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TC358768XBG

Functional Specification

Tentative

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HISTORY

Revision	Date	Note
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Rev 0.23	05/10/2011	Updated - Section 3.2 (Pin Layout) - Section 6 (Package)
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Rev 0.32	09/01/2011	1. Add 32-bit write requirement to MIPI Related Registers 2. Add FIFOStatus Register

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1 Overview

The Parallel Port to MIPI DSI (TC358768XBG) is a bridge device that converts RGB to DSI. All internal registers can be access through I2C or SPI. .

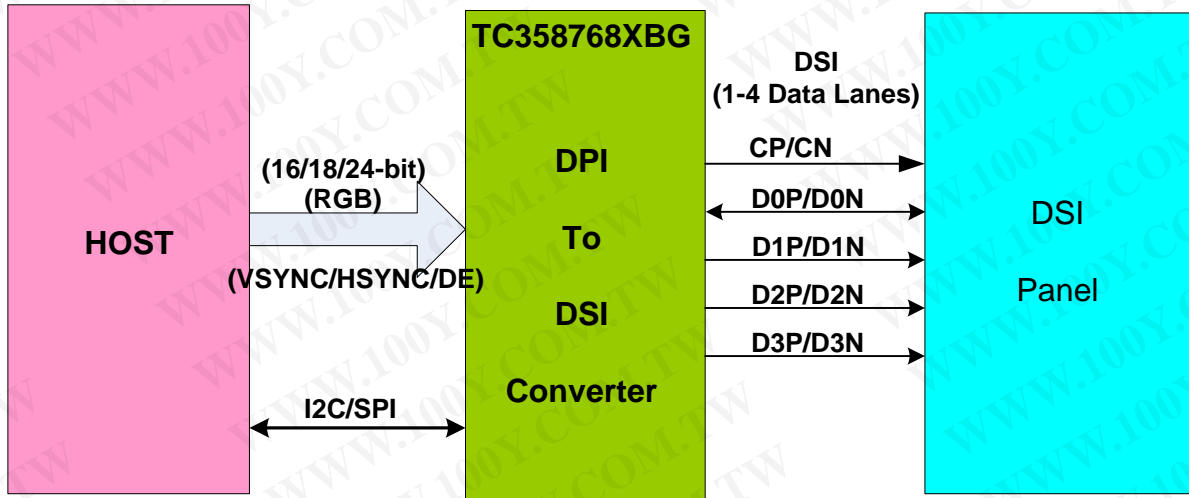


Figure 1-1 System Overview with TC358768XBG in RGB to DSI-TX

2 Features

Below are the main features supported by TC358768XBG.

DSI-TX Interface

- ◇ MIPI DSI compliant (Version 1.02.00 – June 28, 2010)
 - Support DSI Video Mode data transfer
 - DCS Command for panel register access
- ◇ Supports up to 1 Gbps per data lane
- ◇ Supports 1,2,3 or 4 data lanes
- ◇ Supports video data formats
 - RGB888/666/565

RGB Interface

- ◇ Supports data formats
 - 24-bit data bus
 - ◇ RGB888/666/565 data formats
- ◇ Up to 166 MHz input clock
- ◇ Support VSYNC/HSYNC polarity option (default LOW)
- ◇ Support DE polarity option (default High)

I2C/SPI Slave Interface (Option to select either I2C or SPI interface)

- ◇ I2C Interface (when CS=L)
 - Support for normal (100KHz), fast mode (400 KHz) and Special mode (1 MHz)
 - Configure all TC358768XBG internal registers
 - Writing to DCS registers will trigger DCS Command transmits over DSI
- ◇ SPI interface (when CS =H)
 - SPI interface support for up to 25 MHz operation.
 - Configure all TC358768XBG internal registers
 - Writing to DCS registers will trigger DCS Command transmits over DSI

GPIO signals

- ◇ 2 GPIO signals
 - Two GPIO signals can be configured as SPI signals (SPI_SS and SPI_MISO)
 - Or One GPIO signal can be configured as Interrupt output signal (INT).

System

- ◇ Clock and power management support to achieve low power states.

Power supply inputs

- ✧ Core and MIPI D-PHY: 1.2V
- ✧ I/O: 1.8V – 3.3V

Power Consumption

- ✧ 720P @60fps: DPI Clk: 74.25 MHz, DSIClk: 219.6 MHz → 52.4 mW
- ✧ 1080P @60fps: DPI Clk: 148.5 MHz, DSIClk: 471.6 MHz → 91.3 mW

3 External Pins

TC358768XBG resides in BGA72 pin packages. The following table gives the signals of TC358768XBG and their function.

Table 3-1 TC358768XBG Functional Signal List

Group	Pin Name	I/O	Type	Initial	Function	Note
System: Reset & Clock (4)	RESX	I	Sch	-	System reset input, active low	
	REFCLK	I	N	-	Reference clock input (6MHz – 40MHz)	
	MSEL	I	N	-	Mode Select 1'b0: Test mode 1'b1: Normal mode	
	CS	I	N	-	Configuration Select - When CS=L, enable I2C interface - When CS=H, enable SPI interface	
MIPI-DSI (10)	MIPI_CP		PHY		MIPI-DSI clock positive	
	MIPI_CN		PHY		MIPI-DSI clock negative	
	MIPI_D0P		PHY		MIPI-DSI Data 0 positive	
	MIPI_D0N		PHY		MIPI-DSI Data 0 negative	
	MIPI_D1P		PHY		MIPI-DSI Data 1 positive	
	MIPI_D1N		PHY		MIPI-DSI Data 1 negative	
	MIPI_D2P		PHY		MIPI-DSI Data 2 positive	
	MIPI_D2N		PHY		MIPI-DSI Data 2 negative	
	MIPI_D3P		PHY		MIPI-DSI Data 3 positive	
	MIPI_D3N		PHY		MIPI-DSI Data 3 negative	
I2C (2)	I2C_SCL	OD	Sch		I2C serial clock or SPI_SCLK	4mA
	I2C_SDA	OD	Sch		I2C serial data or SPI_MOSI	4mA
Parallel Port (28)	PD[23:0]	I	N		Parallel Port Input Data Note: PD[23:16] can be config to be GPIO[10:3]	
	VSYNC	I	N		Parallel port VSYNC signal	
	HSYNC	I	N		Parallel port HSYNC signal	
	DE	I	N		Parallel Port DE signal	
	PCLK	I	N		Parallel Port Clock signal	
GPIOx (2)	GPIO[2:1]	I/O	N		GPIO[2:1] signals - (GPIO[1] option to become SPI_SS or INT signal) - (GPIO[2] option to become SPI_MISO signal)	4mA
POWER (9)	VDDC (1.2V)	NA			VDD for Internal Core (3)	
	VDDIO (1.8V – 3.3V)	NA			VDDIO is for IO power supply (4)	
	VDD_MIPI (1.2V)	NA			VDD for the MIPI (2)	
Ground (17)	VSS	NA			Ground	

3.1 TC358768XBG BGA72 Pin Count Summary

Table 3-2 BGA72 Pin Count Summary

Group Name	Pin Count	Notes
SYSTEM	4	
DSI IF	10	
I2C	2	
GPIOx	2	
Parallel Port IF	28	
POWER	9	IO, MIPI and Core Power
GROUND	17	
TOTAL	72	

3.2 Pin Layout

A1 VSS	A2 PD17	A3 PD19	A4 PD21	A5 PD23	A6 GPIO2	A7 I2C_SCL	A8 MSEL	A9 VSS
B1 VDDC	B2 PD16	B3 PD18	B4 PD20	B5 PD22	B6 GPIO1	B7 I2C_SDA	B8 RESX	B9 VDDIO
C1 PD15	C2 PD14	C3 VSS	C4 VSS	C5 VSS	C6 VSS	C7 VDD_MIPI	C8 MIPI_D3P	C9 MIPI_D3N
D1 PD13	D2 PD12	D3 VSS				D7 VSS	D8 MIPI_D2P	D9 MIPI_D2N
E1 VSS	E2 VSS	E3 VDDC				E7 VDD_MIPI	E8 MIPI_CP	E9 MIPI_CN
F1 VSS	F2 VSS	F3 VSS				F7 VSS	F8 MIPI_D1P	F9 MIPI_D1N
G1 PD11	G2 PD10	G3 VDDIO	G4 VSS	G5 VSS	G6 VDDIO	G7 VDDIO	G8 MIPI_D0P	G9 MIPI_D0N
H1 VDDC	H2 PD8	H3 PD6	H4 PD4	H5 PD2	H6 PD0	H7 PCLK	H8 DE	H9 CS
J1 VSS	J2 PD9	J3 PD7	J4 PD5	J5 PD3	J6 PD1	J7 REFCLK	J8 VSYNC	J9 HSYNC

Figure 3-1 TC358768XBG 64-Pin Layout

3.3 System Overview

TC358768XBG received the data/controls from RGB then transmits them out to MIPI DSI TX. Host uses I2C/SPI interface to configure all TC358768XBG internal registers.

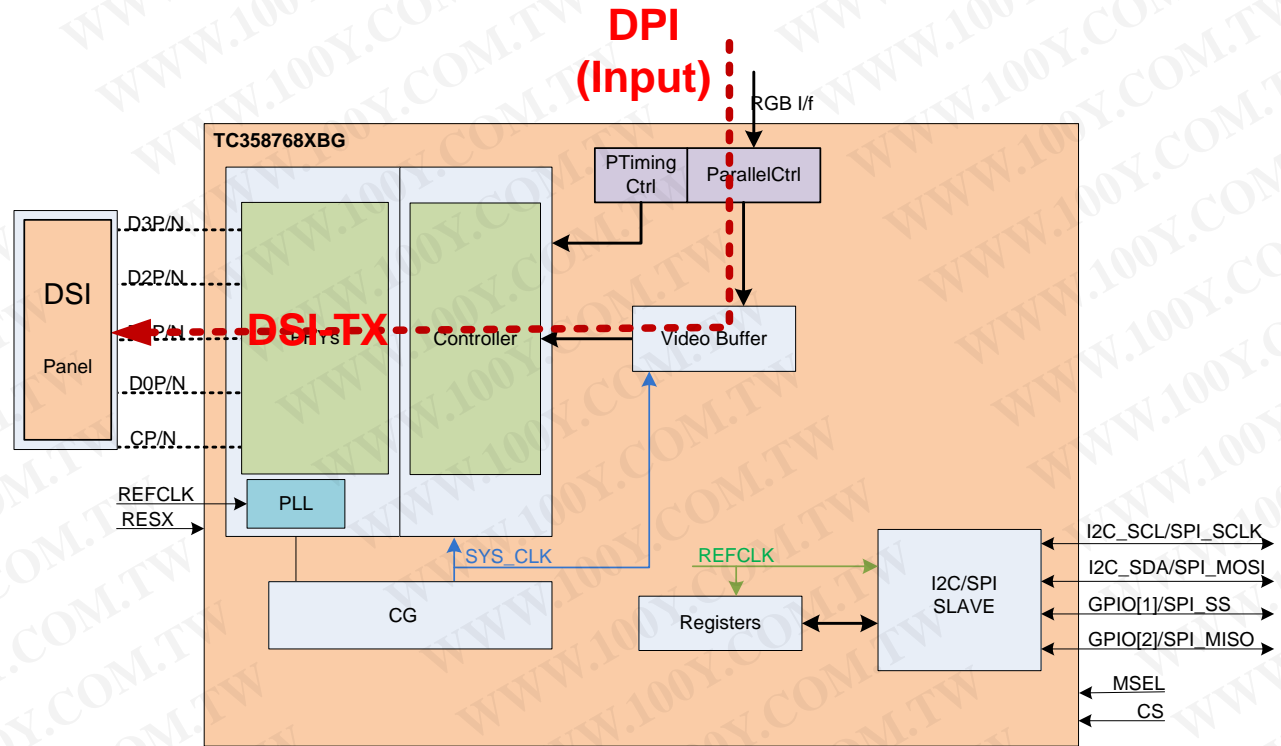


Figure 3-2 TC358768XBG Data/Controls Flow in RGB to DSI-TX

3.4 DSI TX Protocol

Table below shows all the data types that supported in TC358768XBG.

Table 3-3 Supports Data Types

Data Type	Description	Packet Size
0x01	Sync Event, V Sync Start	Short
0x11	Sync Event, V Sync End	Short
0x21	Sync Event, H Sync Start	Short
0x31	Sync Event, H Sync End	Short
0x08	End of Transmission packet (EoTp)	Short
0x02	Color Mode (CM) Off Command	Short
0x12	Color Mode (CM) On Command	Short
0x22	Shut Down Peripheral Command	Short
0x32	Turn On Peripheral Command	Short
0x03	Generic Short WRITE, no parameters	Short
0x13	Generic Short WRITE, 1 parameter	Short
0x23	Generic Short WRITE, 2 parameters	Short
0x04	Generic READ, no parameters	Short
0x14	Generic READ, 1 parameter	Short
0x24	Generic READ, 2 parameters	Short
0x05	DCS Short WRITE, no parameters	Short
0x15	DCS Short WRITE, 1 parameter	Short
0x06	DCS READ, no parameters	Short
0x37	Set Maximum Return Packet Size	Short
0x29	Generic Long Write (Max 8 byte for register access)	Long
0x39	DCS Long Write (Max 8 byte for register access)	Long
0x0E	Packed Pixel Stream, 16-bit RGB, 5-6-5 Format	Long
0x1E	Packed Pixel Stream, 18-bit RGB, 6-6-6 Format	Long
0x2E	Loosely Packed Pixel Stream, 18-bit RGB, 6-6-6 Format	Long
0x3E	Packed Pixel Stream, 24-bit RGB, 8-8-8 Format	Long

3.4.1 Video Mode Transmission

In Video mode, TC358768XBG transmits all video timing events and pixel data in proper sequence and time. Video timing events are transmitted in these DSI short packets: VSYNC Start, VSYNC End, HSYNC Start, and HSYNC End. They are multiplexed with null (or blank) packets (or transitioned to LP idle cycle) and pixel data packets in the DSI serial link such that their reception at the chip will reflect in signal transition on VSYNC and HSYNC at proper timing for the receiving display panel. Pixel data is expected to be transmitted using Pixel Stream packet types (Data Type ID = 0x0E, 0x1E, 0x2E or 0x3E.).

VSYNC Start, VSYNC End, HSYNC Start and HSYNC End are trigger by RGB VSYNC and HSYNC pulse. Refer to Figure 3-6 for more information.

Video Line byte count must be configs into Word Count Register 1 (WordCnt1) before starting transfer video over RGB.

3.4.2 Pixel Format

The chip supports RGB-565, RGB-666 packed or loose, and RGB-888 pixel formats in video data packets.

In video mode transmission, pixel format is differentiated by the data type ID in the header of pixel stream packets received. Data type ID must be configured into DSITX_DT register before starting video transmission.

3.5 DSI TX Video Packet Operation

Below describes the TC358768XBG sequence for transmit out the video data onto DSI TX.

- 1) Configures all registers.
- 2) Enable Parallel Input port.
- 3) Detects VSYNC transition
 - a. If detect VSYNC transition from HIGH to LOW. Transmits VSYNC Start packet.
 - b. Detect HSYNC pulse (generate Hsync Start, Hsync End packets accordingly)
 - c. If detect VSYNC transition from LOW to HIGH. Transmits VSYNC End packet. Go to step "4"
- 4) Detect HSYNC pulse (generate Hsync Start, Hsync End packets accordingly). Once detect DE transition from LOW to HIGH then go to step "5".
- 5) Wait for the Video buffer reaches the programmable "FIFO Level" go to step "6"
- 6) Transmits Video packet (one line) then go to step "7"
- 7) Detects HSYNC pulse (generate Hsync Start, Hsync End packets accordingly). If detect DE transition from LOW to HIGH then go to step "5"
 - a. If detect VSYNC transition from HIGH to LOW. Transmits VSYNC Start packet, go to step "3"

Note: Assume VSYNC/HSYNC are active LOW.

3.6 DSI TX Command Packet Operation

Below describes the TC358768XBG sequence for transmitting out DSI, including DCS, Command over DSI TX. Host can use either I2C or SPI interface to access to TC358768XBG registers.

By programming the following registers, TC358768XBG will generate/transmit DSI command packets. ECC and CRC are generated and attached automatically by the hardware.

- DSICMD_TX (Register 0x0600)
 - Contains DSI Command Packet Start Transmit bit.
- DSICMD_TYPE (Register 0x0602)
 - Contains DSI (short or long) CommandPacket Type
 - Contains DSI Packet Data ID
- DSICMD_WC (Register 0x0604)
 - Contains DSI Command Packet Word Count
- DSICMD_WD0, DSICMD_WD1, DSICMD_WD2, DSICMD_WD3 (0x0610 – 0x0616)
 - Contains DSI Command Packet Data Bytes (total 8 bytes)

3.6.1 TX Short Packet (DCS) Write Command

The relationship/assembly of a short DSI packet respect to the DSICMD_** registers are illustrated in Figure 3-3. The command code, either DCS command or Panel specific command, is stored in Data Byte 0 while Data Byte1 contains either command parameter or “0x00”.

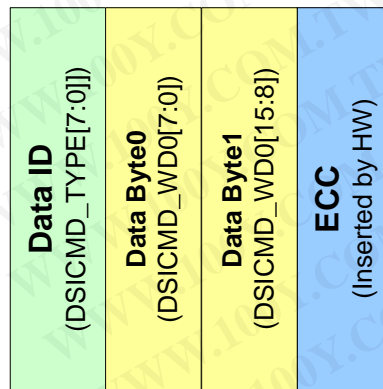


Figure 3-3 DSI Short Command Packet Assembly

The step-by-step procedure is listed below with two examples:

- 1 Set register DSICMD_TYPE[PkType] = 0x10 for DSI short packet.
- 2 Choose desired DCS Short Write Command in register DSICMD_TYPE[DATA_ID] = 0x05 or 0x15 for DCS Command without parameter or with 1 parameter, respectively.
- 3 Be sure to set 0x0000 in DSICMD_WC register.
- 4 Program DCS command code (as specified in MIPI DCS Command Spec in DSICMD_WD0[7:0].

- 5 If DSICMD_TYPE[DATA_ID] = 0x15, set DCS Command Parameter in DSICMD_WD0[15:8]. Otherwise set "0x00" in DSICMD_WD0[15:8].
- 6 Set DSICMD_TX = 0x01 to start DCS Write Short packet.

Example1: TX DCS Short Command: Exit_Sleep_Mode (0x11), no parameter

0x0602 = 0x1005 (Short packet, Data ID = 0x05)
 0x0604 = 0x0000 (WC1,WC0=0 for DSC short write)
 0x0610 = 0x0011 (Data1= 0,DCS Command)
 0x0600 = 0x0001 (Start transfer)

Example2: TX DCS Short Command: Set_Pixel_Format (0x3A), 1 parameter (DPI RGB888)

0x0602 = 0x1015 (Short packet, Data ID = 0x15)
 0x0604 = 0x0000 (WC1,WC0=0 for DSC short write)
 0x0610 = 0x703A (DPI RGB888,DCS Command)
 0x0600 = 0x0001 (Start transfer)

3.6.2 TX Long Packet Write Command

The relationship/assembly of a long DSI packet respect to the DSICMD_** registers are illustrated in Figure 3-4. The command code, either DCS command or Panel specific command, is stored in Data Byte 0 while Data Byte1 to Data 7 contains either command parameters. The maximum word count for DSI Long Command is limited to 8 bytes. For a single byte command code, the maximum parameters length can be 7 bytes.

