THCV217 and THCV218

V-by-One® HS High-speed Video Data Transmitter and Receiver

General Description

THCV217 and THCV218 are designed to support video data transmission between the host and display.

One high-speed lane can carry up to 32bit data and 3 bits of synchronizing signals at a pixel clock frequency from 20MHz to 85MHz.

The chipset, which has two high-speed data lanes, can transmit video data up to 1080p/10b/60Hz. The maximum serial data rate is 3.4Gbps/lane.

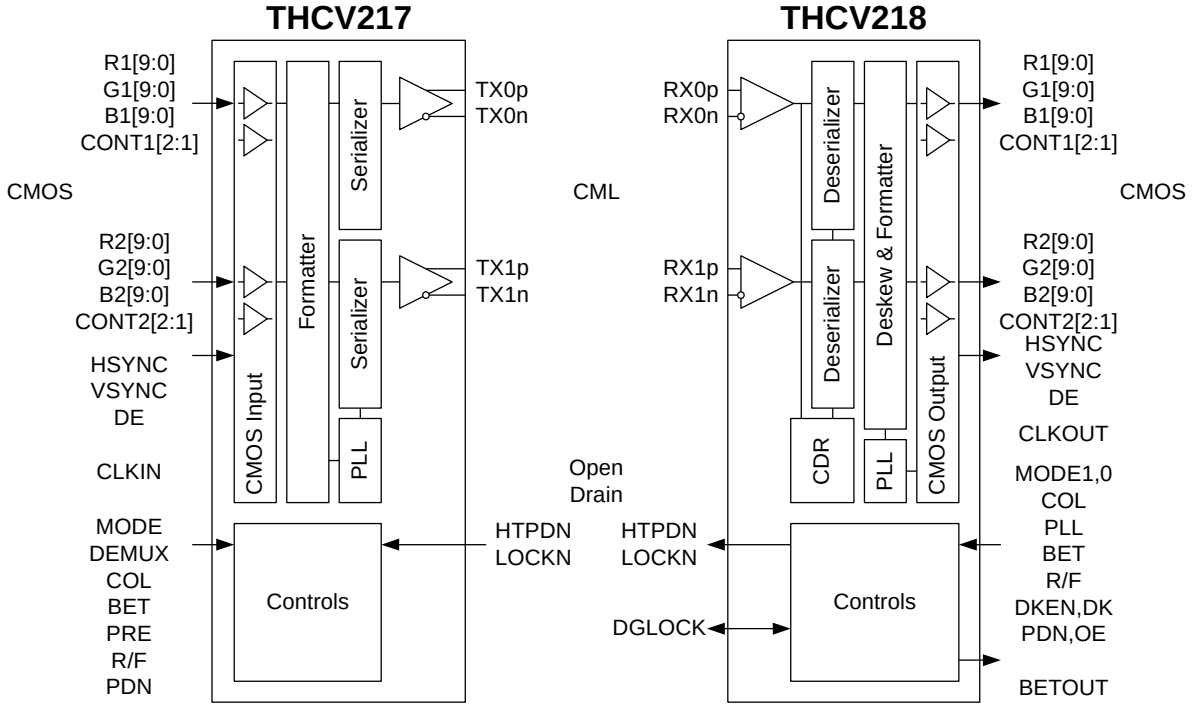
Features

- Color depth selectable: 24(8×3)/32(10×3)bit
- Single-in/Single-out, Single-in/Dual-out, and Dual-in/Dual-out selectable for THCV217
- Single-in/Single-out, Dual-in/Single-out, and Dual-in/Dual-out selectable for THCV218
- AC coupling for high-speed lines
- CORE 1.8V, CMOS IO 3.3V
- Package: 217(TFBGA105), 218(TFBGA145)
- Wide frequency range
- CDR requires no external frequency reference
- Spread Spectrum Clocking tolerant
  Up to 30kHz / ±0.5% (center spread)
- V-by-One® HS standard Version1.4 compliant.

Product	Link	Pixel Clock Frequency
THCV217	Si/So	20MHz to 85MHz
	Di/Do	
	Si/Do	40MHz to 170MHz
THCV218	Si/So	20MHz to 85MHz
	Di/Do	
	Di/So	40MHz to 170MHz

Si/So: Single-in/Single-out, Di/Do: Dual-in/Dual-out
Di/So: Dual-in/Single-out, Si/Do: Single-in/Dual-out

Block Diagram



Contents Page

Pin Configuration

THCV217

TOP VIEW

	1	2	3	4	5	6	7	8	9	10	11	
A	B10	B11	G18	G16	G14	G12	G10	R18	R16	R14	R12	**A**
B	B12	B13	G19	G17	G15	G13	G11	R19	R17	R15	R13	**B**
C	B14	B15	DVDH	GND	GND	VDL	VDL	HTPDN	LOCKN	R11	R10	**C**
D	B16	B17	DVDH						CAVDL	CONT11	CONT12	**D**
E	B18	B19	DVDH		GND	GND	GND		CAVDL	TX0n	TX0p	**E**
F	R20	R21	R/F		GND	GND	GND		CAVDL	TX1n	TX1p	**F**
G	R22	R23	PRE		GND	GND	GND		CPVDL	CONT21	CONT22	**G**
H	R24	R25	COL						PDN	B29	B28	**H**
J	R26	R27	GND	DVDH	DEMUX	Reserved 0	MODE	DVDH	BET	CLKIN	DE	**J**
K	R28	R29	G23	G25	G27	G29	B21	B23	B25	B27	VSYNC	**K**
L	G20	G21	G22	G24	G26	G28	B20	B22	B24	B26	HSYNC	**L**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	

THCV218

TOP VIEW

	1	2	3	4	5	6	7	8	9	10	11	12	13	
A	HSYNC	B19	B17	B15	B13	B11	G19	G17	G15	G13	G11	G10	R19	**A**
B	DE	VSYNC	B18	B16	B14	B12	B10	G18	G16	G14	G12	R18	R17	**B**
C	CONT11	CONT12	Reserved 4	Reserved 1	VDL	VDL	DVDH	DVDH	DVDH	DVDH	DVDH	R16	R15	**C**
D	HTPDN	LOCKN	Reserved 3								DVDH	R14	R13	**D**
E	BETOUT	Reserved 5	CAVDL		GND	GND	GND	GND	GND		DVDH	R12	R11	**E**
F	RX0n	RX0p	CAVDL		GND	GND	GND	GND	GND		DVDH	DVDH	R10	**F**
G	Reserved 6	Reserved 7	CAVDL		GND	GND	GND	GND	GND		GND	GND	CLKOUT	**G**
H	RX1n	RX1p	CAVDL		GND	GND	GND	GND	GND		DVDH	CONT22	CONT21	**H**
J	MODE1	BET	CAVDL		GND	GND	GND	GND	GND		DVDH	B29	B28	**J**
K	PLL	MODE0	DK								DVDH	B27	B26	**K**
L	PDN	OE	COL	DKEN	VDL	VDL	DVDH	DVDH	DVDH	DVDH	DVDH	B25	B24	**L**
M	R/F	R21	R23	R25	R27	R29	G21	G23	G25	G27	G29	B23	B22	**M**
N	DGLOCK	R20	R22	R24	R26	R28	G20	G22	G24	G26	G28	B21	B20	**N**
	1	2	3	4	5	6	7	8	9	10	11	12	13	

Pin Description

THCV217

THCV217 Pin Description

Name	Ball #	Type*	Description
TX0n,TX0p	E10,E11	CO	CML output for Lane0
TX1n,TX1p	F10,F11	CO	CML output for Lane1. Must be left OPEN when not used.
R19-R10	B8,A8,B9,A9, B10,A10,B11, A11,C10,C11	I3	1st pixel data inputs
G19-G10	B3,A3,B4,A4, B5,A5,B6, A6,B7,A7	I3	1st pixel data inputs
B19-B10	E2,E1,D2,D1, C2,C1,B2, B1,A2,A1	I3	1st pixel data inputs
CONT11,12	D10,D11	I3	User defined data inputs, serialized with 1st pixel data. Active only in 10bit mode.
R29-R20	K2,K1,J2,J1, H2,H1,G2, G1,F2,F1	I3	2nd pixel data inputs
G29-G20	K6,L6,K5,L5, K4,L4,K3, L3,L2,L1	I3	2nd pixel data inputs
B29-B20	H10,H11,K10, L10,K9,L9, K8,L8,K7,L7	I3	2nd pixel data inputs
CONT21,22	G10,G11	I3	User defined data inputs, serialized with 2nd pixel data. Active only in 10bit
DE	J11	I3	DE input
HSYNC	L11	I3	Hsync input
VSYNC	K11	I3	Vsync input
CLKIN	J10	I3	Pixel clock input
HTPDN	C8	I3L	Hot plug detect input. Must be connected to Rx HTPDN with a 10kW pull-up resistor.
LOCKN	C9	I3L	Lock detect input. Must be connected to Rx LOCKN with a 10kW pull-up resistor.

*type symbol
CO=CML Output
I3=3.3V CMOS input, I3L=Low speed 3.3V CMOS input
O3=3.3V CMOS output
P=1.8V power supply, P3=3.3V power supply

THCV217 Pin Description (Continued)

Name	Ball #	Type*	Description
PDN	H9	I3	Power down input H: Normal operation L: Power Down
COL	H3	I3	Color depth select input H: 8bit mode L: 10bit mode
PRE	G3	I3	Pre emphasis level select input H: 100% L: 0%
BET	J9	I3L	Field BET enable H: Enable L: Normal Operation
DEMUX	J5	I3	Operation mode select input DEMUX,MODE=HH: Reserved (Forbidden) HL: Single-in/Dual-out LH: Single-in/Single-out LL: Dual-in/Dual-out
MODE	J7	I3L	
R/F	F3	I3	Input clock triggering edge select input for latching input data H: Rising edge L: Falling edge
Reserved0	J6	I3	Reserved Inputs. Must be tied to GND
VDL	C6,C7	P	1.8V power supply pins for digital circuitry
CAVDL	D9,E9,F9	P	1.8V power supply pins for CML outputs
CPVDL	G9	P	1.8V power supply pins for PLL circuitry
DVDH	C3,D3,E3,J4,J8	P3	3.3V power supply pins for TTL inputs
GND	C4,C5,E5,E6,E7,F5, F6,F7,G5,G6,G7,J3	GND	Ground pins

*type symbol
CO=CML Output
I3=3.3V CMOS input, I3L=Low speed 3.3V CMOS input
O3=3.3V CMOS output
P=1.8V power supply, P3=3.3V power supply

THCV218

THCV218 Pin Description

PIN Name	Ball #	Type*	Description
RX0n,RX0p	F1,F2	CI	CML input for Lane0
RX1n,RX1p	H1,H2	CI	CML input for Lane1. Must be left OPEN when not used.
R19-R10	A13,B12,B13, C12,C13,D12, D13,E12,E13,F13	O3	1st pixel data outputs
G19-G10	A7,B8,A8,B9, A9,B10,A10, B11,A11,A12	O3	1st pixel data outputs
B19-B10	A2,B3,A3,B4, A4,B5,A5, B6,A6,B7	O3	1st pixel data outputs
CONT11,12	C1,C2	O3	User defined data outputs. Active only in 10bit mode.
R29-R20	M6,N6,M5,N5, M4,N4,M3, N3,M2,N2	O3	2nd pixel data outputs
G29-G20	M11,N11,M10, N10,M9,N9, M8,N8,M7,N7	O3	2nd pixel data outputs
B29-B20	J12,J13,K12, K13,L12,L13, M12,M13,N12,N13	O3	2nd pixel data outputs
CONT21,22	H13,H12	O3	User defined data outputs. Active only in 10bit mode.
DE	B1	O3	DE Output
VSYNC	B2	O3	Vsync Output
HSYNC	A1	O3	Hsync Output
CLKOUT	G13	O3	Pixel clock output
HTPDN	D1	OD3	Hot plug detect output. Must be connected to Tx HTPDN with a 10kW pull-up resistor. Hi-Z : when PDN=L, L: when PDN=H
LOCKN	D2	OD3	Lock detect output. Must be connected to Tx LOCKN with a 10kW pull-up resistor. It drives Low when the CDR locks to the incoming data.
PDN	L1	I3	Power down input H: Normal operation L: Power Down
COL	L3	I3	Color depth select input H: 8bit mode L: 10bit mode
BET	J2	I3L	Field BET enable H: Enable L: Normal Operation When BET=High, Reserved7 must be Low.
MODE1,0	J1,K2	I3	Operation mode select input HH: Reserved (Forbidden) HL: Single-in/Single-out LH: Dual-in/Single-out LL: Dual-in/Dual-out

