

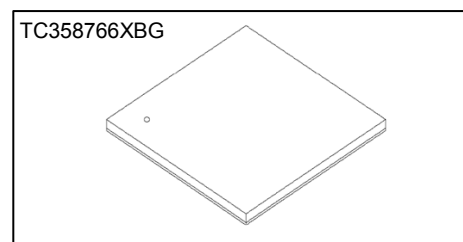
CMOS Digital Integrated Circuit Silicon Monolithic

TC358766XBG

Mobile Peripheral Devices

Overview

The DSI/DPI to DisplayPort™ converter TC358766XBG is a bridge device that enables video streaming from a Host (application or baseband processor) over MIPI® DSI or DPI link to drive DisplayPort™ display panels.



P-VFBGA120-0606-0.50AZ
Weight: 62mg (Typ.)

Features

- Translates MIPI® DSI/DPI Link video stream from Host to DisplayPort™ Link data to external display devices.
- The inputs are driven by a DSI Host with 4-Data Lanes, upto1 Gbps/lane or DPI Host with 16/18/24 bit interface upto154 MHz parallel clock.
- Supports HDCP Digital Content Protection version 1.3 (DisplayPort™ amendment Rev1.1).
- The output Interface consists of a DisplayPort™ Tx with a 2-lane Main Link and AUX-Ch.
- Register Configuration: From DSI link, SPI or I²C interface (only one of the SPI and I²C interfaces can be active at any time).
- Internally generated H/VSync in DSI mode can be muxed out to Host.
- Interrupt to host to inform any error status or status needing attention from Host.
- Internal test pattern (color bar) generator for DP o/p testing without any video (DSI/DPI) i/p.
- Debug/Test Port: I²C Slave
- **DSI Receiver:** Supports one DSI Interface between TC358766XBG and Host.
 - ✧ MIPI® DSI: v1.01 / MIPI® D-PHY: v0.90 Compliant.
 - ✧ Up to four (4) Data Lanes with Bi-direction support on Data Lane 0.
 - ✧ Maximum speed at 1 Gbps/lane.
 - ✧ Supports Burst as well as Non-Burst Mode Video Data.
 - Video data packets are limited to one row per Hsync period.
 - ✧ Supports video stream packets for video data transmission.
 - ✧ Supports generic long packets for accessing the chip's register set.
 - ✧ Video input data formats:
 - RGB-565, RGB-666 and RGB-888.
 - New DSI V1.02 Data Type Support: 16-bit YCbCr 422
 Interlaced video mode is not supported.
- **DPI Receiver:** Supports one DPI Interface between TC358766XBG and Host.
 - ✧ Up to 16 / 18 / 24 bit parallel data interface.
 - ✧ Maximum speed at 154 MPs (MPixel per sec).
 - ✧ Video input data formats: RGB-565, RGB-666 and RGB-888.
 - ✧ Only Progressive mode supported.
 - ✧ Shutdown support (can be used in non-DPI mode also).
- **DisplayPort™ Interface:** Supports a DisplayPort™ link from TC358766XBG to display panels.
 - ✧ High speed serial bridge chip using VESA DisplayPort™ 1.1a Standard.
 - ✧ Supports one dual-lane DisplayPort™ port for high bandwidth applications
 - ✧ Supports up to two (2) single-lane ports for connection to two DisplayPort™ panels.
 - ✧ Support 1.62 or 2.7 Gbps/lane data rate with voltage swings @0.4, 0.6, 0.8 or 1.2V
 - ✧ Support of pre-emphasis levels of 0, 3.5dB and 6dB.
 - ✧ Supports Audio related Secondary Data Packets
 - ✧ AUX channel supported at 1 Mbps.
 - ✧ HPD support through GPIO[1:0] based interrupts
 - ✧ Enhanced mode supported for HDCP content protection. Support HDCP encryption Version 1.3 with DisplayPort™ amendment Revision 1.1. (on DisplayPort™0 in case two port configuration is used)
 - ✧ Stream Policy Maker is assumed handled by the Host (software/firmware).
 - Start Link training in response to HPD & read final Link training status
 - Configure DP link for actual video streaming & start video streaming

- ✧ Link Policy maker is assumed shared between the Host and TC358766XBG chip.
 - In auto_correction = 0 mode, control link training
 - Initiate Display device capabilities read and configure TC358766XBG accordingly.
- ✧ Video timing generation as per panel requirement.
- ✧ SSCG with up to 30 kHz modulation to reduce EMI.
- ✧ Toshiba Magic Square algorithm – RGB666 18b produces RGB888 24b like quality (with up to 16-million colors).
- ✧ Built in PRBS7 Generator to test DisplayPort™ Link.
- **RGB Parallel Output Interface:**
 - ✧ RGB888 output mode (DisplayPort™ disabled) with only DSI input supported in this mode
 - ✧ PCLK max = 100 MHz
 - ✧ Polarity control for PCLK, VSYNC, HSYNC & DE.
- **I²C Interface:**
 - ✧ I²C slave interface for chip register set access enabled using a boot-strap option.
 - ✧ I²C compliant slave interface support for normal (100 kHz) and fast mode (400 kHz).
- **SPI Interface:**
 - ✧ SPI slave interface for chip register set access enabled using a boot-strap option.
 - ✧ SPI interface support for up to 30 MHz operation.
- **GPIO Interface:**
 - ✧ 2 bits of GPIO (shared with other digital logic).
 - ✧ Direction controllable by Host I²C accesses.
- **Clock Source:**
 - ✧ DisplayPort™ clock source is from an external clock input or clock from DSI interface (13, 26, 19.2 or 38.4 MHz) – generates all internal & output clocks to interfacing display devices.
 - ✧ Built-in PLLs generate high-speed DisplayPort™ link clock requiring no external components. These PLLs are part of the DisplayPort™ PHY.
- Clock and power management support to achieve low power states.
- **Possible modes of Operation:** Supports six (6) modes of operation:
 - ✧ MODE S21: TC358766XBG uses DisplayPort™ Tx as single 2-lane DisplayPort™ link to interface to single DisplayPort™ display device. Video stream source is from MIPI® DSI Host.
 - ✧ MODE S22: TC358766XBG uses DisplayPort™ Tx port as two independent 1-lane DisplayPort™ links to interface to two (2) DisplayPort™ display devices. Video stream source is from MIPI® DSI Host. Same video stream can be displayed on two display devices.
 - ✧ MODE P21: TC358766XBG uses DisplayPort™ Tx as single 2-lane DisplayPort™ link to interface to single DisplayPort™ display device. Video stream source is from MIPI® DPI Host.
 - ✧ MODE P22: TC358766XBG uses DisplayPort™ Tx port as two independent 1-lane DisplayPort™ links to interface to two (2) DisplayPort™ display devices. Video stream source is from MIPI® DPI Host. Same video stream is displayed on two display devices.
 - ✧ MODE SP22: TC358766XBG uses DisplayPort™ Tx as two independent DisplayPort™ output links (each single lane). TC358766XBG routes the DSI input to one DisplayPort™ Tx link and routes the DPI input to the second DisplayPort™ Tx link.
 - ✧ MODE S2P: TC358766XBG uses only Parallel output port and disables DisplayPort™ Tx to interface to single RGB display device. Video stream source is from MIPI® DSI Host.
- **Power supply inputs**
 - ✧ Core and MIPI® D-PHY: 1.2V ±0.06V
 - ✧ Digital I/O: 1.8V ±0.09V
 - ✧ DisplayPort™: 1.8V ±0.09V
 - ✧ DisplayPort™: 1.2V ±0.06V
- **Power Consumptions (based on estimations)**
 - ✧ Power-down mode (DSI-Rx in ULPS, DP PHY & PLLs disabled, clocks stopped):
 - DSI Rx: 0.01 mW
 - DP PHY: 2.34 mW
 - PLL9: 0.01 mW
 - Core: 0.96 mW
 - Rest: 0.01 mW
 - ✧ Normal operation (1920 x 1080 resolution with DSI-Rx in 4-lane @925 Mbps per lane, DP PHY in dual lane link @2.7 Gbps per lane):
 - DSI Rx: 21.79 mW
 - DP PHY: 142.70 mW
 - PLL9: 2.42 mW
 - Core: 87.64 mW
 - IOs: 1.68 mW

