

DLC Display Co., Limited

德爾西顯示器有限公司



MODEL No: DLC0686ADP12MF-4

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Record of Revision

| Date | Revision No. | Summary |
|------------|--------------|--------------------|
| 2022-02-25 | 1.0 | Rev 1.0 was issued |
| | | |
| | | |

1. Scope

This data sheet is to introduce the specification of DLC0686ADP12MF-4, active matrix TFT module. It is composed of a color TFT-LCD panel, driver IC, FPC and a backlight unit. The 6.86" display area contains 480(RGB) x 1280 pixels.

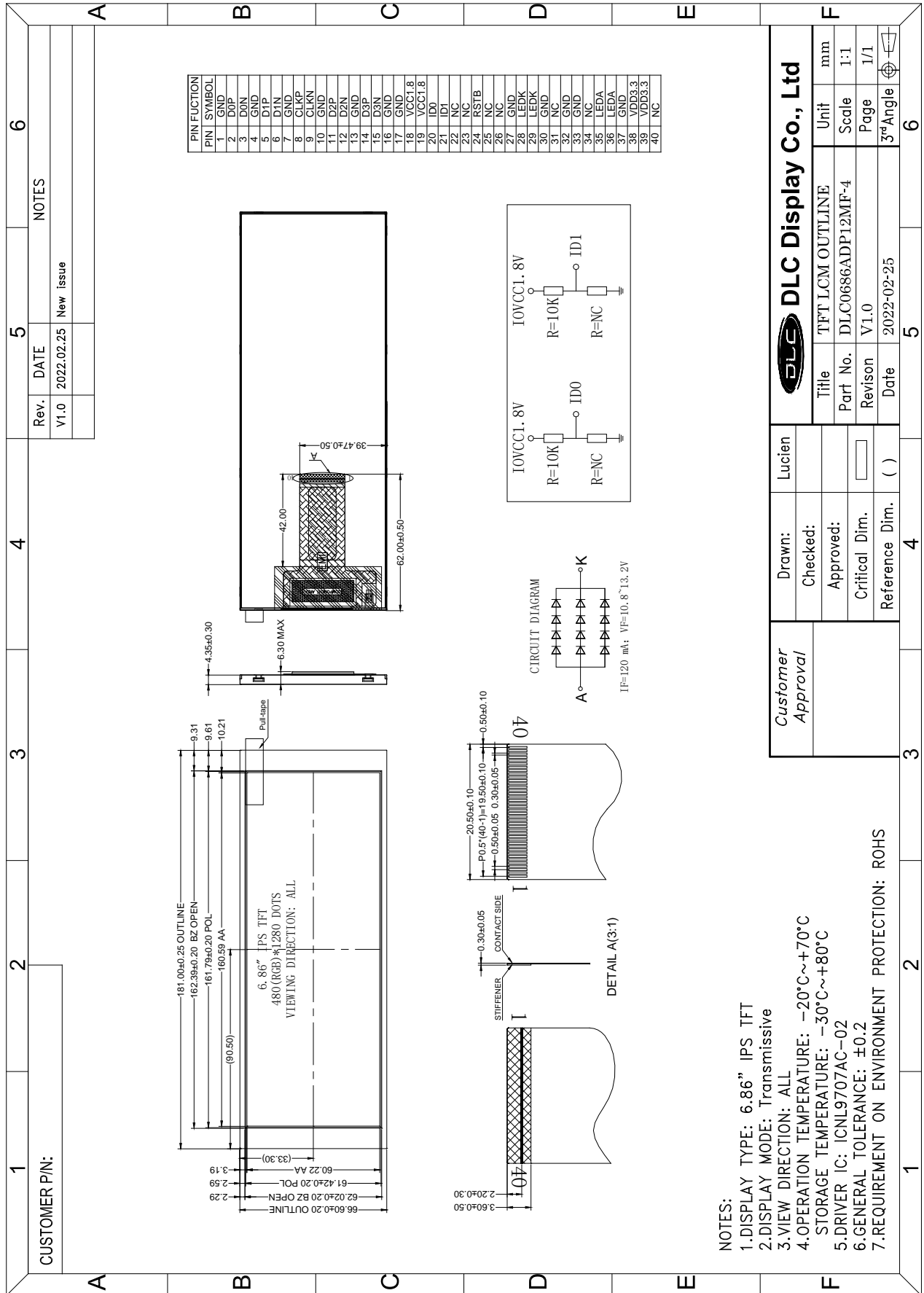
2. Application

Digital equipments which need color display, mobile navigator/video systems.

