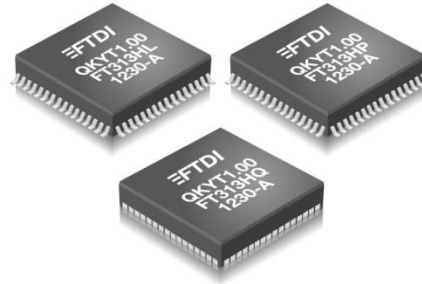


Future Technology Devices International Ltd.

FT313H (USB2.0 HS Embedded Host Controller)



The FT313H is a Hi-Speed Universal Serial Bus (USB) Host Controller compatible with Universal Serial Bus Specification Rev 2.0 and supports data transfer speeds of up to 480M bit/s. The FT313H has the following advanced features:

- Single chip USB2.0 Hi-Speed compatible.
- Compatible to Enhanced Host Controller Interface Specification Rev 1.0.
- The USB1.1 host is integrated into the USB2.0 EHCI compatible host controller.
- Single USB host port.
- Supports data transfer at high-speed (480M bit/s), full-speed (12M bit/s), and low-speed (1.5M bit/s).
- Supports the Isochronous, Interrupt, Control, and Bulk transfers.
- Supports the split transaction for high-speed Hub and the preamble transaction for full-speed Hub.
- Supports multiple processor interfaces with 8-bit or 16-bit bus: SRAM, NOR Flash, and General multiplex.
- Single configurable interrupt (INT) line for host controller.
- Integrated 24kB high speed RAM memory.
- Supports DMA operation.
- Integrated Phase-Locked Loop (PLL) supports external 12MHz, 19.2MHz, and 24MHz crystal, and direct external clock source input.
- Low power consumption for portable application.
- Supports bus interface I/O voltage from 1.62V to 3.63V.
- Supports hybrid power mode; VCC(3V3) is not present, VCC(I/O) is powered.
- Internal voltage regulator supplies 1.2v to the digital core.
- Supports Battery Charging Specification Rev 1.2.
- The downstream port can be configured as SDP, CDP or DCP.
- Supports VBUS power switching and over current control.
- -40°C to 85°C extended operating temperature range.
- Available in compact Pb-free 64 Pin QFN, LQFP and TQFP packages (all RoHS compliant).

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1 Typical Applications

- TV/TV box
- Printer
- Instrumentation
- Media player
- Tablet
- Set-top box

1.1 Part Numbers

| Part Number | Package |
|-------------|-------------|
| FT313HQ-x | 64 Pin QFN |
| FT313HL-x | 64 Pin LQFP |
| FT313HP-x | 64 Pin TQFP |

Table 1-1 FT313H Numbers

Note: Packaging codes for x is:

-R: Taped and Reel, (QFN is 3000pcs, LQFP is 1000 pcs, TQFP is 2500pcs per reel)

-T: Tray packing, (QFN is 2600pcs, LQFP is 1600 pcs, TQFP is 2500pcs per tray)

For example: FT313HQ-R is 3000 QFN pcs in taped and reel packaging

1.2 USB Compliant

At the time of writing this datasheet, the FT313H was still to complete USB compliance testing.

2 FT313H Block Diagram

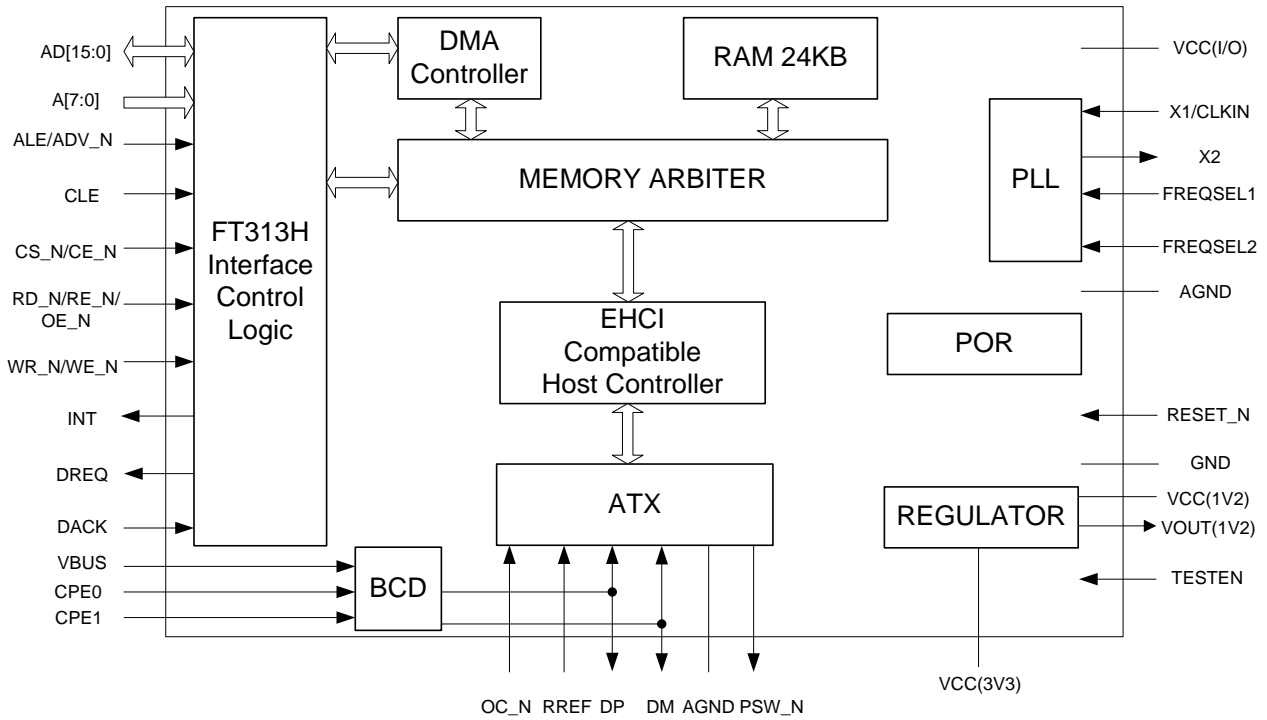


Figure 2-1 FT313H Block Diagram

For a description of each function please refer to Section 4.

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3 Device Pin Out and Signal Description

3.1 Pin Out – 64pin QFN

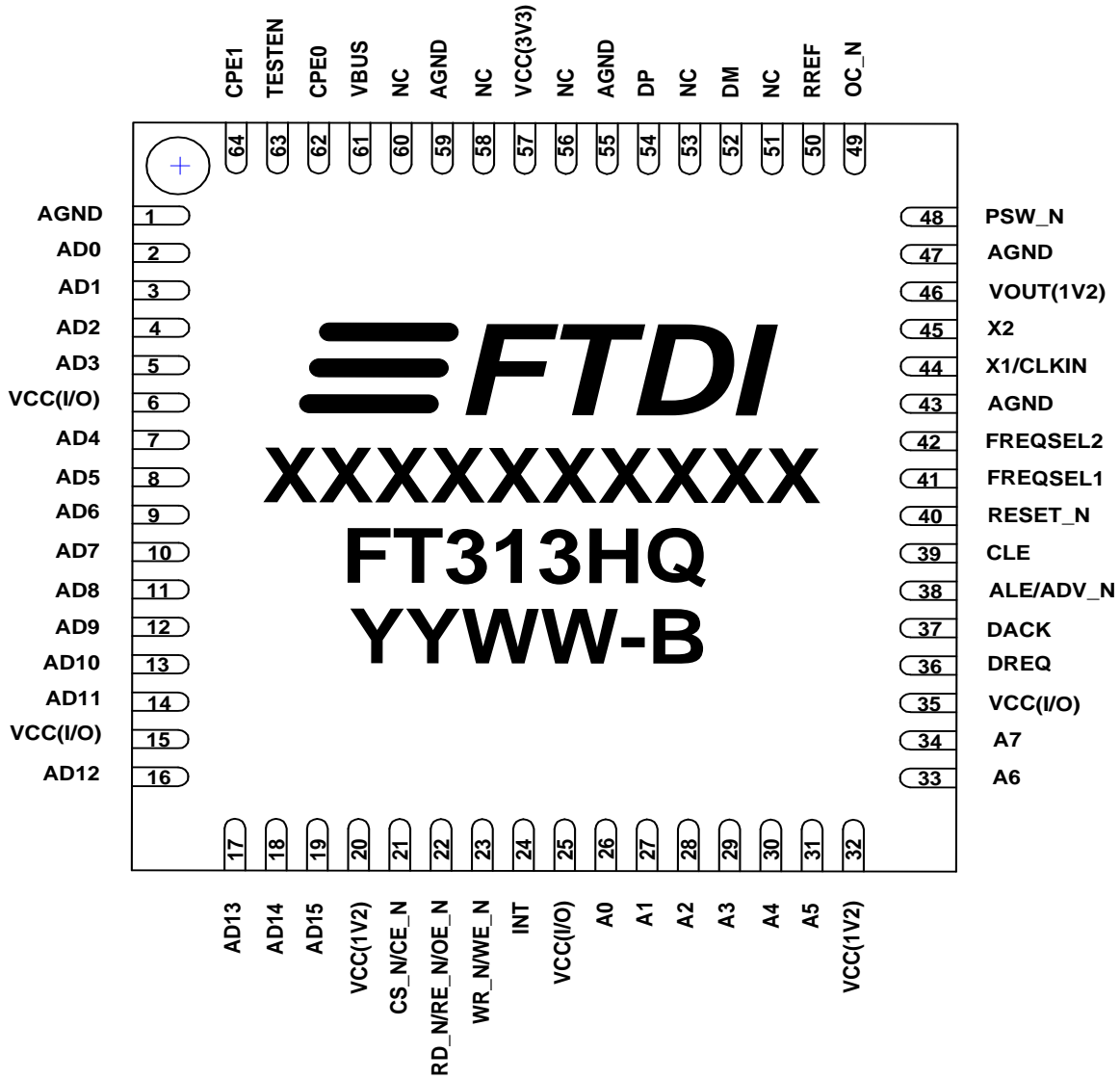


Figure 3-1 Pin Configuration QFN64 (top-down view)

3.2 Pin Out – 64pin LQFP

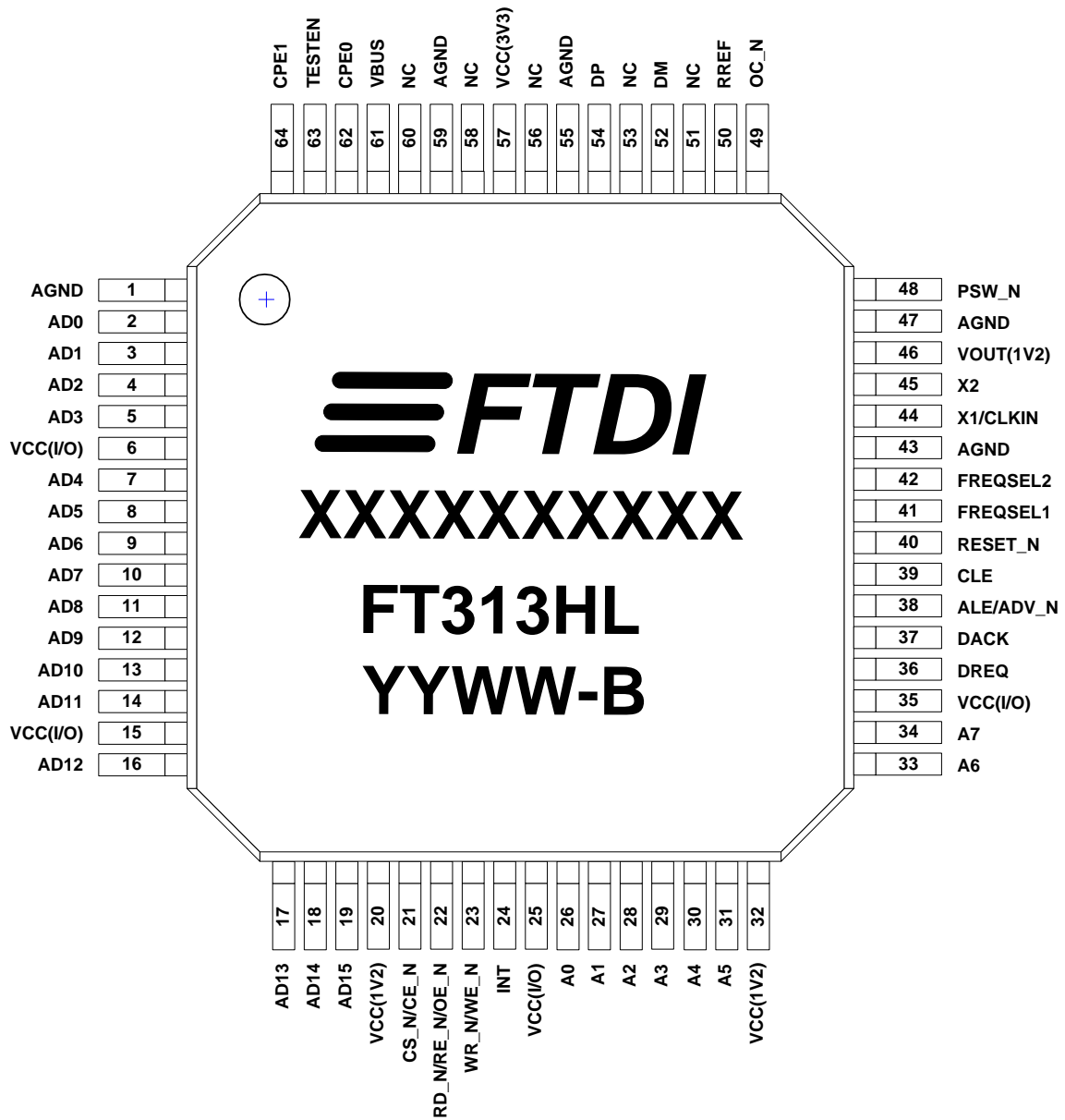


Figure 3-2 Pin Configuration LQFP64 (top-down view)

3.3 Pin Out – 64pin TQFP

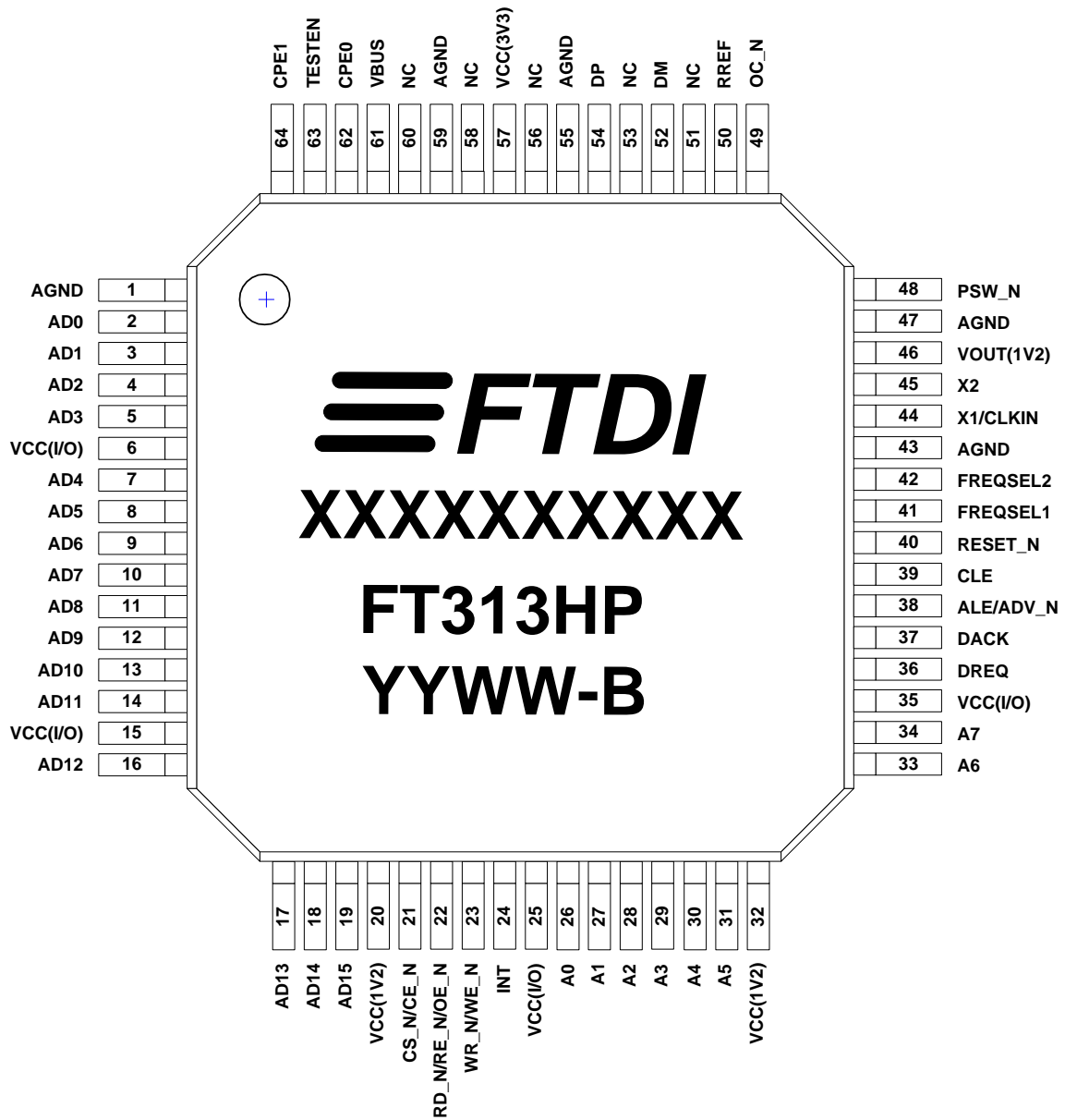


Figure 3-3 Pin Configuration TQFP64 (top-down view)

