

Electronic Iris Control IC

Description

The CXD2401R is an IC which performs electronic iris control by applying a CCD electronic shutter.

Features

- Electronic iris control drive
- Generates system clocks in response to the CXA1390AR series
- Generates timing pulses to drive the 510H system CCD image sensor
- H driver for CCD (5V direct drive for Type 1/3 CCD)

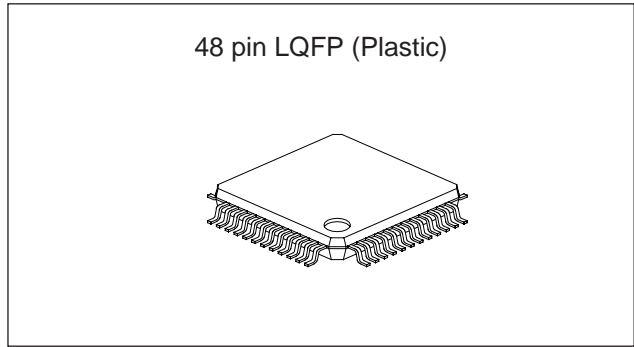
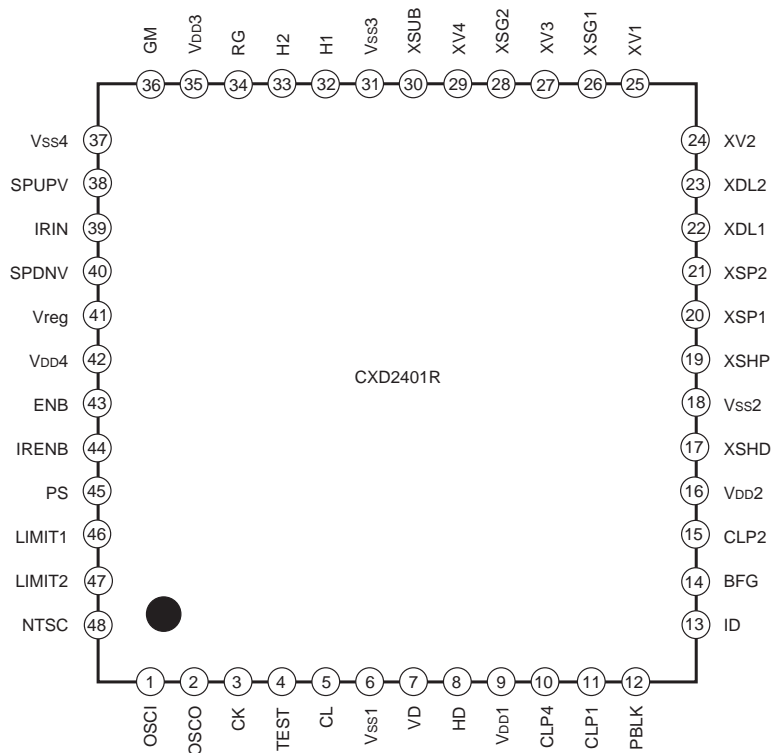
Absolute Maximum Ratings

- Supply voltage V_{DD} $V_{SS} - 0.5$ to $+7.0$ V
- Input voltage V_I $V_{SS} - 0.5$ to $V_{DD} + 0.5V$
- Output voltage V_O $V_{SS} - 0.5$ to $V_{DD} + 0.5V$
- Operating temperature T_{opr} -20 to $+75$ °C
- Storage temperature T_{stg} -55 to $+150$ °C

Recommended Operating Conditions

- Supply voltage V_{DD} 4.75 to 5.25 V
- Operating temperature T_{opr} -20 to $+75$ °C

Pin Configuration



Applications

CCD monitoring cameras

Structure

Silicon gate CMOS IC

Applicable CCD Image Sensors

- 510H system SONY CCD
- ICX054BK (Type 1/3 NTSC CCD)
- ICX055BK (Type 1/3 PAL CCD)

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Pin Description

Pin No.	Symbol	I/O	Description
1	OSCI	I	Inverter input for oscillation. (NTSC: 1820fH, PAL: 1816fH)
2	OSCO	O	Inverter output for oscillation. (NTSC: 1820fH, PAL: 1816fH)
3	CK	I	Input for main clock in IC. (NTSC: 1820fH, PAL: 1816fH)
4	TEST	I	IC test input. Fixed at GND in normal operation. (With pull-down resistor)
5	CL	O	CK/2 clock output. NTSC: 910fH = 4fsc, PAL: 908fH
6	Vss1	—	GND
7	VD	I	Vertical sync signal input.
8	HD	I	Horizontal sync signal input.
9	VDD1	—	5V power supply.
10	CLP4	O	Clamping pulse for CCD dummy output.
11	CLP1	O	Clamping pulse for CCD optical black.
12	PBLK	O	Cleaning pulse for vertical/horizontal blanking.
13	ID	O	Vertical direction line identification signal.
14	BFG	O	Burst flag gate pulse.
15	CLP2	O	Clamping pulse in horizontal blanking.
16	VDD2	—	5V power supply.
17	XSHD	O	CCD data level sample-and-hold pulse output.
18	Vss2	—	GND
19	XSHP	O	CCD precharge level sample-and-hold pulse output.
20	XSP1	O	Color separation sample-and-hold pulse output.
21	XSP2	O	Color separation sample-and-hold pulse output.
22	XDL1	O	Clock output for CCD DL (Delay Line).
23	XDL2	O	Clock output for CCD DL (Delay Line).
24	XV2	O	CCD vertical clock output.
25	XV1	O	CCD vertical clock output.
26	XSG1	O	Clock output for CCD sensor readout.
27	XV3	O	CCD vertical clock output.
28	XSG2	O	Clock output for CCD sensor readout.
29	XV4	O	CCD vertical clock output.
30	XSUB	O	Clock output for CCD electronic shutter.
31	Vss3	—	GND
32	H1	O	CCD horizontal clock output.
33	H2	O	CCD horizontal clock output.
34	RG	O	CCD reset gate pulse output.

Pin No.	Symbol	I/O	Description
35	V _{DD3}	—	5V power supply.
36	GM	I	Used for GND connection.
37	V _{SS4}	—	GND
38	SPUPV	I	When set in electronic iris mode: Shutter speedup reference voltage input When set in serial mode of electronic shutter: Strobe input
39	IRIN	I	When set in electronic iris mode: Iris signal input When set in serial mode of electronic shutter: Clock input
40	SPDNV	I	When set in electronic iris mode: Shutter speed-down reference voltage input When set in serial mode of electronic shutter: Data input
41	V _{reg}	—	Current source for comparator. Connected to 5V power supply via 33kΩ resistor.
42	V _{DD4}	—	5V power supply.
43	ENB	I	Generation/halt switching of electronic shutter pulse (Pin 30). (With pull-up resistor)
44	I _{REN} B	I	Electronic iris/electronic shutter switching. (With pull-up resistor)
45	PS	I	Parallel/serial input switching of electronic shutter speed data. (With pull-up resistor)
46	LIMIT1	I	Selecting limit value of max. shutter speed. (With pull-down resistor)
47	LIMIT2	I	Selecting limit value of max. shutter speed. (With pull-down resistor)
48	NTSC	I	NTSC/PAL switching. (With pull-down resistor)

Electrical Characteristics

DC Characteristics

(Within recommended operating range)

Item	Pin No.	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply voltage 1	9, 16, 35, 42	V _{DD}		4.75	5.0	5.25	V
Input voltage 1	38, 40 (Electronic iris mode)	V _{IN1}		1.9		V _{DD}	V
Input voltage 2	39 (Electronic iris mode)	V _{IN2}		V _{SS}		V _{DD}	V
Input voltage 3*	4, 7, 8, 36, 38, 39, 40, 43, 44, 45, 46, 47, 48 (Pins 38, 39 and 40 are when set in electronic shutter mode)	V _{IH3}		0.7V _{DD}			V
		V _{IL3}				0.3V _{DD}	V
Output voltage 1	5, 10, 11	V _{OH1}	I _{OH} = -4mA	V _{DD} - 0.8			V
		V _{OL1}	I _{OL} = 8mA			0.4	V
Output voltage 2	15, 17, 19, 20, 21, 22, 23, 34	V _{OH2}	I _{OH} = -8mA	V _{DD} - 0.8			V
		V _{OL2}	I _{OL} = 8mA			0.4	V
Output voltage 3	32, 33	V _{OH3}	I _{OH} = -20mA	V _{DD} - 0.8			V
		V _{OL3}	I _{OL} = 20mA			0.4	V
Output voltage 4	12, 13, 14, 24, 25, 26, 27, 28, 29, 30	V _{OH4}	I _{OH} = -2mA	V _{DD} - 0.8			V
		V _{OL4}	I _{OL} = 4mA			0.4	V
Pull-up resistance value	43, 44, 45	R _{PU}	V _{IL} = 0V	25	50	75	kΩ
Pull-down resistance value	4, 36, 46, 47, 48	R _{PD}	V _{IH} = V _{DD}	25	50	75	kΩ

* Pins 7 and 8 do not have a protective diode at the power supply side.