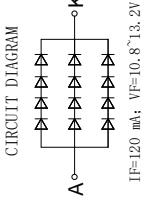
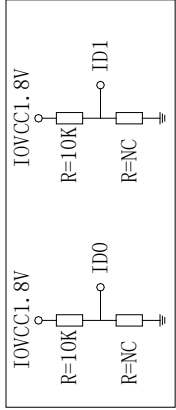
3. General Information

| Item | Contents | Unit |
|-------------------------------|--|---------|
| Size | 6.86 | inch |
| Resolution | 480(RGB) x 1280 | / |
| Interface | MIPI | / |
| Technology type | IPS | / |
| Display Color | The panel can display up to 16.7M colors | / |
| Pixel pitch | 0.1255 x 0.1255 | mm |
| Pixel Configuration | R.G.B. Stripe | / |
| Outline Dimension (W x H x D) | 181.00 x 66.60 x 4.35 | mm |
| Active Area | 160.59 x 60.22 | mm |
| Display Mode | Transmissive, Normally Black | / |
| Viewing Direction | ALL | o'clock |
| Driver IC | ICNL9707AC-02 | / |
| Backlight Type | LED | / |

4. Outline Drawing



| PIN | SYMBOL | PIN FUNCTION |
|-----|--------|--------------|
| 1 | GND | GND |
| 2 | D0N | D0N |
| 3 | D1N | D1N |
| 4 | GND | GND |
| 5 | D1P | D1P |
| 6 | D1N | D1N |
| 7 | GND | GND |
| 8 | CLKP | CLKP |
| 9 | CLKN | CLKN |
| 10 | GND | GND |
| 11 | D2P | D2P |
| 12 | D2N | D2N |
| 13 | GND | GND |
| 14 | D3P | D3P |
| 15 | D3N | D3N |
| 16 | GND | GND |
| 17 | GND | GND |
| 18 | VCC1.8 | VCC1.8 |
| 19 | VCC1.8 | VCC1.8 |
| 20 | ID0 | ID0 |
| 21 | ID1 | ID1 |
| 22 | NC | NC |
| 23 | NC | NC |
| 24 | RS1B | RS1B |
| 25 | NC | NC |
| 26 | NC | NC |
| 27 | GND | GND |
| 28 | LEDA | LEDA |
| 29 | LEDB | LEDB |
| 30 | GND | GND |
| 31 | NC | NC |
| 32 | GND | GND |
| 33 | GND | GND |
| 34 | NC | NC |
| 35 | LEDA | LEDA |
| 36 | LEDA | LEDA |
| 37 | GND | GND |
| 38 | VDD3.3 | VDD3.3 |
| 39 | VDD3.3 | VDD3.3 |
| 40 | NC | NC |



- NOTES:
- 1.DISPLAY TYPE: 6.86" IPS TFT
 - 2.DISPLAY MODE: Transmissive
 - 3.VIEW DIRECTION: ALL
 - 4.OPERATION TEMPERATURE: -20°C~+70°C
 - 5.STORAGE TEMPERATURE: -30°C~+80°C
 - 6.DRIVER IC: ICN19707AC-02
 - 7.GENERAL TOLERANCE: ±0.2
 - 7.REQUIREMENT ON ENVIRONMENT PROTECTION: ROHS

| | | | | |
|-------------------|--|------------------|----------------------|------------|
| Customer Approval | | Drawn: Lucien | DLC Display Co., Ltd | |
| Checked: | | TFT LCM OUTLINE | | Unit: mm |
| Approved: | | DLC0686ADP12MF-4 | | Scale: 1:1 |
| Critical Dim.: | | V1.0 | | Page: 1/1 |
| Reference Dim.: | | 2022-02-25 | | 3rd Angle |

5. Interface signals

| No | Symbol | Description | Remark |
|-------|---------|---|--------|
| 1 | GND | Ground | |
| 2 | D0P | Positive MIPI differential data inputs | |
| 3 | D0N | Negative MIPI differential data inputs | |
| 4 | GND | Ground | |
| 5 | D1P | Positive MIPI differential data inputs | |
| 6 | D1N | Negative MIPI differential data inputs | |
| 7 | GND | Ground | |
| 8 | CLKP | Positive MIPI differential clock inputs | |
| 9 | CLKN | Negative MIPI differential clock inputs | |
| 10 | GND | Ground | |
| 11 | D2P | Positive MIPI differential data inputs | |
| 12 | D2N | Negative MIPI differential data inputs | |
| 13 | GND | Ground | |
| 14 | D3P | Positive MIPI differential data inputs | |
| 15 | D3N | Negative MIPI differential data inputs | |
| 16~17 | GND | Ground | |
| 18~19 | VCC1.8V | A power supply for the logic power | |
| 20 | ID0 | ID0 (Pull high) | |
| 21 | ID1 | ID1 (Pull high) | |
| 22~23 | NC | No connection | |
| 24 | RSTB | Reset pin | |
| 25~26 | NC | No connection | |
| 27 | GND | Ground | |
| 28~29 | LEDK | LED cathode | |
| 30 | GND | Ground | |
| 31 | NC | No connection | |
| 32~33 | GND | Ground | |
| 34 | NC | No connection | |
| 35~36 | LEDA | LED anode | |
| 37 | GND | Ground | |
| 38~39 | VDD3.3V | A power supply for the analog power | |
| 40 | NC | No connection | |

6. Absolute maximum Ratings

6.1. Electrical Absolute max. ratings

| Parameter | Symbol | MIN | MAX | Unit | Remark |
|----------------------|--------|------|-----|------|--------|
| Power supply voltage | VDD | -0.3 | 6.5 | V | |
| | VCC | -0.3 | 3.8 | V | |

6.2. Environment Conditions

| Item | Symbol | MIN | MAX | Unit | Remark |
|-----------------------|--------|-----|-----|------|--------|
| Operating Temperature | TOPR | -20 | +70 | °C | |
| Storage Temperature | TSTG | -30 | +80 | °C | |

