

Product Specification

- ❖ Product Name: AMOLED
- ❖ Model Name: DO0164FMST02
- ❖ Description: 1.64 inch (280 x 456)

Proposed by			Customer's Approval
Designed	Checked	Approved	

Document Revision History

Rev. No.	Date	Contents	Remark
0.0	2024-01-26	-Initial issue	Preliminary
0.1	2024-03-20	-Correction of recommended connector type (in block diagram)	

1.General Description:

- Driving Mode: Active Matrix.
- Color Mode: Full Color (65K/262K/16.7M color)
- Display Format: 1.64" (280 x 456)
- Display Driver IC : ICNA3311(CO5300) or Compatible
- Touch Driver IC : FT3168 or Compatible
- Display Interface: SPI 3-wire/ SPI 4-wire/QSPI/MIPI-DSI 1Lane
- Touch Interface: IIC [Slave Addr A[6:0]---0X38]
- Application: Handheld & PDA
- RoHS Compatible

2.Mechanical Data

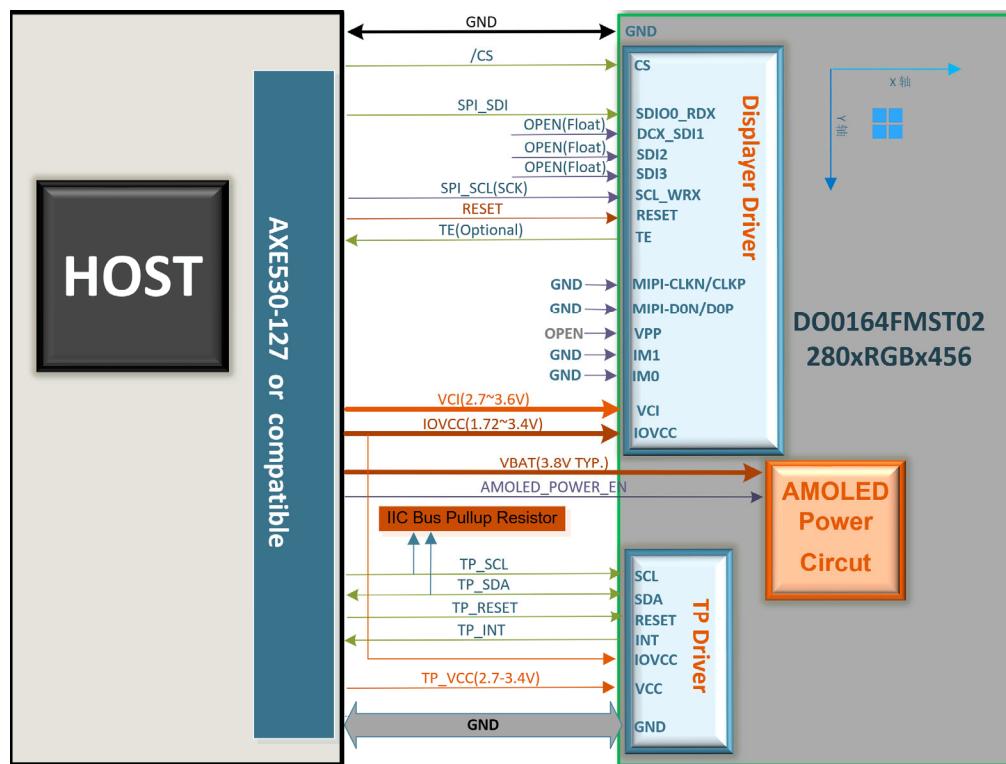
Item	Specification	unit
Display Mode	AMOLED	-
Dimensional outline [Without Cover Lens]	23.74(W) x 38.62(H) x0.8 (T)	mm
Number of dots	280(W) x RGB x 456(H)	dots
Active area	21.84(W) x 35.57(H)	mm
Diagonal Inch	1.64	inch
Pixel pitch	78*78	μm
Weight	TBD	g

*See attached drawing for details.

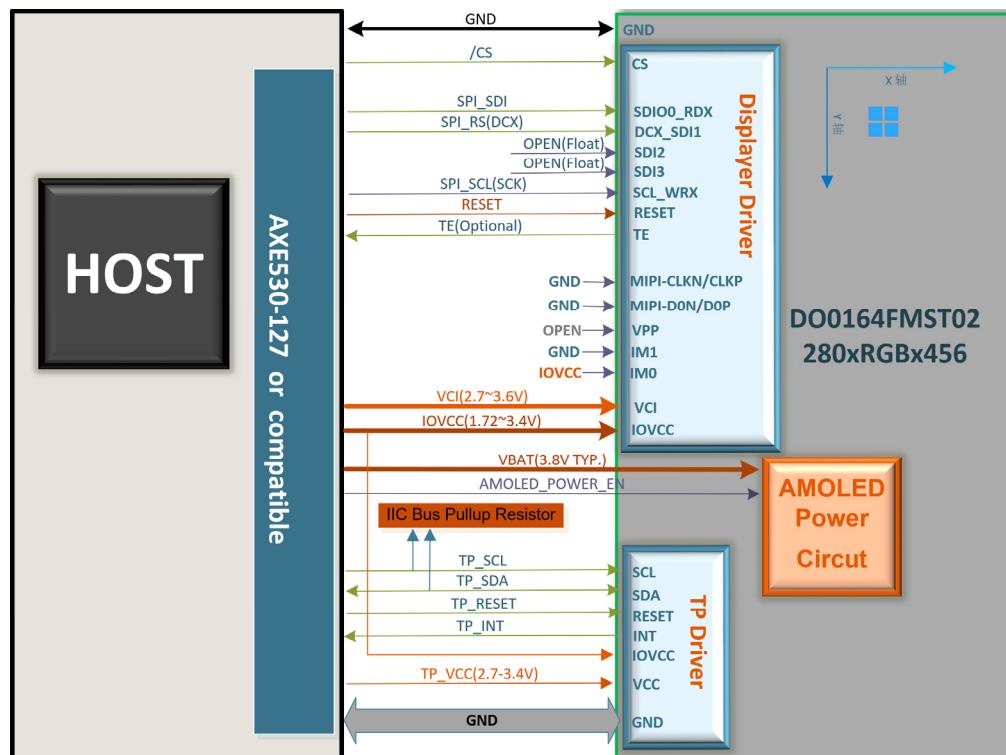
3. Block Diagram

DO0164FMST02 support various interfaces, and interfaces are selected by the IM[1:0] pins.

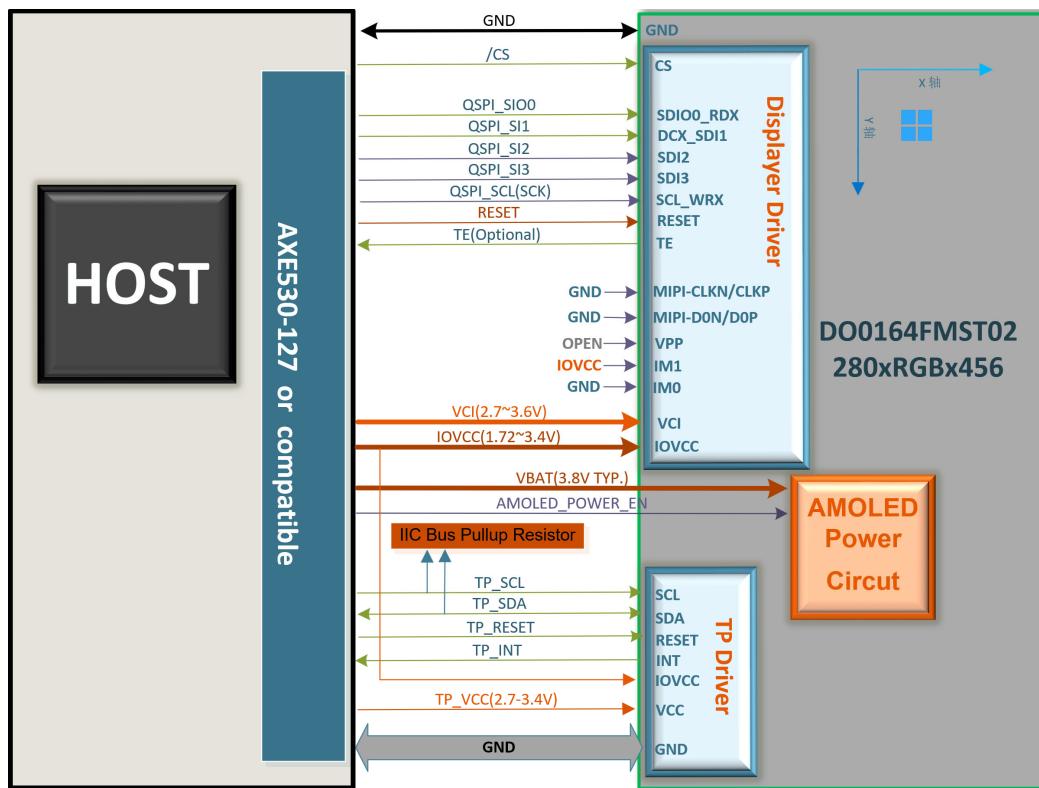
A: If IM1=GND,IM0=GND, DO0164FMST02 set to spi-3wire interface



