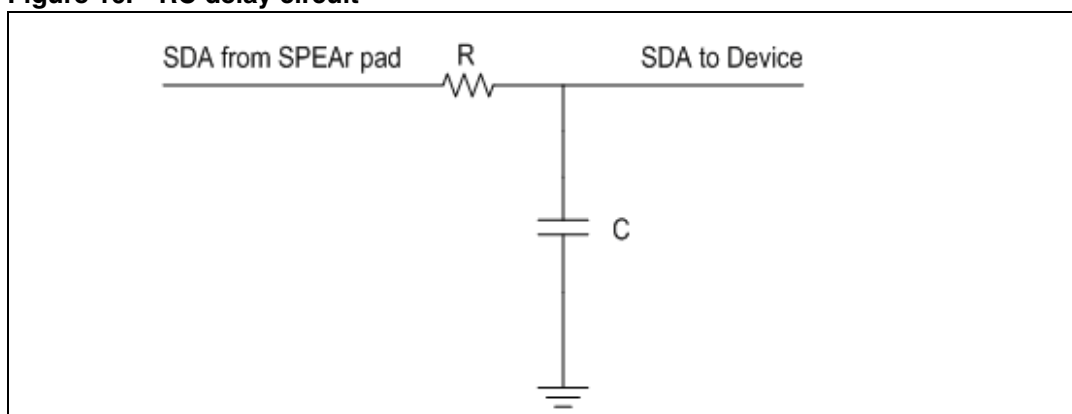
$IC_{FS_SCL_HCNT}=99$ and $IC_{FS_SCL_LCNT}=215$ registers (for Fast-Speed mode);

$IC_{SS_SCL_HCNT}=664$ and $IC_{SS_SCL_LCNT}=780$ registers (for Standard-Speed mode).

These minimum values depend on the AHB clock frequency, which is 166 MHz.

- 2 A device may internally require a hold time of at least 300 ns for the SDA signal (referred to the V_{IHmin} of the SCL signal) to bridge the undefined region of the falling edge of SCL (Please refer to the I²C Bus Specification v3-0 Jun 2007). However, the SDA data hold time in the I²C controller of SPEAr300 is one-clock cycle based (6 ns with the HCLK clock at 166 MHz). This time may be insufficient for some slave devices. A few slave devices may not receive the valid address due to the lack of SDA hold time and will not acknowledge even if the address is valid. If the SDA data hold time is insufficient, an error may occur.
- 3 **Workaround:** If a device needs more SDA data hold time than one clock cycle, an RC delay circuit is needed on the SDA line as illustrated in the following figure:

Figure 16. RC delay circuit



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For example, $R=K$ and $C = 200$ pF.

5.9 FSMC timing characteristics

The characterization timing is done using primetime considering an output load of 3pF on the data, 15pF on NF_CE, NF_RE and NF_WE and 10pF on NF_ALE and NF_CLE.

The operating conditions are $V=0.90V$, $T=125^{\circ}C$ in worst case and $V=1.10V$, $T= 40^{\circ}C$ in best case.

5.9.1 8-bit NAND Flash configuration

Figure 17. Output pads for 8-bit NAND Flash configuration

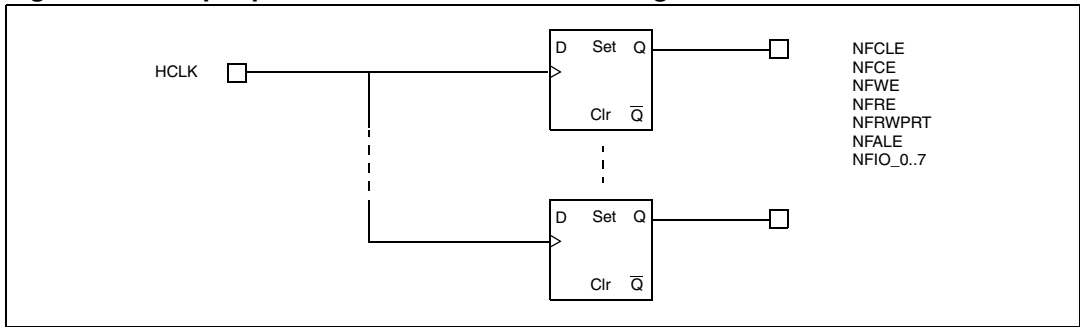


Figure 18. Input pads for 8-bit NAND Flash configuration

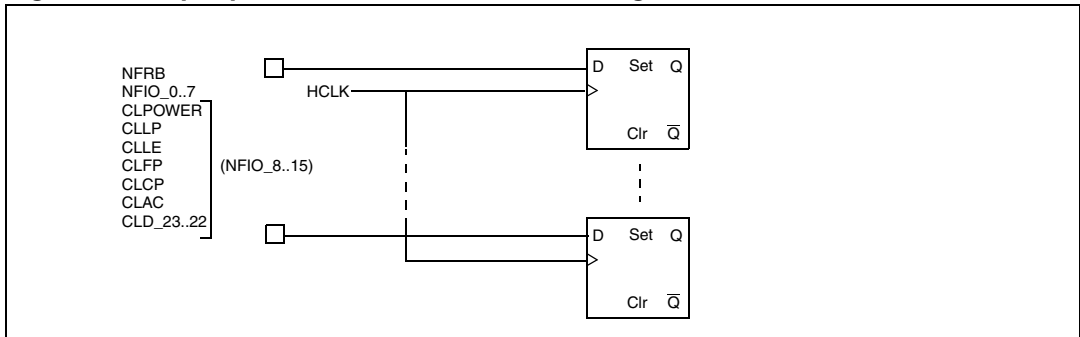
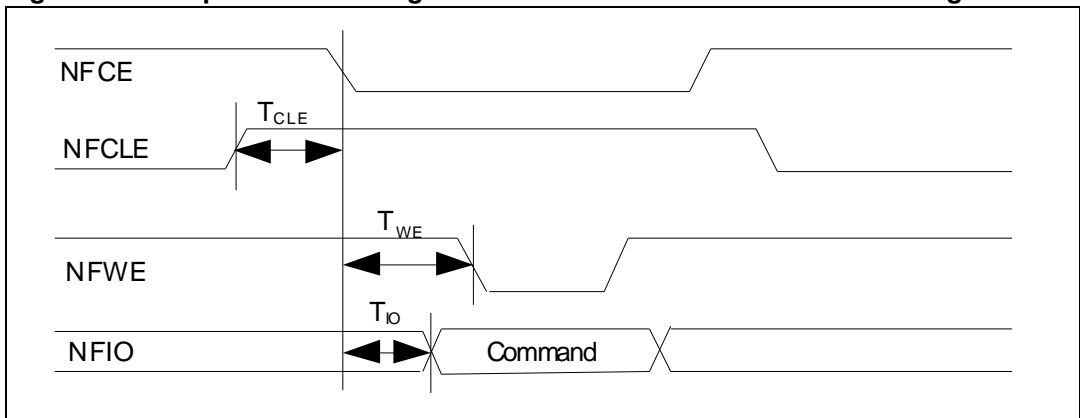


Figure 19. Output command signal waveforms for 8-bit NAND Flash configuration



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Figure 20. Output address signal waveforms for 8-bit NAND Flash configuration