7. Electrical Specifications

7.1 Electrical characteristics

GND=0V, Ta=25°C

| Item | Symbol | MIN | TYP | MAX | Unit |
|----------------------|--------|---------|-----|---------|------|
| Power supply voltage | VDD | 2.5 | 3.3 | 3.6 | V |
| | VCC | 1.65 | 1.8 | 3.6 | V |
| Input High voltage | VIH | 0.7*VCC | -- | VCC | V |
| Input Low voltage | VIL | GND | -- | 0.3*VCC | |

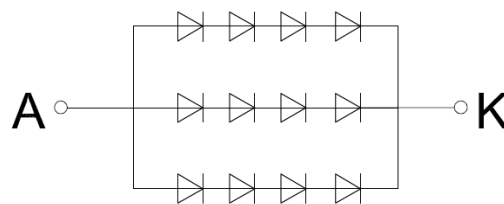
7.2 LED Backlight

Ta=25°C

| Item | Symbol | MIN | TYP | MAX | Unit | Remark |
|-----------------|--------|------|--------|------|------|--------|
| Forward Current | IL | - | 120 | | mA | |
| Forward Voltage | VL | 10.8 | -- | 13.2 | V | |
| LED life time | - | - | 30,000 | - | Hrs | Note |

Note: The "LED life time" is defined as the module brightness decrease to 50% original brightness at Ta=25°C and IL=120mA. The "LED life time" could be decreased if operating IL is larger than 120mA.

CIRCUIT DIAGRAM

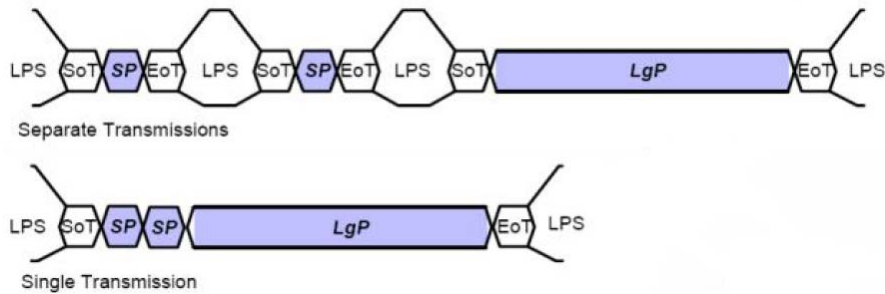


$$I_F = 120 \text{ mA}; V_F = 10.8 \sim 13.2 \text{ V}$$

8. Command/AC Timing

8.1 DSI Protocol

The protocol layer appends packet-protocol information and headers. The receiver side of a DSI Link performs the converse of the transmitter side, decomposing the packet into parallel data, signal events and commands. The DSI protocol permits multiple packets which is useful for events such as peripheral initialization, where many registers may be loaded separate white commands at system startup.

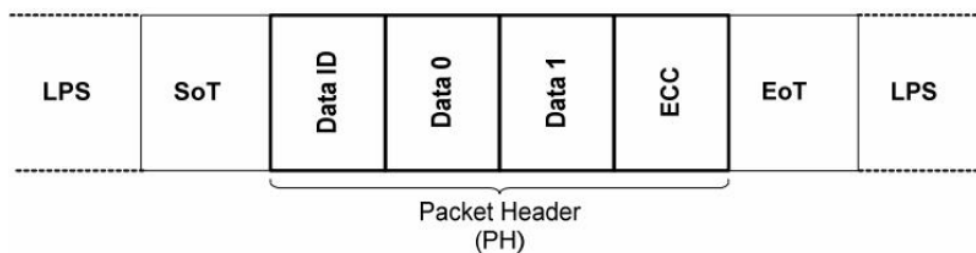


- LPS: Low power state
- SoT: Start of Transmission
- SP: Short Packet
- LgP: Long Packet
- EoT: End of Transmission

Figure: Multiple packets transmission

The packet includes two types which are Long packet and Short packet. The first byte of the packet, the Data Identifier (DI), includes information specifying the type of the packet. Command Mode systems send commands and an associated set of parameters, with the number of parameters depending on the command type.

Short packets are four bytes in length including the ECC. Short packet is used for most Command Mode commands and associated parameters. Where Short packets format include an 8-bit Data ID followed by two command or data and an 8-bit ECC.



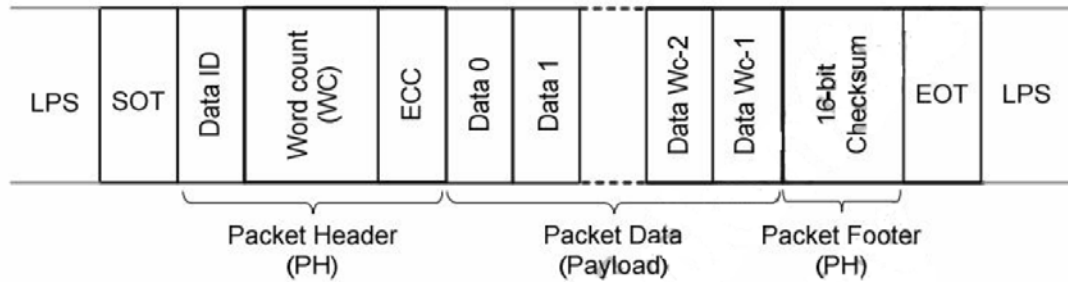
DI(Data ID): Contain Virtual Channel Identifier and Data Type.

