



PRODUCT SPECIFICATION

TFT MODULE

MODEL: LT-028320240-C01N Rev A

CUSTOMER APPROVAL	
SIGNATURE	DATE

PREPARED	CHECKED	APPROVED

RECORDS OF REVISION

Date	Rev.	Description	Note	Page
2015-09-02	A	Preliminary		

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Note : For detailed information please refer to IC datasheet : Sitronix—ST7789S.

1. SPECIFICATIONS

1.1 Features

Item	Standard Value
Display Type	240*(R,G,B)*320 Dots
LCD Type	Color TFT , Transmissive ,Positive
Screen Size(inch)	2.8(Diagonal)
Viewing Direction	12 O'clock
Backlight	White LED B/L
Weight	25.5g
Interface	16 bits 8080 system parallel interface
Other(controller/driver IC)	Sitronix __ST7789S

1.2 Mechanical Specifications

Item	Standard Value	Unit
Outline Dimension	50.0 (W) * 69.2 (H) *4.25(H)(MAX)	mm
Viewing Area	43.8(W)*58.20(H)	mm
LCD Active Area	43.2 (W) * 57.6 (H)	mm
TP Active Area	44.2(W)*58.6*H)	mm
Dots Pitch	0.18 (W)*0.18(H)	mm

Note : For detailed information please refer to LCM drawing

1.3 Absolute Maximum Ratings

Item	Symbol	Condition	Min.	Max.	Unit
Power Supply Voltage	V _{DD}	-	-0.3	4.6	V
Operating Temperature	T _{OP}		-20	70	°C
Storage Temperature	T _{ST}		-30	80	°C
Storage Humidity	H _D	-	20	90	%RH

1.4 DC Electrical Characteristics

Ta = 25°C

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Logic Supply Voltage	V _{DD}	-	2.4	3.3	3.5	V
LCM Driver voltage	VCC		-	3.3V	-	
“H” Input Voltage	V _{IH}	-	0.7 V _{DD}	-	V _{DD}	V
“L” Input Voltage	V _{IL}	-	V _{SS}	-	0.3 V _{DD}	V
“H” Output Voltage	V _{OH}	-	0.8 V _{DD}	-	V _{DD}	V
“L” Output Voltage	V _{OL}	-	V _{SS}	-	0.2 V _{DD}	V
Supply Current	I _{DD}	V _{DD} = 3.3V, Pattern=Black	-	6	9	mA
Power Consumption (panel+LSI)	Black mode	V _{DD} = 3.3V	-	19.8	29.7	mW

1.5 Optical Characteristics

Ta = 25°C

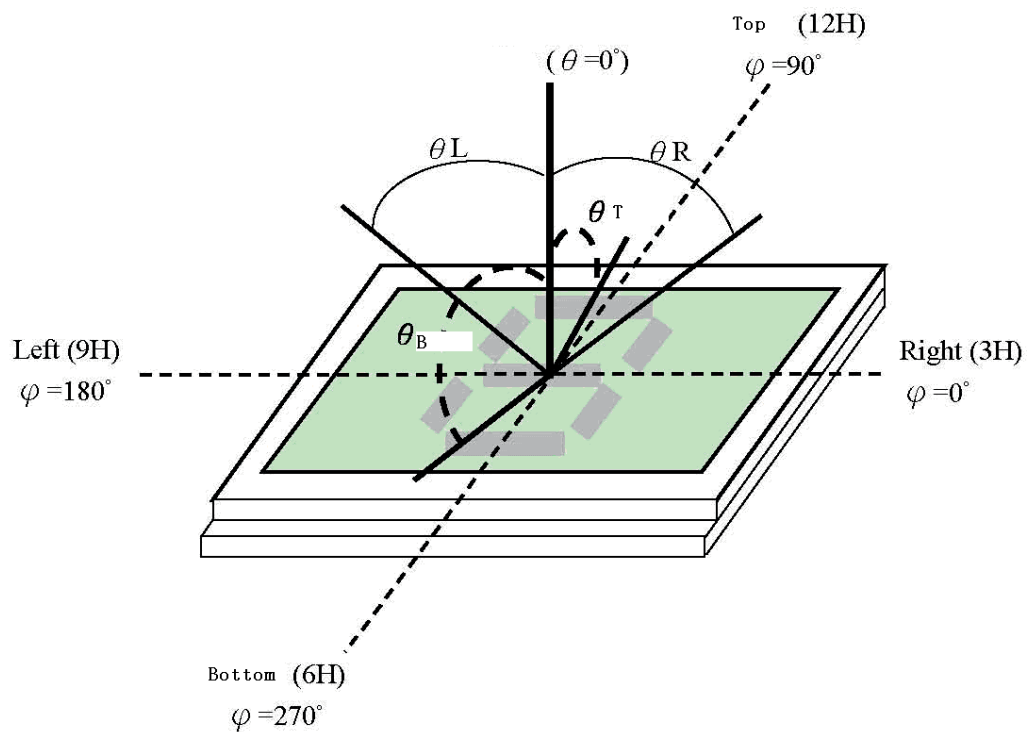
Item		Symbol	Conditions	Min.	Typ.	Max.	Reference
View Angle	TOP	$\Theta y+$	$CR_{\geq 10}$	55	65°	-	Notes 1 & 2
	BOTTOM	$\Theta y-$		50	55°	-	
	LEFT	$\Theta x+$		55	65°	-	
	RIGHT	$\Theta x-$		55	65°	-	
CIE *1	WHITE	X	$TA=25^{\circ}$ $\Theta x, \Theta Y=0^{\circ}$	0.237	0.257	0.323	
		Y		0.273	0.299	0.345	
	RED	X		0.580	0.626	0.646	
		Y		0.333	0.354	0.379	
	GREEN	X		0.257	0.277	0.357	
		Y		0.559	0.589	0.619	
	BLUE	X		0.122	0.142	0.162	
		Y		0.05	0.08	0.142	
Contrast Ratio		C	$\theta Y = 5^{\circ}, \varnothing = 0^{\circ}$	400	500	-	Note 3
Response Time(rise)		tr	$\theta = 5^{\circ}, \varnothing = 0^{\circ}$	-	4ms	8 ms	Note 2
Response Time(fall)		tf	$\theta = 5^{\circ}, \varnothing = 0^{\circ}$	-	12ms	24 ms	Note 2

*1: This value will be changed while mass product.

Note 1.

