

## Timing Generator for Color Liquid Crystal Panel

### Description

The CXD2403AR is a timing signal generator for color liquid crystal panel drivers.

### Features

- Generates the LCX003, LCX004 and LCX005 drive pulses
- Supports line inversion and field inversion
- AC drive for liquid crystal panel during no signal (NTSC/PAL)
- Generates timing signal of external sample-and-hold circuit
- AFC circuit supporting static and dynamic fluctuations
- Pulse driver for liquid crystal panel driver (12.0V)

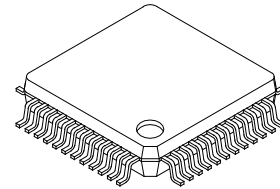
### Applications

Color liquid crystal viewfinders

### Structure

Silicon gate CMOS IC

48 pin LQFP (Plastic)



### Absolute Maximum Ratings (5V system)

(Ta = +25°C, VSS1 = 0V)

• Supply voltage	VCC	-0.3 to +7.0	V
• Input voltage	VI	-0.3 to VDD +0.3	V
• Output voltage	VO	-0.3 to VDD +0.3	V
• Operating temperature	Topr	-20 to +75	°C
• Storage temperature	Tstg	-55 to +125	°C

### Absolute Maximum Ratings (12V system)

(Ta = +25°C, VSS3 = 0V)

• Supply voltage	VEE	-0.3 to +20.0	V
• Output voltage	VO	-0.3 to VEE +0.3	V
• Operating temperature	Topr	-20 to +75	°C
• Storage temperature	Tstg	-55 to +125	°C

### Recommended Operating Conditions (5V system)

• Supply voltage	VDD	2.7 to 5.5	V
• Operating temperature	Topr	-20 to +75	°C

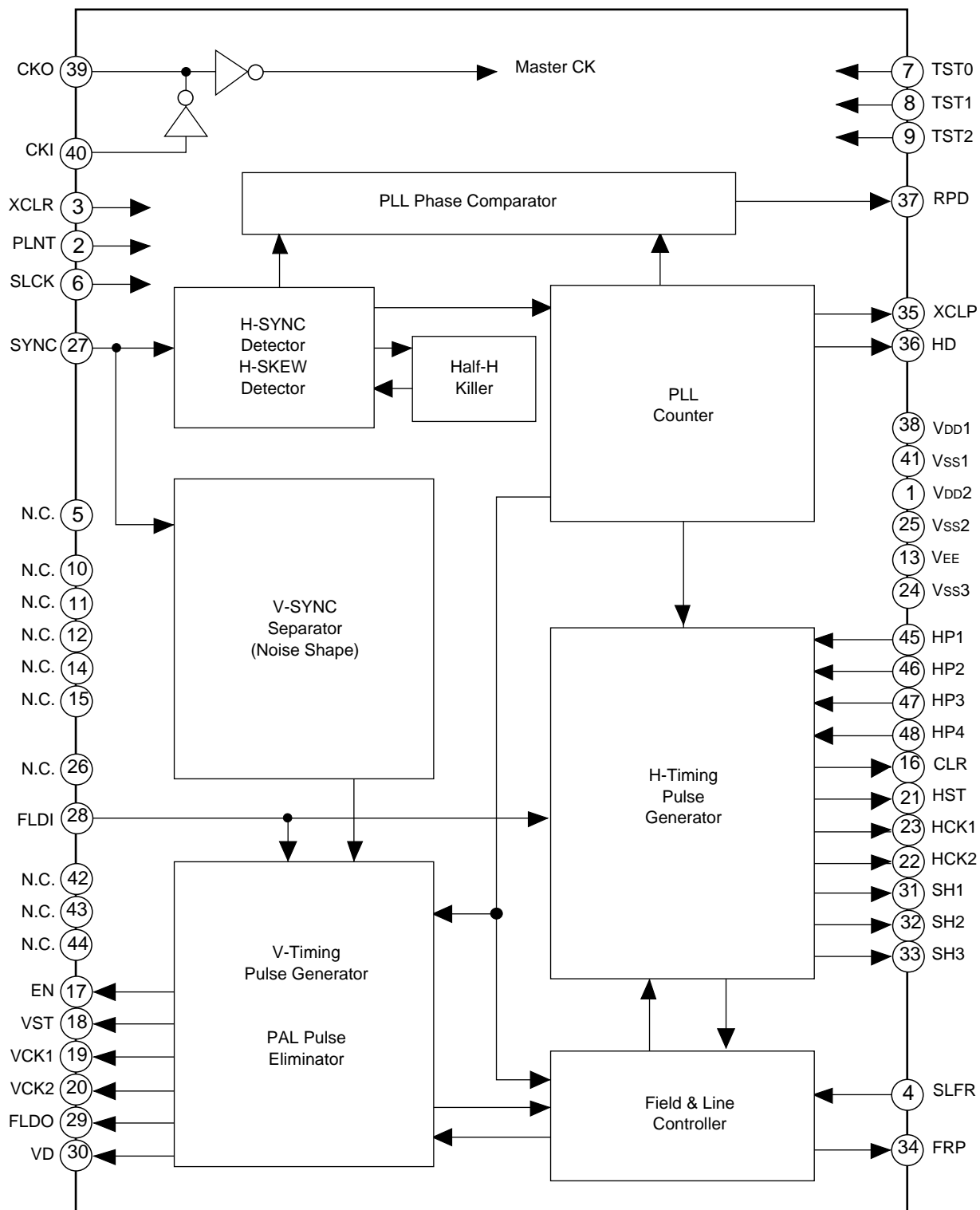
### Recommended Operating Conditions (12V system)

• Supply voltage	VEE	11.5 to 12.5	V
• Operating temperature	Topr	-20 to +75	°C

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Block Diagram



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## Pin Description

(H: Pull Up, L: Pull Down)

Pin No.	Symbol	I/O	Description	Input Pin for Open Status
1	VDD2	I	5V system power supply	
2	PLNT	I	Switches between PAL (High) and NTSC (Low)	L
3	XCLR	I	Reset at 0V	H
4	SLFR	I	Switches between field inversion (High) and line inversion (Low)	L
5	N.C.	—	No connected	—
6	SLCK	I	Switches between LCX003/004 (Low) and LCX005 (High)	L
7	TST0	I	Test	L
8	TST1	I	Test	L
9	TST2	I	Test	L
10	N.C.	—	No connected	—
11	N.C.	—	No connected	—
12	N.C.	—	No connected	—
13	VEE	I	12V system power supply	—
14	N.C.	—	No connected	—
15	N.C.	—	No connected	—
16	CLR	O	CLR pulse output (positive polarity)	—
17	EN	O	EN pulse output (negative polarity)	—
18	VST	O	V start pulse output (positive polarity)	—
19	VCK1	O	V clock pulse 1 output (positive polarity)	—
20	VCK2	O	V clock pulse 2 output (positive polarity)	—
21	HST	O	H start pulse output (positive polarity)	—
22	HCK2	O	H clock pulse 2 output (positive polarity)	—
23	HCK1	O	H clock pulse 1 output (positive polarity)	—
24	Vss3	I	12V system GND	—
25	Vss2	I	5V system GND	—
26	N.C.	—	No connected	—
27	SYNC	I	Composite sync input (positive polarity)	—
28	FLDI	I	Field identification signal input ODD (High)/EVEN (Low)	—
29	FLDO	O	Field identification signal output	—
30	VD	O	VD pulse output (positive polarity)	—
31	SH1	O	Sample-and-hold pulse output (positive polarity)	—
32	SH2	O	Sample-and-hold pulse output (positive polarity)	—
33	SH3	O	Sample-and-hold pulse output (positive polarity)	—
34	FRP	O	AC drive timing pulse output	—
35	XCLP	O	Burst position clamp pulse output (negative polarity)	—
36	HD	O	HD pulse output (positive polarity)	—
37	RPD	O	Phase comparator output	—
38	Vdd1	I	5V system power supply	—
39	CKO	O	Oscillation cell (output)	—
40	CKI	I	Oscillation cell (input)	—

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Pin No.	Symbol	I/O	Description	Input Pin for Open Status
41	Vss1	I	5V system GND	
42	N.C.	—	No connected	—
43	N.C.	—	No connected	—
44	N.C.	—	No connected	—
45	HP1	I	Switches for the horizontal display start position	H
46	HP2	I	Switches for the horizontal display start position	L
47	HP3	I	Switches for the horizontal display start position	L
48	HP4	I	Switches for the horizontal display start position	H

**Electrical Characteristics 1**DC Characteristics ( $V_{DD} = 5.0V \pm 10\%$ )

Item	Applicable Pins	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit	
Input voltage	SYNC	$V_{IH}$		$0.7 \cdot V_{DD}$		5.5	V	
		$V_{IL}$		VSS		$0.3 \cdot V_{DD}$		
Output current	Other than CKO and RPD	$I_{OH}$	$V_{OH} = V_{DD} - 0.8V$			-2.0	mA	
		$I_{OL}$	$V_{OL} = 0.4V$	4				
	RPD	$I_{OH}$	$V_{OH} = V_{DD} - 0.8V$			-2		
		$I_{OL}$	$V_{OL} = 0.4V$	2				
	CKO	$I_{OH}$	$V_{OH} = V_{DD}/2$		-18			-3.0
		$I_{OL}$	$V_{OL} = V_{DD}/2$		3.0			18
Input leak current	Normal input pins	$I_{II}$	$V_{IN} = V_{SS} \text{ or } V_{DD}$	-2		2	$\mu A$	
	Pull-up resistor connected	$I_{IL}$	$V_{IN} = V_{SS}$	-240		-10		
	Pull-down resistor connected	$I_{IH}$	$V_{IN} = V_{DD}$	10		240		
Output leak current	RPD (at high impedance state)	$I_{O2}$	$V_{IN} = V_{SS} \text{ or } V_{DD}$	-40		40		

Output voltage	12V system output pins	$V_{OH}$	$I_{OUT} = -20\mu A$	11.9	12.0	—	V
		$V_{OL}$	$I_{OUT} = 20\mu A$	—	0.0	0.1	
Output current	12V system output pins	$I_{OH}$	$V_{OH} = 11.5V$ (VEE=12V)			-1.0	mA

Item		Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit
Current consumption	5V system	$I_{DD}$	Note 1)			25.0	mA
	12V system	$I_{EE}$	Note 1)			2.0	

Note:

1. Master clock frequency  $F_{CKI} = 12MHz$ , input conditions  $V_{IH} = V_{DD}$ ,  $V_{IL} = V_{SS}$ , no output load.