ECC(Error Correction Code): The Error Correction Code allows single-bit errors to be corrected and 2-bit errors to be detected in the Short packet.

Figure: Structure of the short packet

Long packets specify the payload length using a two-byte Word Count field and then the payload maybe from 0 to 65,535 bytes in length. Long packets permit transmission of large blocks of pixel or other data. (Figure: Structure of the short packet) shows the structure of the Long packet. Long Packet Header composed of three elements: an 8-bit Data Identifier, a-16-bit Word Count, and 8-bit ECC. An application-specific Data Payload has Word Count*bytes following the Packet Header. The packet Footer has one element, a 16-bit checksum. Long packets can be from 6 to 65,541 bytes in length.

Where 65,541 bytes = 4 bytes PH + (2¹⁶-1)bytes Payload + 2 bytes PF



DI (Data ID): Contain Virtual Channel Identifier and Data Type.

WC (Word Count): The receiver use WC to determine the packet end.

ECC (Error Correction Code): The Error Correction Code allows single-bit errors to be corrected and 2-bit errors to be detected in the Packet Header.

PF (Packet Footer): Mean 16-bit Checksum.

Figure: Structure of the long packet

According to packet form, basic elements include DI and ECC. (Figure: Structure of the long packet) The shows format of Data ID.

| | | | | | | | |
|----------------------|-----|----------------|-----|-----|-----|-----|-----|
| DI7 | DI6 | DI5 | DI4 | DI3 | DI2 | DI1 | DI0 |
| VC (Virtual Channel) | | DT (Data Type) | | | | | |

DI[7:6]: These two bits identify the data as directed to one of four virtual channels.

DI[5:0]: These six bits specify the Data Type.

Figure: The format of data ID

Due to Data Type (DT) mean format of transmission type, (Figure: The format of data ID) show Short-/Long-packet transmission command sequence.

Long packet write Command/Parameters/Pixel Datas



DI: Write suitable Data type.

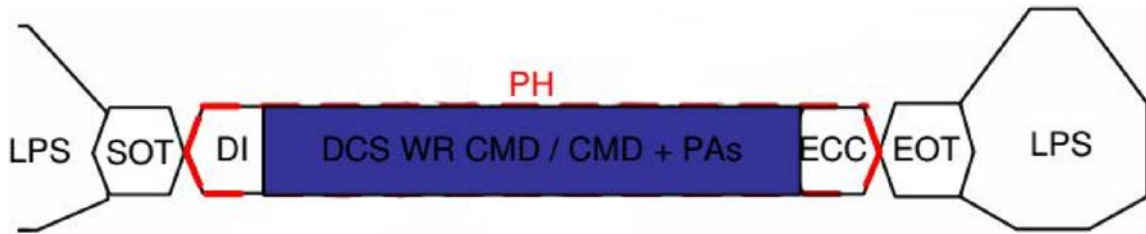
WC: Write number of Payload Data.

Ex: One CMD write, WC setting as 1.

CMD + PAs write, WC setting as number of (CMD+PAs).

CMD + DATA write, WC setting as number of (CMD+Pixel DATA).

Short packet write Command/Parameters



DI: Write suitable Data type.

Ex: One CMD write, DI + DCS WR CMD.

CMD + PAs write, DI + DCS WR CMD+PAs.

Figure: Show short-/long-packet transmission command sequence

8.2 DC Characteristic for DSI HS Mode

| Parameter | Symbol | Condition | Min. | Typ. | Max. | Unit | Notes |
|---|-----------|-----------------------|---------------------|------|-------------------|---------|-------|
| Power generation & Operation Voltage | | | | | | | |
| Analog operating voltage | VCI | Operating voltage | 2.6 | 3.0 | 3.6 | V | |
| Analog operating voltage | VCI | Operating voltage | 4.5 | 5.5 | 6.5 | V | |
| Analog operating voltage | VSP | Operating voltage | 4.5 | 5.5 | 6.5 | V | |
| Analog operating voltage | VSN | Operating voltage | -6.5 | -5.5 | -4.5 | V | |
| Analog operating voltage | VCOM | Operating voltage | -0.3 | - | -4 | V | |
| Analog operating voltage | VGMP | Operating voltage | 3 | 4.5 | 6 | V | |
| Analog operating voltage | VGMN | Operating voltage | -6 | -4.5 | -3 | V | |
| Analog operating voltage | IVGH-VGLI | Operating voltage | $IVGH-VGLI \leq 30$ | | | V | |
| I/O operating voltage | IOVCC | I/O supply voltage | 1.65 | 1.8 | 1.95 | V | |
| MIPI operating voltage | HS_VCC | HS_VCC supply voltage | 1.1 | 1.2 | 1.3 | V | |
| Logic Input/Output | | | | | | | |
| Logic high level input voltage | VIH | | $0.7 \cdot IOVCC$ | - | IOVCC | V | |
| Logic low level input voltage | VIL | | VSS | - | $0.3 \cdot IOVCC$ | V | |
| Logic high level output voltage | VOH | $IOH = -0.1mA$ | $0.8 \cdot IOVCC$ | - | IOVCC | V | |
| Logic low level output voltage | VOL | $IOL = +0.1mA$ | VSS | - | $0.2 \cdot IOVCC$ | V | |
| Logic high level leakage | ILIH1 | $Vin = 0$ to IOVCC | - | - | 1 | μA | |