Optical characteristics-2

Viewing angle

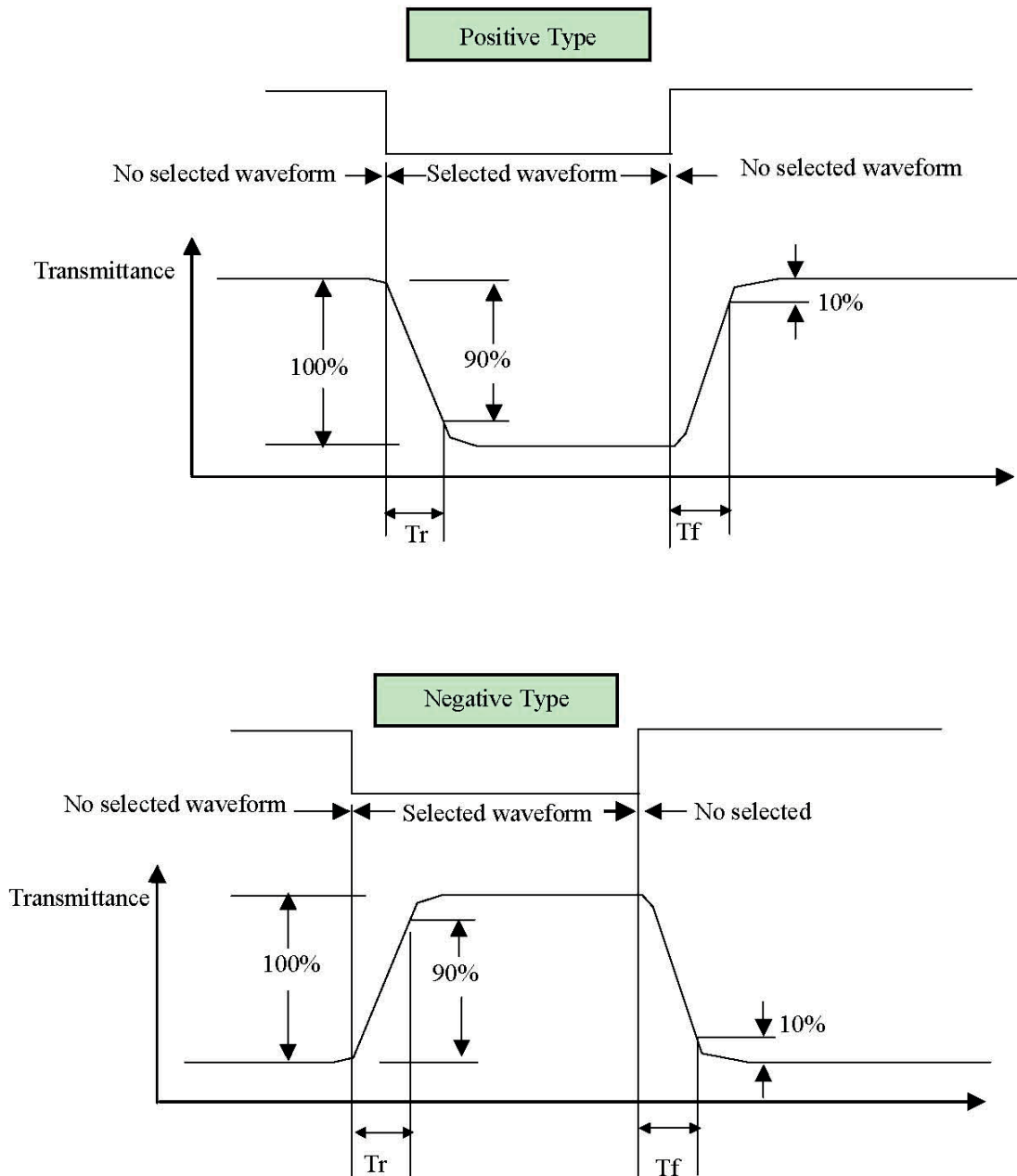


Viewing angle

Note 2.

Optical characteristics-3

Fig.2 Definition of response time



Electrical characteristics-2

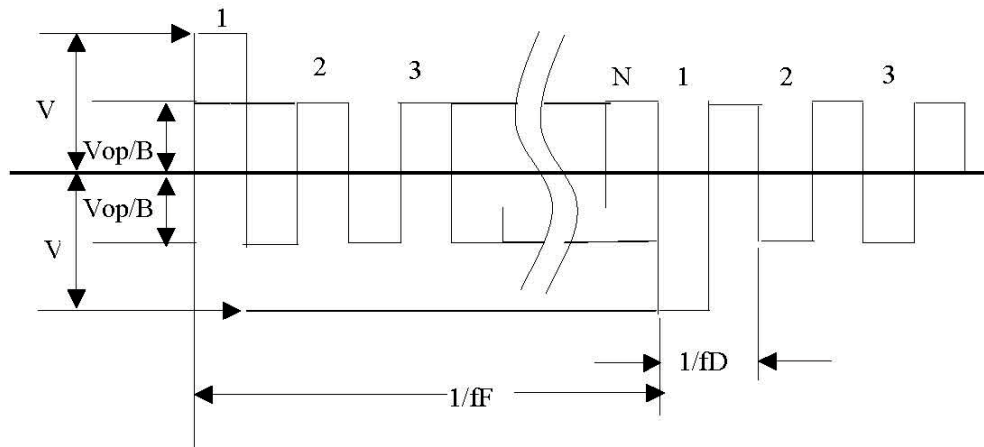
※2 Drive waveform

Vop: Drive voltage fF: Frame frequency

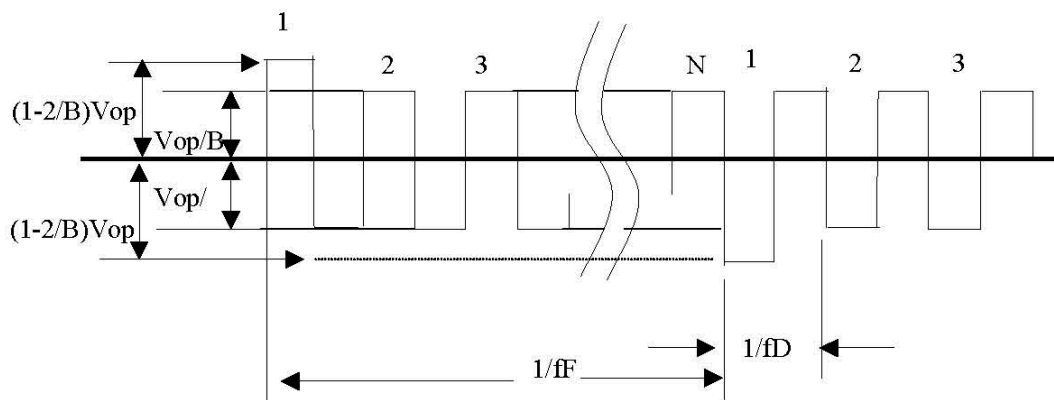
1/B: Bias fD: Drive frequency

N: Duty

(1) Selected waveform



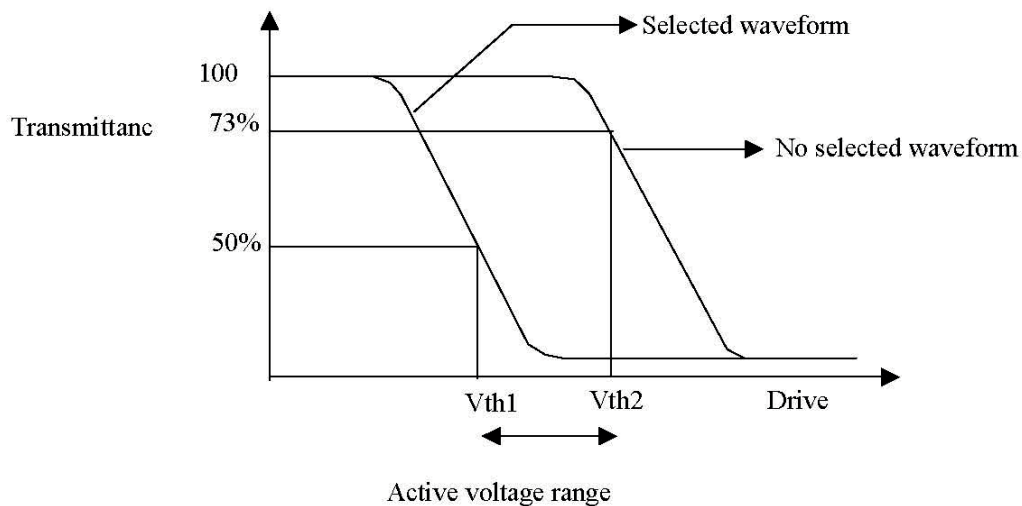
(2) Non- Selected wave form



Note:

Frame frequency is defined as follows: Common side supply
voltage peak - to - peak / 2 = 1 period

Note 3. : Definition of Vth

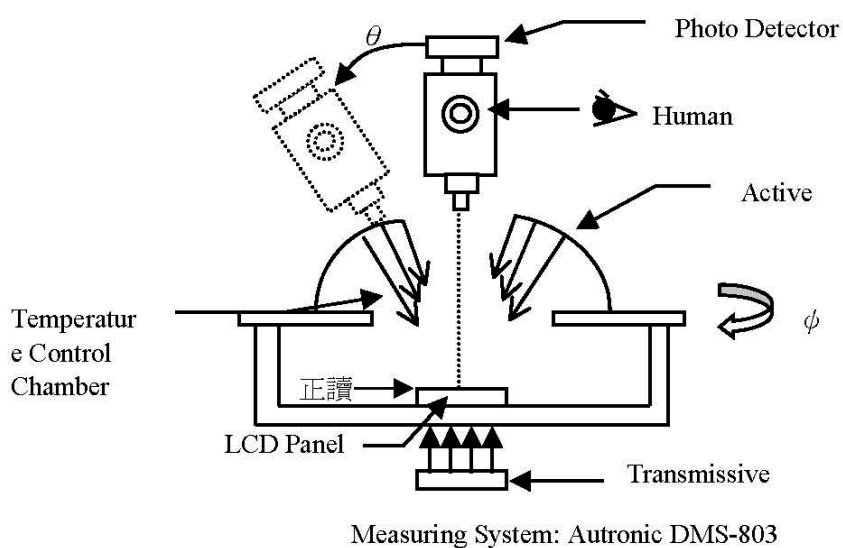


	Vth1	Vth2
View direction	10°	40°
Drive waveform	(Selected waveform)	(No selected waveform)
Transmittance	50%	73%

※1 Contrast ratio

= (Brightness in OFF state) / (Brightness in ON state)