[查询"CXD2403AR"供应商](#)**AC Characteristics** ( $V_{DD} = 5.0V \pm 10\%$ )

## 5V System

Item	Applicable Pins	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit
Clock input cycle	CK1 Note 4)	tck		83			ns
High level pulse width		tw (H)		30			
Low level pulse width		tw (L)		30			
Clock rise time		tr (ck)				10	
Clock fall time		tf (ck)				10	
Output rise time	SH1, SH2	tr	CL = 10pF			20	
Output fall time	SH3	tf	CL = 10pF			20	
Output rise delay time	5V system	tpr	CL = 20pF			70	
Output fall delay time	output pins	tpf	CL = 20pF			70	

## 12V System

Output rise time	12V system all Output pins Note 3)	tr	CL = 10pF			50	ns
			CL = 40pF			80	
Output fall time		tf	CL = 10pF			50	
			CL = 40pF			80	
Cross point time difference Note 2)	VCK1, 2 HCK1, 2	$\Delta t$	CL = 10pF			15	
			CL = 40pF			15	
Output rise delay time	12V system all output pins Note 3)	tpLH	CL = 10pF			160	
			CL = 40pF			180	
Output fall delay time		tpHL	CL = 10pF			160	
			CL = 40pF			180	
HCK1, SH1 delay time difference	HCK1 SH1	dt1	CL = 40pF (HCK1, HCK2)	80		125	
HCK2, SH2 delay time difference	HCK2 SH1	dt2	CL = 20pF (SH1) Note 5)	90		130	
HCK delay time difference	HCK1 HCK2	tH-tL	CL = 40pF	-30		40	

## Notes:

- Applicable to the relationships between HCK1 and HCK2, and VCK1 and VCK2.
- 12V system output pins : HST, HCK1, HCK2, VST, VCK1, VCK2, EN, CLR.
- CKI input voltage conditions : The input signal must have the full swing amplitude.
- Master clock frequency fCKI=8MHz.

[查询"CXD2403AR"供应商](#)**Electrical Characteristics 2**DC Characteristics ( $V_{DD} = 2.7V$  to  $3.6V$ )

Item	Applicable Pins	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit
Input voltage Note) 4	SYNC	$V_{IH}$		$0.7 \cdot V_{DD}$		5.5	V
		$V_{IL}$		$V_{SS}$		$0.3 \cdot V_{DD}$	
Output current	Other than CKO	$I_{OH}$	$V_{OH} = V_{DD} - 0.8V$			-1.1	mA
		$I_{OL}$	$V_{OL} = 0.4V$	1.0			
	CKO	$I_{OH}$	$V_{OH} = V_{DD}/2$	-8.0		-0.7	
		$I_{OL}$	$V_{OL} = V_{DD}/2$	0.75		8.0	
Input leak current	Normal input pins	$I_I$	$V_{IN} = V_{SS}$ or $V_{DD}$	-2		2	$\mu A$
	Pull-up resistor connected	$I_{IL}$	$V_{IN} = V_{SS}$	-240		-3	
	Pull-down resistor connected	$I_{IH}$	$V_{IN} = V_{DD}$	5		240	
Output leak current	RPD (at high impedance state)	$I_{O2}$	$V_{IN} = V_{SS}$ or $V_{DD}$	-40		40	

Output voltage	12V system output pins	$V_{OH}$	$I_{OUT} = -20\mu A$	11.9	12.0	—	V
		$V_{OL}$	$I_{OUT} = 20\mu A$	—	0.0	0.1	
Output current	12V system output pins	$I_{OH}$	$V_{OH} = 11.5V$ ( $V_{EE} = 12V$ )			-1.0	mA
		$I_{OL}$	$V_{OL} = 0.5V$	1.0			

Item	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit	
Current consumption	5V system	$I_{DD}$	Note 1)			25.0	mA
	12V system	$I_{EE}$	Note 1)			2.0	

Notes:

- Master clock frequency  $F_{CKI} = 12MHz$ , input conditions  $V_{IH} = V_{DD}$ ,  $V_{IL} = V_{SS}$ , no output load.
- CKI input voltage conditions : The input signal must have the full swing amplitude.

[查询"CXD2403AR"供应商](#)**AC Characteristics** ( $V_{DD} = 2.7V$  to  $3.6V$ )

## 5V System

Item	Applicable Pins	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit
Clock input cycle	CKI Note 4)	tck		83			ns
High level pulse width		tw (H)		30			
Low level pulse width		tw (L)		30			
Clock rise time		tr (ck)				10	
Clock fall time		tf (ck)				10	
Output rise time	SH1, SH2	tr	CL = 10pF			30	
Output fall time	SH3	tf	CL = 10pF			30	
Output rise delay time	5V system	tpr	CL = 20pF			200	
Output fall delay time	output pins	tpf	CL = 20pF			200	

## 12V System

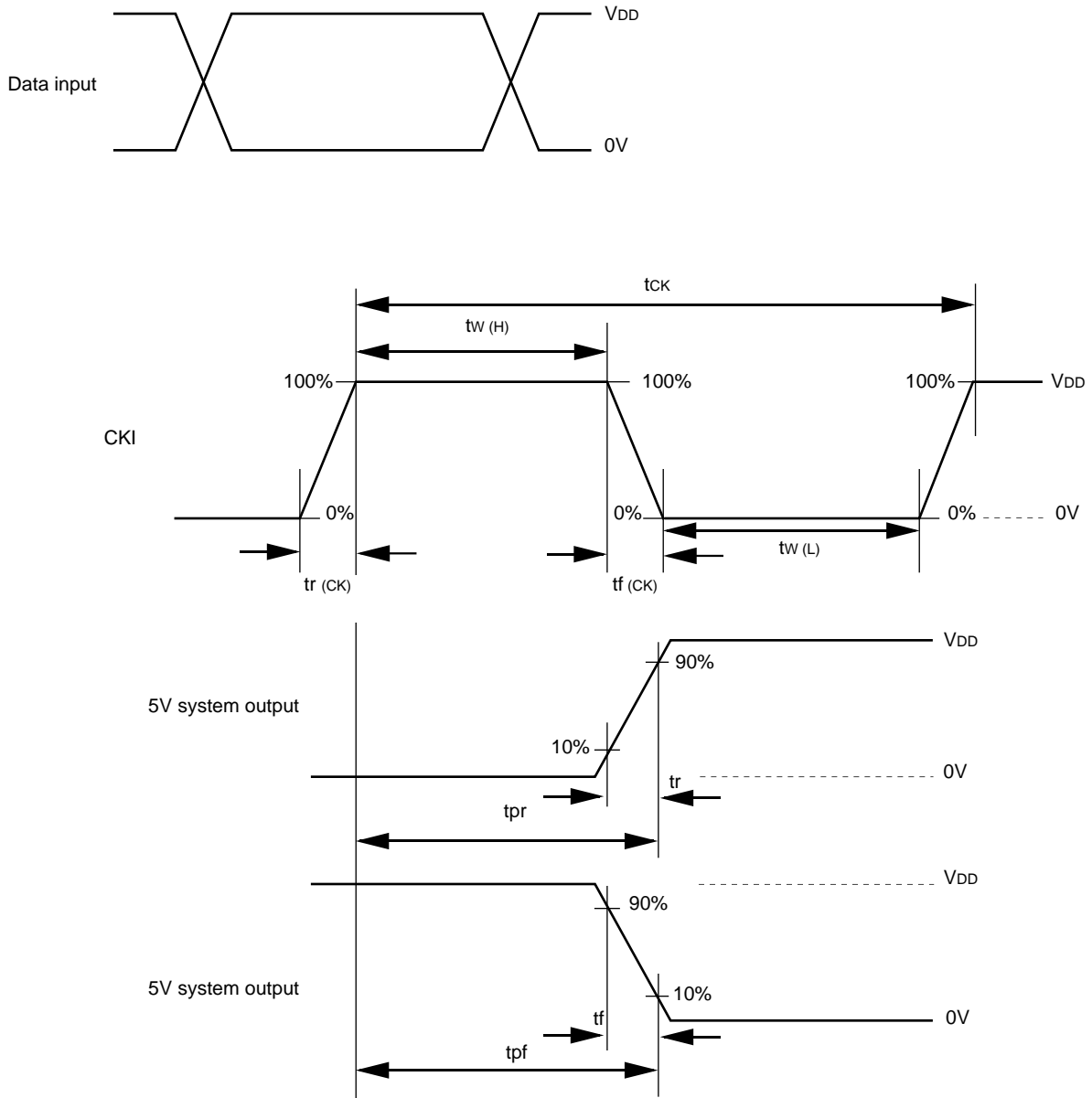
Output rise time	12V system all Output pins Note 3)	tr	CL = 10pF			50	ns
			CL = 40pF			80	
Output fall time		tf	CL = 10pF			50	
			CL = 40pF			80	
Cross point time difference Note 2)	VCK1, 2 HCK1, 2	$\Delta t$	CL = 10pF			15	
			CL = 40pF			15	
Output rise delay time	12V system all ouput pins Note 3)	tpLH	CL = 10pF			200	
			CL = 40pF			250	
Output fall delay time		tpHL	CL = 10pF			200	
			CL = 40pF			250	
HCK1, SH1 delay time difference	HCK1 SH1	dt1	CL = 40pF (HCK1, HCK2)	80		145	
HCK2, SH2 delay time difference	HCK2 SH1	dt2	CL = 20pF (SH1) Note 5)	90		145	
HCK delay time difference	HCK1 HCK2	tH-tL	CL = 40pF	-30		40	

## Notes:

- Applicable to the relationships between HCK1 and HCK2, and VCK1 and VCK2.
- 12V system output pins : HST, HCK1, HCK2, VST, VCK1, VCK2, EN, CLR.
- CKI input voltage conditions : The input signal must have the full swing amplitude.
- Master clock frequency fck1 = 8MHz.