| | | | | | | | |
|--------------------------|--------|---------------------------|-----|---|-----|----|--|
| Logic low level leakage | ILIL1 | Vin=0 to IOVCC | -1 | - | - | uA | |
| VCSW high level leakage | ILIH2 | Vin=0 to VCI | - | - | 1 | uA | |
| VCSW low level leakage | ILIL2 | Vin=0 to VCI | -1 | - | - | uA | |
| Source OP Output | | | | | | | |
| Output deviation voltage | Vdev | Sout≥4.2V Sout≤0.8V | - | - | 30 | mV | |
| Output deviation voltage | Vdev | 4.2V>Sout>0.8V | - | - | 20 | mV | |
| Output offset voltage | Vofset | - | - | - | 40 | mV | |
| Stand-by Current | | | | | | | |
| Sleep in mode | Isttp | DSI LP mode IOVCC current | - | - | 150 | uA | |
| | | DSI LP mode VSP current | - | - | 18 | uA | |
| | | DSI LP mode VSN current | -15 | - | - | uA | |

8.3 Power On/Off Sequence

Applied Power: IOVCC, VCI

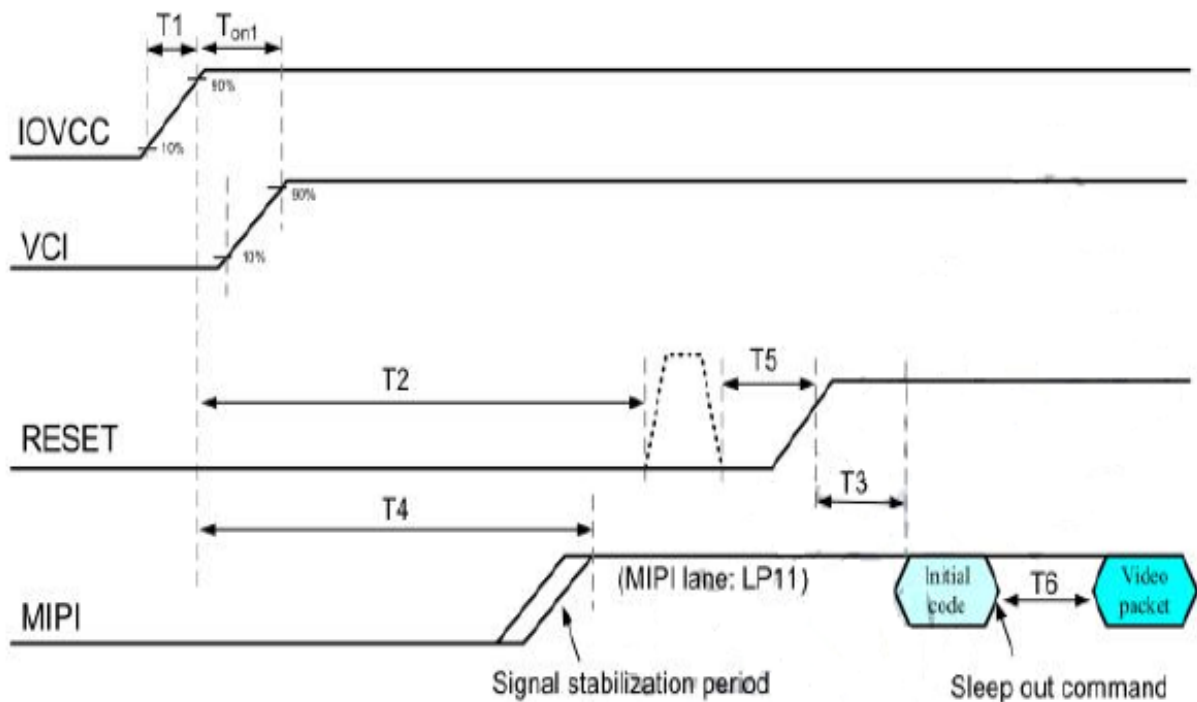


Figure: Power on sequence at PCCS[1:0]=[1,0] mode

Note1: IOVCC in the under format just is the VCC1.8 of the LCM interface

VCI in the under format just is the VDD3.3 of the LCM interface

Note2: Unless otherwise specified, timings herein show cross point at 50% of signal/power level.