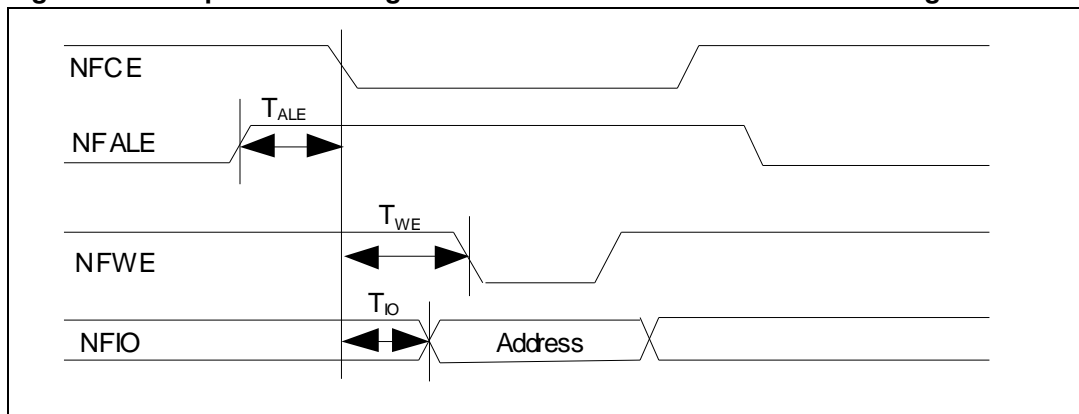


Figure 21. In/out data address signal waveforms for 8-bit NAND Flash configuration

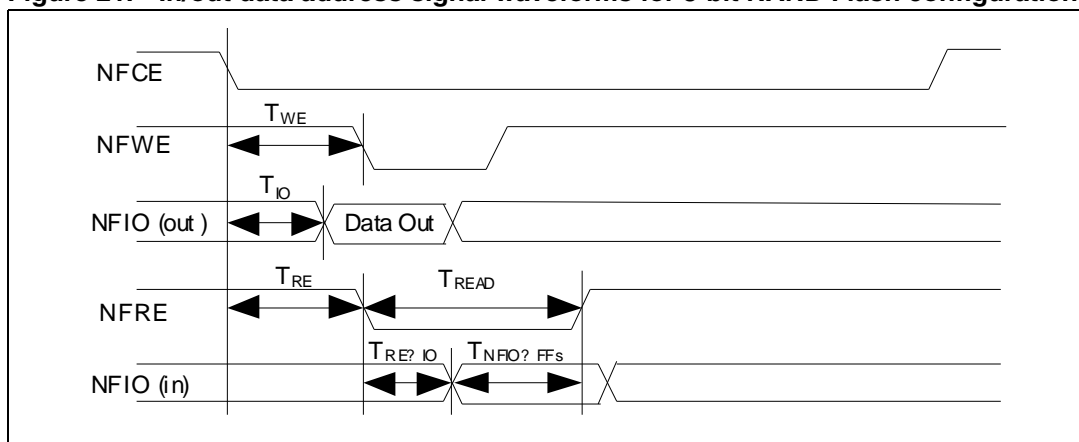


Table 32. Time characteristics for 8-bit NAND Flash configuration

Parameter	Min	Max	Unit
t_{CLE}	-16.85	-19.38	ns
t_{ALE}	-16.84	-19.37	
$t_{WE} (s=1)$	11.10	13.04	
$t_{RE} (s=1)$	11.18	13.05	
$t_{IO} (h=1)$	3.43	8.86	

Note: Values in [Table 32](#) are referred to the common internal source clock which has a period of $THCLK = 6 \text{ ns}$.

5.9.2 16-bit NAND Flash configuration

Figure 22. Output pads for 16-bit NAND Flash configuration

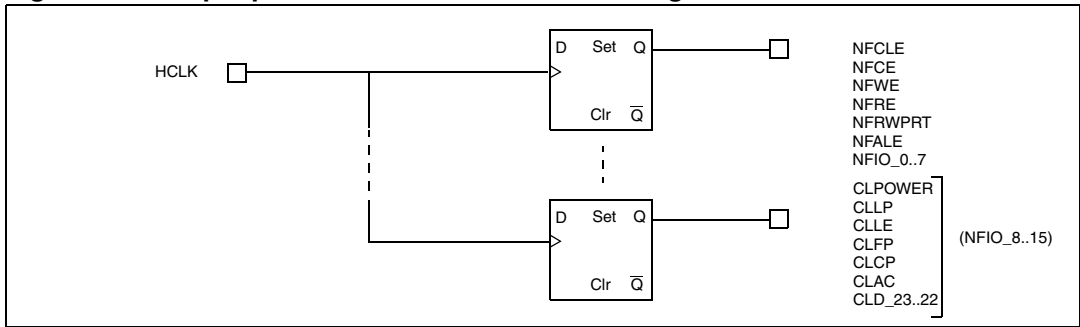


Figure 23. Input pads for 16-bit NAND Flash configuration

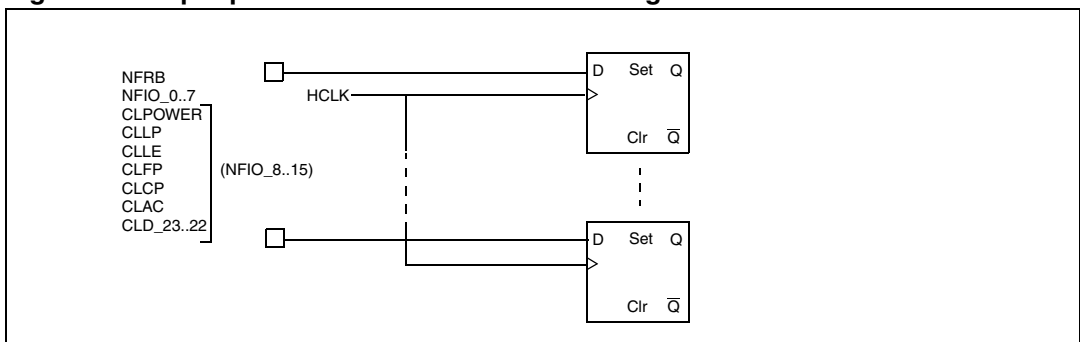
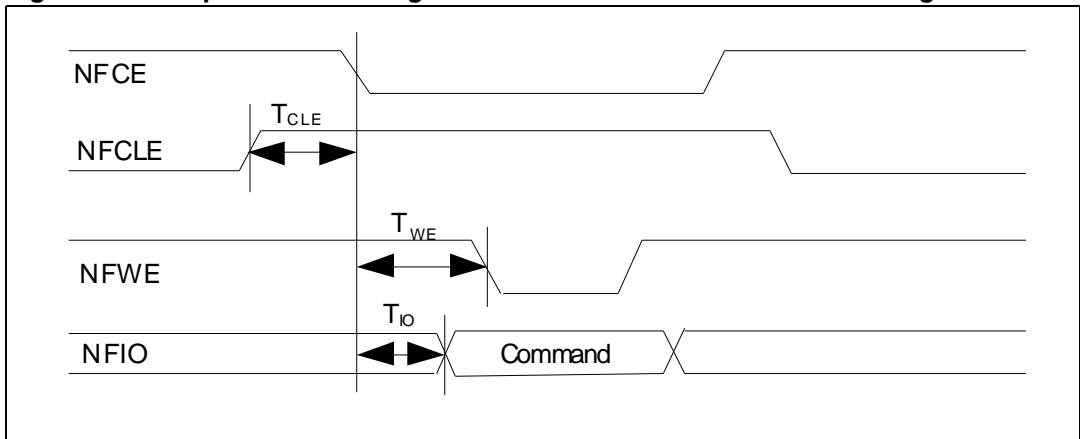