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1. Overview

The DSI/DPI to DisplayPort™ converter (TC358766XBG) is a bridge device that enables video streaming from a Host (application or baseband processor) over MIPI® DSI or DPI link to drive DisplayPort™ display panels. TC358766XBG provides a low power bridge solution to efficiently translate MIPI® DSI or DPI transfers to DisplayPort™ transfers. As the DisplayPort™ uses fewer wires compared to other existing display panel standards, it simplifies the LCD connectivity. The effect of using TC358766XBG is to enable existing baseband devices supporting DSI or DPI streaming to connect to new panels supporting DisplayPort™ interface and also to connect to existing panels over longer distance using DisplayPort™ adaptors at far-end. TC358766XBG can interface to up to two independent devices.

The chip can be configured through the DSI link by sending write/read register commands through DSI Generic Long Write packets. It can also be configured through the I²C Slave interface or the SPI interface. The selection between I²C or SPI slave interface is done using a boot-strap option.

The DSI-RX receiver supports from 1 to 4-Lane configurations at bit rate up to 1 Gbps per lane. Host can transmit video in continuous video streaming mode. Host controls video timing by sending video frame and line sync events together with video pixel data; video data transmission can be burst or non-burst. Since the chip integrates only a small video buffer, Host still has to take care of transmitting pixel data at appropriate video line time in order to avoid buffer overflow (or underflow).

The DPI-Rx receiver supports 16, 18 or 24 bits parallel interface along with the required control signals for the Pixel clock and HSync/VSync/DE.

The TC358766XBG also supports content protection using HDCP copy protection.

The DisplayPort™ transmitter supports data throughput at 1.62 Gbps or 2.7 Gbps per lane of main link.

TC358766XBG supports five (6) configuration modes as briefed below. These modes mainly differ based on the source of input stream and number of display devices that TC358766XBG can be connected to.

- **Mode_S21:** A system configuration where TC358766XBG may typically be used is shown in Figure 1.1. In this system, TC358766XBG could be connected to a single display. In this configuration, the TC358766XBG can support displays with resolution up to WUXGA (1920x1200) at 24bit, 60 fps or WUXGA (1920x1200) at 18bit, 60 fps. Video stream source is from DSI Host.
- **Mode_S22:** An alternate system configuration where TC358766XBG may typically be used is shown in Figure 1.2. In this system, TC358766XBG could be connected to two independent displays. In this configuration, the TC358766XBG can support displays with resolution up to WXGA+, WSXGA (1440x900) at 24bit, 60 fps or WSXGA+ (1680x1050) at 18bit, 60 fps. Video stream source is from DSI Host. Both display devices are used to display the same video stream.
- **Mode_P21:** A system configuration where TC358766XBG may typically be used is shown in Figure 1.3. This is similar to the Mode_S21 except that the video stream source is from DPI Host. In this configuration, the TC358766XBG can support displays with resolution up to WUXGA (1920x1200) at 24bit, 60 fps.
- **Mode_P22:** An alternate system configuration where TC358766XBG may typically be used is shown in Figure 1.4. This is similar to the Mode_S22 except that the video stream source is from DPI Host. Same video stream is displayed on both display devices. In this configuration, the TC358766XBG can support displays with resolution up to WXGA+, WSXGA (1440x900) at 24bit, 60 fps or WSXGA+ (1680x1050) at 18bit, 60 fps.
- **Mode_SP22:** In this mode, the DisplayPort™ Tx Main links are used as two independent links (each one lane) as shown in Figure 1.5. One DisplayPort™ Tx Main link lane is used to receive the video stream from the DSI Rx port, while the second DisplayPort™ Tx Main link lane is used to receive the video stream from the DPI Rx port. In this configuration, the TC358766XBG can support displays with resolution up to WXGA+, WSXGA (1440x900) at 24bit, 60 fps or WSXGA+ (1680x1050) at 18bit, 60 fps.
- **Mode_S2P:** A system configuration where TC358766XBG may typically be used is shown in Figure 1.6. In this mode, DisplayPort™ output is not used and the chip rather behaves as a DSI to RGB convertor. In this system, TC358766XBG could be connected to a single display. In this configuration, the TC358766XBG can support displays with resolution up to WXGA (1280x800 or 1366x768). Max output PCLK is 80 MHz. Video stream source is from DSI Host.

The chip supports power management to conserve power when its functions are not in use. Host manages the chip's power consumption modes by using ULPS messages over DSI link or the shutdown pin (SD) during DPI input mode.

The following figures show all these modes, where TC358766XBG, display panels and a Host are connected in target Reference system for mobile large display panel applications.