*type symbol
CI=CML Input, OD3=3.3V Open drain output, O3=3.3V CMOS output
I3=3.3V CMOS input, I3L=Low speed 3.3V CMOS input, I3PU=3.3V CMOS inout with an on-chip pullup resistor
P=1.8v power supply, P3=3.3v power supply

THCV218 Pin Description (Continued)

PIN Name	Ball #	Type*	Description
PLL	K1	I3	PLL bandwidth select H: CLKIN<40MHz, when SiSo,DiDo L: Normal Operation
OE	L2	I3	Output enable input (See Table 1 for details) H: All CMOS outputs enabled L: All CMOS outputs disabled, except for LOCKN, HTPDN
DGLOCK	N1	I3PU	Connect all DGLOCK pins in multiple-chip configuration. Must be left OPEN for single-chip configuration.
R/F	M1	I3	Output clock triggering edge select input H: Rising edge L: Falling edge
DKEN	L4	I3	DK enable H: DK enabled L: DK disabled (Default)
DK	K3	I3	Output clock delay timing select input. Enabled by DKEN. H: Late L: Early Refer to Figure 10 for details.
BETOUT	E1	O3	Field BET result output. Must be left OPEN when NOT used.
Reserved7	G2	I3	CTL bit transmission on DE=low blanking period enable H: CTL bit enabled (CTL are transmitted except the 1st and the last pixel of DE=Low) L: CTL bit disabled (CTL are Low fixed during DE=Low) When BET=High, Reserved7 must be Low.
Reserved3	D3	O3	Reserved outputs. Must be left OPEN.
Reserved1, 4-6	C4,C3,E2,G1	I3	Reserved input. Must be tied to GND
VDL	C5,C6,L5,L6	P	1.8V power supply pins for digital circuitry
CAVDL	E3,F3,G3,H3,J3	P	1.8V power supply pins for CML inputs and PLL circuitry
DVDH	C7,C8,C9,C10,C11, D11,E11,F11,F12, H11,J11,K11,L7, L8,L9,L10,L11	P3	3.3V power supply pins for TTL outputs
GND	E5,E6,E7,E8,E9,F5, F6,F7,F8,F9,G5,G6, G7,G8,G9,G11, G12,H5,H6,H7,H8, H9,J5,J6,J7,J8,J9	GND	Ground pins

*type symbol
CI=CML Input, OD3=3.3V Open drain output, O3=3.3V CMOS output
I3=3.3V CMOS input, I3L=Low speed 3.3V CMOS input, I3PU=3.3V CMOS inout with an on-chip pullup resistor
P=1.8V power supply, P3=3.3V power supply

PDN	OE	R/G/B/CONT H,Vsync,DE,CLKOUT
L	L	Hi-Z
L	H	All Low
H	L	Hi-Z
H	H	Data Out

Table 1. Output Control

Functional Description

Functional Overview

With V-by-One®HS's proprietary encoding scheme and CDR (Clock and Data Recovery) architecture, THCV217 and THCV218 enable transmission of 8/10 bit RGB, 2bits of user-defined data (CONT), synchronizing signals HSYNC, VSYNC, and DE by single/dual differential pair cable with minimal external components.

THCV217, the transmitter, inputs CMOS data (including video data, CONT, HSYNC, VSYNC, and DE) and serializes video data and synchronizing signals separately, depending on the polarity of DE. DE is a signal which indicates whether video or synchronizing data are active. When DE is high, it serializes video data inputs into differential data streams. And it transmits serialized synchronizing data when DE is low.

Figure 1 is the conceptual diagram of the basic operation of the chipset.

THCV218, the receiver, automatically extracts the clock from the incoming data streams and converts the serial data into video data with DE being high or synchronizing data with DE being low, recognizing which type of serial data is being sent by the transmitter. And it outputs the recovered data in the form of CMOS data.

THCV218 can operate for a wide range of a serial bit rate from 600Mbps to 3.4Gbps/channel.

Figure 2 shows the timing diagram of the basic operation of the chipset.

It does not need any external frequency reference, such as a crystal oscillator.

Data Enable

There are some requirements for DE signal as described in Figure 1, Figure 2, and Table 18.

If DE=Low, control data of same cycle and possibly particular assigned data bit 'CTL' except the first and the last pixel are transmitted. Otherwise video data are transmitted during DE=High.

Control data from receiver in DE=High period are previous data of DE transition. See Figure 2.

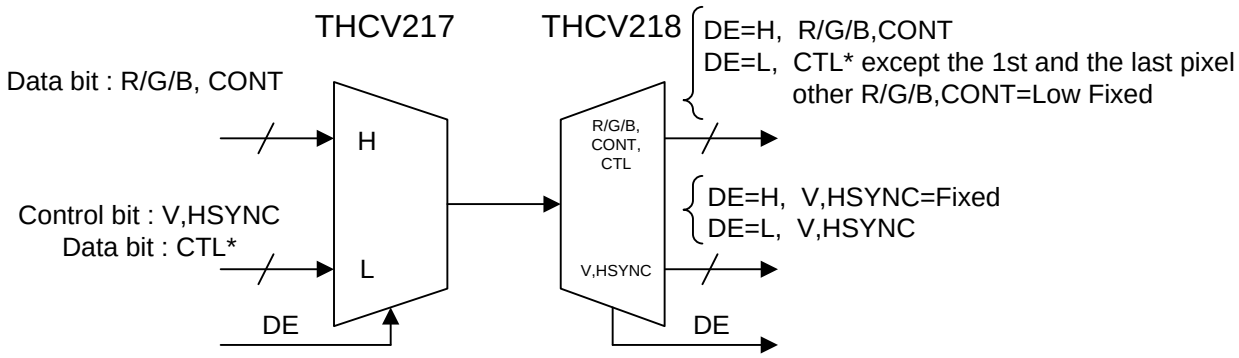
The length of DE being low and high is at least 2 clock cycles long, as described in Table 18.

Data Enable must be toggled like High -> Low -> High at regular interval.

CTL bit transmission

There are particular assigned data bit 'CTL' which can be transmitted both on DE=High and on DE=Low except the first and the last pixel on DE=Low.

This function is enabled by setting THCV218 Reserved7 pin to High.



*CTL are particular assigned bit among R/G/B, CONT that can carry arbitrary data during DE=Low period.
*CTL bit transmission is activated by setting THCV218 Reserved7 pin to High.

Figure 1. Conceptual diagram of the basic operation of the chipset

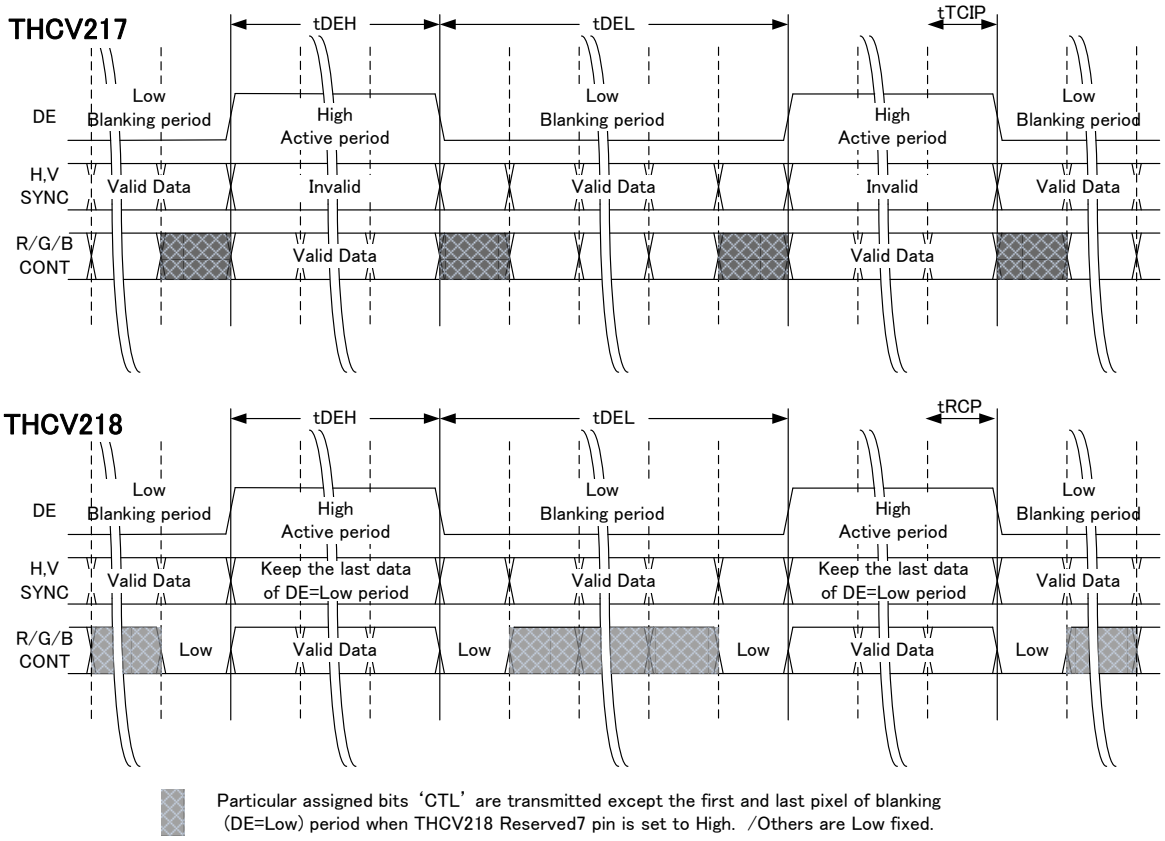
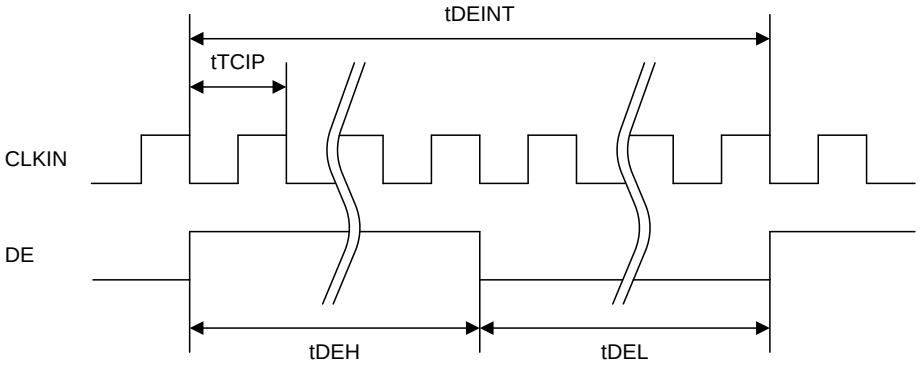


Figure 2. Data and synchronizing signals transmission timing diagram



Note: The period between rising edges of DE(tDEINT),high time of DE(tDEH) should always satisfy following equations.

$$tDEH = tTCIP \times (2m)$$

$$tDEINT = tTCIP \times (2n)$$

tDEL >= 4tTCIP (This tDEL rule is only in SiDo mode.)

m,n = positive integer, m≠n

Requirement for DE minimum length limitation is described in Table 18.

Figure2-1. DE input timing

Operation Mode and Color Depth Mode function

THCV217 and 218 support a variety of operation modes to optimize power consumption, number of PCB traces, or signal integrity. Refer to Table 2, Table 3, and Figure 3 for details.