Figure 24. Output command signal waveforms 16-bit NAND Flash configuration



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Figure 25. Output address signal waveforms 16-bit NAND Flash configuration

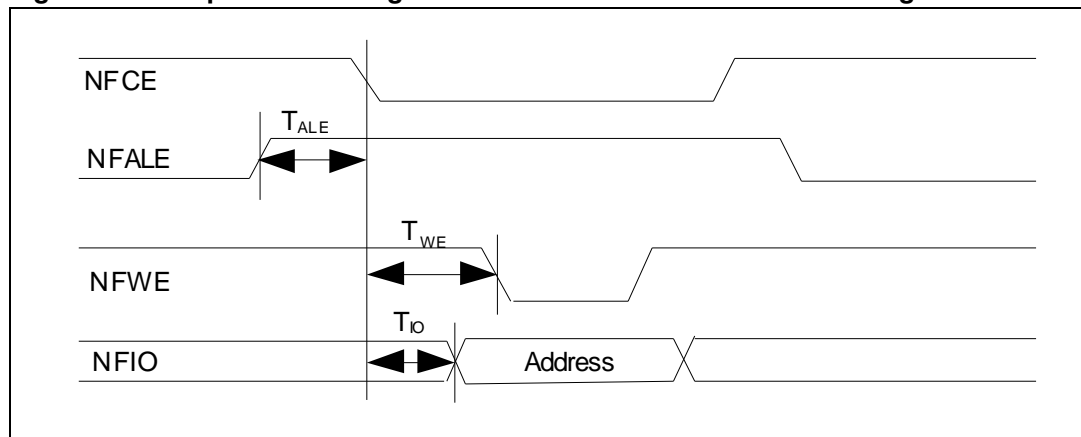


Figure 26. In/out data signal waveforms for 16-bit NAND Flash configuration

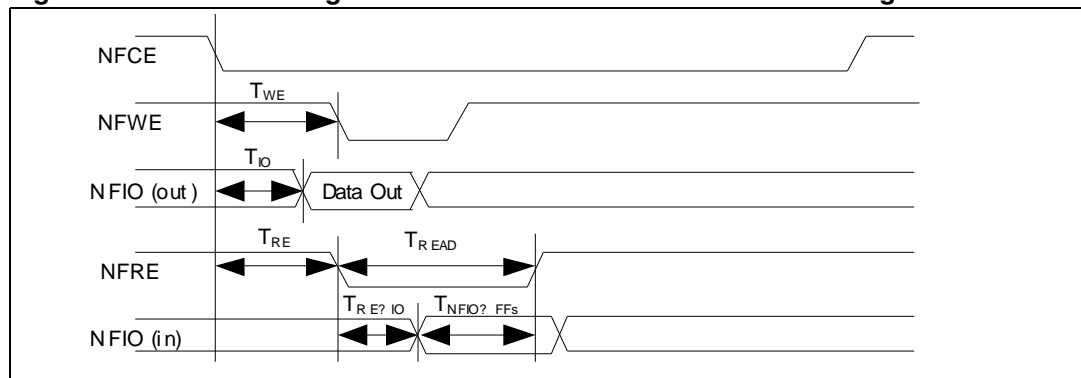


Table 33. Time characteristics for 16-bit NAND Flash configuration

Parameter	Min	Max	Unit
t_{CLE}	-16.85	-19.38	ns
t_{ALE}	-16.84	-19.37	
$t_{WE} (s=1)$	11.10	13.04	
$t_{RE} (s=1)$	11.18	13.05	
$t_{IO} (h=1)$	3.27	11.35	

Note: Values in Table 33 are referred to the common internal source clock which has a period of $THCLK = 6 \text{ ns}$.

5.10 Ether MAC 10/100/1000 Mbps (GMAC-Univ) timing characteristics

The characterization timing is given for an output load of 5 pF on the GMII TX clock and 10 pF on the other pads. The operating conditions are in worst case $V=0.90 \text{ V}$ $T=125^\circ \text{ C}$ and in best case $V=1.10 \text{ V}$ $T= 40^\circ \text{ C}$.

5.10.1 GMII Transmit timing specifications

Figure 27. GMII TX waveforms

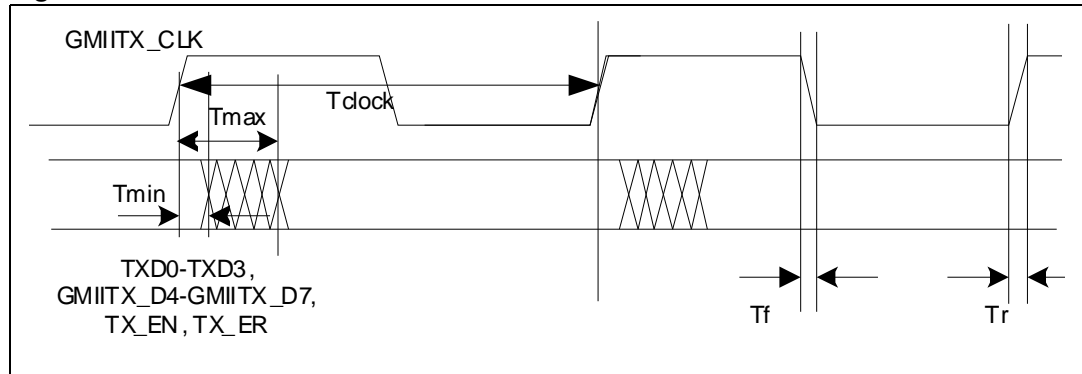


Figure 28. Block diagram of GMII TX pins

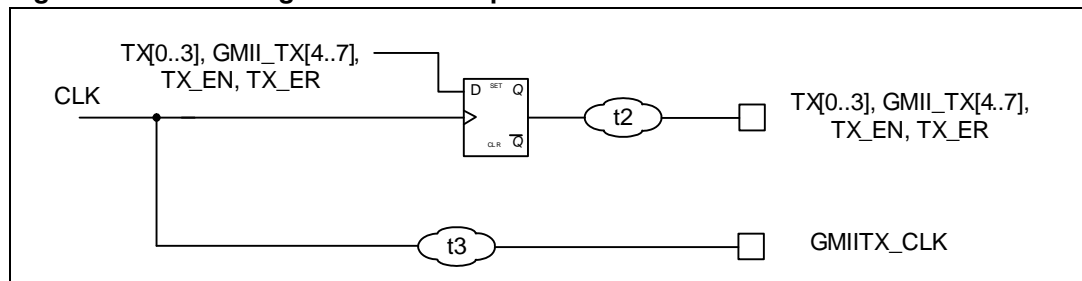


Table 34. GMII TX timing

Parameter	Value using GMII [t _{CLK} period = 8 ns 125 MHz]
t _{rise} (t _r)	<1 ns
t _{fall} (t _f)	<1 ns
t _{max} = t _{2_max} - t _{3_min}	2.8 ns
t _{min} = t _{2_min} - t _{3_max}	0.4 ns
t _{SETUP}	5.19 ns

Note: To calculate the t_{SETUP} value for the PHY you have to consider the next t_{CLK} rising edge, so you have to apply the following formula: t_{SETUP} = t_{CLK} - t_{max}