3.4 Pin Description

| Pin No. | Name | Type | Description |
|---------|----------|------|---|
| 1 | AGND | P | Analog Ground |
| 2 | AD0 | I/O | Bit 0 of the address and data bus Bidirectional pad; push-pull, three-state output. 3.3V tolerant |
| 3 | AD1 | I/O | Bit 1 of the address and data bus Bidirectional pad; push-pull, three-state output. 3.3V tolerant |
| 4 | AD2 | I/O | Bit 2 of the address and data bus Bidirectional pad; push-pull, three-state output. 3.3V tolerant |
| 5 | AD3 | I/O | Bit 3 of the address and data bus Bidirectional pad; push-pull, three-state output. 3.3V tolerant |
| 6 | VCC(I/O) | P | I/O supply voltage; connect a 0.1uF decoupling capacitor 1.8V, 2.5V or 3.3V |
| 7 | AD4 | I/O | Bit 4 of the address and data bus Bidirectional pad; push-pull, three-state output. 3.3V tolerant |
| 8 | AD5 | I/O | Bit 5 of the address and data bus Bidirectional pad; push-pull, three-state output. 3.3V tolerant |
| 9 | AD6 | I/O | Bit 6 of the address and data bus Bidirectional pad; push-pull, three-state output. 3.3V tolerant |
| 10 | AD7 | I/O | Bit 7 of the address and data bus Bidirectional pad; push-pull, three-state output. 3.3V tolerant |
| 11 | AD8 | I/O | Bit 8 of the address and data bus Bidirectional pad; push-pull, three-state output. 3.3V tolerant |
| 12 | AD9 | I/O | Bit 9 of the address and data bus Bidirectional pad; push-pull, three-state output. 3.3V tolerant |
| 13 | AD10 | I/O | Bit 10 of the address and data bus Bidirectional pad; push-pull, three-state output. 3.3V tolerant |
| 14 | AD11 | I/O | Bit 11 of the address and data bus Bidirectional pad; push-pull, three-state output. 3.3V tolerant |
| 15 | VCC(I/O) | P | I/O supply voltage; connect a 0.1uF decoupling capacitor |

| Pin No. | Name | Type | Description |
|---------|--------------------|------|---|
| | | | 1.8V, 2.5V or 3.3V |
| 16 | AD12 | I/O | Bit 12 of the address and data bus Bidirectional pad; push-pull, three-state output. 3.3V tolerant |
| 17 | AD13 | I/O | Bit 13 of the address and data bus Bidirectional pad; push-pull, three-state output. 3.3V tolerant |
| 18 | AD14 | I/O | Bit 14 of the address and data bus Bidirectional pad; push-pull, three-state output. 3.3V tolerant |
| 19 | AD15 | I/O | Bit 15 of the address and data bus Bidirectional pad; push-pull, three-state output. 3.3V tolerant |
| 20 | VCC(1V2) | P | Core power 1.2V input; for normal operation, this pin must be connected to pin 46. Connect a 0.1uF decoupling capacitor |
| 21 | CS_N/CE_N | I | Chip select; Input ; 3.3V tolerant |
| 22 | RD_N /RE_N/OE_N | I | Read enable, or read latch; when not in use, connect to VCC(I/O) Input; 3.3V tolerant |
| 23 | WR_N /WE_N | I | Write enable; when not in use, connect to VCC(I/O) Input; 3.3V tolerant |
| 24 | INT | O | Interrupt output Push-pull output; 3.3V tolerant |
| 25 | VCC(I/O) | P | I/O supply voltage; connect a 0.1uF decoupling capacitor 1.8V, 2.5V or 3.3V |
| 26 | A0 | I | Bit 0 of the address bus; when not in use, connect to GND Input; 3.3V tolerant |
| 27 | A1 | I | Bit 1 of the address bus; when not in use, connect to GND Input; 3.3V tolerant |
| 28 | A2 | I | Bit 2 of the address bus; when not in use, connect to GND Input; 3.3V tolerant |
| 29 | A3 | I | Bit 3 of the address bus; when not in use, connect to GND Input; 3.3V tolerant |

| Pin No. | Name | Type | Description |
|---------|------------|------|--|
| 30 | A4 | I | Bit 4 of the address bus; when not in use, connect to GND Input; 3.3V tolerant |
| 31 | A5 | I | Bit 5 of the address bus; when not in use, connect to GND Input; 3.3V tolerant |
| 32 | VCC (1V2) | P | Core power 1.2V input; for normal operation, this pin must be connected to pin 46. Connect a 0.1uF decoupling capacitor. |
| 33 | A6 | I | Bit 6 of the address bus; when not in use, connect to GND Input; 3.3V tolerant |
| 34 | A7 | I | Bit 7 of the address bus; when not in use, connect to GND Input; 3.3V tolerant |
| 35 | VCC(I/O) | P | I/O supply voltage; connect a 0.1uF decoupling capacitor 1.8V, 2.5V or 3.3V |
| 36 | DREQ | O | DMA request; Push-pull output; 3.3V tolerant |
| 37 | DACK | I | DMA acknowledge; Internal pull-down. Input; 3.3V tolerant |
| 38 | ALE/ADV_N | I | Address latch enable Input; 3.3V tolerant |
| 39 | CLE | I | Command latch enable Input; 3.3V tolerant |
| 40 | RESET_N | I | Chip reset; Internal pull-up. Input; 3.3V tolerant |
| 41 | FREQSEL1 | I | Input clock frequency selection pin1 Input; 3.3V tolerant |
| 42 | FREQSEL2 | I | Input clock frequency selection pin2 Input; 3.3V tolerant |
| 43 | AGND | P | Analog Ground |
| 44 | X1/CLKIN | AI | Crystal oscillator or clock input; 3.3V peak input allowed |
| 45 | X2 | AO | Crystal oscillator output; leave open if an external clock is applied on pin X1/CLKIN |
| 46 | VOOUT(1V2) | AO | Internal 1.2V regulator output; connect 4.7uF and |

| Pin No. | Name | Type | Description |
|---------|----------|------|---|
| | | | 0.1uF decoupling capacitors to this pin. |
| 47 | AGND | P | Analog Ground |
| 48 | PSW_N | OD | Port power switch; when not in use, connect to VCC(3V3) through a 10kΩ resistor Open drain output; 5V tolerant |
| 49 | OC_N | I | Over current input; when not in use, connect to VCC(3V3) through a 10KΩ resistor Input; 5V tolerant |
| 50 | RREF | AI | Port reference resistor connection Connect 12 kΩ±1% resistor between RREF and GND |
| 51 | NC | | No connect |
| 52 | DM | AI/O | Port DM; connect to the D- pin of the USB connector |
| 53 | NC | | No connect |
| 54 | DP | AI/O | Port DP; connect to the D+ pin of the USB connector |
| 55 | AGND | P | Analog Ground |
| 56 | NC | | No connect |
| 57 | VCC(3V3) | P | Supply 3.3V voltage; Connect 10uF and 0.1uF decoupling capacitors |
| 58 | NC | | No connect |
| 59 | AGND | P | Analog Ground |
| 60 | NC | | No connect |
| 61 | VBUS | OD | VBUS discharge. 5V tolerant |
| 62 | CPE0 | I | Bit 0 to select charging port emulation type |
| 63 | TESTEN | I | Enable test mode. Internal pull-down. For normal operation leave floating. |
| 64 | CPE1 | I | Bit 1 to select charging port emulation type |

Table 3-1 FT313H pin description

Notes:

| | | | |
|----|---------------------|------|---------------------------------|
| P | : Power or ground | I/O | : Bi-direction Input and Output |
| I | : Input | AI | : Analog Input |
| O | : Output | AO | : Analog Output |
| OD | : Open drain output | AI/O | : Analog Input / Output |

4 Function Description

The FT313H is a USB2.0 compatible EHCI single port host controller which is mainly composed of the following:

- Microcontroller bus interface
- SRAM bus interface mode
- NOR bus interface mode
- General multiplex bus interface mode
- Interface mode lock
- DMA controller
- EHCI host controller
- System clock
- Power management
- BCD mode

The functions for each block are briefly described in the following subsections.

4.1 Microcontroller Bus Interface

The FT313H has a fast advance general purpose interface to communicate with most types of microcontrollers and microprocessors. This microcontroller interface is configured using pins ALE/ADV_N and CLE to accommodate most types of interfaces. The bus interface supports 8-bit and 16-bit, which can be configured using bit DATA_BUS_WIDTH. Three bus interface types are selected using inputs ALE/ADV_N and CLE during power up, the RD_N /RE_N/OE_N and CS_N/CE_N pins, or the RESET_N pin. Table 4.1 provides detail of bus configuration for each mode. Table 4.2 shows pinout information of each bus interface.

| Bus Mode | ALE/ADV_N | CLE | DATA_BUS_WIDTH | Signal Description |
|-------------------------|-----------|------|----------------|--|
| SRAM 8-bit | HIGH | HIGH | 1 | <ul style="list-style-type: none"> • A[7:0]: 8-bit address bus • AD[7:0]: 8-bit data bus • Write (WR_N), read (RD_N), chip select (CS_N): control signals for normal SRAM mode • DACK: DMA acknowledge input • DREQ: DMA request output |
| SRAM 16-bit | HIGH | HIGH | 0 | <ul style="list-style-type: none"> • A[7:0]: 8-bit address bus • AD[15:0]: 16-bit data bus • Write (WR_N), read (RD_N), chip select (CS_N): control signals for normal SRAM mode • DACK: DMA acknowledge input • DREQ: DMA request output |
| NOR 8-bit | HIGH | LOW | 1 | <ul style="list-style-type: none"> • AD[7:0]: 8-bit data bus • ADV_N, write enable, output enable, chip select: control signals |
| NOR 16-bit | HIGH | LOW | 0 | <ul style="list-style-type: none"> • AD[15:0]: 16-bit data bus • ADV_N, write enable, output enable, chip select: control signals |
| General Multiplex 8-bit | LOW | HIGH | 1 | <ul style="list-style-type: none"> • AD[7:0]: 8-bit data bus • ALE, write(WR_N), read(RD_N), chip |

| Bus Mode | ALE/ADV_N | CLE | DATA_BUS_WIDTH | Signal Description |
|--------------------------|-----------|------|----------------|--|
| | | | | select: control signals <ul style="list-style-type: none"> • DACK: DMA acknowledge input • DREQ: DMA request output |
| General Multiplex 16-bit | LOW | HIGH | 0 | <ul style="list-style-type: none"> • AD[15:0]: 16-bit data bus • ALE, write(WR_N), read(RD_N), chip select: control signals • DACK: DMA acknowledge input • DREQ: DMA request output |

Table 4-1 Bus Configuration modes

| SRAM mode | NOR mode | General Multiplex mode | Type | Description |
|-----------|----------|------------------------|------|--------------------------|
| AD[15:0] | AD[15:0] | AD[15:0] | I/O | Data or address bus |
| A[7:0] | - | - | I | Address bus |
| - | ADV_N | ALE | I | Address or command valid |
| CS_N | CS_N | CS_N | I | Chip select |
| RD_N/RE_N | OE_N | RD_N/RE_N | I | Read control |
| WR_N/WE_N | WE_N | WR_N/WE_N | I | Write control |
| INT | INT | INT | O | Interrupt request |
| DREQ | - | DREQ | O | DMA request |
| DACK | - | DACK | I | DMA acknowledge |

Table 4-2 Pin information of the bus interface

4.2 SRAM bus interface mode

The bus interface will be in SRAM 16-bit mode if pins ALE/ADV_N and CLE are HIGH, when:

- The CS_N/CE_N pin goes LOW, and the RD_N /RE_N/OE_N pin goes LOW.

Then, if the DATA_BUS_WIDTH bit is set, the bus interface will be in SRAM 8-bit mode.

In SRAM mode, A[7:0] is the 8-bit address bus and AD[15:0] is the separate 16-bit data bus. The FT313H pins RD_N /RE_N/OE_N and WR_N/WE_N are the read and write strobes. The SRAM bus interface supports both 8-bit and 16-bit bus width that can be configured by setting or clearing bit DATA_BUS_WIDTH. The DMA transfer is also applicable to this interface.

4.3 NOR bus interface mode

The bus interface will be in NOR 16-bit mode, if pin ALE/ADV_N is HIGH and pin CLE is LOW, when:

- The CS_N/CE_N pin goes LOW, and the RD_N /RE_N/OE_N pin goes LOW.

Then, if the DATA_BUS_WIDTH bit is set, the bus interface will be in NOR 8-bit mode.

The NOR Flash interface access consists of two phases: address and data.

The address is valid when CS_N/CE_N and ADV_N are LOW, and the address is latched at the rising edge of ADV_N. For a read operation, WE_N must be HIGH. OE_N is the data output control. When active, the addressed register or the buffer data is driven to the I/O bus. The read operation is completed when CS_N/CE_N is de-asserted. For a write operation, OE_N must be HIGH. The WE_N assertion can start when ADV_N is de-asserted. WE_N is the data input strobe signal. When de-asserted, data will be written to the addressed register or the buffer. The write operation is completed when CS_N/CE_N is de-asserted.

4.4 General multiplex bus interface mode

The bus interface will be in general multiplex 16-bit mode, if pin ALE/ADV_N is LOW and pin CLE is HIGH, when:

- The CS_N/CE_N pin goes LOW, and the RD_N /RE_N/OE_N pin goes LOW.

Then, if the DATA_BUS_WIDTH bit is set, the bus interface will be in general multiplex 8-bit mode. The general multiplex bus interface supports most advance application processors.

The general multiplex interface access consists of two phases: address and data.

The address is valid when ALE/ADV_N goes HIGH, and the address is latched at the falling edge of ALE/ADV_N. For a read operation, WR_N/WE_N must be HIGH. RD_N /RE_N/OE_N is the data output control. When active, the addressed register or the buffer data is driven to the I/O bus. The read operation is completed when CS_N/CE_N is de-asserted. For a write operation, RD_N /RE_N/OE_N must be HIGH. The WR_N/WE_N assertion can start when ALE/ADV_N is de-asserted. WR_N/WE_N is the data input strobe signal. When de-asserted, data will be written to the addressed register or the buffer. The write operation is completed when CS_N/CE_N is de-asserted. The DMA transfer is also applicable to this interface.

4.5 Interface mode lock

The bus interface can be locked in any of the modes, SRAM, NOR, or general multiplex, using bit 3 of the HW Mode Control register. To lock the interface in a particular mode:

1. Read bits 7 and 6 of the SW Reset register.
2. Set bit 3 of the HW Mode Control register to logic 1.
3. Read bits 7 and 6 of the SW Reset register to ensure that the interface is locked in the desired mode.

Note: the default is 16-bit SRAM mode.

4.6 DMA controller

The DMA controller of the FT313H is used to transfer data between the system memory and local buffers. It shares data bus AD[15:0] and control signals WR_N/WE_N, RD_N /RE_N/OE_N, and CS_N/CE_N. The logic is dependent on the bus interface mode setting.

DREQ signal is from the FT313H to indicate the start of DMA transfer. DACK signal is used to differentiate if data transferred is for the DMA or PIO access. When DACK is asserted, it indicates that it is still in DMA mode. When DACK is de-asserted, it indicates that PIO is to be accessed. ALE/ADV_N and CLE are ignored in a DMA access cycle. Correct data will be captured only on the rising edge of WR_N/WE_N and RD_N /RE_N/OE_N.

The DMA controller of the FT313H has only one DMA channel. Therefore, only one DMA read or DMA write may take place at a time. Assign the DMA transfer length in the Data Session Length register for each DMA transfer. If the transfer length is larger than the burst counter, the DREQ signal will de-assert at the end of each burst transfer. DREQ will re-assert at the beginning of the each burst.

When DMA is transferring data from/to local buffer, if it wants to access local buffer content by PIO mode, can use auxiliary memory access registers AUX_MEMADDR and AUX_DATAPORT to read/write data from/to local buffer with single cycle.

For a 16-bit DMA transfer, the minimum burst length is 2 bytes. This means that the burst length is only one DMA cycle. Therefore, DREQ and DACK will assert and de-assert at each DMA cycle.

The FT313H will be asserted DMA EOT interrupt to indicate that the DMA transfer has either successfully completed or terminated.

4.7 EHCI host controller

The FT313H is a one-port EHCI-compatible host controller which supports all the USB 2.0 compliant Low-speed, Full-speed, and High-speed devices and split/preamble transactions for the HS/FS hub.

The EHCI host controller supports two categories of the transfer types, the periodic and asynchronous transfer types. The periodic transfer type includes the isochronous and interrupt transfers, while the asynchronous transfer type includes the control and bulk transfers.

The EHCI host controller has schedule interface that provides to the separate schedules for each category of the transfer type. The periodic schedule is based on a time-oriented frame list that represents a slide window of time of the host controller work items. All the ISO and INT transfers are serviced via the periodic schedule. The asynchronous schedule is a simple circular list of the schedule work items that provides a round robin service opportunity for all the asynchronous transfers.

The EHCI host controller contains the Isochronous Transfer Descriptor (iTDD), Queue Head (qH) and Queue Element Transfer Descriptor (qTDD), and Split Transaction Isochronous Transfer Descriptor (siTDD) data structure interface to support the isochronous/interrupt/control/bulk transfers and split transaction.

The EHCI host controller internal buffer memory is 24KB. START_ADDR_MEM register is allocated from 0x0000 to 0x5FFF.

4.8 System clock

4.8.1 Phase Locked Loop (PLL) clock multiplier

The internal PLL supports 12MHz, 19.2MHz, or 24MHz input, which can be crystal or a clock already existing in system. The frequency selection can be done using the FREQSEL1 and FREQSEL2 pins. Table 4.3 provides clock frequency selection.

| FREQSEL1 | FREQSEL2 | Clock Frequency |
|----------|----------|-----------------|
| 0 | 0 | 12MHz |
| 1 | 0 | 19.2MHz |
| 0 | 1 | 24MHz |

Table 4-3 Clock frequency select

4.9 Power management

4.9.1 Power up and reset sequence

When VCC(I/O) and VCC(3V3) are on, an internal regulator will power on with VCC(3V3) on. An internal POR pulse will be generated during the regulator power on, so that internal circuits are in reset state until the regulator power is stable.

4.9.2 Power supply

Power supplies are defined in Table 4.4.

| Symbol | Typical | Description |
|----------|------------------------|----------------------------|
| VCC(I/O) | 1.8V, or 2.5V, or 3.3V | Supply for digital I/O pad |
| VCC(3V3) | 3.3V | Supply for chip |

Table 4-4 Power supply

4.9.3 ATX reference voltage

The ATX circuit provides a stable internal voltage reference (+1.2V) to bias the analog circuitry. This circuit requires an accurate external reference resistor. Connect 12kΩ±1% resistor between pins RREF and GND.

4.9.4 Power modes

Power management configuration defined in Table 4.5.

For each bit description, see CONFIG register.

| OSC_EN | PLL_EN | HC_CLK_EN | Description |
|--------|--------|-----------|----------------|
| 1 | 1 | 1 | Operation mode |
| 0 | 0 | 0 | Suspend mode |

Table 4-5 power management configuration

4.9.4.1 Operation mode

All power supplies are present. Host controller is active.

4.9.4.2 Suspend mode

All power supplies are present. Host controller goes to USB suspend.

The steps for the host suspend are as follows:

1. Clear the RS bit of the USBCMD register to stop the host controller from executing schedule.
2. Set the PO_SUSP bit of the PORTSC register to force the host controller to go into suspend.
3. Disable OSC_EN, PLL_EN and HC_CLK_EN bits of the CONFIG register to save power.
4. Clear the U_SUSP_U bit of the EOTTIME register to put the chip into suspend mode.

4.9.4.3 Wake up

The regulator will be in normal operating mode and the clock/oscillator/PLL will be enabled when either of these conditions is triggered:

1. Dummy read access with a LOW pulse on pins CS_N/CE_N and RD_N /RE_N/OE_N.
2. USB device connects or disconnects.
3. Remote wake up from external USB device.
4. Over current condition is triggered on OC_N if enabled by register.

After wake up automatically set corresponding bit of the CONFIG register, must set the U_SUSP_U bit of the EOTIME register to wake up the chip.

4.10 BCD mode

The FT313H is an EHCI-compatible host controller with BCD block function, which follows the Battery Charging Specification Revision 1.2(BC1.2) by USB-IF. The block function that emulates USB host port as either Charging Downstream Port (CDP) or Dedicated Charging Port (DCP) which provides higher current source than Standard Downstream Port (SDP).