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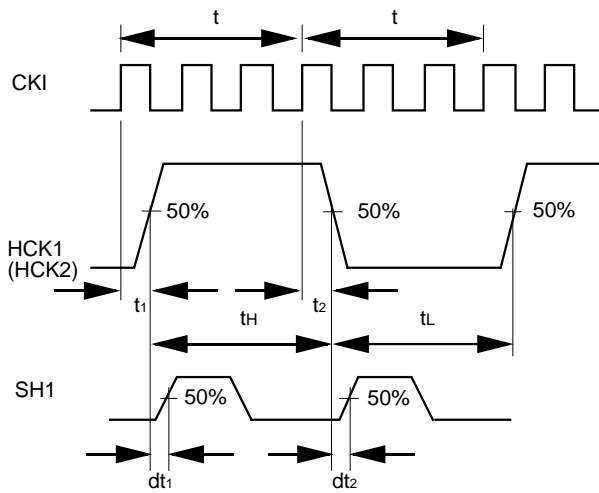
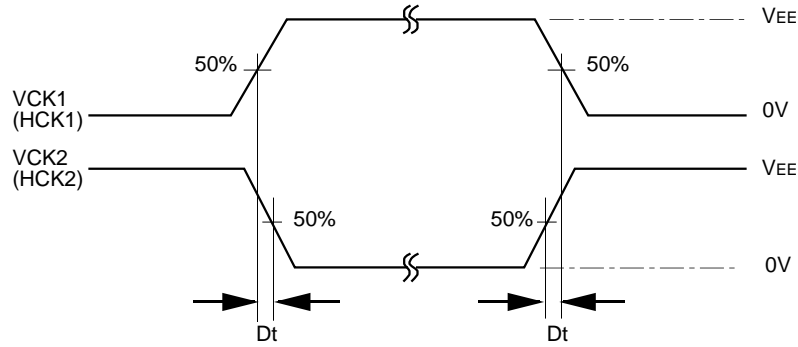
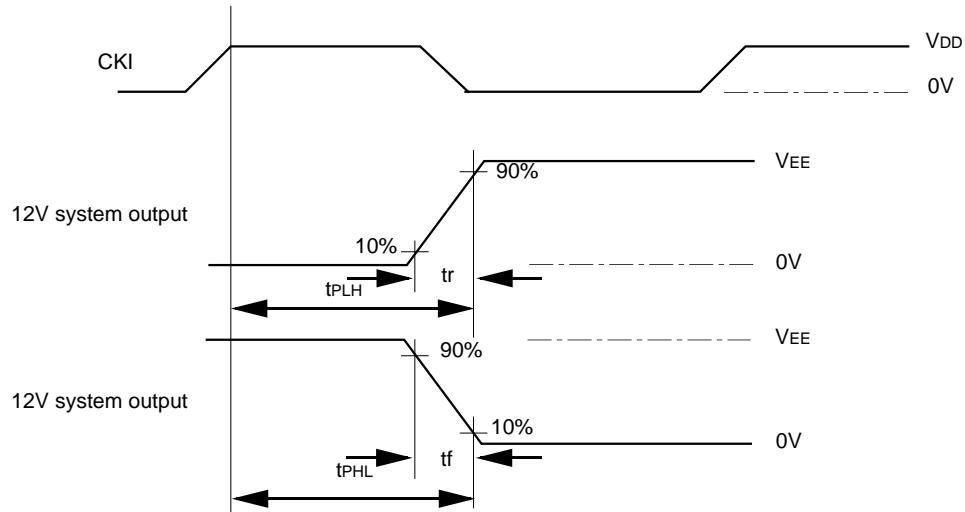
Timing Definition for 5V System Pins





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Timing Definition for 12V System Pins



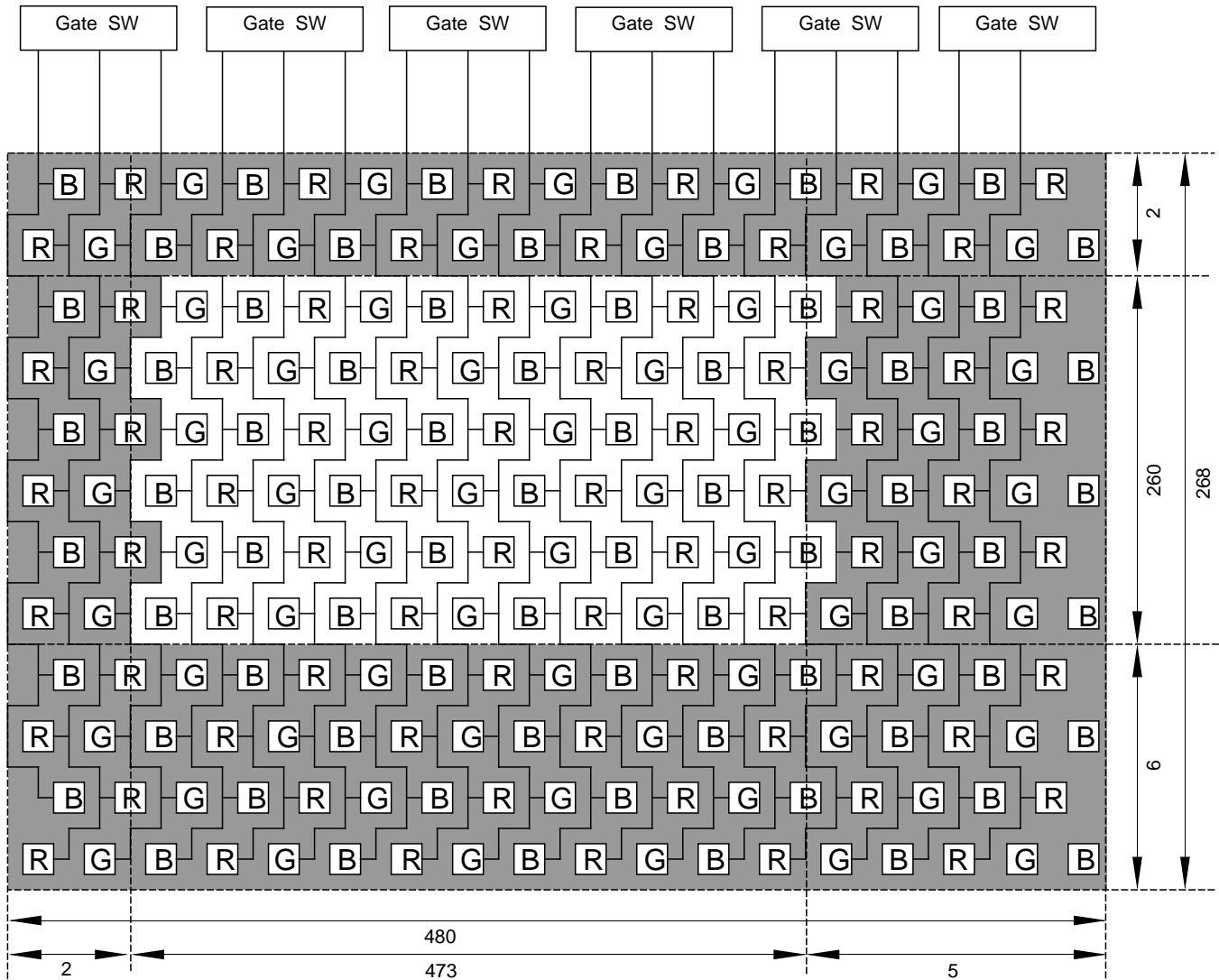
$$t - t_L = 2(t - t_1)$$

$$\left( \begin{array}{l} t_H = t - t_1 + t_2 \\ t_L = t - t_2 + t_1 \\ t_H - t_L = 2(t_2 - t_1) \end{array} \right)$$



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Liquid Crystal Panel Structure