5.10.2 MII transmit timing specifications

Figure 29. MII TX waveforms

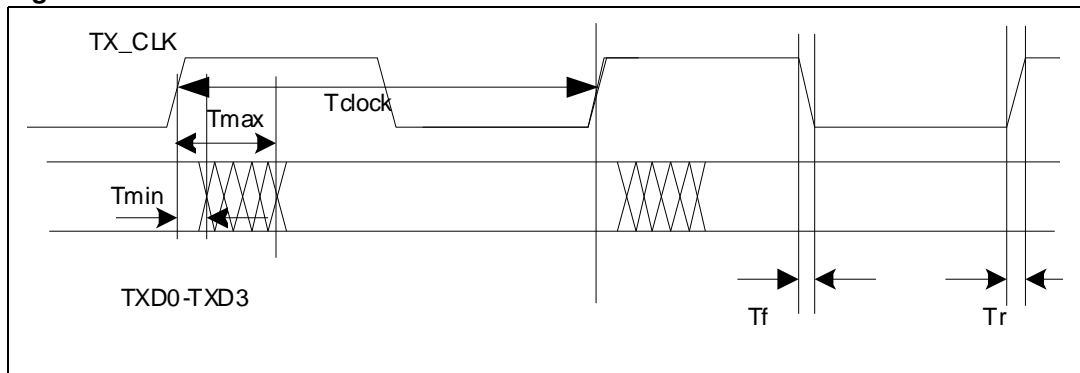


Figure 30. Block diagram of MII TX pins

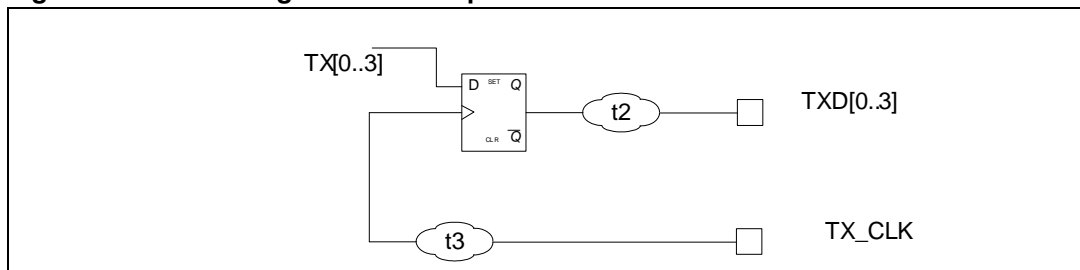


Table 35. MII TX timings

Parameter	Value using MII 10 Mb [t_{CLK} period = 40 ns 25 MHz]	Value using MII 100 Mb [t_{CLK} period = 400 ns 2.5 MHz]
$t_{max} = t2_{max} - t3_{min}$	6.8 ns	6.8 ns
$t_{min} = t2_{min} - t3_{max}$	2.9 ns	2.9 ns
t_{SETUP}	33.2 ns	393.2 ns

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Note: To calculate the t_{SETUP} value for the PHY you have to consider the next t_{CLK} rising edge, so you have to apply the following formula: $t_{SETUP} = t_{CLK} - t_{max}$

5.10.3 GMII-MII Receive timing specifications

Figure 31. GMII-MII RX waveforms

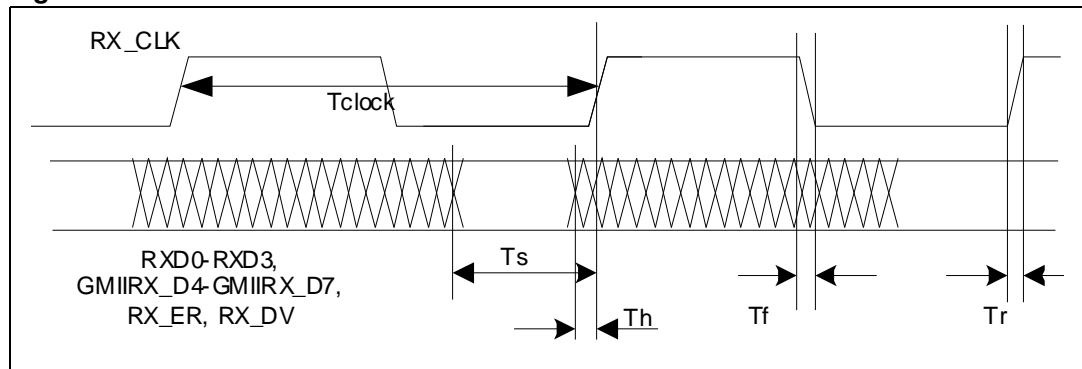
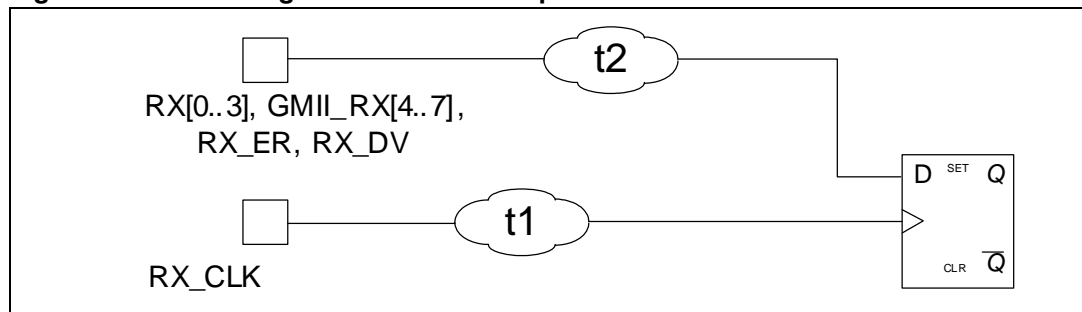


Figure 32. Block diagram of GMII-MII RX pins



Note: The input stage is the same for all the interfaces (GMII and MII10/100) so t_{SETUP} and t_{HOLD} values are equal in all the cases.
 The receive path is optimized for the GMII interface: this also ensures correct capture of data for the MII10/100 interface.