The BCD logic block will decode the mode of operation and choose by following setting:

1. BCD function is default enable by CONFIG register bit[5] setting.
2. BCD mode selection is default controlled by external pins configuration. Set CONFIG register bit[15] to take over BCD mode setting by software.
3. Same configuration by CONFIG register bit[14:13] to set BCD mode if software takes over control.

| CPE1 | CPE0 | Mode | BCD_EN | Description |
|------|------|------|--------|--|
| 0 | 0 | SDP | 1 | Standard downstream port, VBUS current limit \leq 500mA |
| 0 | 1 | DCP | 1 | Dedicated charging port, USB host no functional on this port, VBUS current limit \leq 1.5A |
| 1 | 1 | CDP | 1 | Charging downstream port alternative configuration, VBUS current limit \leq 1.5A |
| X | X | X | 0 | BCD function disable |

Table 4-6 BCD mode configuration

5 Host controller specific registers

5.1 Overview of registers

Table 5.1 shows the definitions of the FT313H host controller specific registers.

| Address | Register | Reset value | Description |
|----------------------------------|----------------------------------|-------------|---|
| EHCI operational register | | | |
| 00h | HCCAPLENGTH | 0100 0010h | Capability register |
| 04h | HCSPARAMS | 0000 0001h | Structural parameter register |
| 08h | HCCPARAMS | 0000 0006h | Capability parameter register |
| 10h | USBCMD | 0008 0B00h | USB command register |
| 14h | USBSTS | 0000 1000h | USB status register |
| 18h | USBINTR | 0000 0000h | USB interrupt enable register |
| 1Ch | FRINDEX | 0000 0000h | Frame index register |
| 24h | PERIODICLISTADDR | 0000 0000h | Periodic frame list base address register |
| 28h | ASYNCLISTADDR | 0000 0000h | Current asynchronous list address register |
| 30h | POSTSC | 0000 0000h | Port status and control register |
| Configuration register | | | |
| 34h | EOFTIME | 0000 0041h | EOF time and asynchronous schedule sleep timer register |
| 80h | CHIPID | 0313 0001h | Chip ID register |
| 84h | HWMODE | 0000 0000h | HW mode control register |
| 88h | EDGEINTC | 0000 001Fh | Edge interrupt control register |
| 8Ch | SWRESET | 0000 0000h | SW reset register |
| 90h | MEMADDR | 0000h | Memory address register |
| 92h | DATAPORT | 0000h | Data port register |
| 94h | DATASESSION | 0000h | Data session length register |
| 96h | CONFIG | 1FA0h | Configuration register |
| 98h | AUX_MEMADDR | 0000h | Auxiliary memory address register |
| 9Ah | AUX_DATAPORT | 0000h | Auxiliary data port register |
| 9Ch | SLEEPTIMER | 0400h | Sleep timer register |
| Interrupt register | | | |
| A0h | HCINTSTS | 0000h | Host controller interrupt status register |

| Address | Register | Reset value | Description |
|----------------------|----------------------------|-------------|---|
| A4h | HCINTEN | 0000h | Host controller interrupt enable register |
| USB testing register | | | |
| 50h | TESTMODE | 0000 0000h | Test mode register |
| 70h | TESTPMSET1 | 0000 0000h | Test parameter setting 1 register |
| 74h | TESTPMSET2 | 0000 0000h | Test parameter setting 2 register |

Table 5-1 Overview of host controller specific registers

5.2 EHCI operational registers

5.2.1 HCCAPLENGTH register (address = 00h)

This register is used as an offset to add to register base to find the beginning of the operational register space. The high two bytes contain a BCD encoding of the EHCI revision number supported by this host controller. The most significant byte of this register represents a major revision and the least significant byte is the minor revision.

| Bit | Name | Type | Default value | Description |
|---------|------------|------|---------------|---|
| [31:16] | HCIVERSION | RO | 16'h0100 | Host Controller Interface Version Number This register is a 2-byte register containing a BCD encoding of the EHCI revision number supported by the host controller. |
| [15:8] | Reserved | RO | 8'h0 | - |
| [7:0] | CAPLENGTH | RO | 8'h10 | Capability Register Length This register is used as an offset added to register base to find out the beginning of the Operational Register Space. |

Table 5-2 Capability register

5.2.2 HCSPARAMS register (address = 04h)

This is a set of fields that are structural parameter: number of downstream ports, etc.

| Bit | Name | Type | Default value | Description |
|--------|----------|------|---------------|--|
| [31:4] | Reserved | RO | 28'h0 | - |
| [3:0] | N_PORTS | RO | 4'h1 | Number of Ports This field specifies the number of the physical downstream ports implemented on the host controller. |

Table 5-3 Structural parameter register

5.2.3 HCCPARAMS register (address = 08h)

This is multiple mode control (time base bit functionality) and addressing capability.

| Bit | Name | Type | Default value | Description |
|--------|----------|------|---------------|--|
| [31:3] | Reserved | RO | 29'h0 | - |
| 2 | ASPC | RO | 1'b1 | Asynchronous Schedule Park Capability The host controller supports the park feature for high-speed queue heads in the Asynchronous Schedule. This feature can be disabled or enabled and set to a specific level by using the <i>Asynchronous Schedule Park Mode Enable</i> and <i>Asynchronous Schedule Park Mode Count</i> fields in the USB_CMD register. |
| 1 | PFLF | RO | 1'b1 | Programmable Frame List Flag When this bit is set to 1b, the system software can specify and use a smaller frame list and configure the host controller via <i>Frame List Size</i> field of the USB_CMD register. This requirement ensures that the frame list is always physically contiguous. |
| 0 | Reserved | RO | 1'b0 | - |

Table 5-4 Capability parameter register

5.2.4 USB_CMD register (address = 10h)

The command register indicates the command to be executed by the serial bus host controller. Writing to the register causes a command to be executed.

| Bit | Name | Type | Default value | Description |
|---------|----------|------|---------------|--|
| [31:24] | Reserved | RO | 8'h0 | - |
| [23:16] | INT_THRC | R/W | 8'h08 | Interrupt Threshold Control This field is used by the system software to select the maximum rate at which the host controller will issue the interrupts. The only valid values are described as below: Value Max Interrupt Interval for the high-speed 00h Reserved 01h No limited interval 02h 2 micro-frames 04h 4 micro-frames 08h 8 micro-frames (Default, equals to 1 ms) 10h 16 micro-frames (2 ms) 20h 32 micro-frames (4 ms) 40h 64 micro-frames (8 ms) |

| Bit | Name | Type | Default value | Description |
|---------|-------------|------|---------------|--|
| | | | | <p>Note1: This is further gated by MIN_WIDTH bits of EDGEINTC register if edge trigger interrupt is used.</p> <p>Note2: In the full-speed mode, these registers are reserved.</p> |
| [15:12] | Reserved | RO | 4'b0 | - |
| 11 | ASYN_PK_EN | R/W | 1'b1 | <p>Asynchronous Schedule Park Mode Enable</p> <p>Software uses this register to enable or disable the Park mode. When this register is set to '1', the Park mode is enabled.</p> |
| 10 | Reserved | RO | 1'b0 | - |
| [9:8] | ASYN_PK_CNT | R/W | 2'b11 | <p>Asynchronous Schedule Park Mode Count</p> <p>This field contains a count for the number of successive transactions that the host controller is allowed to execute from a high-speed queue head on the asynchronous schedule.</p> |
| 7 | Reserved | RO | 1'b0 | - |
| 6 | INT_OAAD | R/W | 1'b0 | <p>Interrupt on Asynchronous Advance Doorbell</p> <p>This bit is used as a doorbell by software to ring the host controller to issue an interrupt at the next advance of the asynchronous schedule.</p> |
| 5 | ASCH_EN | R/W | 1'b0 | <p>Asynchronous Schedule Enable</p> <p>This bit controls whether the host controller skips the processing of asynchronous schedule.</p> <p>0: Do not process the asynchronous schedule</p> <p>1: Use the ASYNCLISTADDR register to access the asynchronous schedule</p> |
| 4 | PSCH_EN | R/W | 1'b0 | <p>Periodic Schedule Enable</p> <p>This bit controls whether the host controller skips the processing of the periodic schedule.</p> <p>0: Do not process the periodic schedule</p> <p>1: Use the PERIODICKISTBASE register to access the periodic schedule</p> |
| [3:2] | FRL_SIZE | R/W | 2'b00 | <p>Frame List Size</p> <p>This field specifies the size of the frame list.</p> <p>00: 1024 elements (4096 bytes; default value)</p> <p>01: 512 elements (2048 bytes)</p> <p>10: 256 elements (1024 bytes)</p> <p>11: Reserved</p> |
| 1 | HC_RESET | R/W | 1'b0 | <p>Host Controller Reset</p> <p>This control bit is used by the software to reset the host controller.</p> |

| Bit | Name | Type | Default value | Description |
|-----|------|------|---------------|--|
| 0 | RS | R/W | 1'b0 | Run/Stop When this bit is set to 1b, the host controller proceeds with the execution of schedule. 0: Stop 1: Run |

Table 5-5 USB command register

5.2.5 USBSTS register (address = 14h)

This register indicates pending interrupts and various states of the Host Controller. The status resulting from a transaction on the serial bus is not indicated in this register. Software sets a bit to 0 in this register by writing a 1 to it.

| Bit | Name | Type | Default value | Description |
|---------|-------------|------|---------------|---|
| [31:16] | Reserved | RO | 16'h0 | - |
| 15 | ASCH_STS | RO | 1'b0 | Asynchronous Schedule Status This bit reports the actual status of the asynchronous schedule. |
| 14 | PSCH_STS | RO | 1'b0 | Periodic Schedule Status This bit reports the actual status of the periodic schedule. |
| 13 | Reclamation | RO | 1'b0 | Reclamation This is a read-only status bit, and used to detect an empty of the asynchronous schedule. |
| 12 | HCHalted | RO | 1'b1 | Host Controller Halted This bit is a zero whenever the Run/Stop bit is set to '1.' The host controller sets this bit to '1' after it has stopped the executing as a result of the Run/Stop bit being set to 0b. |
| [11:6] | Reserved | RO | 6'b0 | - |
| 5 | INT_OAA | R/WC | 1'b0 | Interrupt on Asynchronous Advance This status bit indicates the assertion of <i>interrupt on Async Advance Doorbell</i> . |
| 4 | H_SYSERR | R/WC | 1'b0 | Host System Error The Host Controller sets this bit to '1' when a serious error occurred during a host system access involving the host controller module. |
| 3 | FRL_ROL | R/WC | 1'b0 | Frame List Rollover The host controller sets this bit to '1' when the <i>Frame List Index</i> rolls over from its maximum value to zero. |
| 2 | PO_CHG_DET | R/WC | 1'b0 | Port Change Detect The host controller sets this bit to '1' when any port has a change bit transition from '0' to '1.' In addition, this bit is loaded with the OR of all of |

| Bit | Name | Type | Default value | Description |
|-----|------------|------|---------------|--|
| | | | | the PORTSC change bits. |
| 1 | USBERR_INT | R/WC | 1'b0 | USB Error Interrupt The host controller sets this bit to '1' when the completion of a USB transaction results in an error condition. |
| 0 | USB_INT | R/WC | 1'b0 | USB Interrupt The host controller sets this bit to '1' upon the completion of a USB transaction. |

Table 5-6 USB status register

5.2.6 USBINTR register (address = 18h)

This register enables and disables reporting of the corresponding interrupt to the software. When a bit is set and the corresponding interrupt is active, an interrupt is generated to the host. Interrupt sources that are disabled in this register still appear in the USBSTS to allow the software to poll for events.

| Bit | Name | Type | Default value | Description |
|--------|---------------|------|---------------|---|
| [31:6] | Reserved | RO | 26'h0 | - |
| 5 | INT_OAA_EN | R/W | 1'b0 | Interrupt on Async Advance Enable When this bit is set to '1,' and the <i>Interrupt on Async Advance</i> bit in the USBSTS register is set to '1' also, the host controller will issue an interrupt at the next interrupt threshold. |
| 4 | H_SYSERR_EN | R/W | 1'b0 | Host System Error Enable When this bit is set to '1,' and the <i>Host System Error Status</i> bit in the USBSTS register is set to '1' also, the host controller will issue an interrupt. |
| 3 | FRL_ROL_EN | R/W | 1'b0 | Frame List Rollover Enable When this bit is set to '1,' and the <i>Frame List Rollover</i> bit in the USBSTS register is set to '1' also, the host controller will issue an interrupt. |
| 2 | PO_CHG_DET_EN | R/W | 1'b0 | Port Change Interrupt Enable When this bit is set to '1,' and the <i>Port Change Detect</i> bit in the USBSTS register is set to '1' also, the host controller will issue an interrupt. |
| 1 | USBERR_INT_EN | R/W | 1'b0 | USB Error Interrupt Enable When this bit is set to '1,' and the USBERRINT bit in the USBSTS register is set to '1' also, the host controller will issue an interrupt at the next interrupt threshold. |
| 0 | USB_INT_EN | R/W | 1'b0 | USB Interrupt Enable When this bit is set to '1,' and the USBINT bit in the USBSTS register is a set to '1' also, the host controller will issue an interrupt at the next interrupt threshold. If set interrupt threshold to 01h, means that when interrupt event occurred, the INT signal will be toggled at once. |

Table 5-7 USB interrupt enable register

5.2.7 FRINDEX register (address = 1Ch)

This register is used by the host controller to index into the periodic frame. The register updates every 125 microseconds (one each micro-frame).

| Bit | Name | Type | Default value | Description | | | | | | | | | | | | |
|---------|----------|------|---------------|--|-----|--------|----|-----|-------|----|-----|-------|----|-----|----------|--|
| [31:14] | Reserved | RO | 28'h0 | - | | | | | | | | | | | | |
| [13:0] | FRINDEX | R/W | 14'b0 | <p>Frame Index</p> <p>This register is used by the host controller to index the frame into the Periodic Frame List. It updates every 125 microseconds. This register cannot be written unless the host controller is at the halted state.</p> <p>Bits[N:3] are used for Frame List current index. This means that each location of the frame list is accessed 8 times before moving to the next index.</p> <p>USBCMD[Frame List Size] Number Elements N</p> <table border="0"> <tr> <td>00b</td> <td>(1024)</td> <td>12</td> </tr> <tr> <td>01b</td> <td>(512)</td> <td>11</td> </tr> <tr> <td>10b</td> <td>(256)</td> <td>10</td> </tr> <tr> <td>11b</td> <td>Reserved</td> <td></td> </tr> </table> | 00b | (1024) | 12 | 01b | (512) | 11 | 10b | (256) | 10 | 11b | Reserved | |
| 00b | (1024) | 12 | | | | | | | | | | | | | | |
| 01b | (512) | 11 | | | | | | | | | | | | | | |
| 10b | (256) | 10 | | | | | | | | | | | | | | |
| 11b | Reserved | | | | | | | | | | | | | | | |

Table 5-8 Frame index register

5.2.8 PERIODICLISTADDR register (address = 24h)

This 32-bit register contains the beginning address of the periodic frame list in the system memory.

| Bit | Name | Type | Default value | Description |
|---------|--------------|------|---------------|--|
| [31:12] | PERI_BASEADR | R/W | 20'h0 | <p>Periodic Frame List Base Address</p> <p>This 32-bit register contains the beginning address of the Periodic Frame List in the system memory. These bits correspond to the memory address signals[31:12].</p> |
| [11:0] | Reserved | RO | 12'b0 | - |

Table 5-9 Periodic frame list base address register

5.2.9 ASYNCLISTADDR register (address = 28h)

This 32-bit register contains the address of the next asynchronous queue head to be executed.

| Bit | Name | Type | Default value | Description |
|--------|------------|------|---------------|--|
| [31:5] | ASYNC_LADR | R/W | 27'h0 | <p>Current Asynchronous List Address</p> <p>This 32-bit register contains the address of the next asynchronous queue head to be executed. These bits correspond to the memory address signals [31:5].</p> |
| [4:0] | Reserved | RO | 5'b0 | - |

Table 5-10 Current asynchronous list address register

5.2.10 POSTSC register (address = 30h)

The port status and control register is in the power well. It is only reset by hardware when the power is initially applied or in response to a host controller reset. The initial conditions of a port are:

- No peripheral connected
- Port disable

The software must not attempt to change the state of the port until the power is stable on the port. The host is required to have power stable to the port within 20 milliseconds of the zero to one transition.