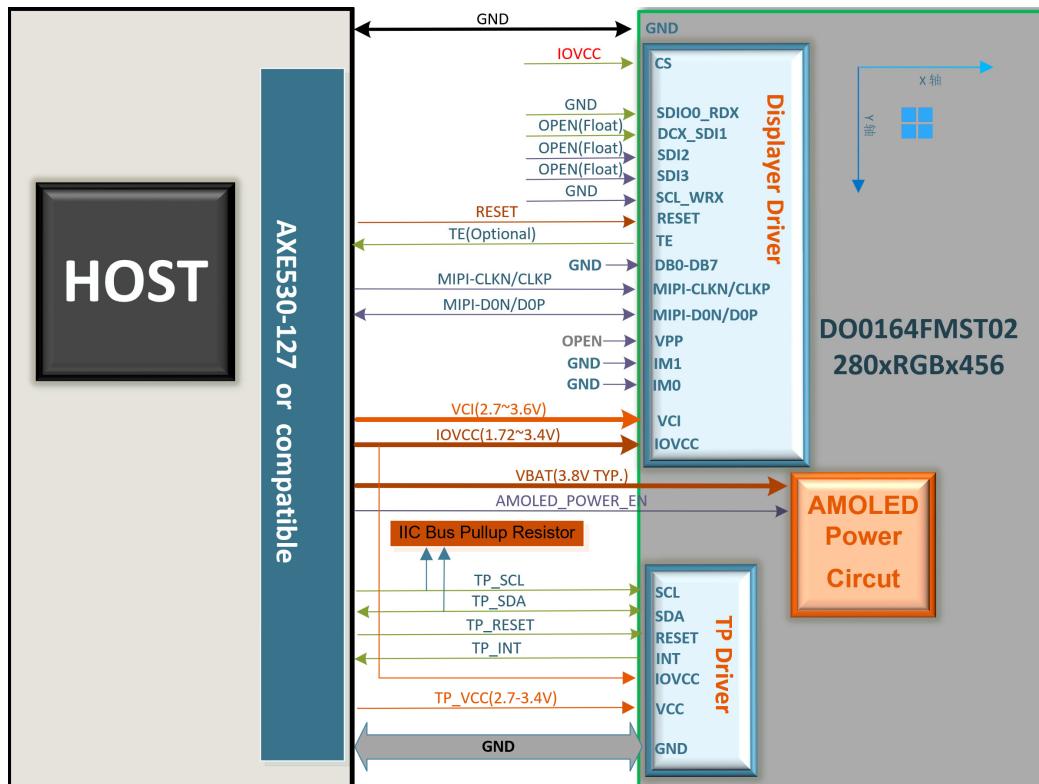
B: If IM1=GND,IM0=IOVCC, DO0164FMST02 set to spi-4wire interface



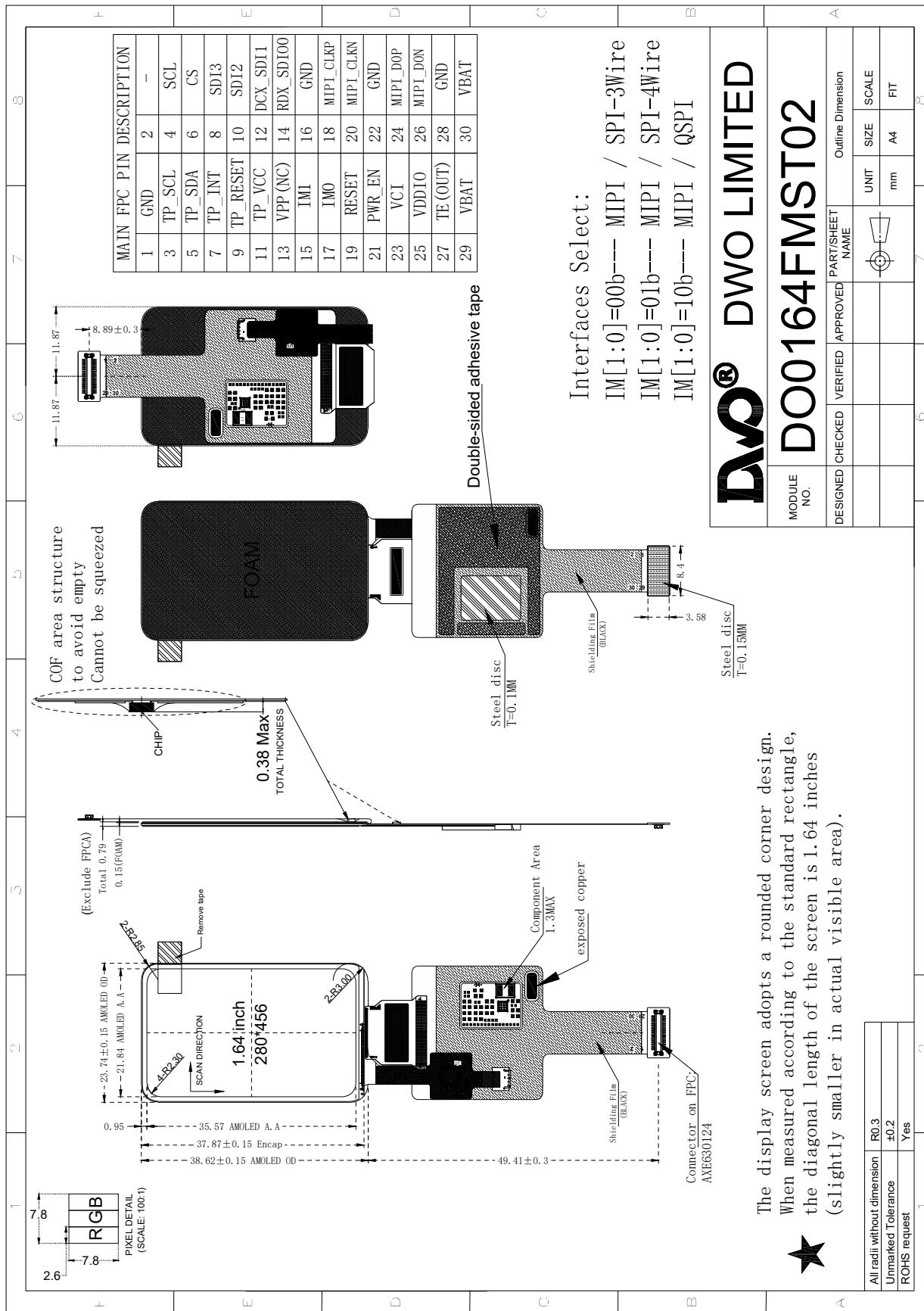
C: If IM1=IOVCC, IM0=GND, DO0164FMST02 set to **QSPI interface**



D: If IM1=GND, IM0=GND, CS=IOVCC, DO0164FMST02 set to **MIPI-DSI interface**



4.Dimension



5.Pin Description

Recomend Connector : AXE530-127.(AXE630124 on AMOLED)

NO.	Pin Name	I/O	Description
1	GND	P	Ground Terminal
3	TP_SCL	I	Touch Panel Clock Input. Communication Voltage follow IOVCC If not used, please open this pin.
5	TP_SDA	I/O	Touch Panel Data Input and output. Communication Voltage follow IOVCC If not used, , please open this pin.
7	TP_INT	O	Touch Panel Interrupt Output. If not used, please open this pin.
9	TP_RESET	I	TP Reset signal Input. Communication Voltage follow IOVCC If not used, , please open this pin.
11	TP_VCC	P	Analog Voltage for TP Driver (2.7~3.4V)
13	VPP(NC)	P	OTP Power Supply(Let it open).
15	IM1	I	Interface type selection
17	IM0	I	Interface type selection
19	RESET	I	AMOLED Reset signal Input
21	PWR_EN	I	Power IC enable control pin.
23	VCI_IN	P	Analog Voltage for Display Driver (2.7~3.6V)
25	VDDIO(IOVCC)	P	Driver IC(Touch + Display) Digital I/O Power Supply(1.72~3.4V)
27	TE	O	Tearing Effect
29	VBAT	P	Battery Voltage 3.8V TYP. (2.9-4.5V)
NO.	Pin Name	I/O	Description
2	-	-	
4	WRX_SCL	I	SCL: A synchronous clock signal in SPI I/F.
6	CS	I	Chip select input pin ("Low" enable) SPI I/F. If not used(MIPI Interface), please connect these pin to IOVCC.
8	SDI3	I	Serial Data Input in QSPI,data Lane 3. If not used, please open this pin.
10	SDI2	I	Serial Data Input in QSPI,data Lane 2. If not used, please open this pin.
12	DCX_SDI1	I/O	Serial Data Input in QSPI,data Lane 2. Serial Data Output in SPI_3Wire/ SPI_4Wire Data Input Signal at Dual Input Mode. Display data / command selection in SPI 4-wire I/F. D/CX = "0" : Command; D/CX = "1" : Display data or Parameter