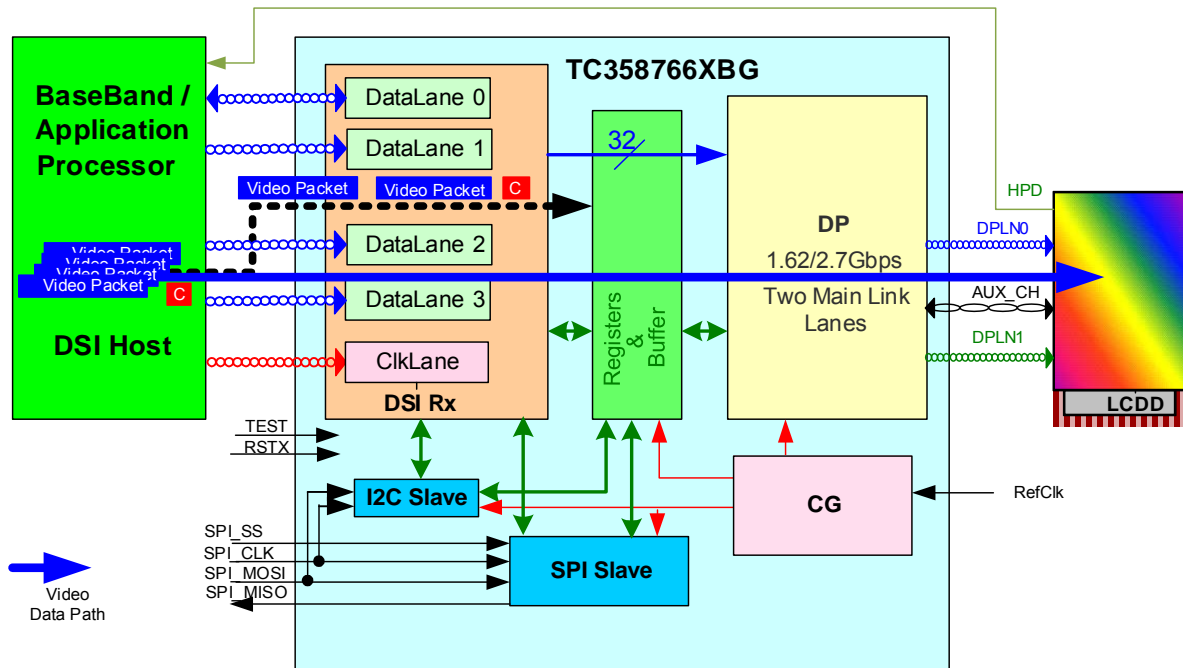


Figure 1.1 System Overview with TC358766XBG in MODE_S21 Configuration

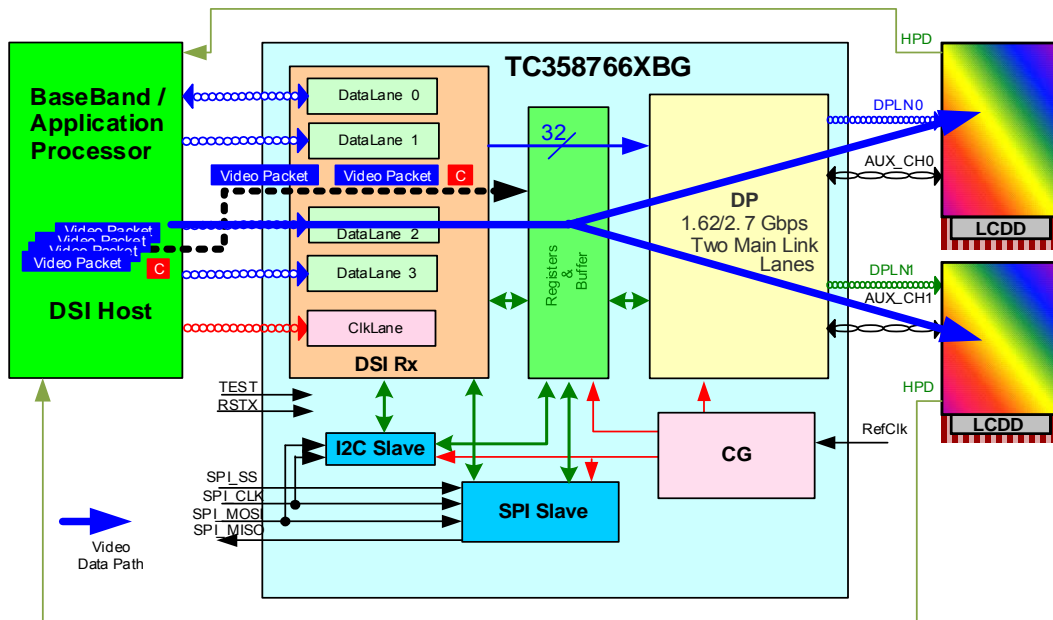


Figure 1.2 System Overview with TC358766XBG in MODE_S22 Configuration

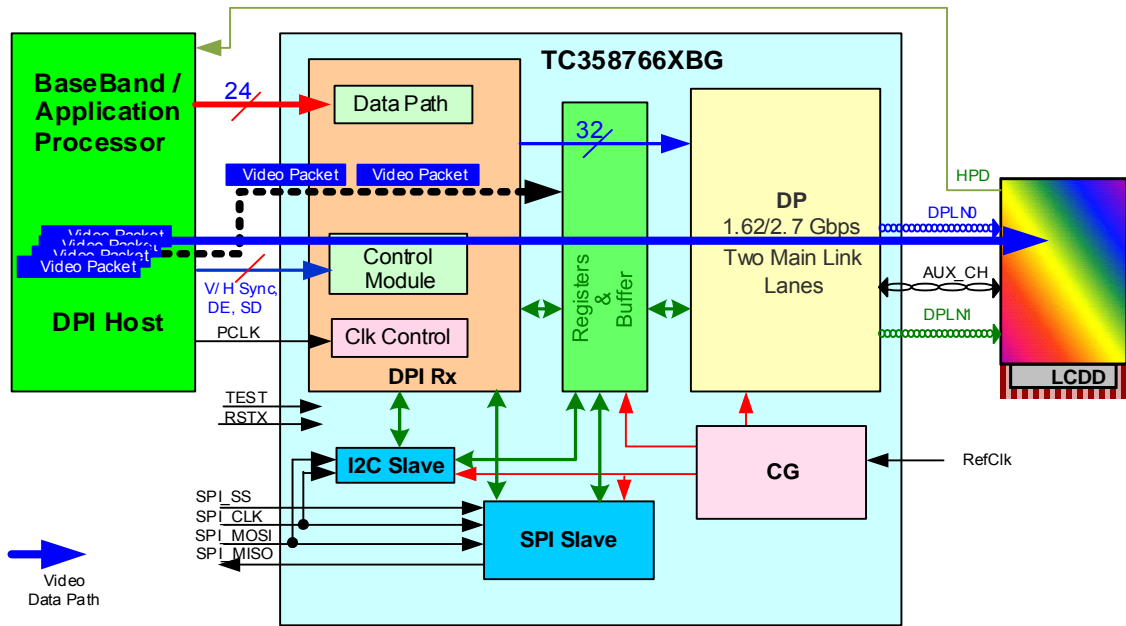


Figure 1.3 System Overview with TC358766XBG in MODE_P21 Configuration

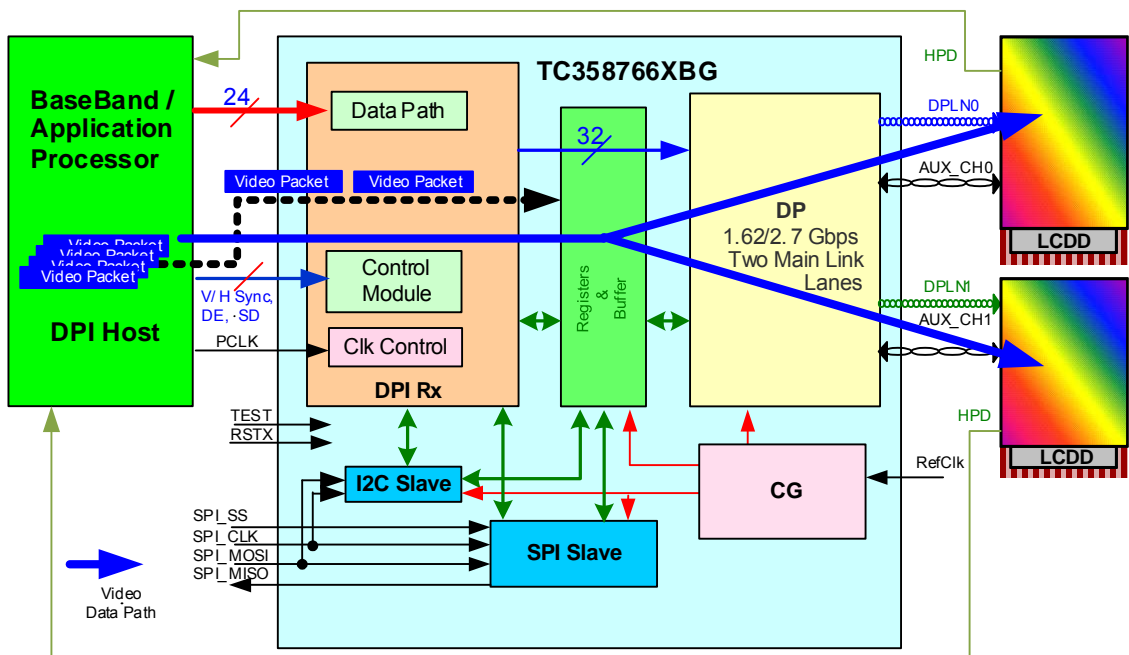