Outline of Electro-Optical Characteristics Measuring System

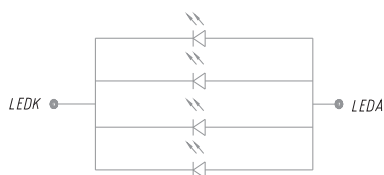


1.6 Backlight Characteristics

LED Backlight

Maximum Ratings

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Forward Current	I_F	$T_a = 25^\circ\text{C}$	--	--	100	mA
Power Dissipation	P_d	$T_a = 25^\circ\text{C}$	--	--	360	mW
Forward Voltage	V_F	$I_F = 80\text{ mA}$	3.0	3.1	3.6	V
Reverse voltage	V_R				5	V
Average Brightness (without LCD & TP)	I_V	$I_F = 80\text{ mA}$	4500	5500		cd/m^2
Operating Temperature	T_{OP}	-	-20	--	70	$^\circ\text{C}$
Storage Temperature	T_{ST}	-	-30	--	80	$^\circ\text{C}$



LCD Module Electrical / Optical Characteristics

Ta =25°C						
Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Average Brightness (with LCD)	I _V	I _F =80 mA	180	200	--	cd/m ²
Uniformity (Without LCD)	U	I _F =80 mA	70	--	--	%
CIE Color Coordinate (Without LCD)	X	I _F =80 mA	0.247	0.257	0.33	-
	Y		0.260	0.28	0.33	
Color	White					

1.7 Touch Characteristics

Item	Specification
Touch Panel	4-wire resister
Input Method	Finger
ITO Glass	400+/-100 Ω Glass
ITO Film	270+/-70 Ω Clear Hard-Coating
ITO Film part number	V270L
Operating Temp range	-20°C~70°C, 10~85%RH
Storage Temp. range	-30°C~80°C, 10~90%RH
Surface Hardness	3H
Hitting Durability	1,000,000 time (R8.0mm, 60°C, 120gf)
Pen Sliding Durability	100,000 times (R0.8mm, 120gf)
Insulation Impedance	DC25V, 20M Ω
Light Transparency	80% min.
Linearity	$\leq 1.5\%$
Linearity Force	80g Max
Activation Force	50gf Max
Bouncing	$\leq 15\text{ms}$
Impact Resistance	X Direction: 200 Ω ~600 Ω
	Y Direction: 250 Ω ~900 Ω

Flexible pattern heat seal peeling strength	500gf/cm(peeling upward by 90 deg)
Flexible pattern bending Resistance	Bending 3 times by bending radius R1.0 mm
Flexible pattern insert/pull out Resistance	1 times at least
Vibration Resistance	15~55HZ for 30 min. each in the directions of X,Y,Z.
Package drop	No damage to the product(1corner,2ridges,4 surfaces, drop from 50cm height)

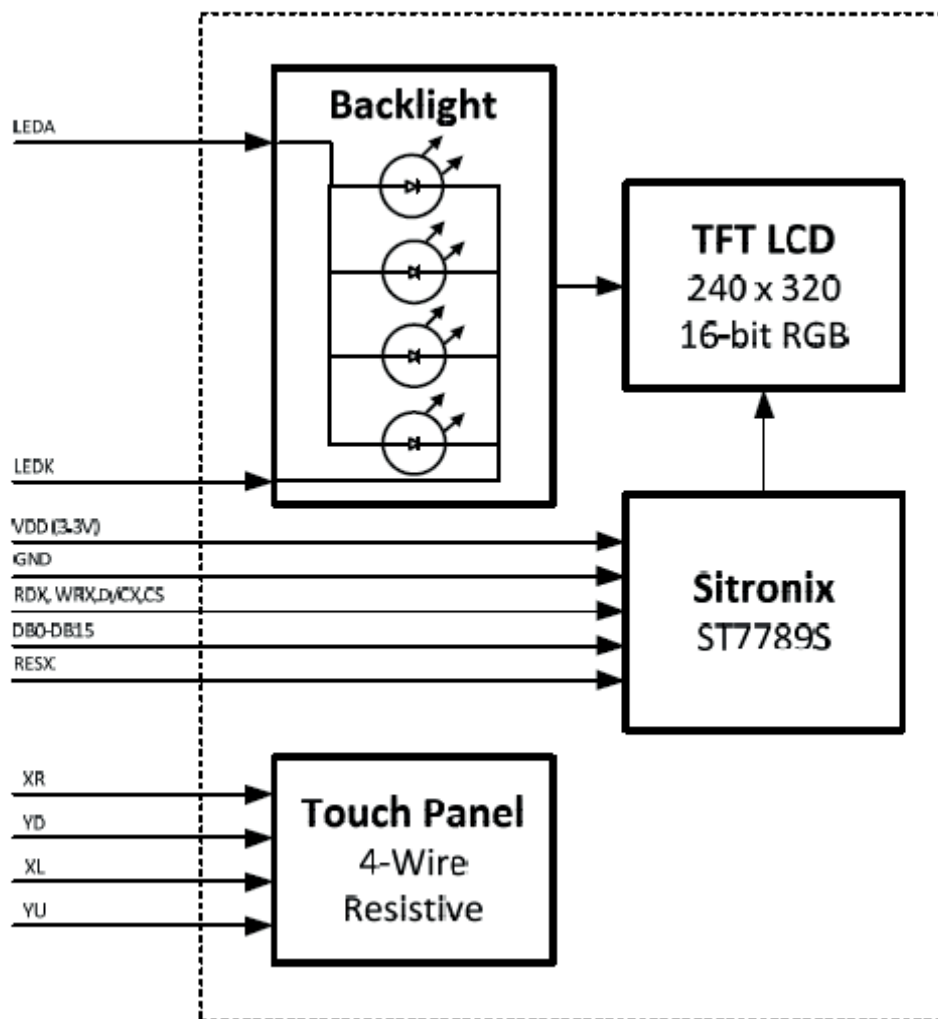
2. MODULE STRUCTURE

2.1 Counter Drawing

2.1.1 LCM Mechanical Diagram

* See Appendix

2.1.2 Block Diagram



2.2 Interface Pin Description

Pin No.	Symbol	Function
1	LEDK	LED Backlight cathode
2	LEDA	LED Backlight anode
3	VSS	Display Module Ground
4	RESX	Active Low Signal to Reset TFT Driver
5	D15	8080 16-bit Parallel Interface : Data Pin
6	D14	8080 16-bit Parallel Interface : Data Pin
7	D13	8080 16-bit Parallel Interface : Data Pin
8	D12	8080 16-bit Parallel Interface : Data Pin
9	D11	8080 16-bit Parallel Interface : Data Pin
10	D10	8080 16-bit Parallel Interface : Data Pin
11	D9	8080 16-bit Parallel Interface : Data Pin
12	D8	8080 16-bit Parallel Interface : Data Pin
13	D7	8080 16-bit Parallel Interface : Data Pin
14	D6	8080 16-bit Parallel Interface : Data Pin
15	D5	8080 16-bit Parallel Interface : Data Pin
16	D4	8080 16-bit Parallel Interface : Data Pin
17	D3	8080 16-bit Parallel Interface : Data Pin
18	D2	8080 16-bit Parallel Interface : Data Pin
19	D1	8080 16-bit Parallel Interface : Data Pin
20	D0	8080 16-bit Parallel Interface : Data Pin
21	RDX	8080 16-bit Parallel Interface : Read Enable Pin
22	WRX	8080 16-bit Parallel Interface : Write Enable Pin
23	D/CX	8080 16-bit Parallel Interface : Data/Command Selection 0=Command, 1=Data
24	CS	8080 16-bit Parallel Interface : Chip selection
25	XR	Touch Panel: X Right Side
26	YD	Touch Panel: Y Down Side
27	XL	Touch Panel: X Left Side
28	YU	Touch Panel: Y Up Side
29	GND	Display Module Ground
30	3.3V	Display Module Power

2.3 Timing Characteristics

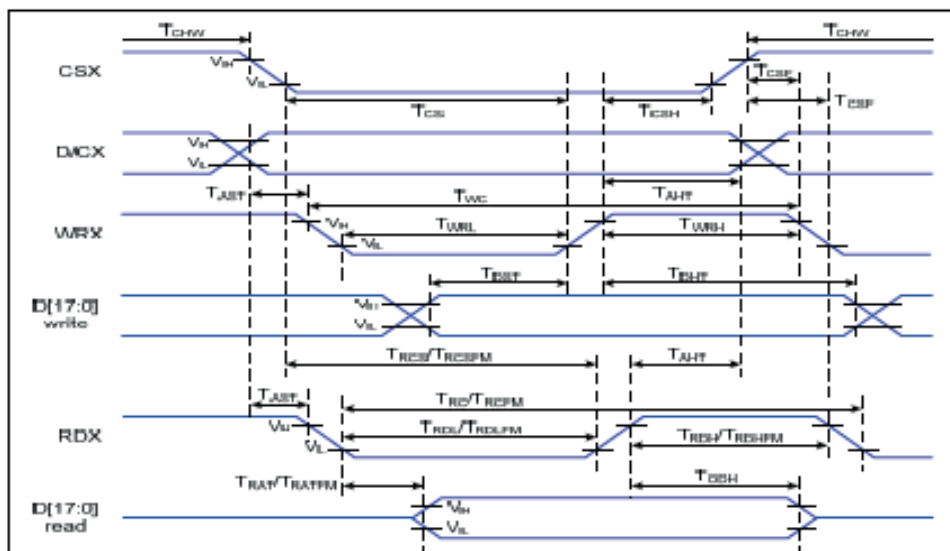


Figure 1 Parallel Interface Timing Characteristics (8080-Series MCU Interface)