			If not used, please open this pin.
14	RDX_SDIO0	I/O	Serial Data Input in QSPI,data Lane 0. Serial Data input in SPI_3Wire/ SPI_4Wire Data Input Signal at Dual Input Mode. RDX : Reads strobe signal to write data when RDX is “Low” in 80-series MPU interface. If not used, please connect these pins to GND.
16	GND	P	Ground Terminal
18	MIPI_CLKP	I	Differential clock signals if MIPI interface. If not used, please connect these pins to GND.
20	MIPI_CLKN	I	Differential clock signals if MIPI interface. If not used, please connect these pins to GND.
22	GND	P	Ground Terminal
24	MIPI_DOP	I/O	Differential data signals if MIPI interface. If not used, please connect these pins to GND.
26	MIPI_DON	I/O	Differential data signals if MIPI interface. If not used, please connect these pins to GND.
28	GND	P	Ground Terminal
30	VBAT	P	Battery Voltage 3.8V TYP. (2.9-4.5V)

6. DC Characteristics

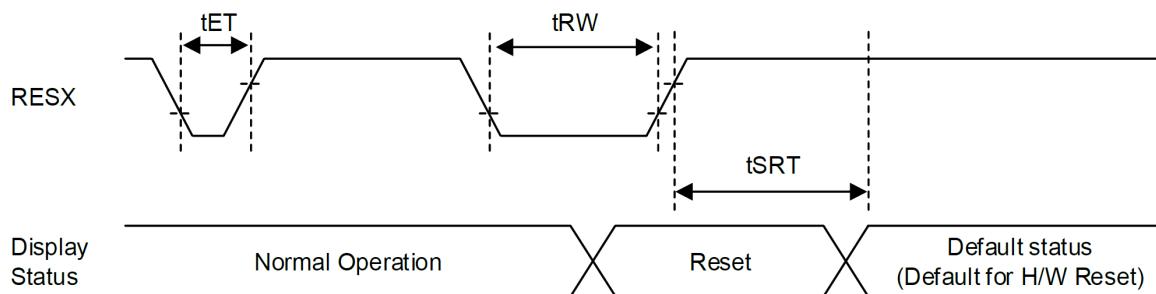
Test Conditions :Voltage Referenced to VSS=0V, IOVCC = 1.8V, VCC=3.3V,VBAT=3.3V,TA = 25°C
Unless otherwise specified

Parameter		Symbol	Condition	Min	Typ	Max	Unit
Supply voltage (Display)	VCC			2.7	3.3	3.6	V
	IOVCC			1.65	1.8	3.4	V
	BAT	-		2.9	3.8	4.5	V
Input voltage	'L' level	VIL	IOVCC=1.65V ~3.3V	GND	-	0.2*IOVCC	V
	'H' level	VIH		0.8*IOVCC	-	IOVCC	V
Output voltage	'L' level	VOL	I(OH)=-1mA I(OL)=+1mA	GND	-	0.2*IOVCC	V
	'H' level	VOH		0.8*IOVCC	-	IOVCC	V
Current (Display)	Sleep out mode	I _{VCC}	Full white display, 350nits,	-	2.9	-	mA
		I _{IOVCC}		-	1.8	-	mA
		I _{VBAT}		-	50	-	mA
	Sleep in mode	I _{VCC}		-	300	500	uA
		I _{IOVCC}		-	300	500	uA
		I _{VBAT}		-	10	150	uA
	Deep Standby Mode	I _{VCC}		-	TBD	TBD	uA
		I _{IOVCC}		-	TBD	TBD	uA
		I _{VBAT}		-	10	30	uA
Frame Frequency		f _{FRM}		-	60	-	Hz

7.AC characteristics

7-1 Reset Timing

Reset timing characteristic



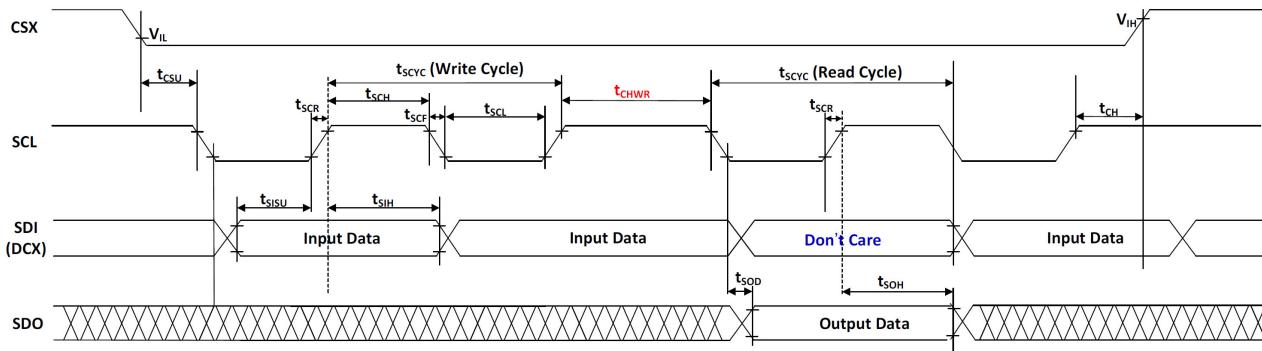
VSS=0V, VDDIO=1.7V to 3.3V, VCI=2.5V to 3.3V, Ta = -30 to 70°C

Parameter	Symbol	Pad	Min.	Typ.	Max.	Unit	Note
Reset low pulse width	tRW	RESX	10	—	—	μs	—
Secure reset completion time	tSRT	RESX	—	—	5	ms	Reset during Sleep In mode
		RESX	—	—	150		Reset during Sleep Out mode
Reset un-reacted pulse width	tET	RESX			5	μs	—

7-2 SPI Timing

SPI-3Wire/ SPI-4Wire Interface Characteristics

3/4-wire SPI

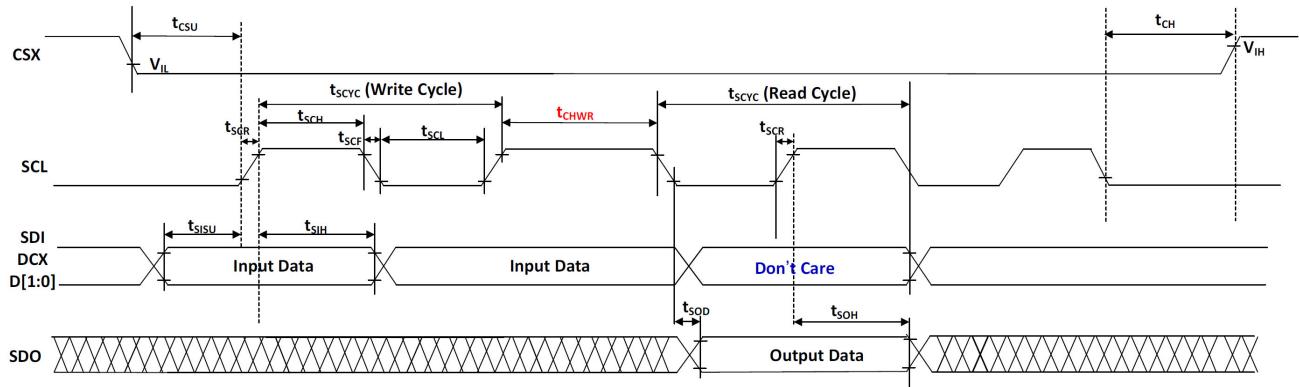


Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Clock cycle	tSCYC	Write	20			ns
		Read	300			ns
Clock high pulse width	tSCH	Write	6.5			ns
		Read	140			ns
Clock low pulse width	tSCL	Write	6.5			ns
		Read	140			ns
Clock rise time	tSCR	0.2*VDDI -> 0.8*VDDI			3.5	ns
Clock fall time	tSCF	0.8*VDDI -> 0.2*VDDI			3.5	ns
Chip select setup time	tCSU		10			ns
Chip select hold time	tCH		10			ns
Data input setup time	tSISU	To V _{IL} of SCL's rising edge	5			ns
Data input hold time	tSIH		5			ns
Access time of output data	tsOD	From V _{IL} of SCL's falling edge			120	ns
Hold time of output data	tSOH	From V _{IH} of SCL's rising edge	5			ns
Transition time from Write cycle to Read cycle	tCHWR	From V _{IH} of SCL's rising edge	150			ns

Notes:

- (1) Logic high and low levels are specified as 80% and 20% of VDDI for Input signals.
- (2) For the 4-wire SPI, the DCX's timing is the same as input data.
- (3) Ta = -30°C to 70°C, VDDI=1.65V to 3.3V, VCI=2.7V to 3.6V, and VSS=0V

7-3 QSPI Interface Characteristics



Note: The max SCL frequency for each pixel data format is specified as the below table.