COL	DEMUX	MODE	Description	CMOS Input		CML Output	
				CLKIN Range	# of data	TX0/1 Range	# of lanes
L	L	L	10bit Dual-in/Dual-out	20 to 85 MHz	(32+3)×2	0.8 to 3.4Gbps	2
L	L	H	10bit Single-in/Single-out	20 to 85 MHz	(32+3)×1	0.8 to 3.4Gbps	1
L	H	L	10bit Single-in/Dual-out	40 to 170 MHz	(32+3)×1	0.8 to 3.4Gbps	2
L	H	H	Reserved (Forbidden)	-	-	-	-
H	L	L	8bit Dual-in/Dual-out	20 to 85 MHz	(24+3)×2	0.6 to 2.55Gbps	2
H	L	H	8bit Single-in/Single-out	20 to 85 MHz	(24+3)×1	0.6 to 2.55Gbps	1
H	H	L	8bit Single-in/Dual-out	40 to 170 MHz	(24+3)×1	0.6 to 2.55Gbps	2
H	H	H	Reserved (Forbidden)	-	-	-	-

Table 2. THCV217 operation mode select

COL	MODE1	MODE0	Description	CML Input		CMOS Output	
				RX0/1 Range	# of lanes	CLKOUT Range	# of data
L	L	L	10bit Dual-in/Dual-out	0.8 to 3.4Gbps	2	20 to 85 MHz	(32+3)×2
L	L	H	10bit Dual-in/Single-out	0.8 to 3.4Gbps	2	40 to 170 MHz	(32+3)×1
L	H	L	10bit Single-in/Single-out	0.8 to 3.4Gbps	1	20 to 85 MHz	(32+3)×1
L	H	H	Reserved (Forbidden)	-	-	-	-
H	L	L	8bit Dual-in/Dual-out	0.6 to 2.55Gbps	2	20 to 85 MHz	(24+3)×2
H	L	H	8bit Dual-in/Single-out	0.6 to 2.55Gbps	2	40 to 170 MHz	(24+3)×1
H	H	L	8bit Single-in/Single-out	0.6 to 2.55Gbps	1	20 to 85 MHz	(24+3)×1
H	H	H	Reserved (Forbidden)	-	-	-	-

Table 3. THCV218 operation mode select

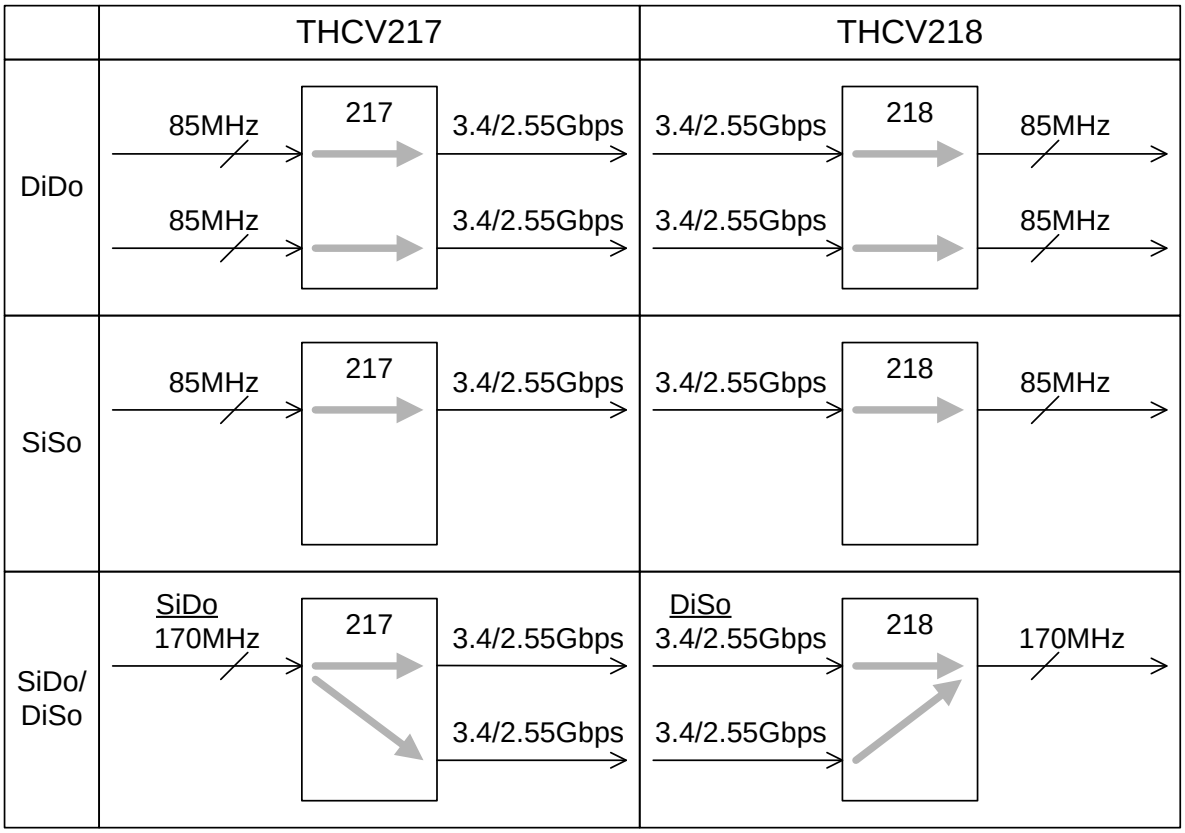


Figure 3. Operation modes of the chipset (10bit/8bit)

CML Buffer

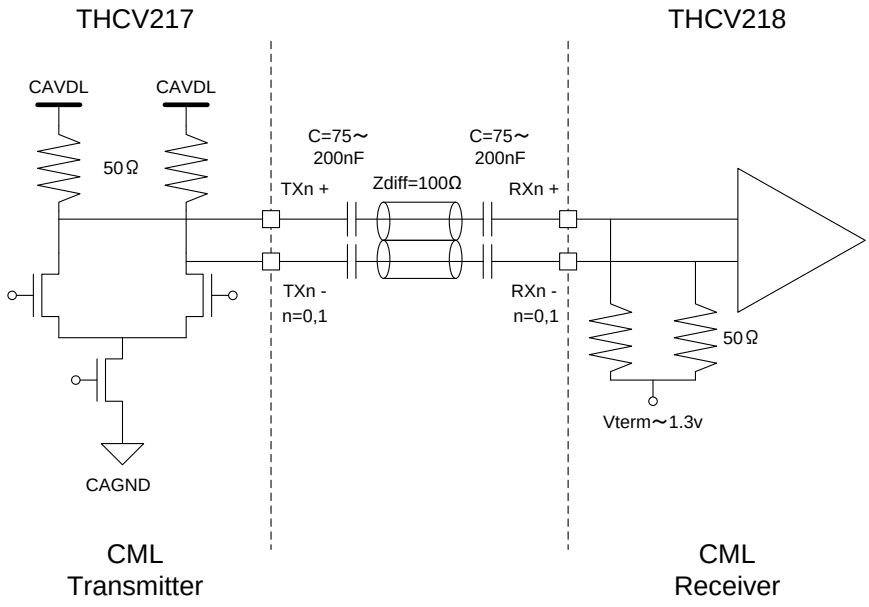


Figure 4. CML buffer scheme

Lock Detect and Hot-Plug Function

LOCKN and HTPDN of Rx must be connected with those of Tx as in Figure 5.

LOCKN and HTPDN on THCV218 are both open drain outputs. Pull-up resistors are needed at Tx side.

If THCV218 is not active (in the power down mode, powered off, or not connected), THCV218's HTPDN turns high-Z, and the pull-up resister at the Tx side makes the HTPDN input of THCV217 high. THCV217 then enters into the power down mode.

When THCV218 is active, HTPDN is pulled down by THCV218. Then THCV217 starts up and transmits the "training pattern" for link training.

LOCKN indicates whether THCV218 is in the lock state or not. If THCV218 is not the lock state, LOCKN turns high-Z. Otherwise (in the lock state), it's pulled down by THCV218.

THCV217 keeps transmitting the "training pattern" until LOCKN turns low. And then THCV217 starts transmitting serialized input data.

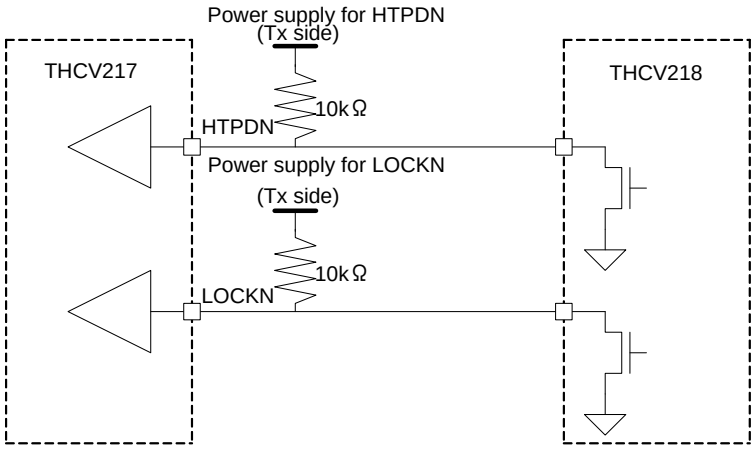


Figure 5. Hot-plug and Lock detect scheme

HTPDN connection between THCV217 and THCV218 can be omitted as an application option. In this case, HTPDN at the Transmitter side should always be taken as Low. See Figure 6.

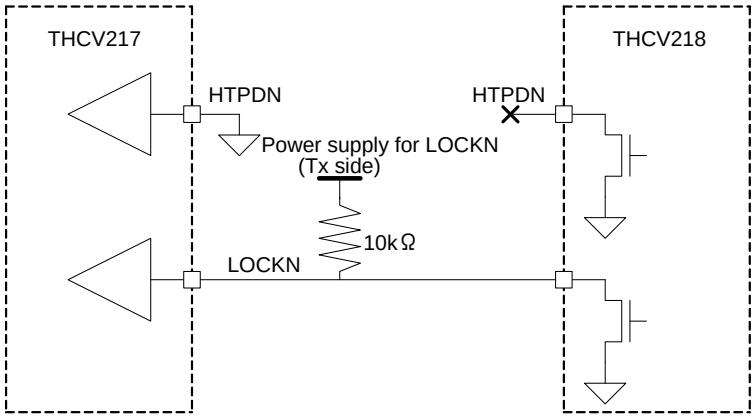


Figure 6. HTPDN is not connected scheme

Pre-emphasis

Pre-emphasis can equalize severe signal degradation caused by long-distance or high-speed transmission. The PRE pin selects the strength of pre-emphasis. See Table 4.

PRE	Description
H	w/ 100% Pre-emphasis
L	w/o Pre-emphasis

Table 4. Pre-emphasis function table

Power Down Function

Setting the PDN pin low places THCV217 in the power-down mode. All the internal circuitry turns off and the TXmp/n (m=0, 1) outputs turn to CAVDL.

Setting the PDN pin low places THCV218 in the power-down mode. All the internal circuitry turns off and the CMOS outputs drives low.

Field BET Operation

In order to help users to debug high-speed serial links (CML lines), THCV217 and THCV218 have an operation mode in which they act as the bit error tester (BET). In this mode, THCV217 internally generates a test pattern, which is then serialized onto CML high-speed lines. THCV218 receives the data stream and checks the sampled data for bit errors.

This "Field BET" mode is activated by setting BET= H on THCV217, and BET=H and Reserved7=L on THCV218.

In the Field BET mode, the on-chip pattern generator on THCV217 is enabled and generates the test pattern as long as the clock is applied onto CLKIN. Other CMOS data inputs are ignored. The generated data pattern is then 8b/10b encoded, scrambled, and serialized onto CML channels. As for THCV218, the internal test pattern check circuit gets enabled and the pattern check result is output on BETOUT. The BETOUT pin goes LOW whenever bit errors occur, and it stays HIGH when there is no bit error. Please refer to Figure 7 and Figure 8.