When a peripheral device is attached, the port state transitions to the connected state and system software will process this as with any status change notification.

| Bit | Name | Type | Default value | Description |
|---------|-------------|------|---------------|--|
| [31:17] | Reserved | RO | 15'h0 | - |
| 16 | TST_FORCEEN | R/W | 1'b0 | Test Force Enable When this signal is written as '1,' the downstream facing port will be enabled in the high-speed mode. Then the Run/Stop bit must be transitioned to one in order to enable the transmission of the SOFs out of the port under test. This enables testing of the disconnect detection. |
| [15:12] | Reserved | RO | 4'b0 | - |
| [11:10] | LINE_STS | RO | 2'b00 | Line Status These bits reflect the current logical levels of the D+ and D- signal lines. Bits[11:10] USB state 00b SE0 10b J-state 01b K-state 11b Undefined |
| 9 | Reserved | RO | 1'b0 | - |
| 8 | PO_RESET | R/W | 1'b0 | Port Reset 1 = Port is in the reset state. 0 = Port is not in the reset state. When the software writes a '1' to this bit, the bus reset sequence as defined in the USB specification will start. Software writes a '0' to this bit to terminate the bus reset sequence. Software must keep this bit at a '1' long enough to ensure the reset sequence. Note: Reset signal which shall be followed by the USB2.0 chapter 7.1.7.5 Reset Signal requirement. If detected HS device, the software shall wait more than 200us for port reset clearing. Before setting this bit, RUN/STOP bit should be set to '0.' |
| 7 | PO_SUSP | R/W | 1'b0 | Port Suspend 1 = Port is in the suspend state 0 = Port is not in the suspend state. |

| Bit | Name | Type | Default value | Description | | | | | | | | |
|----------------------------|------------|------|---------------|---|----------------------------|------------|----|---------|----|--------|----|---------|
| | | | | <p>The Port Enable Bit and Suspend Bit of this register define the port state as follows:</p> <table border="0"> <tr> <td>Bits[Port Enable, Suspend]</td> <td>Port State</td> </tr> <tr> <td>0X</td> <td>Disable</td> </tr> <tr> <td>10</td> <td>Enable</td> </tr> <tr> <td>11</td> <td>Suspend</td> </tr> </table> <p>At the suspend state, the downstream propagation of the data is blocked on this port, except for the port reset. While at the suspend state, the port is sensitive to resume detection. Writing a '0' to this bit is ignored by the host controller. The host controller will unconditionally set this bit to a '0' when:</p> <ul style="list-style-type: none"> The software sets Force Port Resume bit to a '0' (From a one) The software sets Port Reset bit to a '1' (From a '0') <p>Note: Before setting this bit, RUN/STOP bit should be set to 0.</p> | Bits[Port Enable, Suspend] | Port State | 0X | Disable | 10 | Enable | 11 | Suspend |
| Bits[Port Enable, Suspend] | Port State | | | | | | | | | | | |
| 0X | Disable | | | | | | | | | | | |
| 10 | Enable | | | | | | | | | | | |
| 11 | Suspend | | | | | | | | | | | |
| 6 | F_PO_RESM | R/W | 1'b0 | <p>Force Port Resume</p> <p>1 = Resume detected/driven on port. 0 = No resume detected/driven on port.</p> <p>Software sets this bit to a '1' to resume signal. The host controller sets this bit to a '1' if a J-to-K transition is detected while the port is in the suspend state. When this bit transits to a '1' for the detection of a J-to-K transition, the Port Change Detect bit in USBSTS register is also set to a '1'.</p> | | | | | | | | |
| [5:4] | Reserved | RO | 2'b00 | - | | | | | | | | |
| 3 | PO_EN_CHG | R/WC | 1'b0 | <p>Port Enable/Disable Change</p> <p>1 = Port enable/disable status has changed. 0 = No change</p> | | | | | | | | |
| 2 | PO_EN | R/W | 1'b0 | <p>Port Enable/Disable</p> <p>1 = Enable 0 = Disable</p> <p>Ports can only be enabled by the host controller as a part of the reset and enable. Software cannot enable a port by writing a one to this field.</p> | | | | | | | | |
| 1 | CONN_CHG | R/WC | 1'b0 | <p>Connect Status Change</p> <p>1 = Change current connect status 0 = No change.</p> <p>This bit indicates a change has occurred in the current connect status of the port.</p> | | | | | | | | |
| 0 | CONN_STS | RO | 1'b0 | <p>Current Connect Status</p> <p>1 = Device is presented on the port. 0 = No device is presented.</p> | | | | | | | | |

| Bit | Name | Type | Default value | Description |
|-----|------|------|---------------|--|
| | | | | This value reflects the current state of the port, and may not correspond directly to cause the Connect Status Change bit to be set. |

Table 5-11 Port status and control register

5.3 Configuration registers

5.3.1 EOTTIME register (address = 34h)

| Bit | Name | Type | Default value | Description |
|--------|-----------|------|---------------|---|
| [31:7] | Reserved | RO | 25'h0 | - |
| 6 | U_SUSP_N | R/W | 1'b1 | <p>Transceiver Suspend Mode</p> <p>Active low</p> <p>Places the transceiver in the suspend mode that draws the minimal power from the power supplies. This is part of the power management.</p> |
| [5:4] | EOF2_TIME | R/W | 2'b00 | <p>EOF 2 Timing Points</p> <p>Control EOF2 timing point before next SOF.</p> <p>High-Speed EOF2 Time</p> <p>00b 2 clocks (30 MHz) = 66 ns 01b 4 clocks (30 MHz) = 133 ns 10b 8 clocks (30 MHz) = 266 ns 11b 16 clocks (30 MHz) = 533 ns</p> <p>Full-Speed EOF2 Time</p> <p>00b 20 clocks (30 MHz)=8 clocks (12 MHz) = 666 ns 01b 40 clocks (30 MHz)=16 clocks (12 MHz) = 1.333 μs 10b 80 clocks (30 MHz) = 32 clocks (12 MHz) = 2.66 μs 11b 160 clocks (30 MHz) = 64 clocks (12 MHz) = 5.3 μs</p> <p>Low-Speed EOF2 Time</p> <p>00b 40 clocks (30 MHz) = 16 clocks (12 MHz) = 1.33 μs 01b 80 clocks (30 MHz) = 32 clocks (12 MHz) = 2.66 μs 10b 160 clocks (30 MHz) = 64 clocks (12 MHz) = 5.33 μs 11b 320 clocks (30 MHz) = 128 clocks (12 MHz) = 10.66 μs</p> |
| [3:2] | EOF1_TIME | R/W | 2'b00 | <p>EOF 1 Timing Points</p> <p>Controls the EOF1 timing point before next SOF. This value should be adjusted according to the maximum packet size.</p> <p>High-Speed EOF1 Time</p> <p>00b 540 clocks (30 MHz) = 18 μs 01b 360 clocks (30 MHz) = 12 μs 10b 180 clocks (30 MHz) = 6 μs 11b 720 clocks (30 MHz) = 24 μs</p> <p>Full-Speed EOF1 Time</p> <p>00b 1600 clocks (30 MHz) = 640 clocks (12 MHz) = 53.3 μs 01b 1400 clocks (30 MHz) = 560 clocks (12 MHz) = 46.6 μs 10b 1200 clocks (30 MHz) = 480 clocks (12 MHz) = 40 μs 11b 21000 clocks (30 MHz) = 8400 clocks (12 MHz)=700 μs</p> <p>Low-Speed EOF1 Time</p> |

| Bit | Name | Type | Default value | Description |
|-------|---------------|------|---------------|--|
| | | | | 00b 3750 clocks (30 MHz) = 1500 clocks (12 MHz) = 125 μ s 01b 3500 clocks (30 MHz) = 1400 clocks (12 MHz) = 116 μ s 10b 3250 clocks (30 MHz) = 1300 clocks (12 MHz) = 108 μ s 11b 4000 clocks (30 MHz) = 1600 clocks (12 MHz) = 133 μ s |
| [1:0] | ASYN_SCH_SLPT | R/W | 2'b01 | Asynchronous Schedule Sleep Timer Controls the Asynchronous Schedule sleep timer. 00b 5 μ s 01b 10 μ s 10b 15 μ s 11b 20 μ s |

Table 5-12 EOF time and asynchronous schedule sleep timer register

5.3.2 CHIPID register (address = 80h)

This chip ID register contains the chip identification and hardware version numbers.

| Bit | Name | Type | Default value | Description |
|--------|---------|------|---------------|----------------|
| [31:0] | CHIP_ID | RO | 32'h03130001 | Chip ID |

Table 5-13 Chip ID register

5.3.3 HWMODE register (address = 84h)

| Bit | Name | Type | Default value | Description |
|---------|--------------|------|---------------|--|
| [15: 8] | Reserved | RO | 8'b0 | - |
| [7: 6] | HOST_SPD_TYP | RO | 2'b00 | Host Speed Type Indicate the speed type of attached device 2'b10: HS 2'b00: FS 2'b01: LS 2'b11: Reserved |
| 5 | DACK_POL | R/W | 1'b0 | DACK Polarity 0: active LOW 1: active HIGH |
| 4 | DREQ_POL | R/W | 1'b0 | DREQ Polarity 0: active LOW 1: active HIGH |
| 3 | INTF_LOCK | R/W | 1'b0 | Interface Lock 0: Unlock the bus interface 1: Lock the bus interface |

| Bit | Name | Type | Default value | Description |
|-----|----------------|------|---------------|--|
| 2 | INTR_POL | R/W | 1'b0 | Interrupt Polarity 0: active LOW 1: active HIGH |
| 1 | INTR_LEVEL | R/W | 1'b0 | Interrupt Level 0: level trigger 1: Edge triggered. The pulse width depends on the NO_OF_CLK bits in the EDGEINTC register. |
| 0 | GLOBAL_INTR_EN | R/W | 1'b0 | Globe interrupt enable 0: INT assertion disabled. INT will never be asserted, regardless of other settings or INT events. 1: INT assertion enabled. INT will be asserted according to the HCINTEN register, and event setting and occurrence. |

Table 5-14 HW mode register

5.3.4 EDGEINTC register (address = 88h)

| Bit | Name | Type | Default value | Description |
|---------|-----------|------|---------------|--|
| [31:24] | MIN_WIDTH | R/W | 8'b0 | Minimum Interval Indicates the minimum interval between two edge interrupts in uSOFs (1 uSOF = 125us). This is not valid for level interrupts. A count of zero means that an interrupt occurs as when an event occurs. |
| [23:16] | Reserved | RO | 8'b0 | - |
| [15: 0] | NO_OF_CLK | R/W | 16'b1F | Number of clocks Number of clocks that an Edge Interrupt must be kept asserted on the interface. The default INT pulse width is approximately 500ns. (N+1)*60MHz system clock. |

Table 5-15 Edge interrupt control register

5.3.5 SWRESET register (address = 8Ch)

| Bit | Name | Type | Default value | Description |
|---------|-----------|------|---------------|---|
| [15: 8] | Reserved | RO | 8'b0 | - |
| [7: 6] | INTF_MODE | RO | 2'b00 | Interface mode 00b: Reserved 01b: Generic Multiplex mode |

| Bit | Name | Type | Default value | Description |
|-----|----------------|------|---------------|--|
| | | | | 10b: NOR mode 11b: SRAM mode Write to these bits have no effect. |
| 5 | Reserved | RO | 1'b0 | - |
| 4 | DATA_BUS_WIDTH | R/W | 1'b0 | Data bus width 0: Defines a 16-bit data bus width. 1: Sets a 8-bit data bus width. |
| 3 | Reserved | RO | 1'b0 | - |
| 2 | RESET_ATX | R/W | 1'b0 | Reset USB transceiver 0: No reset 1: Enable reset When the software writes a '1' to this bit, the USB PHY reset sequence will start. Automatic clear zero. |
| 1 | RESET_HC | R/W | 1'b0 | Reset host controller 0: No reset 1: Enable reset When the software writes a '1' to this bit, the Host Controller reset sequence will start. Automatic clear zero. |
| 0 | RESET_ALL | R/W | 1'b0 | Reset all system 0: No reset 1: Enable reset When the software writes a '1' to this bit, the whole system reset sequence will start. Automatic clear zero. |

Table 5-16 SW reset register

5.3.6 MEMADDR register (address = 90h)

| Bit | Name | Type | Default value | Description |
|---------|----------------|------|---------------|--|
| [15: 0] | START_ADDR_MEM | R/W | 16'b0 | Start address for memory read / write Internal 24K RAM memory address from 0x0000 to 0x5FFF. Used by PIO and DMA. |

Table 5-17 Memory address register

5.3.7 DATAPORT register (address = 92h)

| Bit | Name | Type | Default value | Description |
|---------|-----------|------|---------------|---|
| [15: 0] | DATA_PORT | R/W | 16'b0 | Data port Read / write data from / to memory must go through this port. Used by PIO and DMA. |

Table 5-18 Data port register

5.3.8 DATASESSION register (address = 94h)

| Bit | Name | Type | Default value | Description |
|---------|----------|------|---------------|---|
| 15 | MEM_RW | R/W | 1'b0 | Memory read or write 0: Write data into memory 1: Read data from memory Used by PIO and DMA |
| [14: 0] | DATA_LEN | R/W | 15'b0 | Data length for memory read or write Preset the data length for memory read/write. The max data length is 24K. Used by PIO and DMA |

Table 5-19 Data session length register

5.3.9 CONFIG register (address = 96h)

| Bit | Name | Type | Default value | Description |
|---------|---------------|------|---------------|--|
| 15 | BCD_MODE_CTRL | R/W | 1'b0 | BCD Mode override control 0: External CPE0 and CPE1 pins configuration take effect. 1: BCD_MODE [1:0] register bits take effect |
| [14:13] | BCD_MODE[1:0] | R/W | 2'b00 | BCD Mode setting 00: SDP Standard downstream port, VBUS current limit ≥ 500mA. 01: DCP |

| Bit | Name | Type | Default value | Description |
|--------|------------|------|---------------|---|
| | | | | Dedicated charging port. USB host not functional on this port, VBUS current limit \leq 1.5A. 10: Reserved 11: CDP Charging downstream port, VBUS current limit \leq 1.5A. |
| 12 | Reserved | - | 1'b1 | - |
| 11 | OSC_EN | R/W | 1'b1 | Oscillator enable 0: Oscillator is not active 1: Oscillator is active |
| 10 | PLL_EN | R/W | 1'b1 | Internal PLL enable 0: PLL is disable 1: PLL is enable |
| 9 | Reserved | - | 1'b1 | - |
| 8 | HC_CLK_EN | R/W | 1'b1 | Host controller clock enable 0: clocks are disabled 1: clocks are enabled |
| 7 | VBUS_OFF | R/W | 1'b1 | VBUS power switch This bit controls the voltage on the VBUS on/off (default is "1") by switch external power switcher. 0: VBUS on, PSW_N signal is active LOW. 1: VBUS off, PSW_N signal is not active. |
| 6 | PORT_OC_EN | R/W | 1'b0 | Port overcurrent enable 0: disable over current detection 1: enable over current detection |
| 5 | BCD_EN | R/W | 1'b1 | BCD module enable 0: disable BCD module 1: enable BCD module |
| 4 | Reserved | RO | 1'b0 | - |
| [3: 2] | BURST_LEN | R/W | 2'b00 | DMA burst length 00: Single DMA burst 01: 4-cycle DMA burst 10: 8-cycle DMA burst 11: 16-cycle DMA burst |
| 1 | ENABLE_DMA | R/W | 1'b0 | Enable DMA 0: terminate DMA |

| Bit | Name | Type | Default value | Description |
|-----|-----------|------|---------------|---|
| | | | | 1: enable DMA |
| 0 | DMA_ABORT | R/W | 1'b0 | DMA abort 0: DMA continuous running 1: DMA abort implement |

Table 5-20 DMA configuration register

5.3.10 AUX_MEMADDR register (address = 98h)

| Bit | Name | Type | Default value | Description |
|---------|--------------------|------|---------------|---|
| [15: 0] | AUX_START_ADDR_MEM | R/W | 16'b0 | Auxiliary start address of memory read / write When memory is occurred by DMA, use auxiliary start address for PIO memory access. |

Table 5-21 AUX Memory address register

5.3.11 AUX_DATAPORT register (address = 9Ah)

| Bit | Name | Type | Default value | Description |
|---------|---------------|------|---------------|--|
| [15: 0] | AUX_DATA_PORT | R/W | 16'b0 | Auxiliary data port When memory is occurred by DMA, use auxiliary data port for PIO memory access. |

Table 5-22 AUX data port register

5.3.12 SLEEPTIMER register (address = 9Ch)

| Bit | Name | Type | Default value | Description |
|---------|-------------|------|---------------|--|
| [15: 0] | SLEEP_TIMER | R/W | 16'b0400 | Sleep timer When host controller detected USB bus has no activity, the sleep timer will be started. When timer reduce to zero, the BUSINACTIVE interrupt will be generated, if the respective enable bit in the HCINTEN register is set. Default sleep timer is approximately 10ms. |

Table 5-23 Sleep timer register

5.4 Interrupt registers

5.4.1 HCINTSTS register (address = A0h)

| Bit | Name | Type | Default value | Description |
|---------|-----------|------|---------------|---|
| [15: 8] | Reserved | RO | 10'b0 | - |
| 7 | WAKEUPINT | R/WC | 1'b0 | Wake up interrupt on device connect or |

| Bit | Name | Type | Default value | Description |
|-----|-------------|------|---------------|--|
| | | | | <p>disconnect</p> <p>Indicates that wake up event is triggered. The INT line will be asserted if the respective enable bit in the HCINTEN register is set.</p> <p>0: No wake up event has occurred on the port when device connects or disconnects.</p> <p>1: Wake up event has occurred on the port when device connects or disconnects.</p> |
| 6 | OCINT | R/WC | 1'b0 | <p>Overcurrent interrupt</p> <p>Indicates that overcurrent event is triggered. The INT line will be asserted if the respective enable bit in the HCINTEN register is set.</p> <p>0: No overcurrent event has occurred.</p> <p>1: Overcurrent event has occurred.</p> |
| 5 | CLKREADY | R/WC | 1'b0 | <p>Clock ready</p> <p>Indicates that internal clock signals are running stable. The INT line will be asserted if the respective enable bit in the HCINTEN register is set.</p> <p>0: No clock ready event has occurred.</p> <p>1: Clock ready event has occurred.</p> |
| 4 | BUSINACTIVE | R/WC | 1'b0 | <p>USB Bus inactive interrupt</p> <p>Indicates that USB bus is inactive. The INT line will be asserted if the respective enable bit in the HCINTEN register is set.</p> <p>0: USB bus is active.</p> <p>1: USB bus is inactive.</p> |
| 3 | REMOTEWKINT | R/WC | 1'b0 | <p>Remote Wake up interrupt</p> <p>Indicates INT was generated when the host controller remote wakeup. The INT line will be asserted if the respective enable bit in the HCINTEN register is set.</p> <p>0: No remote wake up.</p> <p>1: Remote wake up event occurred.</p> |
| 2 | DMAEOTINT | R/WC | 1'b0 | <p>DMA EOT interrupt</p> <p>Indicates the DMA transfer completion. The INT line will be asserted if the respective enable bit in the HCINTEN register is set.</p> <p>0: No DMA transfer is completed.</p> <p>1: DMA transfer is completed.</p> |
| 1 | SOFINT | R/WC | 1'b0 | <p>SOF interrupt</p> <p>The INT line will be asserted if the respective bit enable is set.</p> |

| Bit | Name | Type | Default value | Description |
|-----|---------|------|---------------|--|
| | | | | 0: No SOF event has occurred. 1: SOF event has occurred. |
| 0 | MSOFINT | R/WC | 1'b0 | uSOF interrupt The INT line will be asserted if the respective enable bit in the HCINTEN register is set. 0: No uSOF event has occurred. 1: uSOF event has occurred. |

Table 5-24 HC interrupt status register

5.4.2 HCINTEN register (address = A4h)

| Bit | Name | Type | Default value | Description |
|---------|----------------|------|---------------|--|
| [15: 8] | Reserved | RO | 10'b0 | - |
| 7 | WAKEUPINT_EN | R/W | 1'b0 | Wake up interrupt enable on device connect or disconnect Control the INT generation when the device connects or disconnects as wake up events. 0: No INT will be generated when device connects or disconnects as wake up events. 1: INT will be asserted when device connects or disconnects as wake up events. |
| 6 | OCINT_EN | R/W | 1'b0 | Overcurrent interrupt enable Control the INT generation when the overcurrent event triggers 0: No INT will be generated after overcurrent event is triggered. 1: INT will be asserted after overcurrent event is triggered. |
| 5 | CLKREADY_EN | R/W | 1'b0 | Clock ready enable Control the INT generation when the internal clock signals are running stable 0: No INT will be generated after clock runs stable. 1: INT will be asserted after clock runs stable. |
| 4 | BUSINACTIVE_EN | R/W | 1'b0 | USB Bus inactive enable Control the INT generation when the USB bus is inactive 0: No INT will be generated when the USB bus is inactive. 1: INT will be asserted when the USB bus is inactive. |
| 3 | | R/W | 1'b0 | Remote wake up interrupt enable |

| Bit | Name | Type | Default value | Description |
|-----|----------------|------|---------------|--|
| | REMOTEWKINT_EN | | | Control the INT generation when the host controller supports remote wake up 0: No INT will be generated when remote wake up occurred. 1: INT will be asserted when remote wake up occurred. |
| 2 | DMAEOTINT_EN | R/W | 1'b0 | DMA EOT interrupt enable Control assertion of INT on the DMA transfer completion 0: No INT will be generated when a DMA transfer is completed. 1: INT will be asserted when a DMA transfer is completed. |
| 1 | SOFINT_EN | R/W | 1'b0 | SOF interrupt enable Control the INT generation at every SOF occurrence 0: No INT will be generated on SOF. 1: INT will be asserted at every SOF. |
| 0 | MSOFINT_EN | R/W | 1'b0 | uSOF interrupt enable Control the INT generation at every uSOF occurrence 0: No INT will be generated on uSOF. 1: INT will be asserted at every uSOF. |

Table 5-25 HC interrupt status register

5.5 USB testing registers

5.5.1 TESTMODE register (address = 50h)

This register allows the firmware to set the DP and DM pins to predetermined states for testing purposes. Once force one test mode on host, must use test device on port connection.