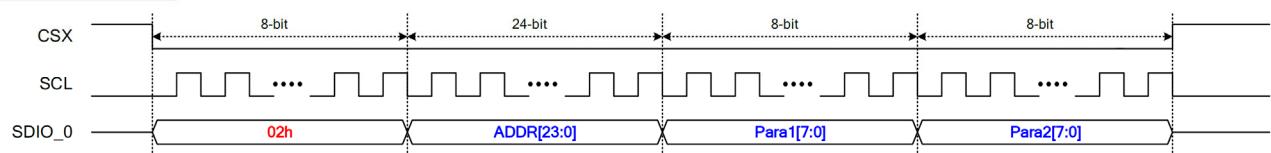
Note: Logic high and low levels are specified as 20% and 80% of VDDI for Input signals.

Note: $T_a = -30$ to 70 °C, VDDI=1.65V to 3.3V, VCI=2.7V to 3.6V, GND=0V

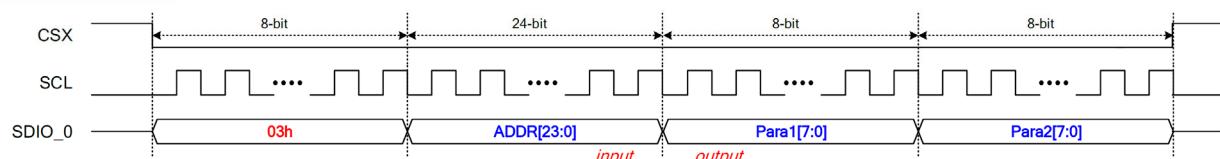
QSPI Timing

Quad SPI Interface Protocol – Register Read and Write

Command Write

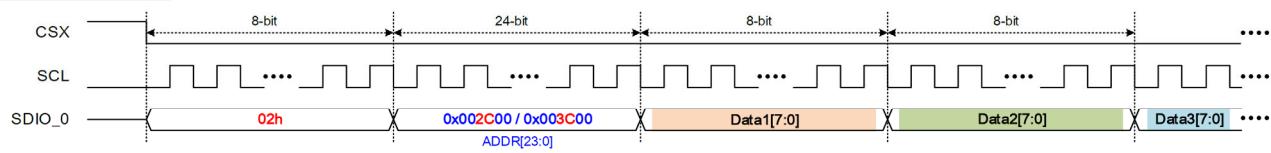


Command Read

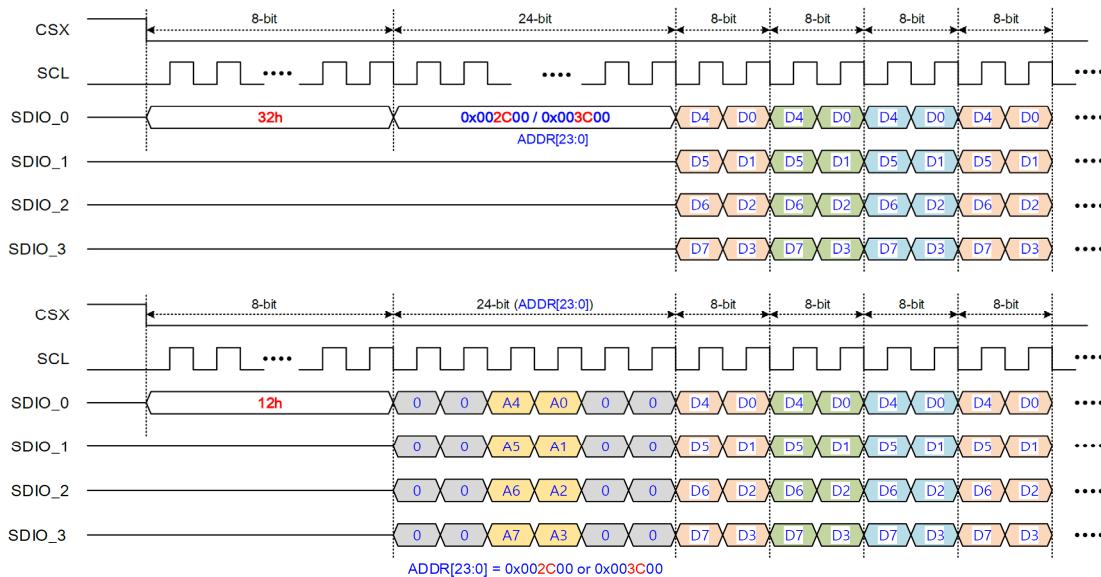


Quad SPI Interface Protocol – Pixel Interface

1-Wire Pixel Write

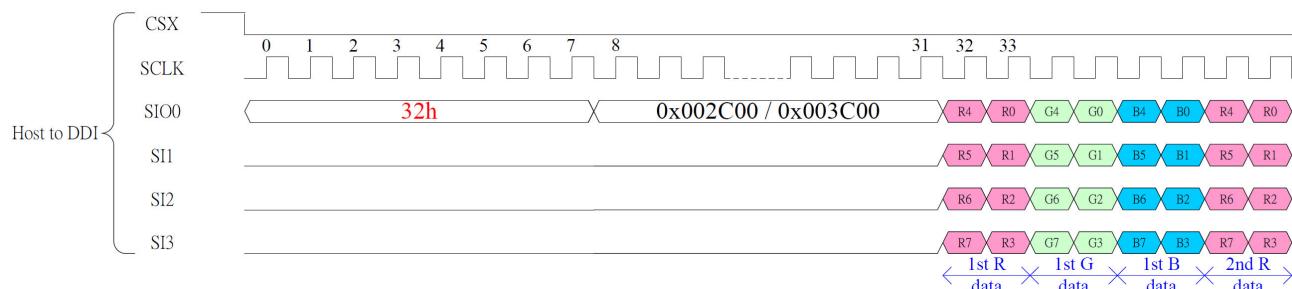


4-Wire Pixel Write

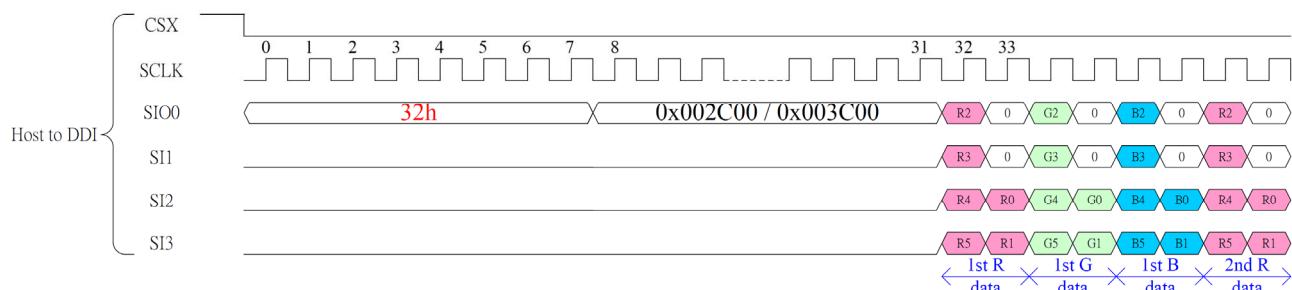


SPI-4Lanes Pixel Write Data Waveform

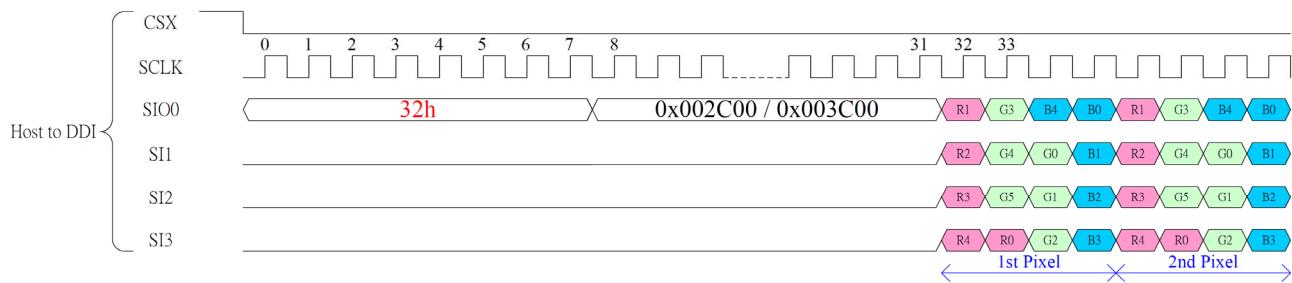
RGB888 – 4-Lanes



RGB666 – 4-Lanes

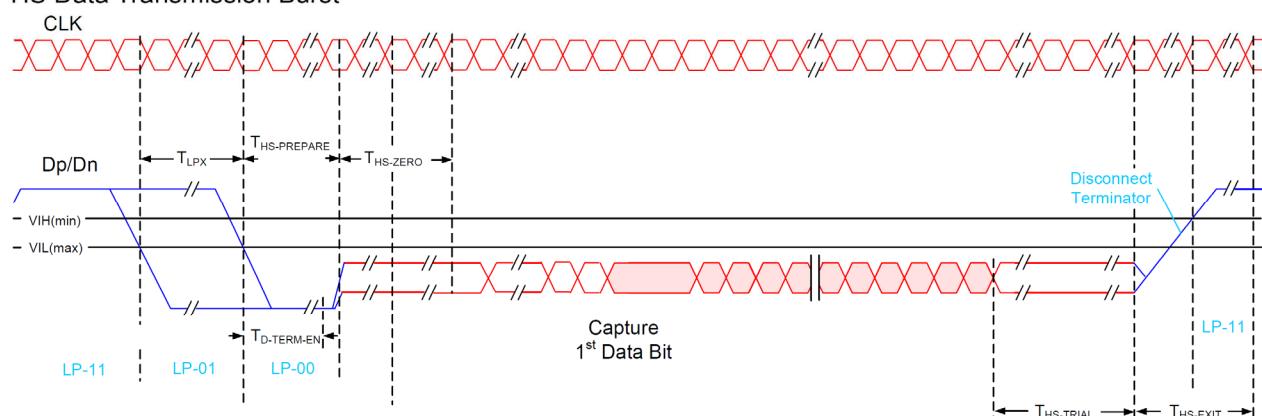


RGB565 – 4-Lanes

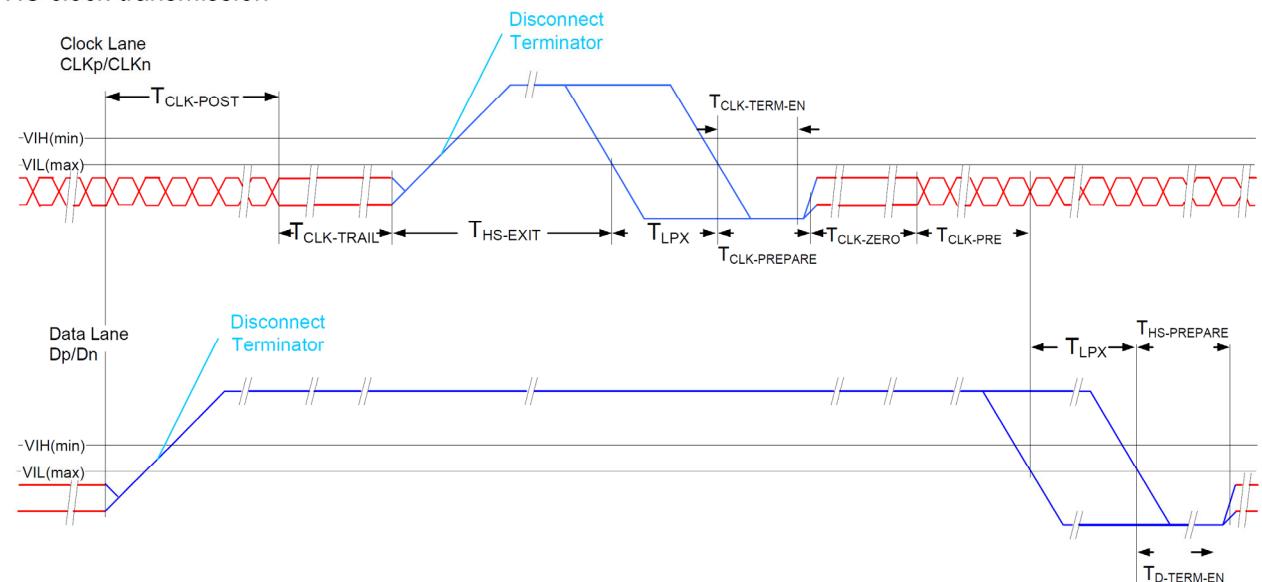


7-4 MIPI-DSI 1 lane Interface Characteristics

HS Data Transmission Burst



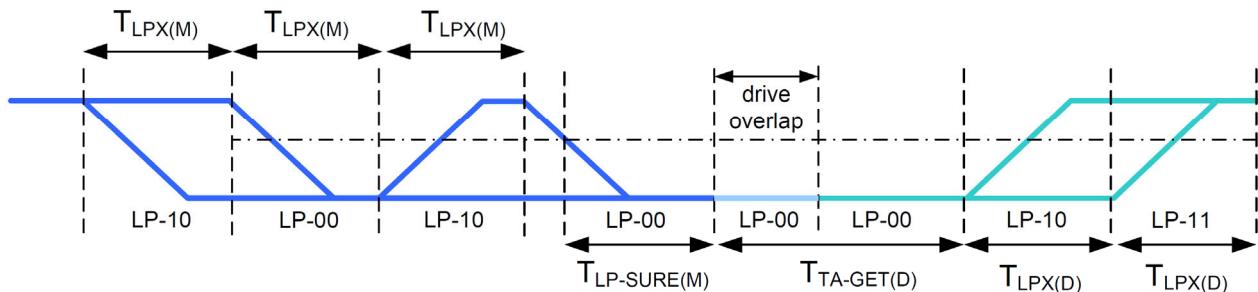
HS clock transmission



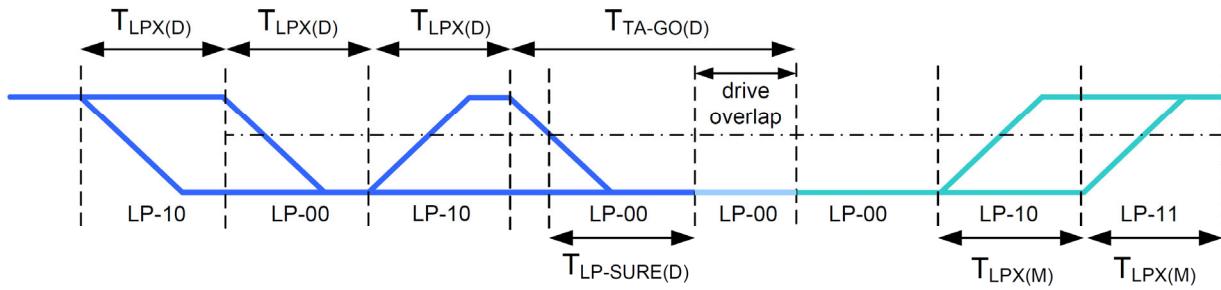
Timing Parameters:

Parameter	Description	Min	Typ	Max	Unit
$T_{CLK-POST}$	Time that the transmitter continues to send HS clock after the last associated Data Lane has transitioned to LP Mode. Interval is defined as the period from the end of $T_{HS-TRAIL}$ to the beginning of $T_{CLK-TRAIL}$.	60ns + 52*UI			ns
$T_{CLK-TRAIL}$	Time that the transmitter drives the HS-0 state after the last payload clock bit of a HS transmission burst.	60			ns