Table 5 shows possible combinations of Tx and Rx for normal operation and Field BET operation.

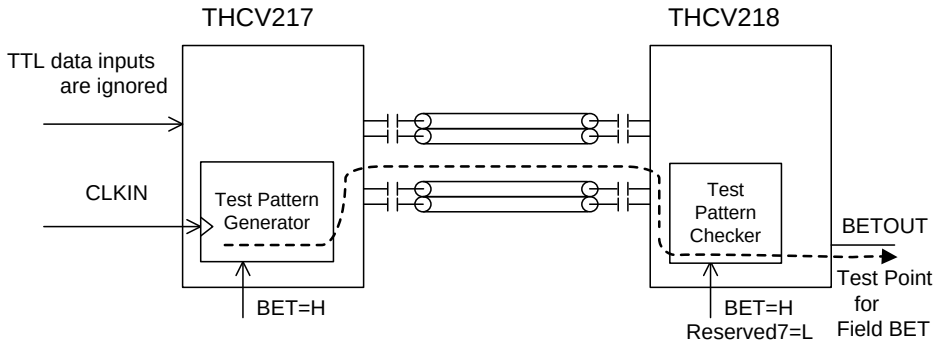


Figure 7. Field BET Configuration

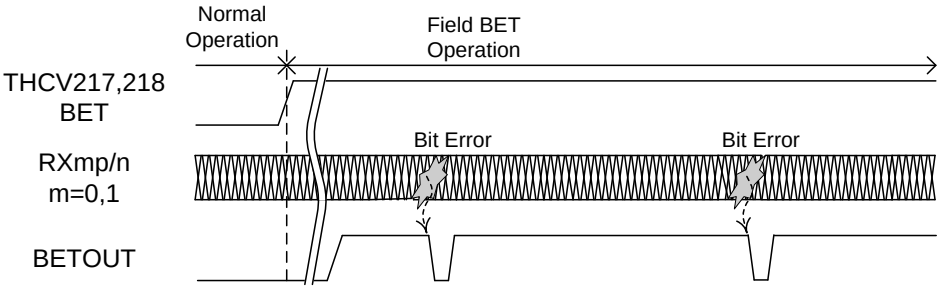


Figure 8. Relationship between bit error and BETOUT

	Tx	Rx
1	THCV217	THCV218
2	THCV215	THCV218
3	THCV217	THCV216

Table 5. Possible combinations of Tx and Rx for Field BET mode

DGLOCK

In order to reduce the number of cables needed for HTPDN and LOCKN in multiple-Rx chip configuration, THCV218 is equipped with the DGLOCK pin. When all the DGLOCK pins are connected as in Figure 9, the connected Rx chips can share the CDR lock status, making all the Rx chips in the same operation status.

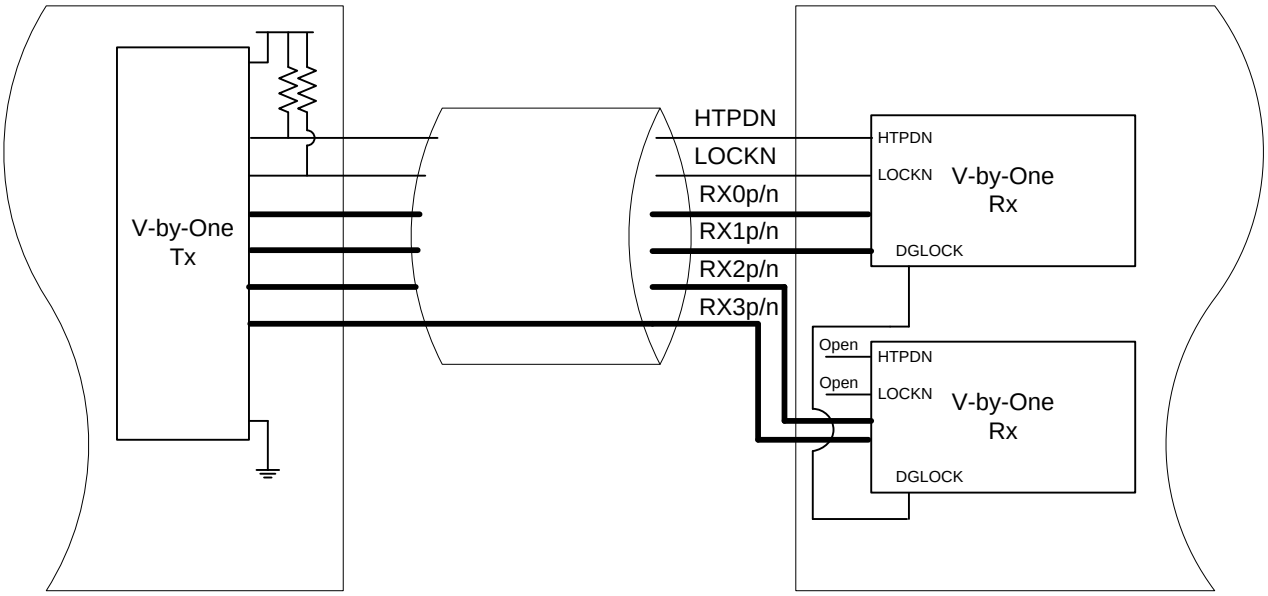


Figure 9. Usage of DGLOCK in multiple-Rx configuration

PLL Frequency Range Select

The THCV218's PLL input pin selects the operating frequency range of THCV218. Table 6 shows the selectable frequency ranges for operation modes.

Operation Mode	PLL	CLKOUT
Dual-in/Dual-out	H	20 to 40MHz
	L	40 to 85MHz
Dual-in/Single-out	H	Forbidden
	L	40 to 170MHz
Single-in/Single-out	H	20 to 40MHz
	L	40 to 85MHz

Table 6. Frequency range select

Absolute Maximum Ratings

Parameter	Min.	Typ.	Max.	Units
1.8V Supply Voltage（VDL,CAVDL,CPVDL）	-0.3	-	+2.1	V
3.3V Supply Voltage (DVDH)	-0.3	-	+4.0	V
CMOS Intput Voltage	-0.3	-	DVDH+0.3	V
CML Transmitter Output Voltage	-0.3	-	CAVDL+0.3	V
CML Output Current	-50	-	50	mA
Storage Temperature	-55	-	+125	℃
Junction Temperature	-	-	+125	℃
Reflow Peak Temperature/Time	-	-	+260/10sec	℃
Maximum Power Dissipation @+25℃		2.47		W

Table 7. THCV217 Absolute Maximum Ratings

Parameter	Min.	Typ.	Max.	Units
1.8V Supply Voltage (VDL,CAVDL)	-0.3	-	+2.1	V
3.3V Supply Voltage (DVDH)	-0.3	-	+4.0	V
CMOS Input Voltage	-0.3	-	DVDH+0.3	V
CMOS Output Voltage	-0.3	-	DVDH+0.3	V
CMOS Open drain Output Voltage	-0.3	-	+4.0	V
CML Receiver Input Voltage	-0.3	-	CAVDL+0.3	V
Storage Temperature	-55	-	+125	℃
Junction Temperature	-	-	+125	℃
Reflow Peak Temperature/Time	-	-	+260/10sec	℃
Maximum Power Dissipation @+25℃		2.7		W

Table 8. THCV218 Absolute Maximum Ratings

Operating Conditions

Prameter	Min.	Typ.	Max.	Units
1.8V Supply Voltage（VDL,CAVDL,CPVDL）	1.62	1.80	1.98	V
3.3V Supply Voltage(DVDH)	3.00	3.30	3.60	V
Operating Temperature	-20	-	85	℃

Table 9. THCV217 Operating Conditions

Parameter	Min.	Typ.	Max.	Units
1.8V Supply Voltage（VDL,CAVDL,CPVDL）	1.62	1.80	1.98	V
3.3V Supply Voltage(DVDH)	3.00	3.30	3.60	V
Operating Temperature	-20	-	85	℃

Table 10. THCV218 Operating Conditions

* “Absolute Maximum Ratings” are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The tables of “Electrical Characteristics” specify conditions for device operation.

Electrical Specifications

3.3V CMOS DC Specifications

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
VIH	High Level Input Voltage	I3,I3PU	2.0	-	DVDH	V
		I3L	2.0	-	DVDH	V
VIL	Low Level Input Voltage	I3,I3PU	0	-	0.8	V
		I3L	0	-	0.7	V
VOH	High Level Output Voltage	O3 IOH=-8mA	2.4	-	-	V
VOL	Low Level Output Voltage	O3 IOL=8mA	-	-	0.4	V
		OD3,I3PU IOL=4mA	-	-	0.4	V
IIH	Input Leak Current High	VIN=DVDH	-	-	±10	uA
IIL	Input Leak Current Low	VIN=0V	-	-	±10	uA
IOZH	Output Leak Current High in	VIN=DVDH, OE=L	-	-	±10	uA
IOZL	Output Leak Current Low in	VIN=0V, OE=L	-	-	±10	uA

Table 11. THCV217and THCV218 3.3V CMOS DC Specifications

CML DC Specifications

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
VTOD	CML Differential Mode Output Voltage	PRE=L	200	300	400	mV
PRE	CML Pre-emphasis Level	PRE=L	-	0	-	%
		PRE=H	80	100	120	%
VTOC	CML Common Mode Output Voltage	PRE=L	CAVDL-VTOD			mV
		PRE=H	CAVDL-2×VTOD			mV
ITOH	CML Output Leak Current High	PDN=H	-	-	±10	uA
ITOS	CML Output Short Circuit	CAVDL=1.8V	-90	-	-	mA

Table 12. THCV217 CML DC Specifications

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
VRTH	CML Differential Input High Threshold		-	-	50	mV
VRTL	CML Differential Input Low Threshold		-50	-	-	mV
IRIH	CML Input Leak Current High	PDN=L, RX0/1=CAVDL	-	-	±10	uA
IRIL	CML Input Leak Current Low	PDN=L,RX0/1=0V	-	-	±10	uA
IRRIH	CML Input Current High	RX0/1=CAVDL	-	-	2	mA
IRRIL	CML Input Current Low	RX0/1=0V	-6	-	-	mA
RRIN	CML Differential Input Resistance		80	100	120	Ω

Table 13. THCV218 CML DC Specifications

Supply Currents

Symbol	Parameter	conditions	Min.	Typ.	Max.	Units
ITCCW	Transmitter Supply Current for VDL, CAVDL, CPVDL (Worst Case Pattern)	DiDo 10bit PRE = H	-	-	185	mA
		SiSo 10bit PRE = H	-	-	115	mA
		SiDo 10bit PRE = H	-	-	180	mA
ITCCW33	Transmitter Supply Current for DVDH (Worst Case Pattern)	DiDo 10bit PRE = H	-	-	10	mA
		SiSo 10bit PRE = H	-	-	7	mA
		SiDo 10bit PRE = H	-	-	10	mA
ITCCS	Transmitter Power Down	PDN = L	-	-	200	uA

Table 14. THCV217 Supply Currents

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
IRCCW	Receiver Supply Current for VDL, CAVDL (Worst Case Pattern)	DiDo 10bit	-	-	180	mA
		SiSo 10bit	-	-	95	mA
		DiSo 10bit	-	-	170	mA
IRCCW33	Receiver Supply Current for DVDH (Worst Case Pattern)	DiDo 10bit CL=8pF	-	-	200	mA
		SiSo 10bit CL=8pF	-	-	100	mA
		DiSo 10bit CL=8pF	-	-	200	mA
IRCCS	Receiver Power Down Supply Current	PDN = L Input = Fixed L or H	-	-	200	uA