VDDI=1.65 to 3.3V, VDD=2.4 to 3.3V, AGND=DGND=0V, Ta= -30 to 70 °C

Signal	Symbol	Parameter	Min	Max	Unit	Description
D/CX	T _{AST}	Address setup time	0		ns	-
	T _{AHT}	Address hold time (Write/Read)	10		ns	
CSX	T _{CHW}	Chip select "H" pulse width	0		ns	-
	T _{CS}	Chip select setup time (Write)	15		ns	
	T _{RCs}	Chip select setup time (Read ID)	45		ns	
	T _{RCsFM}	Chip select setup time (Read FM)	355		ns	
	T _{CSF}	Chip select wait time (Write/Read)	10		ns	
	T _{CSH}	Chip select hold time	10		ns	
WRX	T _{WC}	Write cycle	86		ns	-
	T _{WRH}	Control pulse "H" duration	15		ns	
	T _{WRL}	Control pulse "L" duration	15		ns	
RDX (ID)	T _{RC}	Read cycle (ID)	160		ns	When read ID data
	T _{RDH}	Control pulse "H" duration (ID)	90		ns	
	T _{RDL}	Control pulse "L" duration (ID)	45		ns	
RDX (FM)	T _{RCFM}	Read cycle (FM)	450		ns	When read from frame memory
	T _{RDHF}	Control pulse "H" duration (FM)	90		ns	
	T _{RDLF}	Control pulse "L" duration (FM)	355		ns	
D[17:0]	T _{DST}	Data setup time	10		ns	For CL=30pF

T_{DHT}	Data hold time	10		ns
T_{RAT}	Read access time (ID)		40	ns
T_{RATFM}	Read access time (FM)		340	ns
T_{ODH}	Output disable time	20	80	ns

Table 4 8080 Parallel Interface Characteristics

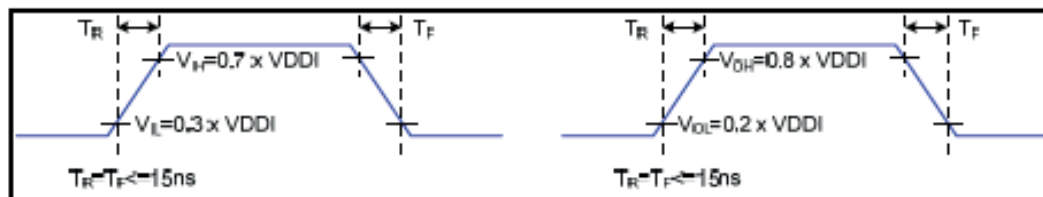


Figure 2 Rising and Falling Timing for I/O Signal

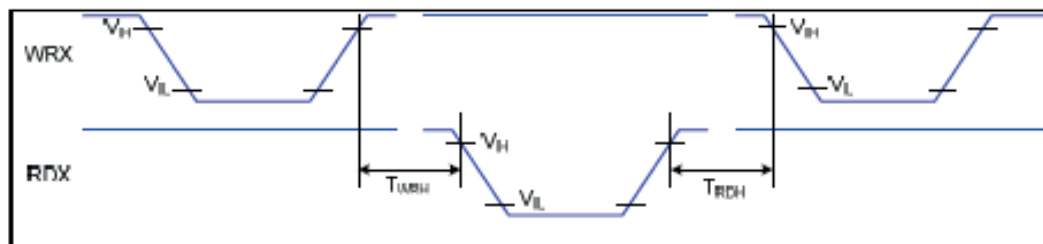


Figure 3 Write-to-Read and Read-to-Write Timing

Note: The rising time and falling time (T_R , T_F) of input signal and fall time are specified at 15 ns or less. Logic high and low levels are specified as 30% and 70% of VDDI for input signals.

2.4 Display Command

Instruction	D/CX	WRX	RDX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	Hex	Function
NOP	0	↑	1	-	0	0	0	0	0	0	0	0	(00h)	No operation
SWRESET	0	↑	1	-	0	0	0	0	0	0	0	1	(01h)	Software reset
RDOID	0	↑	1	-	0	0	0	0	0	1	0	0	(04h)	Read display ID
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	ID17	ID16	ID15	ID14	ID13	ID12	ID11	ID10		ID1 read
	1	1	↑	-	ID27	ID26	ID25	ID24	ID23	ID22	ID21	ID20		ID2 read
	1	1	↑	-	ID37	ID36	ID35	ID34	ID33	ID32	ID31	ID30		ID3 read
RDOST	0	↑	1	-	0	0	0	0	1	0	0	1	(09h)	Read display status
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	BSTON	MY	MX	MV	ML	RGB	MH	ST24		-
	1	1	↑	-	ST23	IFPF2	IFPF1	IFPF0	IDMON	PTLON	SLOUT	NORON		-
	1	1	↑	-	ST15	ST14	INVON	ST12	ST11	DISON	TEON	GCS2		-
	1	1	↑	-	GCS1	GCS0	TEM	ST4	ST3	ST2	ST1	ST0		-
ROOPM	0	↑	1	-	0	0	0	0	1	0	1	0	(0Ah)	Read display power
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	BSTON	IDMON	PTLON	SLPOUT	NORON	DISON	0	0		
RDO MADCTL	0	↑	1	-	0	0	0	0	1	0	1	1	(0Bh)	Read display
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	MY	MX	MV	ML	RGB	MH	0	0		-
RDO COLMOD	0	↑	1	-	0	0	0	0	1	1	0	0	(0Ch)	Read display pixel
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	0	D6	D5	D4	0	D2	D1	D0		-
RDOIM	0	↑	1	-	0	0	0	0	1	1	0	1	(0Dh)	Read display image
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	VSSON	0	INVON	0	0	GCS2	GCS1	GCS0		-
ROOSM	0	↑	1	-	0	0	0	0	1	1	1	0	(0Eh)	Read display signal
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read

Instruction	D/CX	WRX	RDX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	Hex	Function
	1	1	↑	-	TEON	TEM	0	0	0	0	0	0		-
ROOSDR	0	↑	1	-	0	0	0	0	1	1	1	1	(0Fh)	Read display self-diagnostic result
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	D7	D6	0	0	0	0	0	0		-
SLPIN	0	↑	1	-	0	0	0	1	0	0	0	0	(10h)	Sleep in
SLPOUT	0	↑	1	-	0	0	0	1	0	0	0	1	(11h)	Sleep out
PTLON	0	↑	1	-	0	0	0	1	0	0	1	0	(12h)	Partial mode on
NORON	0	↑	1	-	0	0	0	1	0	0	1	1	(13h)	Partial off (Normal)
INVOFF	0	↑	1	-	0	0	1	0	0	0	0	0	(20h)	Display Inversion off
INVON	0	↑	1	-	0	0	1	0	0	0	0	1	(21h)	Display Inversion on
GAMSET	0	↑	1	-	0	0	1	0	0	0	0	1	(26h)	Display Inversion
	1	↑	1	-	0	0	0	0	GC3	GC2	GC1	GC0		on
DISPOFF	0	↑	1	-	0	0	1	0	1	0	0	0	(28h)	Display off
DISPON	0	↑	1	-	0	0	1	0	1	0	0	1	(29h)	Display on
CASET	0	↑	1	-	0	0	1	0	1	0	1	0	(2Ah)	Column address set
	1	↑	1	-	XS15	XS14	XS13	XS12	XS11	XS10	XS9	XS8		X address start:
	1	↑	1		XS7	XS6	XS5	XS4	XS3	XS2	XS1	XS0		$0 \leq XS \leq X$
	1	↑	1		XE15	XE14	XE13	XE12	XE11	XE10	XE9	XE8		X address start:
	1	↑	1		XE7	XE6	XE5	XE4	XE3	XE2	XE1	XE0		$8 \leq XE \leq X$
RASET	0	↑	1	-	0	0	1	0	1	0	1	1	(2Bh)	Row address set
	1	↑	1	-	YS15	YS14	YS13	YS12	YS11	YS10	YS9	YS8		Y address start:
	1	↑	1		YS7	YS6	YS5	YS4	YS3	YS2	YS1	YS0		$0 \leq YS \leq Y$
	1	↑	1		YE15	YE14	YE13	YE12	YE11	YE10	YE9	YE8		Y address start:
	1	↑	1		YE7	YE6	YE5	YE4	YE3	YE2	YE1	YE0		$8 \leq YE \leq Y$
RAMWR	0	↑	1	-	0	0	1	0	1	1	0	0	(2Ch)	Memory write
	1	↑	1	D1[17:8]	D1[7]	D1[6]	D1[5]	D1[4]	D1[3]	D1[2]	D1[1]	D1[0]		Write data
	1	↑	1	Dx[17:8]	Dx[7]	Dx[6]	Dx[5]	Dx[4]	Dx[3]	Dx[2]	Dx[1]	Dx[0]		
	1	↑	1	Dn[17:8]	Dn[7]	Dn[6]	Dn[5]	Dn[4]	Dn[3]	Dn[2]	Dn[1]	Dn[0]		
RAMRD	0	↑	1	-	0	0	1	0	1	1	1	0	(2Eh)	Memory read