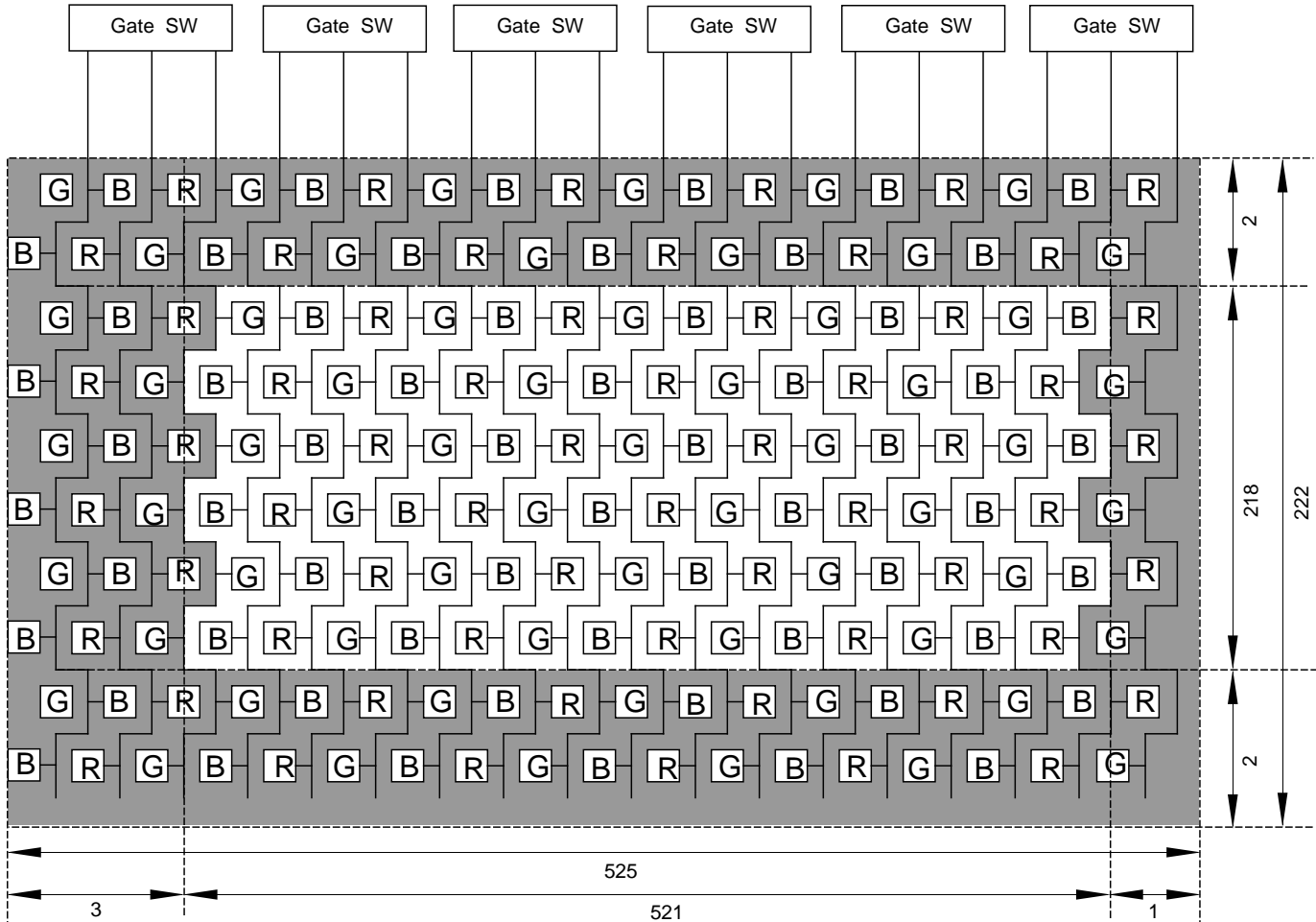


LCX004

Basic Specifications		
Total number of horizontal pixels	(A line) :	479H
	(B line) :	480H
Number of horizontal display pixels	(A line) :	473H
	(B line) :	473H
Total number of vertical pixels	:	268H
Number of vertical display pixels	:	260H
Total number of pixels	:	128506
Number of display pixels	:	122980

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Liquid Crystal Panel Structure



LCX005

Basic Specifications	
Total number of horizontal pixels	: 525H
Number of horizontal display pixels	: 521H
Total number of vertical pixels	: 222H
Number of vertical display pixels	: 218H
Total number of pixels	: 116550
Number of display pixels	: 113578

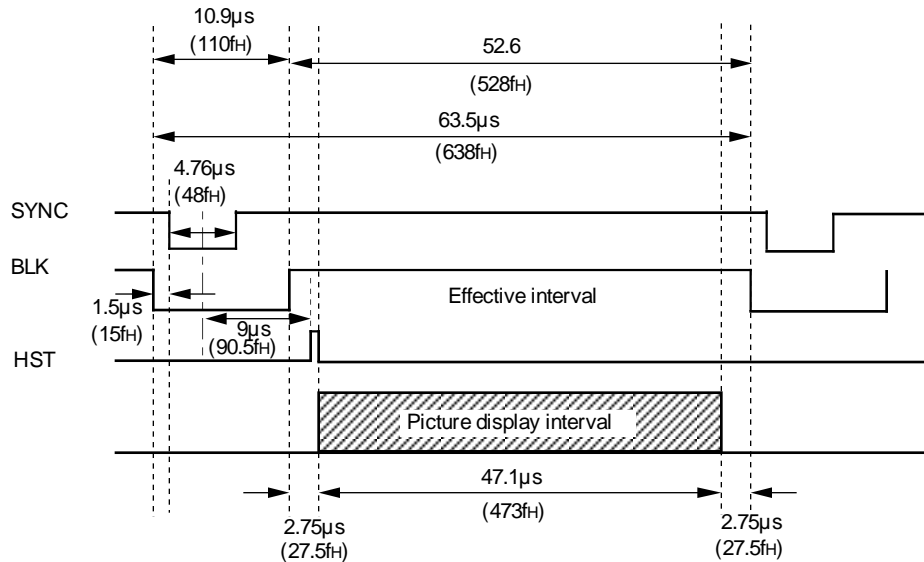
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**Horizontal Direction Output Pulse**

The picture display timing of horizontal direction is as follows.

The horizontal start position is offset by two clocks in 16 different ways with the HP1 to 4 pins.

**Effective Pixel Display Timing (for the LCX003)**

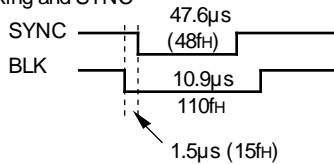


**Horizontal Start Position Concept**

Horizontal scan interval

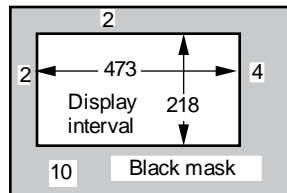
$$63.5\mu s = 638fH$$

Blanking and SYNC



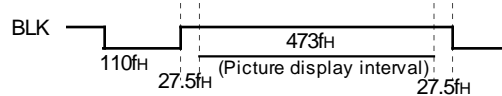
Picture display interval

$$47.1\mu s = 473fH$$

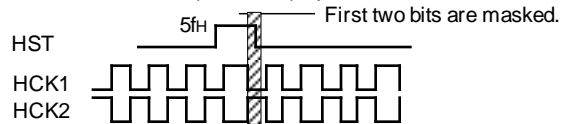


Interval from sync signal to picture display

Picture display starts  $(528-473)/2 = 27.5fH$  later from the end of BLK. Therefore, picture display starts  $11 - 15 + 27.5 = 122.5fH$  later.



Interval from HST to picture display



Therefore, the interval between HST and display start is 6 clocks.

Interval from the center of sync signal to HST.

Add time delayed four bits of sync separation circuit.  
 $110-15-26+27.5-6-4=90.5fH$  (9.0μs)

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**Variable Range from the Center of Sync Signal to Hst Rise Timing**

HP4	HP3	HP2	HP1	
0	0	0	0	108CLK (10.7μs)
0	0	0	1	106CLK
0	0	1	0	104CLK
0	0	1	1	102CLK
0	1	0	0	100CLK
0	1	0	1	98CLK
0	1	1	0	96CLK
0	1	1	1	94CLK (9.4μs)
1	0	0	0	92CLK
1	0	0	1	90CLK
1	0	1	0	88CLK
1	0	1	1	86CLK
1	1	0	0	84CLK
1	1	0	1	82CLK
1	1	1	0	80CLK
1	1	1	1	78CLK (7.8μs)

HP1 to HP4 pins can be used to vary the interval from the center of sync signal to HST rise as shown in the left table.

Internal preset: 1001 (90CLK)  
 NTSC (typ.): 1001 (90CLK)  
 PAL (typ.): 1000 (92CLK)

**Liquid Crystal Panel Driving Pulse Generation**

HST, HCK1, HCK2, VST, VCK1, and VCK2 (EN, CLR in LCX005 mode only) are generated for the liquid crystal panel driver.

Low. Polarity is not specified for each field. The point is changed from VCK1 and VCK2 pulse change points after 1 clock.

**External Sample-and-Hold Pulse Generation**

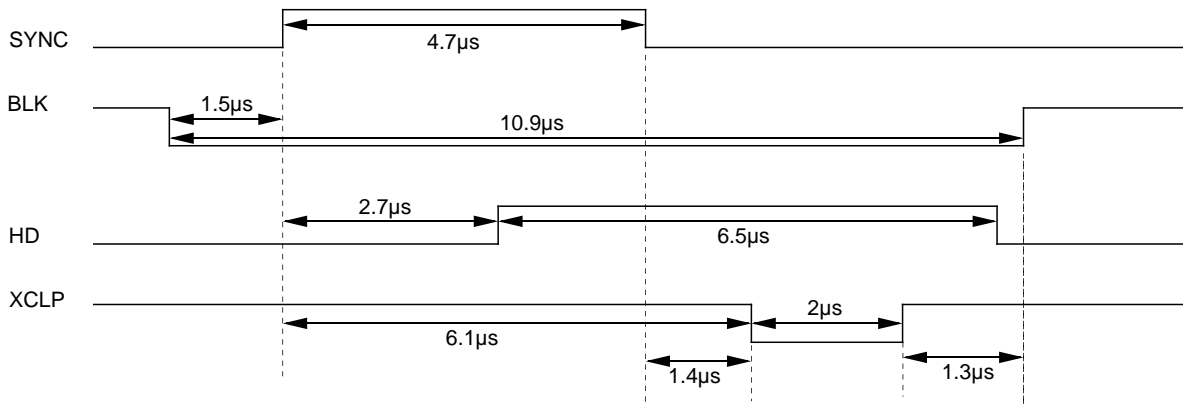
Timing pulses of external sample-and-hold circuit SH1, SH2, and SH3 are generated.

**HD-Clamp Pulse Generation**

HD pulse is output during horizontal BLK in order to drive the backlight (fluorescent tube). Even during no signal, raster screen with no screen noise can be created synchronizing to the free running frequency. XCLP is output for BF timing clamp pulse.