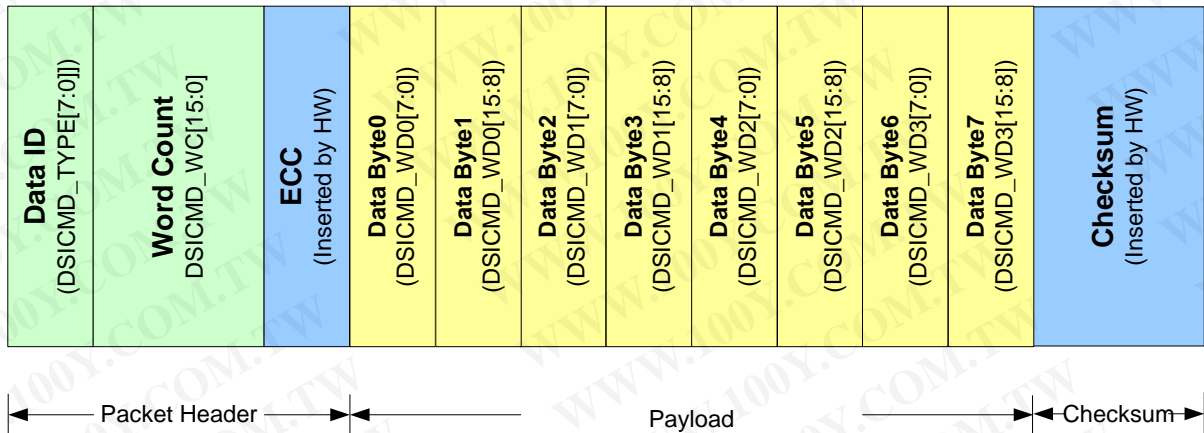


Figure 3-4 DSI Long Command Packet Assembly

The step-by-step procedure is listed below with an examples:

- 1 Set register DSICMD_TYPE[PkType] = 0x40 for DSI long packet.
- 2 Choose desired DSI Long Write Packet/Command, ex, 0x19 for Generate Long Write Packet, in register DSICMD_TYPE[DATA_ID] field.
- 3 Set DSICMD_WC register to the correct word count, number of data bytes in the packet.
- 4 Fill update to 8-bytes of data in registers DSICMD_WD0, 1, 2 & 3 in sequence.
- 5 For DCS Long Write Command, the command code should be set at register DSICMD_WD0[7:0].
- 6 Set DSICMD_TX = 0x01 to start DCS Write Short packet.

Example: TX Generic Long Write Packet with 4 bytes of Data: 0x12, 0x34, 0x56, 0x78

0x0602 = 0x4029	(DSI Long Command/Packet, Data ID = 0x29)
0x0604 = 0x0004	(WC1,WC0)
0x0610 = 0x3412	(Data1,Data0)
0x0612 = 0x7856	(Data3,data2)
0x0600 = 0x0001	(Start transfer)

3.6.3 TX (Short) Packet Read Command

All the DSI Read packet are short packets. After issuing any read command, TC358768 will automatically performs bus turn around and the data returned will be stored in register DSICMD_RDFIFO for Application Processor to read. DSICMD_RDFIFO is a 32 x 8 FIFO, which means TC35768 can accept up to 32 byte of data per DSI Read command. TC35768 is expected to send DSI "Set Maximum Return Packet Size" short packet (Data ID = 0x37) to the DSI Rx to indicate how many bytes it needs to read in the following read command(s). The sequence are:

- 1 Inform DSI Rx the desired bytes to read by sending "Maximum Return Packet Size" short packet

0x0602 = 0x1037	(Short packet, Data ID = 0x37)
0x0604 = 0x0000	(WC1,WC0=0 for Short Packet)
0x0610 = 0x0008	(Read 8-byte of Data, 2 parameters)
0x0600 = 0x0001	(Start transfer)
- 2 Issue a DCS Read Command get_power_mode (0x0A)

0x0602 = 0x1006	(Short packet, Data ID = 0x06, DCS Read, no parameter)
0x0604 = 0x0000	(WC1,WC0=0 for DSC Short Packet)
0x0610 = 0x000A	(Data1, DCS Command)
0x0600 = 0x0001	(Start transfer)
- 3 TC35768 performs Bus Turn Around (BTA) automatically to let DSI Rx to send one byte of data.

- a. The received data will be pushed into DSICMD_RDFIFO (0x0430), where Host can read the data from
- b. Host can monitor registers bit RDFIFO_STATUS[5] when asserted data arrived.
- c. Host needs to track the data which is read into DSICMD_RDFIFO if multiple read commands were issued before it fetch the data.

TC358768 does not extract data out of each LP packets received from DSIRx, a whole packet is stored into DSICMD_RXFIFO, packed into 32-bit boundary as shown in Figure 3-5 below. It is up to the Host to fetch and interpret the data.

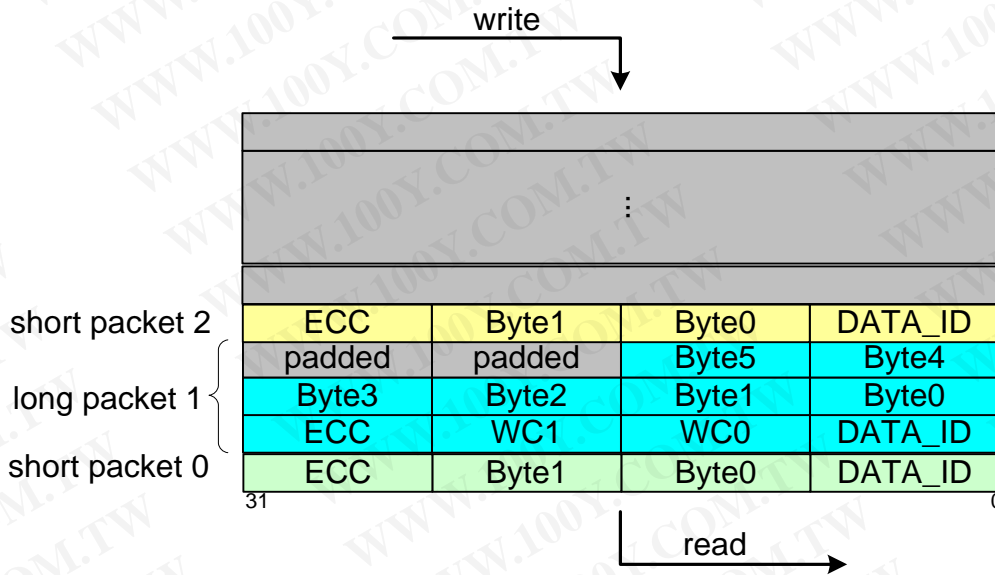


Figure 3-5 DSICMD_RXFIFO Data Arrangement

3.7 Parallel Input (RGB)

3.7.1 Overview

24-bit parallel input interface is capable to transfer various types of data formats (RGB888/666/565). The signal connections for these types are shown in below Table.

Table 3-4 24-bit Unpacked Data bus

Data Type	Mode	Pin Usage	
		PD[23:0]	Comment
RGB888	0	{R[7:0],G[7:0],B[7:0]}	1 pixel/PClk
RGB888	1	{R[1:0]G[1:0],B[1:0],R[7:2],G[7:2],B[7:2]}	1 pixel/PClk
RGB666	0	{2'b0,R[5:0],2'b0,G[5:0],2'b0,B[5:0]}	1 pixel/PClk
RGB666	1	{6'b0,R[5:0],G[5:0],B[5:0]}	1 pixel/PClk
RGB565	0	{2'b0,R[4:0],3'b0,G[5:0],2'b0,B[4:0],1'b0}	1 pixel/PClk
RGB565	1	{3'b0,R[4:0],2'b0,G[5:0],3'b0,B[4:0]}	1 pixel/PClk
RGB565	2	{8'b0,R[4:0],G[5:0],B[4:0]}	1 pixel/PClk

The Parallel Input controller received the video data from external RGB transmitter. It then packed these into 32-bit data format then transfers the packed data into the Video buffer. The 32-bit data format is showed in Table 3-5.

Parallel Input controller is operated with PCLK only. All asynchronous logic is handled inside Video buffer Controller

3.7.2 Timing Diagrams for Video signals (Vsync and Hsync)

Below Figures show the timing relationship between HSYNC, VSYNC, DE and DSI-TX.

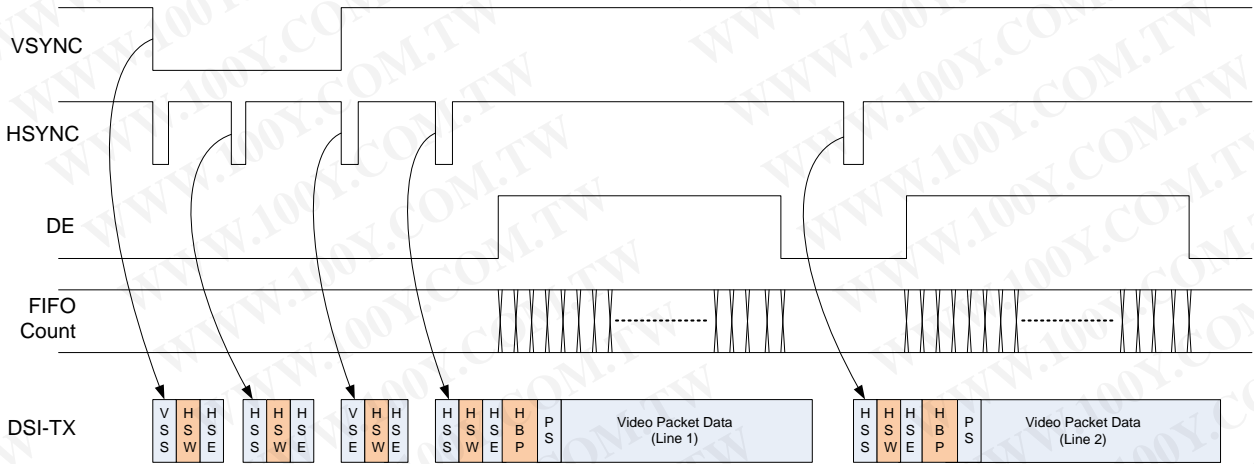


Figure 3-6 VSYNC/HSYNC/DE Timing Diagram – Pulse mode

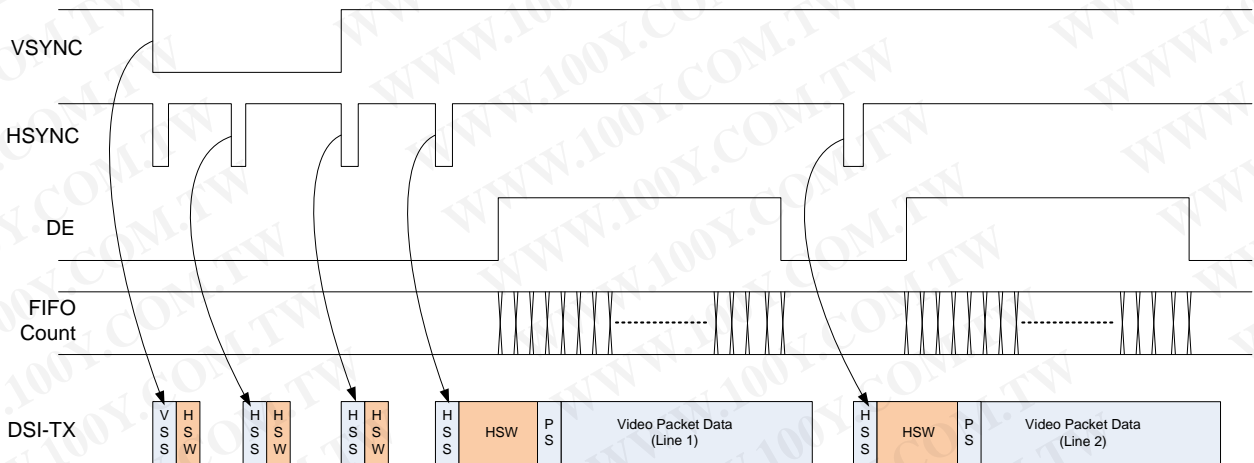


Figure 3-7 VSYNC/HSYNC/DE Timing Diagram – Event mode

3.8 I2C Slave Interface

3.8.1 Overview

TC358768XBG supports an I2C slave function. The I2C module supports the following features:

- Fail safe I2C pad operation
- Up to 400 KHz fast mode operation or 1MHz for special mode operation.
- Supports 7 bit slave addresses recognition (slave address=7'b0000_111X)
- No support for general call address
- Supports 16 bit index value for TC358768XBG I2C slave access

The I2C slave function supports a fixed slave address only and does not support general call address. The I2C slave function does not require any programmable configuration parameters.

3.8.2 I2C Write Access Translation

Registers in TC358768XBG are 16 bit aligned. This implies that I2C accesses to registers should always be done on 16 bit boundaries. The I2C slave will update an internal 16-bit write data register indexed by the lsb of the internal address index. Write access to TC358768XBG registers over the register interface is performed when a byte of data has been received and the internal address index has hit a 16-bit boundary. This mechanism allows 16-bit aligned registers to be updated simultaneously based on the register address value presented on the I2C bus interface. Note that data transferred on the I2C bus is sent MSB first.

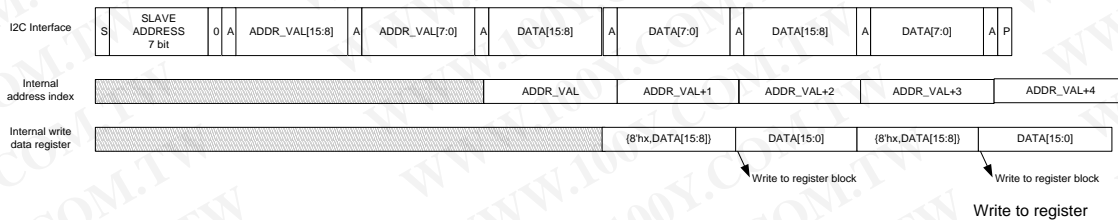


Figure 3-8 I2C Write Transfers Translated to Register Write Accesses

3.8.3 I2C Read Access Translation

Registers in TC358768XBG are 16 bit aligned. This implies that I2C accesses to registers should always be done on 16 bit boundaries. The I2C slave will update an internal 16-bit read data register when it received the I2C read command or when a byte transfer has completed and the internal address index has hit a 16-bit boundary. Data from the internal read register indexed by the lsb of the internal address index is then transferred over the I2C bus. This mechanism allows 16-bit aligned registers to be read without any side effects. Note that data transferred on the I2C bus is sent MSB first.

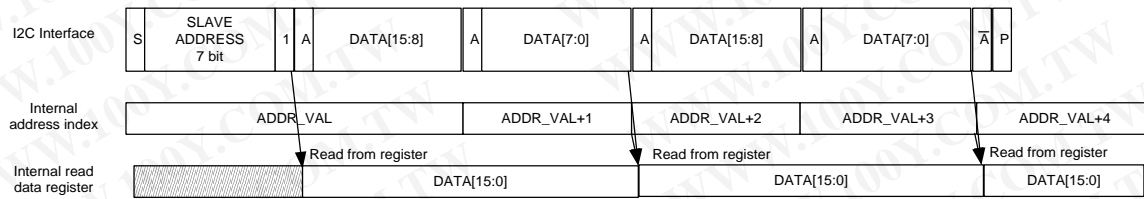


Figure 3-9 I2C Read Transfers to Register Read Accesses

3.9 SPI Slave Interface

The TC358768XBG Bridge Chip incorporates a SPI Slave Interface port which Host can drive to configure registers in the chip.

The following features are supported:

- Slave select pin supported
- Clock Polarity and Phase selectable
- Transfer Frame size of 32 bits
- Slave speed is up to 25 MHz
- Supports 16 bit index value for TC358768XBG SPI slave access

The basic operation of SPI interface is shown below where the standard 4-wire interface is used for transactions between the Host (SPI Master) and TC358768XBG (SPI Slave).

The Host asserts (active low) the Slave Select signal (SPI_SS) when it wants to initiate a read or write transaction. This is followed by the Host sending 32 pulses on the SPI Clock signal (SPI_SCK). In this spec., the bit slots are assumed numbered 31 to 0 from left to right.

Once the intended 16 bits (for TC358768XBG register address and command) and the additional data bits have been transferred, the Host de-asserts the Slave Select signal (SPI_SS) to indicate end of frame transfer.

This is shown in a simplistic way in the figure below (16 bits transfer size shown in the figure).

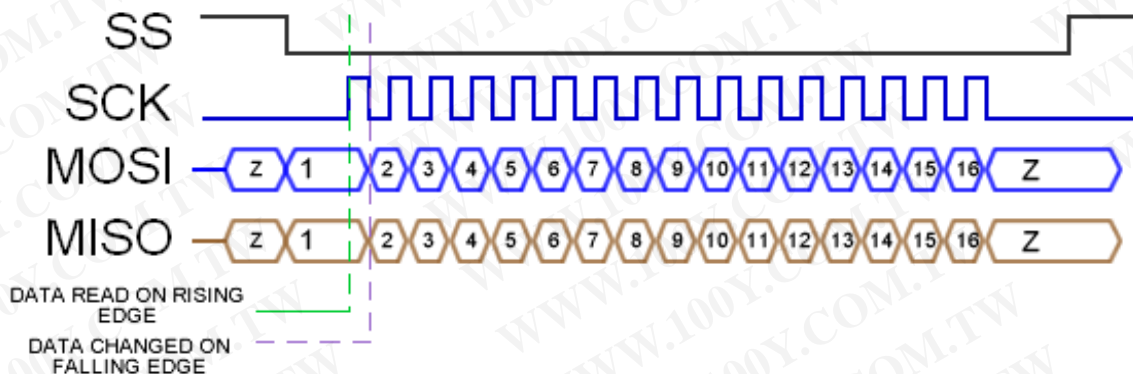


Figure 3-10 SPI basic operation

3.9.1 Clocking Modes

The SPI slave function supports one clocking mode which shown below.

Table 3-5 SPI Clocking modes

Mode	SPOL	SPHA	Drive Edge	Sample Edge	Comments
3	1	1	negedge	posedge	Master/Slave drive first data on first active clock edge

3.9.1.1 Timing Diagram

In this transfer format, the first bit value is captured on the second clock edge. This will be on a rising edge. The levels on the MOSI and MISO signals always change with the inactive clock edges on SCLK. The inactive clock edge will be the falling edge. It will idle high.