5.10.4 MDIO timing specifications

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Figure 33. MDC waveforms

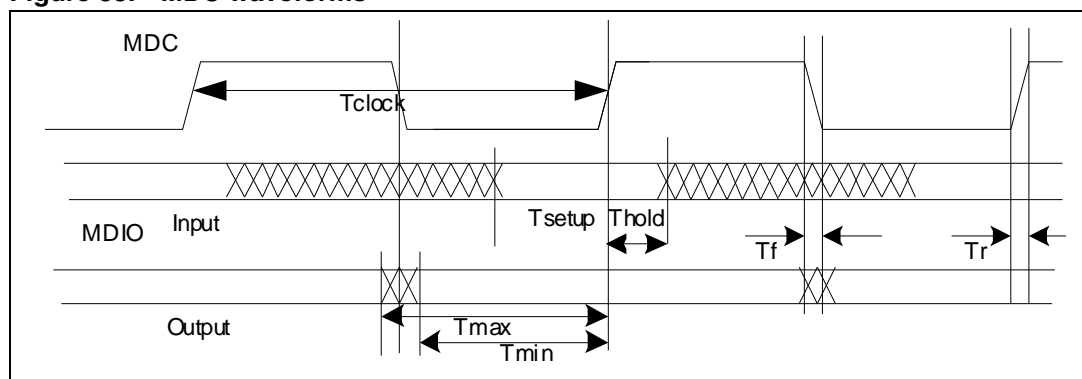


Figure 34. Paths from MDC/MDIO pads

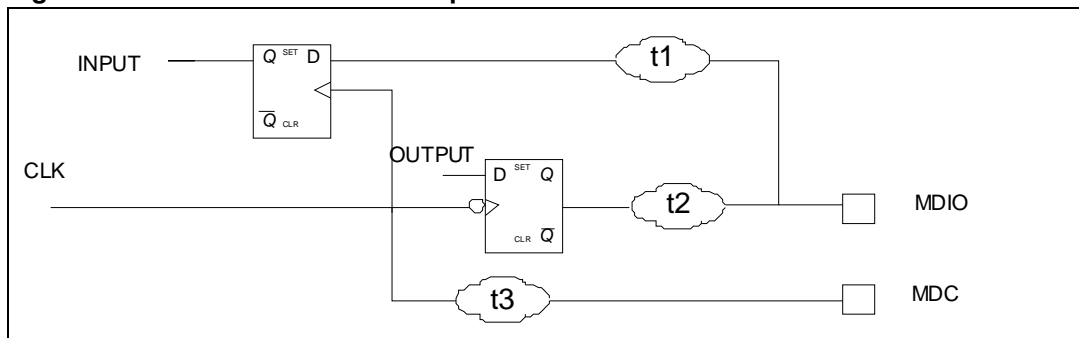


Table 36. MDC/MDIO timing

Parameter	Value	Frequency
$t_{\text{CLK period}}$	614.4 ns	1.63 MHz
$t_{\text{CLK fall}} (t_f)$	1.18 ns	
$t_{\text{CLK rise}} (t_r)$	1.14 ns	
Output		
$t_{\text{max}} = \sim t_{\text{CLK}} / 2$	307 ns	
$t_{\text{min}} = \sim t_{\text{CLK}} / 2$	307 ns	
Input		
$t_{\text{SETUPmax}} = t1_{\text{max}} - t3_{\text{min}}$	6.88 ns	
$t_{\text{HOLDmin}} = t1_{\text{min}} - t3_{\text{max}}$	-1.54 ns	

Note: When MDIO is used as output the data are launched on the falling edge of the clock as shown in [Figure 33](#).

5.11 SMI - Serial memory interface

Figure 35. SMIDATAIN data path

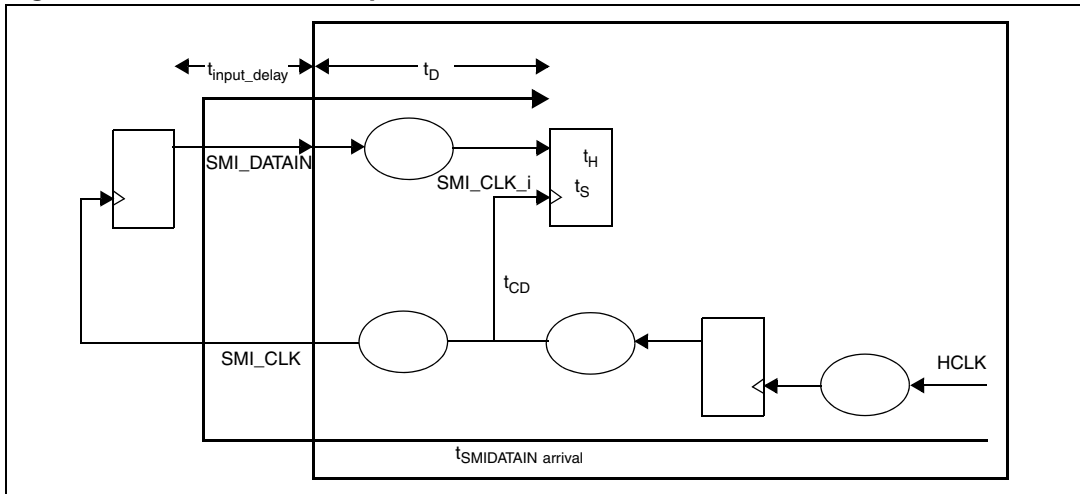
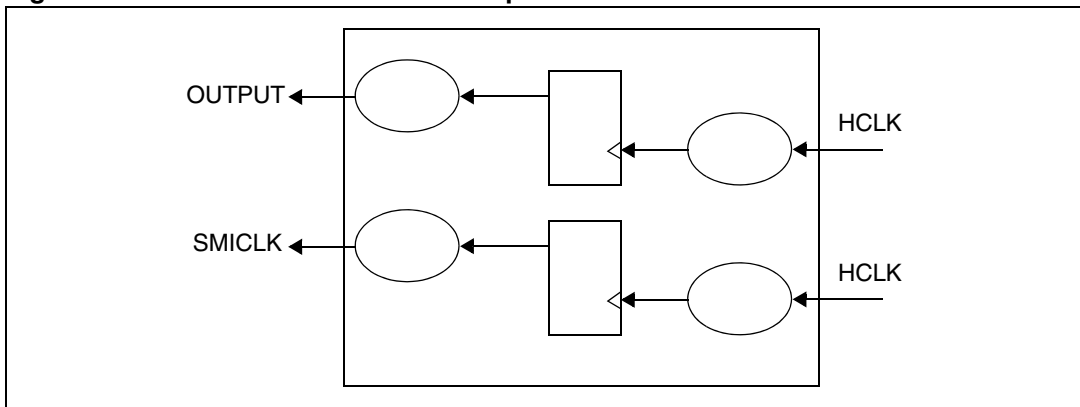


Table 37. SMIDATAIN timings

Signal	Parameter	Value
SMI_DATAIN	t_{d_max}	$t_{SMIDATAIN_arrival_max} - t_{input_delay}$
	t_{d_min}	$t_{SMIDATAIN_arrival_min} - t_{input_delay}$
	t_{cd_min}	$t_{SMI_CLK_i_arrival_min}$
	t_{cd_max}	$t_{SMI_CLK_i_arrival_max}$
	t_{SETUP_max}	$t_s + t_{d_max} - t_{cd_min}$
	t_{HOLD_min}	$t_h - t_{d_min} + t_{cd_max}$

Figure 36. SMIDATAOUT/SMICSn data paths



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Figure 37. SMIDATAOUT timings

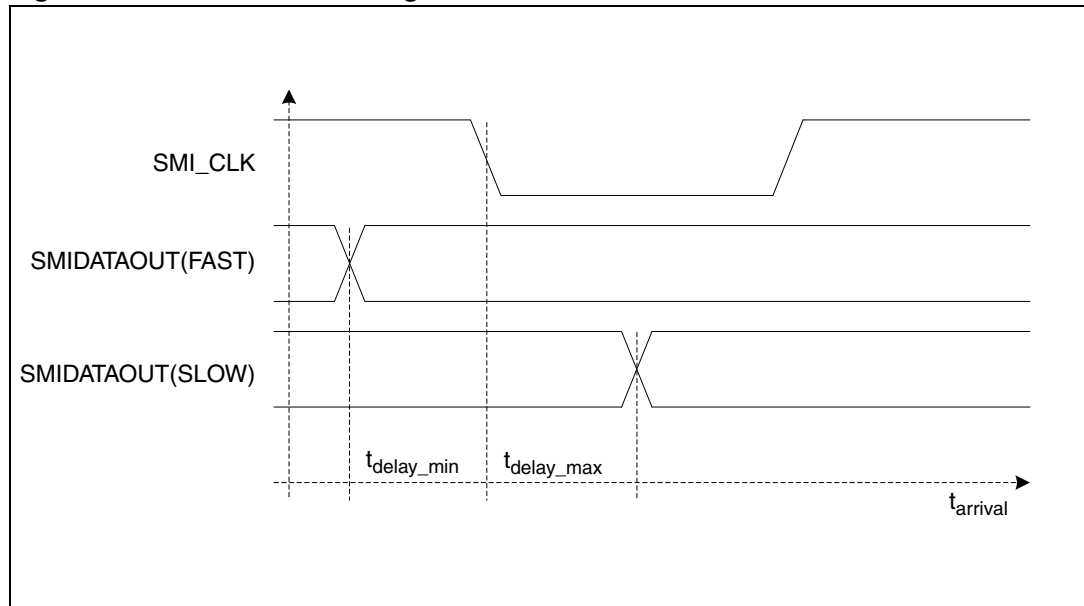


Table 38. SMIDATAIN timings

Signal	Parameter	Value
SMI_DATAOUT	t _{delay_max}	t _{arrivalSMIDATAOUT_max} - t _{arrival_SMI_CLK_min}
	t _{delay_min}	t _{arrivalSMIDATAOUT_min} - t _{arrival_SMI_CLK_max}