Application Power: IOVCC, VCI,

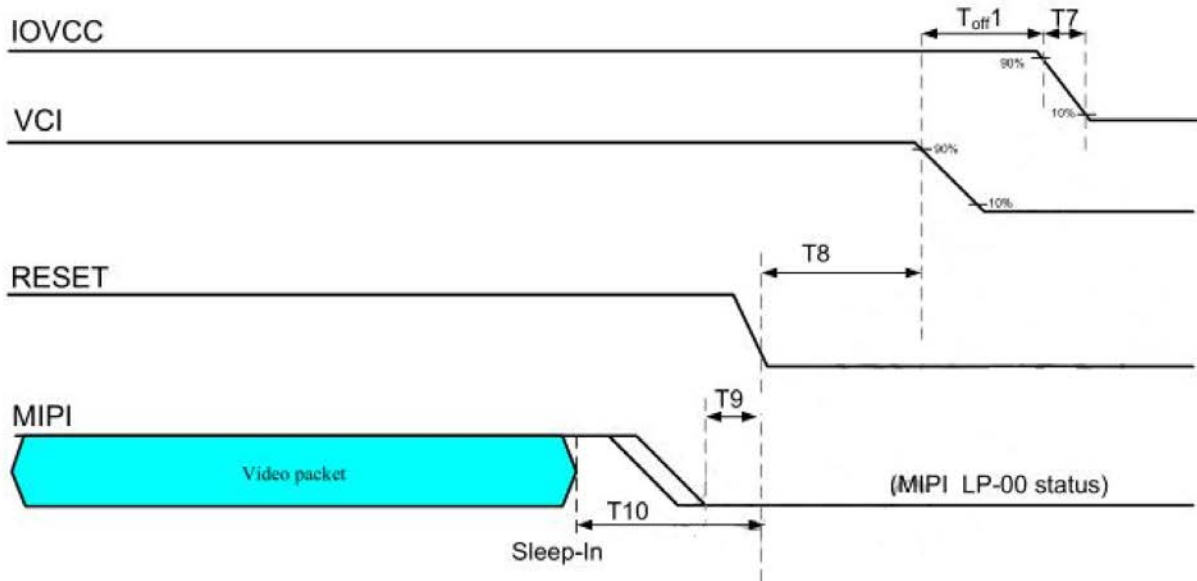


Figure: Power off sequence at PCCS[1:0]=[1,0] mode

Note1: IOVCC in the under format just is the VCC1.8 of the LCM interface

VCI in the under format just is the VDD3.3 of the LCM interface

Note2: Unless otherwise specified, timings herein show cross point at 50% of signal/power level.

9. Optical Specification

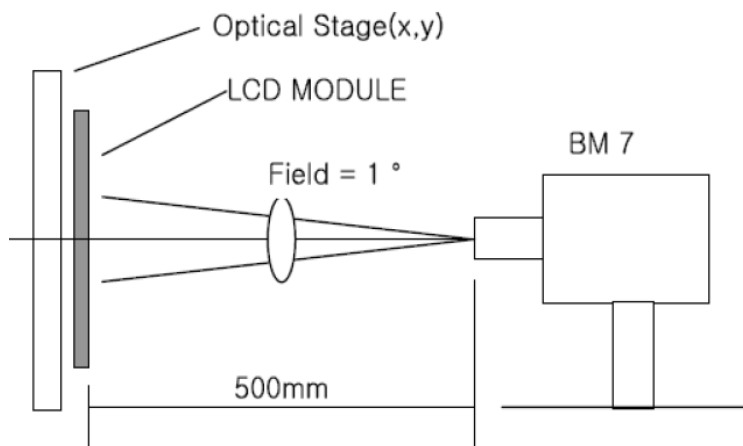
Ta=25°C

| Item | Symbol | Condition | Min | Typ. | Max. | Unit | Remark |
|----------------|------------|------------------|------------------|----------|----------|-------------------|-----------------|
| Contrast Ratio | CR | $\theta=0^\circ$ | 1000 | 1500 | -- | | Note1 Note2 |
| Response Time | Tr + Tf | 25°C | -- | 25 | 35 | ms | Note1 Note3 |
| View Angles | ΘT | $CR \geq 10$ | 70 | 80 | -- | Degree | Note 4 |
| | ΘB | | 70 | 80 | -- | | |
| | ΘL | | 70 | 80 | -- | | |
| | ΘR | | 70 | 80 | -- | | |
| Chromaticity | White | x | Brightness is on | Typ-0.05 | Typ+0.05 | | Note5, Note1 |
| | | y | | | | | |
| | Red | x | | | | | |
| | | y | | | | | |
| | Green | x | | | | | |
| | | y | | | | | |
| | Blue | x | | | | | |
| | | y | | | | | |
| Luminance | L | | -- | 500 | -- | cd/m ² | Note1 Note6 |
| Uniformity | U | | 70 | 75 | -- | % | Note1 Note7 |

Note 1: Definition of optical measurement system.