Table 15. THCV218 Supply Currents

Switching Characteristics

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
tTRF	TX0/1 Rise and Fall Time (20%-80%)		50	-	150	ps
tTOSK	TX0/1 Output Inter Pair Skew		-2	-	2	UI
tTCIP	CLKIN Period	SiSo, DiDo	11.76	-	50	ns
		SiDo	5.88	-	25	ns
tTCH	CLK IN High Time		0.35×tTCIP	0.5×tTCIP	0.65×tTCIP	ns
tTCL	CLK IN Low Time		0.35t×TCIP	0.5×tTCIP	0.65×tTCIP	ns
tTS	CMOS Data Setup to CLK IN		2.0	-	-	ns
tTH	CMOS Data Hold to CLK IN		0.5	-	-	ns
tTCD	Input Clock to Output Data Delay	SiSo / DiDo 8bit	typ.-10	(13+7/10)×tTCIP	typ.+10	ns
		SiSo / DiDo 10bit		13×tTCIP		
		SiDo 8bit	typ.-10-tTCIP	(21+4/10)×tTCIP	typ.+10+tTCIP	
		SiDo 10bit		20×tTCIP		
tTPD	Power On to PDN High Delay		0	-	-	ns
tTPLL0	PDN High to CML Output Delay		-	-	10	ms
tTPLL1	PDN Low to CML Output High Fix Delay		-	-	20	ns
tTNP0	LOCKN High to Training Pattern Output Delay		-	-	10	ms
tTNP1	LOCKN Low to Data Pattern Output Delay		-	-	10	ms

Table 16. THCV217 Switching Characteristics

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
tRBIT	Unit Interval	COL=L	294	-	1250	ps
		COL=H	392	-	1667	ps
tRISK	RX0/1 Input Inter Pair Skew		-	-	15	UI
tRCP	CLKOUT Period	SiSo, DiDo	11.76	T	50.0	ns
		DiSo	5.88		25.0	ns
tRCH	CLKOUT High Time		-	T/2	-	ns
tRCL	CLKOUT Low Time		-	T/2	-	ns
tDOUT	CMOS Data OUT Period		-	T	-	ns
tRS	CMOS Data Setup to CLKOUT		0.45×tRCP-0.45	-	-	ns
tRH	CMOS Data Hold to CLKOUT		0.45×tRCP-0.45	-	-	ns
tDK	CLKOUT Delay Time	PLL=H	-	3T/16	-	ns
		PLL=L	-	3T/32	-	ns
tTLH	CMOS Low to High Transition Time	Clock	-	0.7	1.0	ns
		Data	-	1.4	2.0	ns
tTHL	CMOS High to Low Transition Time	Clock	-	0.7	1.0	ns
		Data	-	1.4	2.0	ns
tRDC	Input Data to Output Clock Delay	SiSo/DiDo 8bit PLL=L	typ.-10	(18+5/10)×tRCP	typ.+10	ns
		SiSo/DiDo 10bit PLL=L		18×tRCP		
		SiSo/DiDo 8bit PLL=H		(16+4/10)×tRCP		
		SiSo/DiDo 10bit PLL=H		(15+7/10)×tRCP		
		DiSo 8bit		(39+5/10)×tRCP		
		DiSo 10bit		38t×RCP		
tRPD	Power On to PDN High Delay		0	-	-	ns
tRHPD0	PDN High to HTPDN Low Delay		-	-	1	us
tRHPD1	PDN Low to HTPDN High Delay		-	-	1	us
tRPLL0	Training Pattern Input to LOCKN Low Delay		-	-	10	ms
tRPLL1	PDN Low to LOCKN High		-	-	10	us
tRLCK0	LOCKN Low to TTL Output		-	-	5	ms
tRLCK1	LOCKN High to TTL Low-fixed		-	-	0	ns

Table 17. THCV218 Switching Characteristics

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
tDEH	DE=High Duration		2×tTCIP	-	-	sec
tDEL	DE=Low Duration	SiSo, DiDo	2×tTCIP	-	-	sec
		SiDo, DiSo	4×tTCIP	-	-	sec