Comparator Characteristics

(Within recommended operating range)

Item	Pin No.	Symbol	Conditions	Min.	Typ.	Max.	Unit	
Input offset voltage	38, 39, 40	Vos			1.1	50	mV	
Response time		Rise	t _{pd +}	Response time when a step input of 100mV amplitude/5mV overdrive is applied.		140		ns
		Fall	t _{pd -}			190		ns
Current consumption		I _{DD}				98	140	μA
In-phase input voltage range		V _{ICR}			1.9 to 5			V
Indefinite region		V _f					±10	mW

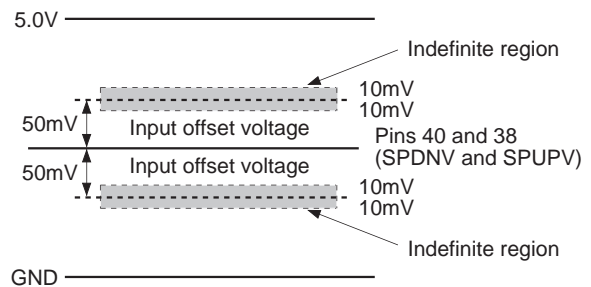
Bias current source for comparator. Pin No.: 41. Connected to power supply via 33kΩ resistor.

Note) 1. Input offset voltage and indefinite region

Input offset voltage and indefintie region are existed in the comparator which builds in this IC as shown right figure. Note that this when designing external circuit.

2. Pins 40 and 38 for electronic iris mode

Use it in this state of Pin 40 (SPDNV) > Pin 38 (SPUPV).



Oscillating Inverter I/O Characteristics

(Within recommended operating range)

Item	Pin No.	Symbol	Conditions	Min.	Typ.	Max.	Unit
Logical V _{th}	1	LV _{th}			V _{DD} /2		V
Input voltage		V _{IH}		0.7V _{DD}			V
		V _{IL}				0.3V _{DD}	V
Output voltage	2	V _{OH}	I _{OH} = -12mA	V _{DD} /2			V
		V _{OL}	I _{OL} = 12mA			V _{DD} /2	V
Feedback resistor	1 to 2	R _{FE}	V _{IN} = V _{DD} or V _{SS}	250k	1M	2.5M	Ω
Oscillator frequency		f		20		30	MHz

Duty Control Inverter Input Characteristics

(Within recommended operating range)

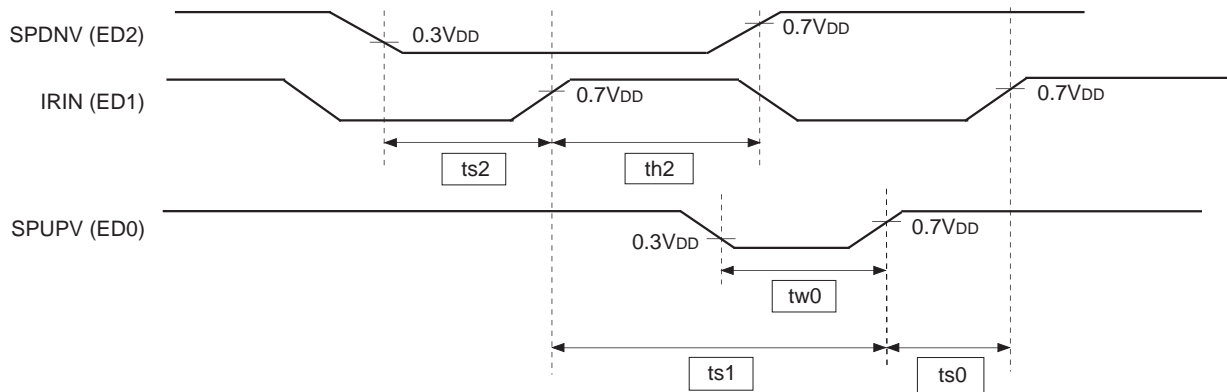
Item	Pin No.	Symbol	Conditions	Min.	Typ.	Max.	Unit
Logical V _{th}	3	LV _{th}			V _{DD} /2		V
Input voltage		V _{IH}		0.7V _{DD}			V
		V _{IL}				0.3V _{DD}	V
Input amplification		V _{IN}	f _{max} = 50MHz sine wave	0.5			V _{pp}
Feedback resistor		R _{FE}	V _{IN} = V _{DD} or V _{SS}	250k	1M	2.5M	Ω

Note) The input voltage is the input voltage characteristics for an external direct power input, and input amplification is the input amplification characteristics for input through capacitor.

Electrical Characteristics

AC Characteristics

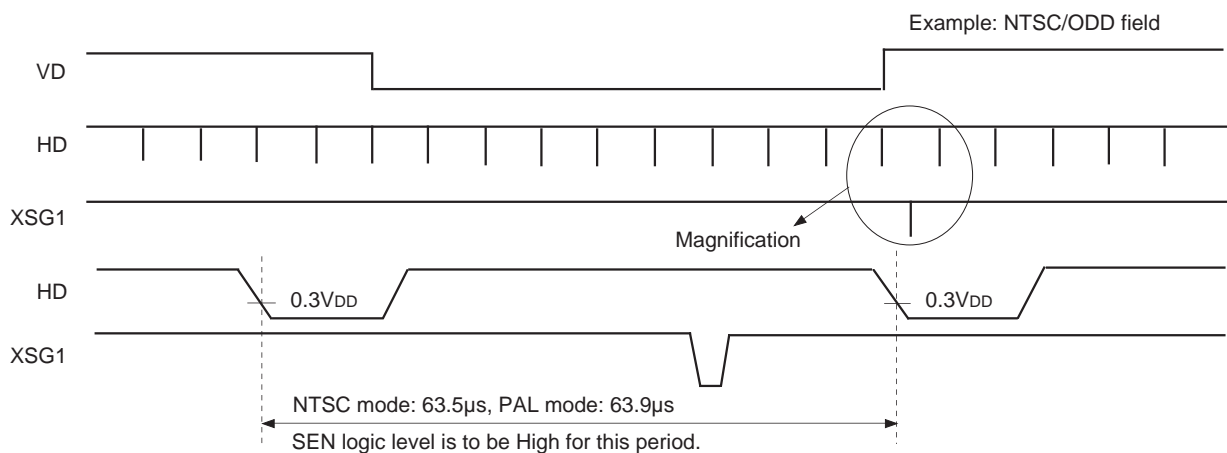
1) AC characteristics among serial communication clocks (SPDNV (ED2), IRIN (ED1), SPUPV (ED0))



(Within recommended operating range)

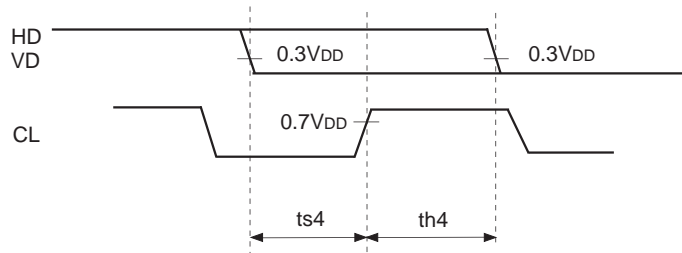
Symbol	Definition	Min.	Typ.	Max.
ts2	SPDNV (ED2) set-up time, activated by the rising edge of IRIN (ED1)	20ns		
th2	SPDNV (ED2) hold time, activated by the rising edge of IRIN (ED1)	20ns		
ts1	IRIN (ED1) rising set-up time, activated by the rising edge of SPUPV (ED0)	20ns		
tw0	SPUPV (ED0) pulse width	20ns		50μs
ts0	SPUPV (ED0) rising set-up time, activated by the rising edge of IRIN (ED1)	20ns		

2) Microcomputer communication clock → IC take-in characteristics



Note) During the 1H period for generating XSG1, the phase against AVD differs according to each mode. Please always maintain the SEN logic level at High for "the 1H period when XSG1 varies."