Figure 1.4 System Overview with TC358766XBG in MODE_P22 Configuration

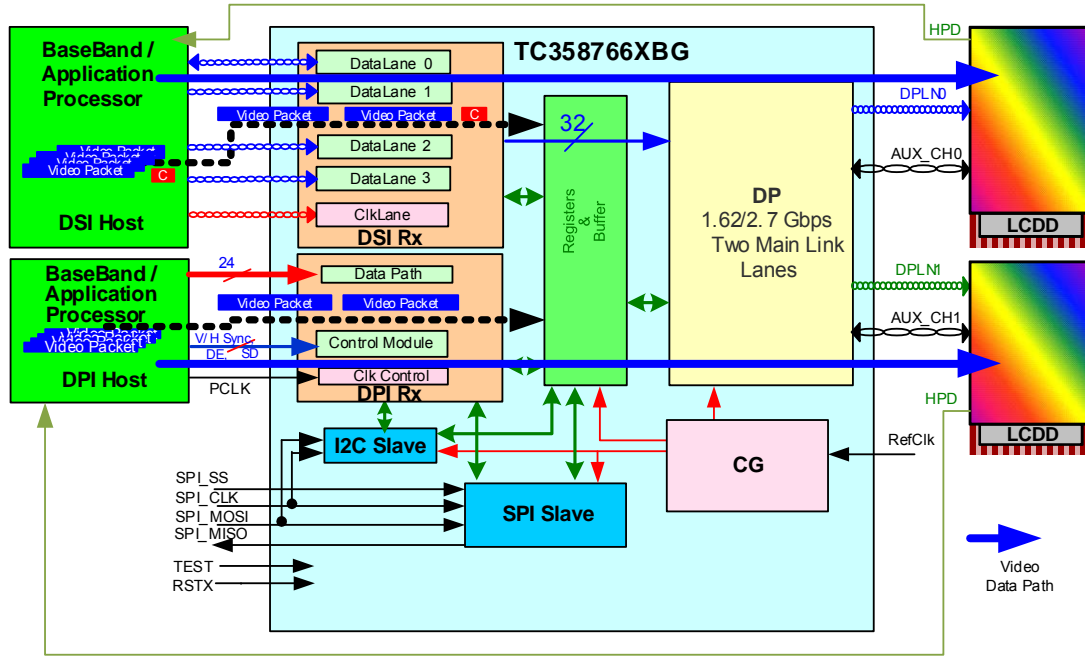


Figure 1.5 System Overview with TC358766XBG in MODE_SP22 Configuration

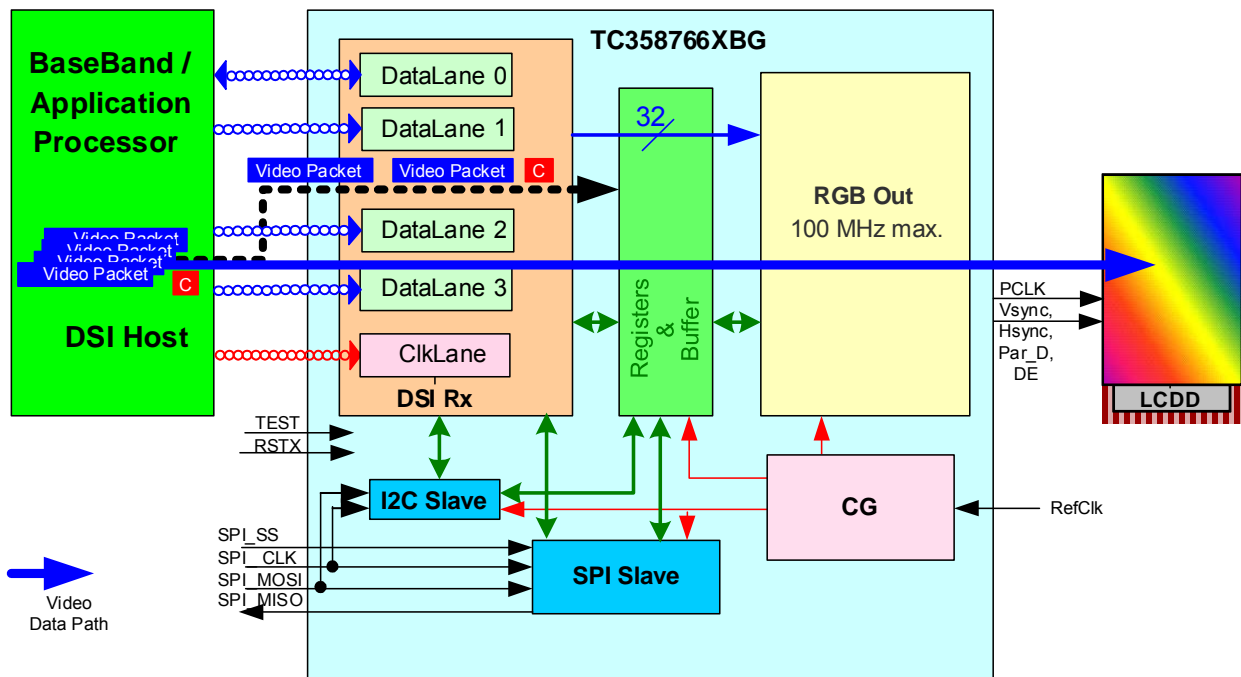


Figure 1.6 System Overview with TC358766XBG in MODE_S2P Configuration

2. Features

Below are the main features supported by TC358766XBG.