Instruction	D/CX	WRX	RDX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	Hex	Function
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	D1[17:8]	D1[7]	D1[6]	D1[5]	D1[4]	D1[3]	D1[2]	D1[1]	D1[0]		Read data
	1	1	↑	Dx[17:8]	Dx[7]	Dx[6]	Dx[5]	Dx[4]	Dx[3]	Dx[2]	Dx[1]	Dx[0]		
	1	1	↑	Dn[17:8]	Dn[7]	Dn[6]	Dn[5]	Dn[4]	Dn[3]	Dn[2]	Dn[1]	Dn[0]		
PTLAR	0	↑	1	-	0	0	1	1	0	0	0	0	(30h)	Partial start/end address set
	1	↑	1	-	PSL15	PSL14	PSL13	PSL12	PSL11	PSL10	PSL9	PSL8		Partial start address: (0, 1, 2, ...P)
	1	↑	1	-	PSL7	PSL6	PSL5	PSL4	PSL3	PSL2	PSL1	PSL0		
	1	↑	1	-	PEL15	PEL14	PEL13	PEL12	PEL11	PEL10	PEL9	PEL8		Partial end address (0, 1, 2, 3, ...P)
VSCRDEF	0	↑	1	-	0	0	1	1	0	0	1	1	(33h)	Vertical scrolling definition
	1	↑	1	-	TFA15	TFA14	TFA13	TFA12	TFA11	TFA10	TFA9	TFA8		
	1	↑	1	-	TFA7	TFA6	TFA5	TFA4	TFA3	TFA2	TFA1	TFA0		
	1	↑	1	-	VSA15	VSA14	VSA13	VSA12	VSA11	VSA10	VSA9	VSA8		
	1	↑	1	-	VSA7	VSA6	VSA5	VSA4	VSA3	VSA2	VSA1	VSA0		
	1	↑	1	-	BFA15	BFA14	BFA13	BFA12	BFA11	BFA10	BFA9	BFA8		
	1	↑	1	-	BFA7	BFA6	BFA5	BFA4	BFA3	BFA2	BFA1	BFA0		
TEOFF	0	↑	1	-	0	0	1	1	0	1	0	0	(34h)	Tearing effect line off
TEON	0	↑	1	-	0	0	1	1	0	1	0	1	(35h)	Tearing effect line on
	1	↑	1	-	-	-	-	-	-	-	-	TEM		
MADCTL	0	↑	1	-	0	0	1	1	0	1	1	0	(36h)	Memory data access control
	1	↑	1	-	MY	MX	MV	ML	RGB	0	0	0		-
VSCRBADD	0	↑	1	-	0	0	1	1	0	1	1	1	(37h)	Vertical scrolling start address
	1	↑	1	-	VSP15	VSP14	VSP13	VSP12	VSP11	VSP10	VSP9	VSP8		
	1	↑	1	-	VSP7	VSP6	VSP5	VSP4	VSP3	VSP2	VSP1	VSP0		
IDMOFF	0	↑	1	-	0	0	1	1	1	0	0	0	(38h)	Idle mode off
IDMON	0	↑	1	-	0	0	1	1	1	0	0	1	(39h)	Idle mode on
COLMOD	0	↑	1	-	0	0	1	1	1	0	1	0	(3Ah)	Interface pixel format

Instruction	D/CX	WRX	RDX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	Hex	Function
	1	↑	1	-	0	D6	D5	D4	0	D2	D1	D0		Interface format
RAMWRC	0	↑	1	-	0	0	1	1	1	1	0	0	(3Ch)	Memory write continue
	1	↑	1	D1[17:8]	D1[7]	D1[6]	D1[5]	D1[4]	D1[3]	D1[2]	D1[1]	D1[0]		Write data
	1	↑	1	Dx[17:8]	Dx[7]	Dx[6]	Dx[5]	Dx[4]	Dx[3]	Dx[2]	Dx[1]	Dx[0]		
	1	↑	1	Dn[17:8]	Dn[7]	Dn[6]	Dn[5]	Dn[4]	Dn[3]	Dn[2]	Dn[1]	Dn[0]		
RAMRDC	0	↑	1	-	0	0	1	1	1	1	1	0	(3Eh)	Memory read continue
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy Read
	1	1	↑	D1[17:8]	D1[7]	D1[6]	D1[5]	D1[4]	D1[3]	D1[2]	D1[1]	D1[0]		
	1	1	↑	Dx[17:8]	Dx[7]	Dx[6]	Dx[5]	Dx[4]	Dx[3]	Dx[2]	Dx[1]	Dx[0]		
	1	1	↑	Dn[17:8]	Dn[7]	Dn[6]	Dn[5]	Dn[4]	Dn[3]	Dn[2]	Dn[1]	Dn[0]		
TESCAN	0	↑	1	-	0	1	0	0	0	1	0	0	(44h)	Set tear scanline
	1	↑	1	-	N15	N14	N13	N12	N11	N10	N9	N8		
	1	↑	1	-	N7	N6	N5	N4	N3	N2	N1	N0		
RDTESCAN	0	↑	1	-	0	1	0	0	0	1	0	1	(45h)	Get scanline
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy Read
	1	1	↑	-	-	-	-	-	-	-	N9	N8		
	1	1	↑	-	N7	N6	N5	N4	N3	N2	N1	N0		
WRDISBV	0	↑	1	-	0	1	0	1	0	0	0	1	(51h)	Write display brightness
	1	↑	1	-	DBV7	DBV6	DBV5	DBV4	DBV3	DBV2	DBV1	DBV0		
RDDBSV	0	↑	1	-	0	1	0	1	0	0	1	0	(52h)	Read display brightness value
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	DBV7	DBV6	DBV5	DBV4	DBV3	DBV2	DBV1	DBV0		
WRCTRLD	0	↑	1	-	0	1	0	1	0	0	1	1	(53h)	Write CTRL display
	1	↑	1	-	0	0	BCTRL	0	DD	BL	0	0		
RDCTRLD	0	↑	1	-	0	1	0	1	0	1	0	0	(54h)	Read CTRL value display
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	0	0	BCTRL	0	DD	BL	0	0		