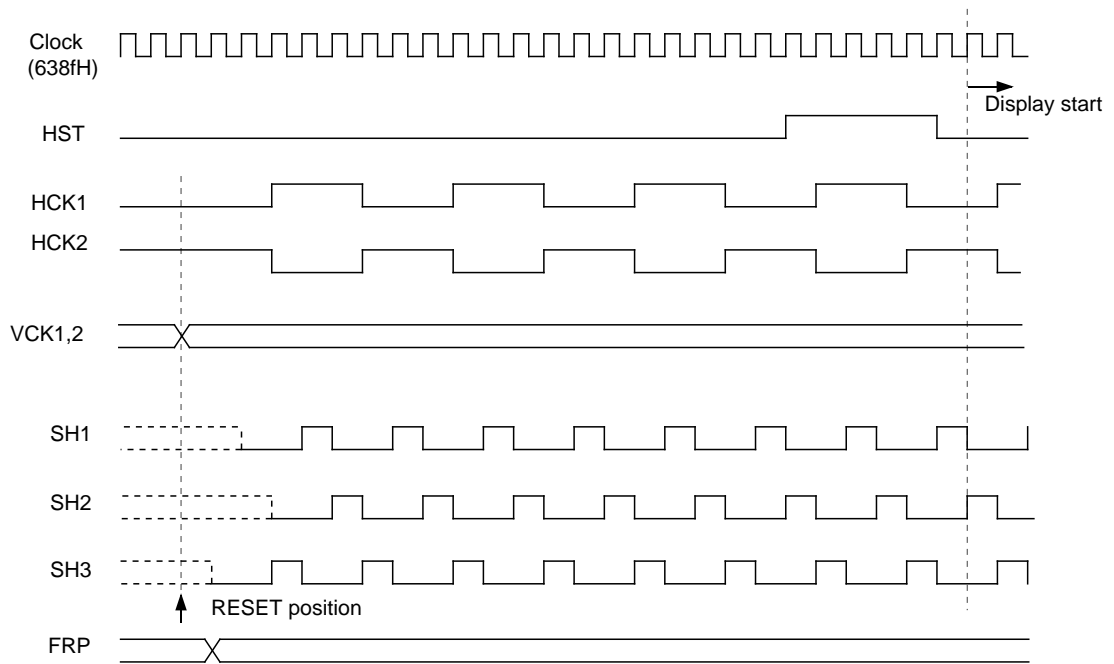
**AC Driving Pulse Generation**

FRP is output for liquid crystal AC driving. Field inverts when F/H input pin is High and line inverts when



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**Pulse Timing Chart (for the LCX003)**



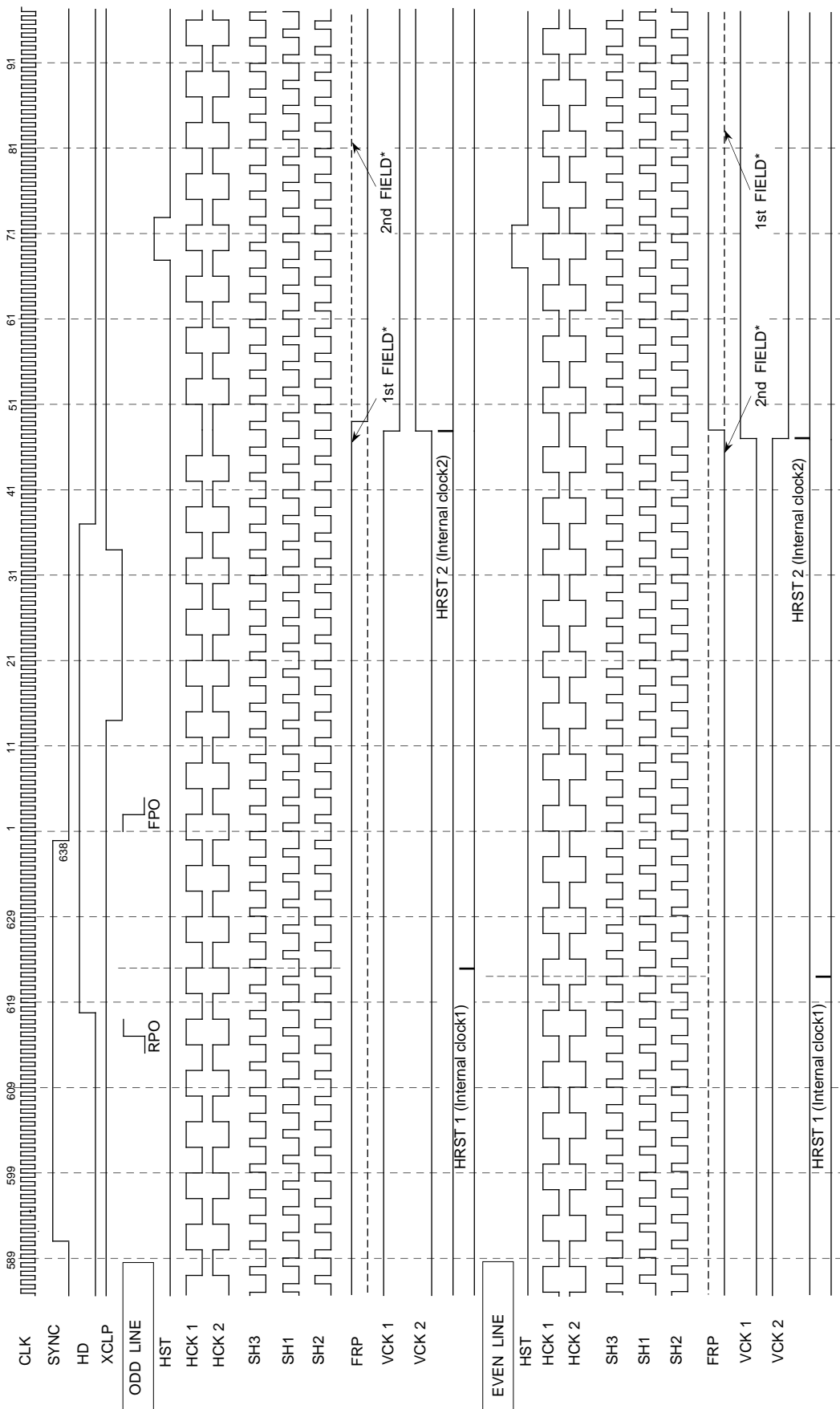
\* In accordance with the layout of picture elements on LCD panel, timings between the adjacent lines and fields are offset accordingly.

1.5 bit offset pulse → HST, HCK1, HCK2, SH1, SH2, SH3, CLR

1 bit offset pulse → VCK1, VCK2, FRP, EN

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LCX003/004 Horizontal Direction Timing Chart — NTSC, PAL (HPOS-1001)



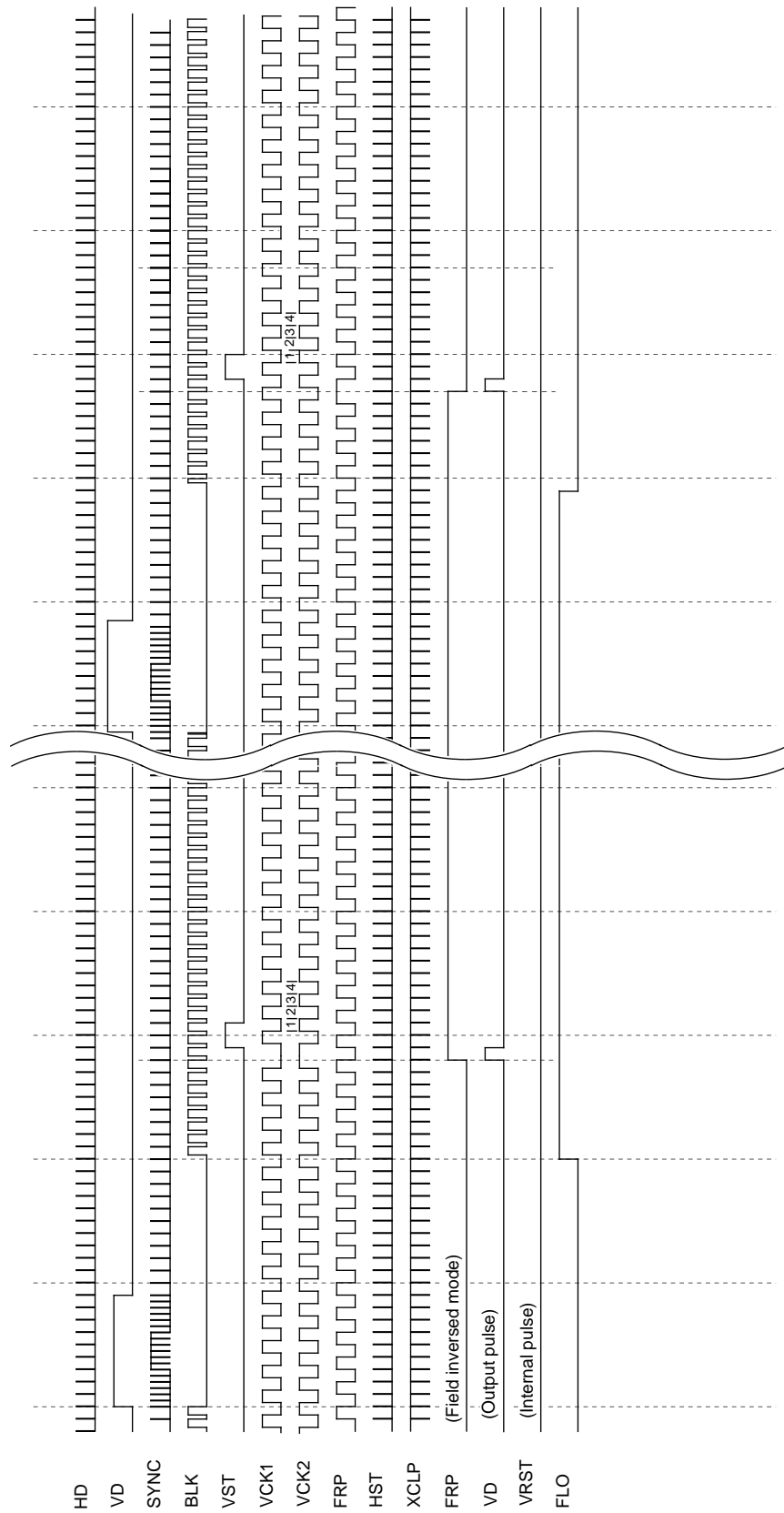
\*FRP polarity is not specified for each field.