Figure 38. SMICSn fall timings

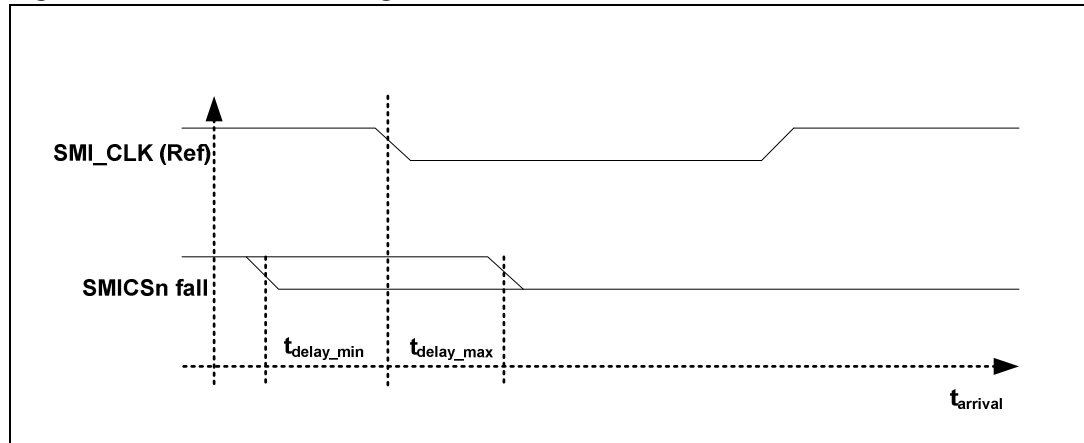


Table 39. SMICSn fall timings

Signal	Parameter	Value
SMI_CS _n fall	t _{delay_max}	t _{arrivalSMICSn_max_fall} - t _{arrival_SMI_CLK_min_fall}
	t _{delay_min}	t _{arrivalSMICSn_min_fall} - t _{arrival_SMI_CLK_max_fall}

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Figure 39. SMICSn rise timings

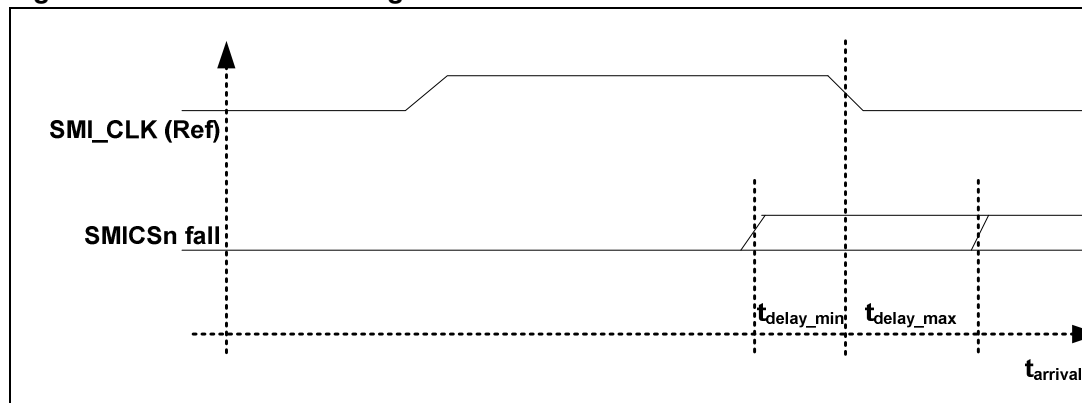


Table 40. SMICSn rise timings

Signal	Parameter	Value
SMI_CS _n rise	$t_{\text{delay_max}}$	$t_{\text{arrivalSMICSn_max_rise}} - t_{\text{arrival_SMI_CLK_min_fall}}$
	$t_{\text{delay_min}}$	$t_{\text{arrivalSMICSn_min_rise}} - t_{\text{arrival_SMI_CLK_max_fall}}$

Table 41. Timing requirements for SMI

Parameter		Input setup-hold/output delay	
		Max	Min
SMI_CLK	Fall time	1.8209	1.4092
	Rise time	1.6320	1.1959
SMIDATAIN	Input setup time	8.27482	
	Input hold time	-2.595889	
SMIDATAOUT Output valid time		2.039774	
SMICS_0 Output valid time	fall	1.922779	
	rise	1.69768	
SMICS_1 Output valid time	fall	1.7898169	
	rise	1.638069	

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5.12 SPI

This module provides a programmable length shift register which allows serial communication with other SPI devices through a 3 or 4 wire interface (SPI_SCK, MISO, MOSI and SPI_CS_n).

Figure 40. SPI_CLK timings

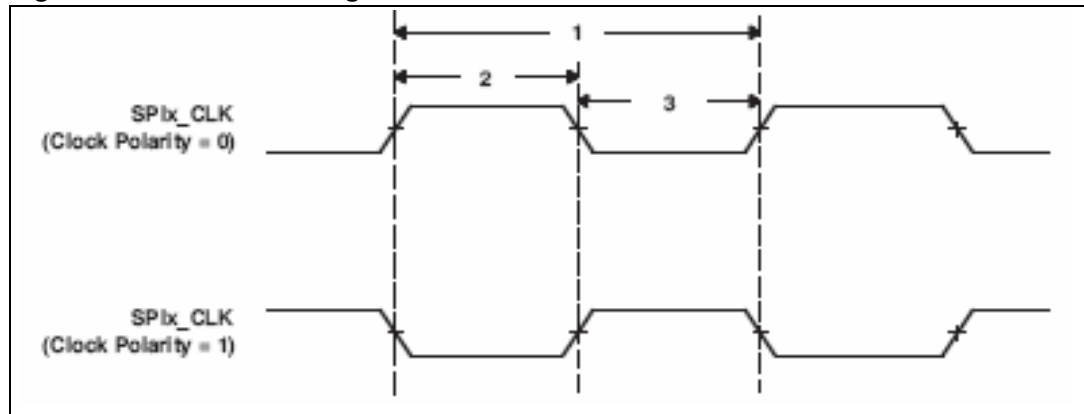
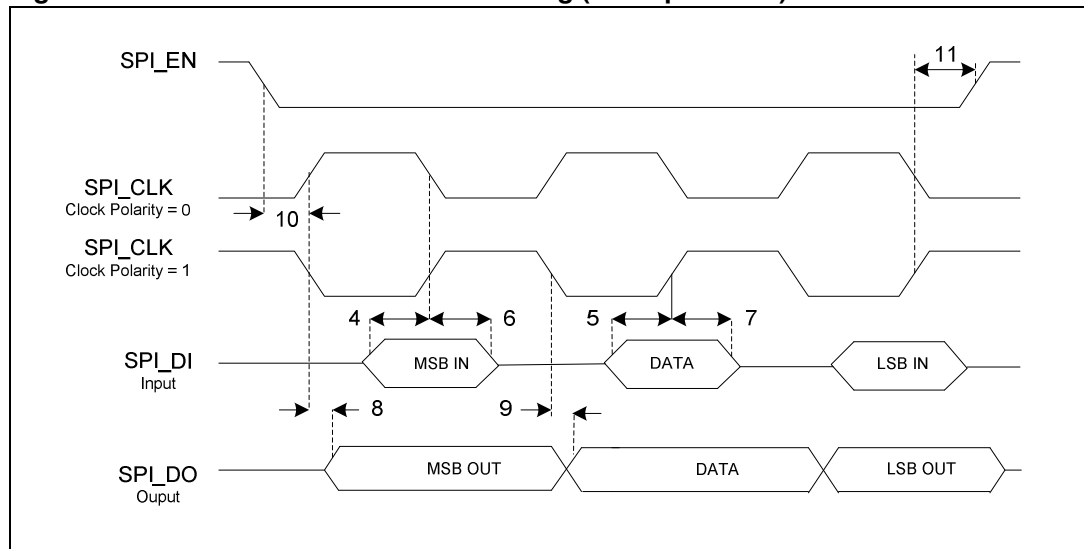