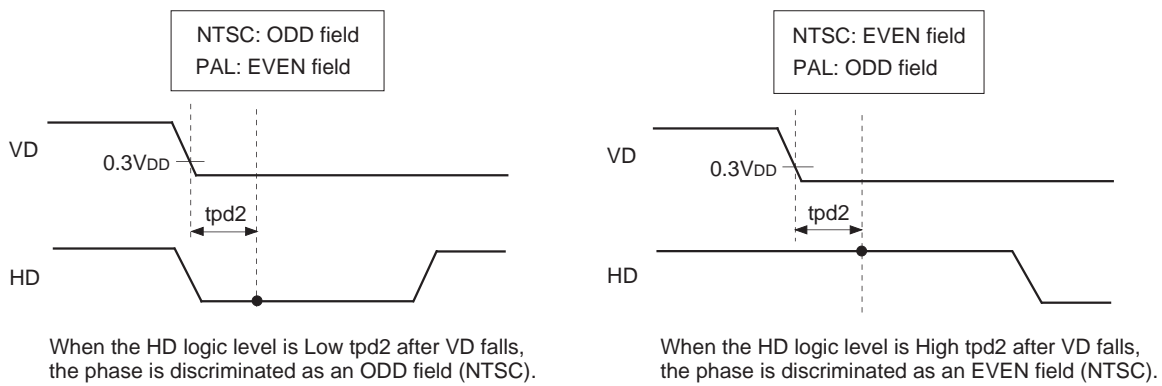
3) HD/VD take-in characteristics



(Within recommended operating range, Load capacity of CL = 30pF)

Symbol	Definition	Min.	Typ.	Max.	Unit
ts4	HD/VD set-up time, activated by CL	5			ns
th4	HD/VD hold time, activated by CL	7			ns

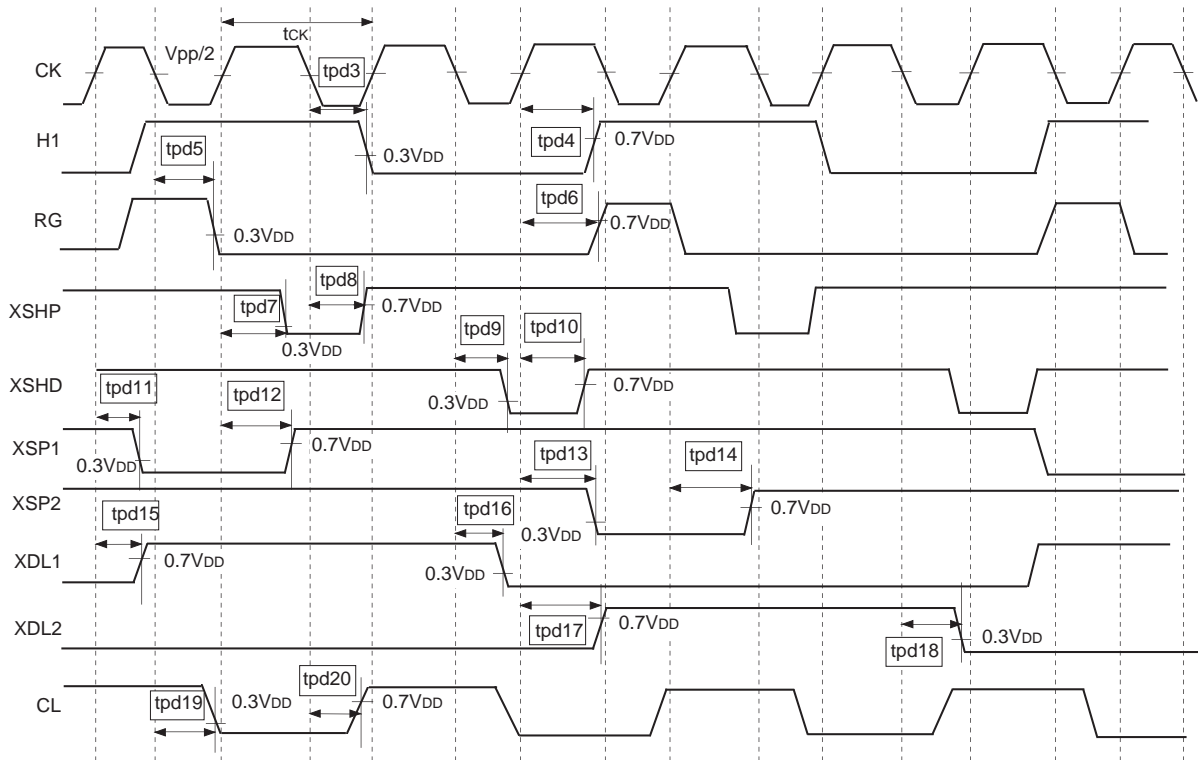
4) Phase discrimination characteristics by VD/HD input



(Within recommended operating range)

Symbol	Definition	Min.	Typ.	Max.	Unit
tpd2	Field discriminating clock phase, activated by the falling edge of VD	700		1000	ns

5) Phase characteristics of H1, RG, XSHP, XSHD, XSP1, XSP2, XDL1, XDL2, and CL

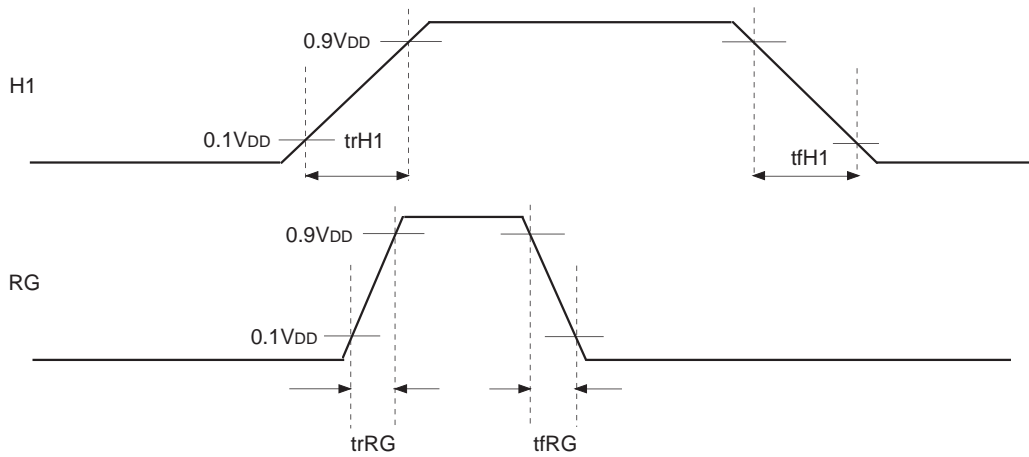


(Within recommended operating range)

CK-duty = within $50 \pm 4\%$, Load capacity of H1 = 150pF, Load capacity of CL = 30pF, Load capacity of RG, XSHP, XSHD, XSP1, XSP2, XDL1, and XDL2 = 10pF

Symbol	Definition	Min.	Typ.	Max.	Unit
t_{CK}	CK cycle		35		ns
$tpd3$	H1 falling delay, activated by the falling edge of CK	16.22	29	56.9	ns
$tpd4$	H1 rising delay, activated by the rising edge of CK	17.25	31	60.38	ns
$tpd5$	RG falling delay, activated by the falling edge of CK	20.18	36	70.58	ns
$tpd6$	RG rising delay, activated by the rising edge of CK	18.61	33	65.32	ns
$tpd7$	XSHP falling delay, activated by the rising edge of CK	15.86	28	55.59	ns
$tpd8$	XSHP rising delay, activated by the falling edge of CK	15.76	28	55.32	ns
$tpd9$	XSHD falling delay, activated by the falling edge of CK	14.92	27	52.26	ns
$tpd10$	XSHD rising delay, activated by the rising edge of CK	14.76	26	51.62	ns
$tpd11$	XSP1 falling delay, activated by the rising edge of CK	14.79	26	51.74	ns
$tpd12$	XSP1 rising delay, activated by the rising edge of CK	15.05	27	52.58	ns
$tpd13$	XSP2 falling delay, activated by the rising edge of CK	15.09	27	52.82	ns
$tpd14$	XSP2 rising delay, activated by the rising edge of CK	15.29	27	53.54	ns
$tpd15$	XDL1 rising delay, activated by the rising edge of CK	14.49	26	50.79	ns
$tpd16$	XDL1 falling delay, activated by the falling edge of CK	15.05	27	52.67	ns
$tpd17$	XDL2 rising delay, activated by the rising edge of CK	14.46	26	50.65	ns
$tpd18$	XDL2 falling delay, activated by the falling edge of CK	14.92	27	52.47	ns
$tpd19$	CL falling delay, activated by the falling edge of CK	15.33	27	53.01	ns
$tpd20$	CL rising delay, activated by the falling edge of CK	14.71	26	51.58	ns

6) Waveform characteristics of H1 and RG



V_{DD} = 5.0V, Topr = 25°C, Load capacity of H1 = 150pF, Load capacity of RG = 10pF

Symbol	Definition	Min.	Typ.	Max.	Unit
trH1	H1 rise time		7		ns
tfH1	H1 fall time		7		ns
trRG	RG rise time		3		ns
tfRG	RG fall time		3		ns

I/O Pin Capacitances

Item	Symbol	Min.	Typ.	Max.	Unit
Input pin capacitance	C _{IN}			9	pF
Output pin capacitance	C _{OUT}			11	pF
I/O pin capacitance	C _{I/O}			11	pF

Description of Operation

The operations of the CXD2401R are described below.