Temperature = 25°C(±3°C) ,

LED back-light: ON, Environment brightness < 150 lx

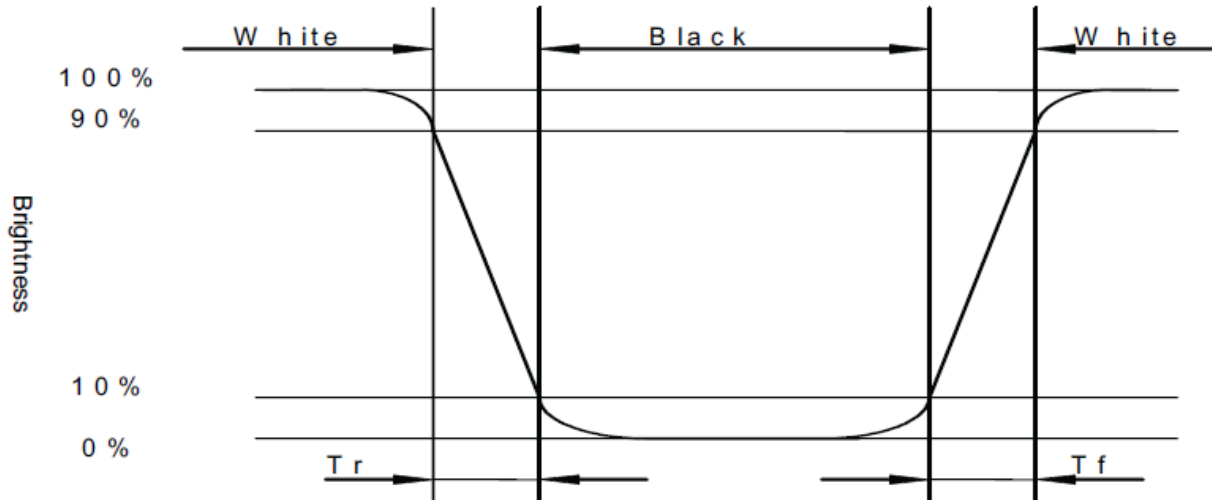


Note 2: Contrast ratio is defined as follow:

$$\text{Contrast Ratio} = \frac{\text{Surface Luminance with all white pixels}}{\text{Surface Luminance with all black pixels}}$$

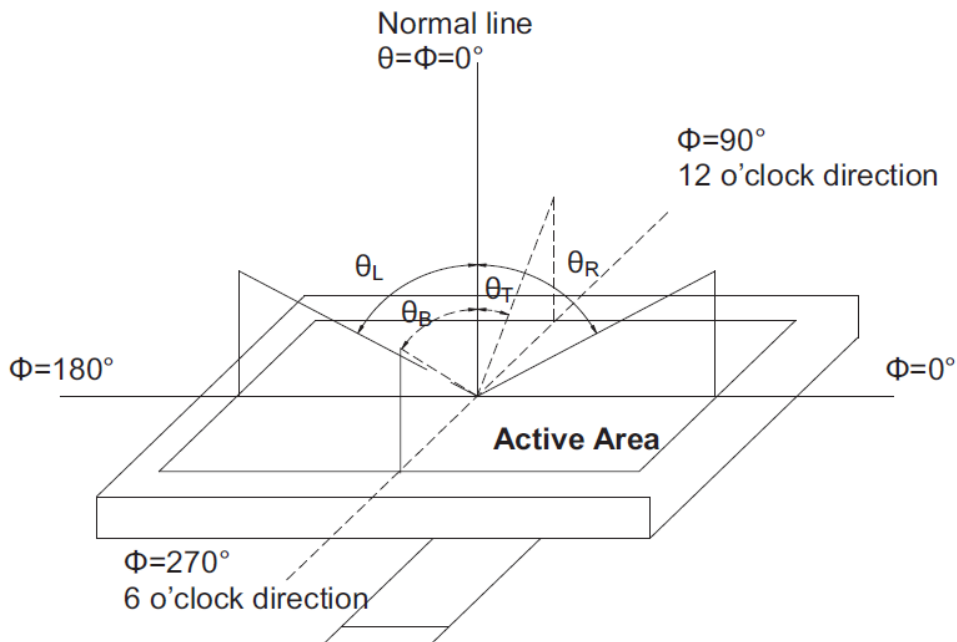
Note 3: Response time is defined as follow:

Response time is the time required for the display to transition from black to white (Rise Time, T_r) and from white to black (Decay Time, T_f).



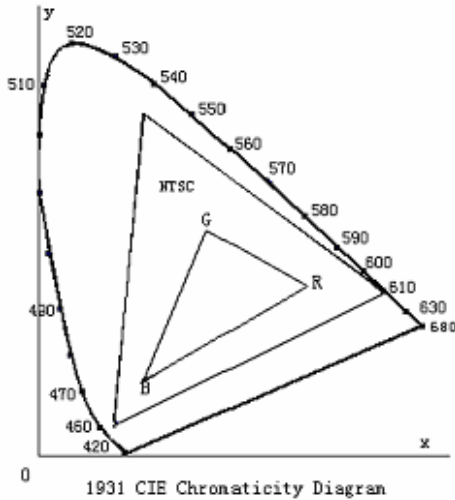
Note 4: Viewing angle range is defined as follow:

Viewing angle is measured at the center point of the LCD.



Note 5: Color chromaticity is defined as follow: (CIE1931)

Color coordinates measured at center point of LCD.



$$S = \frac{\text{area of RGB triangle}}{\text{area of NTSC triangle}} \times 100\%$$

Note 6: Luminance is defined as follow:

Luminance is defined as the brightness of all pixels “White” at the center of display area on optimum contrast.