Table 18. DE requirement

AC Timing Diagrams and Test Circuits

CMOS Input Switching Characteristics

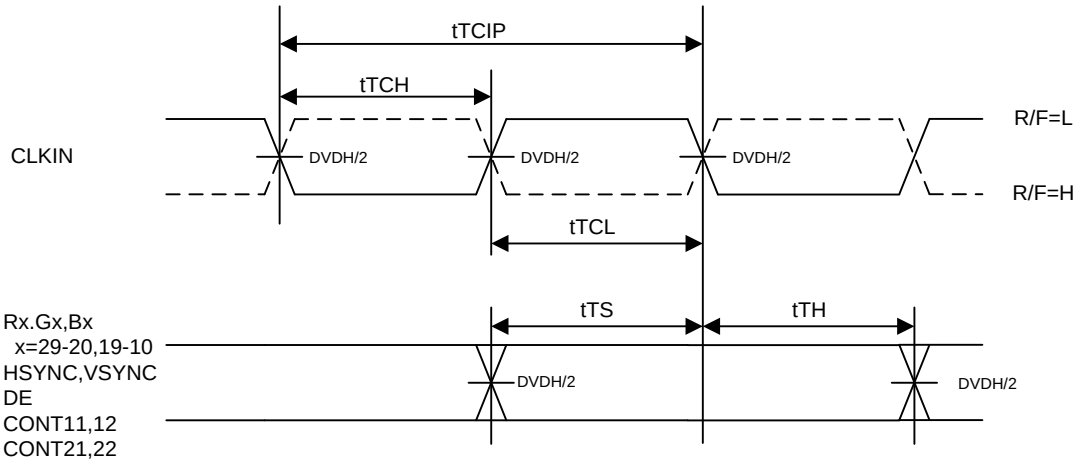


Figure 10. CMOS Input Switching Timing Diagrams

CMOS Output Switching Characteristics

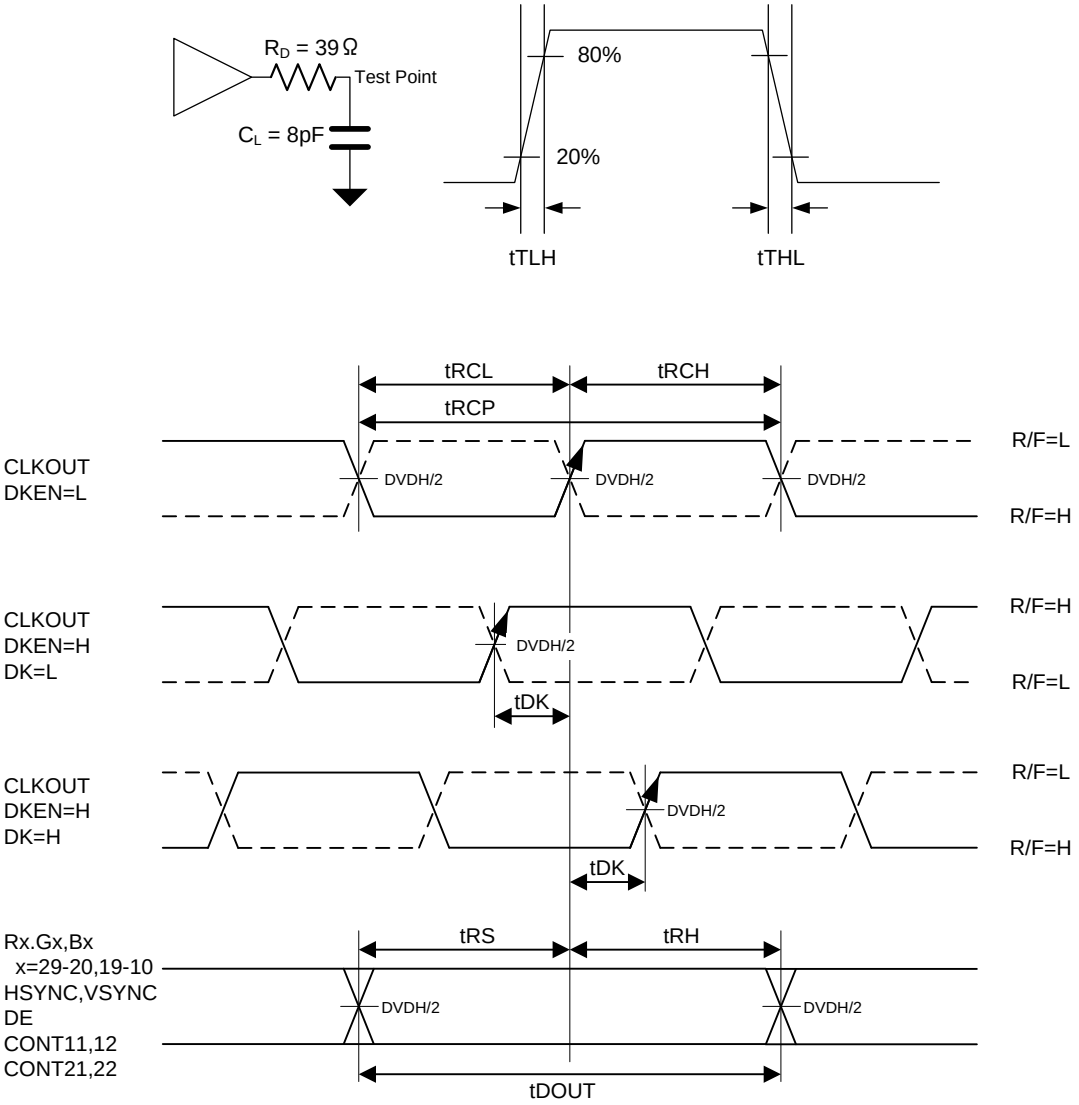


Figure 11. CMOS Output Switching Timing Diagrams and Test Circuit

CML Output Switching Characteristics

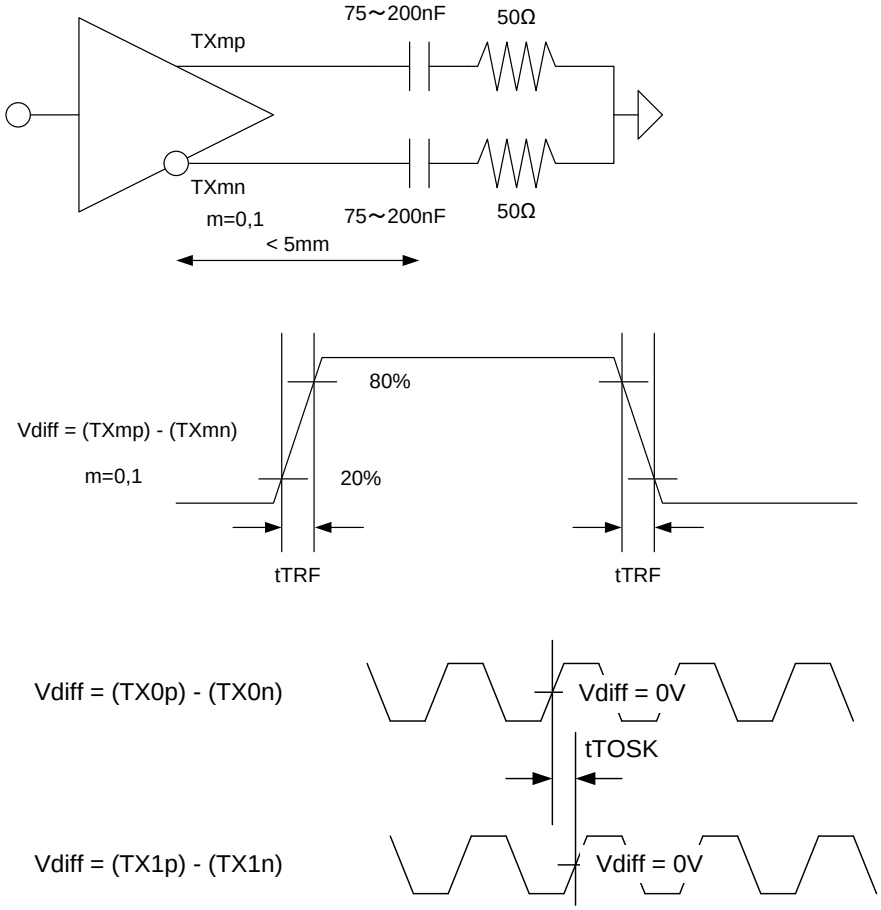


Figure 12. CML Output Switching Timing Diagrams and Test Circuit

CML Input Switching Characteristics

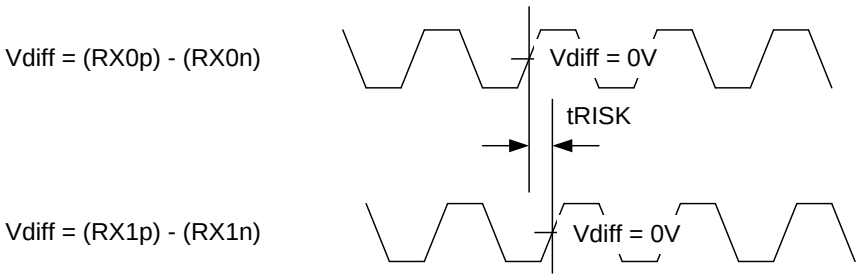
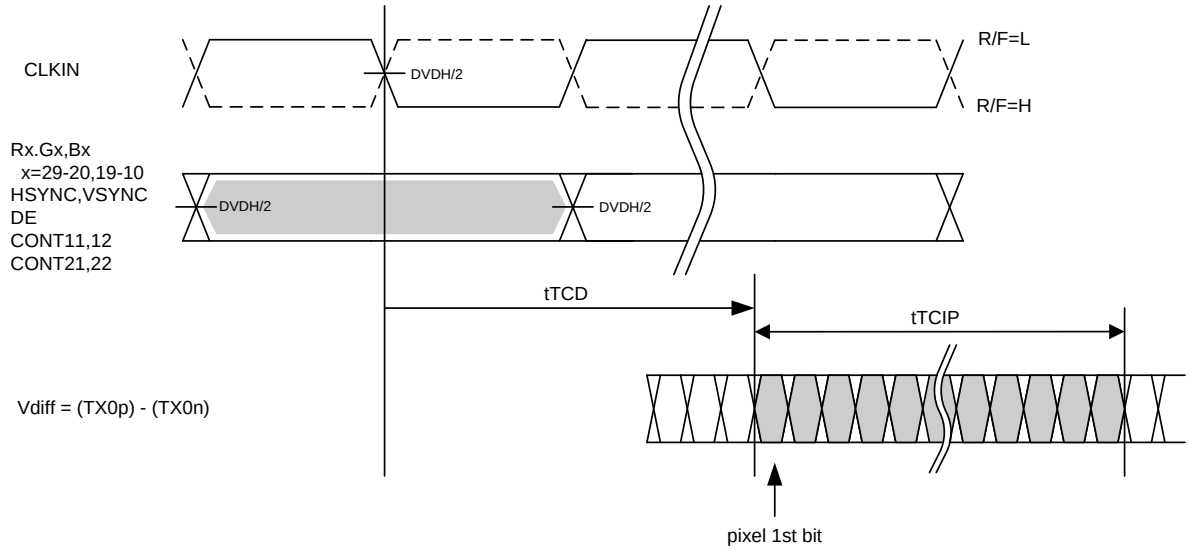


Figure 13. CML Input Timing Diagrams

Latency Characteristics



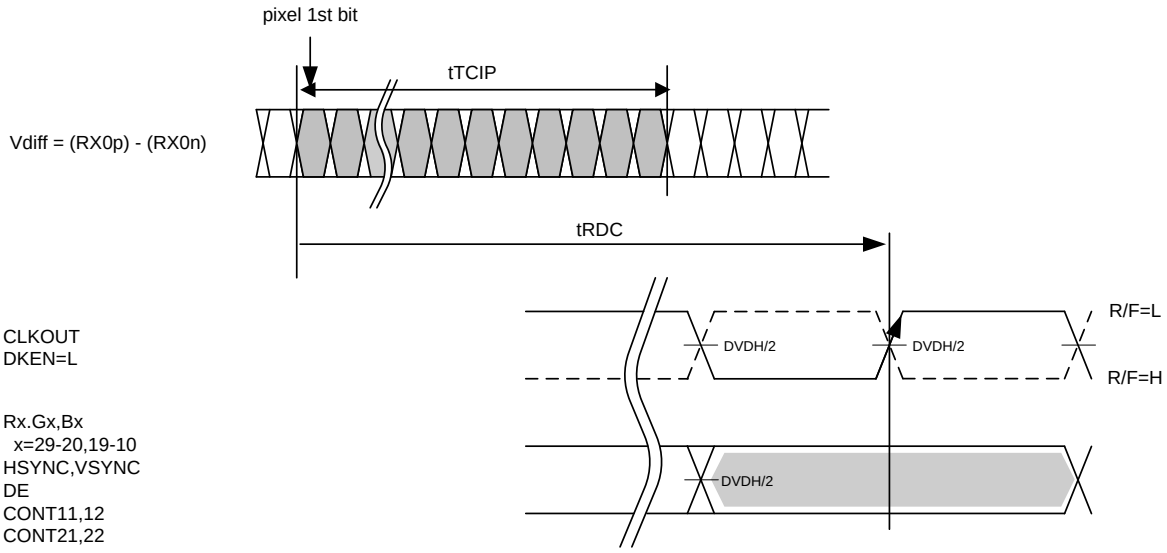


Figure 14. THCV217 and THCV218 Latency

Lock and Unlock Sequence

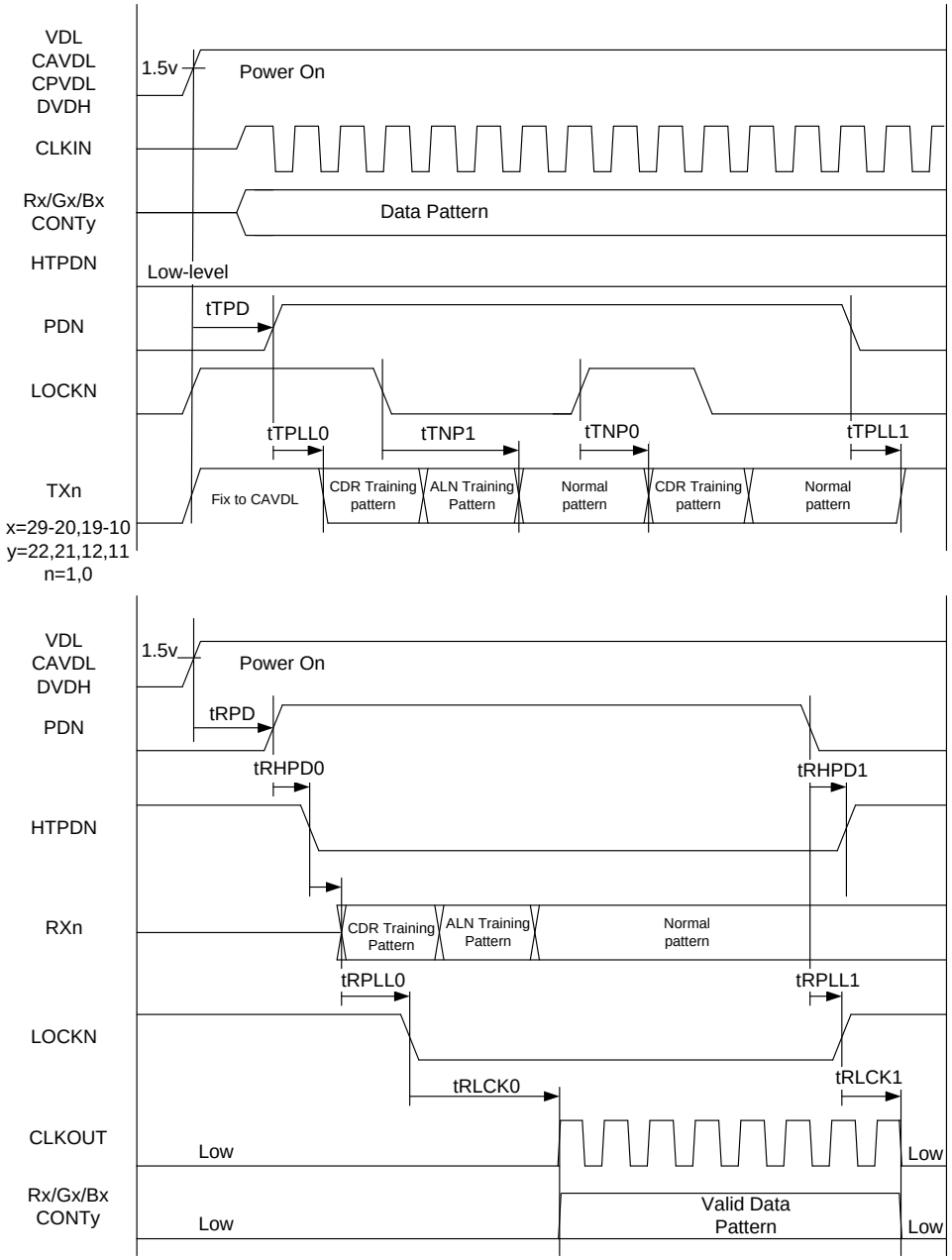


Figure 15. THCV217 and THCV218 Lock and Unlock Sequence

tTPD and tRPD minimum is 0sec; therefore, PDN can be applied at the same time as VDL, CAVDL, CPVDL and DVDH. tTPLL0 is the time from “both PDN=High and HTPDN=Low“ moment to Training pattern ignition. HTPDN could transit from High to Low under PDN=High condition at THCV217, which is different from what Figure 15 indicates but is natural situation.

Note: When change and discontinuation occur in the clock frequency to THCV217, in order to collateralize the operation after clock frequency change or return, please insert a Low pulse to the PDN pin of THCV218 to reset the internal PLL.

THCV217 Input Data Mapping

Data Signals		Transmitter Input Pin Name		Symbol defined by V-by-One® HS
10bit (30bpp)	8bit (24bpp)	10bit (30bpp)	8bit (24bpp)	
R0*1	-	R10	-	D30
R1*1	-	R11	-	D31
R2	R0	R12	R12	D0
R3	R1	R13	R13	D1
R4	R2	R14	R14	D2
R5	R3	R15	R15	D3
R6	R4	R16	R16	D4
R7	R5	R17	R17	D5
R8	R6	R18	R18	D6
R9	R7	R19	R19	D7
G0*1	-	G10	-	D28
G1*1	-	G11	-	D29
G2	G0	G12	G12	D8
G3	G1	G13	G13	D9
G4	G2	G14	G14	D10
G5	G3	G15	G15	D11
G6	G4	G16	G16	D12
G7	G5	G17	G17	D13
G8	G6	G18	G18	D14
G9	G7	G19	G19	D15
B0*1	-	B10	-	D26
B1*1	-	B11	-	D27
B2*1	B0*1	B12	B12	D16
B3*1	B1*1	B13	B13	D17
B4*1	B2*1	B14	B14	D18
B5*1	B3*1	B15	B15	D19
B6*1	B4*1	B16	B16	D20
B7*1	B5*1	B17	B17	D21
B8*1	B6*1	B18	B18	D22
B9*1	B7*1	B19	B19	D23
CONT1*1*2	-	CONT11	-	D25
CONT2*1*2	-	CONT12	-	D24
HSYNC	HSYNC	HSYNC	HSYNC	HSYNC
VSYNC	VSYNC	VSYNC	VSYNC	VSYNC
DE	DE	DE	DE	DE

*1 CTL bits, which are carried during DE=Low except the 1st and the last pixel.

*2 3D flags defined in the V-by-One® HS Standard are assigned to the following bit.