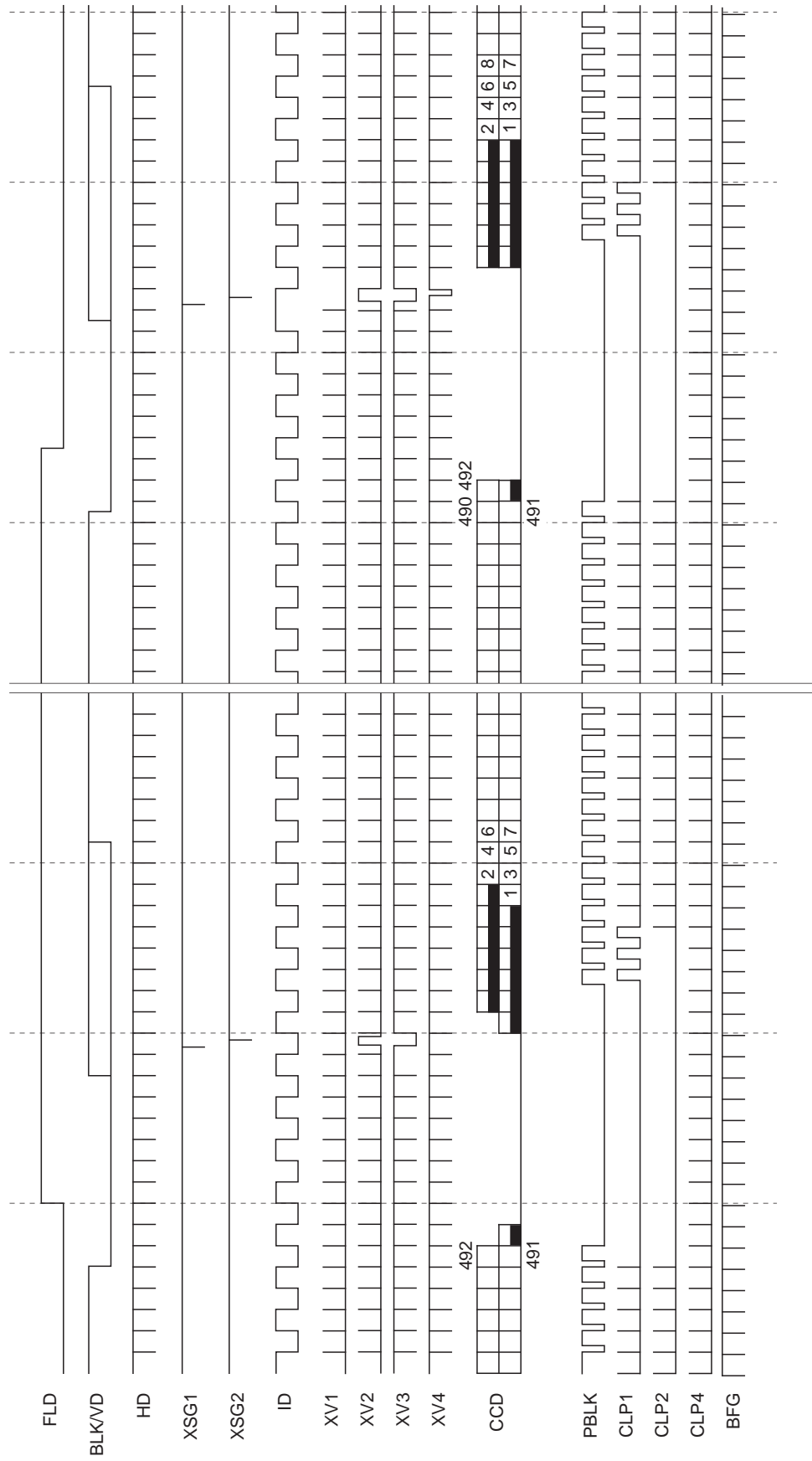
Control pin	Detailed description
NTSC (Pin 48)	<p>Low: The CXD2401R performs control drive in accordance with NTSC. In this case, the CXD2401R operates by assuming the signals input to Pin 7 (VD) and Pin 8 (HD) are NTSC sync signals.</p> <p>High: The CXD2401R performs control drive in accordance with PAL. In this case, the CXD2401R operates by assuming the signals input to Pin 7 (VD) and Pin 8 (HD) are PAL sync signals.</p> <p>Refer to the "Timing Chart" for the control drive pulse for either NTSC or PAL.</p>
ENB (Pin 43)	<p>Low: Pin 30 (XSUB) is always High. That is, the electronic iris and electronic shutter to which XSUB pulses are applied suspend operation (electronic iris and electronic shutter OFF).</p> <p>High: Pin 30 (XSUB) outputs control pulses for the electronic iris and electronic shutter. (electronic iris and electronic shutter ON).</p>
IRENB (Pin 44)	<p>Low: Realizes the electronic shutter control.</p> <p>High: Realizes the electronic iris control.</p> <p>The control pins (SPUPV, IRIN, and SPDNV) are used in common for both electronic shutter control and electronic iris control. The operations of these pins differ depending on the state of IRENB pin.</p>
PS (Pin 45)	<p>This pin is valid when the operation of electronic shutter is assigned (IRENB = Low).</p> <p>Low: Electronic shutter speed can be controlled by inputting serial data into SPUPV, IRIN, and SPDNV pins.</p> <p>High: Electronic shutter speed can be controlled by inputting parallel data into SPUPV, IRIN, and SPDNV pins.</p> <p>Note) The PS pin is invalid when IRENB = High, and the CXD2401R does not accept data, whether PS is Low or High.</p>