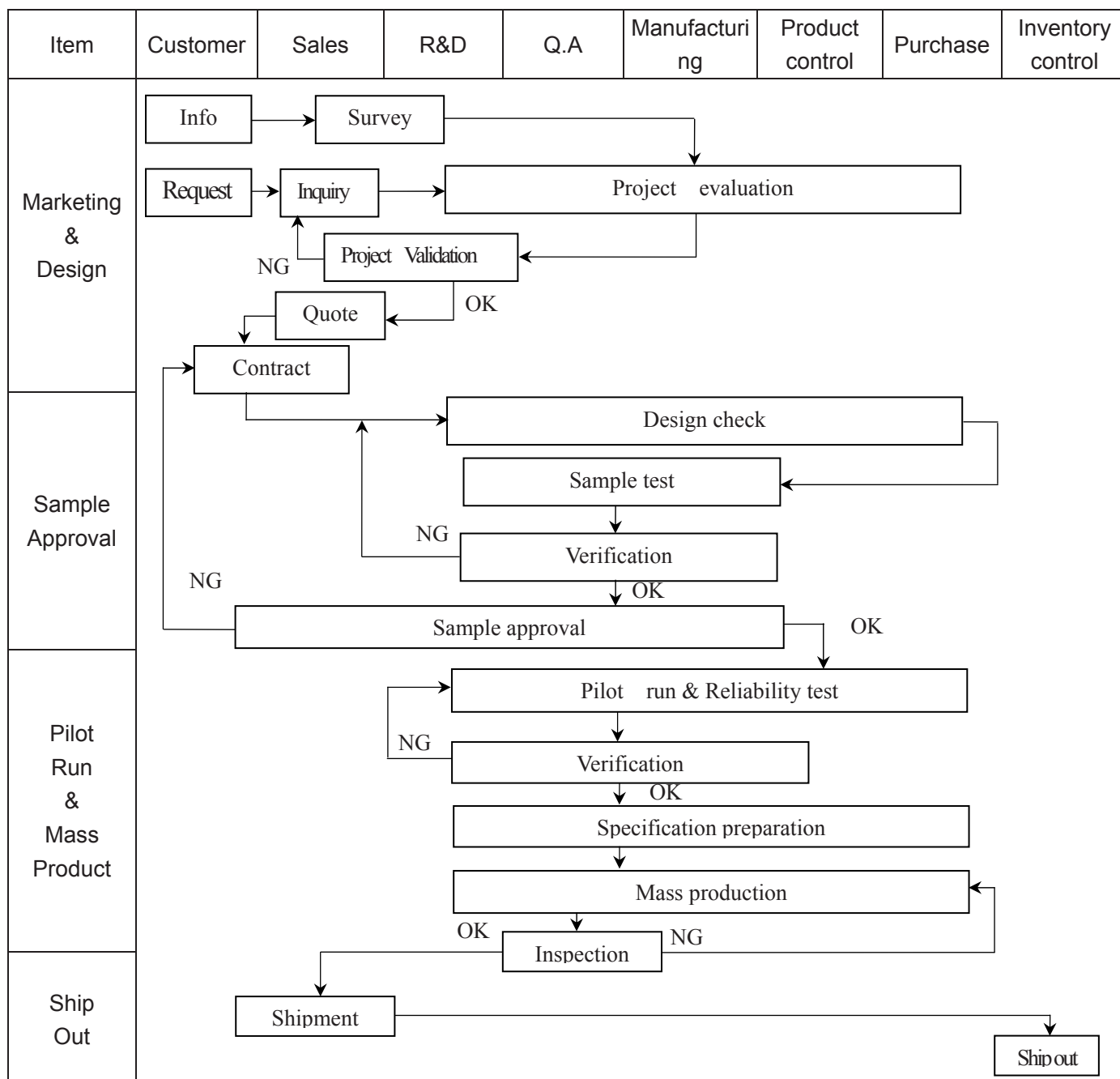
Instruction	D/CX	WRX	RDX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	Hex	Function
WRCACE	0	↑	1	-	0	1	0	1	0	1	0	1	(55h)	Write content adaptive brightness control and Color enhancement
	1	↑	1	-	CECTRL	0	CE1	CE0	0	0	C1	C0		
RDCABC	0	↑	1	-	0	1	0	1	0	1	1	0	(56h)	Read content adaptive brightness control
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	0	CECTRL	0	0	0	0	C1	C0		
WRCABCMB	0	↑	1	-	0	1	0	1	1	1	1	0	(5Eh)	Write CABC minimum brightness
	1	↑	1	-	CMB7	CMB6	CMB5	CMB4	CMB3	CMB2	CMB1	CMB0		
RDCABCMB	0	↑	1	-	0	1	0	1	1	1	1	1	(5Fh)	Read CABC minimum brightness
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	CMB7	CMB6	CMB5	CMB4	CMB3	CMB2	CMB1	CMB0		
RDID1	0	↑	1	-	1	1	0	1	1	0	1	0	(Dah)	Read ID1
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	ID17	ID16	ID15	ID14	ID13	ID12	ID11	ID10		Read parameter
RDID2	0	↑	1	-	1	1	0	1	1	0	1	1	(DBh)	Read ID2
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	ID27	ID26	ID25	ID24	ID23	ID22	ID21	ID20		Read parameter
RDID3	0	↑	1	-	1	1	0	1	1	1	0	0	(DCh)	Read ID3
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑		ID37	ID36	ID35	ID34	ID33	ID32	ID31	ID30		Read parameter

Table 18 System Function Command List

"-": Don't care

3. QUALITY ASSURANCE SYSTEM

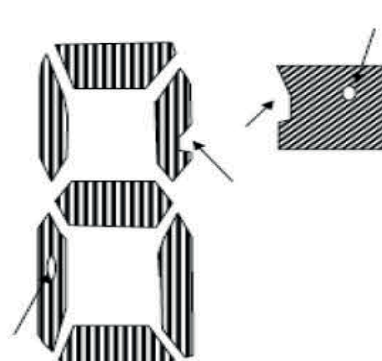
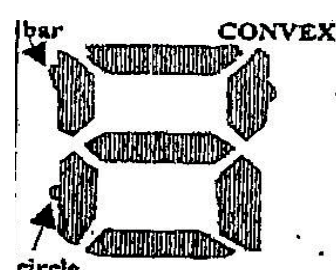
3.1 Quality Assurance Flow Chart

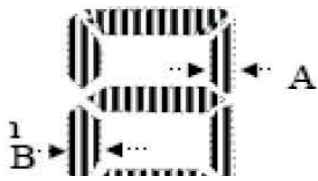
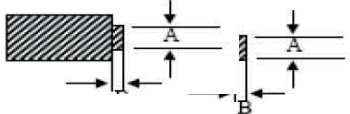
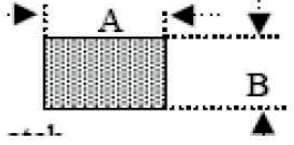


3.2 Inspection Specification

Electrical inspection failure

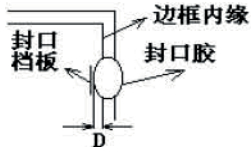
Defect	Define/description	Criteria
1. 开路/不显示（主要） open circuit/no displaying (maj)	线路断开造成缺划或不显 missing or no displaying due to Circuit open	拒收 reject
2. 短路（主要） short circuit (maj)	线路短接 Circuit short	拒收 reject
3. 光暗（主要） Dim (maj)	部分笔划比正常状态明显显示淡 part of figures display dim than normal obviously	拒收 reject
4. 显示淡（主要） all display dim (maj)	比样板明显显示淡 all the figure display dimmer than sample	如有特殊要求参考样板范围 if required strictly, refer to the signed sample limit. 一般情况下， $ V_{th, \text{产品}} - V_{th, \text{样品}} \leq 0.05V$. Normally, $ V_{th, \text{product}} - V_{th, \text{sample}} \leq 0.05V$.
5. 鬼影（主要） ghost (maj)	不该显示的部分显示 the figures in Voff state display	如有特殊要求参考样板范围 if required strictly, refer to the signed sample limit. 一般情况下， $ V_{th, \text{产品}} - V_{th, \text{样品}} \leq 0.05V$. Normally, $ V_{th, \text{product}} - V_{th, \text{sample}} \leq 0.05V$.
6. 大电流（主要） Large current (maj)	功耗大于规范 the current larger than the engineer SPEC.	不允许 Reject
7. 反应慢（主要） Response slow (maj)	响应速度超出规范 The response time is longer than the Spec.	不允许 Reject
8. 视角方向错（主要） Wrong viewing angle (maj)	视角方向与工程规定不一致 Viewing angle different from spec. (Or sample)	不允许 Reject

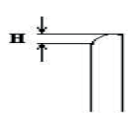
9. 扭字（主要） Twist segment (maj)	个别字体或笔划的视角方向与正常方向不一致。 Some segments displaying with the wrong viewing angle.	不允许 Reject	
10. 化字（主要） Segment pervasion (maj)	字体像浸水似的扩散 The displaying segment pervasion	不允许 Reject	
11. 多余线路（主要） Extra lines (maj)	不该显示的 ITO 走线在通电时显示出了来 Displaying the extra lines than the Spec	不允许 Reject	
12. 针孔、白点（次要） Pinhole、white spots (min)	针孔、图白、图缺 PIN hole、lack  $\psi = (L+W) /$	规格 Specification	允许个数 acceptable number
		$\psi \leq 0.1 \text{ mm}$	无视(不可密集) disregard(no gathering)
		$0.10\text{mm} < \psi \leq 0.2 \text{ mm}$	3
		(两点距离需 $\geq 5 \text{ mm}$) (The distance between two points $\geq 5\text{mm}$)	
		$0.2\text{mm} < \psi \leq 0.25 \text{ mm}$	1
		$\psi > 0.25\text{mm}$	0
		$\psi > 1/3$ 字节宽 $\psi > 1/3$ width of the character	0
		$0.10 \text{ mm} < \psi \leq 0.15\text{mm}$	2
(单片LCD之总个数需 ≤ 3 个, 两点距离 $\geq 5\text{mm}$). total amount on single LCD sheet ≤ 3 , The distance between two points $\geq 5\text{mm}$			
13. 突點:(次要) Bar (min)	 $\phi = (\bar{L}+\bar{W})/2$ $\psi = (L+W) / 2$	规格 Specification	允许个数 acceptable number
		$\psi > 0.25\text{mm}$	0
		$\psi > 1/3$ 字节宽 $\psi > 1/3$ width of the character	0
		接收标准:1个字最多1個, 全部最多3 個 Acceptable case: per character, not more than 1 per cell, not more than 3.	