V-by-One® HS Standard Packer/Unpacker D[24](3DLR) <=> CONT2

V-by-One® HS Standard Packer/Unpacker D[25](3DEN) <=> CONT1

Table 19. CMOS Input Data Mapping for Single-in/Single-out, Single-in/Dual-out mode

THCV217 Input Data Mapping (Continued)

1st Pixel Data				2nd Pixel Data				Symbol defined by V-by-One® HS
Data Signals		Transmitter Input Pin Name		Data Signals		Transmitter Input Pin Name		
10bit (30bpp)	8bit (24bpp)	10bit (30bpp)	8bit (24bpp)	10bit (30bpp)	8bit (24bpp)	10bit (30bpp)	8bit (24bpp)	
R10*1	-	R10	-	R20*1	-	R20	-	D30
R11*1	-	R11	-	R21*1	-	R21	-	D31
R12	R10	R12	R12	R22	R20	R22	R22	D0
R13	R11	R13	R13	R23	R21	R23	R23	D1
R14	R12	R14	R14	R24	R22	R24	R24	D2
R15	R13	R15	R15	R25	R23	R25	R25	D3
R16	R14	R16	R16	R26	R24	R26	R26	D4
R17	R15	R17	R17	R27	R25	R27	R27	D5
R18	R16	R18	R18	R28	R26	R28	R28	D6
R19	R17	R19	R19	R29	R27	R29	R29	D7
G10*1	-	G10	-	G20*1	-	G20	-	D28
G11*1	-	G11	-	G21*1	-	G21	-	D29
G12	G10	G12	G12	G22	G20	G22	G22	D8
G13	G11	G13	G13	G23	G21	G23	G23	D9
G14	G12	G14	G14	G24	G22	G24	G24	D10
G15	G13	G15	G15	G25	G23	G25	G25	D11
G16	G14	G16	G16	G26	G24	G26	G26	D12
G17	G15	G17	G17	G27	G25	G27	G27	D13
G18	G16	G18	G18	G28	G26	G28	G28	D14
G19	G17	G19	G19	G29	G27	G29	G29	D15
B10*1	-	B10	-	B20*1	-	B20	-	D26
B11*1	-	B11	-	B21*1	-	B21	-	D27
B12*1	B10*1	B12	B12	B22*1	B20*1	B22	B22	D16
B13*1	B11*1	B13	B13	B23*1	B21*1	B23	B23	D17
B14*1	B12*1	B14	B14	B24*1	B22*1	B24	B24	D18
B15*1	B13*1	B15	B15	B25*1	B23*1	B25	B25	D19
B16*1	B14*1	B16	B16	B26*1	B24*1	B26	B26	D20
B17*1	B15*1	B17	B17	B27*1	B25*1	B27	B27	D21
B18*1	B16*1	B18	B18	B28*1	B26*1	B28	B28	D22
B19*1	B17*1	B19	B19	B29*1	B27*1	B29	B29	D23
CONT11*1*2	-	CONT11	-	CONT21*1*2	-	CONT21	-	D25
CONT12*1*2	-	CONT12	-	CONT22*1*2	-	CONT22	-	D24
HSYNC	HSYNC	HSYNC	HSYNC	-	-	-	-	HSYNC
VSYNC	VSYNC	VSYNC	VSYNC	-	-	-	-	VSYNC
DE	DE	DE	DE	-	-	-	-	DE

*1 CTL bits, which are carried during DE=Low except the 1st and the last pixel.

*2 3D flags defined in the V-by-One® HS Standard are assigned to the following bit.

V-by-One® HS Standard Packer/Unpacker D[24](3DLR) <=> CONT12/CONT22

V-by-One® HS Standard Packer/Unpacker D[25](3DEN) <=> CONT11/CONT21

Table 20. CMOS Input Data Mapping for Dual-in/Dual-out mode

THCV218 Output Data Mapping

Data Signals		Receiver Output Pin Name		Symbol defined by V-by-One® HS
10bit (30bpp)	8bit (24bpp)	10bit (30bpp)	8bit (24bpp)	
R0*1	-	R10	-	D30
R1*1	-	R11	-	D31
R2	R0	R12	R12	D0
R3	R1	R13	R13	D1
R4	R2	R14	R14	D2
R5	R3	R15	R15	D3
R6	R4	R16	R16	D4
R7	R5	R17	R17	D5
R8	R6	R18	R18	D6
R9	R7	R19	R19	D7
G0*1	-	G10	-	D28
G1*1	-	G11	-	D29
G2	G0	G12	G12	D8
G3	G1	G13	G13	D9
G4	G2	G14	G14	D10
G5	G3	G15	G15	D11
G6	G4	G16	G16	D12
G7	G5	G17	G17	D13
G8	G6	G18	G18	D14
G9	G7	G19	G19	D15
B0*1	-	B10	-	D26
B1*1	-	B11	-	D27
B2*1	B0*1	B12	B12	D16
B3*1	B1*1	B13	B13	D17
B4*1	B2*1	B14	B14	D18
B5*1	B3*1	B15	B15	D19
B6*1	B4*1	B16	B16	D20
B7*1	B5*1	B17	B17	D21
B8*1	B6*1	B18	B18	D22
B9*1	B7*1	B19	B19	D23
CONT1*1*2	-	CONT11	-	D25
CONT2*1*2	-	CONT12	-	D24
HSYNC	HSYNC	HSYNC	HSYNC	HSYNC
VSYNC	VSYNC	VSYNC	VSYNC	VSYNC
DE	DE	DE	DE	DE

*1 CTL bits, which are carried during DE=Low except the 1st and the last pixel.

*2 3D flags defined in the V-by-One® HS Standard are assigned to the following bit.

V-by-One® HS Standard Packer/Unpacker D[24](3DLR) <=> CONT2

V-by-One® HS Standard Packer/Unpacker D[25](3DEN) <=> CONT1

Table 21. CMOS Output Data Mapping for Single-in/Single-out, Dual-in/Single-out mode

THCV218 Output Data Mapping (Continued)

1st Pixel Data				2nd Pixel Data				Symbol defined by V-by-One® HS
Data Signals		Receiver Output Pin Name		Data Signals		Receiver Output Pin Name		
10bit (30bpp)	8bit (24bpp)	10bit (30bpp)	8bit (24bpp)	10bit (30bpp)	8bit (24bpp)	10bit (30bpp)	8bit (24bpp)	
R10*1	-	R10	-	R20*1	-	R20	-	D30
R11*1	-	R11	-	R21*1	-	R21	-	D31
R12	R10	R12	R12	R22	R20	R22	R22	D0
R13	R11	R13	R13	R23	R21	R23	R23	D1
R14	R12	R14	R14	R24	R22	R24	R24	D2
R15	R13	R15	R15	R25	R23	R25	R25	D3
R16	R14	R16	R16	R26	R24	R26	R26	D4
R17	R15	R17	R17	R27	R25	R27	R27	D5
R18	R16	R18	R18	R28	R26	R28	R28	D6
R19	R17	R19	R19	R29	R27	R29	R29	D7
G10*1	-	G10	-	G20*1	-	G20	-	D28
G11*1	-	G11	-	G21*1	-	G21	-	D29
G12	G10	G12	G12	G22	G20	G22	G22	D8
G13	G11	G13	G13	G23	G21	G23	G23	D9
G14	G12	G14	G14	G24	G22	G24	G24	D10
G15	G13	G15	G15	G25	G23	G25	G25	D11
G16	G14	G16	G16	G26	G24	G26	G26	D12
G17	G15	G17	G17	G27	G25	G27	G27	D13
G18	G16	G18	G18	G28	G26	G28	G28	D14
G19	G17	G19	G19	G29	G27	G29	G29	D15
B10*1	-	B10	-	B20*1	-	B20	-	D26
B11*1	-	B11	-	B21*1	-	B21	-	D27
B12*1	B10*1	B12	B12	B22*1	B20*1	B22	B22	D16
B13*1	B11*1	B13	B13	B23*1	B21*1	B23	B23	D17
B14*1	B12*1	B14	B14	B24*1	B22*1	B24	B24	D18
B15*1	B13*1	B15	B15	B25*1	B23*1	B25	B25	D19
B16*1	B14*1	B16	B16	B26*1	B24*1	B26	B26	D20
B17*1	B15*1	B17	B17	B27*1	B25*1	B27	B27	D21
B18*1	B16*1	B18	B18	B28*1	B26*1	B28	B28	D22
B19*1	B17*1	B19	B19	B29*1	B27*1	B29	B29	D23
CONT11*1*2	-	CONT11	-	CONT21*1*2	-	CONT21	-	D25
CONT12*1*2	-	CONT12	-	CONT22*1*2	-	CONT22	-	D24
HSYNC	HSYNC	HSYNC	HSYNC	-	-	-	-	HSYNC
VSYNC	VSYNC	VSYNC	VSYNC	-	-	-	-	VSYNC
DE	DE	DE	DE	-	-	-	-	DE

*1 CTL bits, which are carried during DE=Low except the 1st and the last pixel.

*2 3D flags defined in the V-by-One® HS Standard are assigned to the following bit.

V-by-One® HS Standard Packer/Unpacker D[24](3DLR) <=> CONT12/CONT22

V-by-One® HS Standard Packer/Unpacker D[25](3DEN) <=> CONT11/CONT21

Table 22. CMOS Output Data Mapping for Dual-in/Dual-out mode

Note

1)Power On Sequence

Don't input clock nor data before THCV217 is on in order to keep absolute maximum ratings.

2)Cable Connection and Disconnection

Don't connect and disconnect the CML cable, when the power is supplied to the system.

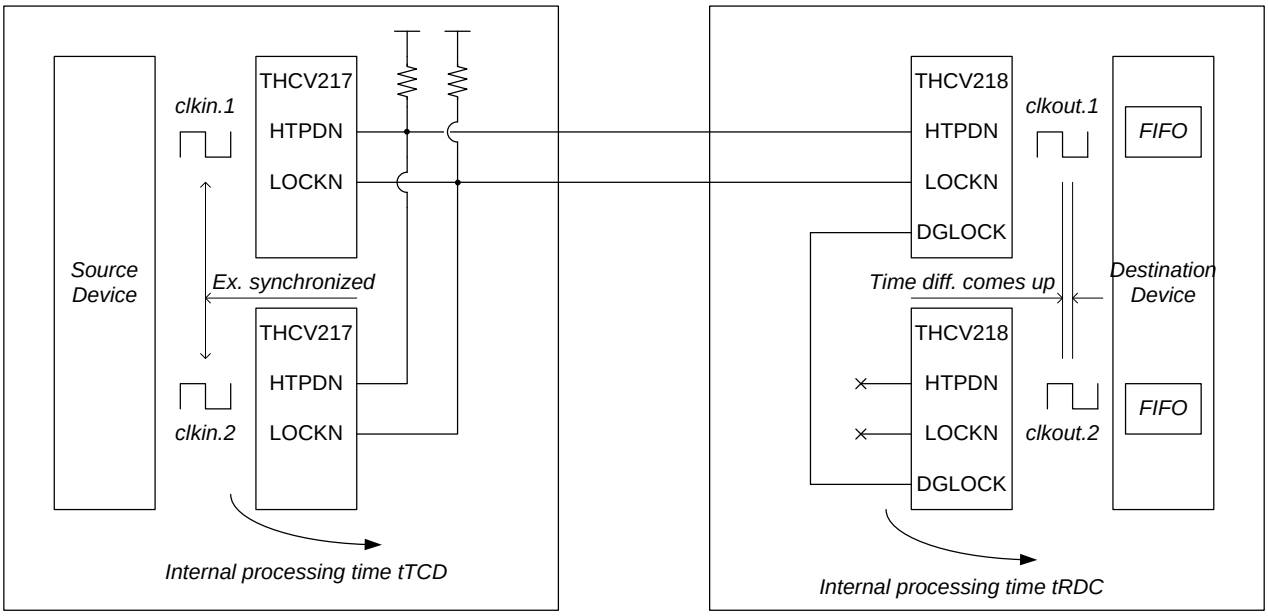
3)GND Connection

Connect the each GND of the PCB which Transmitter, Receiver and THCV217-218 on it. It is better for EMI reduction to place GND cable as close to CML cable as possible.