Control pin	Detailed description																																																																
SPUPV (Pin 38) IRIN (Pin 39) SPDNV (Pin 40)	<p>The operations of SPUPV, IRIN, and SPDNV pins differ according to the mode (IRENB control) of the electronic iris and electronic shutter. The operations are described below for each case.</p> <p>IRENB = Low: When the operation of electronic shutter is assigned</p> <p>PS = Low: When inputting serial data is assigned</p> <p>SPUPV : Strobe input pin IRIN : Clock input pin SPDNV : Data input pin</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th>D7</th> <th>D6</th> <th>D5</th> <th>D4</th> <th>D3</th> <th>D2</th> <th>D1</th> <th>D0</th> </tr> </thead> <tbody> <tr> <td>Ld : Shutter speed data Ex.: Ld = 100 [decimal]</td> <td>0</td> <td>1</td> <td>1</td> <td>0</td> <td>0</td> <td>1</td> <td>0</td> <td>0</td> </tr> </tbody> </table>		D7	D6	D5	D4	D3	D2	D1	D0	Ld : Shutter speed data Ex.: Ld = 100 [decimal]	0	1	1	0	0	1	0	0																																														
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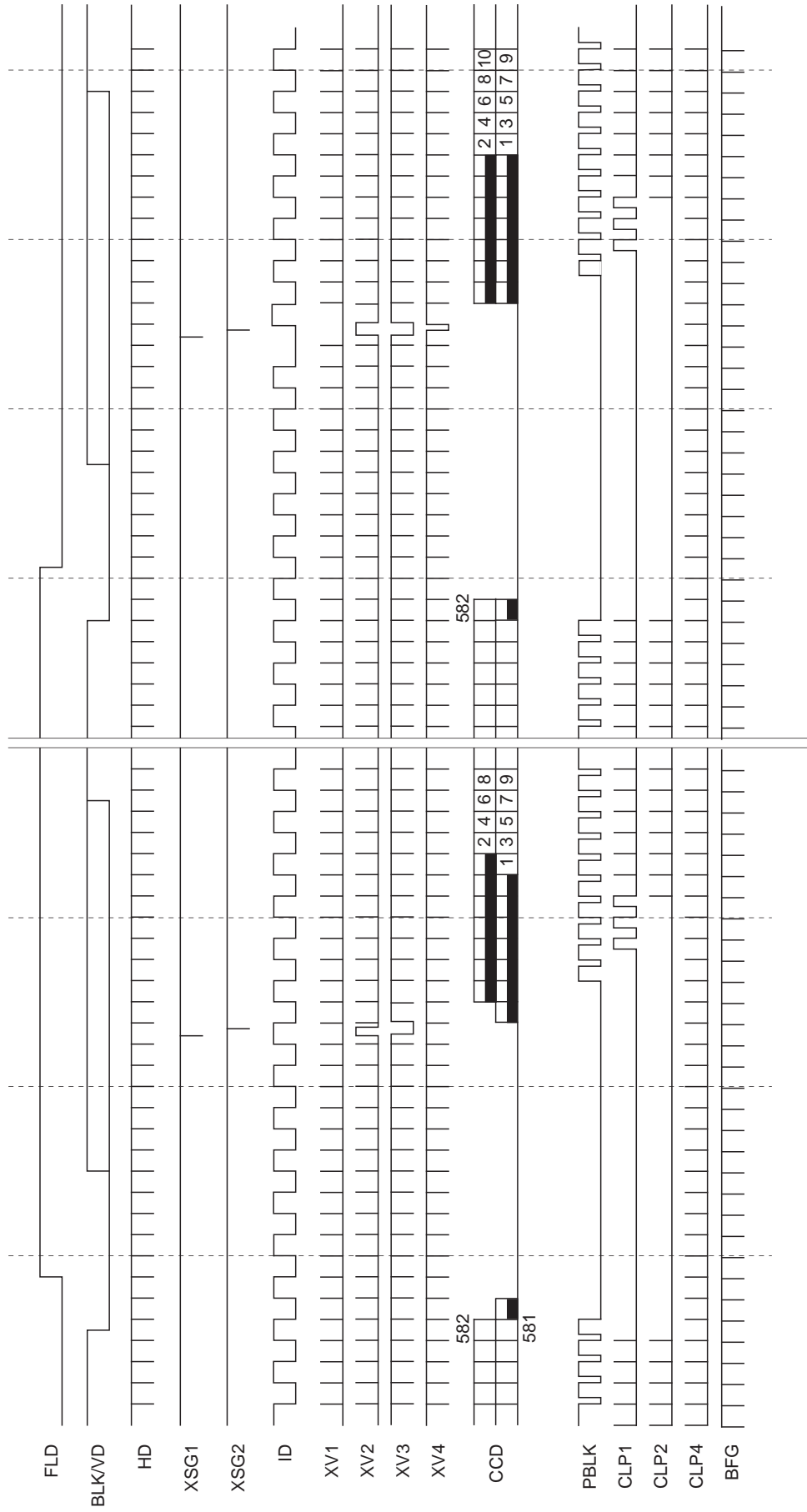
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	<div data-bbox="311 286 1136 331" style="border: 1px solid black; padding: 2px;">IRENB = Low: When the operation of electronic shutter is assigned</div> <div data-bbox="331 353 971 398" style="border: 1px solid black; padding: 2px; margin-top: 10px;">PS = High: When inputting parallel data is assigned</div> <p data-bbox="347 443 758 477" style="text-align: center;">Shutter Speed Compatibility Chart</p> <table border="1" data-bbox="347 488 1259 969"> <thead> <tr> <th rowspan="2">SPUPV</th> <th rowspan="2">IRIN</th> <th rowspan="2">SPDNV</th> <th colspan="2">Shutter speed (s)</th> </tr> <tr> <th>NTSC(Pin 48) = L</th> <th>NTSC(Pin 48) = H</th> </tr> </thead> <tbody> <tr><td>H</td><td>H</td><td>H</td><td>1/100</td><td>1/120</td></tr> <tr><td>L</td><td>H</td><td>H</td><td>1/250</td><td>1/250</td></tr> <tr><td>H</td><td>L</td><td>H</td><td>1/500</td><td>1/500</td></tr> <tr><td>L</td><td>L</td><td>H</td><td>1/1000</td><td>1/1000</td></tr> <tr><td>H</td><td>H</td><td>L</td><td>1/2000</td><td>1/2000</td></tr> <tr><td>L</td><td>H</td><td>L</td><td>1/5000</td><td>1/5000</td></tr> <tr><td>H</td><td>L</td><td>L</td><td>1/10000</td><td>1/10000</td></tr> <tr><td>L</td><td>L</td><td>L</td><td>1/100000</td><td>1/110000</td></tr> </tbody> </table>	SPUPV	IRIN	SPDNV	Shutter speed (s)		NTSC(Pin 48) = L	NTSC(Pin 48) = H	H	H	H	1/100	1/120	L	H	H	1/250	1/250	H	L	H	1/500	1/500	L	L	H	1/1000	1/1000	H	H	L	1/2000	1/2000	L	H	L	1/5000	1/5000	H	L	L	1/10000	1/10000	L	L	L	1/100000	1/110000
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<p data-bbox="148 1048 252 1243">SPUPV (Pin 38) IRIN (Pin 39) SPDNV (40Pin)</p>	<div data-bbox="311 1041 1094 1086" style="border: 1px solid black; padding: 2px;">IRENB = High: When the operation of electronic iris is assigned</div> <div data-bbox="422 1120 1300 1400" style="text-align: center;"> <p>The diagram shows three inputs: SPDNV, IRIN, and SPUPV. SPDNV and IRIN are connected to the inputs of Comp1. IRIN and SPUPV are connected to the inputs of Comp2. The outputs of Comp1 and Comp2 are connected to the inputs of a DECODE block. The output of the DECODE block is labeled 'Shutter Speed Cont'.</p> </div> <div style="display: flex; justify-content: space-around; margin-top: 20px;"> <div data-bbox="327 1467 790 1668"> <p data-bbox="327 1467 566 1500">Comp 1 Truth Table</p> <table border="1" data-bbox="327 1512 790 1668"> <thead> <tr><th>SPDNV</th><th>IRIN</th><th>Comp1</th></tr> </thead> <tbody> <tr><td>L</td><td>H</td><td>H</td></tr> <tr><td>H</td><td>L</td><td>L</td></tr> </tbody> </table> </div> <div data-bbox="837 1467 1412 1758"> <p data-bbox="837 1467 1093 1500">DECODE Truth Table</p> <table border="1" data-bbox="837 1512 1412 1758"> <thead> <tr><th>Comp1</th><th>Comp2</th><th>Shutter Speed Cont</th></tr> </thead> <tbody> <tr><td>L</td><td>L</td><td>Shutter speed; Faster</td></tr> <tr><td>L</td><td>H</td><td>Shutter speed; Hold</td></tr> <tr><td>H</td><td>L</td><td>Shutter speed; Hold</td></tr> <tr><td>H</td><td>H</td><td>Shutter speed; Slower</td></tr> </tbody> </table> </div> </div> <div data-bbox="327 1680 790 1870" style="margin-top: 20px;"> <p data-bbox="327 1680 566 1713">Comp 2 Truth Table</p> <table border="1" data-bbox="327 1713 790 1870"> <thead> <tr><th>IRIN</th><th>SPUPV</th><th>Comp2</th></tr> </thead> <tbody> <tr><td>L</td><td>H</td><td>L</td></tr> <tr><td>H</td><td>L</td><td>H</td></tr> </tbody> </table> </div> <p data-bbox="311 1892 1444 2004" style="margin-top: 20px;">In the electronic iris control operation, the electronic shutter speed is controlled according to the logic above. The variations of shutter speed by each control are the same as those shown in <Shutter speed calculation formula> for "electronic shutter; inputting serial data".</p>	SPDNV	IRIN	Comp1	L	H	H	H	L	L	Comp1	Comp2	Shutter Speed Cont	L	L	Shutter speed; Faster	L	H	Shutter speed; Hold	H	L	Shutter speed; Hold	H	H	Shutter speed; Slower	IRIN	SPUPV	Comp2	L	H	L	H	L	H														
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Control pin	Detailed description				
LIMIT1 (Pin 46) LIMIT2 (Pin 47)	LIMIT1 and LIMIT2 pins function only when IRENB = High (when the operation of electronic iris is assigned). (Inputs from LIMIT1 and LIMIT2 are not accepted when IRENB = Low: when the operation of electronic shutter is assigned.)				
	Maximum Electronic Shutter Speed				
	LIMIT1	LIMIT2	Max. shutter speed (s)		Purpose
			NTSC (Pin 48) = L	NTSC (Pin 48) = H	
	L	L	1/200	1/200	Reduces flickers caused by an indoor fluorescent lamp.
	L	H	1/2000	1/2000	Intermediate mode between indoor and outdoor applications.
H	L	1/20000	1/20000	Reduces CCD smear outdoors.	
H	H	1/90000	1/100000	Secures dynamic range of iris.	
Electronic iris control of the CXD2401R is realized by applying functions of the electronic shutter. The electronic shutter has a dynamic range from 1/60s when Pin 48 (NTSC) = Low or from 1/50s when Pin 48 (NTSC) = High up to the maximum shutter speed in the table above. Select one of the four dynamic ranges of the electronic iris, according to the application conditions of the CXD2401R. The dynamic range is also determined by also taking into consideration the influence of the electronic shutter on image quality, as shown in the table above.					