14. 組合歪 (次要) assembly not match (min)	 $\psi = (L+W)/2$	1. $B-A > 0.25\text{mm}$ 拒收 (reject) 2. $A/B \leq 3/4$ 拒收 (reject)	
15. 点阵针孔\缺口 (次要) Dot Matrix Pin Hole Lack (min)	Dot Matrix: Pin Hole Lack 	规格 Specification	允许个数 Acceptable number
		$\phi \leq 0.1\text{mm}$	Disregard
		$0.1\text{mm} < \phi \leq 0.2\text{mm}$ (Distance between two points $\geq 10\text{mm}$)	3
		$0.2\text{mm} < \phi \leq 0.25\text{mm}$	1
		$\phi > 0.25\text{mm}$	0
16. 图凸 (次要) Convex (min)		1. $A > 0.25\text{mm}$ 2. $B > 0.05\text{mm}$	拒收 Reject
17. 点距阵组合歪(次要) assembly not match(min)	assembly not match(dot-matrix) 	1. A 变形: $ A - \text{规格值} / \text{规格值} \leq 15\%$ Distortion of A: $ A - \text{define} / \text{define} \leq 15\%$ 2. B 变形: $ B - \text{规格值} / \text{规格值} \leq 15\%$: Distortion of B : $ B - \text{define} / \text{define} \leq 15\%$	允许 Accept
18. 显示黑点(斑) (次要) Black spot (min)	显示时出现点状或斑状更黑的部位 Black spots in displaying	正常显示时对比不明显, 接收。明显时按点状缺陷看 if not clear in normal state of working, regardless. If defect clear, according to item of black/white spot.	

Appearance inspection

不良项目	内容或图示	判定标准
1. 漏液(主要) Leakage (maj)	盒内液晶漏出 LC in the cell leaks out.	不允许 Reject

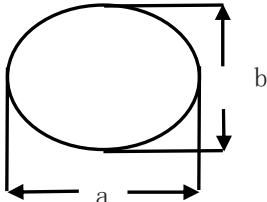
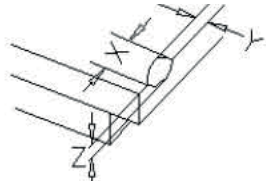
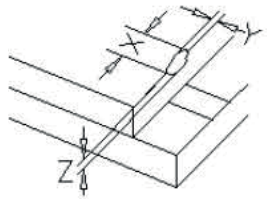
2. 玻璃裂痕(主要) Cracks (maj)	玻璃破裂 ITO glass crack	不允许 Reject
3. 排列不良 Misalignment	LC 排列不良, 在不通电下颜色与正常不一致。 Different color from normal due to misalignment	点状或线状的参照点状或线状不良标准 Refer to the standard of spots and lines.
4. 封口宽、高(次要) End sealant over height, over width (min)		超出在产品资料规定尺寸范围, 不允许; According to engineering spec.
5. 封口胶 (次要) Permeating resin (min)		有封口挡板: 超出封口挡板不允许; Baffle: not overstep baffle 无封口挡板: 不允许超出 C 区; No baffle: The resin exceed the C zone, reject.
6. 边框肥大/偏细 (次要) seal line larger/smaller (min)	边框胶的宽度比规定粗或细 The width of the seal larger or smaller than the define.	1. 参照规范。Refer to the Spec. 2. 一般情况: A: 实测值 the measurement value B: 规范值 (样品值) Spec. (or Value of sample) $ A-B /B \leq 1/3$
7. 彩虹 (次要) Rainbow (min)	同一个 LCD 有两种或以上的颜色 Different color in one panel	在规定的视角范围内观察明显, 拒收; In the viewing angle, if the rainbow is obvious, reject. 对客户有特殊要求, 以双方确认的样板为准; If required strictly, sign and refer to the limited samples.
8. ITO 底影 (次要) ITO lines appear	不通电时能清楚地看到 ITO 图形或走线 Design shows without voltage input	拒收 Reject (if required strictly, sign and refer to the limited samples.)
9. 磨角 (次要) Cutting defect (min)		1. 尺寸不能超出产品设计值 2. 不能损伤胶边 3. 玻璃崩裂参考相关规定 1. Dimension refers to engineering

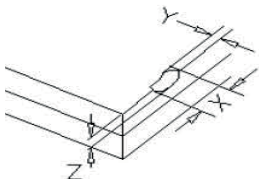
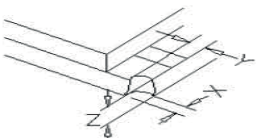
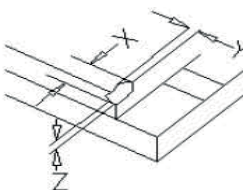
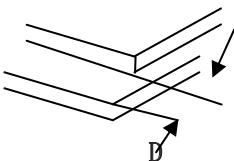
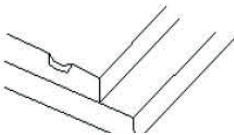
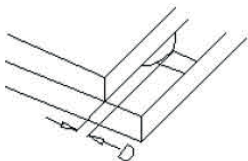
		spec. 2. Not allowed to damage the Epoxy. 3. Glass damage refers the related spec.
10. 磨边 (次要) Grind off edge defect (min)		磨损高度 $H \leq 0.10 \text{ mm}$; 具体要求的见限度样板 The damaged height: $H \leq 0.10 \text{ mm}$, according to the limited sample
11. 钻孔 (次要) Drilling (min)		1. 孔径和位置参照设计规范。 Diameter and position according to engineering spec. 2. 崩裂玻璃: 不允许损伤胶边 Not allow damaging Epoxy, and referring to related Spec.
12. 玻璃边麻点 (次要) Dirty spot of ITO glass (min)		边框以外的麻点不计边框以内的麻点按 03 项黑/白 要求判定 A: outside seal expose, disregard B: inside seal epoxy, according to black spot
13. 油墨丝印 Back print (min)	丝印断线、针孔, 凸点, 起毛(次要) Broken line; pinhole; convex; fuzz (min)	A: 丝印断线, 针孔, 凸点按点状, 线状不良标准 B: 丝印毛边 1/4 丝印宽度 A: Broken line; pinhole; convex refer to item of black/white spot or linear B: fuzz of printing over 1/4 spec reject
	丝印缺划, 多印, 印反 (主要) (主要) Some printing missing; extra printing; printing on wrong face; invert printing (maj)	不允许 Reject
	尺寸和位置 (主要) Position and dimension	尺寸超过规定不允许 Refer to the engineer spec
14. 偏光片 Polarizer attaching	偏光片品种贴错 (主要) Wrong polarizer type (maj)	不允许 Reject

	偏光片贴反（主要） Attaching on the wrong face (maj)	不允许 Reject
	偏光片损伤（次要） polarizer damage (min)	不允许穿孔，按点状或线状缺陷 Not allow perforation of polarizer. Refer to the standard of spots and lines
	偏光片贴歪（次要） Polarizer slanting (min)	偏光片须覆盖所有的边框内缘且不能超出玻璃外边。 Polarizer should touch all the inner sealing side and not exceeding outside of the glass.
15. 装 PIN 脚 Pin defect	尺寸和位置 Dimensions	尺寸偏差不超过设计尺寸公差 According to engineering spec
	装 PIN 脚歪斜 Pin tilt	歪斜角度 $> 5^\circ$ 则拒收 Tilt angle $> 5^\circ$ reject
	少（多）脚断脚（主要），则不允许 not allow the more or less number of metal pin	
	UV 胶污染偏光片或渗入偏光片与玻璃之间则不允许 UV glue permeates inside polarizer or polarizer surface is polluted by UV glue reject	
	UV 胶超出上偏光片之高度（次）则拒收； The height of UV glue over the front polarizer. Reject	
	PIN 脚或两脚间无胶不允许； There is no glue on the Pin or between two pins. Reject.	
	装 PIN 脚夹头之间距 Pitch of pins	Standard Accept
	D 标准间距 (spec)	$ D-E < 1/6D$ 无视 disregard
	E 实际间距 (actual)	$1/6D \leq D-E \leq 1/3D$ 2
		$ D-E > 1/3D$ 0
16. 热压斑马纸 Heat seal connector Defect	对位尺寸（次要） Dimension (min)	超出规范 Out of the Spec 拒收 Reject
	斑马纸断裂（主要） Connector broken (maj)	斑马纸断裂造成缺划或光暗 Connector broken cause missing or dim 拒收 Reject