- Translates MIPI® DSI/DPI Link video stream from Host to DisplayPort™ Link data to external display devices.
- The inputs are driven by a DSI Host with 4-Data Lanes, upto1 Gbps/lane or DPI Host with 16/18/24 bit interface upto154 MHz parallel clock.
- Supports HDCP Digital Content Protection version 1.3 (DisplayPort™ amendment Rev1.1).
- The output Interface consists of a DisplayPort™ Tx with a 2-lane Main Link and AUX-Ch.
- Register Configuration: From DSI link, SPI or I²C interface (only one of the SPI and I²C interfaces can be active at any time).
- Internally generated H/VSyn in DSI mode can be muxed out to Host.
- Interrupt to host to inform any error status or status needing attention from Host.
- Internal test pattern (color bar) generator for DP o/p testing without any video (DSI/DPI) i/p.
- Debug/Test Port: I²C Slave
- **DSI Receiver:** Supports one DSI Interface between TC358766XBG and Host.
 - ✧ MIPI® DSI: v1.01 / MIPI® D-PHY: v0.90 Compliant.
 - ✧ Up to four (4) Data Lanes with Bi-direction support on Data Lane 0.
 - ✧ Maximum speed at 1 Gbps/lane.
 - ✧ Supports Burst as well as Non-Burst Mode Video Data.
 - Video data packets are limited to one row per Hsync period.
 - ✧ Supports video stream packets for video data transmission.
 - ✧ Supports generic long packets for accessing the chip's register set.
 - ✧ Video input data formats:
 - RGB-565, RGB-666 and RGB-888.
 - New DSI V1.02 Data Type Support: 16-bit YCbCr 422
 - ✧ Interlaced video mode is not supported.
- **DPI Receiver:** Supports one DPI Interface between TC358766XBG and Host.
 - ✧ Up to 16 / 18 / 24 bit parallel data interface.
 - ✧ Maximum speed at 154 MPs (MPixel per sec).
 - ✧ Video input data formats: RGB-565, RGB-666 and RGB-888.
 - ✧ Only Progressive mode supported.
 - ✧ Shutdown support (can be used in non-DPI mode also).
- **DisplayPort™ Interface:** Supports a DisplayPort™ link from TC358766XBG to display panels.
 - ✧ High speed serial bridge chip using VESA DisplayPort™ 1.1a Standard.
 - ✧ Supports one dual-lane DisplayPort™ port for high bandwidth applications
 - ✧ Supports up to two (2) single-lane ports for connection to two DisplayPort™ panels.
 - ✧ Support 1.62 or 2.7 Gbps/lane data rate with voltage swings @0.4, 0.6, 0.8 or 1.2V
 - ✧ Support of pre-emphasis levels of 0, 3.5dB and 6dB.
 - ✧ AUX channel supported at 1 Mbps.
 - ✧ HPD support through GPIO[1:0] based interrupts
 - ✧ Enhanced mode supported for HDCP content protection.
 - ✧ Support HDCP encryption Version 1.3 with DisplayPort™ amendment Revision 1.1. (on DisplayPort™0 in case two port configuration is used)

- ◇ Stream Policy Maker is assumed handled by the Host (software/firmware).
 - Start Link training in response to HPD & read final Link training status
 - Configure DP link for actual video streaming & start video streaming
- ◇ Link Policy maker is assumed shared between the Host and TC358766XBG chip.
 - In auto_correction = 0 mode, control link training
 - Initiate Display device capabilities read and configure TC358766XBG accordingly.
- ◇ Video timing generation as per panel requirement.
- ◇ SSCG with up to 30 kHz modulation to reduce EMI.
- ◇ Toshiba Magic Square algorithm – RGB666 18b produces RGB888 24b like quality (with up to 16-million colors).
- ◇ Built in PRBS7 Generator to test DisplayPort™ Link.
- **RGB Parallel Output Interface:**
 - ◇ RGB888 output mode (DisplayPort™ disabled) with only DSI input supported in this mode
 - ◇ PCLK max = 100 MHz
 - ◇ Polarity control for PCLK, VSYNC, HSYNC & DE.
- **I²C Interface:**
 - ◇ I²C slave interface for chip register set access enabled using a boot-strap option.
 - ◇ I²C compliant slave interface support for normal (100 kHz) and fast mode (400 kHz).
- **SPI Interface:**
 - ◇ SPI slave interface for chip register set access enabled using a boot-strap option.
 - ◇ SPI interface support for up to 30 MHz operation.
- **GPIO Interface:**
 - ◇ 2 bits of GPIO (shared with other digital logic).
 - ◇ Direction controllable by Host I²C accesses.
- **Clock Source:**
 - ◇ DisplayPort™ clock source is from an external clock input or clock from DSI interface (13, 26, 19.2 or 38.4 MHz) – generates all internal & output clocks to interfacing display devices.
 - ◇ Built-in PLLs generate high-speed DisplayPort™ link clock requiring no external components. These PLLs are part of the DisplayPort™ PHY.
- Clock and power management support to achieve low power states.
- **Possible modes of Operation:** Supports six (6) modes of operation:
 - ◇ MODE S21: TC358766XBG uses DisplayPort™ Tx as single 2-lane DisplayPort™ link to interface to single DisplayPort™ display device. Video stream source is from MIPI® DSI Host.
 - ◇ MODE S22: TC358766XBG uses DisplayPort™ Tx port as two independent 1-lane DisplayPort™ links to interface to two (2) DisplayPort™ display devices. Video stream source is from MIPI® DSI Host. Same video stream can be displayed on two display devices.
 - ◇ MODE P21: TC358766XBG uses DisplayPort™ Tx as single 2-lane DisplayPort™ link to interface to single DisplayPort™ display device. Video stream source is from MIPI® DPI Host.
 - ◇ MODE P22: TC358766XBG uses DisplayPort™ Tx port as two independent 1-lane DisplayPort™ links to interface to two (2) DisplayPort™ display devices. Video stream source is from MIPI® DPI Host. Same video stream is displayed on two display devices.
 - ◇ MODE SP22: TC358766XBG uses DisplayPort™ Tx as two independent DisplayPort™ output links (each single lane). TC358766XBG routes the DSI input to one DisplayPort™ Tx link and routes the DPI input to the second DisplayPort™ Tx link.