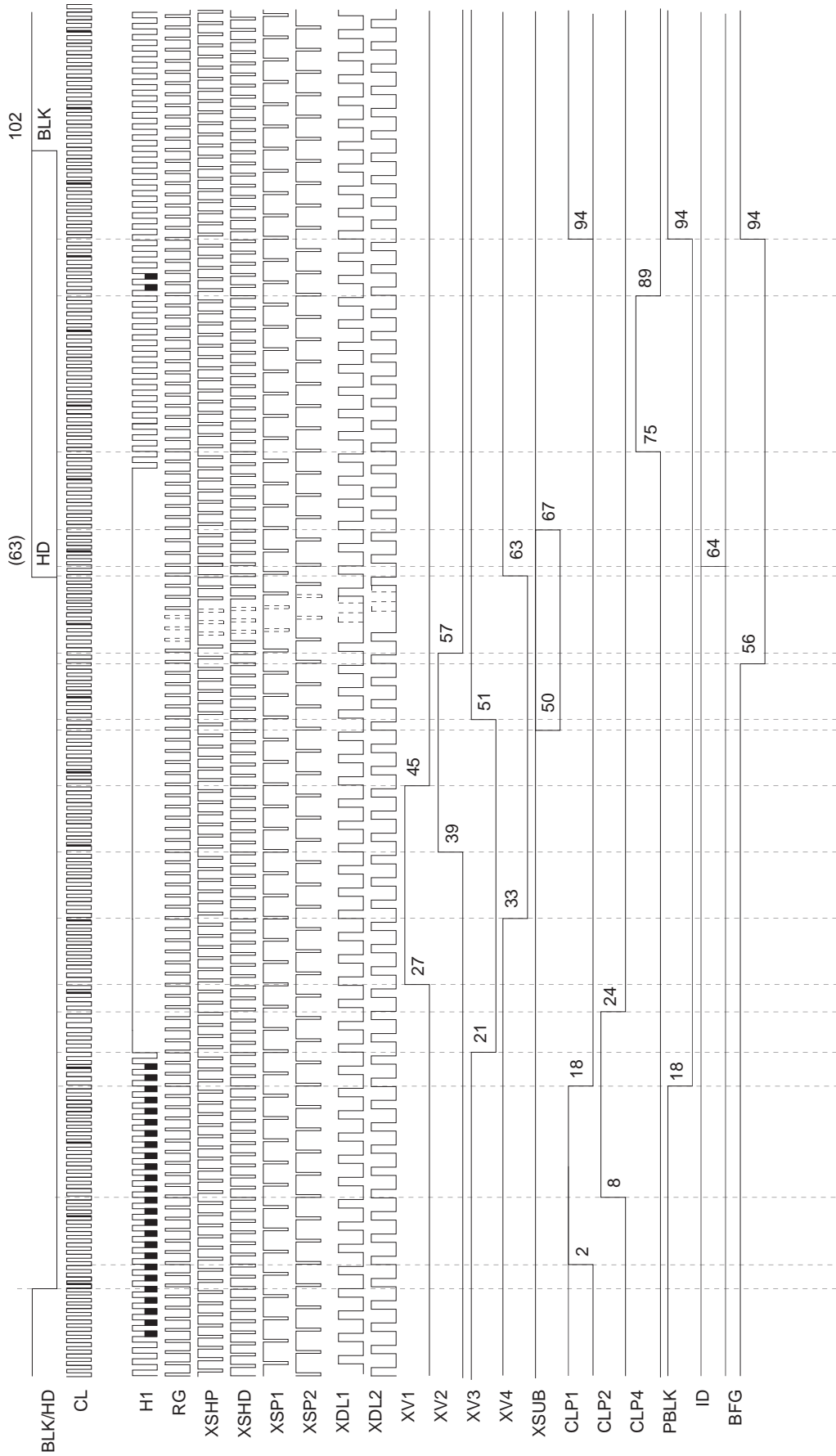
NTSC Vertical Direction Timing Chart



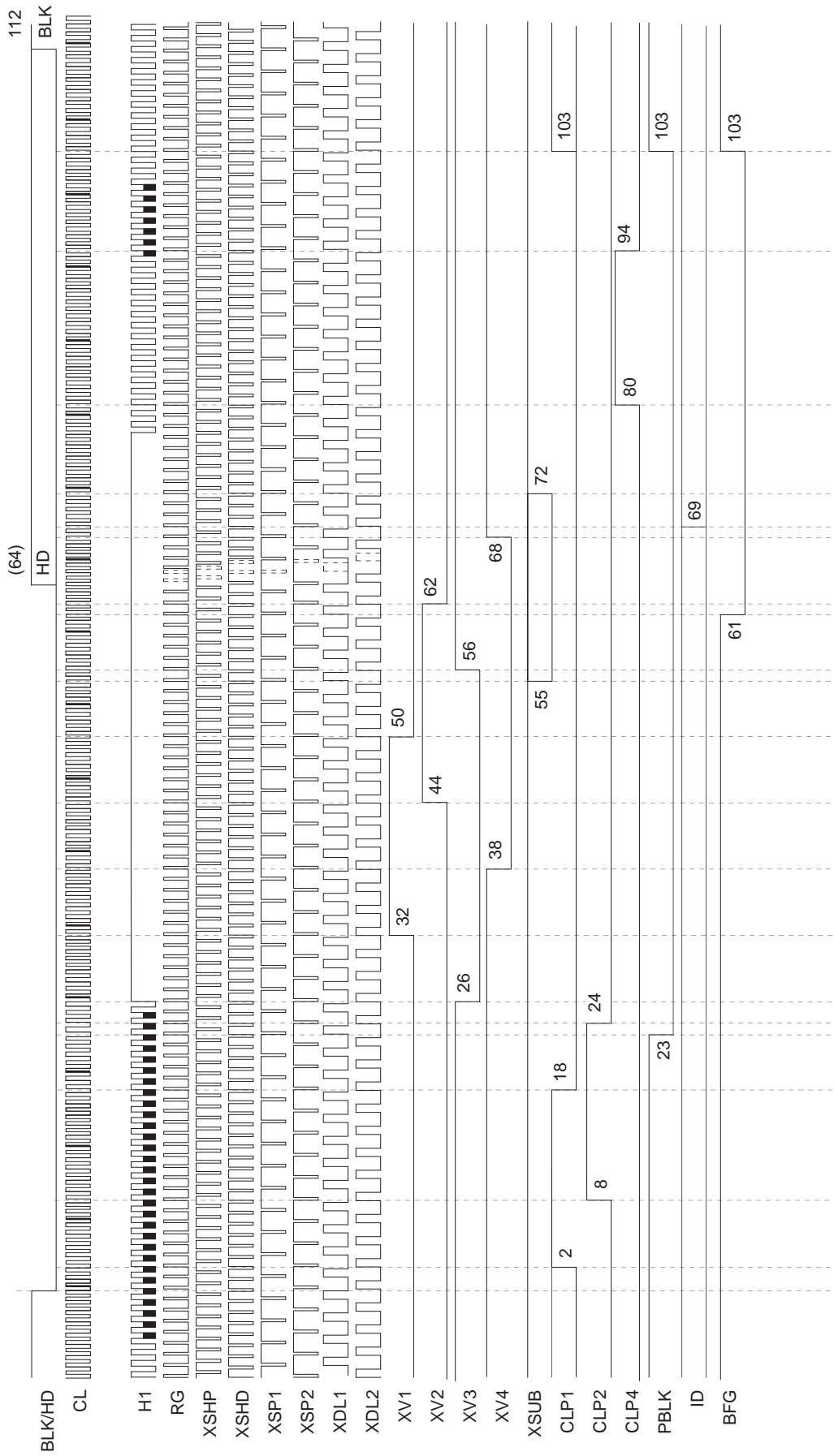
PAL Vertical Direction Timing Chart



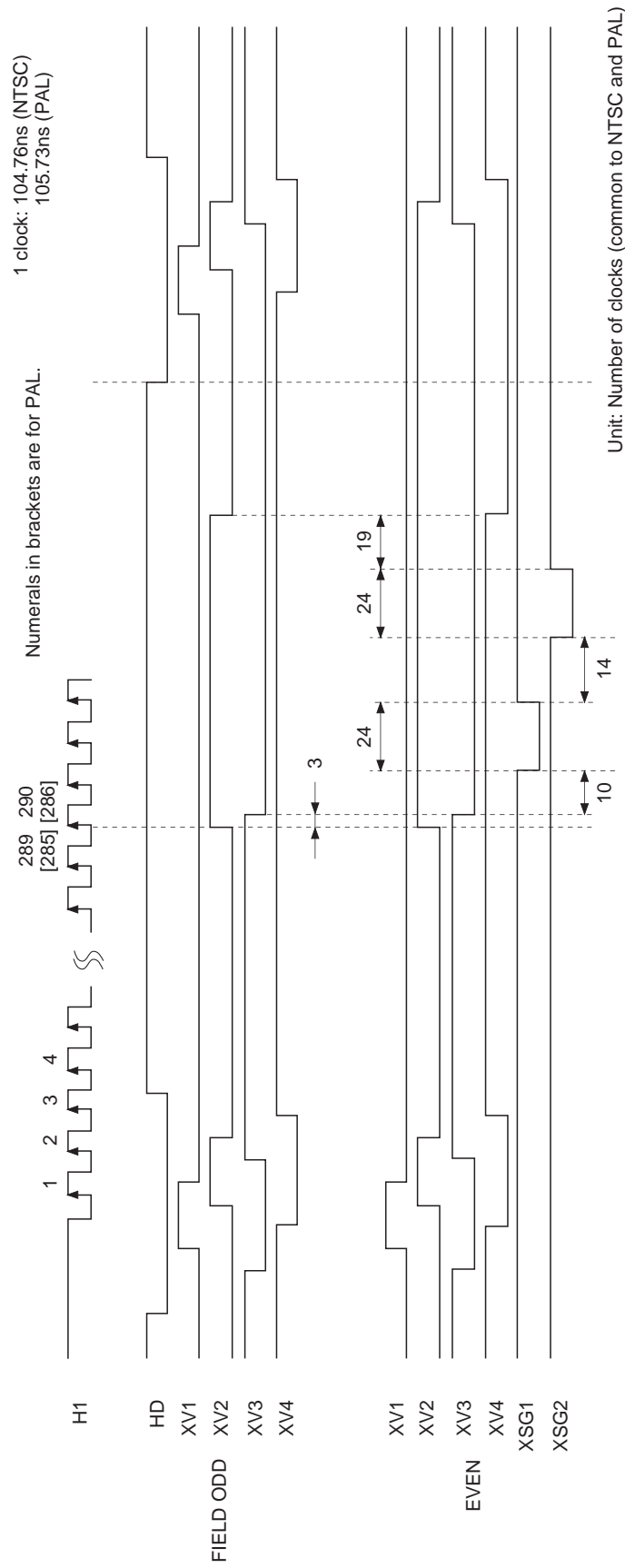
NTSC Horizontal Direction Timing Chart



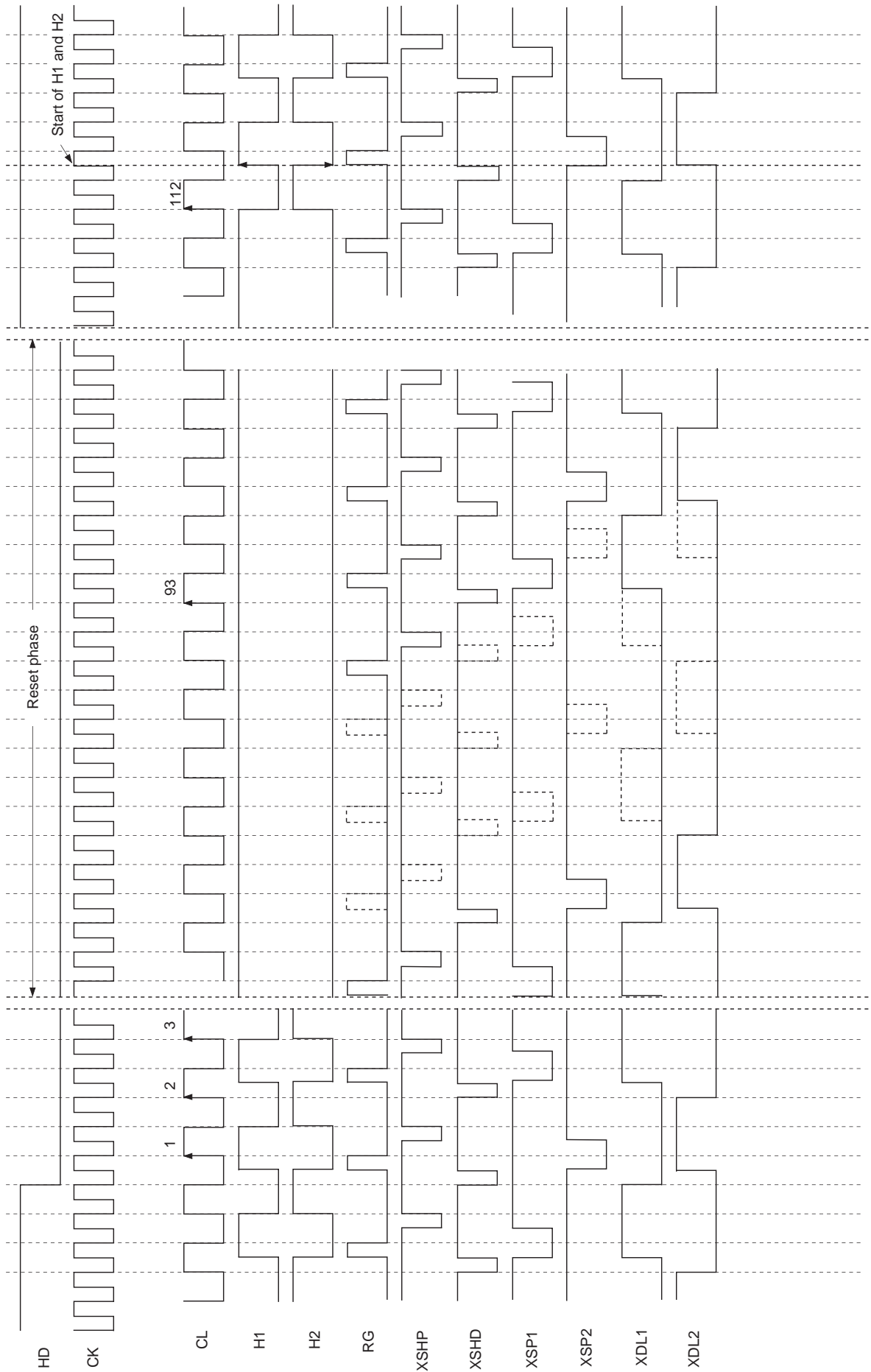