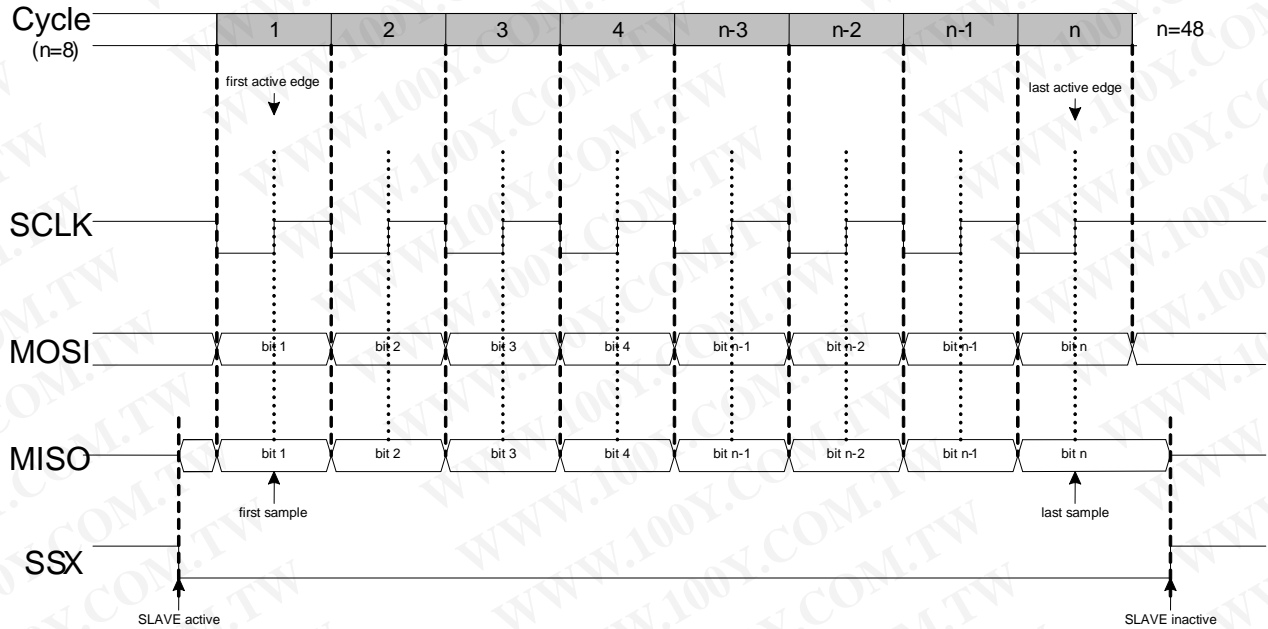


Figure 3-11 SPI transfer

3.9.1.2 Providing Register Address over SPI Interface

The SPI transactions are performed in 32 bits wide frames. The SPI master drives the command and address of the TC358768XBG register to be accessed. The first 15 bits provide the register address bits 15 to 1. The 16th bit of a frame is the command: 0=Write / 1=Read. Meaning of rest of the bits is based on transaction type. This frame structure is shown in the figure below for a write transaction.



Figure 3-12 Register Write Transfer over SPI (transfer size=32 bits)

CMD = Command: 1=Read / 0=Write

SPI slave function supports random write and read accesses.

3.9.1.3 SPI Write Access Translation

Registers in TC358768XBG are 16 bit aligned. This implies that SPI accesses to registers should always be done on 16 bit boundaries. The SPI slave will update an internal 16-bit write data register indexed by the address in the SPI frame. The data in bit slots 15 to 0 (after the first 16 bits of address and command) on MOSI line is used as the write data for these writes. Write access to TC358768XBG registers over the register interface is performed when a frame transfer is completed with command bit set to 0. During the write transaction, the data on the MISO line is not related to the write transaction. How to handle the data on MISO line during write transactions is discussed more in section on full-duplex mode.

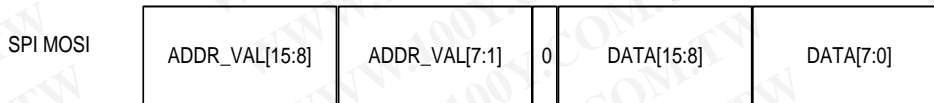


Figure 3-13 Register Write Transfer over SPI (transfer size=32 bits)

3.9.1.4 SPI Read Access Translation

Registers in TC358768XBG are 16 bit aligned. This implies that SPI accesses to registers should always be done on 16 bit boundaries. The SPI slave will access an internal 16-bit data register indexed by the address in the SPI frame.

Read access to TC358768XBG registers is completed in two frames. The first frame is similar to a write frame (as shown above) but with the 16 bits of data on MOSI line ignored by TC358768XBG. This step provides the 15 bits index address of the TC358768XBG register to be accessed. The only difference in this step from Write frame is that the command bit is set to 1 (Read command). During the second frame period, the TC358768XBG stuffs the read data into the bit slots 15 to 0 based on the data from the TC358768XBG register indexed by the read command address in the first frame as shown below. Handling of MISO line during first frame period and MOSI line during the second frame period is discussed further in full-duplex mode section.

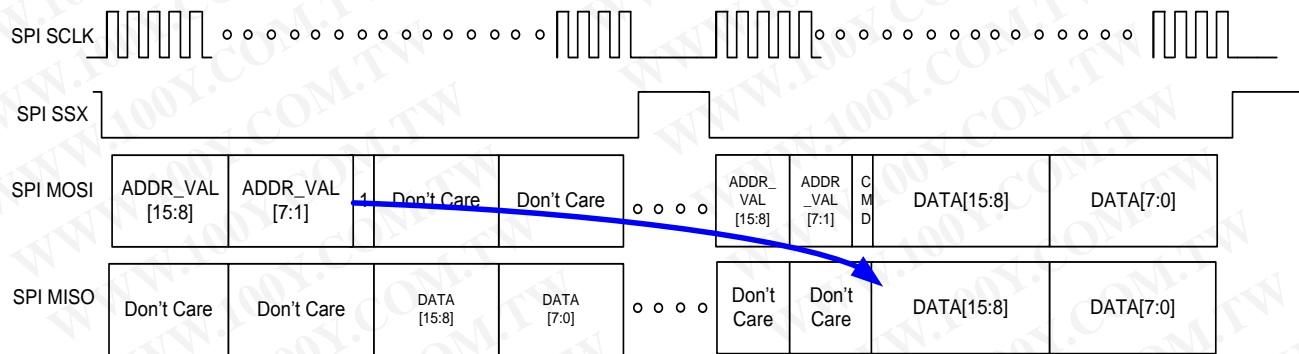


Figure 3-14 Register Read (Normal) Transfer over SPI (transfer size=32 bits)

3.9.2 Full Duplex

All above transactions are considered as full duplex by TC358768XBG by default. During any frame, TC358768XBG inserts the data from the TC358768XBG register that was last addressed by the read command from the SPI master into the bit slots 15 to 0 of the frame on MISO line. During any frame, the bits on the MOSI line bit slots 31 to 17 are considered as the address with the bit slot 16 providing the command. Data on MOSI line during bit slots 15 to 0 are used as write data.

The data on MISO line during bit slots 15 to 0 always corresponds to the previous frame's read command and can be ignored by the SPI Master if the previous frame command was a read command.

The data on MOSI line during bit slots 31 to 17 always provides the address for the TC358768XBG register for the current frame command.

The data on MOSI line during bit slots 15 to 0 will always be written into the TC358768XBG register addressed by current frame's address bits (bit slots 31 to 17) if the command in the current frame is a write command.

Four scenarios are possible for back to back transactions as explained below.

3.9.2.1 Back-2-back writes

In this case, the data on the MOSI line is always valid during both back-2-back frames and used for TC358768XBG register writes. The data on the MISO line in first frame might correspond to a read command issued in the previous frame. Data on the MISO line in 2nd frame is redundant (corresponds to the TC358768XBG register addressed by the last read command some frames ago).

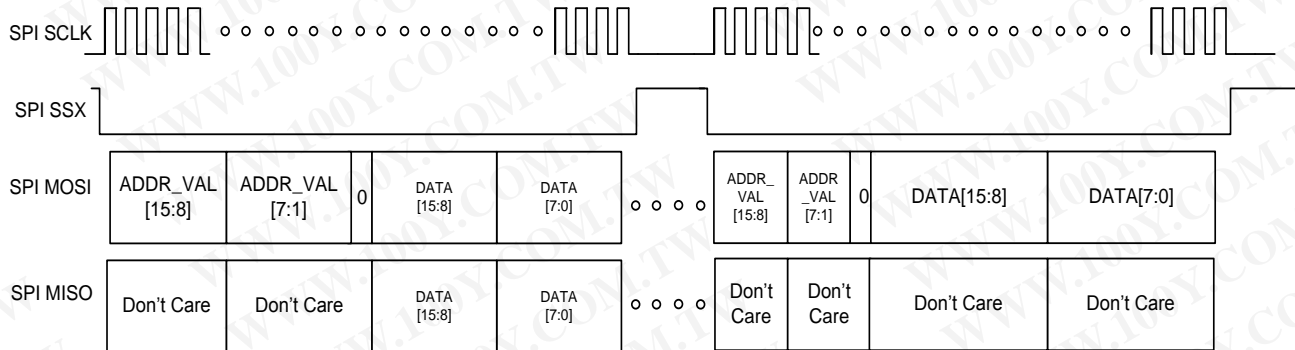


Figure 3-15 Back-2-Back Write Transfers over SPI

3.9.2.2 Back-2-back reads

In this case, the data on the MOSI line is always valid only during first 16 bits (bit slots 31 to 16) in both back-2-back frames and used for TC358768XBG register reads. The data on the MISO line in first frame might correspond to a read command issued in the previous frame. Data on the MISO line in 2nd frame corresponds to the TC358768XBG register addressed by the read command in 1st frame. The read data corresponding to the register addressed by the read command in 2nd frame shall be available in the next (3rd) frame on MISO line.

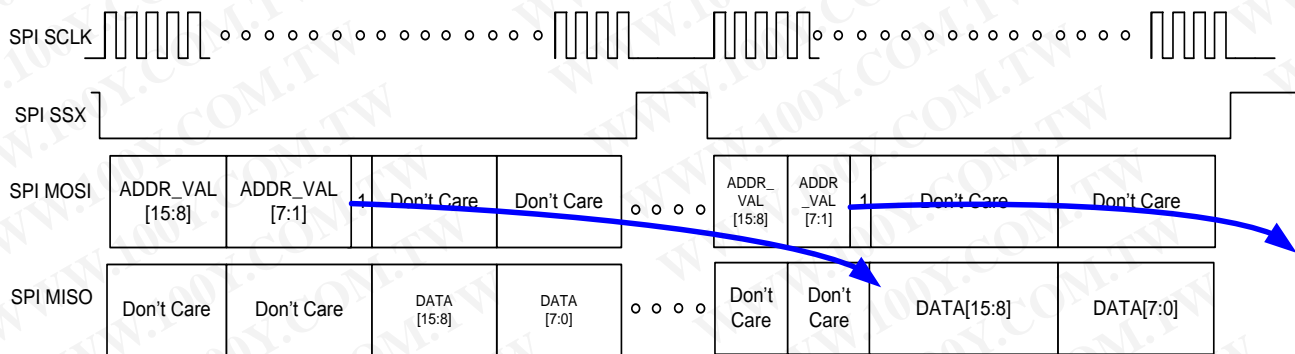


Figure 3-16 Back-2-Back Read Transfers over SPI

3.9.2.3 Write-after-Read

In this case, the handling of data on MISO and MOSI lines during first frame is similar to the “Back-to-Back reads” case. Data on the MOSI line during first 16 bits (bit slots 31 to 16) in 2nd frame provides the address and command for the write (write-after-read). Data on the MOSI line during bit slots 15 to 0 in 2nd frame provides the write data for the write command. Data on the MISO line in 2nd frame corresponds to the TC358768XBG register addressed by the read command in 1st frame.

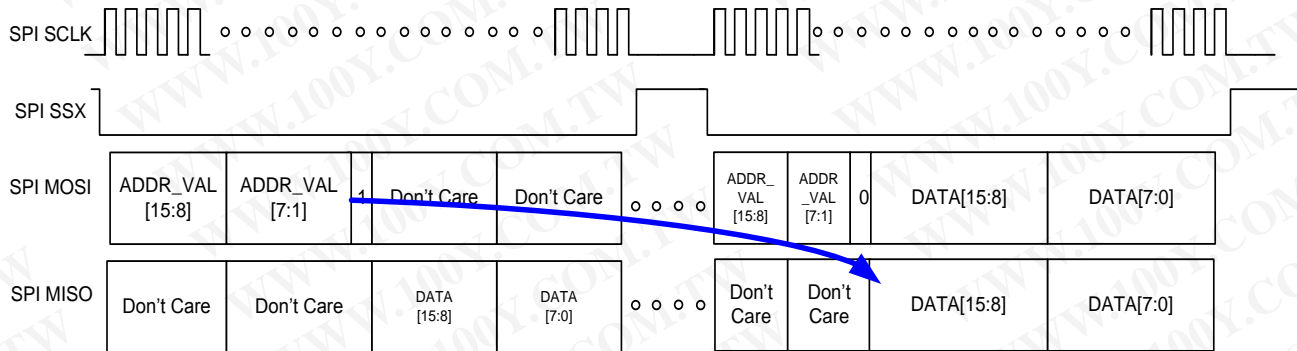


Figure 3-17 Write-after-Read Transfer over SPI

3.9.2.4 Read-after-Write

In this case, the handling of data on MISO and MOSI lines during first frame is similar to the “Back-to-Back writes” case. Data on the MOSI line during first 16 bits (bit slots 31 to 16) in 2nd frame provides the address and command for the read (read-after-write). Data on the MOSI line during bit slots 15 to 0 in 2nd frame is redundant. Data on the MISO line in 2nd frame is redundant. The read data corresponding to the register addressed by the read command in 2nd frame shall be available in the next (3rd) frame on MISO line.

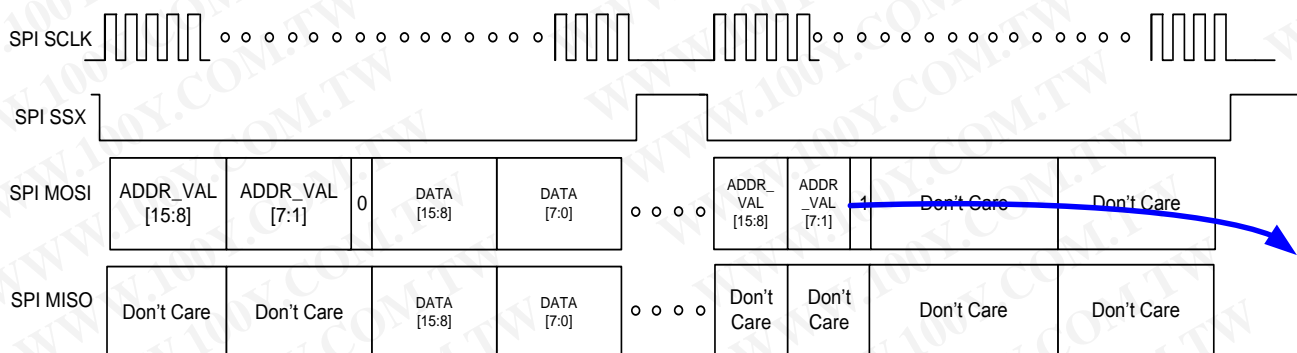


Figure 3-18 Read-after-Write Transfer over SPI

3.9.2.5 NOP-after-Read

In this case, where there is a read alone followed by no more immediate request, the handling of data on MISO and MOSI lines during first frame is similar to the “Back-to-Back reads” case. Data on the MOSI line during first 16 bits (bit slots 31 to 16) in 2nd frame should contain all 1’s to point to a dummy address for SPI and command for the write. Data on the MOSI line during bit slots 15 to 0 in 2nd frame is redundant. Data on the MISO line in 2nd frame corresponds to the TC358768XBG register addressed by the read command in 1st frame. The write on MOSI line in 2nd frame points to a dummy address (all 1’s) and so redundant.

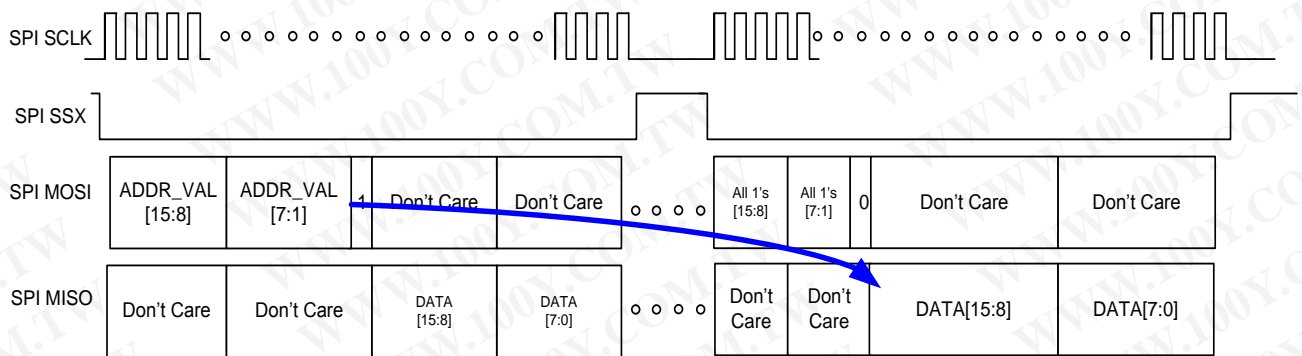


Figure 3-19 NOP-after-Read Transfer over SPI

4 Clock and System

The clock generation unit (CG) makes use of a single PLL. PLL Clock output frequency is same as DSITX Bit clock frequency. DSITX Byte clock will be used for DSITX controller and Video Buffer controller. PCLK input will be used for Parallel port input controller. Rest of the module will used either REFCLK or PCLK/4.

PLL uses either an external input clock REFCLK (6MHz to 40 MHz) or PCLK/4 to generate PLL Refclk. After reset, if REFCLK is not present on the system, automatically TC358768XBG will select PCLK/4 as the clock source.

4.1.1 Example of PLL Generated Clock Frequency

The possible clock frequencies generated from the PLL are achieved by varying the values in registers [PLLFB](#) and [PLLDiv](#).

$$pll_clk = RefClk * [(FBD + 1) / (PRD + 1)] * [1 / (2^{FRS})]$$

or

$$pll_clk = (PCLK/4) * [(FBD + 1) / (PRD + 1)] * [1 / (2^{FRS})]$$

Table 4-1 provides possible frequencies that may be used in TC358768XBG.