✧ MODE S2P: TC358766XBG uses only Parallel output port and disables DisplayPort™ Tx to interface to single RGB display device. Video stream source is from MIPI® DSI Host.

- **Power supply inputs**

- ✧ Core and MIPI® D-PHY: 1.2V ±0.06V

- ✧ Digital I/O: 1.8V ±0.09V

- ✧ DisplayPort™: 1.8V ±0.09V

- ✧ DisplayPort™: 1.2V ±0.06V

- **Power Consumptions (based on estimations)**

- ✧ Power-down mode (DSI-Rx in ULPS, DP PHY & PLLs disabled, clocks stopped):

- DSI Rx: 0.01 mW

- DP PHY: 2.34 mW

- PLL9: 0.01 mW

- Core: 0.96 mW

- Rest: 0.01 mW

- ✧ Normal operation (DSI-Rx in 4-lane @900 Mbps per lane, DP PHY in dual lane link @2.7 Gbps per lane):

- DSI Rx: 21.79 mW

- DP PHY: 142.70 mW

- PLL9: 2.42 mW

- Core: 87.64 mW

- IOs: 1.68 mW

- **Package**

- 0.5mm ball pitch, 120 balls, 6 x 6 mm BGA package

Table 2.1 TC358766XBG operational modes summary with panel size support information

Mode	Input Configuration			Register Access Method	Output Configuration	
	# of input streams	DSI input	DPI input		# of output panels	Max Panel size example
S21	1	Active	X	DSI or DSI+I ² C or DSI+SPI	1	WUXGA 18bpp @ 60fps WUXGA 24bpp @ 60fps
S22	1	Active	X	DSI or DSI+I ² C or DSI+SPI	2	WSXGA+ 18bpp @ 60fps WXGA+ 24bpp @ 60fps WSXGA 24bpp @ 60fps
P21	1	X	Active	I ² C or SPI	1	WUXGA 24bpp @ 60fps
P22	1	X	Active	I ² C or SPI	2	WSXGA+ 18bpp @ 60fps WXGA+ 24bpp @ 60fps WSXGA 24bpp @ 60fps
SP2	2	Active	Active	DSI or DSI+I ² C or DSI+SPI	2	WSXGA+ 18bpp @ 60fps WXGA+ 24bpp @ 60fps WSXGA 24bpp @ 60fps

Tables below provide an idea of different panel sizes that can be supported by using different data link lane configurations.

Table 2.2 Panel Size v/s Data link required by TC358766XBG in DSI input case

Frame Size			FPS	Pixel Clock (MHz)	RGB666				RGB888			
-	-	With OverHead			Bit Rate (Gbps)	# DSI Data lanes	# DP Main links		Bit Rate (Gbps)	# DSI Data lanes	# DP Main links	
							1.62G	2.7G			1.62G	2.7G
XGA	1024x768	1184x790	60	56	1.01	2	1	1	1.34	2	2	1
WXGA+ / WSXGA	1440x900	1600x926	60	89	1.60	2	2	1	2.13	3	2	1
SXGA+	1400x1050	1560x1080	60	89	1.82	2	2	1	2.43	3	2	2
WSXGA+	1680x1050	1840x1080	60	119	2.15	3	2	1	2.86	3	-	2
UXGA	1600x1200	1760x1235	60	130	2.35	3	2	2	3.13	-	-	2
WUXGA	1920x1200	2080x1235	60	154	2.77	3	-	2	3.70	-	-	2

Table 2.3 Panel Size v/s Data link required by TC358766XBG in DPI input case

Frame Size			FPS	Pixel Clock (MHz)	DPI Support 154 MHz PCLK	RGB666			RGB888		
-	-	With OverHead				Bit Rate (Gbps)	# DP Main links		Bit Rate (Gbps)	# DP Main links	
							1.62G	2.7G		1.62G	2.7G
XGA	1024x768	1184x790	60	56	Yes	1.01	1	1	1.34	2	1
WXGA+ / WSXGA	1440x900	1600x926	60	89	Yes	1.60	2	1	2.13	2	1
SXGA+	1400x1050	1560x1080	60	89	Yes	1.82	2	1	2.43	2	2
WSXGA+	1680x1050	1840x1080	60	119	Yes	2.15	2	1	2.86	-	2
UXGA	1600x1200	1760x1235	60	130	Yes	2.35	2	2	3.13	-	2
WUXGA	1920x1200	2080x1235	60	154	Yes	2.77	-	2	3.70	-	2

Note: These are the formats commonly used by displays. Support for other sizes is possible as long as they satisfy the maximum data rate constraints on the DSI and DisplayPort™ link interfaces.

NOTE: Throughout the rest of the document, “DP” is used to denote “DisplayPort™”. Both these words have been used interchangeably and refer to the VESA DisplayPort™ specification as mentioned in the references.

3. External Pins

TC358766XBG chip uses a 120pin package. Following table gives the signals of TC358766XBG and their function.