$T_{HS-EXIT}$	Time that the transmitter drives LP-11 following a HS burst.	300			ns
$T_{CLK-TERM-EN}$	Time for the Clock Lane receiver to enable the HS line termination, starting from the time point when Dn crosses $V_{IL,MAX}$.	Time for Dn to reach $V_{TERM-EN}$		38	ns
$T_{CLK-PREPARE}$	Time that the transmitter drives the Clock Lane LP-00 Line state immediately before the HS-0 Line state starting the HS transmission.	38		95	ns
$T_{CLK-PRE}$	Time that the HS clock shall be driven by the transmitter prior to any associated Data Lane beginning the transition from LP to HS mode.	8			UI
$T_{CLK-PREPARE} + T_{CLK-ZERO}$	$T_{CLK-PREPARE}$ + time that the transmitter drives the HS-0 state prior to starting the Clock.	300			ns
$T_{D-TERM-EN}$	Time for the Data Lane receiver to enable the HS line termination, starting from the time point when Dn crosses $V_{IL,MAX}$.	Time for Dn to reach $V_{TERM-EN}$		35 ns + 4*UI	
$T_{HS-PREPARE}$	Time that the transmitter drives the Data Lane LP-00 Line state immediately before the HS-0 Line state starting the HS transmission	40ns + 4*UI		85 ns + 6*UI	ns
$T_{HS-PREPARE} + T_{HS-ZERO}$	$T_{HS-PREPARE} +$ time that the transmitter drives the HS-0 state prior to transmitting the Sync sequence.	145ns + 10*UI			ns
$T_{HS-TRAIL}$	Time that the transmitter drives the flipped differential state after last payload data bit of a HS transmission burst	60ns + 4*UI			ns