Table 4-1 Possible PLL parameters

Reference clock (MHz) (REFCLK or PCLK/4)	FBD	PRD	FRS	pll_clk (MHz)
16.6	255	7	1	265.60
	319	5	2	221.33
	319	6	2	189.71
	319	7	2	166.00

Table 4-2 Controllers' Operating Frequency

Controllers	Operating Frequency		Source
	min (MHz)	max (MHz)	
VB controller (Write port)	10	166	Input PCLK
VB controller (Read port)	---	125	DSI Byte clock (PLL)
Parallel Input controller	---	166	Input PCLK
SPI/I2C controller	6	40	Input REFCLK
Register module	6	40	Input REFCLK

4.1.2 TC358768XBG Power Up Procedure

The following sequence should happen before TC358768XBG is able to operate properly:

1. Provide voltage and clock sources to TC358768XBG.
2. For voltage source, it is desired to turn on core power (1.2) source first, then Analog PHY and IO power as shown in Figure 4-1 Power On Sequence.
3. RefClk, PClk/4, clock source can be from 6 MHz to 40 MHz. **PClk has to toggle first before accessing/programing TC358768XBG.**
4. The timing parameters for Figure 4-1 are tabulated in Table 4-3.

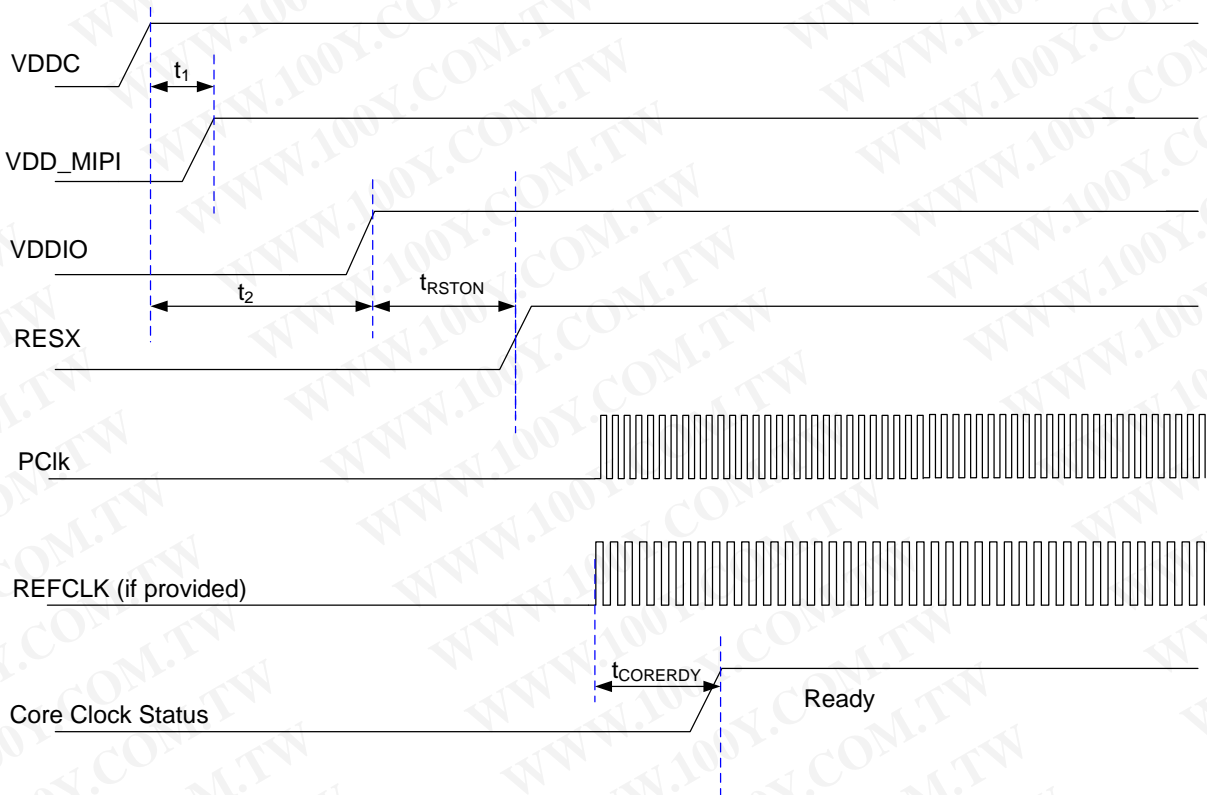


Figure 4-1 Power On Sequence

Table 4-3 Power On Sequence Timing

Parameters	Description	Min.	Typ.	Max.	Units
RefClk	Reference clock frequency	6	---	40	MHz
t_1	VDD_MIPI on delay from VDDC.	0	---	10	msec
t_2	VDDIO on delay from VDDC	0	---	10	msec
t_{RSTON}	RESET width period	200	---	---	nsec
$t_{CORERDY}$	Period after reset de-assertion when TC358768XBG clocks are stable (Dependent on REFCLK frequency)	.7	---	1	msec

4.1.3 TC358768XBG Power Down Procedure



Figure 4-2 Power Down Sequence

Table 4-4 Power Down Sequence Timing

Parameters	Description	Min.	Typ.	Max.	Units
t_1	VDD_MIPI off delay from VDDIO off	0	---	10	msec
t_2	VDDC off delay from VDD_MIPI off	0	---	10	msec

5 RegFile Block

Host accesses TC358768XBG RegFile block to read status and/or write control registers through the I2C or SPI slave interface.

Registers in Group Global and CSITX_CTL (Table 5-1) can be accessed as 16-bit registers. While the others have to be written as 32-bit registers, even if the upper 16-bits are all zeros.

5.1 Register Map

The control and status registers in TC358768XBG is provided in Table 5-1.

Table 5-1 Register Map

Group	Address	Register	Description
Global	0x0000	ChipID	TC358768XBG Chip and Revision ID
	0x0002	SysCtl	System Control Register
	0x0004	ConfCtl	Configuration Control Register
	0x0006	FiFoCtl	FiFo Control Register
	0x0008	DataFmt	Data Format Control Register
	0x000E	GPIOEn	GPIO Enable Control Register
	0x0010	GPIODir	GPIO Pin Direction Control Register
	0x0012	GPIOIn	GPIO Input Pin Value
	0x0014	GPIOOut	GPIO Output Pin Value
	0x0016	PLLctl0	PLL control Register 0
	0x0018	PLLctl1	PLL control Register 1
	0x0050	DSITX_DT	DSITX Data Type Register
0x00F8	FiFoStatus	FiFo Underflow/Overflow Status	
TX PHY	0x0100	CLW_DPHYCONTTX	Clock Lane DPHY Tx Control register
	0x0104	D0W_DPHYCONTTX	Data Lane0 DPHY Tx Control register
	0x0108	D1W_DPHYCONTTX	Data Lane1 DPHY Tx Control register
	0x010C	D2W_DPHYCONTTX	Data Lane2 DPHY Tx Control register
	0x0110	D3W_DPHYCONTTX	Data Lane3 DPHY Tx Control register
	0x0114 – 0x013F	Reserved	
	0x0140	CLW_CNTRL	Clock Lane DPHY Control Register
	0x0144	D0W_CNTRL	Data Lane 0 DPHY Control Register
	0x0148	D1W_CNTRL	Data Lane 1 DPHY Control Register
	0x014C	D2W_CNTRL	Data Lane 2 DPHY Control Register
0x0150	D3W_CNTRL	Data Lane 3 DPHY Control Register	
TX PPI	0x0200	Reserved	
	0x0204	STARTCNTRL	DSITX Start Control Register
	0x0208	STATUS	DSITX Status Register
	0x020C	Reserved	
	0x0210	LINEINICNT	DSITX Line Initialization Control Register
	0x0214	LPTXTIMECNT	SYSLPTX Timing Generation Counter
	0x0218	TCLK_HEADERCNT	TCLK_ZERO and TCLK_PREPARE Counter
	0x021C	TCLK_TRAILCNT	TCLK_TRAIL Counter
	0x0220	THS_HEADERCNT	THS_ZERO and THS_PREPARE Counter
	0x0224	TWAKEUP	TWAKEUP Counter
	0x0228	TCLK_POSTCNT	TCLK_POST Counter
	0x022C	THS_TRAILCNT	THS_TRAIL Counter
	0x0230	HSTXVREGCNT	TX Voltage Regulator setup Wait Counter
	0x0234	HSTXVREGEN	Voltage regulator enable for HSTX Data Lanes
	0x0238	TXOPTIONCNTRL	TX Option Control
0x023C	BTACNTRL1	BTA Control	

TX CTRL	0x0400- 0x0408	Reserved	
	0x040C	DSI_CONFR	DSI Configuration Read Register
	0x0410	RDFIFO_STATUS	DSI Command Read Data FIFO Status Register
	0x0430	DSICMD_RDFIFO	DSI Command Read Data FIFO
	0x0500	DSI_CONFW	DSI TX Configure Write Register
	0x0504 – 0x0517	Reserved	
	0x0518	DSI_START	DSI – Starts DSI-TX operation
DSITX CTRL	0x0600	DSICMD_TX	DSI Command Packet Start register
	0x0602	DSICMD_TYPE	DSI Command Packet Type register
	0x0604	DSICMD_WC	DSI Command Packet Word Count
	0x0610	DSICMD_WD0	DSI Command Packet Data register 0
	0x0612	DSICMD_WD1	DSI Command Packet Data register 1
	0x0614	DSICMD_WD2	DSI Command Packet Data register 2
	0x0616	DSICMD_WD3	DSI Command Packet Data register 3
	0x0620	DSI_EVENT	DSI Hsync Event Mode
	0x0622	DSI_VSW	DSI Vsync Width register
	0x0624	DSI_VBPR	DSI Vsync Back Porch lines register
	0x0626	DSI_VACT	DSI Vsync Active lines register
	0x0628	DSI_HSW	DSI Hsync Width register
	0x062A	DSI_HBPR	DSI Hsync Back Porch register
0x062C	DSI_HACT	DSI Hsync Active Piels register	

5.2 Register Description

The following sections provide a detailed description of the registers.

5.2.1 Chip and Revision ID (ChipID: 0x0000)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	ChipID							
Type	RO							
Default	0x44							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	RevID							
Type	RO							
Default	0x0							

Table 5-2 Chip and Revision ID

Register Field	Bit	Default	Description
ChipID	[15:8]	0x44	Chip ID Chip ID assigned for this device by Toshiba.
RevID	[7:0]	0x04	Revision ID Revision ID for this device assigned by Toshiba.

5.2.2 System Control Register (SysCtl:0x0002)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved							
Type	RO							
Default	0x0							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved						SLEEP	SReset
Type	RO						R/W	R/W
Default	0x0						0x1	0x0

Table 5-3 System Control Register

Register Field	Bit	Default	Description
Reserved	[15:2]	0x0	
SLEEP	1	0x1	SLEEP control 0: Normal operation 1: Sleep mode
SReset	0	0x0	Software Reset (Active high) This bit is set to force TC358768XBG logic to reset state except all configuration registers content (regFile) and I2C slave module. 0: Normal operation 1: Reset operation Software needs to clear SReset when set.

5.2.3 Input Control Register (InputCtl: 0x0004)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved		INTEn2	Reserved			PDataF	
Type	RO		R/W	RO			R/W	

Default	0x0		0x0	0x0			0x0	
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved	PPEn	VsyncP	HsyncP	Reserved	Auto	Reserved	
Type	RO	R/W	R/W	R/W	RO	R/W	RO	
Default	0x0	0x0	0x0	0x0	0x0	0x1	0x0	

Table 5-4 Input Control Register

Register Field	Bit	Default	Description
Reserved	[15:14]	0x0	Reserved
INTEn2	13	0x0	INT Output Enable 2 0: Normal (Default to GPIO1 function) 1: Enable (output INT to GPIO1)
Reserved	[12:10]	0x0	Reserved
PDataF	[9:8]	0x0	Parallel Data Format Option 2'b00: Mode 0 2'b01: Mode 1 2'b10: Mode 2 2'b11: Reserved Note: See Table 3-4 for more information
Reserved	7	0x0	Reserved
PPEn	6	0x0	Parallel Port Enable 0: Parallel Port Disable 1: Parallel Port Enable
VsyncP	5	0x0	VSynC/HsynC Polarity Control 0: Active low 1: Active high
DEP	4	0x0	DE Polarity Control 0: Active high 1: Active low
Reserved	3	0x0	Reserved
Auto	2	0x1	I2C slave index increment 0: I2C address index does not increment on every data byte transfer 1: I2C address index increments on every data byte transfer Note: For I2C interface only
Reserved	[1:0]	0x0	Reserved

Note: All Reserved bits must program "0"

5.2.4 FiFo Control Register (FiFoCtl: 0x0006)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved						FiFoLevel[9:8]	
Type	RO						R/W	
Default	0x0						0x0	
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	FiFoLevel[7:0]							
Type	R/W							
Default	0x1							

Table 5-5 FiFo Control Register

Register Field	Bit	Default	Description
Reserved	[15:10]	0x0	Reserved
FiFo_Level	[9:0]	0x1	FiFo Level This field determines the FiFo write data level, when reaches to this level FiFo controller asserts FiFoRdy for DSITX to start output data

5.2.5 Data Format Control Register (DataFmt: 0x0008)

Bit	B15	B14	B13	B12	B11	B10	B9	B8	
Name	Reserved								
Type	RO								
Default	0x0								
Bit	B7	B6	B5	B4	B3	B2	B1	B0	
Name	PDFFormat				spmode_en	rdswap_en	dsitx_en	txdt_en	
Type	R/W				R/W	R/W	R/W	R/W	
Default	0x0				0x0	0x0	0x0	0x0	

Table 5-6 Data Format Control Register

Register Field	Bit	Default	Description
Reserved	[15:8]	0x0	Reserved
PDFFormat	[7:4]	0x0	Peripheral Data Format 0000: User Define 0001: Reserved 0010: Reserved 0011: RGB888 0100: RGB666 0101: RGB565 0110: Reserved 0111: Reserved 1000: Reserved 1001: Reserved 1010: Reserved 1011 – 1111: Reserved Notes: This field used for parallel input port packing logic
spmode_en	[3]	0x0	Special mode enable 0: Normal 1: RGB666: select Loosely pack Note: Only valid when rdswap_en=1
rdswap_en	[2]	0x0	RGB Swap R & B enable Note: Must program to “1”
dsitx_en	[1]	0x0	DSITX i/f enable 0: Disable 1: Enable
txdt_en	[0]	0x0	DSITX Data Type ID enable Must program to “1” DSITX: Use Data Type ID defined in DSITX_DT register

5.2.6 GPIO Enable Register (GPIOEn: 0x000E)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	GPIOEn[10:3]							
type	R/W							
Default	0x0							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved							
type	RO							
Default	0x0							

Table 5-7 GPIO Direction Register

Register Field	Bit	Default	Description
GPIOEn	[15:8]	0x0	GPIO Enable 0: Disable (GPIOx function depend on mode of operation) 1: Enable (GPIOx function depend on GPIODir)
Reserved	[7:0]	0x0	Reserved

5.2.7 GPIO Direction Register (GPIODir: 0x0010)

Bit	B15	B14	B13	B12	B11	B10	B9	B8	
Name	GPIODir[10:3]								
type	R/W								
Default	0xFF								
Bit	B7	B6	B5	B4	B3	B2	B1	B0	
Name	Reserved					GPIODir[2:1]		Reserved	
type	R/W					R/W		R/W	
Default	0x1F					0x3		0x1	

Table 5-8 GPIO Direction Register

Register Field	Bit	Default	Description
GPIODir	[15:8]	0x0	GPIO[10:3] Pin Direction
Reserved	[7:3]	0x1F	Do not change default value
GPIODir	[2:1]	0x3	GPIO[2:1] Pin Direction 0: GPIO Pin is set to Output Mode 1: GPIO Pin is set to Input Mode
Reserved	[0]	0x1	Do not change default value

5.2.8 GPIO Pin Value Register (GPIOPin: 0x0012)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	GPIOIn[10:3]							
type	RO							

Default	0x??							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved				GPIOIn[2:1]		Reserved	
type	RO				RO		RO	
Default	0x??				0x??		0x??	

Table 5-9 GPIO Pin Value Register

Register Field	Bit	Default	Description
GPIOPin	[15:8]	0x??	GPIO[10:3] Pin Value
Reserved	[7:3]	0x??	
GPIOPin	[2:1]	0x??	GPIO[2:1] Pin Value
Reserved	[0]	0x??	

5.2.9 GPIO Output Value Register (GPIOOut: 0x0014)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	GPIOOut[10:3]							
type	R/W							
Default	0x00							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved				GPIOOut[2:1]		Reserved	
type	R/W				R/W		R/W	
Default	0x00				0x0		0x0	

Table 5-10 GPIO Output Value Register

Register Field	Bit	Default	Description
GPIOOut	[15:8]	0x0	GPIO[10:3] Output Register Value
Reserved	[7:3]	0x0	
GPIOOut	[2:1]	0x0	GPIO[2:1] Output Register Value
Reserved	[0]	0x0	

5.2.10 PLL Control Register 0 (PLLctl0: 0x0016)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	PLL_PRD				Reserved		PLL_FBD[8]	
Type	R/W				RO		R/W	
Default	0x4				0x00		0x0	
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	PLL_FBD[7:0]							
Type	R/W							
Default	0x63							

Table 5-11 PLL Control Register 0

Register Field	Bit	Default	Description
PLL_PRD	[15:12]	0x4	Input divider setting

			Division ratio = (PRD3..0) + 1
Reserved	[11:9]	0x0	
PLL_FBD	[8:0]	0x063	Feedback divider setting Division ratio = (FBD8...0) + 1

5.2.11 PLL Control Register 1 (PLLctl1: 0x0018)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved				PLL_FRS		PLL_LBWS	
Type	RO				R/W		R/W	
Default	0x0				0x1		0x2	
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Revsd	LFBREN	BYPCKEN	CKEN	Reserved		RESETB	PLL_EN
Type	RO	R/W	R/W	R/W	RO		R/W	R/W
Default	0x0	0x0	0x0	0x0	0x0		0x0	0x0

Table 5-12 PLL Control Register 1

Register Field	Bit	Default	Description
Reserved	[15:12]	0x0	
PLL_FRS	[11:10]	0x1	Frequency range setting (post divider) for HSKC frequency 2'b00: 500MHz – 1GHz HSKC frequency 2'b01: 250MHz – 500MHz HSKC frequency 2'b10: 125 MHz – 250MHz HSKC frequency 2'b11: 62.5MHz – 125MHz HSKC frequency
PLL_LBWS	[9:8]	0x2	Loop bandwidth setting 2'b00: 25% of maximum loop bandwidth 2'b01: 33% of maximum loop bandwidth 2'b10: 50% of maximum loop bandwidth (default) 2'b11: maximum loop bandwidth
Reserved	[7]	0x0	
PLL_LFBREN	[6]	0x0	Lower Frequency Bound Removal Enable 1'b0: REFCLK toggling → normal operation, REFCLK stops → no oscillation 1'b1: REFCLK toggling → normal operation, REFCLK stops → free running PLL
PLL_BYPCKEN	[5]	0x0	Bypass clock enable 1'b0: Normal operation 1'b1: bypass mode, REFCLK is used instead of PLL_VCO output
PLL_CKEN	[4]	0x0	Clock enable 1'b0: clocks switched off (output LOW) 1'b1: clocks switched on
Reserved	[3:2]	0x0	
PLL_RESETB	[1]	0x0	PLL Reset 1'b0: Reset 1'b1: Normal operation
PLL_EN	[0]	0x0	PLL Enable 1'b0: PLL off 1'b1: PLL on

5.2.12 DSITX Data Type Register (DSITX_DT: 0x0050)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved							
Type	RO							
Default	0x0							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	dsitx_dt[7:0]							
Type	R/W							
Default	0x30							

Table 5-13 DSITX Data Type Register

Register Field	Bit	Default	Description
dsitx_dt	[7:0]	0x30	DSITX Data Type ID This field uses for DSITX Data Type ID when txdt_en = 1;

5.2.13 FIFO Status Register (FIFOSTATUS: 0x00F8)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved							
Type	RO							
Default	0x00							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved						Vb_uflow	Vb_oflow
Type	RO						RO	RO
Default	0x00						0x0	0x0

Table 5-14 FIFO Status Register

Register Field	Bit	Default	Description
Reserved	[15:2]		
vb_uflow	1	0	VB Under Flow Status 0: Normal 1: Under flow Read this register will clear the status
vb_oflow	0	0	VB Over Flow Status 0: Normal 1: Over flow Read this register will clear the status

5.2.14 Clock Lane DPHY TX Control register (CLW_DPHYCONTTX: 0x0100)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved						CLW_CAP1	CLW_CAP0
Type	RO	RO	RO	RO	RO	RO	R/W	R/W
Default	0	0	0	0	0	0	1	0
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	DLYCNTR L3	DLYCNTR L2	DLYCNTRL 1	DLYCNT RL0	Reserved		CLW_LPTXCU RR1EN	CLW_LPTX CURROEN
Type	R/W	R/W	R/W	R/W	RO	RO	R/W	R/W
Default	0	0	0	0	0	0	1	0

Table 5-15 Clock Lane DPHY TX Control register

Register Field	Bit	Default	Description
Reserved	[31:10]	0x0	
CLW_CAP1	[9]	0x1	Selection bit 1 of different HSTX output capacitors for Clock Lane
CLW_CAP0	[8]	0x0	Selection bit 0 of different HSTX output capacitors for Clock Lane (CAP1,CAP0): = (00): 0 [pF] (CAP1,CAP0): = (01): 2.8 [pF] (CAP1,CAP0): = (10): 3.2 [pF] (CAP1,CAP0): = (11): 3.6 [pF]
DLYCNTRL[3:0]	[7:4]	0x0	Tuning of transmit window position. The High Speed Clock output can be delayed according to the setting. The recommended value is determined by evaluating the LSI in which this module is implemented. Typical delay for rising/falling edge is about DLYCNTRL x 24ps/27ps. Rising edge : DLYCNTRL x 24ps, Falling edge : DLYCNTRL x 27ps.
Reserved	[3:2]	0x0	
CLW_LPTXCURR1EN	[1]	0x1	Selection bit-1 for LPTX output current (TRLP/TFLP tuning) for clock Lane.