Note: Only one bit can be set to logic 1 at a time. After writing to this register, need add 150ns delay before writing this register again. The registers 70h and 74h both have same operation.

| Bit | Name | Type | Default value | Description |
|--------|------------|------|---------------|--|
| [31:5] | Reserved | RO | 27'b0 | - |
| 4 | TST_LOOPBK | R/W | 1'b0 | Turn on the loop back mode. When this bit is set to '1', the host controller will enter the loop back mode. |
| 3 | Reserved | RO | 1'b0 | - |
| 2 | TST_PKT | R/W | 1'b0 | TEST_PACKET After entering the high speed and writing 1'b1 to this bit, users should command the DMA by the test parameter setting registers (0x70h and 0x74h) to move the packet data defined |

| Bit | Name | Type | Default value | Description |
|-----|----------|------|---------------|--|
| | | | | in the USB2.0 specification from the memory to FIFO. Then, send the packet to the transceiver. |
| 1 | TST_KSTA | R/W | 1'b0 | TEST_K Upon writing a '1,' the D+/D- are set to the high-speed K state. |
| 0 | TST_JSTA | R/W | 1'b0 | TEST_J Upon writing a '1,' the D+/D- are set to the high-speed J state. |

Table 5-26 Test mode register

5.5.2 TESTPMSET1 register (address = 70h)

This parameter setting register is only used by test packet mode.

| Bit | Name | Type | Default value | Description |
|---------|-----------|------|---------------|---|
| [31:25] | Reserved | RO | 7'b0 | - |
| [24: 8] | DMA_LEN | R/W | 11'h000 | DMA Length The total bytes of the DMA controller will move. The maximum length is 1024 - 1 Bytes. |
| [7: 2] | Reserved | RO | 6'b0 | - |
| 1 | DMA_TYPE | R/W | 1'b0 | DMA Type The transfer type of data moving 0: FIFO to Memory 1: Memory to FIFO |
| 0 | DMA_START | R/W | 1'b0 | DMA Start This bit informs the DMA controller to initiate the DMA transfer. |

Table 5-27 Test mode parameter setting 1 register

5.5.3 TESTPMSET2 register (address = 74h)

This parameter setting register is only used by test packet mode.

| Bit | Name | Type | Default value | Description |
|--------|-----------|------|---------------|--|
| [31:0] | DMA_MADDR | R/W | 32'b0 | DMA Memory Address The starting address of memory to request the DMA transfer. |

Table 5-28 Test parameter setting 2 register

6 Devices Characteristics and Ratings

6.1 Absolute Maximum Ratings

The absolute maximum ratings for the FT313H device are as follows. These are in accordance with the Absolute Maximum Rating System (IEC 60134). Exceeding these may cause permanent damage to the device.

| Parameter | Value | Unit |
|--|---|-----------|
| Storage Temperature | -65°C to 150°C | Degrees C |
| Floor Life (Out of Bag) At Factory Ambient (30°C / 60% Relative Humidity) | 168 Hours (IPC/JEDEC J-STD-033A MSL Level 3 Compliant)* | Hours |
| Ambient Temperature (Power Applied) | -40°C to 85°C | Degrees C |
| VCC Supply Voltage | 0 to +5 | V |
| VCC(I/O) Supply Voltage | 0 to +5 | V |
| DC Input Voltage – USBDP and USBDM | -0.5 to +5 | V |
| DC Input Voltage – OC_N (5V tolerant) | -0.5 to +5.5 | V |
| DC Input Voltage – All Other Inputs | -0.5 to +5 | V |

Table 6-1 Absolute Maximum Ratings

* If devices are stored out of the packaging beyond this time limit the devices should be baked before use. The devices should be ramped up to a temperature of +125°C and baked for up to 17 hours.

6.2 DC Characteristics

DC Characteristics (Ambient Temperature = -40°C to +85°C)

| Parameter | Description | Minimum | Typical | Maximum | Units | Conditions |
|------------|---------------------------------|---------|---------|---------|-------|--|
| VCC(I/O) | VCCIO operating supply voltage | 1.62 | 1.8 | 1.98 | V | Normal Operation |
| | | 2.25 | 2.5 | 2.75 | V | |
| | | 2.97 | 3.3 | 3.63 | V | |
| VCC(3V3) | VCC operating supply voltage | 2.97 | 3.3 | 3.63 | V | Normal Operation |
| Icc1 | Idle current | - | 20 | - | mA | Idle |
| Icc2 | Operating current | - | 35 | - | mA | Normal Operation High speed data transfer |
| Icc3 | USB suspend | - | 200 | - | uA | USB suspend |
| VCC(1V2) | Core supply voltage | 1.08 | 1.2 | 1.32 | V | Normal Operation |
| VOOUT(1V2) | Internal 1.2V regulator voltage | - | 1.2 | - | V | Normal Operation |

Table 6-2 Operating Voltage and Current

| Parameter | Description | Minimum | Typical | Maximum | Units | Conditions |
|-----------|---------------------------------------|---------|---------|---------|-------|---------------------|
| Voh | Output Voltage High | 2.4 | 3.3 | - | V | Ioh=8mA |
| Vol | Output Voltage Low | - | - | 0.4 | V | Iol=8mA |
| Vih | Input High Voltage | 2.0 | - | - | V | - |
| Vil | Input Low Voltage | - | - | 0.8 | V | - |
| Vth | Schmitt Hysteresis Voltage | 0.3 | 0.45 | 0.5 | V | - |
| Ipu | Input pull-up current | 25 | 42 | 60 | uA | Vin = 0V |
| Rpu | Input pull-up resistance equivalent | 120K | 78K | 60K | ohm | Vin = 0V |
| Ipd | Input pull-down current | 25 | 42 | 60 | uA | Vin = VCC(I/O) |
| Rpd | Input pull-down resistance equivalent | 120K | 78K | 60K | ohm | Vin = VCC(I/O) |
| Iin | Input leakage current | -10 | ±1 | 10 | uA | Vin = VCC(I/O) or 0 |
| Ioz | Tri-state output leakage current | -10 | ±1 | 10 | uA | - |

Table 6-3 Digital I/O Pin Characteristics (VCC(I/O) = +3.3V, Standard Drive Level)

| Parameter | Description | Minimum | Typical | Maximum | Units | Conditions |
|-----------|---------------------------------------|------------------|---------|-------------|-------|---------------------|
| Voh | Output Voltage High | VCC(I/O) -0.4 | 2.5 | - | V | Ioh=6mA |
| Vol | Output Voltage Low | - | - | 0.4 | V | Iol=6mA |
| Vih | Input High Voltage | 0.7VCC(I/O) | - | - | V | - |
| Vil | Input Low Voltage | - | - | 0.3VCC(I/O) | V | - |
| Vth | Schmitt Hysteresis Voltage | 0.28 | 0.39 | 0.5 | V | - |
| Ipu | Input pull-up current | 14 | 23 | 35 | uA | Vin = 0 |
| Rpu | Input pull-up resistance equivalent | 160K | 108K | 78K | ohm | Vin = 0 |
| Ipd | Input pull-down current | 14 | 23 | 35 | uA | Vin = VCC(I/O) |
| Rpd | Input pull-down resistance equivalent | 160K | 108K | 78K | ohm | Vin = VCC(I/O) |
| Iin | Input leakage current | -10 | ±1 | 10 | uA | Vin = VCC(I/O) or 0 |
| Ioz | Tri-state output leakage current | -10 | ±1 | 10 | uA | - |

Table 6-4 Digital I/O Pin Characteristics (VCC(I/O) = +2.5V, Standard Drive Level)

| Parameter | Description | Minimum | Typical | Maximum | Units | Conditions |
|-----------|---------------------------------------|------------------|---------|-------------|-------|---------------------|
| Voh | Output Voltage High | VCC(I/O) -0.4 | 1.8 | - | V | Ioh=3.6mA |
| Vol | Output Voltage Low | - | - | 0.4 | V | Iol=3.6mA |
| Vih | Input High Voltage | 0.7VCC(I/O) | - | - | V | - |
| Vil | Input Low Voltage | - | - | 0.3VCC(I/O) | V | - |
| Vth | Schmitt Hysteresis Voltage | 0.25 | 0.35 | 0.5 | V | - |
| Ipu | Input pull-up current | 6 | 10 | 15 | uA | Vin = 0 |
| Rpu | Input pull-up resistance equivalent | 270K | 180K | 130K | ohm | Vin = 0 |
| Ipd | Input pull-down current | 6 | 10 | 15 | uA | Vin = VCC(I/O) |
| Rpd | Input pull-down resistance equivalent | 270K | 180K | 130K | ohm | Vin = VCC(I/O) |
| Iin | Input leakage current | -10 | ±1 | 10 | uA | Vin = VCC(I/O) or 0 |
| Ioz | Tri-state output leakage current | -10 | ±1 | 10 | uA | - |

Table 6-5 Digital I/O Pin Characteristics (VCC(I/O) = +1.8V, Standard Drive Level)

| Parameter | Description | Minimum | Typical | Maximum | Units | Conditions |
|--|--|---------|---------|---------|-------|-------------------------------|
| Input level for high speed | | | | | | |
| Vhscm | Voltage of high speed data signal in the common mode | -50 | - | 500 | mV | - |
| Vhssq | High speed squelch detection threshold | - | - | 100 | mV | Squelch is detected |
| | | 150 | - | - | mV | Squelch is not detected |
| Vhdsdc | High speed disconnection detection threshold | 625 | - | - | mV | Disconnection is detected |
| | | - | - | 525 | mV | Disconnection is not detected |
| Output level for high speed | | | | | | |
| Vhsoi | High speed idle output voltage (Differential) | -10 | - | 10 | mV | - |
| Vhsol | High speed low level output voltage (Differential) | -10 | - | 10 | mV | - |
| Vhsoh | High speed high level output voltage (Differential) | -360 | - | 400 | mV | - |
| Vchirpj | Chirp-J output voltage (Differential) | 700 | - | 1100 | mV | - |
| Vchirpk | Chirp-K output voltage (Differential) | -900 | - | -500 | mV | - |
| Input level for full speed and low speed | | | | | | |
| Vdi | Differential input voltage sensitivity | 0.2 | - | - | V | Vdp-Vdm |
| Vcm | Differential common mode voltage | 0.8 | - | 2.5 | V | - |
| Vse | Single ended receiver threshold | 0.8 | - | 2.0 | V | - |
| Output level for full speed and low speed | | | | | | |
| Vol | Low level output voltage | 0 | - | 0.3 | V | - |
| Voh | High level output voltage | 2.8 | - | 3.6 | V | - |
| Resistance | | | | | | |

| Parameter | Description | Minimum | Typical | Maximum | Units | Conditions |
|-----------|-------------------------|---------|---------|---------|-------|--|
| Rdrv | Driver output impedance | 40.5 | 45 | 49.5 | ohm | Equivalent resistance used as an internal chip |

Table 6-6 USB I/O Pin (USBDP, USBDM) Characteristics

| Parameter | Description | Minimum | Typical | Maximum | Units | Conditions |
|-----------|---|--------------|---------|---------|-------|-------------------------------|
| Voh | Output Voltage High | 2.4 | - | - | V | Ioh=2mA~16mA |
| Vol | Output Voltage Low | - | - | 0.4 | V | Iol=2mA~16mA |
| Vih | Input High Voltage | 2.0 | - | - | V | LVTTL |
| Vil | Input Low Voltage | - | - | 0.8 | V | LVTTL |
| Vopu* | Output pull up voltage for 5V tolerant I/Os | VCC(3V3)-0.9 | - | - | V | Ipu = 1uA |
| Iin | Input leakage current | - | ±1 | - | uA | Vin = VCC(3V3) or 0 |
| | | - | ±1 | - | uA | Vin = 5V or 0 |
| Cin | Input capacitor | - | 2.3 | - | pF | VCC(3V3) with 5V tolerant I/O |

Table 6-7 5V Tolerant Pin (PSW_N, OC_N, VBUS) Characteristics

Note*: This parameter is to indicate that the pull up resistor for the 5V tolerant I/Os cannot reach VCC(3V3) DC level even without DC loading current.

6.3 AC Characteristics

AC Characteristics (Ambient Temperature = -40°C to +85°C)

System clock dynamic characteristics:

| Parameter | Value | | | Unit |
|-----------------------|---------|---------|---------|------|
| | Minimum | Typical | Maximum | |
| Crystal oscillator | | | | |
| Clock frequency | - | 12.00 | - | MHz |
| | - | 19.20 | - | |
| | - | 24.00 | - | |
| External clock input | | | | |
| external clock jitter | - | - | 500 | ps |
| clock duty cycle | 45 | 50 | 55 | % |

| | | | | |
|-------------------------------|---|-----|---|---|
| Input voltage on pin X1/CLKIN | - | 3.3 | - | V |
|-------------------------------|---|-----|---|---|

Recommended accuracy of the clock frequency is 50ppm for the crystal.

Table 6-8 System clock characteristics

Analog I/O pins (DP/DM) dynamic characteristics:

| Parameter | Description | Minimum | Typical | Maximum | Units | Conditions |
|---|--------------------------------------|---------|---------|---------|-------|---|
| Driver characteristic for high speed | | | | | | |
| Thsr | High speed differential rise time | 500 | - | - | ps | - |
| Thsf | High speed differential fall time | 500 | - | - | ps | - |
| Driver characteristic for full speed | | | | | | |
| Tfr | Rise time of DP/DM | 4 | - | 20 | ns | Cl=50pF 10%~90% of Voh-Vol |
| Tff | Fall time of DP/DM | 4 | - | 20 | ns | Cl=50pF 10%~90% of Voh-Vol |
| Tfrma | Differential rise/fall time matching | 90 | - | 110 | % | The first transition exclude from the idle mode |
| Driver characteristic for low speed | | | | | | |
| Tlr | Rise time of DP/DM | 75 | - | 300 | ns | Cl=200pF~600pF 10%~90% of Voh-Vol |
| Tlf | Fall time of DP/DM | 75 | - | 300 | ns | Cl=200pF~600pF 10%~90% of Voh-Vol |
| Tlrma | Differential rise/fall time matching | 80 | - | 125 | % | The first transition exclude from the idle mode |

Table 6-9 Analog I/O pins characteristics

6.4 Timing

6.4.1 PIO timing

SRAM PIO timing characteristics (Ambient Temperature = -40°C to +85°C)

| Parameter | Description | VCC(I/O)=1.8V | | VCC(I/O)=2.5V | | VCC(I/O)=3.3V | | Unit |
|-----------|---|---------------|-----|---------------|-----|---------------|-----|------|
| | | Min | Max | Min | Max | Min | Max | |
| Tcs | CS_N setup time before WR_N / RD_N low | 0 | - | 0 | - | 0 | - | ns |
| Tch | CS_N hold time after WR_N / RD_N high | 0 | - | 0 | - | 0 | - | ns |
| Tcp | CS_N pulse width for read | 40 | - | 40 | - | 40 | - | ns |
| | CS_N pulse width for write | 40 | - | 40 | - | 40 | - | ns |
| Tasrw | address setup time before WR_N / RD_N low | 0 | - | 0 | - | 0 | - | ns |
| Tahrw | Address Hold Time after WR_N/RD_N LOW | 0 | - | 0 | - | 0 | - | ns |
| Tap | Address Latch Pulse Width | | | | | | | ns |
| Twc | Write Cycle Time | 80 | - | 79 | - | 78.5 | - | ns |
| Twp | WR_N Pulse Width | 40 | - | 40 | - | 40 | - | ns |
| Tdh | RD_N High to Output Hi-Z | 4 | 9 | 4 | 7 | 4 | 6 | ns |
| | WR_N High to Input Hi-Z | 0 | - | 0 | - | 0 | - | ns |
| Tdadvh | DATA Setup Time before DATA Latch | 6 | - | 6 | - | 6 | - | ns |
| Toe | RD_N Low to DATA Output Enable | 8 | - | 7 | - | 6 | - | ns |
| Trp | RD_N Pulse Width | 40 | - | 40 | - | 40 | - | ns |
| Trc | Read Cycle Time | 80 | - | 79.5 | - | 79 | - | ns |