Turnaround Procedure



Bus turnaround (BAT) from MPU to display module timing



Bus turnaround (BAT) from display module to MPU timing

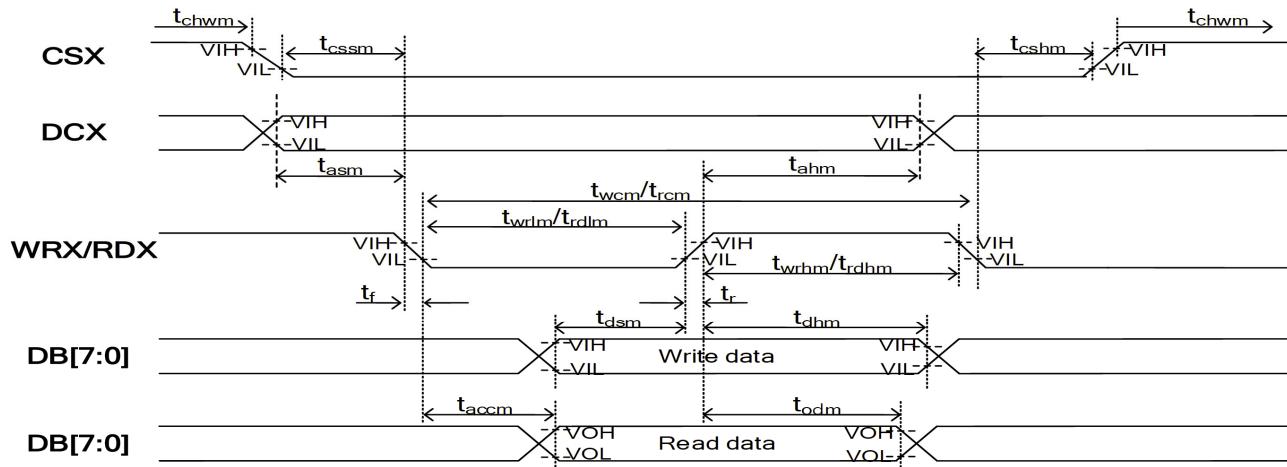
Low Power Mode :

Parameter	Description	Min	Typ	Max	Unit	Notes
$T_{LPX(M)}$	Transmitted length of any Low-Power state period of MCU to display module	50		150	ns	1,2
$T_{TA-SURE(M)}$	Time that the display module waits after the LP-10 state before transmitting the Bridge state (LP-00) during a Link Turnaround.	$T_{LPX(M)}$		$2*T_{LPX(M)}$	ns	2
$T_{LPX(D)}$	Transmitted length of any Low-Power state period of display module to MCU	50		150	ns	1,2
$T_{TA-GET(D)}$	Time that the display module drives the Bridge state (LP-00) after accepting control during a Link Turnaround.		$5*T_{LPX(D)}$		ns	2
$T_{TA-GO(D)}$	Time that the display module drives the Bridge state (LP-00) before releasing control during a Link Turnaround.		$4*T_{LPX(D)}$		ns	2
$T_{TA-SURE(D)}$	Time that the MPU waits after the LP-10 state before transmitting the Bridge state (LP-00) during a Link Turnaround.	$T_{LPX(D)}$		$2*T_{LPX(D)}$	ns	2

NOTE:

1. TLPX is an internal state machine timing reference. Externally measured values may differ slightly from the specified values due to asymmetrical rise and fall times.
2. Transmitter-specific parameter

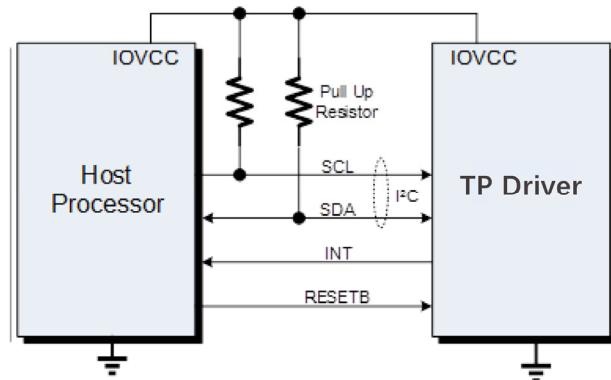
7-5 i8080-8Bits Interface Characteristics



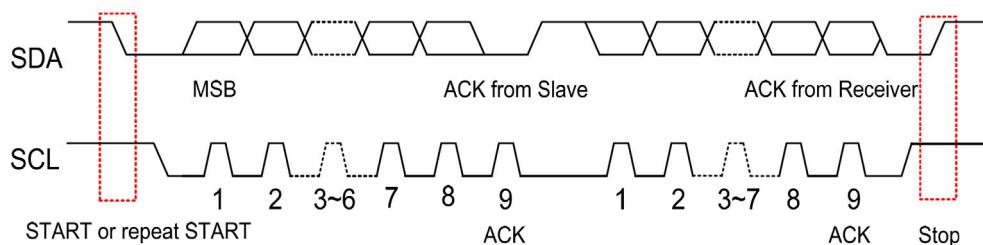
Characteristic	Symbol	Specification		Unit
		Min.	Max.	
Chip select setup time	CSX	t_{cssm}	10	–
Chip select hold time		t_{cshm}	10	–
Chip select “High” pulse width		t_{chwm}	20	–
Address setup time	DCX	t_{asm}	10	–
Address hold time(Write/Read)		t_{ahm}	10	–
Write cycle time	WRX (Write)	t_{wcm}	20	–
WRX “High” period (Write)		t_{wrhm}	10	–
WRX “Low” period (Write)		t_{wrilm}	10	–
Read cycle time (Register Read)	RDX (Register Read)	t_{rcm}	100	–
RDX “High” period (Register Read)		t_{rdhm}	50	–
RDX “Low” period (Register Read)		t_{rdlm}	50	–
Read cycle time (Memory Read)	RDX (Memory Read)	t_{rcm}	200	–
RDX “High” period (Memory Read)		t_{rdhm}	100	–
RDX “Low” period (Memory Read)		t_{rdlm}	100	–
Data setup time	DB[7:0]	t_{dsm}	10	–
Data hold time		t_{dhn}	10	–
Access time	DB[7:0]	t_{accm}	–	40
Output disable time		t_{odm}	20	–
Rise/Fall time	-	t_r/t_f	–	1

7-6 Touch Panel(TP) IIC Timing Characteristics

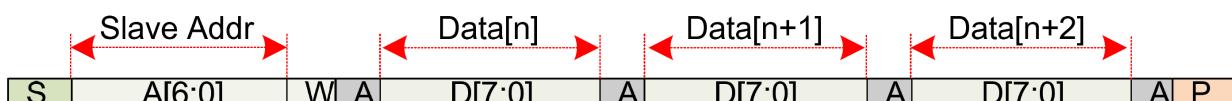
The TP driver communicates to the host through the IIC interface and follows the IIC protocol. IIC bus utilize the SCL and SDA, a two-wire synchronous communication interface and can operate at a maximum bit rate of 400kbps.