Register Field	Bit	Default	Description
CLW_LPTXCURROEN	[0]	0x0	Selection bit-0 for LPTX output current (TRLP/TFLP tuning) for clock Lane. 00: no additional output current 01: 25% additional output current 10: 25% additional output current 11: 50% additional output current The default value is "10". However, if "00" is set, the rise/fall time will become later and if "11" is set, the rise/fall time will become earlier.

5.2.15 Data Lane 0 DPHY TX Control register (D0W_DPHYCONTTX:0x0104)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved						D0W_CAP1	D0W_CAP0
Type	RO	RO	RO	RO	RO	RO	R/W	R/W
Default	0	0	0	0	0	0	1	0
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	DLYCNT RL3	DLYCNT RL2	DLYCNT RL1	DLYCNT RL0	Reserved	Reserved	D0W_LPTXCUR R1EN	D0W_LPTXCUR ROEN
Type	R/W	R/W	R/W	R/W	RO	RO	R/W	R/W
Default	0	0	0	0	0	0	1	0

Table 5-16 Data Lane 0 DPHY TX Control register

Register Field	Bit	Default	Description
Reserved	[15:10]	0x0	
D0W_CAP1	[9]	0x1	Selection bit 1 of different HSTX output capacitors for Data Lane 0.
D0W_CAP0	[8]	0x0	Selection bit 0 of different HSTX output capacitors for Data Lane 0. (CAP1,CAP0): = (00): 0 [pF] (CAP1,CAP0): = (01): 2.8 [pF] (CAP1,CAP0): = (10): 3.2 [pF] (CAP1,CAP0): = (11): 3.6 [pF]

Register Field	Bit	Default	Description
DLYCNTRL[3:0]	[7:4]	0x0	Tuning of transmit window position. The High Speed Data output can be delayed according to the setting. The recommended value is determined by evaluating the LSI in which this module is implemented. Typical delay for rising/falling edge is about DLYCNTRL x 24ps/27ps. Rising edge : DLYCNTRL x 24ps, Falling edge : DLYCNTRL x 27ps.
Reserved	[3:2]	0x0	
D0W_LPTXCURR1EN	[1]	0x1	Selection bit-1 for LPTX output current (TRLP/TFLP tuning) for Data Lane 0.
D0W_LPTXCURROEN	[0]	0x0	Selection bit-0 for LPTX output current (TRLP/TFLP tuning) for Data Lane 0. 00: no additional output current 01: 25% additional output current 10: 25% additional output current 11: 50% additional output current The default value is "10". However, if "00" is set, the rise/fall time will become later and if "11" is set, the rise/fall time will become earlier.

5.2.16 Data Lane 1 DPHY TX Control Register (D1W_DPHYCONTTX: 0x0108)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved						D1W_CAP1	D1W_CAP0
Type	RO	RO	RO	RO	RO	RO	R/W	R/W
Default	0	0	0	0	0	0	1	0
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	DLYCNT RL3	DLYCNTR L2	DLYCNT RL1	DLYCNTR L0	Reserved		D1W_LPTXCU RR1EN	D1W_LPTXCU RROEN
Type	R/W	R/W	R/W	R/W	RO	RO	R/W	R/W
Default	0	0	0	0	0	0	1	0

Table 5-17 Data Lane 1 DPHY TX Control Register

Register Field	Bit	Default	Description
Reserved	[15:10]	0x0	
D1W_CAP1	[9]	0x1	Selection bit 1 of different HSTX output capacitors for Data Lane 1.
D1W_CAP0	[8]	0x0	Selection bit 0 of different HSTX output capacitors for Data Lane 1. (CAP1,CAP0): = (00): 0 [pF] (CAP1,CAP0): = (01): 2.8 [pF] (CAP1,CAP0): = (10): 3.2 [pF] (CAP1,CAP0): = (11): 3.6 [pF]
DLYCNTRL[3:0]	[7:4]	0x0	Tuning of transmit window position. The High Speed Clock output can be delayed according to the setting. The recommended value is determined by evaluating the LSI in which this module is implemented. Typical delay for rising/falling edge is about DLYCNTRL x 24ps/27ps. Rising edge : DLYCNTRL x 24ps, Falling edge : DLYCNTRL x 7ps.
Reserved	[3:2]	0x0	
D1W_LPTXCURR1EN	[1]	0x1	Selection bit-1 for LPTX output current (TRLP/TFLP tuning) for Data Lane 1.

Register Field	Bit	Default	Description
D1W_LPTXCURREN	[0]	0x0	Selection bit-0 for LPTX output current (TRLP/TFLP tuning) for Data Lane 1. 00: no additional output current 01: 25% additional output current 10: 25% additional output current 11: 50% additional output current The default value is "10". However, if "00" is set, the rise/fall time will become later and if "11" is set, the rise/fall time will become earlier.

5.2.17 Data Lane 2 DPHY TX Control Register (D2W_DPHYCONTTX: 0x010C)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved						D2W_CAP1	D2W_CAP0
Type	RO	RO	RO	RO	RO	RO	RO	R/W
Default	0	0	0	0	0	0	1	0
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	DLYCNT RL3	DLYCNTRL 2	DLYCNTR L1	DLYCNT RL0	Reserved		D2W_LPTXC URR1EN	D2W_LPTXCU RROEN
Type	R/W	R/W	R/W	R/W	RO	RO	R/W	R/W
Default	0	0	0	0	0	0	1	0

Table 5-18 Data Lane 2 DPHY TX Control Register

Register Field	Bit	Default	Description
Reserved	[15:10]	0x0	
D2W_CAP1	[9]	0x1	Selection bit 1 of different HSTX output capacitors for Data Lane 2.
D2W_CAP0	[8]	0x0	Selection bit 0 of different HSTX output capacitors for Data Lane 2. (CAP1,CAP0): = (00): 0 [pF] (CAP1,CAP0): = (01): 2.8 [pF] (CAP1,CAP0): = (10): 3.2 [pF] (CAP1,CAP0): = (11): 3.6 [pF]
DLYCNTRL[3:0]	[7:4]	0x0	Tuning of transmit window position. The High Speed Clock output can be delayed according to the setting. The recommended value is determined by evaluating the LSI in which this module is implemented. Typical delay for rising/falling edge is about DLYCNTRL x 24ps/27ps. Rising edge : DLYCNTRL x 24ps, Falling edge : DLYCNTRL x 27ps.
Reserved	[3:2]	0x0	
D2W_LPTXCURR1EN	[1]	0x1	Selection bit-1 for LPTX output current (TRLP/TFLP tuning) for Data Lane 2.
D2W_LPTXCURROEN	[0]	0x0	Selection bit-0 for LPTX output current (TRLP/TFLP tuning) for Data Lane 2. 00: no additional output current 01: 25% additional output current 10: 25% additional output current 11: 50% additional output current The default value is "10". However, if "00" is set, the rise/fall time will become later and if "11" is set, the rise/fall time will become earlier.

5.2.18 Data Lane 3 DPHY TX Control Register (D3W_DPHYCONTTX: 0x0110)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved						D3W_CAP1	D3W_CAPO
Type	RO	RO	RO	RO	RO	RO	RO	R/W
Default	0	0	0	0	0	0	1	0
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	DLYCNT RL3	DLYCNTRL 2	DLYCNT RL1	DLYCNTR L0	Reserved		D3W_LPTXC URR1EN	D3W_LPTXCU RROEN
Type	R/W	R/W	R/W	R/W	RO	RO	R/W	R/W
Default	0	0	0	0	0	0	1	0

Table 5-19 Data Lane 2 DPHY TX Control Register

Register Field	Bit	Default	Description
Reserved	[15:10]	0x0	
D3W_CAP1	[9]	0x1	Selection bit 1 of different HSTX output capacitors for Data Lane 3.
D3W_CAPO	[8]	0x0	Selection bit 0 of different HSTX output capacitors for Data Lane 3. (CAP1,CAP0): = (00): 0 [pF] (CAP1,CAP0): = (01): 2.8 [pF] (CAP1,CAP0): = (10): 3.2 [pF] (CAP1,CAP0): = (11): 3.6 [pF]
DLYCNTRL[3:0]	[7:4]	0x0	Tuning of transmit window position. The High Speed Clock output can be delayed according to the setting. The recommended value is determined by evaluating the LSI in which this module is implemented. Typical delay for rising/falling edge is about DLYCNTRL x 24ps/27ps. Rising edge : DLYCNTRL x 24ps, Falling edge : DLYCNTRL x 27ps.
Reserved	[3:2]	0x0	
D3W_LPTXCURR1EN	[1]	0x1	Selection bit-1 for LPTX output current (TRLP/TFLP tuning) for Data Lane 3.

Register Field	Bit	Default	Description
D3W_LPTXCURROEN	[0]	0x0	Selection bit-0 for LPTX output current (TRLP/TFLP tuning) for Data Lane 3. 00: no additional output current 01: 25% additional output current 10: 25% additional output current 11: 50% additional output current The default value is "10". However, if "00" is set, the rise/fall time will become later and if "11" is set, the rise/fall time will become earlier.

5.2.19 Clock Lane DPHY Control Register (CLW_CNTRL: 0x0140)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved						CLW_CNTRL1	CLW_CNTRL0
Type	RO	RO	RO	RO	RO	RO	R/W	R/W
Default	0	0	0	0	0	0	0	0
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved						CLW_LaneDisable	
Type	RO	RO	RO	RO	RO	RO	RO	R/W
Default	0	0	0	0	0	0	0	1

Table 5-20 Clock Lane DPHY Control Register

Register Field	Bit	Default	Description
Reserved	[15:10]	0x0	
CLW_CNTRL1	[9]	0x0	Control Bit. Reserved, not assigned. 1'b0: (default).
CLW_CNTRL0	[8]	0x0	Control Bit. Reserved, not assigned. 1'b0: (default).
Reserved	[7:1]	0x0	
CLW_LaneDisable	[0]	0x1	Force Lane Disable for Clock Lane. 1'b1: Force Lane Disable 1'b0: Bypass Lane Enable from PPI Layer enable. When SCANTESTMODE=1, this register is disabled. When SCANMODE=0, this register is always enabled.

5.2.20 Data Lane 0 DPHY Control Register (DOW_CNTRL: 0x0144)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved						DOW_CNTRL1	DOW_CNTRL0
Type	RO	RO	RO	RO	RO	RO	R/W	R/W
Default	0	0	0	0	0	0	0	0
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved							DOW_LaneDisable
Type	RO	RO	RO	RO	RO	RO	RO	R/W
Default	0	0	0	0	0	0	0	1

Table 5-21 Data Lane 0 DPHY Control Register

Register Field	Bit	Default	Description
Reserved	[15:10]	0x0	
DOW_CNTRL1	[9]	0x0	Control Bit. Reserved, not assigned. 1'b0: (default).
DOW_CNTRL0	[8]	0x0	Control Bit. Reserved, not assigned. 1'b0: (default).
Reserved	[7:1]	0x0	
DOW_LaneDisable	[0]	0x1	Force Lane Disable for Data Lane 0. 1'b1: Force Lane Disable 1'b0: Bypass Lane Enable from PPI Layer enable. When SCANTESTMODE=1, this register is disabled. When SCANMODE=0, this register is always enabled.

5.2.21 Data Lane 1 DPHY Control Register (D1W_CNTRL: 0x0148)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved						D1W_CNTRL1	D1W_CNTRL0
Type	RO	RO	RO	RO	RO	RO	R/W	R/W
Default	0	0	0	0	0	0	0	0
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved							D1W_LaneDisable
Type	RO	RO	RO	RO	RO	RO	RO	R/W
Default	0	0	0	0	0	0	0	1

Table 5-22 Data Lane 1 DPHY Control Register

Register Field	Bit	Default	Description
Reserved	[15:10]	0x0	
D1W_CNTRL1	[9]	0x0	Control Bit. Reserved, not assigned. 1'b0: (default).
D1W_CNTRL0	[8]	0x0	Control Bit. Reserved, not assigned. 1'b0: (default).
Reserved	[7:1]	0x0	
D1W_LaneDisable	[0]	0x1	Force Lane Disable for Data Lane 1. 1'b1: Force Lane Disable 1'b0: Bypass Lane Enable from PPI Layer enable. When SCANTESTMODE=1, this register is disabled. When SCANMODE=0, this register is always enabled.

5.2.22 Data Lane 2 DPHY Control Register (D2W_CNTRL:0x014C)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved						D2W_CNTRL1	D2W_CNTRL0
Type	RO	RO	RO	RO	RO	RO	R/W	R/W
Default	0	0	0	0	0	0	0	0
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved							D2W_LaneDisable
Type	RO	RO	RO	RO	RO	RO	RO	R/W
Default	0	0	0	0	0	0	0	1

Table 5-23 Data Lane 2 DPHY Control Register

Register Field	Bit	Default	Description
Reserved	[15:10]	0x0	
D2W_CNTRL1	[9]	0x0	Control Bit. Reserved, not assigned. 1'b0: (default).
D2W_CNTRL0	[8]	0x0	Control Bit. Reserved, not assigned. 1'b0: (default).
Reserved	[7:1]	0x0	
D2W_LaneDisable	[0]	0x1	Force Lane Disable for Data Lane 2. 1'b1: Force Lane Disable 1'b0: Bypass Lane Enable from PPI Layer enable. When SCANTESTMODE=1, this register is disabled. When SCANMODE=0, this register is always enabled.

5.2.23 Data Lane 3 DPHY Control Register (D3W_CNTRL: 0x0150)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved						D3W_CNTRL1	D3W_CNTRL0
Type	RO	RO	RO	RO	RO	RO	R/W	R/W
Default	0	0	0	0	0	0	0	0
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved							D3W_LaneDisable
Type	RO	RO	RO	RO	RO	RO	RO	R/W
Default	0	0	0	0	0	0	0	1

Table 5-24 Data Lane 2 DPHY Control Register

Register Field	Bit	Default	Description
Reserved	[15:10]	0x0	
D3W_CNTRL1	[9]	0x0	Control Bit. Reserved, not assigned. 1'b0: (default).
D3W_CNTRL0	[8]	0x0	Control Bit. Reserved, not assigned. 1'b0: (default).
Reserved	[7:1]	0x0	
D3W_LaneDisable	[0]	0x1	Force Lane Disable for Data Lane 3. 1'b1: Force Lane Disable 1'b0: Bypass Lane Enable from PPI Layer enable. When SCANTESTMODE=1, this register is disabled. When SCANMODE=0, this register is always enabled.

5.2.24 STARTCNTRL (STARTCNTRL: 0x0204)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved							
Type	RO	RO	RO	RO	RO	RO	RO	RO
Default	0	0	0	0	0	0	0	0
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved							START
Type	RO	RO	RO	RO	RO	RO	RO	W
Default	0	0	0	0	0	0	0	0

Table 5-25 STARTCNTRL

Register Field	Bit	Default	Description
Reserved	[15:1]	0x0	
START	[0]	0x0	<p>START control bit of PPI-TX function. By writing 1 to this bit, PPI starts function. 0: Stop function. (default). Writing 0 is invalid and the bit can be set to zero by system reset only. 1: Start function. The following registers are set to appropriate value before starting any transmission by START bit in STARTCTRL register. Once START bit is set to high, the change of the register bits does not affect to function. In order to change the values, initialization by RESET_N is necessary.</p>

5.2.25 STATUS (STATUS: 0x0208)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved							
Type	RO	RO	RO	RO	RO	RO	RO	RO
Default	0	0	0	0	0	0	0	0
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved							BUSY
Type	RO	RO	RO	RO	RO	RO	RO	R
Default	0	0	0	0	0	0	0	0

Table 5-26 STATUS

Register Field	Bit	Default	Description
Reserved	[15:1]	0x0	

BUSY	[0]	0x0	After writing 1 to the START bit in the STARTCNTRL register, this bit is set until RESET_N is asserted. 0: Not Busy. (default) 1: Busy.
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5.2.26 LINEINITCNT (LINEINITCNT: 0x0210)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	LINEINITCNT[15:8]							
Type	R/W							
Default	0x20							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	LINEINITCNT[7:0]							
Type	R/W							
Default	0x8E							

Table 5-27 LINEINITCNT

Register Field	Bit	Default	Description
Reserved	[31:16]		
LINEINITCNT	[15:0]	0x208e	Line Initialization Wait Counter This counter is used for line initialization. Set this register before setting [STARTCNTRL].START = 1. MIPI specification requires that the slave device needs to observe LP-11 for 100 us and ignore the received data before the period at initialization time. The count value depends on HFCLK and the value needs to be set to achieve more than 100 us. The counter starts after the START bit of the STARTCNTRL register is set. The Master device needs to output LP-11 for 100 us in order for the slave device to observe LP-11 for the period. For example, in order to set 100 us when the period of HFCLK is 12 ns, the counter value should be more than $8333.3 = 100 \text{ us} / 12 \text{ ns}$. Default is 0x208E.