Notes ) Signals for the timing interval from input SYNC changes with HST according to horizontal start position settings (HP1 to HP4) : HCK1, HCK2, SH1, SH2, SH3, FRP, VCK1, VCK2  
Constant signals regardless of the horizontal start position settings (HP1 to HP4) : SYNC, HD, XCLP



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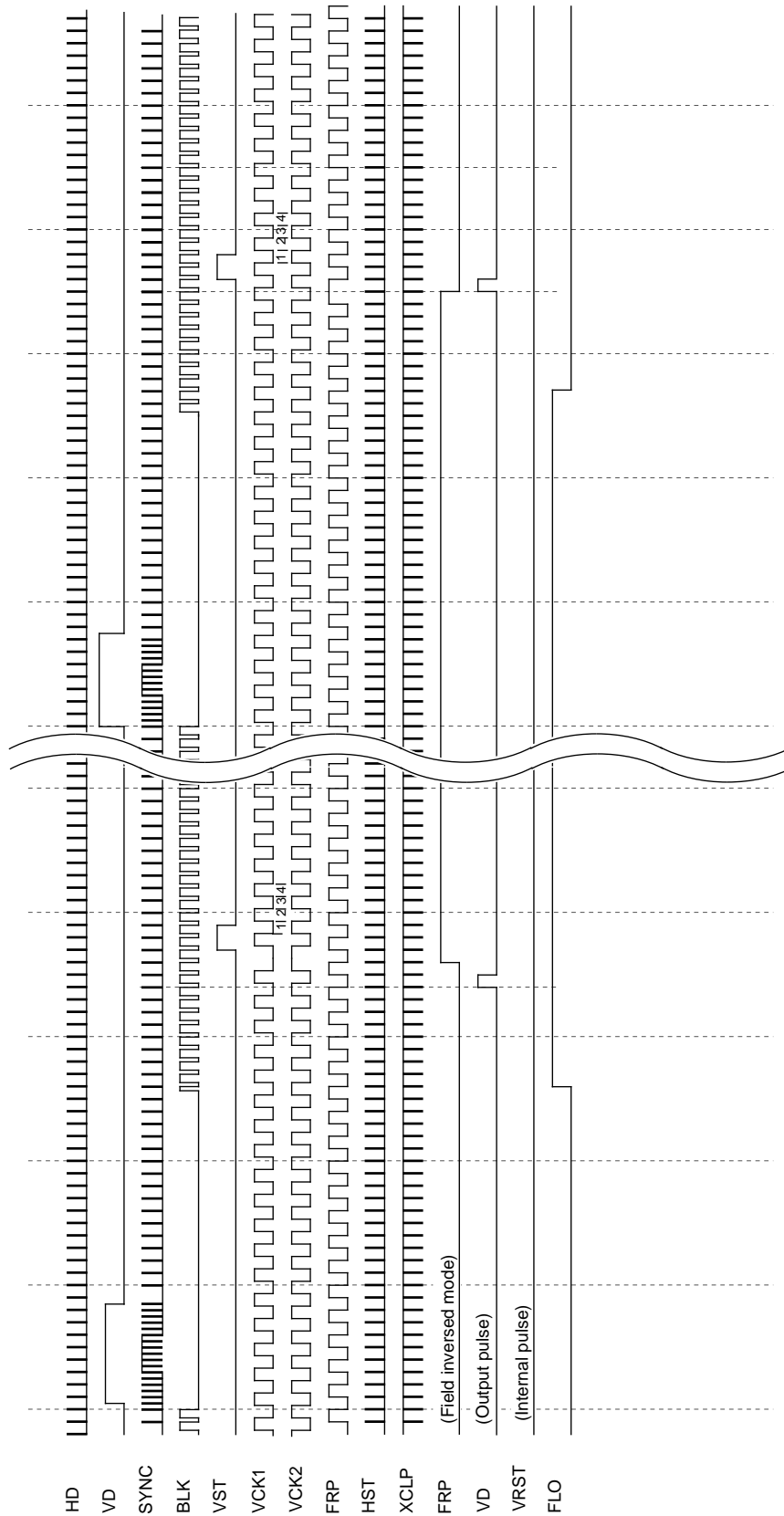
LCX003 Vertical Direction Timing Chart — NTSC



Note) The second row of the timing chart 'VD' is a pulse indicated as a reference and is not a pulse output from pins.

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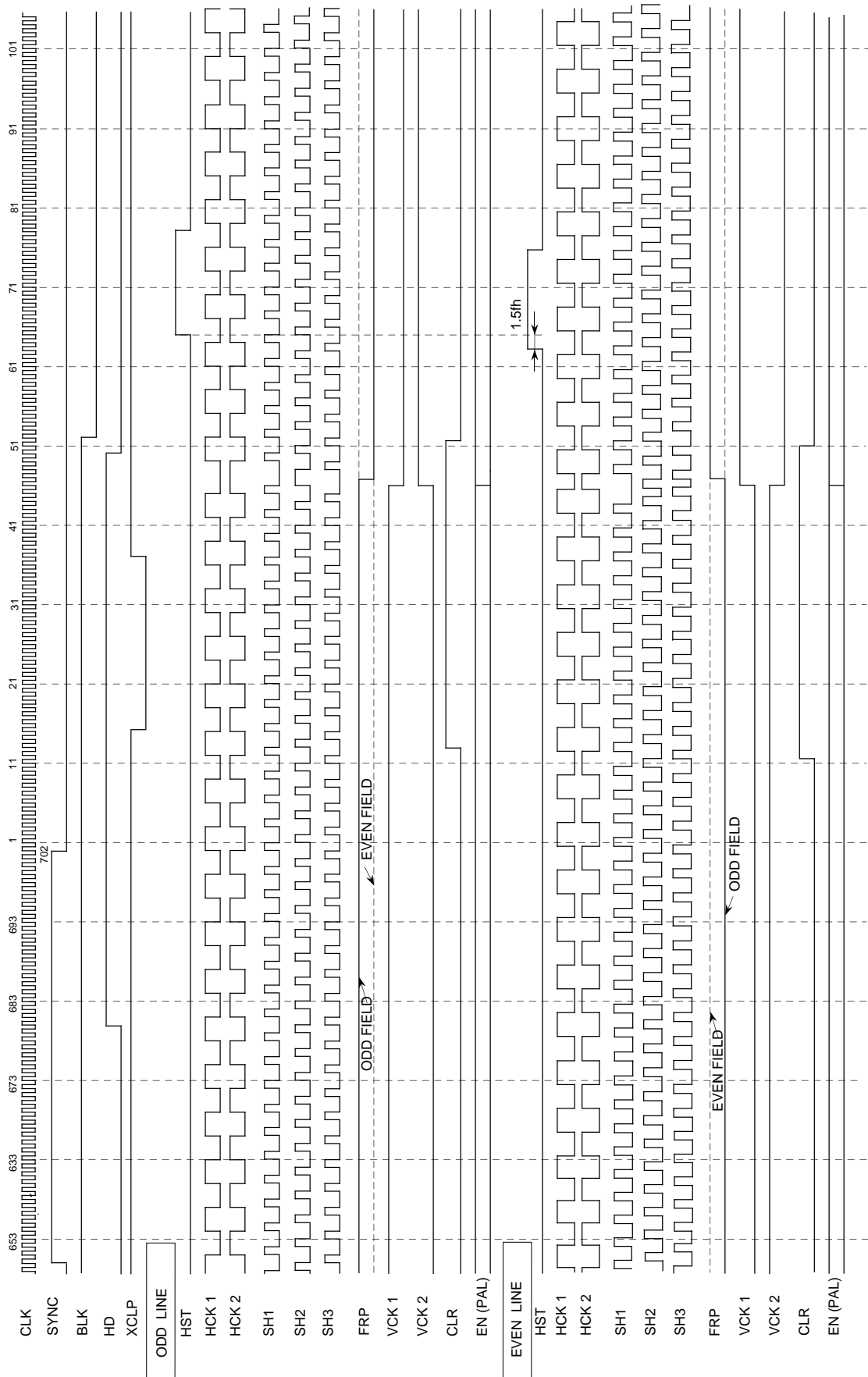
LCX004 Vertical Direction Timing Chart — PAL



Note) The second row of the timing chart 'VD' is a pulse indicated as a reference and is not a pulse output from pins.