Table 6-10 SRAM PIO timing

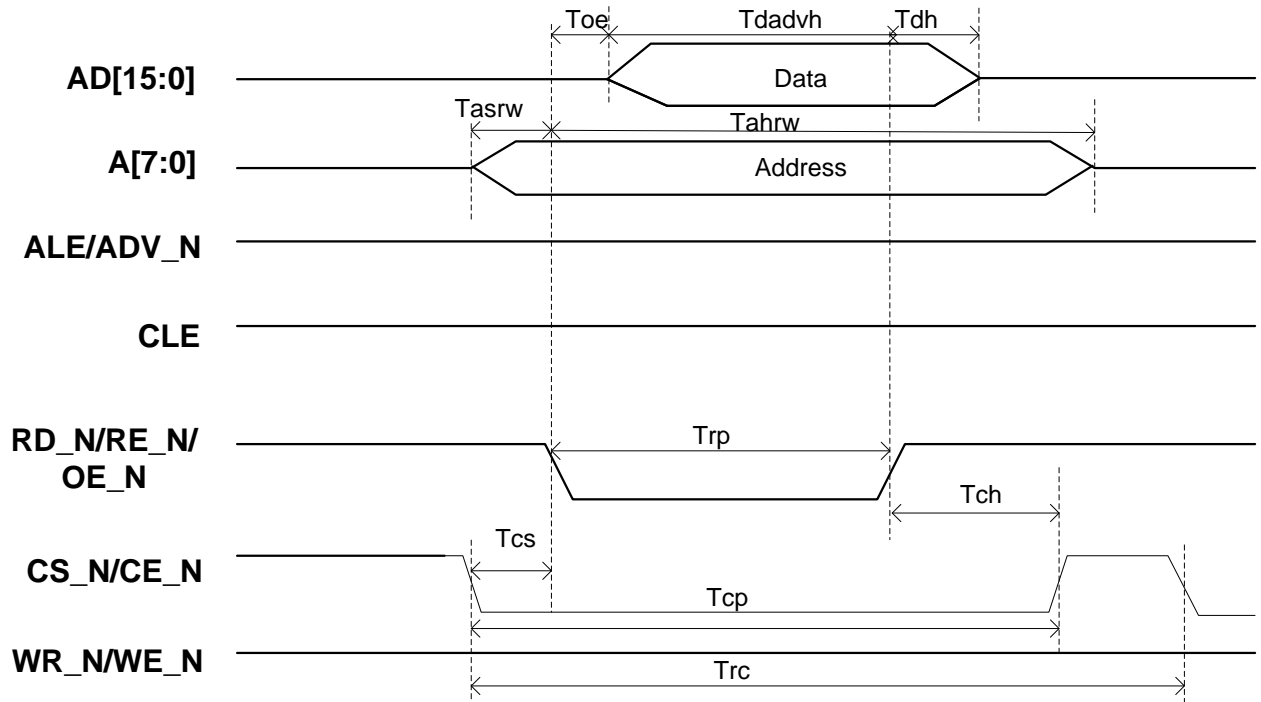


Figure 6-1 Read in SRAM mode

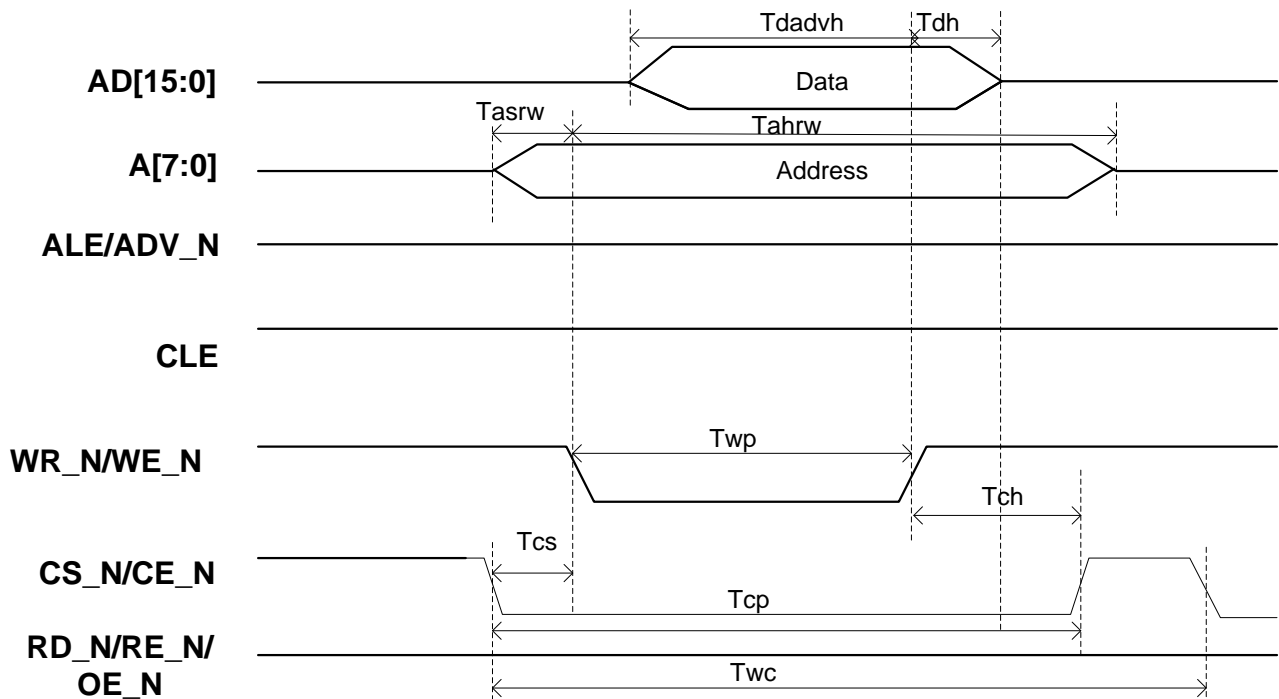


Figure 6-2 Write in SRAM mode

NOR PIO timing characteristics (Ambient Temperature = -40°C to +85°C)

| Parameter | Description | VCC(I/O)=1.8V | | VCC(I/O)=2.5V | | VCC(I/O)=3.3V | | Unit |
|-----------|---|---------------|-----|---------------|-----|---------------|-----|------|
| | | Min | Max | Min | Max | Min | Max | |
| Tch | CS_N hold time after WR_N / RD_N high | 0 | - | 0 | - | 0 | - | ns |
| Tcsdval | CS_N setup time before Address Latch | 6.5 | - | 6.5 | - | 6 | - | ns |
| Tah | Address Hold Time after Address Latch | 0 | - | 0 | - | 0 | - | ns |
| Tas | Address Setup Time before Address Latch | 6 | - | 6 | - | 5 | - | ns |
| Tap | Address Latch Pulse Width | 10 | - | 10 | - | 10 | - | ns |
| Twc | Write Cycle Time | 80 | - | 78.5 | - | 78.5 | - | ns |
| Twp | WR_N Pulse Width | 40 | - | 40 | - | 40 | - | ns |
| Tdh | RD_N High to Output Hi-Z | 4 | 8 | 4 | 7 | 4 | 7 | ns |
| | WR_N High to Input Hi-Z | 0 | - | 0 | - | 0 | - | ns |
| Tdadvh | DATA Setup Time before DATA Latch | 6 | - | 5 | - | 5 | - | ns |
| Toe | RD_N Low to DATA Output Enable | 8 | - | 6 | - | 5 | - | ns |
| Tbds | Ready to WR_N/RD_N Low | 5 | - | 5 | - | 5 | - | ns |
| Trp | RD_N Pulse Width | 40 | - | 40 | - | 40 | - | ns |
| Trc | Read Cycle Time | 80 | - | 79 | - | 79 | - | ns |

Table 6-11 NOR PIO timing

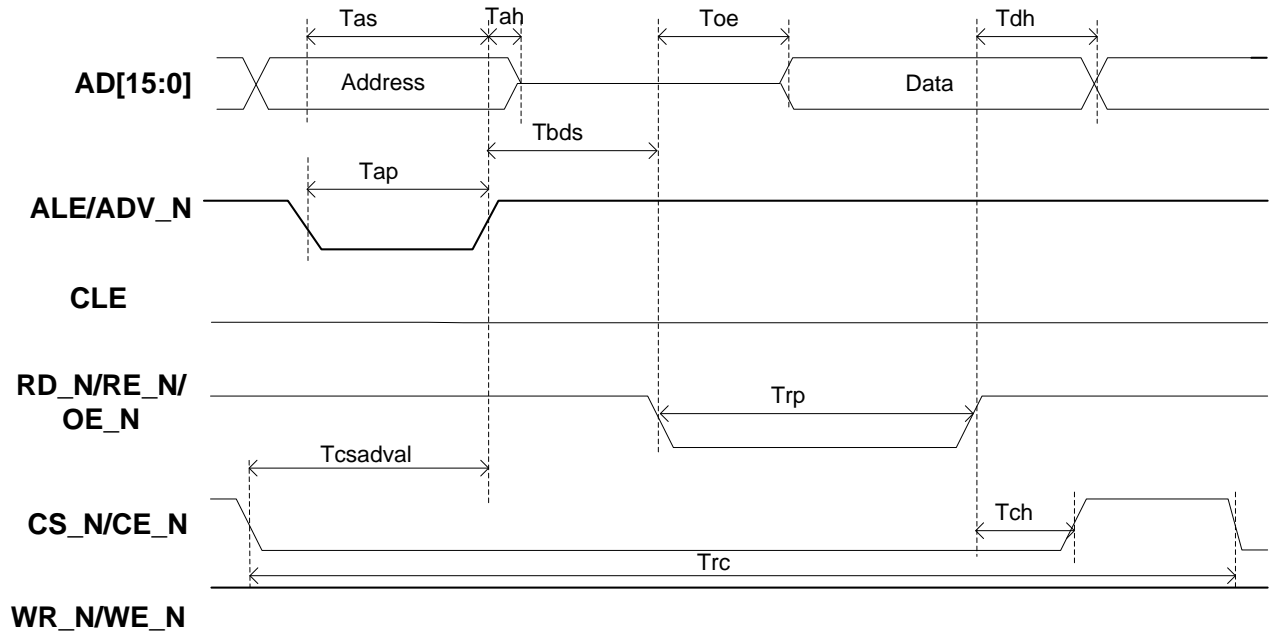


Figure 6-3 Read in NOR mode

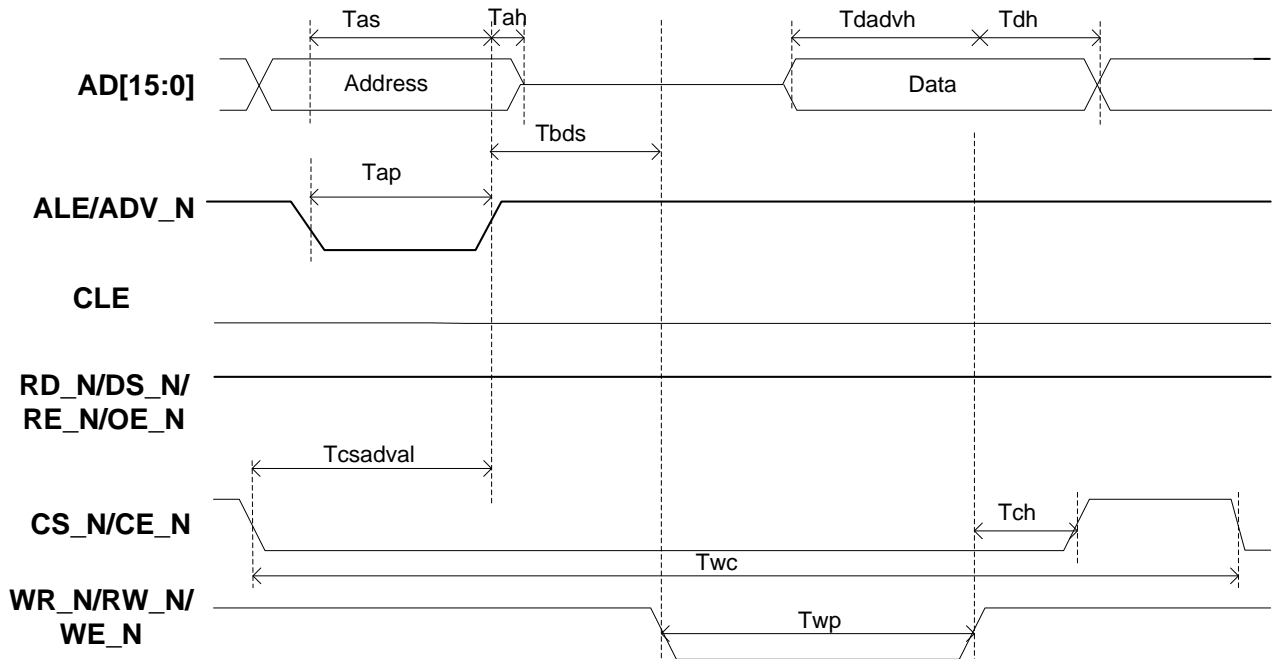


Figure 6-4 Write in NOR mode

General Multiplex PIO timing characteristics (Ambient Temperature = -40°C to +85°C)

| Parameter | Description | VCC(I/O)=1.8V | | VCC(I/O)=2.5V | | VCC(I/O)=3.3V | | Unit |
|-----------|---|---------------|-----|---------------|-----|---------------|-----|------|
| | | Min | Max | Min | Max | Min | Max | |
| Tch | CS_N hold time after WR_N / RD_N high | 0 | - | 0 | - | 0 | - | ns |
| Tcsadval | CS_N setup time before Address Latch | 7.5 | - | 6.5 | - | 6.5 | - | ns |
| Tah | Address Hold Time after Address Latch | 0 | - | 0 | - | 0 | - | ns |
| Tas | Address Setup Time before Address Latch | 7 | - | 6 | - | 6 | - | ns |
| Tap | Address Latch Pulse Width | 10 | - | 10 | - | 10 | - | ns |
| Twc | Write Cycle Time | 80 | - | 78.5 | - | 78.5 | - | ns |
| Twp | WR_N Pulse Width | 40 | - | 40 | - | 40 | - | ns |
| Tdh | RD_N High to Output Hi-Z | 4 | 9 | 4 | 6.5 | 3.5 | 6 | ns |
| | WR_N High to Input Hi-Z | 0 | - | 0 | - | 0 | - | ns |
| Tdadvh | DATA Setup Time before DATA Latch | 6.5 | - | 5 | - | 5 | - | ns |
| Toe | RD_N Low to DATA Output Enable | 8 | - | 6 | - | 5 | - | ns |
| Tbds | Ready to WR_N/RD_N Low | 5 | - | 5 | - | 5 | - | ns |
| Trp | RD_N Pulse Width | 40 | - | 40 | - | 40 | - | ns |
| Trc | Read Cycle Time | 80 | - | 79 | - | 79 | - | ns |

Table 6-12 General Multiplex PIO timing

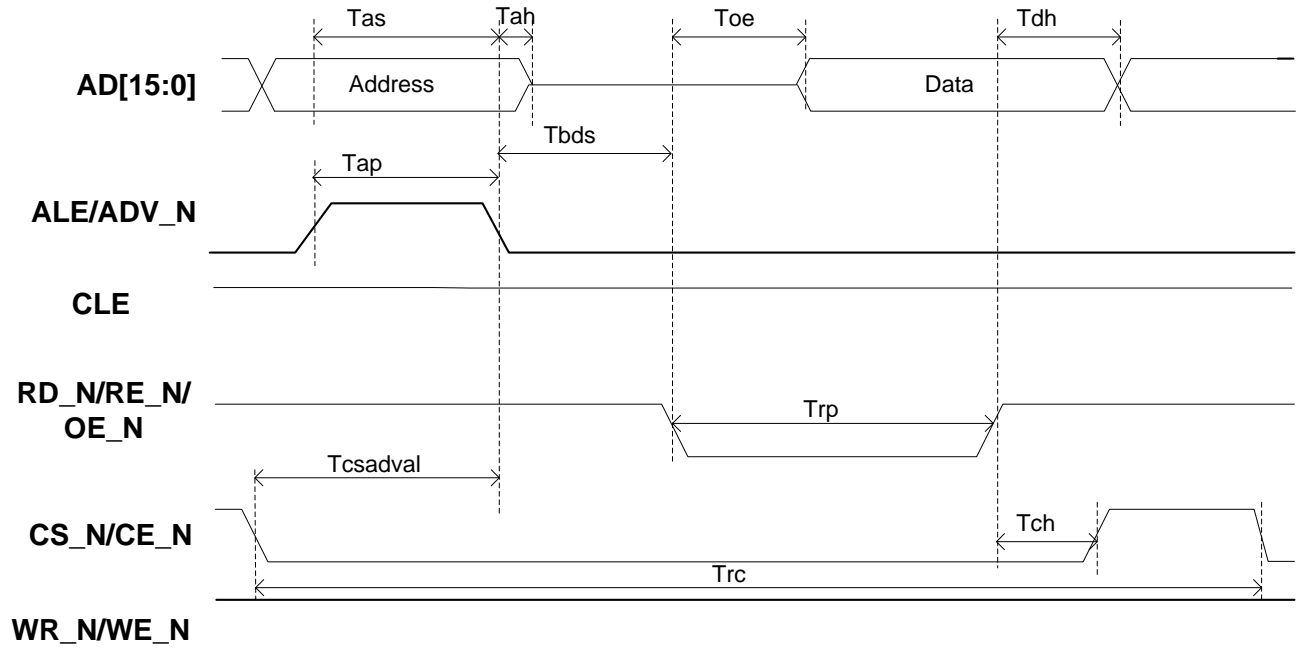


Figure 6-5 Read in General Multiplex mode

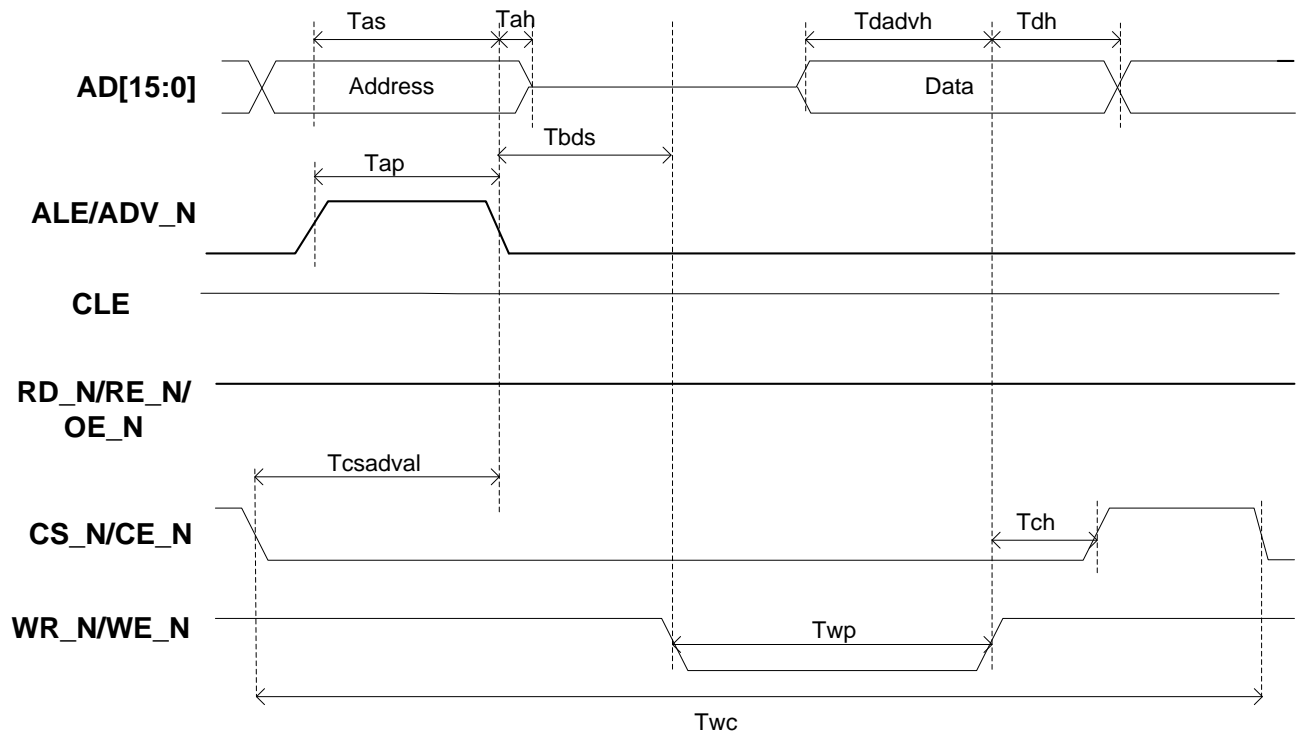


Figure 6-6 Write in General Multiplex mode

6.4.2 DMA timing

DMA timing characteristics (Ambient Temperature = -40°C to +85°C)

| Parameter | Description | Min | Max | Unit |
|-------------------------|---|-----|-----|------|
| $T_{\text{sudreqdack}}$ | DREQ Set-up Time before DACK Assertion | 0 | - | ns |
| $T_{\text{ddackdreq}}$ | DACK De-assertion to Next DREQ Assertion Time | 18 | - | ns |
| $T_{\text{hdreqdack}}$ | DREQ Hold Time after Last Strobe Assertion | - | 35 | ns |
| T_{rwp} | RD_N/WR_N Pulse Width | 40 | - | ns |
| T_{oe} | Data Valid Time after RD_N Assertion | 8 | - | ns |
| T_{rdh} | Read Data Hold Time after RD_N De-asserts | 4 | 9 | ns |
| T_{wdh} | Write Data Hold Time after WR_N De-assertion | 0 | - | ns |
| T_{dadvh} | Write Data Set-up Time before WR_N De-assertion | 6 | - | ns |
| T_{sudackrw} | DACK Set-up Time before RD_N/WR_N Assertion | 0 | - | ns |
| T_{rwdack} | DACK De-assertion after RD_N/WR_N De-assertion | 0 | - | ns |
| T_{cyc} | DMA Read/Write Cycle Time | 80 | - | ns |