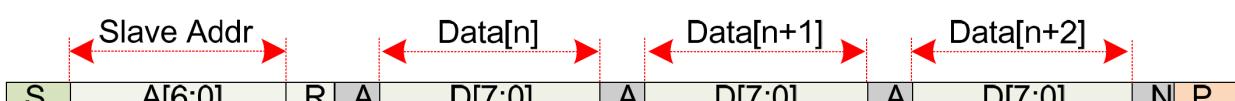
IIC Serial Data Transfer Format



IIC Interface Timing



IIC Master Write, Slave Read



IIC Master Read, Slave Write

TP Driver IC Slave Addr A[6:0]---0X38

Mnemonics	Description
S	I ² C Start or I ² C Restart
A[6:0]	Slave address
R/W	READ/WRITE bit, '1' for read, '0' for write
A(N)	ACK(NACK)
P	STOP: the indication of the end of a packet (if this bit is missing, S will indicate the end of the current packet and the beginning of the next packet)

I²C Timing Characteristics

Parameter	Standard Mode		Fast Mode		Unit
	Min	Max	Min	Max	
SCL frequency (fast mode support)	0	100	0	400	KHz
Clock low period	4.7	-	1.3	-	us
Clock high period	4.0	-	0.6	-	us
Bus free time between a STOP and START condition	4.7	-	1.3	-	us
Hold time (repeated) START condition	4.0	-	0.6	-	us
Data setup time	250	-	100	-	ns
Setup time for a repeated START condition	4.7	-	0.6	-	us
Setup Time for STOP condition	4.0	-	0.6	-	us

TP I/O Communication Voltage follow IOVCC

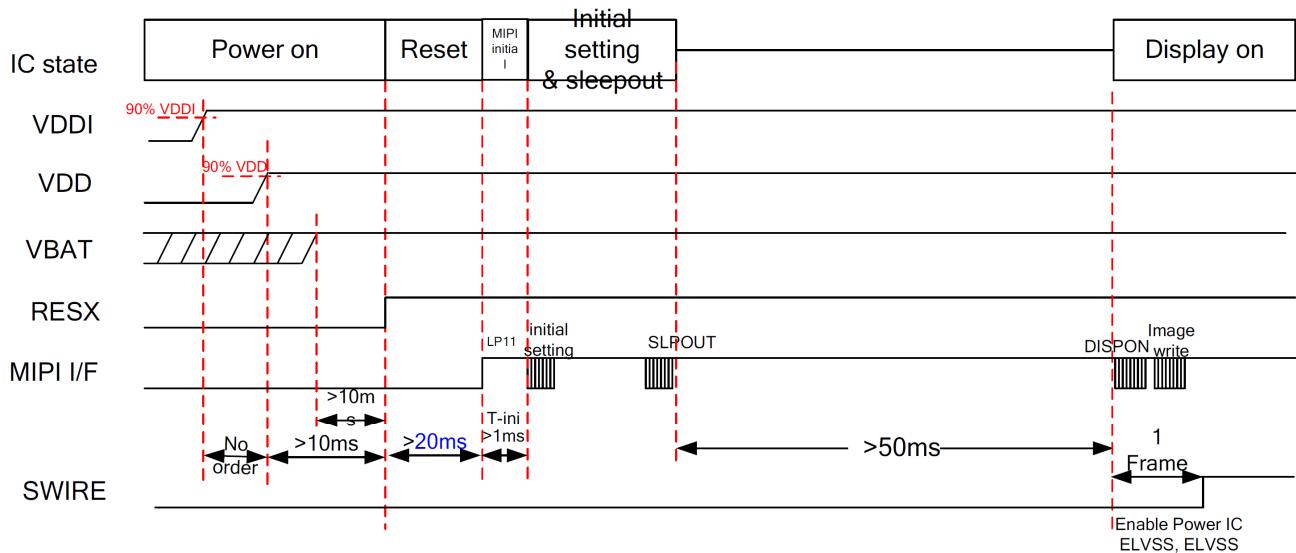
TP DC Characteristics

Item	Symbol	Test Condition	Min.	Typ.	Max.	Unit	Note
Input high-level voltage	VIH		0.7 × IOVCC	-	IOVCC	V	
Input low -level voltage	VIL		-0.3	-	0.3 × IOVCC	V	
Output high -level voltage	VOH	IOH=−0.1mA	0.7 × IOVCC	-	-	V	
Output low -level voltage	VOL	IOH=0.1mA	-	-	0.3 × IOVCC	V	
I/O leakage current	ILI	Vin=0~AVDD	-1	-	1	µA	
Current consumption (Normal operation mode)	Iopr	AVDD=2.8V Ta=25°C MCLK=15MHz	-	1.5	-	mA	
Current consumption (Monitor mode)	Imon	AVDD=2.8V Ta=25°C MCLK=15MHz	-	30	-	µA	
Current consumption (Sleep mode)	Islp	AVDD=2.8V Ta=25°C	-	10	-	µA	
Power Supply voltage	AVDD		2.8	-	3.6	V	