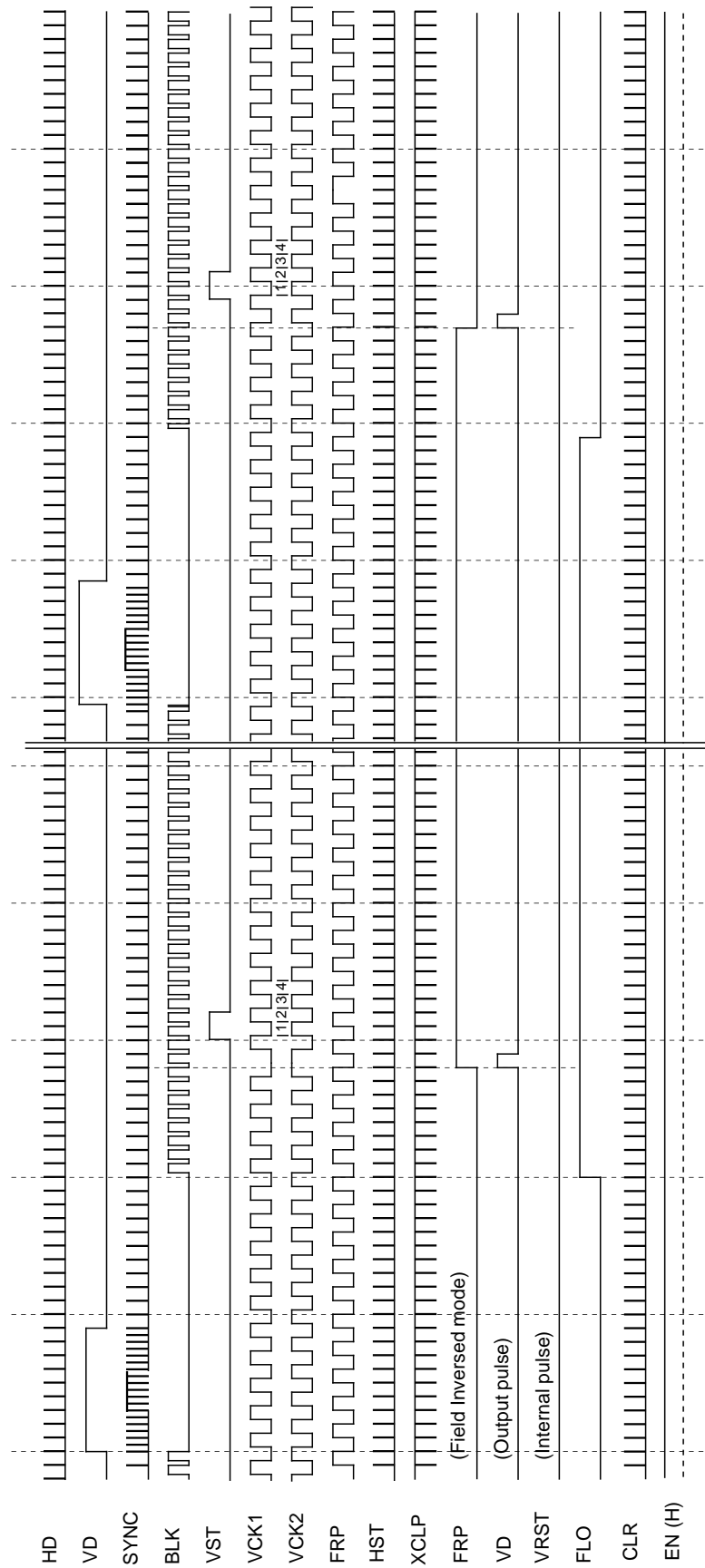
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LCX005 Horizontal Direction Timing Chart — NTSC, PAL (HP=1001)



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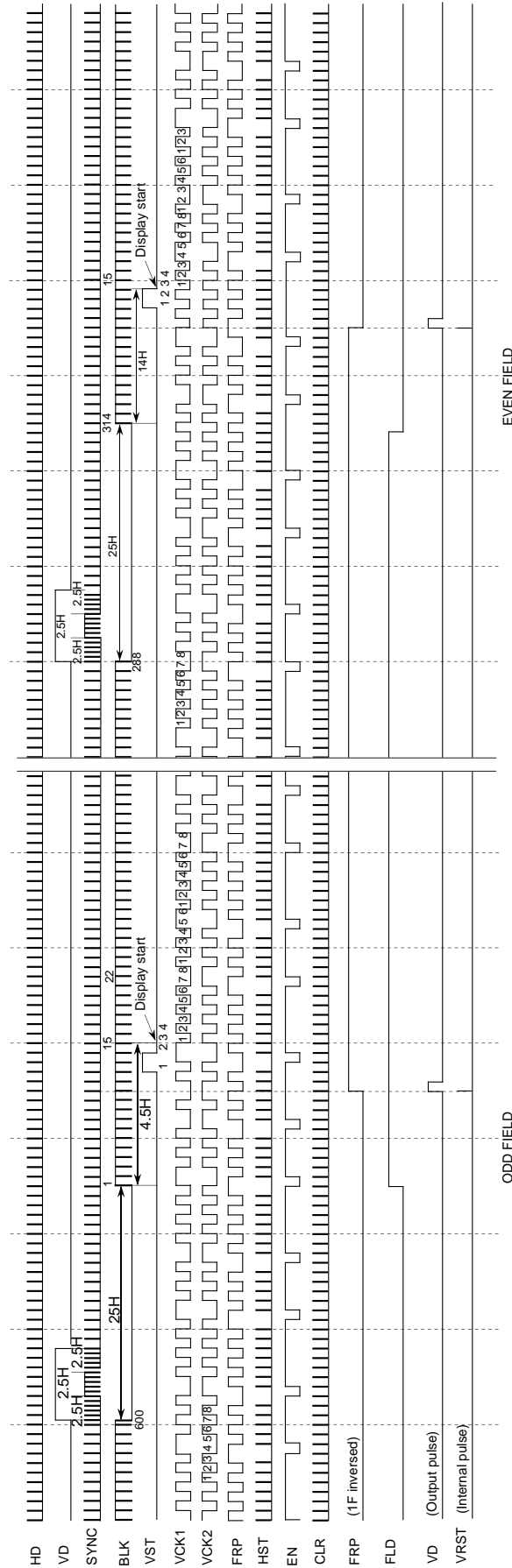
LCX005 Vertical Direction Timing Chart — NTSC



Note) The second row of the timing chart 'VD' is a pulse indicated as a reference and is not a pulse output from pins.

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LCX005 Vertical Direction  
Timing Chart — PAL



Note) The second row of the timing chart 'VD' is a pulse indicated as a reference and is not a pulse output from pins.

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**Driving for No Signal**

HST, HCK1, HCK2, FRP, VCK1, VCK2, XCLP, HD, VD, and VST are made to run free so that the liquid crystal panel is AC driven even when there is no composite sync from the SYNC pin.

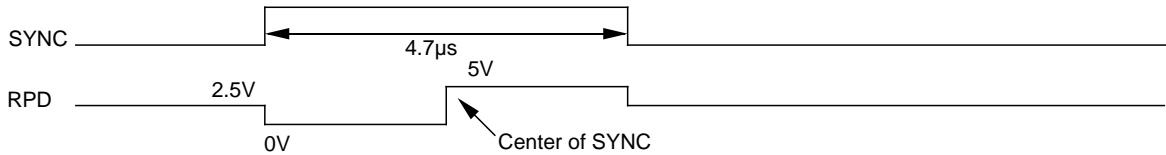
The PLL counter is made to run free because the HSYNC separation circuit stops. In addition, the auxiliary V counter is used to create the reference pulse for generating VD and VST because the VSYNC separation circuit is also stopped.

The period of the V counter is 269H for NTSC and 321H for PAL, and if there is no VSYNC during 269H/321H, it is assumed to be a no signal state.

The RPD pin is kept at high impedance so that the AFC circuit does not cause phase errors by phase comparison.

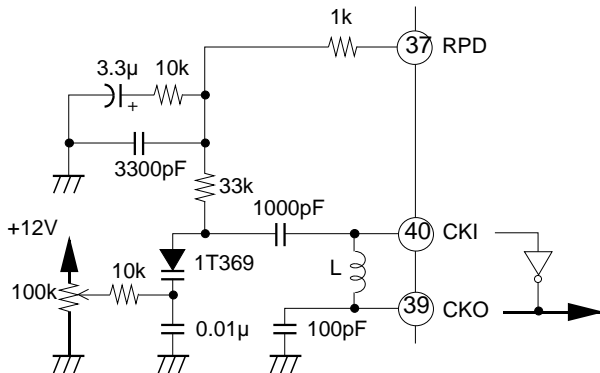
**AFC Circuit (638/702 fh clock generation)**

A fully synchronized AFC circuit is built in. PLL error detection signal is generated at the following timing.



The phase comparison output of the entire bottom of SYNC and the internal H counter becomes RPD. RPD output is converted to DC error with the lag-lead filter. Then the outputs change the vari-cap capacitance and the oscillating frequency is stabilized at 638 fh in LCX003/1004 or 702 fh in LCX005.

**Example of PLL Related Peripheral Circuit**



L value  
 LCX003/004 → 8.2µ  
 LCX005 → 6.8µ

\*The parameters of the elements are reference.

Parts : Vari-cap  
 1T369 (Sony), MA365 (Matsushita)

**Adjustment Method**

1. Adjust the voltage for vari-cap with the variable resistor connected to 12V power supply while checking HSYNC and RPD waveforms with an oscilloscope.

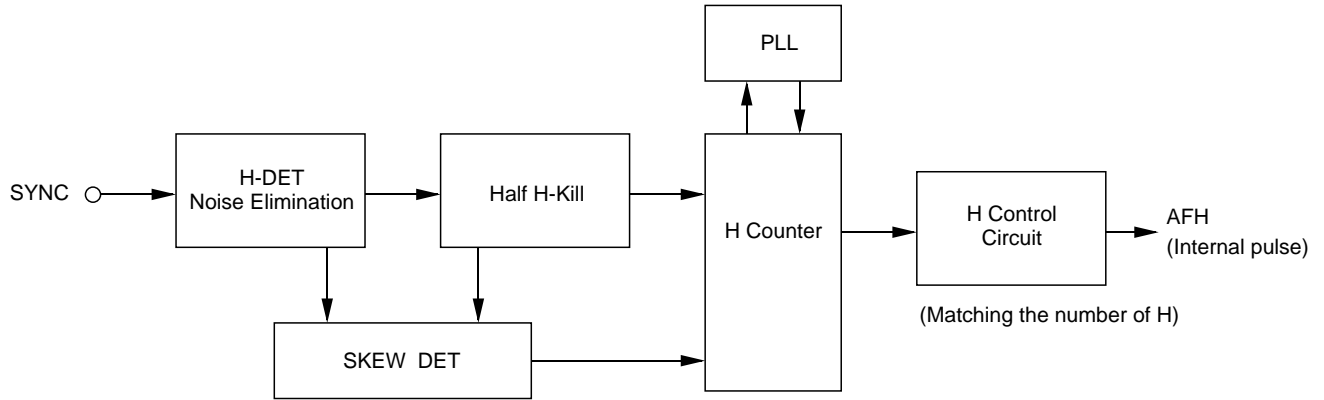
2. When PLL is still not locked, change the L of the LC oscillations.