Table 3.1 TC358766XBG Functional Signal List for 120-pin Package

Group	Pin Name	I/O	Type	Initial	Function	Note
System: Reset & Clock (14)	RESX	I	Sch	-	System Reset – active Low	-
	REFCLK	I	Sch	-	13, 26, 19.2 or 38.4 MHz 50ps phase jitter p2p/ WC duty cycle 40-60%	-
	TEST	I	N	Low	Test Pin, active high	-
	TEST[6:4]	I	N	-	Test Pins, connect to GND	-
	INT	O	N	-	Interrupt to Host	4mA
	SD	I	N	-	Shutdown Input/ Audio Over Sampling Clock ^{*Note1}	-
	SYNC	O	N	-	Internal H/V Sync o/p to Host	4mA
	MODE[4:0]	I	N	Low	Mode Selection pins	-
DSI Rx (10)	DSICP	I	MIPI®-PHY	-	MIPI®-DSI Rx Clock Lane Pos	-
	DSICM	I	MIPI®-PHY	-	MIPI®-DSI Rx Clock Lane Neg	-
	DSIDP[3:0]	I/O	MIPI®-PHY	-	MIPI®-DSI Rx Data Lane Pos	-
	DSIDM[3:0]	I/O	MIPI®-PHY	-	MIPI®-DSI Rx Data Lane Neg	-
DP Out (12)	DPLNP[1:0]	O	DP-PHY	-	eDP Output Main Link Pos	-
	DPLNM[1:0]	O	DP-PHY	-	eDP Output Main Link Neg	-
	DPAUXP[1:0]	I/O	DP-PHY	-	eDP Output AUX Channel Pos	-
	DPAUXM[1:0]	I/O	DP-PHY	-	eDP Output AUX Channel Neg	-
	ATB[1:0]	I/O	DP-PHY	-	Analog Test Bus output ^{*Note1}	-
	PREC_RES[1:0]	I	DP-PHY	-	Precision Resistance (3K @ 1%) connection	-
DPI Rx (28)	DPI_PCLK	I/O	N	-	DPI Pixel Clock (max 154 MHz) (default: Input) ^{*Note1}	4mA
	DPI_VSYNC	I/O	N	-	DPI Vertical Sync (default: Input) ^{*Note1}	4mA
	DPI_HSYNC	I/O	N	-	DPI Horizontal Sync (default: Input) ^{*Note1}	4mA
	DPI_DE	I/O	N	-	DPI Data Enable (default: Input) ^{*Note1}	4mA
	DPI_D [23:0]	I/O	N	-	DPI Parallel Data (default: Input) ^{*Note1}	4mA
SPI / I ² C (4)	SPI_SCLK / I ² C_SCL	OD	FS/Sch	-	SPI Clock / I ² C Clock ^{*Note1}	-
	SPI_MOSI / I ² C_SDA	OD	FS/Sch	-	SPI Input data from Host ^{*Note1}	4mA
	SPI_MISO	O	N	-	SPI Output data to Host	4mA
	SPI_SS/ I ² C_ADR_SEL	I	N	-	SPI Slave Select / I ² C Slave Address Select ^{*Note1}	-
GPIO (2)	GPIO[1:0]	OD	5T-OD	-	GPIO or Test Control ^{*Note1} GPIO[1:0] can be used for HPD support	4mA
POWER (27)	VDDC (VDD12)	NA	-	-	VDD for Internal Core (8)	-
	VDDS (1.8V)	NA	-	-	VDDS for IO Ring power supply (5)	-
	VDD_PLL18 (1.8V)	NA	-	-	VDD for DP PHY PLLs (2)	-
	VDD_PLL12 (1.2V)	NA	-	-	VDD for DP PHY PLLs (2)	-
	VDD_DP18 (1.8V)	NA	-	-	VDD for DP PHY Main Channels (2)	-
	VDD_DPA18 (1.8V)	NA	-	-	VDD for DP PHY Aux Channels	-
	VDD_DP12 (1.2V)	NA	-	-	VDD for DP PHY (2)	-
	VDD_DSI12 (1.2V)	NA	-	-	VDD for the MIPI® DSI PHY (2)	-
	VDD_PLL912 (1.2V)	NA	-	-	VDD for the PLL9	-
VPGM	NA	-	-	eFUSE programming voltage (2)	-	
GROUND (23)	VSS	NA	-	-	Ground (including VSSC (core), VSS_IO (IO), VSS_DSI (MIPI®), VSS_DP (DP), VSS_DPA, VSS_PLL (PLL))	-

Total 120 pins BGA package.

Note 1: Pins with multiplexed Functional mode functions

N: Normal IO

PHY: Either DP analog front end or MIPI® D-PHY

OD: Open drain

Pd: Pull Down

FS: Fail safe IO - gated

Sch: Schmitt trigger input

5T-OD: 5V tolerant bi-direction buffer with Open drain

3.1. Pin Mapping

The mapping of TC358766XBG signals to the external pins is given in the following figure. (BGA array)

Top View (through the die)

A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
MODE_2	MODE_3	DPI_VSYNC	DPI_DE	DPI_D_0	DPI_D_2	DPI_D_3	DPI_D_5	DPI_D_7	DPI_D_9	DPI_D_11
B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
DSIDM_0	DSIDP_0	MODE_0	VDDC	DPI_D_1	SD	DPI_D_4	DPI_D_6	DPI_D_8	DPI_D_10	DPI_D_12
C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
DSIDM_1	DSIDP_1		VSS	TEST_4	TEST_6	DPI_HSYNC	SPI_MISO	VDDC	DPI_D_14	DPI_D_13
D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11
VSS_DSI	VDD_DSI12	MODE_1	INT	TEST_5	SPI_SS	VDDC	VSS	VPGM_1	SPI_SCLK	DPI_D_15
E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11
DSICM	DSICP	TEST	SYNC	VSS	VSS	VSS	VDDS	SPI_MOSI	DPI_D_17	DPI_D_16
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11
VDD_DSI12	VSS_DSI	MODE_4	GPIO_0	VSS_E	VSS_E	VSS_E	RESX	GPIO_1	VPGM_0	DPI_D_18
G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11
DSIDM_2	DSIDP_2	PREC_RES_0	VDDC12	VSS_E	VSS_E	VSS_E	VSS_PLL9	VDDS	VDDC	DPI_PCLK
H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11
DSIDM_3	DSIDP_3	PREC_RES_1	VDD18	VDDC	VDD18	VDD18	VDDC	VSSC	DPI_D_19	VDD_PLL912
J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	J11
ATB_1	VDD_PLL18	VDD_PLL12	VSS_PLL	VSS_PLL	VDD_PLL12	VDD_PLL18	VSS	VDDC	DPI_D_21	DPI_D_20
K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11
REFCLK	VDD_DP12	DPLNP_0	VSS_DP	VDD_DP12	DPLNP_1	VSS_DP	DPAUXP_0	VSS_DPA	DPAUXP_1	DPI_D_22
L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11
ATB_0	VSS_DP	DPLNM_0	VDD_DP18	VSS_DP	DPLNM_1	VDD_DP18	DPAUXM_0	VDD_DPA18	DPAUXM_1	DPI_D_23