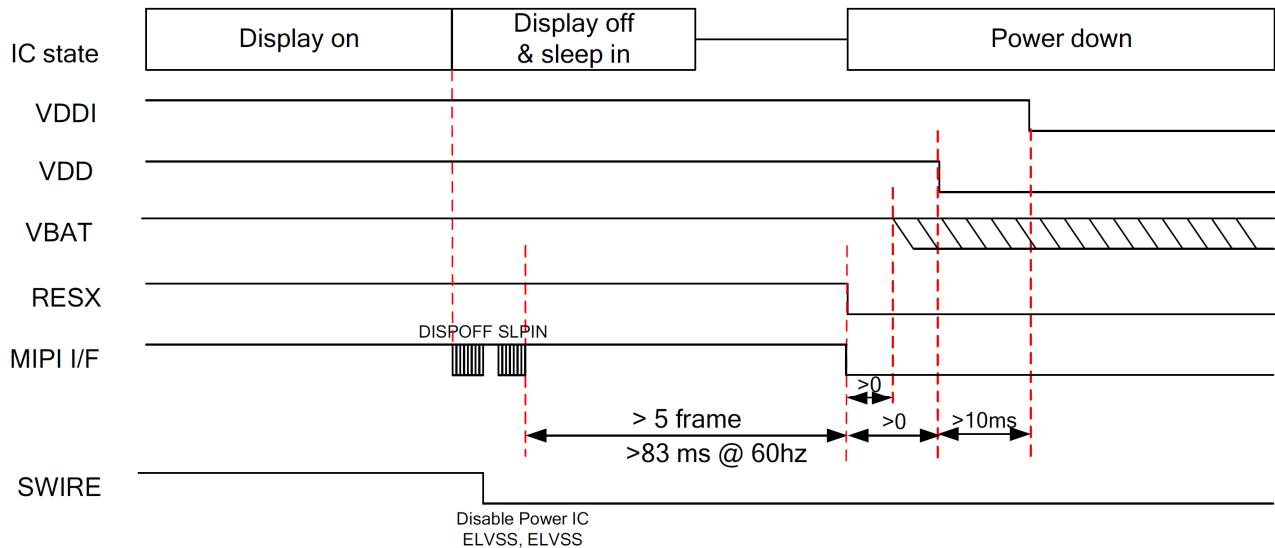
8.Recommended Operating Sequence

8.1 Power on/off sequence and timing

Power On sequence

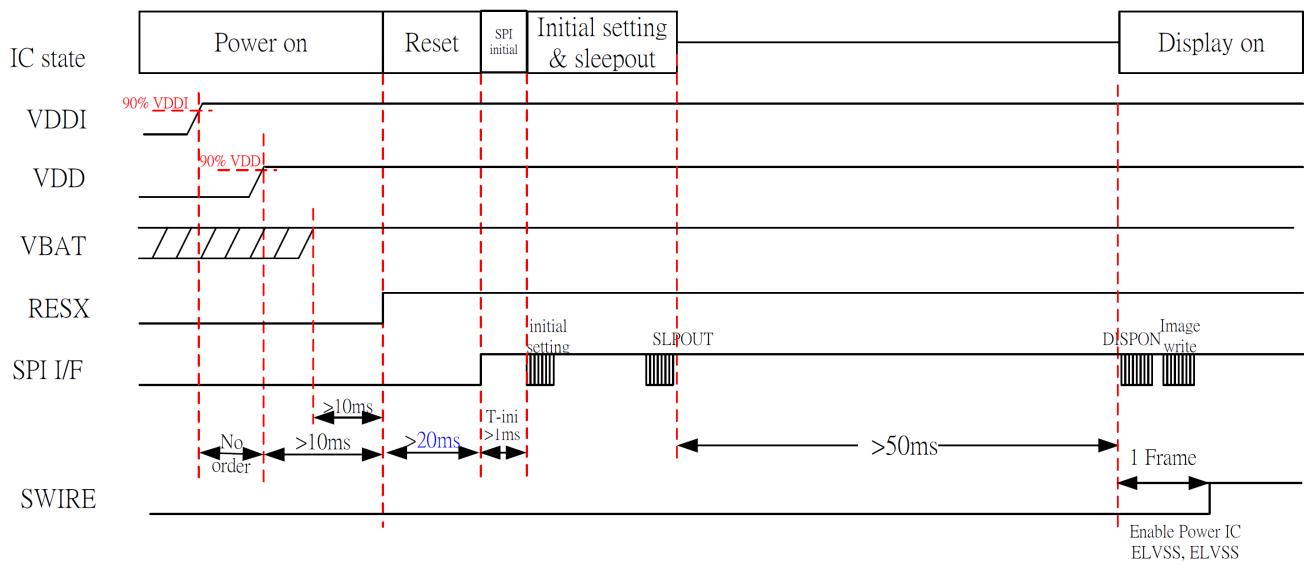


Power Off sequence



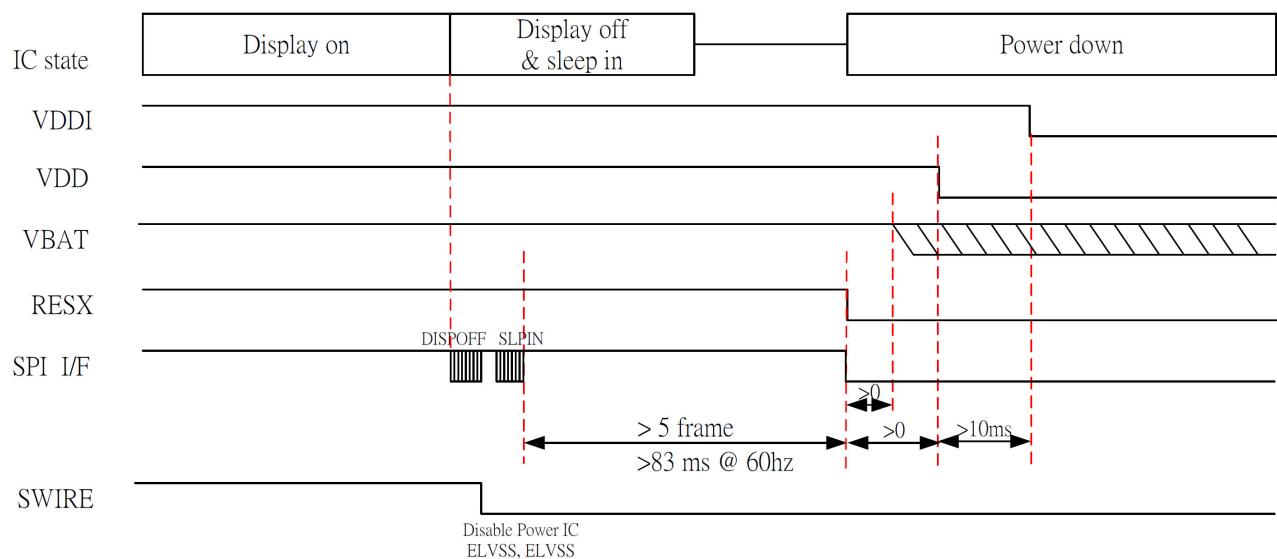
Power On sequence

SPI Interface



Power Off sequence

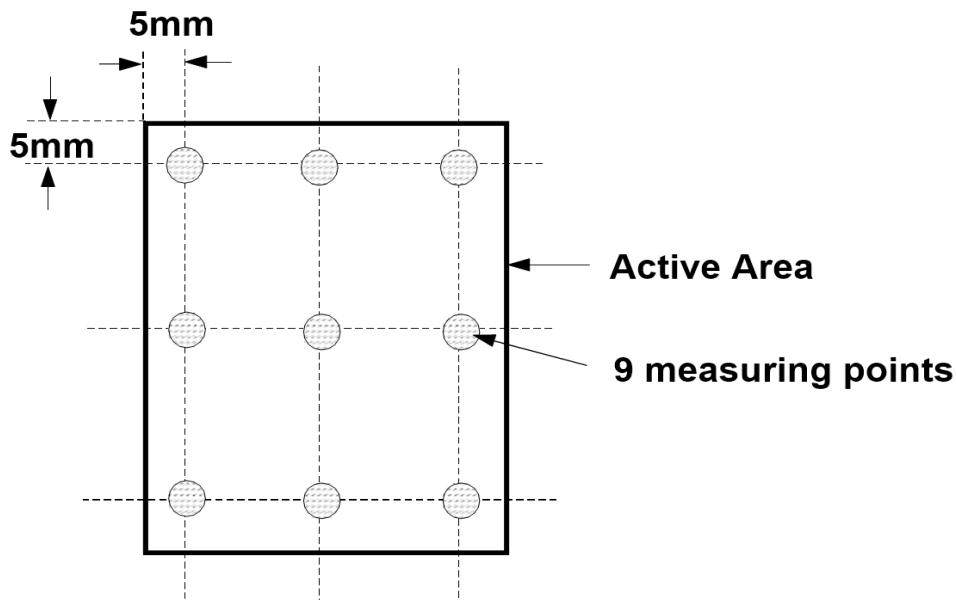
SPI Interface



9.Electro-optical characteristics

Item	Symbol	Temp	Condition	Min.	Typ.	Max.	Unit	Note		
Brightness		25°C	Normal (White Mode)	TBD	350	TBD	cd/m ²	Center brightness		
Uniformity		25°C	Normal (White Mode)	85	90	-	%	(1)		
Contrast ratio	K	25°C	$\Phi=0^\circ, \theta=0^\circ$	60,000		-	-	(1),(2)		
Color of CIE coordinate	White	25°C	$\Phi=0^\circ, \theta=0^\circ$	0.275	0.295	0.315	-	(1),(2),(3)		
				0.295	0.315	0.335	-			
	Red			0.630	0.660	0.690	-			
				0.310	0.340	0.370	-			
	Green			0.170	0.220	0.270	-			
				0.680	0.730	0.780	-			
	Blue			0.115	0.140	0.165	-			
				0.025	0.050	0.075	-			
Color Gamut		25°C	vs. NTSC	85	100	-	%			
Life Time(5)		25°C	50% Brightness drop @250cd/m ² , Full White	-	30,000	-	Hr	(4)		

Note 1): Uniformity Measuring Point

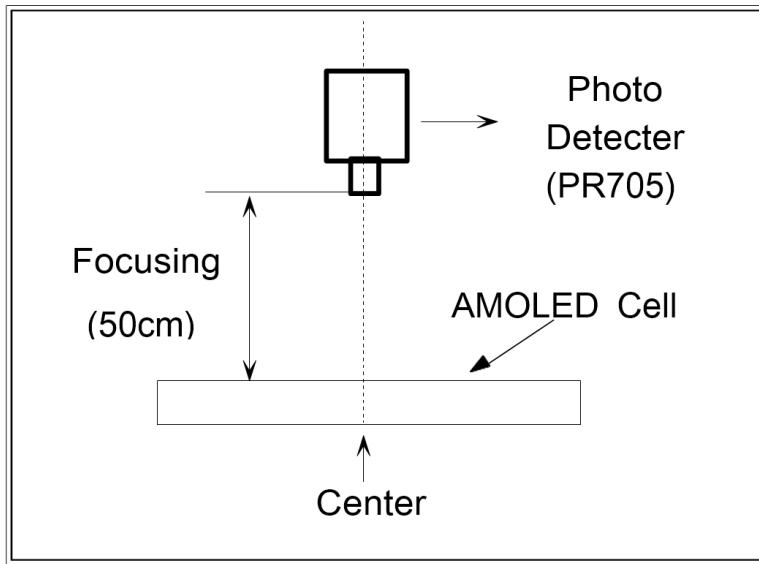


$$\text{Uniformity} = \frac{L_{\min}}{L_{\max}} * 100 \ [\%]$$

Note 2): Definition of contrast ratio (K)

$$\text{Contrast Ratio(K)} = \frac{\text{Brightness of selected dot} \\ (\text{White patterned area}) \text{ at } 250\text{cd/m}^2}{\text{Brightness of non-selected dot} \\ (\text{Black patterned area}) \text{ at } 250\text{cd/m}^2}$$

Note 3): Optical measuring system : temperature regulated chamber



Note 4): Life Time

The elapsed time that the full white brightness decreases to the half of initial value

10. Standard Specification For Reliability

No	Item	Condition	Cycles	Judgment Criterion
1	High Temperature Operation	80°C/ 240hours	10	
2	Low Temperature Operation	-30°C/ 240hours	10	
3	High Temperature Storage	85°C/ 240hours	5	1. No clearly visible defects or remarkable deterioration of display quality. However, any polarizer's deteriorations by the high temperature/ High humidity Storage test and the High temperature/ High humidity Operation test are permitted. 2. No function-related abnormalities.
4	Low Temperature Storage	-40°C/ 240hours	5	
5	High Temperature Humidity Operation	60°C/90%RH/ 240hours	5	
6	Thermal Shock	-40°C~85°C / 100cycles	5	

Note: The results must be measured after 2 hours later under room temperature keeping.

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