5.2.27 LPTXTIMECNT (LPTXTIMECNT: 0x0214)

Bit	B15	B14	B13	B12	B11	B10	B9	B8	
Name	Reserved					LPTXTIMECNT[10:8]			
Type	RO					R/W			
Default	0x00					0x0			
Bit	B7	B6	B5	B4	B3	B2	B1	B0	
Name	LPTXTIMECNT[7:0]								

Type	R/W
Default	0x01

Table 5-28 LPTXTIMECNT

Register Field	Bit	Default	Description
Reserved	[15:11]	0x0	
LPTXTIMECNT	[10:0]	0x1	SYSLPTX Timing Generation Counter The counter generates a timing signal for the period of LPTX. This counter is counted using the HSByteClk (the Main Bus clock), and the value of (setting + 1) * HSByteClk Period becomes the period LPTX. Be sure to set the counter to a value greater than 50 ns.

Set this register before setting [STARTCNTRL].START = 1.

5.2.28 TCLK_HEADERCNT (TCLK_HEADERCNT: 0x0218)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	TCLK_ZEROCNT[7:0]							
Type	R/W							
Default	0x01							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved	TCLK_PREPARECNT[6:0]						
Type	RO	R/W						
Default	0	0x01						

Table 5-29 TCLK_HEADERCNT

Register Field	Bit	Default	Description
TCLK_ZEROCNT	[15:8]	0x1	TCLK_ZERO Counter This counter is used for Clock Lane control in the Master mode. In order to satisfy the timing parameter TCLK-PREPARECNT + TCLK-ZERO for Clock Lane, this counter is used. This counter is counted by HSBYTECLK. Set this register in order to set the minimum time (TCLK-PREPARECNT + TCLK-ZERO) to a value greater than 300 ns. The actual value is ((1 to 2) + (TCLK_ZEROCNT + 1)) x HSByteClkCycle + (PHY output delay). The PHY output delay is about (0 to 1) x HSByteClkCycle in the ByteClk conversion performed during RTL simulation, and is about (2 to 3) x MIPIBitClk cycle in the BitClk conversion.
Reserved	[7]	0x0	

Register Field	Bit	Default	Description
TCLK_PREPARECNT	[6:0]	0x1	<p>TCLK_PREPARE Counter This counter is used for Clock Lane control in the Master mode. In order to satisfy the timing parameter TCLK-PREPARE for Clock Lane, this counter is used. This counter is counted by HSBYTECLK. Set TCLK-PREPARE period that is greater than 38 ns but less than 95 ns. Calculating formula (TCLK_PREPARECNT + 1) x HSByteClkCycle</p>

Set this register before setting [STARTCNTRL].START = 1.

5.2.29 TCLK_TRAILCNT (TCLK_TRAILCNT: 0x021C)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved							
Type	RO							
Default	0x00							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	TCLKTRAILCNT[7:0]							
Type	R/W							
Default	0x01							

Table 5-30 TCLK_TRAILCNT

Register Field	Bit	Default	Description
Reserved	[15:8]	0x0	
TCLK_TRAILCNT	[7:0]	0x1	<p>TCLK_TRAIL Counter This counter is used for Clock Lane control in Master mode. In order to satisfy the timing parameter about TCLK-TRAIL and TEOT for Clock Lane, this counter is used. This counter is counted by HSBYTECLK. Set this register in order to set TCLK-TRAIL to a value greater than 60 ns and TEOT to a value less than 105 ns + 12 x UI. The actual value is (TCLK_TRAILCNT + (1 to 2)) x HSByteClkCycle + (2+(1 to 2)) * HSBYTECLKCycle - (PHY output delay). The PHY output delay is about (0 to 1) x HSByteClkCycle in the ByteClk conversion performed during RTL simulation, and is about (2 to 3) x MIPIBitClk cycle in the BitClk conversion.</p>

Set this register before setting [STARTCNTRL].START = 1.

5.2.30 THS_HEADERCNT (THS_HEADERCNT: 0x0220)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved	THS_ZEROCNT[6:0]						
Type	RO	R/W						
Default	0	0x01						
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved	THS_PREPARECNT[6:0]						
Type	RO	R/W						
Default	0	0x01						

Table 5-31 THS_HEADERCNT

Register Field	Bit	Default	Description
THS_ZEROCNT	[14:8]	0x1	<p>THS_ZERO Counter This counter is used for Data Lane control in Master mode. In order to satisfy the timing parameter about THS-PREPARE + THS-ZERO for Data Lane, this counter is used. This counter is counted by HSBYTECLK. Set this register to set the (THS-PREPARE + THS-ZERO) period, which should be greater than (145 ns + 10 x UI) results. The actual value is ((1 to 2) + 1 + (TCLK_ZEROCNT + 1) + (3 to 4)) x ByteClk cycle + HSByteClk x (2+(1 to 2)) +(PHY delay). The PHY output delay is about (1 to 2) x HSByteClkCycle in the ByteClk conversion performed during RTL simulation, and is about (8+(5 to 6)) x MIPIBitClk cycle in BitClk conversion.</p>
Reserved	[7]	0x0	
THS_PREPARECNT	[6:0]	0x1	<p>THS_PREPARE Counter This counter is used for Data Lane control in Master mode. In order to satisfy the timing parameter about THS-PREPARE for Data Lane, this counter is used. This counter is counted by HSBYTECLK. Set this register in order to set the THS-PREPARE period, which should be greater than (40 ns + 4xUI) and less than (8 5 ns + 6xUI) results. Calculating Formula: (THS_PREPARECNT + 1) x HSByteClkCycle</p>

Set this register before setting [STARTCNTRL].START = 1.

5.2.31 TWAKEUP (TWAKEUP: 0x0224)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	TWAKEUPCNT[15:8]							
Type	R/W							
Default	0x4E							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	TWAKEUPCNT[7:0]							
Type	R/W							
Default	0x20							

Table 5-32 TWAKEUP

Register Field	Bit	Default	Description
Reserved	[31:16]		

Register Field	Bit	Default	Description
TWAKEUPCNT	[15:0]	0x4e20	<p>TWAKEUP Counter</p> <p>This counter is used to exit ULPS state. Ultra-Low Power State is exited by means of a Mark-1 state with a length TWAKEUP followed by a Stop state.</p> <p>This counter is counted by the unit of LPTXIMECNT.</p>

Set this register before setting [STARTCNTRL].START = 1.

5.2.32 TCLK_POSTCNT (TCLK_POSTCNT: 0x0228)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved					TCLK_POSTCNT[10:8]		
Type	RO					R/W		
Default	0x00					0x2		
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	TCLK_POSTCNT[7:0]							
Type	R/W							
Default	0x00							

Table 5-33 TCLK_POSTCNT

Register Field	Bit	Default	Description
Reserved	[15:11]	0x0	
TCLK_POSTCNT	[10:0]	0x200	<p>TCLK_POST Counter</p> <p>This counter is used for Clock Lane control in Master mode.</p> <p>This counter is counted by the HSByteClk.</p> <p>Set a value greater than (60 ns + 52 x UI) results.</p> <p>The actual value is ((1 to 2) + (TCLK_POSTCNT + 1)) x HSByteClk cycle + (1) x HSBYTECLK cycle.</p>

Set this register before setting [STARTCNTRL].START = 1.

5.2.33 THS_TRAILCNT (THS_TRAILCNT: 0x022C)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved							
Type	RO							
Default	0x00							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved				THS_TRAILCNT[3:0]			
Type	RO				R/W			
Default	0x0				0x2			

Table 5-34 THS_TRAILCNT

Register Field	Bit	Default	Description
Reserved	[15:4]	0x0	
THS_TRAILCNT	[3:0]	0x2	<p>THS_TRAIL Counter This counter is used for Data Lane control in Master mode. This counter is counted by HSBYTECLK. Set a value greater 8 x UI or (60 ns + 4 x UI) and less than TEOT which is 105 ns + 12 x UI results. The actual value is (1 + THS_TRAILCNT) x ByteClk cycle + ((1 to 2) + 2) x HSBYTECLK cycle - (PHY output delay). The PHY output delay is about (1 to 2) x HSByteClkCycle in ByteClk conversion performed during RTL simulation and is about (8+(5 to 6)) x MIPIBitClk cycle in BitClk conversion.</p>

Set this register before setting [STARTCNTRL].START = 1.

5.2.34 HSTXVREGCNT (HSTXVREGCNT: 0x0230)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	HSTXVREGCNT[15:8]							
Type	R/W							
Default	0x00							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	HSTXVREGCNT[7:0]							
Type	R/W							
Default	0x20							

Table 5-35 HSTXVREGCNT

Register Field	Bit	Default	Description
HSTXVREGCNT	[15:0]	0x0020	<p>TX Voltage Regulator setup Wait Counter This counter is used for all lanes of HSTXVREG commonly. Counter value is counted by HFCLK. The counter starts when START bit is set. After the counter is counted up, PPI-TX can change the line from LP mode to HS mode. If the counter value is set to zero, there is no wait by the counter. Recommended counter value will be decided by evaluation. It was determined that a value of 200 ns max in the ELDEC TEG skew evaluation results (5/21/2009) is sufficient. LINEINCNT is 100 us, so any value less than that will not affect the value of this counter. The value 1 us is used in the example setting.</p>

Set this register before setting [STARTCNTRL].START = 1.

5.2.35 HSTXVREGEN (HSTXVREGEN: 0x0234)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved							
Type	RO	RO	RO	RO	RO	RO	RO	RO
Default	0	0	0	0	0	0	0	0
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved			D3M_HSTX VREGEN	D2M_HSTX VREGEN	D1M_HST XVREGEN	D0M_HST XVREGEN	CLM_HST XVREGEN
Type	RO	RO	RO	R/W	R/W	R/W	R/W	R/W
Default	0	0	0	0	0	0	0	0

Table 5-36 HSTXVREGEN

Register Field	Bit	Default	Description
Reserved	[15:5]	0x0	
D3M_HSTXVREGEN	[4]	0x0	Voltage regulator enable for HSTX Data Lane 3. In order to reduce power consumption, set to be “disable” when PPI-TX is not used. 0: Disable (Default) 1: Enable
D2M_HSTXVREGEN	[3]	0x0	Voltage regulator enable for HSTX Data Lane 2. In order to reduce power consumption, set to be “disable” when PPI-TX is not used. 0: Disable (Default) 1: Enable
D1M_HSTXVREGEN	[2]	0x0	Voltage regulator enable for HSTX Data Lane 1. In order to reduce power consumption, set to be “disable” when PPI-TX is not used. 0: Disable (Default) 1: Enable
D0M_HSTXVREGEN	[1]	0x0	Voltage regulator enable for HSTX Data Lane 0. In order to reduce power consumption, set to be “disable” when PPI-TX is not used. 0: Disable (Default) 1: Enable
CLM_HSTXVREGEN	[0]	0x0	Voltage regulator enable for HSTX Clock Lane. In order to reduce power consumption, set to be “disable” when PPI-TX is not used. 0: Disable (Default) 1: Enable

Set this register before setting [STARTCNTRL].START = 1.

5.2.36 TXOPTIONCNTRL (TXOPTIONCNTRL: 0x0238)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved							
Type	RO	RO	RO	RO	RO	RO	RO	RO
Default	0	0	0	0	0	0	0	0
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved							CONTCLK MODE
Type	RO	RO	RO	RO	RO	RO	RO	R/W
Default	0	0	0	0	0	0	0	0

Table 5-37 TXOPTIONCNTRL

Register Field	Bit	Default	Description
Reserved	[15:1]	0x0	
CONTCLKMODE	[0]	0x0	Set Continuous Clock Mode Writing “1” to this bit will set the Clock Lane to the Continuous Clock mode regardless of the PPI interface signal and will maintain the Clock Lane output. 0: Non-continuous clock mode. Transitions into the LP11 state in coordination with the Data Lane operation. 1: Continuous clock mode. Maintains the Clock Lane output regardless of the Data Lane operation.

This bit can be rewritten when [STATUS].BUSY is set.

Set this register before setting [STARTCNTRL].START = 1. Do not change this register after START = 1 is set.

5.2.37 BTACNTRL1 (BTACNTRL1: 0x023C)

Bit	B31	B30	B29	B28	B27	B26	B25	B24	
Name	Reserved					TXTAGOCNT[10:8]			
Type	RO	RO	RO	RO	RO	R/W	R/W	R/W	
Default	0	0	0	0	0	0	0	0	
Bit	B23	B22	B21	B20	B19	B18	B17	B16	
Name	TXTAGOCNT[7:0]								
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Default	0	0	0	0	1	0	0	0	
Bit	B15	B14	B13	B12	B11	B10	B9	B8	
Name	Reserved					RXTASURECNT[10:8]			
Type	RO	RO	RO	RO	RO	R/W	R/W	R/W	
Default	0	0	0	0	0	0	0	0	

Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	RXTASURECNT[7:0]							
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Default	0	0	0	0	1	0	0	0

Table 6-29 BTACNTRL1

Register Field	Bit	Default	Description
Reserved	[31:27]	0x0	
TXTAGOCNT	[26:16]	0x8	The TTA-GO period (LP-00 drive period) when drive privileges are released by BTA is set by the setting of this counter. The period for driving LP-00 for the TTA-GO period is $4 \times (\text{TXTAGOCNT} + 1) \times (\text{HSByteClk cycle})$. Set so that the TTA-GO period ($4 \times \text{TLPX}$) described in the MIPI D-PHY specifications results.
Reserved	[15:11]	0x0	
RXTASURECNT	[10:0]	0x8	The timing for starting driving of LP-00 in the TTA-SURE period when drive privileges are obtained by BTA is set by the setting of this counter. The drive start timing is $(\text{RXTASURECNT} + (3 \text{ or } 2)) \times (\text{HSByteClk cycle})$ cycle. Set so as to be within the TTA-SURE period (Min TLPX, Max $2 \times \text{TLPX}$) range described in the MIPI D-PHY specifications.

Set this register before setting [STARTCNTRL].START = 1.

5.2.38 DSI Command Read FIFO STATUS Register (RDFIFO_STATUS: 0x0410)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved							
Type	RO	RO	RO	RO	RO	RO	RO	RO
Default	X	X	X	X	X	X	0	0
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	RxAF	RxAE	RxEEm	Reserved				
Type	RO	RO	RO	RO	RO	RO	RO	RO
Default	0	1	0	X	X	X	X	X

Table 5-38 DSI Command Read FIFO STATUS

Register Field	Bit	Default	Description
Reserved	[15:8]	X	
RxAF	7	0x0	FIFO_ALMOSTFULL This bit indicates that the Receive FIFO is almost full (has less than 3 empty slots).
RxAE	6	0x1	FIFO_ALMOST_EMPTY

Register Field	Bit	Default	Description
			This bit indicates that the Receive FIFO is almost empty (has less than 2 entries).
RxEm	5	0x0	FIFO EMPTYn This bit indicates that the Receive FIFO is not empty.
Reserved	[4:0]	X	

5.2.39 DSI Command Read Data FIFO Register (DSICMD_RDFIFO: 0x0430)

Bit	B31	B30	B29	B28	B27	B26	B25	B24
Name	RDDATA[31:24]							
Type	RO	RO	RO	RO	RO	RO	RO	RO
Default	0	0	0	0	0	0	0	0
Bit	B23	B22	B21	B20	B19	B18	B17	B16
Name	RDDATA[23:16]							
Type	RO	RO	RO	RO	RO	RO	RO	RO
Default	0	0	0	0	0	0	0	0
Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	RDDATA[15:8]							
Type	RO	RO	RO	RO	RO	RO	RO	RO
Default	0	0	0	0	0	0	0	0
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	RDDATA[7:0]							
Type	RO	RO	RO	RO	RO	RO	RO	RO
Default	0	0	0	0	0	0	0	0

Table 5-39 DSI Command Read Data FIFO Register

Register Field	Bit	Default	Description
RDDATA	[31:0]	0x0	RDDATA Data received from the peripheral interface via the DSI link is written to this register.

The data received via a DSI link was written to this register.

5.2.40 DSI Configuration Read Register (DSI_CONFR: 0x040C)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	dsi_mode	Reserved	PrToEn	TaToEn	LrxToEn	HtxToEn	CntDis	EccDis
Type	RO	RO	RO	RO	RO	RO	RO	RO
Default	1	0	1	1	1	1	1	0

Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	TxMd	CrcDis	HsCkMd	Reserved		NOL[1:0]		EoTDis
Type	RO	RO	RO	RO	RO	RO	RO	RO
Default	0	0	0	0	0	0	0	0

Table 5-40 DSI Configuration Read Register

Register Field	Bit	Default	Description
dsi_mode	15	0x1	DSI Mode Selection 0: DSI Mode 1: Reserved
PrToEn	13	0x1	PR_TO_EN 0: Disables the PR_TO timer. 1: Enables the PR_TO timer.
TaToEn	12	0x1	TA_TO_EN 0: Disables the TA_TO timer. 1: Enables the TA_TO timer.
LrxToEn	11	0x1	LPRX_TO_EN 0: Disables the LRX-H_TO timer. 1: Enables the LRX-H_TO timer.
HtxToEn	10	0x1	HSTX_TO_EN 0: Disables the HTX_TO timer. 1: Enables the HTX_TO timer.
CntDis	9	0x1	CONTENTION_DIS This bit disables contention detection.
EccDis	8	0x0	ECC_DISABLE This bit sets operation for when there are multiple-bit ECC errors in the received data. If multiple-bit ECC errors are detected, the ECC Error multi bit (bit 9) bit of the DSI_RXERR register is asserted to "1" regardless of this bit's setting. In the case of ECC single-bit errors, the setting of this bit has no effect on the operation. Single-bit errors can be corrected, so the corrected data can be stored in the Receive FIFO regardless of this bit's setting. At this time, the ECC Error single bit (bit 8) bit of the DSI_RXERR is asserted to "1", and the settings of the DSI_ERR_HALT, and DSI_ERR_INTENA registers are valid. 0: If there are multiple-bit ECC errors in the received data, subsequent processes including the fetching of data from the peripheral interface are terminated and wait for the LP Stop state. Loading to the Receive FIFO of the corresponding packets is not performed. 1: Even if multiple-bit ECC errors are detected in the received data, subsequent processes including the fetching of data from the peripheral interface continue. Either the packet in which multiple bit ECC errors were detected is loaded into the Receive FIFO or the corresponding package waits for a valid Data Type. If the Data Type is invalid, the DSI Data Type no recognized (bit 11) bit of the DSI_RXERR register is set to "1" and the packet is discarded. If a valid Data Type is recognized, the packet is stored in the Receive FIFO. In the case of a long packet, processing continues up to the reception of the data payload.