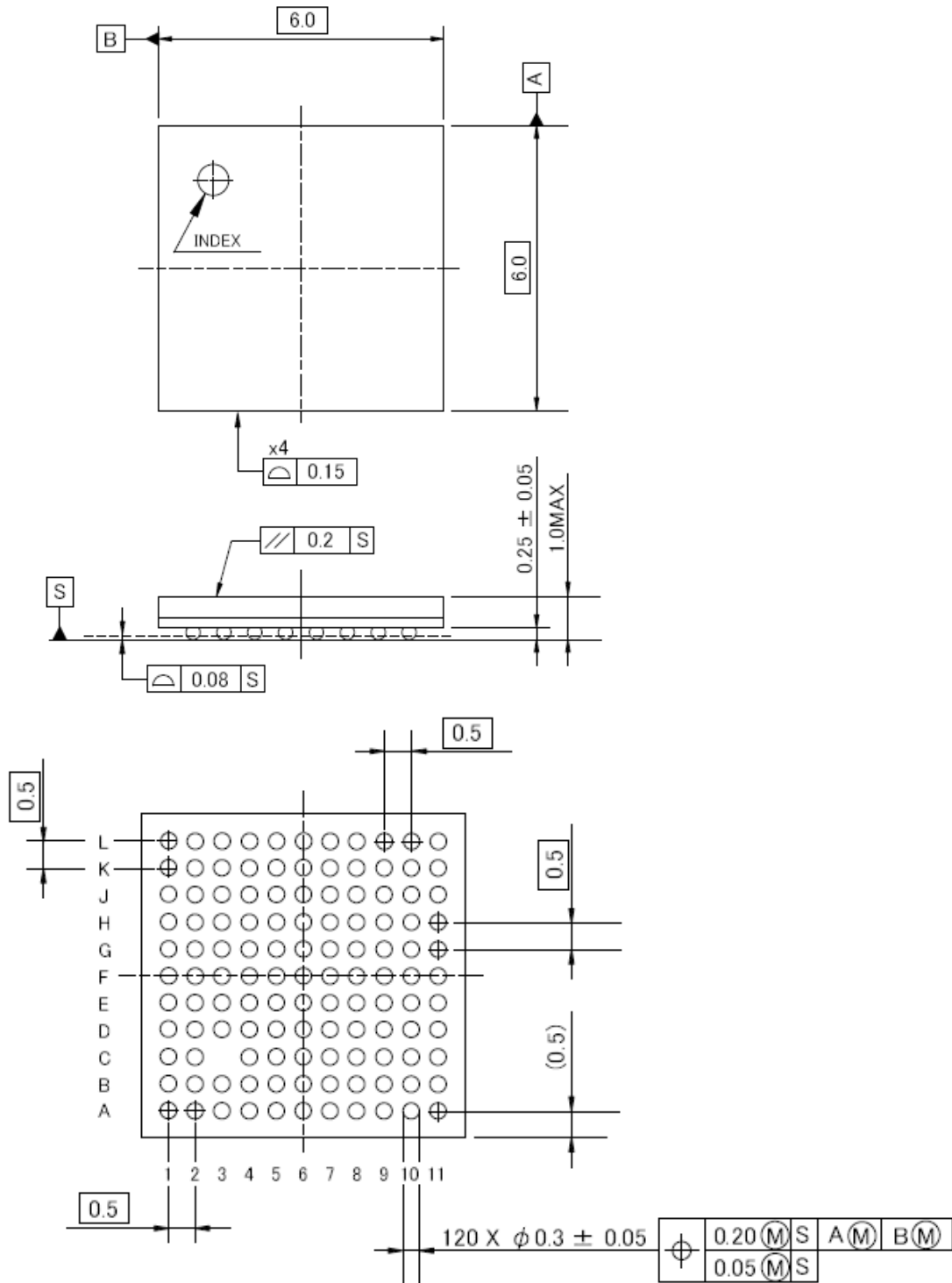
Figure 3.1 TC358766XBG 120-Pin Layout

4. Package

The package for TC358766XBG is described in the figure below.

P-VFBGA120-0606-0.50AZ

"Unit : mm"



Weight : 62mg (Typ.)

Figure 4.1 120 pin TC358766XBG package

The mechanical dimension of BGA120 package is listed below.

Table 4.1 Mechanical Dimension of P-VFBGA120-0606-0.50AZ

Package	Solder Ball Pitch	Solder Ball Height	Package Dimension	Package Height	Note
120-Pin	0.50 mm	0.25 mm	6.0 x 6.0 mm ²	1.0 mm	—

5. Electrical Characteristics

5.1. Absolute Maximum Ratings

VSS = 0 V reference

VDD18 used for VDDS as well as VDD-DP18; VDD12 used for VDDC as well as VDD-DSI12

Parameter	Symbol	Rating	Unit
Supply voltage (1.8V)	VDD18	-0.3 to +3.5	V
Supply voltage (1.2V)	VDD12	-0.3 to +2.0	V
Supply voltage (IO)	VDD18	-0.3 to +3.5	V
	VREF	-0.3 to +3.5	V
Input voltage	VIN	-0.3 to VDDS+0.3	V
Output voltage	VOUT	-0.3 to VDDS+0.3	V
Storage temperature	Tstg	-40 to +125	°C

5.2. Operating Condition

VSS = 0 V reference

VDD18 used for VDDS as well as VDD-DP18; VDD12 used for VDDC as well as VDD-DSI12

Parameter	Symbol	Min	Typ.	Max	Unit
Supply voltage (1.8V)	VDD18	1.71	1.8	1.89	V
Supply voltage (1.2V)	VDD12	1.14	1.2	1.26	V
Operating frequency (internal)	Fopr	-	-	200	MHz
Operating temperature	Ta	-20	-	+70	°C

5.3. DC Electrical Specification

VSS = VSS_C = VSS_IO = VSS_DSI = VSS_DP = VSS_PLL = VSS_REG = 0 V reference

Parameter	Symbol	Min	Typ.	Max	Unit
Input voltage High level CMOS input <small>Note1</small>	VIH	0.7 VDD5	-	VDD5	V
Input voltage Low level CMOS input <small>Note1</small>	VIL	0	-	0.3 VDD5	V
Input voltage High level CMOS Schmitt Trigger <small>Note1</small>	VIHS	0.7 VDD5	-	VDD5	V
Input voltage Low level CMOS Schmitt Trigger <small>Note1</small>	VILS	0	-	0.3 VDD5	V
Output voltage High level <small>Note1, Note2</small>	VOH	0.8 VDD5	-	VDD5	V
Output voltage Low level <small>Note1, Note2</small>	VOL	0	-	0.2 VDD5	V
Input leak current High level	I _{IH1} (Note3)	-10	-	10	μA
Input leak current Low level	I _{IL1} (Note4)	-10	-	10	μA
	I _{IL2} (Note5)	-200	-	-10	μA

Note1: VDD5 within recommended operating condition.

Note2: Output current value is according to each IO buffer specification. Output voltage changes with output current value.

Note3: Normal pin, or Pull-up I/O pin applied VDD18_IO supply voltage to input pin

Note4: Normal pin applied VSS (0V) to input pin

Note5: Pull-up I/O pin applied VSS (0V) to input pin

6. Revision History

Table 6.1 Revision History

Revision	Date	Description
0.1	2014-07-23	Newly released
0.12	2016-04-01	Package's weight is rounding up digits after the decimal point to form an integer.
1.0	2017-11-07	Modified descriptions in Features. Deleted I2S descriptions. Modified Figure 1.1 to Figure 1.6, Figure 3.1 and Table 3.1. Deleted Table 3.2. (It is the same as Table 4.1.) Added section 5 Electrical Characteristics. Changed header, footer and the last page. Changed corporate name.
1.01	2017-12-27	Modified Figure 1.1 to Figure 1.6. Changed frequency to 100MHz in Figure 1.6. Added description, trademarks and modified registered trademarks.
1.1	2018-05-28	Modified Table 2.2 and Table 2.3.

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