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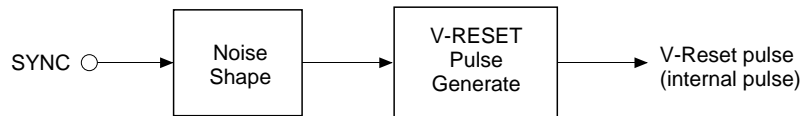
**HSYNC Separation**

HSYNC is separated from the composite sync input. Noise is eliminated with the counter and equivalent pulse is eliminated with the half H killer.

HSYNC jumping detection and address management when jumping occurs frequently (matching the number of H in a field) are also performed.



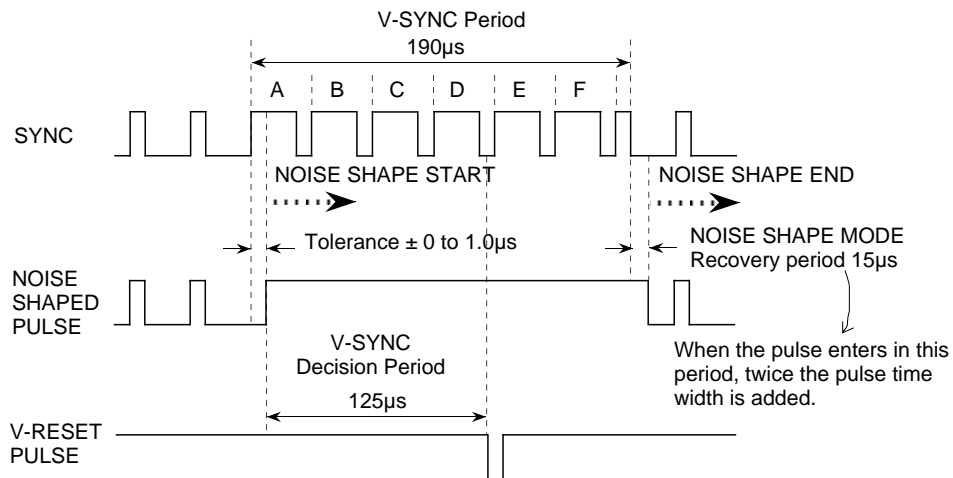
**V. SYNC Separation**



V-SYNC Separation Circuit

V. sync is separated from the composite sync input connected to SYNC connector. The serration pulses are removed as noise. When considerable pulse width is detected, the V reset pulse is output to notify V sync input and to synchronize timing of output signals. When

a V sync having different pulse width from normal one is input, it can be separated when the width of serration pulse is narrower than 2~3 μsec or less which is positioned right after the V sync having 0.5H width during A~F period.

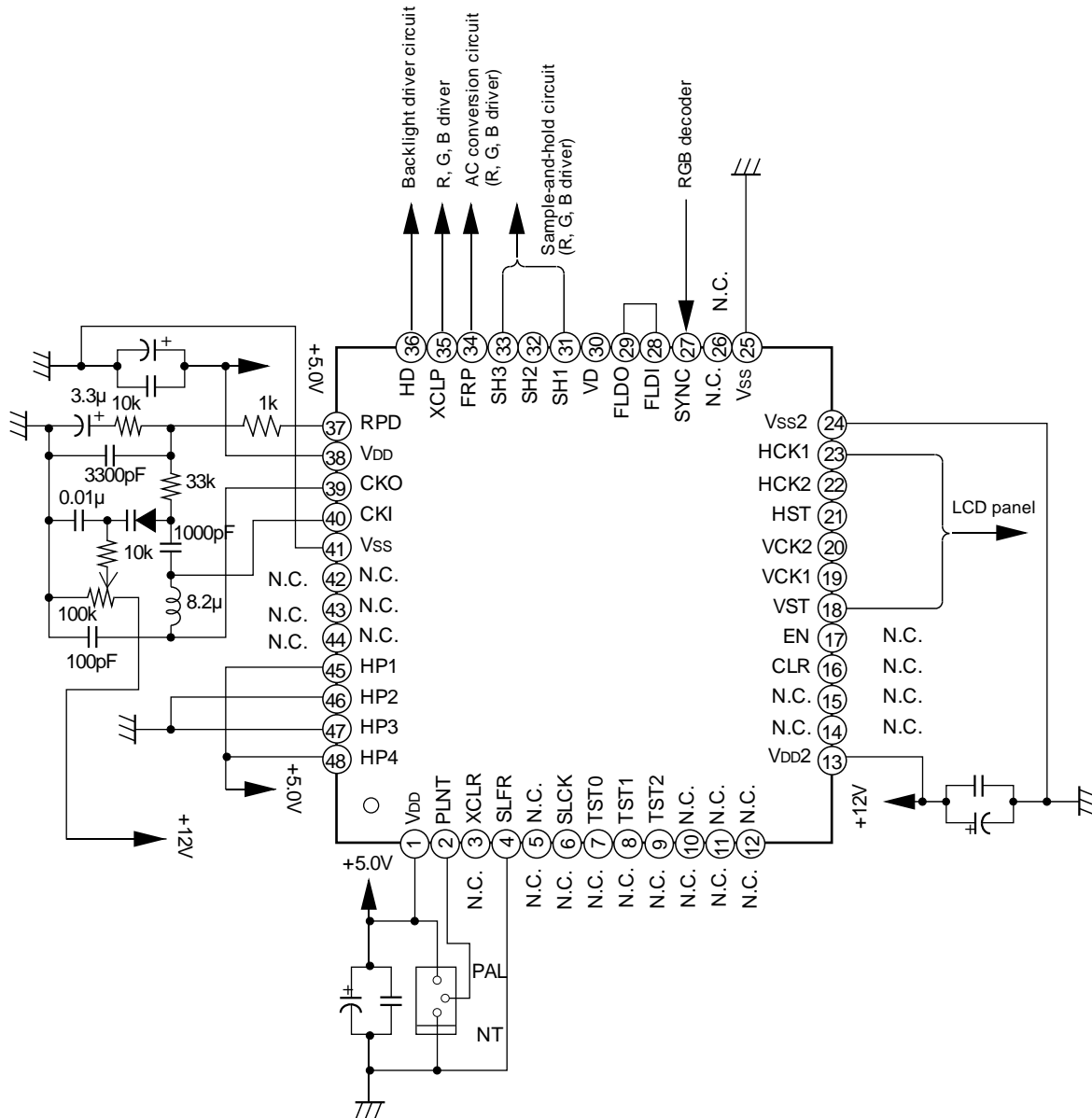


V-SYNC Input Time Axis Specification

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**Application Circuit**

(for driving the liquid crystal panel LCX003)



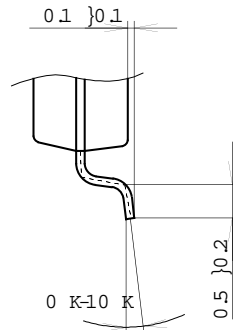
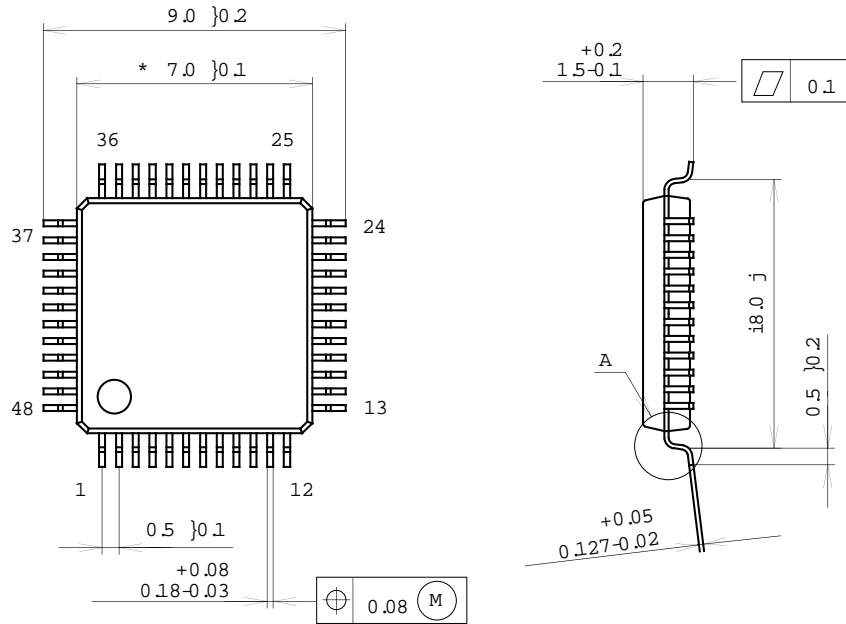
Application circuits shown are typical examples illustrating the operation of the devices. Sony cannot assume responsibility for any problems arising out of the use of these circuits or for any infringement of third party and other right due to same.



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Package Outline Unit : mm

48PIN LQFP (PLASTIC)



DETAIL A

NOTE Dimension g does not include mold protrusion.

SONY CODE	LQFP-48P-L121
EIAJ CODE	LQFP048P-0707-AX
JEDEC CODE	_____

PACKAGE STRUCTURE

PACKAGE MATERIAL	EPOXY RESIN
LEAD TREATMENT	SOLDER PLATING
LEAD MATERIAL	42 ALLOY
PACKAGE WEIGHT	0.2