Table 6-13 DMA timing

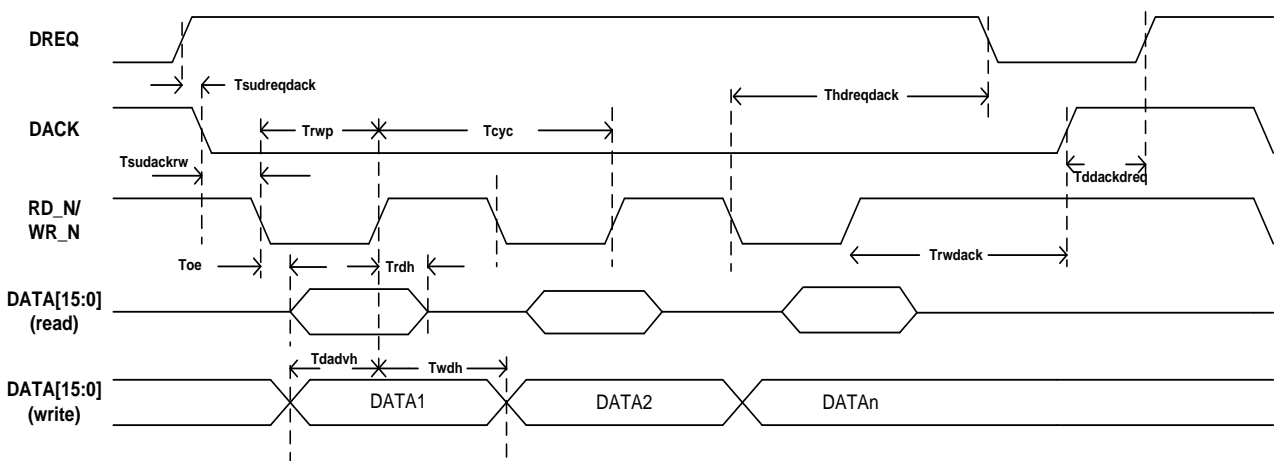
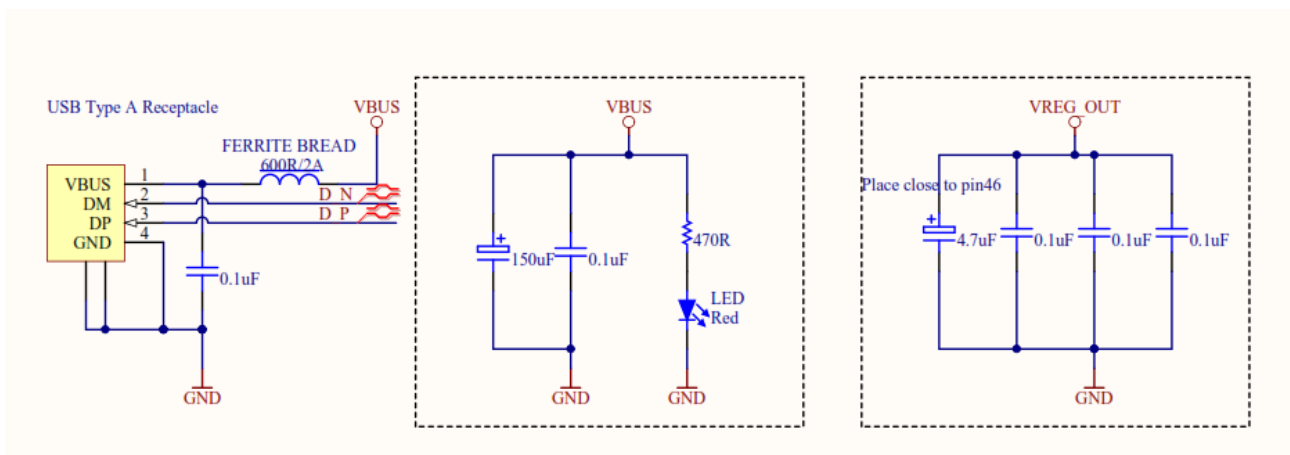
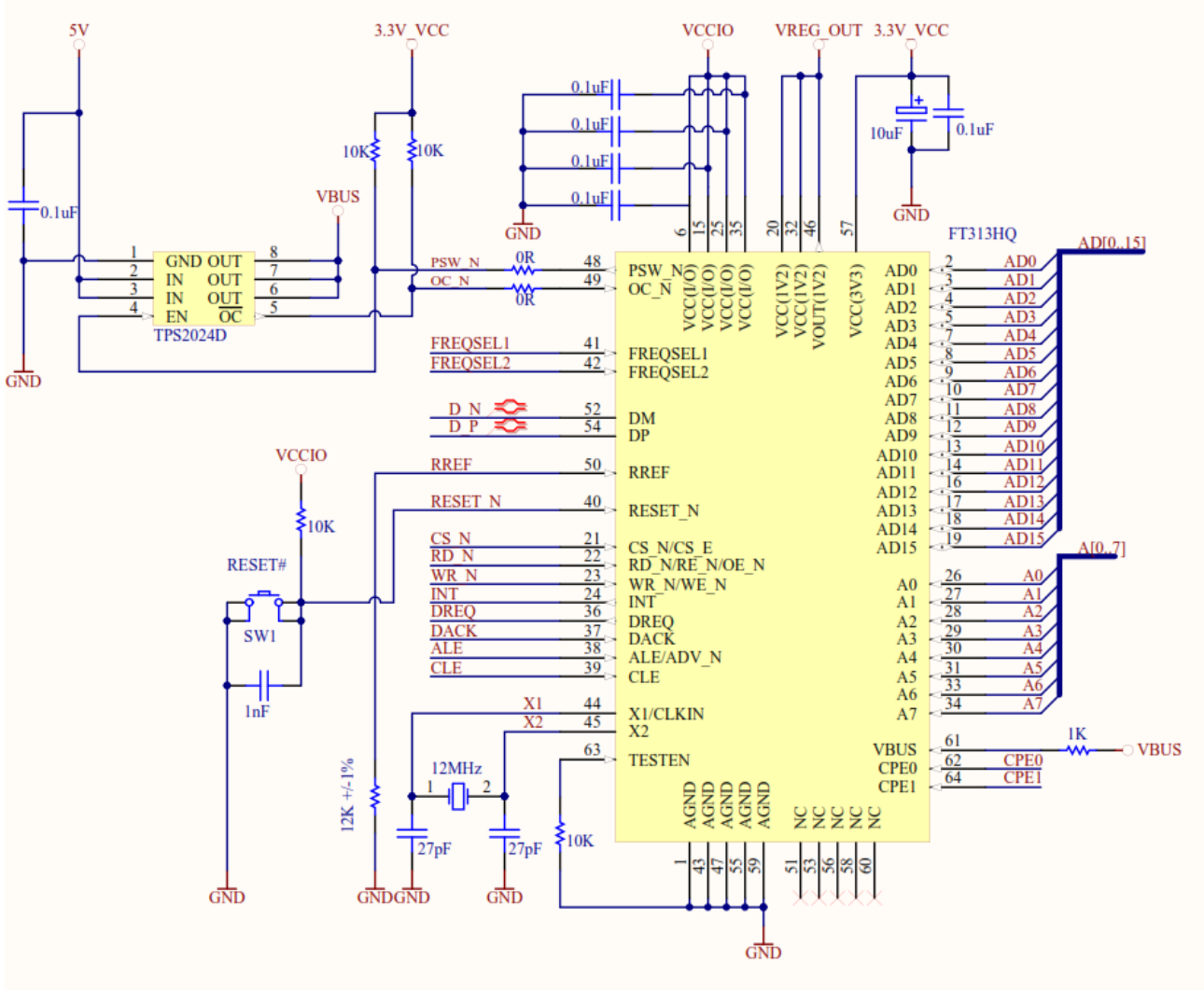
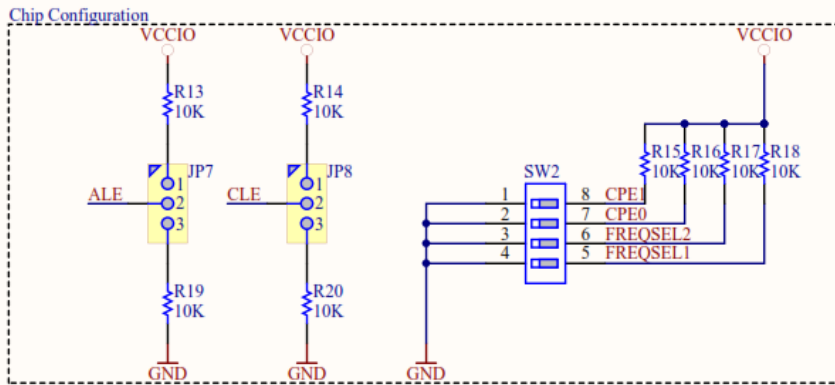


Figure 6-7 DMA read and write

7 Application Examples

FT313H can be configured to communicate with a microcontroller uses 16-bit/8-bit SRAM asynchronous bus interface, NOR interface, and General Multiplex interface. An example schematic is show in Figure 7.1.



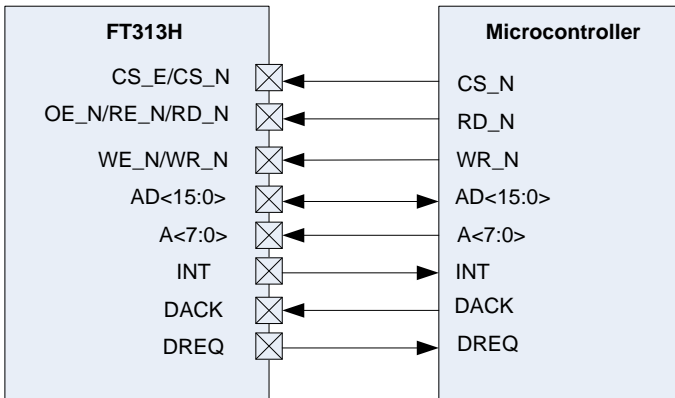


| | | | |
|-----------|-------|-------------------|-------|
| BCD MODE: | SDP | DCP | CDP |
| CPE0: | 0 | 1 | 1 |
| CPE1: | 0 | 0 | 1 |
| BUS IF: | SRAM | General Multiplex | NOR |
| ALE: | 1 | 0 | 1 |
| CLE: | 1 | 1 | 0 |
| CLK FREQ: | 12MHz | 19.2MHz | 24MHz |
| FREQSEL1: | 0 | 1 | 0 |
| FREQSEL2: | 0 | 0 | 1 |

Figure 7-1 FT313H Chip Schematic

7.1 Examples of Bus Interface connection

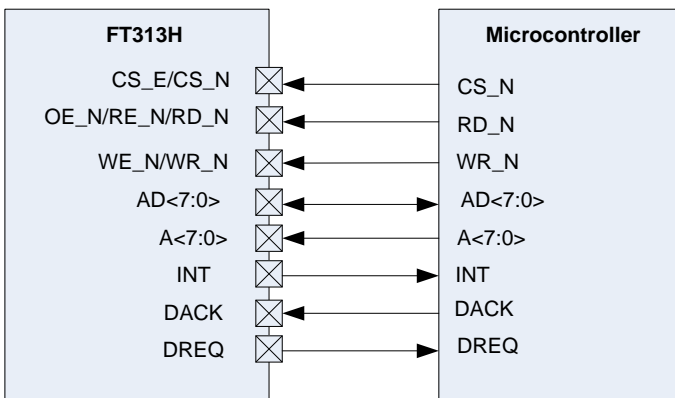
7.1.1 16-Bit SRAM asynchronous bus interface



If DMA transfers are not used the DACK and DREQ signals may be left floating or the DACK signal may be terminated with external 10k ohm pull-down resistor.

If the microcontroller has no AD<0> pin for 16-bit wide devices, the unused AD<0> signal with must be terminated with an external 10k ohm pull-down resistor.

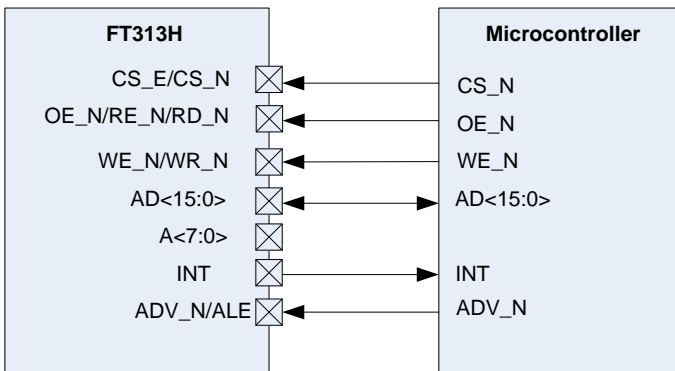
7.1.2 8-Bit SRAM asynchronous bus interface



8-Bit SRAM bus interface doesn't use high AD<15:8> data bus, must terminate AD<15:8> signals with external 10k ohm pull-down resistors.

If DMA transfers are not used the DACK and DREQ signals may be left floating or the DACK signal may be terminated with external 10k ohm pull-down resistor.

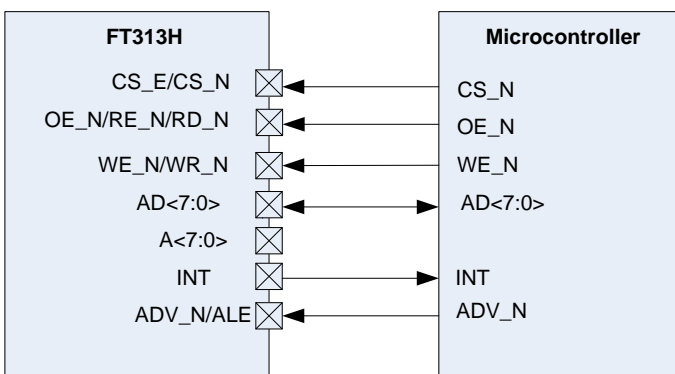
7.1.3 16-Bit NOR asynchronous bus interface



16-Bit NOR uses AD<15:0> signals as address and data bus. Unused A<7:0> address must be terminated with external 10k ohm pull-down resistor.

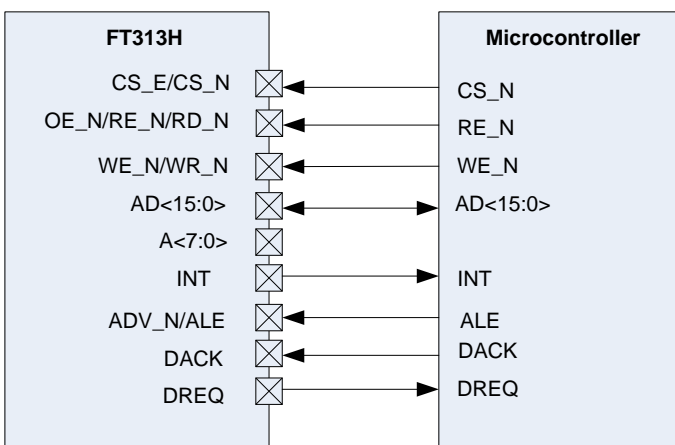
If the microcontroller has no AD<0> pin for 16-bit wide devices, the unused AD<0> signal with must be terminated with an external 10k ohm pull-down resistor.

7.1.4 8-Bit NOR asynchronous bus interface



8-Bit NOR uses AD<7:0> signals as address and data bus. The unused high data bus AD<15:8> and A<7:0> address bus must be terminated with external 10k ohm pull-down resistors.

7.1.5 16-Bit General Multiplex asynchronous bus interface

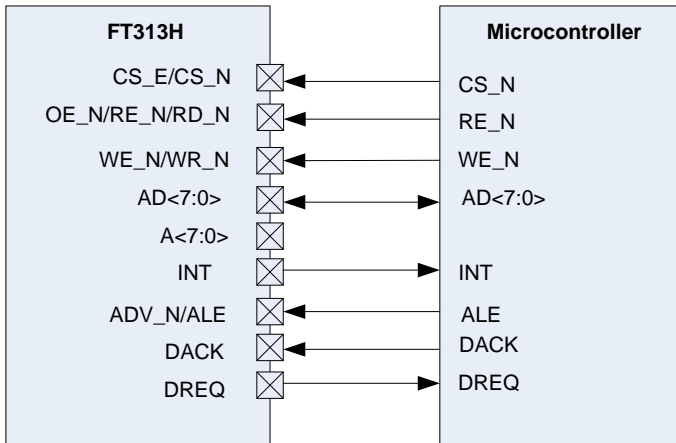


16-Bit General Multiplex uses AD<15:0> signals as address and data bus. Unused A<7:0> address must be terminated with external 10k ohm pull-down resistor.

If the microcontroller has no AD<0> pin for 16-bit wide devices, the unused AD<0> signal with must be terminated with an external 10k ohm pull-down resistor.

If DMA transfers are not used the DACK and DREQ signals may be left floating or the DACK signal may be terminated with external 10k ohm pull-down resistor.

7.1.6 8-Bit General Multiplex asynchronous bus interface



8-Bit General Multiplex uses AD<7:0> signals as address and data bus. The unused high data bus AD<15:8> and A<7:0> address bus must be terminated with external 10k ohm pull-down resistors.

If DMA transfers are not used the DACK and DREQ signals may be left floating or the DACK signal may be terminated with external 10k ohm pull-down resistor.

8 Package Parameters

The FT313H is available in three different packages. The FT313HQ is the QFN-64 package, the FT313HL is the LQFP-64 package and the FT313HP is the TQFP-64 package. The solder reflow profile for all packages is described in following sections.

8.1 FT313H Package Markings

8.1.1 QFN-64

An example of the markings on the QFN package are shown in Figure 8-1. The FTDI part number is too long for the 64 QFN package so in this case the last two digits are wrapped down onto the date code line.

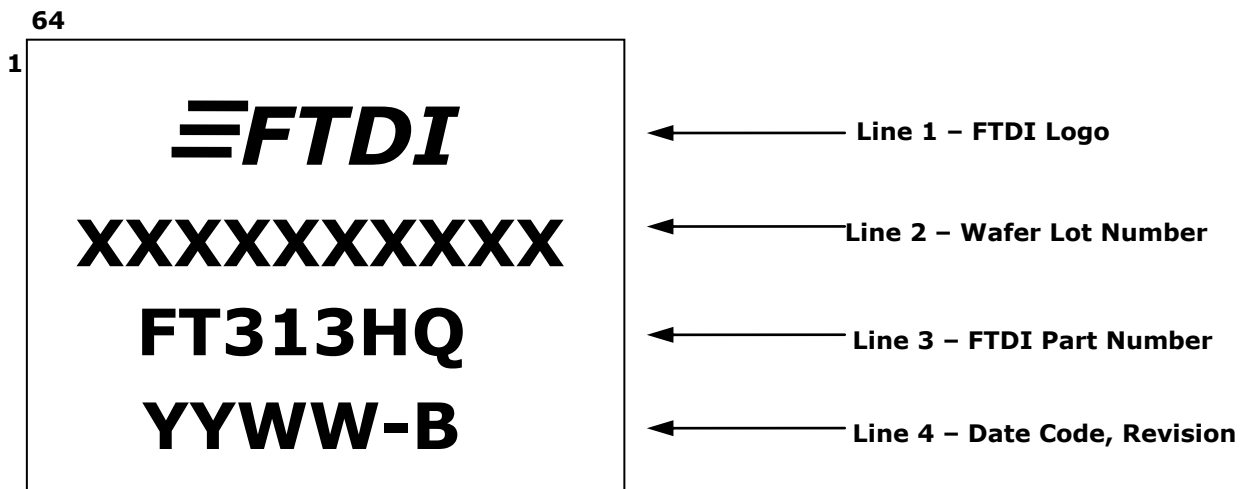


Figure 8-1 QFN Package Markings

Notes:

1. YYWW = Date Code, where YY is year and WW is week number
2. Marking alignment should be centre justified
3. Laser Marking should be used

8.1.2 LQFP-64

An example of the markings on the LQFP package are shown in Figure 8-2.