PAL Horizontal Direction Timing Chart



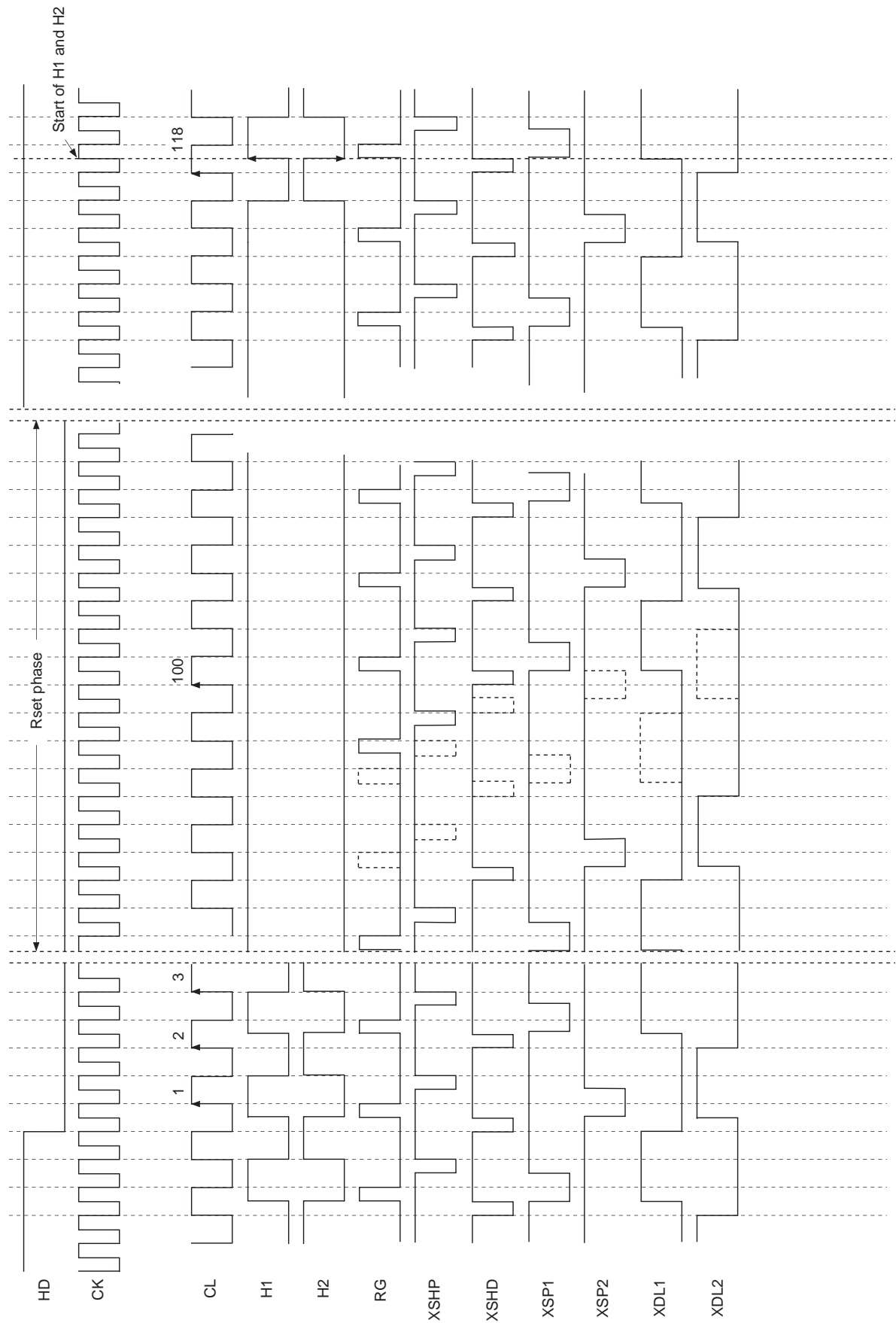
Readout Timing Chart



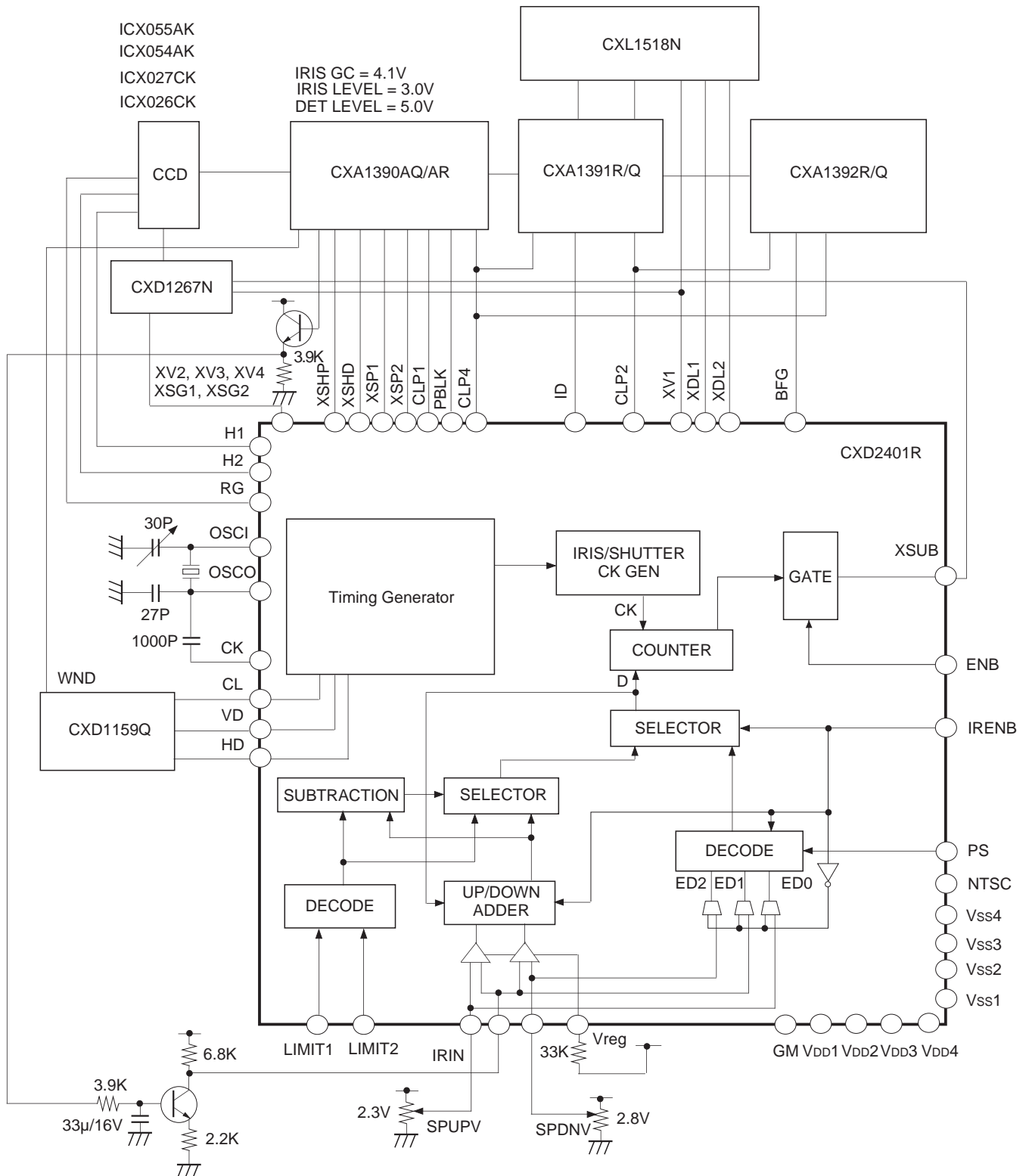
NTSC High-speed Phase Timing Chart



PAL High-speed Phase Timing Chart



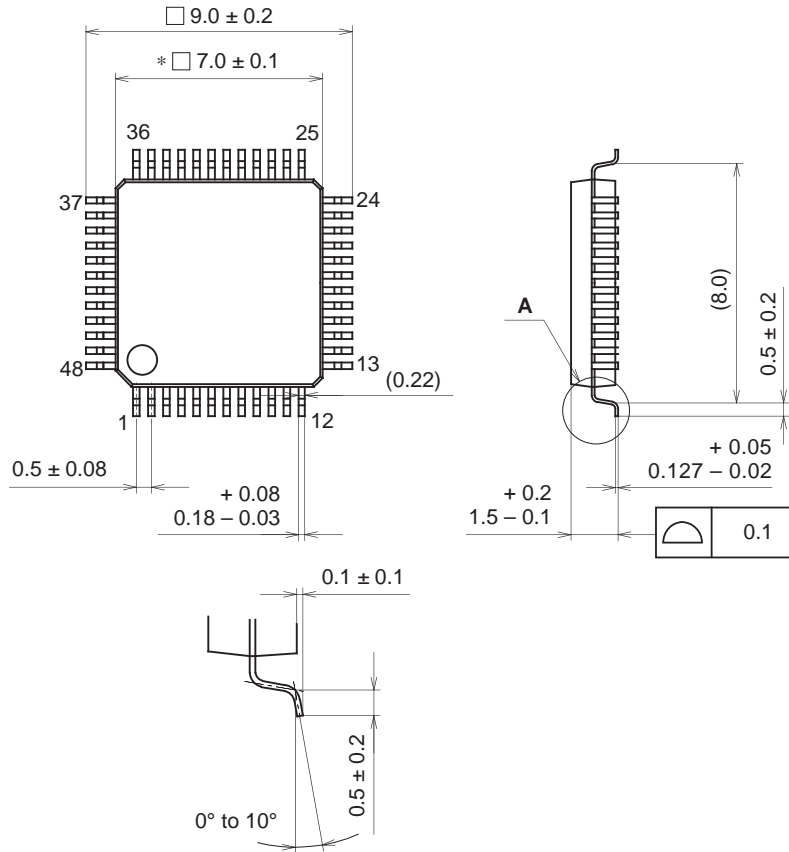
Application Circuit



Package Outline

Unit: mm

48PIN LQFP (PLASTIC)



NOTE: Dimension "*" does not include mold protrusion.

DETAIL A

PACKAGE STRUCTURE

SONY CODE	LQFP-48P-L01
EIAJ CODE	LQFP048-P-0707
JEDEC CODE	—

PACKAGE MATERIAL	EPOXY RESIN
LEAD TREATMENT	SOLDER/PALLADIUM PLATING
LEAD MATERIAL	42/COPPER ALLOY
PACKAGE MASS	0.2g