	拉力 (主要) Peel strength (major)	$F \geq 2\text{N/cm}$	接受 Accepted
	碳粉脱落 (主要) Carbon layer fall off	造成开路, 光暗 Cause missing or dim	不允许 Reject
	保护膜贴歪, 贴皱, 气泡 (次要) Protecting film adhering defect, bubble, crumple etc	不影响客户使用或客户特殊要求, 1. Not affect the use of customer. 2. meet the requirement of customer	接受 Accept

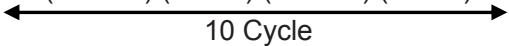
6.4.2 standard for spot、line、cutting breaking defect

不良项目	内容或图示	判定标准				
1. 黑白点（次要） Black/white spots(min)	 $\Phi=(a+b)/2$ 在 10mm 范围内不允许有两个 Not allow 2 defects within 10 mm	Φ (mm)	面积 $\geq 35\text{cm}^2$ $S \geq 35\text{cm}$		普通 normal	
			A 区	B 区	A 区	B 区
		$\Phi \leq 0.10$	不计 disregard	不计 disregard	不计 disregard	不计 disregard
		$0.10 < \Phi \leq 0.15$	不计 disregard	不计 disregard	2	3
		$0.15 < \Phi \leq 0.20$	3	4	1	2
		$0.20 < \Phi \leq 0.30$	2	3	0	1
		$0.30 < \Phi \leq 0.50$	1	2	0	0
		$\Phi > 0.50$	0	0	0	0
2. 玻璃崩边（次要） LCD side damage (min) X: Length Y: Width Z: Depth		$X \leq 2.0\text{mm}$ $Y \leq K1 / 3$ $Z \leq T \quad \text{ACC NO.} \leq 2$ 装管脚的型号: X 的尺寸不计, 缺陷数不计 Products with pins disregard				
		$X \leq 2.0\text{mm}$ $Y \leq \text{边框的外缘}$ Y: not reach the seal line $Z \leq T \quad \text{允许两处}$ ACC NO. ≤ 2				

		$X \leq 2.0\text{mm}$ $Y \leq \text{边框的外缘}$ Y : not reach the seal line $Z \leq T$			
3. 玻璃崩角 Corner damage(min)		X	Y	Z	
		3cm	$\leq K1/3$	$\leq T$	
		X : $\leq 2.0\text{mm}$ 且未崩到银点 X : $\leq 2.0\text{mm}$ and not reach the common point Y : 不允许银点外露 Y : not allow common point appear outside. Z : $\leq T$			
4. 玻璃突出 (次要) Poor cutting		1. $D \leq 0.2\text{mm}$ 且 $D \leq K1/4$ 2. 不允许超出设计尺寸 2. according to engineering diagram			
		不允许超出设计尺寸 According to engineering diagram			
		1. $D \leq 0.25$ 且 $D \leq K1/4$ 2. 不允许超出设计尺寸 2. according to engineering diagram			
5. 线状缺陷 (次要) Linear defect		长 L (mm)	宽 W (mm)	A 区	B 区
		$L \leq 3.0$	$W \leq 0.02$	不计 disregard	不计 disregard
		$L \leq 3.0$	$W \leq 0.03$	2	3
		$L \leq 3.0$	$0.03 < W \leq 0.05$	1	2
		$L \leq 3.0$	$W > 0.05$	0	0

		L>3.0	W≤0.05	0	0
6. 贴片气泡 （次要）	因贴片操作引出的气泡	尺寸		允许个数	
		Φ≤0.3 mm		不计	
		0.3 mm≤Φ≤0.5 mm		1	
		0.5 mm<Φ		0	
		Φ ≤0.3mm 之场合每 cm2 不超过 2 个			
		注 Φ = （长+宽）/2 以上状况于可视区外可忽略不计			

4. RELIABILITY TEST

NO	Item	Test Condition	
1	High Temperature Storage	Storage at $80 \pm 2^{\circ}\text{C}$ 120 hrs Surrounding temperature, then storage at normal condition 4hrs	
2	Low Temperature Storage	Storage at $-30 \pm 2^{\circ}\text{C}$ 120 hrs Surrounding temperature, then storage at normal condition 4hrs	
3	High Temperature Operation	Operation at $70 \pm 2^{\circ}\text{C}$ 120 hrs	
4	Low Temperature Operation	Operation at $-20 \pm 2^{\circ}\text{C}$ 120 hrs	
5	High Temperature /Humidity Storage	1.Storage 120 hrs $60 \pm 2^{\circ}\text{C}$, 90~95%RH surrounding temperature, then storage at normal condition 4hrs. (Excluding the polarizer).or 2.Storage 120 hrs $40 \pm 2^{\circ}\text{C}$, 90~95%RH surrounding temperature, then storage at normal condition 4 hrs.	
6	Temperature Cycling	$-20^{\circ}\text{C} \rightarrow 25^{\circ}\text{C} \rightarrow 70^{\circ}\text{C} \rightarrow 25^{\circ}\text{C}$ (30mins) (5mins) (30mins) (5mins)  10 Cycle	
7	Mechanical Test	Freq.: 10-55Hz Max. Acceleration: 5G X.Y.Z. each direction For 10 mines.	
		Drop them through 50cm height to strike horizontal plane	
8	ESD Test	Air Discharge: Apply 4KV with 5 times Discharge for each polarity +/-	Contact Discharge: Apply 2KV with 5 times Discharge for each polarity +/-
		1. Temperature ambience: $15^{\circ}\text{C} \sim 35^{\circ}\text{C}$ 2. Humidity relative: 30%~60% 3. Energy Storage Capacitance(Cs+Cd): 150pF+/-10% 4. Discharge Resistance(Rd): 330Ω +/-10% 5. Discharge, mode of operation: Single Discharge (time between successive discharges at least 1 sec) (Tolerance if the output voltage indication: +/-5%)	

5. PRECAUTION RELATING PRODUCT HANDLING

5.1 SAFETY

- 5.1.1 If the LCD panel breaks, be careful not to get the liquid crystal to touch your skin.
- 5.1.2 If the liquid crystal touches your skin or clothes, please wash it off immediately by Using soap and water.

5.2 HANDLING

- 5.2.1 Avoid any strong mechanical shock which can break the glass.
- 5.2.2 Avoid static electricity which can damage the CMOS LSI—When working with the Module, be sure to ground your body and any electrical equipment you may be using.
- 5.2.3 Do not remove the panel or frame from the module.
- 5.2.4 The polarizing plate of the display is very fragile. So , please handle it very carefully, do not touch , push or rub the exposed polarizing with anything harder than an HB pencil lead (glass , tweezers , etc.)
- 5.2.5 Do not wipe the polarizing plate with a dry cloth, as it may easily scratch the surface of plate.
- 5.2.6 Do not touch the display area with bare hands , this will stain the display area.
- 5.2.7 Do not use ketonics solvent & aromatic solvent. Use with a soft cloth soaked with a cleaning naphtha solvent.
- 5.2.8 To control temperature and time of soldering is $280 \pm 10^{\circ}\text{C}$ and 3-5 sec.
- 5.2.9 To avoid liquid (include organic solvent) stained on LCM

5.3 STORAGE

- 5.3.1 Store the panel or module in a dark place where the temperature is $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$ And the humidity is below 65% RH.
- 5.3.2 Do not place the module near organics solvents or corrosive gases.
- 5.3.3 Do not crush, shake, or jolt the module.

5.4 TERMS OF WARRANTY

- 5.4.1 Applicable warrant period
The period is within thirteen months since the date of shipping out under normal using and storage conditions.
- 5.4.2 Unaccepted responsibility
This product has been manufactured to your company's specification as a part for use in your company's general electronic products. It is guaranteed to perform according to delivery specifications. For any other use apart from general electronic equipment, we cannot take responsibility if the product is used in nuclear power control equipment, aerospace equipment , fire and security systems or any other applications in which there is a direct risk to human life and where extremely high levels of reliability are required.