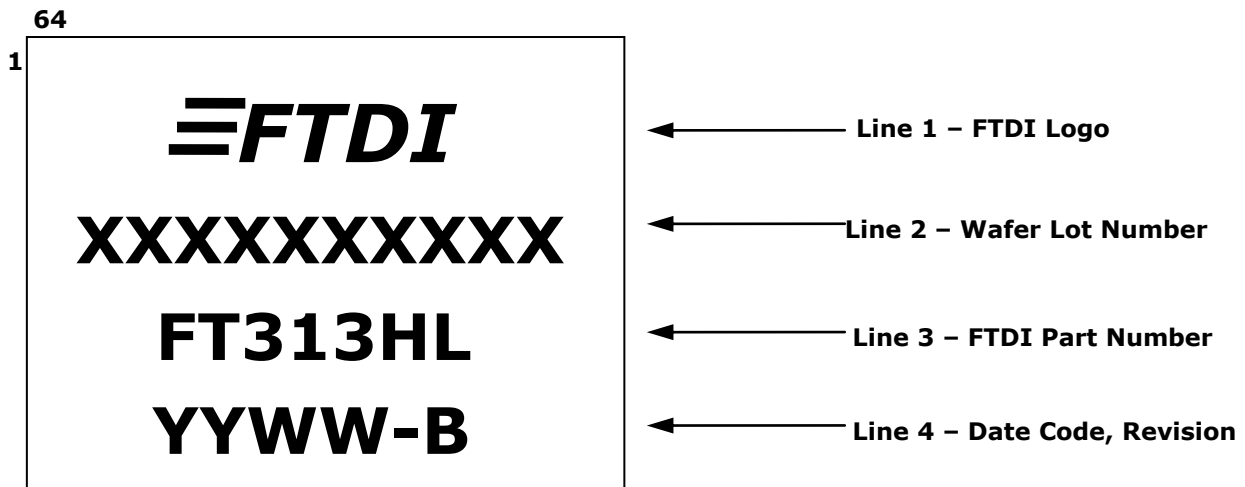


Figure 8-2 LQFP Package Markings

Notes:

1. YYWW = Date Code, where YY is year and WW is week number
2. Marking alignment should be centre justified
3. Laser Marking should be used

8.1.3 TQFP-64

An example of the markings on the TQFP package are shown in **Error! Reference source not found..**

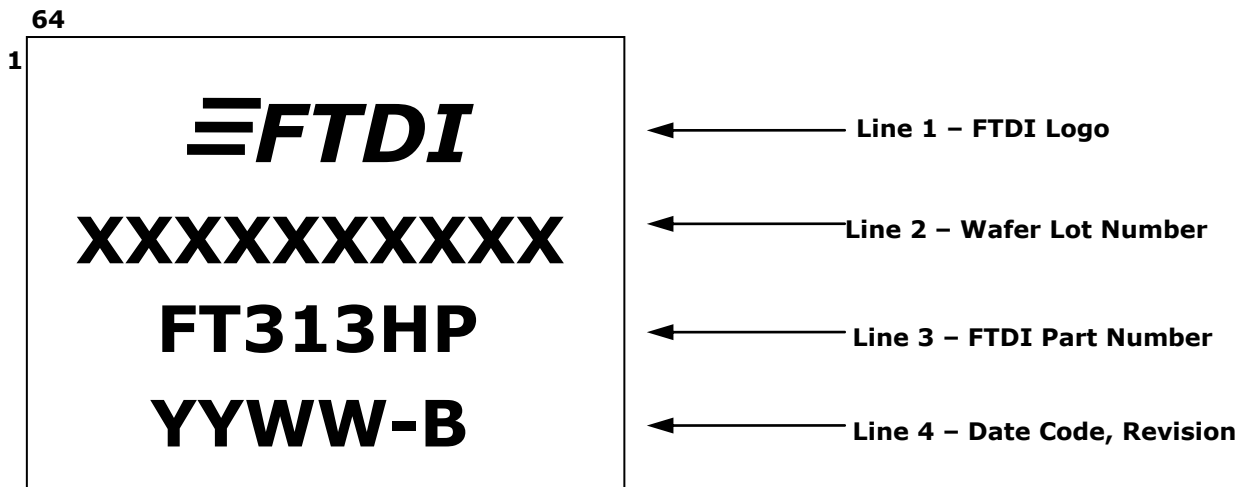


Figure 8-3 TQFP Package Markings

Notes:

1. YYWW = Date Code, where YY is year and WW is week number
2. Marking alignment should be centre justified
3. Laser Marking should be used

8.2 QFN-64 Package Dimensions

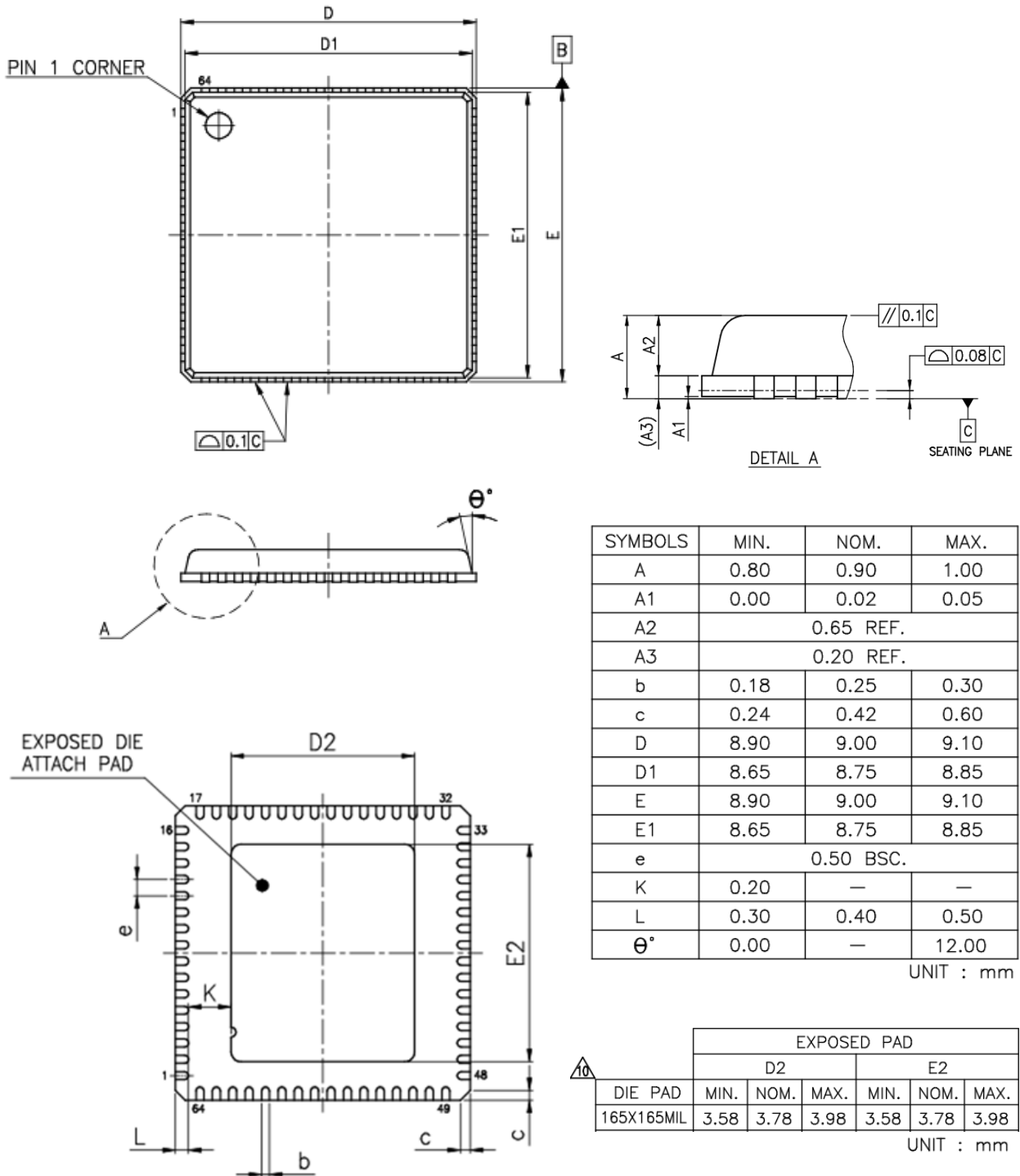
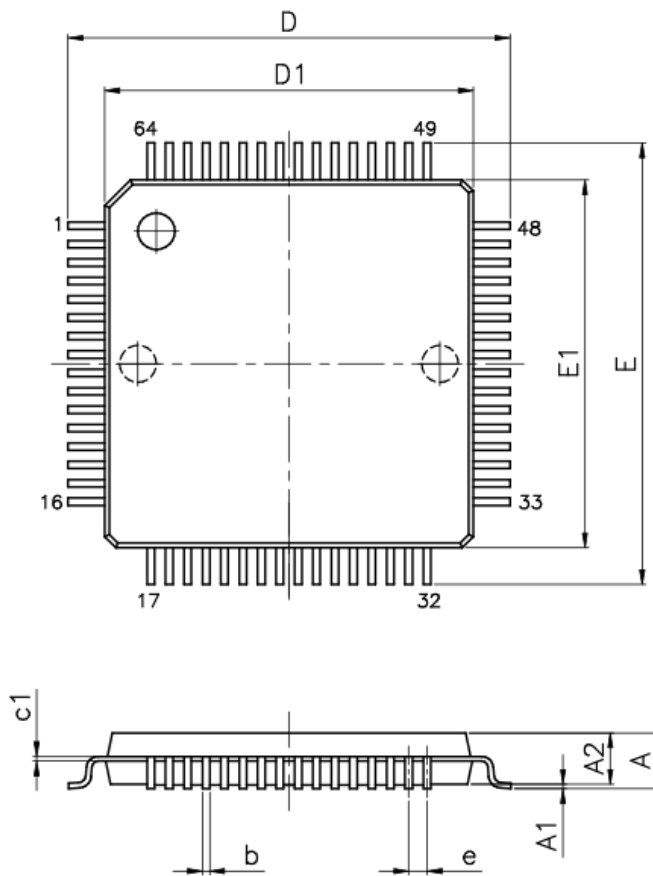


Figure 8-4 QFN-64 Package Markings

8.3 LQFP-64 Package Dimensions



VARIATIONS (ALL DIMENSIONS SHOWN IN MM)

| SYMBOLS | MIN. | NOM. | MAX. |
|------------|----------|-------|-------|
| A | — | — | 1.60 |
| A1 | 0.05 | — | 0.15 |
| A2 | 1.35 | 1.40 | 1.45 |
| b | 0.17 | 0.22 | 0.27 |
| c1 | 0.09 | — | 0.16 |
| D | 11.75 | 12.00 | 12.25 |
| D1 | 9.90 | 10.00 | 10.10 |
| E | 11.75 | 12.00 | 12.25 |
| E1 | 9.90 | 10.00 | 10.10 |
| e | 0.50 BSC | | |
| L | 0.45 | 0.60 | 0.75 |
| L1 | 1.00 REF | | |
| S | 0.20 REF | | |
| θ | 3.5° REF | | |
| θ_1 | 5.0° REF | | |
| θ_2 | 12° REF | | |
| θ_3 | 12° REF | | |
| R1 | 0.16 REF | | |
| R2 | 0.15 REF | | |

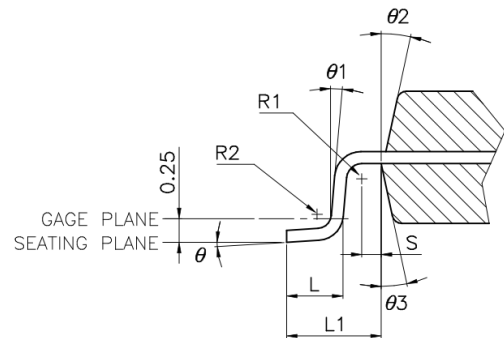
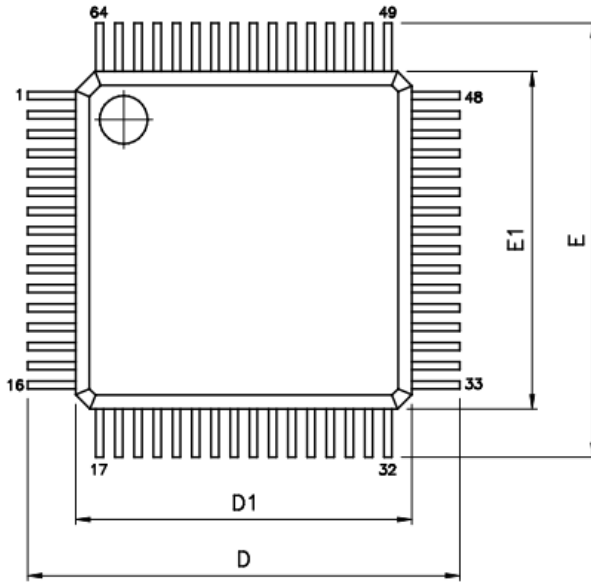


Figure 8-5 LQFP-64 Package Markings

8.4 TQFP-64 Package Dimensions



VARIATIONS (ALL DIMENSIONS SHOWN IN MM)

| SYMBOLS | MIN. | NOM. | MAX. |
|----------|----------|------|------|
| A | -- | -- | 1.20 |
| A1 | 0.05 | -- | 0.15 |
| A2 | 0.95 | 1.00 | 1.05 |
| b | 0.13 | 0.18 | 0.23 |
| c | 0.09 | -- | 0.20 |
| D | 9.00 BSC | | |
| D1 | 7.00 BSC | | |
| E | 9.00 BSC | | |
| E1 | 7.00 BSC | | |
| e | 0.40 BSC | | |
| L | 0.45 | 0.60 | 0.75 |
| L1 | 1.00 REF | | |
| θ | 0° | 3.5° | 7° |

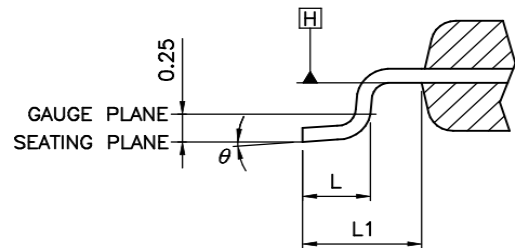
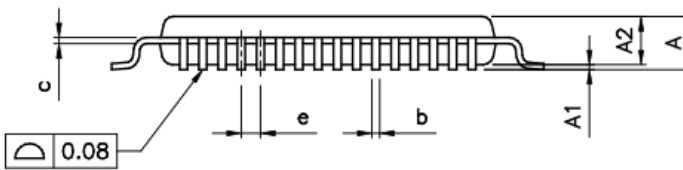


Figure 8-6 TQFP-64 Package Markings

8.5 Solder Reflow Profile

The FT313H is supplied in Pb free QFN-64, LQFP-64 and TQFP-64 packages. The recommended solder reflow profile for all package options is shown in

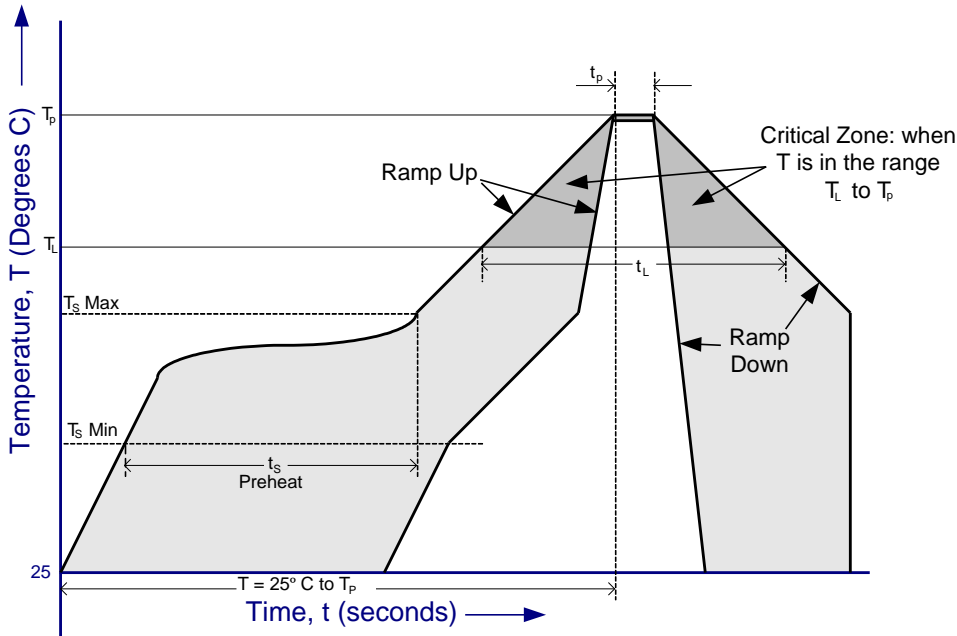


Figure 8-7 FT313H Solder Reflow Profile

The recommended values for the solder reflow profile are detailed in Table 8-1. Values are shown for both a completely Pb free solder process (i.e. the FT313H is used with Pb free solder), and for a non-Pb free solder process (i.e. the FT313H is used with non-Pb free solder).

| Profile Feature | Pb Free Solder Process | Non-Pb Free Solder Process |
|--|-------------------------------------|-------------------------------------|
| Average Ramp Up Rate (T _s to T _p) | 3°C / second Max. | 3°C / Second Max. |
| Preheat - Temperature Min (T _s Min.) - Temperature Max (T _s Max.) - Time (t _s Min to t _s Max) | 150°C 200°C 60 to 120 seconds | 100°C 150°C 60 to 120 seconds |
| Time Maintained Above Critical Temperature T _L : - Temperature (T _L) - Time (t _L) | 217°C 60 to 150 seconds | 183°C 60 to 150 seconds |
| Peak Temperature (T _p) | 260°C | 240°C |
| Time within 5°C of actual Peak Temperature (t _p) | 20 to 40 seconds | 20 to 40 seconds |
| Ramp Down Rate | 6°C / second Max. | 6°C / second Max. |
| Time for T= 25°C to Peak Temperature, T _p | 8 minutes Max. | 6 minutes Max. |

Table 8-1 Reflow Profile Parameter Values

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Appendix A – References

Useful Application Notes

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Appendix C - Revision History

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Компания «ЭлектроПласт» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

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- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



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