TxMd	7	0x0	TXMODE 0: Low power transfer is performed to Tx. 1: High-Speed data transfer is performed to Tx.
CrcDis	6	0x0	CRC_DISABLE Operation for when a CRC error was found in the received data is set. (For long packets only) 0: CRC checking of received long packets is performed. If CRC errors exist in the received data, the CRC Error bit (bit 10) of the DSI_RXERR register is asserted to "1". Transfers to the Receive FIFO for the received data are performed. 1: CRC checking of received long packets is not performed. Even if there are CRC errors in the received data, no notification is made to the DSI_RXERR register. The CRC errors are ignored and transfers to the Receive FIFO for the received data are performed.
HsCkMd	5	0x0	HSCLOCKMODE 0: Operation is in the discontinuous clock mode. 1: Operation is in the continuous clock mode.
Reserved	[4:3]	0x0	
NOL	[2:1]	0x0	NOL This field specifies the number of HS lanes. This field is also used as the LP Lane Enable setting. Data Lane 0 is used as the Enable for LP communication and ULPS. Data Lane 1 or higher is used as the Enable for ULPS. This setting can only be made during initial setup or during reset. 00: Only Data Lane 0 is used. 01: Data Lanes 0 and 1 are used. 10: Data Lanes from 0 to 2 are used. 11: Data Lanes 0 to 3 are used.
EoTDis	0	0x0	EOT_DISABLE 0: The EOT packet is automatically granted at the end of HS transfer then is transmitted. 1: The EOT packet is not automatically granted at the end of HS transfer and is not transmitted.

Only indirect writing, i.e. write to DSI_CONFV Register is possible.

5.2.41 DSI Configuration Register (DSI_CONFV: 0x0500)

Bit	B31	B30	B29	B28	B27	B26	B25	B24
Name	MODE			Address				
Type	WO	WO	WO	WO	WO	WO	WO	WO
Default	0	0	0	0	0	0	0	0
Bit	B23	B22	B21	B20	B19	B18	B17	B16
Name	Reserved[23:16]							
Type	WO	WO	WO	WO	WO	WO	WO	WO
Default	0	0	0	0	0	0	0	0
Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	DATA[15:8]							
Type	WO	WO	WO	WO	WO	WO	WO	WO

Default	0	0	0	0	0	0	0	0
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	DATA[7:0]							
Type	WO	WO	WO	WO	WO	WO	WO	WO
Default	0	0	0	0	0	0	0	0

Table 5-41 DSI Configuration Write Register

Register Field	Bit	Default	Description
MODE	[31:29]	0x0	Set or Clear DSI_CONFR (0x040C) Bits 3'b101: Set Register Bits in DSI_CONFR as indicated in DATA field 3'b110: Clear Register Bits in DSI_CONFR as indicated in DATA field Others: Reserved
Address	[28:24]	0x0	Address Field Set to 0x03, all others are reserved
Reserved	[23:16]	0x0	
DATA	[15:0]	0x0	DATA Field When location DATA[n] is set to '1', the corresponding bit at DSI_CONFR[n] will be cleared or set depending on MODE bits described above. Multiples bits can be set simultaneously

Note: Write to DSI_CONFR Register results to changes in corresponding bit changed in DSI_CONFR Register.

5.2.42 DSI START Register (DSI_START: 0x0518)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved[15:8]							
Type	RO	RO	RO	RO	RO	RO	RO	RO
Default	0	0	0	0	0	0	0	0
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved[7:1]							Strt
Type	RO	RO	RO	RO	RO	RO	RO	WO
Default	0	0	0	0	0	0	0	0

Table 5-42 DSI_START

Register Field	Bit	Default	Description
Reserved	[15:1]	0x0	
Strt	0	0x0	DSI_START 0: The clock is not supplied to modules other than CONIF. 1: The clock is supplied to all modules. When "1" is written to this bit, the clock is supplied to modules other than the DSI-TX CONIF. To start DSI-TX operation, set this bit to "1" after a reset is performed. This bit must be set to "1" even when accessing registers other than DSI_START. Once this bit is set to "1", writing of "0" is

			not allowed. Perform a reset to change this bit from “1” to “0”.
--	--	--	--

5.2.43 DSI Command Packet Start Transmit Register (DSICMD_TX: 0x0600)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved							
type	RO							
Default	0x0							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved							dc_start
type	RO							R/W
Default	0x0							0x0

Table 5-43 DSI Command Packet Start Transmit Register

Register Field	Bit	Default	Description
Reserved	[15:1]	0x0	Reserved
dc_start	[0]	0x0	DCS Command Start 1'b0: Idle 1'b1: Start DCS Command transfer Note: This bit will be reset after DCS command send out to DSITX

5.2.44 DCS Command Type Register (DSICMD_TYPE: 0x0602)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	PktType							
type	R/W							
Default	0x0							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Data ID							
type	R/W							
Default	0x0							

Table 5-44 DSI Command Packet Type Register

Register Field	Bit	Default	Description
PktType	[15:8]	0x0	DSI Short or Long Packet Type There are only two valid values: 0x10: DSI Short Packet 0x40: DSI Long Packet Others : Reserved
DataID	[7:0]	0x0	DSI Packet Data ID Please refer to MIPI DSI specification

5.2.45 DSI Command Packet Word Count Register (DSICMD_WC: 0x0604)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved							
type	RO							

Default	0x0							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved				dc_wc			
type	RO				R/W			
Default	0x0				0x0			

Table 5-45 DSI Command Packet Word Count Register

Register Field	Bit	Default	Description
Reserved	[15:4]	0x0	
dc_wc	[3:0]	0x0	DSI Command Packet Word Count

5.2.46 DSI Command Packet Data Register 0 (DSICMD_WD0: 0x0610)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	dc_word1							
type	R/W							
Default	0x0							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	dc_word0							
type	R/W							
Default	0x0							

Table 5-46 DSI Command Packet Data Register 0

Register Field	Bit	Default	Description
dc_word1	[15:8]	0x0	Word 1 - DSI Command Packet Data Byte 1
dc_word0	[7:0]	0x0	Word 0 - DSI Command Packet Data Byte 0 Word 0 = {Byte1, Byte0}

5.2.47 DSI Command Packet Data Register 1 (DSICMD_WD1: 0x0612)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	dc_word3							
type	R/W							
Default	0x0							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	dc_word2							
type	R/W							
Default	0x0							

Table 5-47 DSI Command Packet Data Register 1

Register Field	Bit	Default	Description
dc_word3	[15:8]	0x0	Word 3 - DSI Command Packet Data Byte 3
dc_word2	[7:0]	0x0	Word 2 - DSI Command Packet Data Byte 2

5.2.48 DSI Command Packet Data Register 2 (DSICMD_WD2: 0x0614)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	dc_word5							

type	R/W							
Default	0x0							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	dc_word4							
type	R/W							
Default	0x0							

Table 5-48 DSI Command Packet Data Register 2

Register Field	Bit	Default	Description
dc_word5	[15:8]	0x0	Word 5 - DSI Command Packet Data Byte 5
dc_word4	[7:0]	0x0	Word 4 - DSI Command Packet Data Byte 4

5.2.49 DSI Command Packet Data Register 3 (DSICMD_WD3: 0x0616)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	dc_word7							
type	R/W							
Default	0x0							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	dc_word6							
type	R/W							
Default	0x0							

Table 5-49 DSI Command Packet Data Register 3

Register Field	Bit	Default	Description
dc_word7	[15:8]	0x0	Word 7 - DSI Command Packet Data Byte 7
dc_word6	[7:0]	0x0	Word 6 - DSI Command Packet Data Byte 6

5.2.50 DSI Event Mode Register (DSI_EVENT: 0x0620)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved							
type	RO							
Default	0x0							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	Reserved							tx_msel
type	RO							R/W
Default	0x0							0x0

Table 5-50 DSI Event Mode Register

Register Field	Bit	Default	Description
Reserved	[15:1]	0x0	
tx_msel	[0]	0x0	DSI Hsync Tx Mode select 0: Pulse mode 1: Event mode

5.2.51 DSI Vsync Width Register 1 (DSI_VSW: 0x0622)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved						tx_vsw	
type	RO						R/W	
Default	0x0						0x0	
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	tx_vsw							
type	R/W							
Default	0x0							

Table 5-51 DSI Vsync Width Register

Register Field	Bit	Default	Description
Reserved	[15:10]	0x0	
tx_vsw	[9:0]	0x0	Blank Line during Vertical blank 0: illegal 1: 1 blank line ...

5.2.52 DSI VBPR Register (DSI_VBPR: 0x0624)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved						tx_vbp	
type	RO						R/W	
Default	0x0						0x0	
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	tx_vbp							
type	R/W							
Default	0x0							

Table 5-52 DSI VBPR Register

Register Field	Bit	Default	Description
Reserved	[15:10]	0x0	
tx_vbp	[9:0]	0x0	Vertical Blank Back Porch 0: 0 blank line 1: 1 blank line ...

5.2.53 DSI Vertical Active Register (DSI_VACT: 0x0626)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	Reserved						tx_val	
type	RO						R/W	
Default	0x0						0x0	
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	tx_val							
type	R/W							
Default	0x0							

Table 5-53 DSI VACT Register

Register Field	Bit	Default	Description
Reserved	[15:12]	0x0	
tx_val	[11:0]	0x0	Vertical Active Line 0: illegal 1: 1 active line ...

5.2.54 DSI Hsync Width Register (DSI_HSW: 0x0628)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	tx_hsw							
Type	R/W							
Default	0x01							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	tx_hsw							
Type	R/W							
Default	0x00							

Table 5-54 DSI Hsync Width Register

Register Field	Bit	Default	Description
tx_hsw	[15:0]	0x0	Horizontal Blank Width Count $tx_hsw = INT\{ ((hsw \text{ in pixel} * \text{ByteClk_freq}) / \text{PCLK_freq}) * \text{DSI \#Data lane}\}$ Note: if enable Event mode, this count included Horizontal Back porch

5.2.55 DSI HBPR Register (DSI_HBPR: 0x062A)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
Name	tx_hbp							
Type	R/W							
Default	0x01							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	tx_hbp							
Type	R/W							
Default	0x0							

Table 5-55 DSI HBPR Register

Register Field	Bit	Default	Description
tx_hbp	[15:0]	0x0	Horizontal Back Porch Count $tx_hbp = INT\{ ((hbp \text{ in pixel} * \text{HSByteCLK_freq}) / \text{PCLK_freq}) * \text{DSI \#Data lane}\}$

5.2.56 DSI Horizontal Active Register (DSI_HACT: 0x062C)

Bit	B15	B14	B13	B12	B11	B10	B9	B8
-----	-----	-----	-----	-----	-----	-----	----	----

Name	tx_hal							
type	R/W							
Default	0x0							
Bit	B7	B6	B5	B4	B3	B2	B1	B0
Name	tx_hal							
type	R/W							
Default	0x0							

Table 5-56 DSI Horizontal Active Register

Register Field	Bit	Default	Description
tx_hal	[15:0]	0x0	Horizontal Active Line Word Count tx_hal = (hal in pixel * #byte per pixel) Note: tx_hal indicates byte count (count by HS Byte clock)

6 Package

The packages for TC358768XBG are described in the figures below.

P-VFBGA72-0404-0.40A3

"Unit : mm"

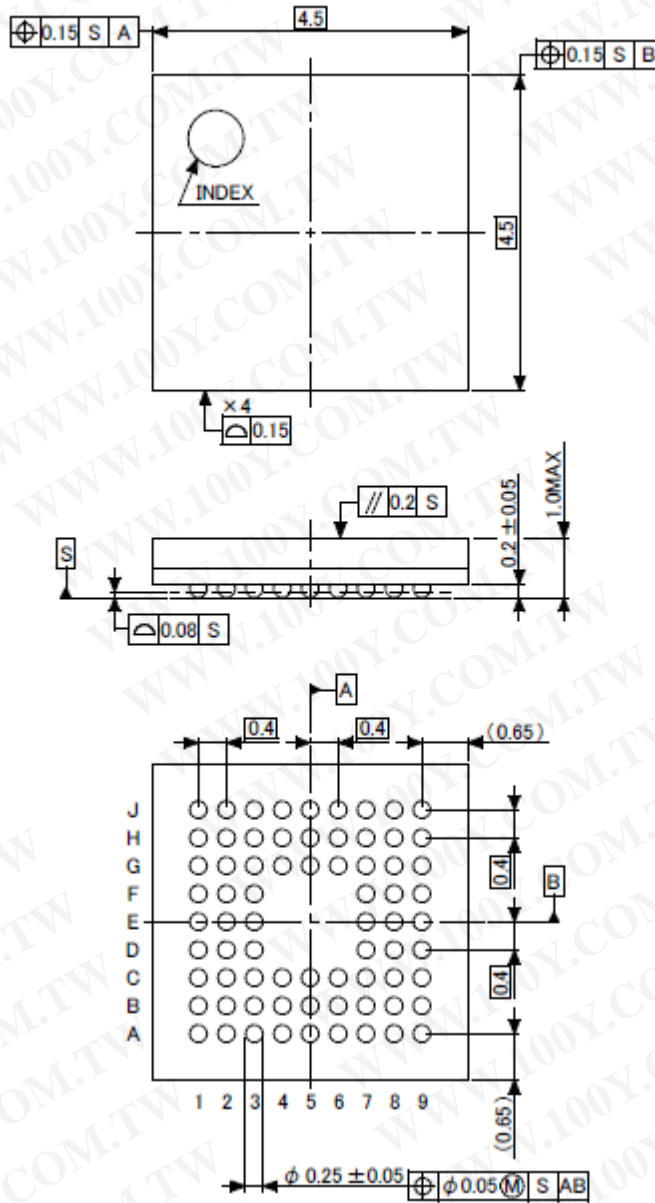


Figure 6-1 P-VFBGA72-0404-0.40A3 package

Table 6-1 P-VFBGA72-0404-0.40A3 Mechanical Dimension

Dimension	Min.	Typ.	Max.
Solder ball pitch	---	0.4 mm	---
Solder ball height	0.15 mm	0.2 mm	0.205 mm
Package dimension	---	4.5 x 4.5 mm ²	---
Package height	---	---	1.0 mm

7 Electrical Characteristics

7.1 Absolute Maximum Ratings

VSS= 0V reference

Parameter	Symbol	Rating	Unit
Supply voltage (1.8V - Digital IO)	VDDIO	-0.3 ~ +3.9	V
Supply voltage (1.2V - Digital Core)	VDDC	-0.3 ~ +1.8	V
Supply voltage (1.2V - MIPI PHY)	VDD_MIPI	-0.3 ~ +1.8	V
Input voltage (DSI IO)	V _{IN_DSI}	-0.3 ~ VDD_MIPI+0.3	V
Output voltage (DSI IO)	V _{OUT_DSI}	-0.3 ~ VDD_MIPI+0.3	V
Input voltage (Digital IO)	V _{IN_IO}	-0.3 ~ VDDIO+0.3	V
Output voltage (Digital IO)	V _{OUT_IO}	-0.3 ~ VDDIO+0.3	V
Junction temperature	T _j	125	°C
Storage temperature	T _{stg}	-40 ~ +125	°C

7.2 Recommended Operating Condition

VSS= 0V reference

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply voltage (1.8V - Digital IO)	VDDIO	1.65	1.8	1.95	V
Supply voltage (3.3V - Digital IO)	VDDIO	3.0	3.3	3.6	V
Supply voltage (1.2V - Digital Core)	VDDC	1.1	1.2	1.3	V
Supply voltage (1.2V - MIPI PHY)	VDD_MIPI	1.1	1.2	1.3	V
Operating temperature (ambient temperature with voltage applied)	T _a	-30	+25	+85	°C
Supply Noise Voltage	V _{SN}			100	mV _{pp}

7.3 DC Electrical Specification

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input voltage, High level input ^{Note1}	V _{IH}	0.7 VDDIO		VDDIO	V
Input voltage, Low level input ^{Note1}	V _{IL}	0		0.3 VDDIO	V
Input voltage High level CMOS Schmitt Trigger ^{Note1,2}	V _{IHS}	0.7 VDDIO		VDDIO	V
Input voltage Low level CMOS Schmitt Trigger ^{Note1,2}	V _{ILS}	0		0.3 VDDIO	V

Output voltage High level (Condition: $I_{OH} = -0.4mA$)	V_{OH}	0.8 VDDIO		VDDIO	V
Output voltage Low level (Condition: $I_{OL} = 2mA$)	V_{OL}	0		0.2 VDDIO	V
Input leak current, High level (Normal IO or Pull-up IO) (Condition: $V_{IN} = +VDDIO$, VDDIO = 3.6V)	I_{ILH1}	-10	-	10	μA
Input leak current, High level (Pull-down IO) (Condition: $V_{IN} = +VDDIO$, VDDIO = 3.6V)	I_{ILH2}	-	-	100	μA
Input leak current, Low level (Normal IO or Pull-down IO) (Condition: $V_{IN} = 0V$, VDDIO = 3.6V)	I_{ILL1}	-10	-	10	μA
Input leak current, Low level (Pull-up IO) (Condition: $V_{IN} = 0V$, VDDIO = 3.6V)	I_{ILL2}	-	-	200	μA

Note1 : Each power source is operating within recommended operation condition.

Note2 : Current output value is specified to each IO buffer individually. Output voltage changes with output current value.

Note3 : Normal pin or Pull-up IO pin applied VDDIO supply voltage to V_{in} (input voltage)

Note4 : Normal pin or Pull-down IO pin applied VSSIO (0V) to V_{in} (input voltage)

8 Timing Definitions

8.1 MIPI – 2 Timings

Timing specification below has been ported from Draft MIPI Alliance specification for D-PHY version 0.91.00 r0.01. Timing defined in Draft MIPI Alliance specification for D-PHY version 0.91.00 r0.01 has precedence over timing described in the sections below.