Table 42. SPI timing requirements (all modes)

No.	Parameters	Min	Max	Unit
1	$t_{c(CLK)}$	Cycle time, SPI_SCK		ns
2	$t_{w(CLKH)}$	Pulse duration, SPI_SCK high		$0.49 \cdot t_{c(CLK)} - 0.51 \cdot t_{c(CLK)}$
3	$t_{w(CLKL)}$	Pulse duration, SPI_SCK low		$0.51 \cdot t_{c(CLK)} - 0.49 \cdot t_{c(CLK)}$

5.12.1 SPI master mode timings (Clock phase = 0)

Figure 41. SPI master mode external timing (clock phase = 0)



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Table 43. Timing Requirements for SPI Master Mode [Clock Phase = 0]

No.	Parameters		Max.	Unit
4	$t_{su(DIV-CLKL)}$	Setup time, MISO (input) valid before SPI_SCK (output) falling edge	Clock Polarity = 0 11.832	ns
5	$t_{su(DIV-CLKH)}$	Setup time, MISO (input) valid before SPI_SCK (output) rising edge	Clock Polarity = 1 11.950	ns
6	$t_h(CLKL-DIV)$	Hold time, MISO (input) valid after SPI_SCK (output) falling edge	Clock Polarity = 0 -7.690	ns
7	$t_h(CLKH-DIV)$	Hold time, MISO (input) valid after SPI_SCK (output) rising edge	Clock Polarity = 1 -7.958	ns

Table 44. Switching characteristics over recommended operating conditions for SPI master mode (clock phase = 0)

No.	Parameters		Max	Unit
8	$t_d(CLKH-DOV)$	Delay time, SPI_SCK (output) rising edge to MOSI (output) transition	Clock Polarity = 0 1.960	ns
9	$t_d(CLKL-DOV)$	Delay time, SPI_SCK (output) falling edge to MOSI (output) transition	Clock Polarity = 1 21.75	ns
10	$t_d(ENL-CLKH/L)$	Delay time, SPI_CS _n (output) falling edge to first SPI_SCK (output) rising or falling edge	T	ns
11	$t_d(CLKH/L-ENH)$	Delay time, SPI_SCK (output) rising or falling edge to SPI_CS _n (output) rising edge	T/2	ns

5.12.2 SPI master mode timings (Clock Phase = 1)

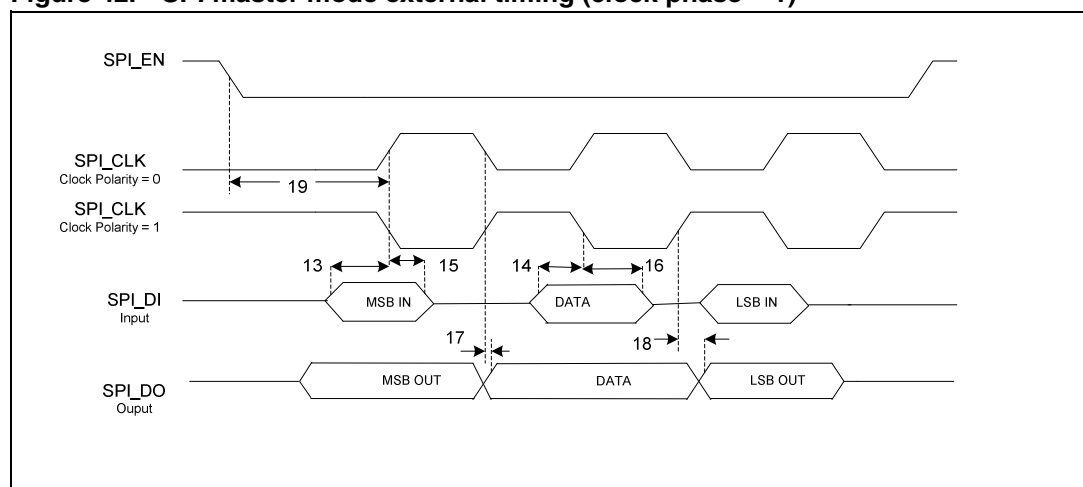
Figure 42. SPI master mode external timing (clock phase = 1)

Table 45. Timing requirements for SPI master mode (clock phase = 1)

No.	Parameters		Max	Unit
12	$t_{su(DIV-CLKL)}$	Setup time, MISO (input) valid before SPI_SCK (output) rising edge	Clock polarity = 0 11.950	ns
13	$t_{su(DIV-CLKH)}$	Setup time, MISO (input) valid before SPI_SCK (output) falling edge	Clock polarity = 1 11.832	ns
14	$t_{h(CLKL-DIV)}$	Hold time, MISO (input) valid after SPI_SCK (output) rising edge	Clock polarity = 0 -7.958	ns
15	$t_{h(CLKH-DIV)}$	Hold time, MISO (input) valid after SPI_SCK (output) falling edge	Clock polarity = 1 -7.690	ns

Table 46. Switching characteristics over recommended operating conditions for SPI master mode (clock phase =1)

No.	Parameters		Max	Unit
16	$t_{d(CLKH-DOV)}$	Delay time, SPI_SCK (output) rising edge to MOSI (output) transition	Clock Polarity = 0 1.960	ns
17	$t_{d(CLKL-DOV)}$	Delay time, SPI_SCK (output) falling edge to MOSI (output) transition	Clock Polarity = 1 2.175	ns
18	$t_{d(ENL-CLKH/L)}$	Delay time, SPI_CS _n (output) falling edge to first SPI_SCK (output) rising or falling edge	T/2	ns
19	$t_{d(CLKH/L-ENH)}$	Delay time, SPI_SCK (output) rising or falling edge to SPI_CS _n (output) rising edge	T	ns