4)Multiple device connection

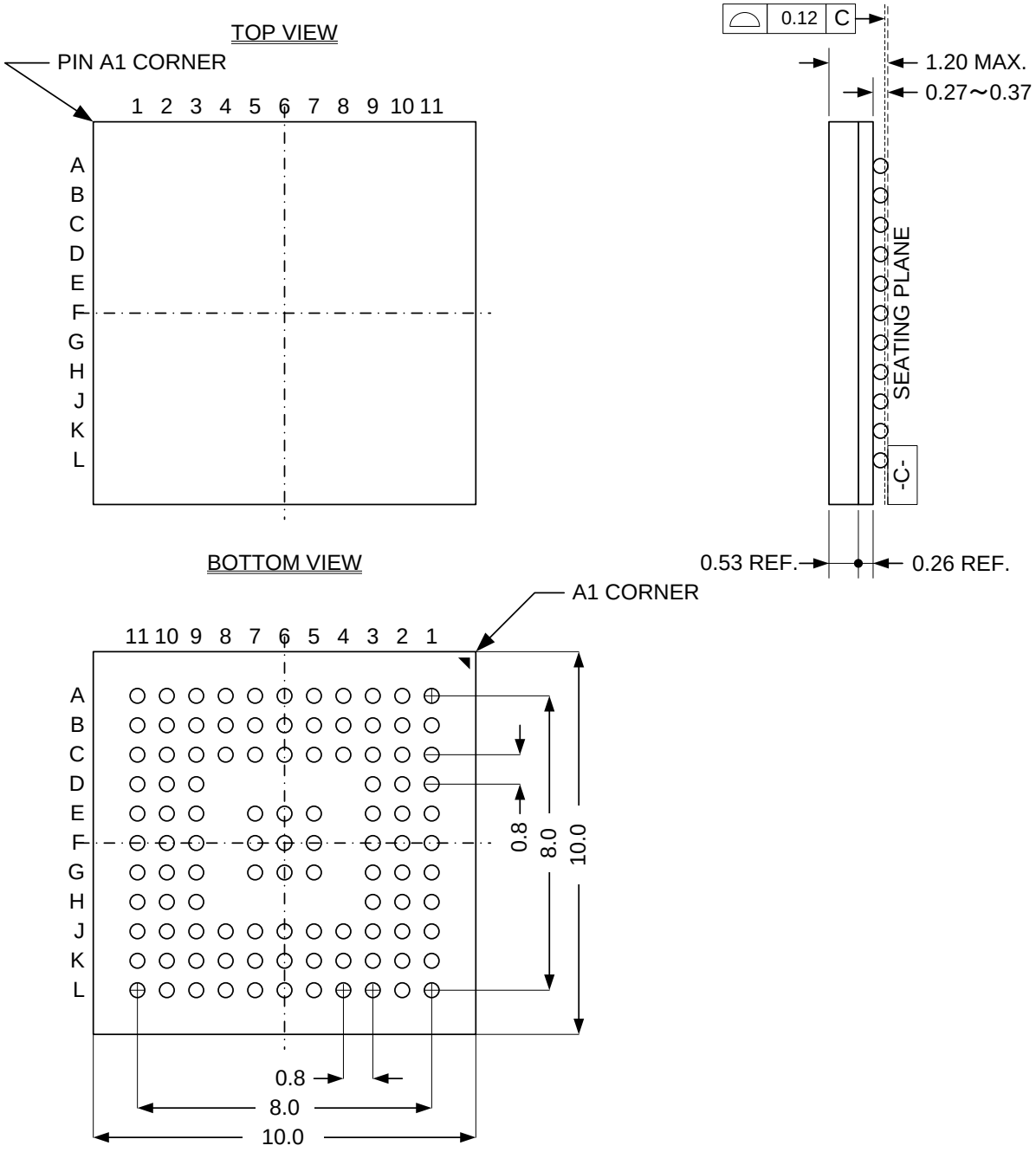
HTPDN and LOCKN signals are supposed to be connected proper for their purpose like the following figure.
HTPDN should be from just one Rx to multiple Tx because its purpose is only ignition of all Tx.
LOCKN should be connected so as to indicate that all Rx CDR become ready to receive normal operation data.
LOCKN of Tx side can be simply split to multiple Tx.
THCV218 DGLOCK connection is appropriate for multiple Rx use.

Also possible time difference of internal processing time (p.19 THCV217 tTCD and p.20 THCV218 tRDC) on multiple data stream must be accommodated and compensated by the following destination device connected to multiple THCV218, which may have internal FIFO.



Package

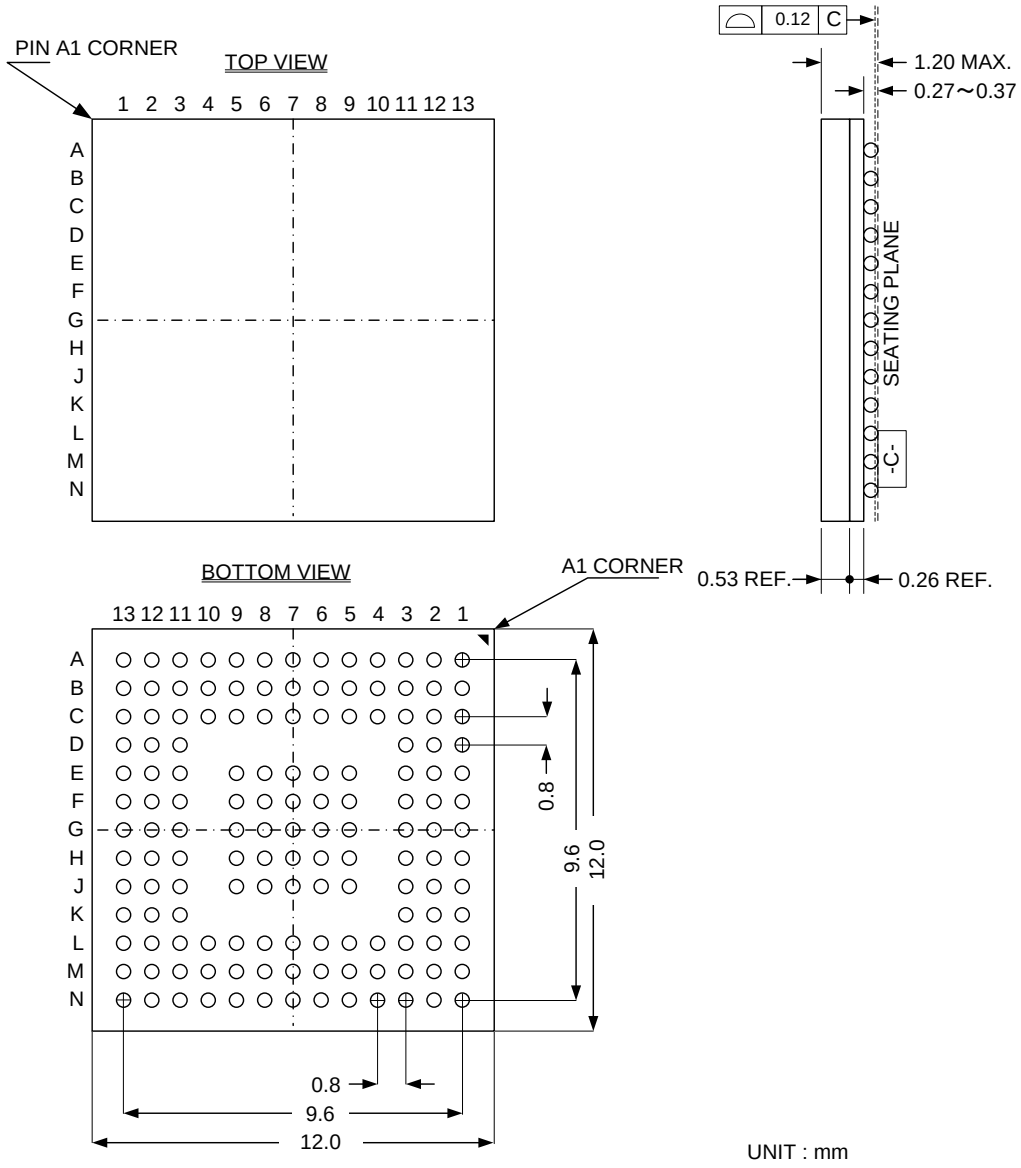
THCV217 TFBGA 10x10 105L



UNIT : mm

Ball Diameter: 0.4
Ball Width: 0.38～0.48

THCV218 TFBGA 12x12 145L



Ball Diameter: 0.4
Ball Width: 0.38～0.48

Notices and Requests

1. The product specifications described in this material are subject to change without prior notice.

2. The circuit diagrams described in this material are examples of the application which may not always apply to the customer's design. THine Electronics, Inc. ("THine") is not responsible for possible errors and omissions in this material. Please note even if errors or omissions should be found in this material, THine may not be able to correct them immediately.

3. This material contains THine's copyright, know-how or other intellectual property rights. Copying, reverse-engineer or disclosing to third parties the contents of this material without THine's prior written permission is prohibited.

4. THINE ACCEPTS NO LIABILITY FOR ANY DAMAGE OR LOSS IN CONNECTION WITH ANY DISPUTE RELATING TO INTELLECTUAL PROPERTY RIGHTS BETWEEN THE USER AND ANY THIRD PARTY, ARISING OUT OF THIS PRODUCT, EXCEPT FOR SUCH DAMAGE OR LOSS IN CONNECTION WITH DISPUTES SUCCESSFULLY PROVED BY THE USER THAT SUCH DISPUTES ARE DUE SOLELY TO THINE. NOTE, HOWEVER, EVEN IN THE AFOREMENTIONED CASE, THINE ACCEPTS NO LIABILITY FOR SUCH DAMAGE OR LOSS IF THE DISPUTE IS CAUSED BY THE USER'S INSTRUCTION.

5. This product is not designed for applications that require extremely high-reliability/safety such as aerospace device, nuclear power control device, or medical device related to critical care, excluding when this product is specified for automotive use by THine and used it for that purpose. THine accepts no liability whatsoever for any damages, claims or losses arising out of the uses set forth above.

6. Despite our utmost efforts to improve the quality and reliability of the product, faults will occur with a certain small probability, which is inevitable to a semi-conductor product. Therefore, you are encouraged to have sufficiently fail-safe design principles such as redundant or error preventive design applied to the use of the product so as not to have our product cause any social or public damage.

7. This product may be permanently damaged and suffer from performance degradation or loss of mechanical functionality if subjected to electrostatic charge exceeding capacity of the ESD (Electrostatic Discharge) protection circuitry. Safety earth ground must be provided to anything in contact with the product, including any operator, floor, tester and soldering iron.

8. Please note that this product is not designed to be radiation-proof.

9. Testing and other quality control techniques are used to this product to the extent THine deems necessary to support warranty for performance of this product. Except where mandated by applicable law or deemed necessary by THine based on the user's request, testing of all functions and performance of the product is not necessarily performed.

10. This product must be stored according to storage method which is specified in this specifications. THine accepts no liability whatsoever for any damage or loss caused to the user due to any storage not according to above-mentioned method.

11. Customers are asked, if required, to judge by themselves if this product falls under the category of strategic goods under the Foreign Exchange and Foreign Trade Act in Japan and the Export Administration Regulations in the United States of America on export or transit of this product. This product is prohibited for the purpose of developing military modernization, including the development of weapons of mass destruction (WMD), and the purpose of violating human rights.

12. The product or peripheral parts may be damaged by a surge in voltage over the absolute maximum ratings or malfunction, if pins of the product are shorted by such as foreign substance. The damages may cause a smoking and ignition. Therefore, you are encouraged to implement safety measures by adding protection devices, such as fuses. THine accepts no liability whatsoever for any damage or loss caused to the user due to use under a condition exceeding the limiting values.

13. All patents or pending patent applications, trademarks, copyrights, layout-design exploitation rights or other intellectual property rights concerned with this product belong to THine or licensor(s) of THine. No license or right is granted to the user for any intellectual property right or other proprietary right now or in the future owned by THine or THine's licensor. The user must enter into a license agreement with THine or THine's licensor to be granted of such license or right.

THine Electronics, Inc.

http://www.thine.co.jp/