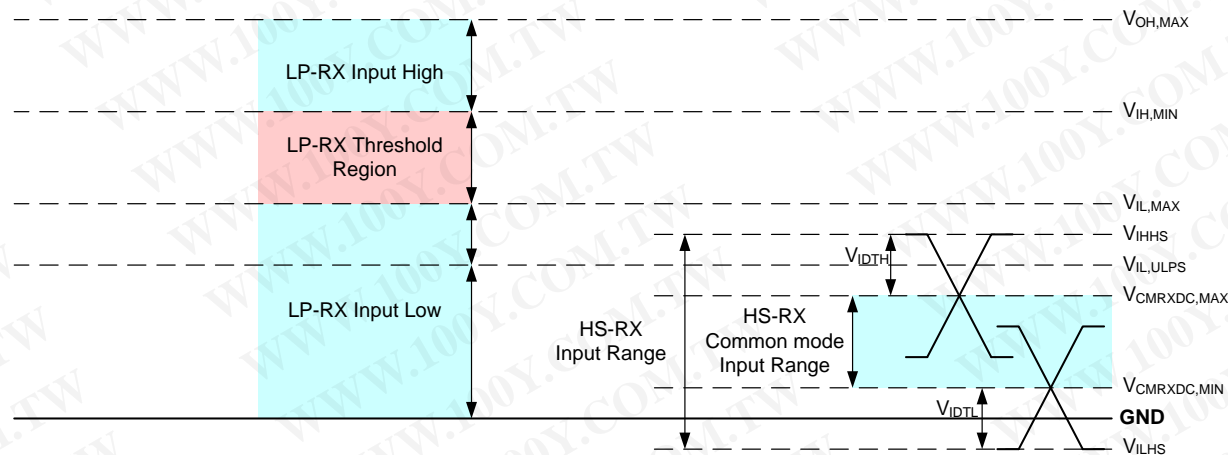


Figure 8-1 Signaling and voltage levels

Table 8-1 DC specifications

Parameter	Description	Min	Nom	Max	Units	Notes
V_{PIN}	Pin signal voltage range	-50		1350	mV	
$V_{PIN(absmax)}$	Transient pin voltage	-0.15		1.45	V	
$T_{VPIN(absmax)}$	Maximum transient time above $V_{PIN(absmax)}$ or below $V_{PIN(absmax)}$.			20	ns	3
V_{OH}	Thevenin output high level	1.1	1.2	1.3	V	
V_{IH}	Logic 1 input voltage	880			mV	
V_{IL}	Logic 0 input voltage, not in ULP State			550	mV	
$V_{IL-ULPS}$	Logic 0 input voltage, ULP State			300	mV	
$V_{CMRX(DC)}$	Common-mode voltage HS receiver mode	70		330	mV	1,2
V_{IDTH}	Differential input high threshold			70	mV	
V_{IDTL}	Differential input low threshold	-70			mV	
V_{IHHS}	Single-ended input high voltage			460	mV	1

V_{ILHS}	Single-ended input low voltage	-40			mV	1
------------	--------------------------------	-----	--	--	----	---

Notes:

1. Excluding possible additional RF interference of 100mV peak sine wave beyond 450MHz.
2. This table value included a ground difference of 50mV between the transmitter and the receiver, the static common-mode level tolerance and variations below 450MHz.
3. The voltage undershoot or overshoot beyond V_{PIN} is only allowed during a single 20 ns window after any LP-0 LP-1 transition or vice versa. For all other situations it must stay within the V_{PIN} range.

Table 8-2 High Speed AC specifications

Parameter	Description	Min	Nom	Max	Units	Notes
$\Delta V_{CMRX(HF)}$	Common-mode interference beyond 450MHz			100	mV	2
$\Delta V_{CMRX(LF)}$	Common-mode interference 50MHz- 450MHz	-50		50	mV	1,3

Notes:

1. Excluding `static` ground shift of 50mV
2. $\Delta V_{CMRX(HF)}$ is the peak amplitude of a sine wave superimposed on the receiver inputs.
3. Voltage difference compared to the DC average common-mode potential.

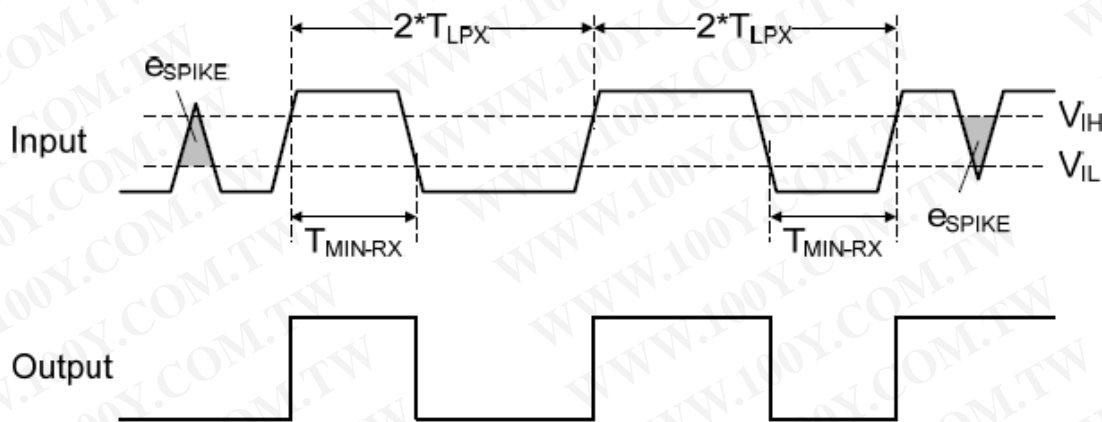


Figure 8-2 Input Glitch Rejection

Table 8-3 Low Power AC characteristics

Parameter	Description	Min	Nom	Max	Units	Notes
e_{SPIKE}	Input pulse rejection			300	V.ps	1,2,3
T_{MIN-RX}	Minimum pulse width response	20			ns	4

V_{INT}	Peak interference amplitude			200	mV	
F_{INT}	Interference frequency	450			MHz	
T_{LPX}	Length of any Low Power state period	50			ns	

Notes:

1. Time-voltage integration of a spike above V_{IL} when being in LP-0 or below V_{IH} when being in LP-1 state.
2. An impulse less than this will not change the receiver state.
3. In addition to the required glitch rejection, implementers shall ensure rejection of known RF-interferers.
4. An input pulse greater than this shall toggle the output.

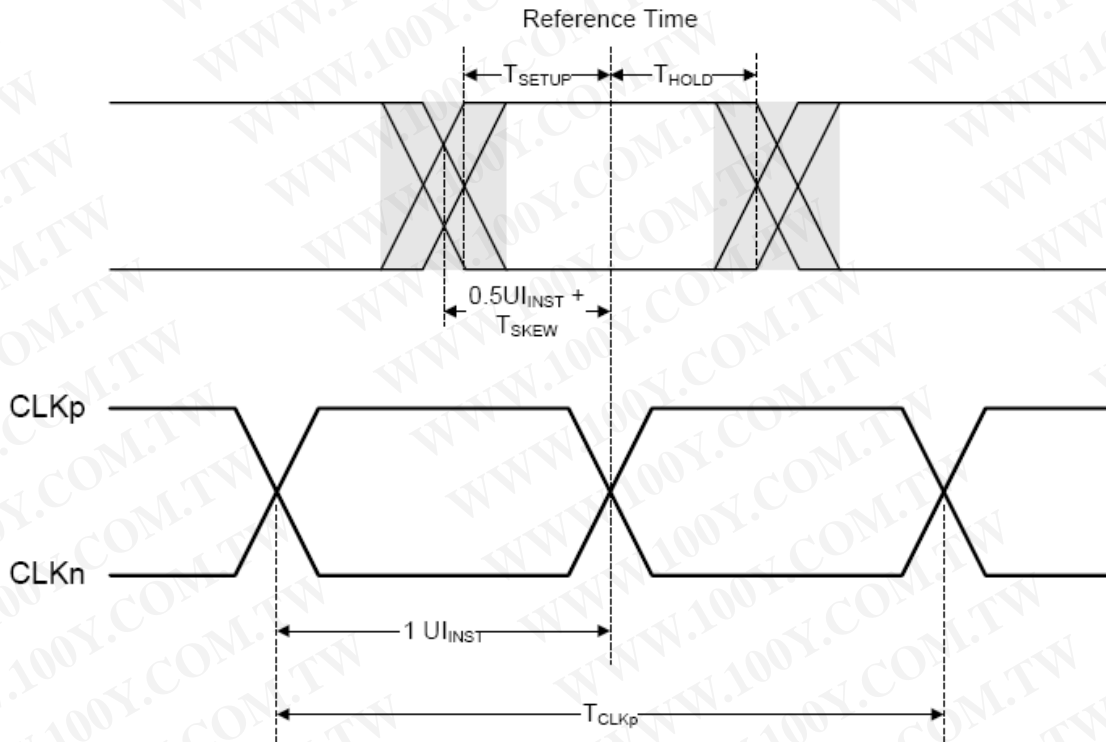


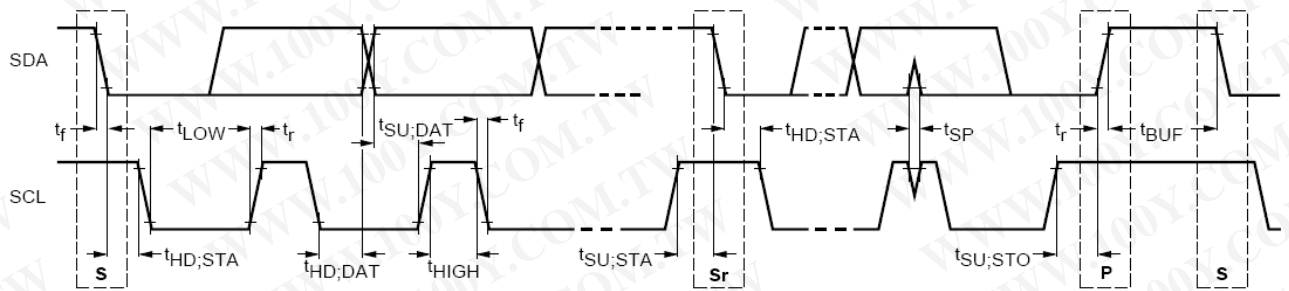
Figure 8-3 Data to clock timing reference

Table 8-4 Data-Clock timing specification

Parameter	Description	Min	Nom	Max	Units	Notes
T_{SKEW}	Data to clock skew measured at the transmitter	-0.15		0.15	UI_{INST}	
T_{SETUP}	Data to clock setup time at	0.15			UI_{INST}	

	receiver					
T_{HOLD}	clock to data hold time at receiver	0.15			U_{INST}	
U_{INST}	1 Data bit time (instantaneous)			12.5	ns	
T_{CLKp}	Period of dual data rate clock	2	2	2	U_{INST}	

8.2 I2C Timings



Item	Symbol	Min	Max	Unit
SCL clock frequency	f_{SCL}	0	400	kHz
Hold time (repeated) START condition. After this period, the first clock pulse is generated	$t_{HD,STA}$	0.6	-	μ s
LOW period of the SCL clock	t_{LOW}	1.3	-	μ s
HIGH period of the SCL clock	t_{HIGH}	0.6	-	μ s
Set-up time for a repeated START condition	$t_{SU,STA}$	0.6	-	μ s
Data hold time: for I2C-bus devices	$t_{HD,DAT}$	0	0.9	μ s
Data set-up time	$t_{SU,DAT}$	100	-	ns
Rise time of both SDA and SCL signals	t_r	$20+0.1C_b$	300	ns
Fall time of both SDA and SCL signals	t_f	$20+0.1C_b$	300	ns

Set-up time for STOP condition	$t_{SU,STO}$	0.6	-	μs
Bus free time between a STOP and START condition	t_{BUF}	1.3	-	μs

Note: C_b = Capacitive load for each bus line (400pF max.)

8.3 Parallel Port Input Timings

Table 8-5 Parallel Input timing

Parameter	Description	Min.	Typ.	Max.	Units
$T_{pd:SU}$	Setup time of data	2	-	-	ns
$T_{pd:HD}$	Hold time of data	1	-	-	ns
$T_{pd:CLK}$	Clock period	6	-	-	ns

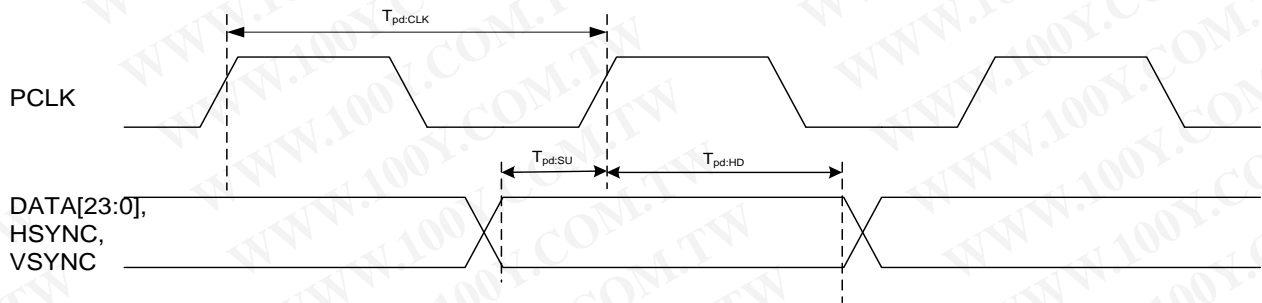


Figure 8-4 Parallel Input timing

Table 8-6 Parallel Vertical timing

Parameter	Description	Min.	Typ.	Max.	Units
T_{VP}	Vertical Sync Period	2	-	-	Lines
T_{VBP}	Vertical Back Porch	2	-	-	Lines
T_{VAFP}	Vertical Active Frame Period	16	-	4096	Lines
T_{VFP}	Vertical Front Porch	2	-	-	Lines

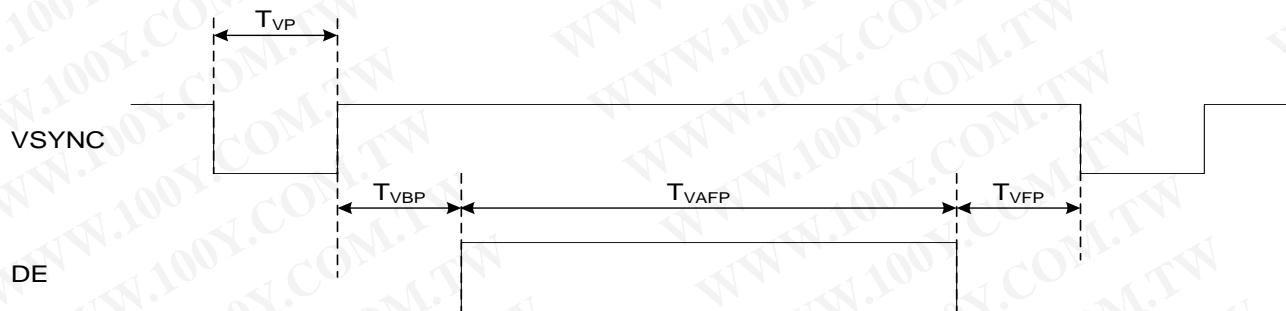


Figure 8-5 Parallel Vertical timing

Table 8-7 Parallel Horizontal timing

Parameter	Description	Min.	Typ.	Max.	Units
T_{HP}	Horizontal Sync Period	2	-	-	PCLK
T_{HBP}	Horizontal Back Porch	2	-	-	PCLK
T_{HAFF}	Horizontal Active Line Period	16	-	1920	PCLK
T_{HFP}	Horizontal Front Porch	2	-	-	PCLK

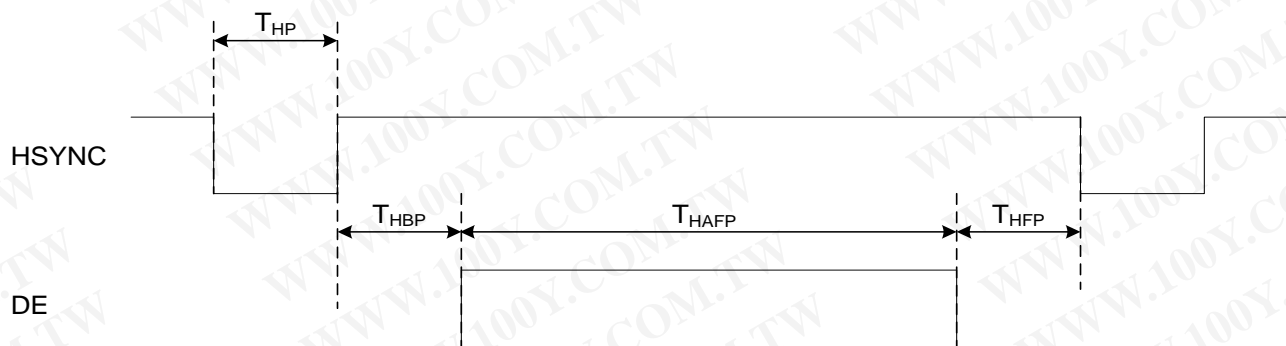


Figure 8-6 Parallel Horizontal timing

8.4 SPI Input/Output Timings

Table 8-8 SPI timing

Parameter	Symbol	Min	Typ	Max	Unit
SPI Clock Frequency	f_{SEIS}	—	—	25	MHz
Clock to Data (MISO) Valid Time	t_{SOD}	—	—	15	ns
Clock to Data (MISO) Invalid Time	t_{SOH}	0	—	—	ns
Data in (MOSI) Setup Time	t_{SIS}	5	—	—	ns
Data in (MOSI) Hold Time	t_{SIH}	5	—	—	ns
Slave Select to Data (MISO) Valid Time	t_{SSDV}	—	—	25 ¹	ns
Slave Select to Clock	t_{SSTC}	$3/f_{SYS}$	—	—	ns
Consecutive Transfer Delay Time	t_{CTDT}	$1/f_{SEIS}$	—	—	ns
Load on SEI Interface Signals	C_{IF}	—	—	10	pF

Notes: Maximum loading of MISO is 10pF

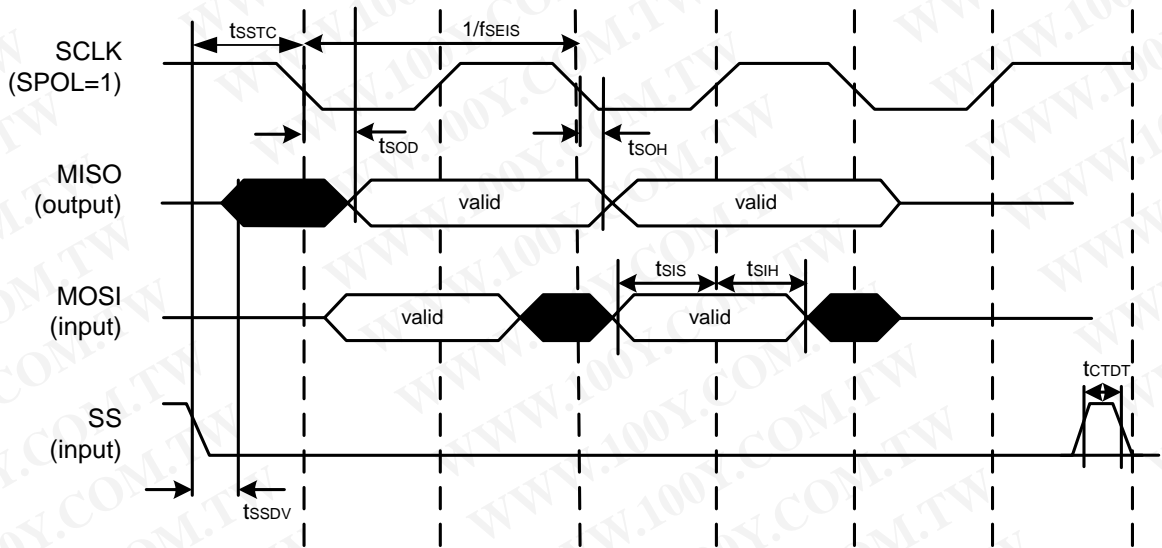


Figure 8-7 SPI timing (data valid on second active clock edge)