5.13 UART (Universal asynchronous receiver/transmitter)

Figure 43. UART transmit and receive timings

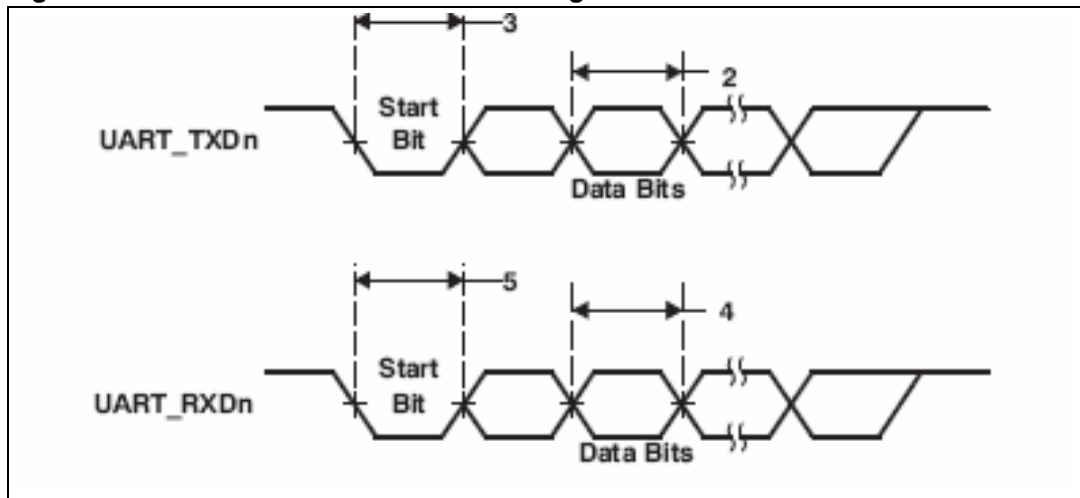


Table 47. UART transmit timing characteristics

S.No.	Parameters	Min	Max	Unit
1	UART Maximum Baud Rate		3	Mbps
2	UART Pulse Duration Transmit Data (TxD)	$0.99B_{(1)}$	$B_{(1)}$	ns
3	UART Transmit Start Bit	$0.99B_{(1)}$	$B_{(1)}$	ns

Table 48. UART receive timing characteristics

S.No.	Parameters	Min	Max	Units
4	UART Pulse Duration Receive Data (RxD)	$0.97B_{(1)}$	$1.06B_{(1)}$	ns
5	UART Receive Start Bit	$0.97B_{(1)}$	$1.06B_{(1)}$	ns

where (1) B = UART baud rate

5.14 Power up sequence

The only requirement is that the various power supplies reach the correct range in less than 10 ms.

5.15 Power on reset (MRESET)

The MRESET must remain active for at least 10 ms after all the power supplies are in the correct range and should become active in no more than 10 μ s when one of the power supplies goes out of the correct range.

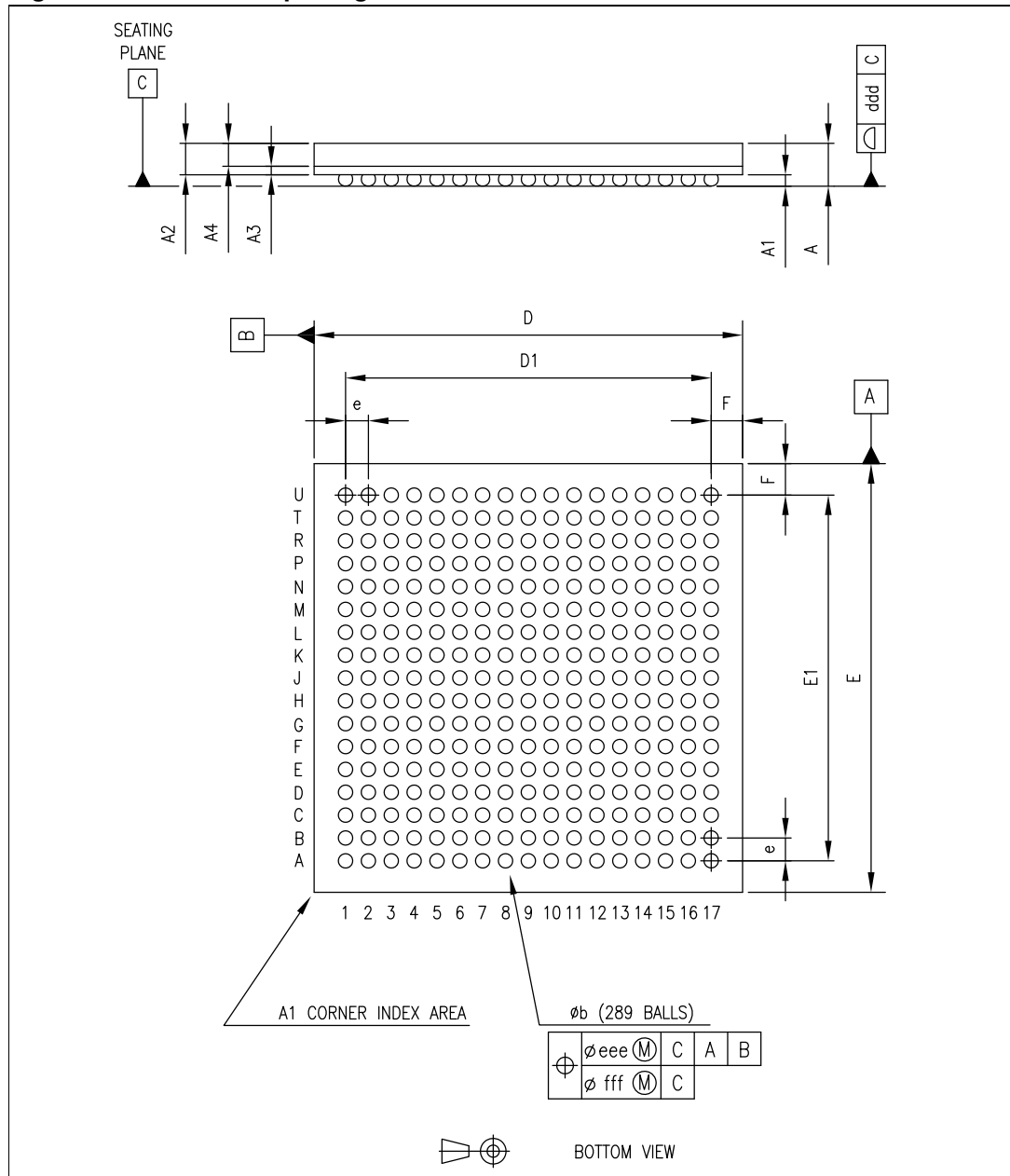
6 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK[®] packages, depending on their level of environmental compliance. ECOPACK[®] specifications, grade definitions and product status are available at: www.st.com. ECOPACK[®] is an ST trademark.

Table 49. LFBGA289 (15 x 15 x 1.7 mm) mechanical data

Dim.	mm			inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.700			0.0669
A1	0.270			0.0106		
A2		0.985			0.0387	
A3		0.200			0.0078	
A4			0.800			0.0315
b	0.450	0.500	0.550	0.0177	0.0197	0.0217
D	14.850	15.000	15.150	0.5846	0.5906	0.5965
D1		12.800			0.5039	
E	14.850	15.000	15.150	0.5846	0.5906	0.5965
E1		12.800			0.5039	
e		0.800			0.0315	
F		1.100			0.0433	
ddd			0.200			0.0078
eee			0.150			0.0059
fff			0.080			0.0031

Figure 44. LFBGA289 package dimensions



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7 Revision history

Table 50. Document revision history

Date	Revision	Changes
15-Oct-2009	1	Initial release.

SPEAr300

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