Note 7: Luminance Uniformity is defined as follow:

Active area is divided into 9 measuring areas (Refer Fig. 2). Every measuring point is placed at the center of each measuring area.

$$\text{Uniformity}(U) = \frac{\text{Minimum Luminance(brightness) in 9 points}}{\text{Maximum Luminance(brightness) in 9 points}}$$

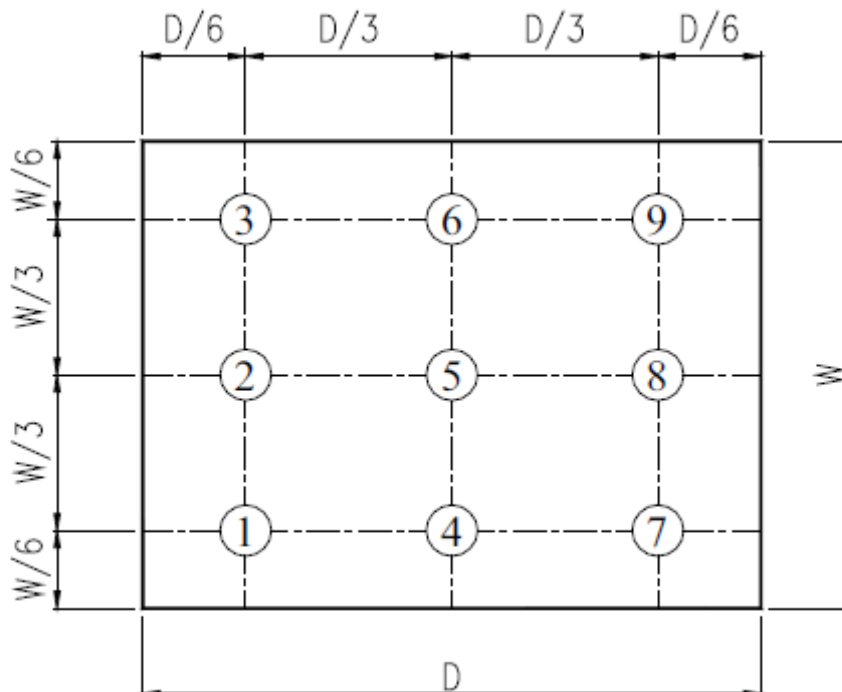


Fig. 2 Definition of uniformity

10. Environmental / Reliability Tests

| No | Test Item | Condition | Judgment criteria |
|----|-----------------------------------|--|---|
| 1 | High Temp Operation | Ta= +70°C, 96hrs | Per table in below |
| 2 | Low Temp Operation | Ta= -20°C, 96hrs | Per table in below |
| 3 | High Temp Storage | Ts= +80°C, 96hrs | Per table in below |
| 4 | Low Temp Storage | Ts= -30°C, 96hrs | Per table in below |
| 5 | High Temp & High Humidity Storage | Ts= +60°C, 90% RH, 96hours | Per table in below (polarizer discoloration is excluded) |
| 6 | Thermal Shock (Non-operation) | -30°C 30 min~+80°C 30 min, Change time:5min, 10 Cycles | Per table in below |
| 7 | ESD (Operation) | C=150pF, R=330Ω, 5points/panel Air:±8KV, 5times; Contact:±4KV, 5 times; | Per table in below |
| 8 | Vibration (Non-operation) | Frequency range:10~55Hz, Stroke:1.5mm Sweep:10Hz~55Hz~10Hz 2 hours for each direction of X.Y.Z. | Per table in below |
| 9 | Shock (Non-operation) | 60G 6ms, ±X,±Y,±Z 3times, for each direction | Per table in below |
| 10 | Package Drop Test | Height:80 cm, 1 corner, 3 edges, 6 surfaces | Per table in below |

| INSPECTION | CRITERION(after test) |
|------------------------|---|
| Appearance | No Crack on the FPC, on the LCD Panel |
| Alignment of LCD Panel | No Bubbles in the LCD Panel No other Defects of Alignment in Active area |
| Electrical current | Within device specifications |
| Function / Display | No Broken Circuit, No Short Circuit or No Black line No Other Defects of Display |

11. Precautions for Use of LCD Modules

11.1 Safety

The liquid crystal in the LCD is poisonous. Do not put it in your mouth. If the liquid crystal touches your skin or clothes, wash it off immediately using soap and water.

11.2 Handling

- A. The LCD and touch panel is made of plate glass. Do not subject the panel to mechanical shock or to excessive force on its surface.
- B. Do not handle the product by holding the flexible pattern portion in order to assure the reliability
- C. Transparency is an important factor for the touch panel. Please wear clear finger sacks, gloves and mask to protect the touch panel from finger print or stain and also hold the portion outside the view area when handling the touch panel.
- D. Provide a space so that the panel does not come into contact with other components.
- E. To protect the product from external force, put a covering lens (acrylic board or similar board) and keep an appropriate gap between them.
- F. Transparent electrodes may be disconnected if the panel is used under environmental conditions where dew condensation occurs.
- G. Property of semiconductor devices may be affected when they are exposed to light, possibly resulting in IC malfunctions.
- H. To prevent such IC malfunctions, your design and mounting layout shall be done in the way that the IC is not exposed to light in actual use.

11.3 Static Electricity

- A. Ground soldering iron tips, tools and testers when they are in operation.
- B. Ground your body when handling the products.
- C. Power on the LCD module before applying the voltage to the input terminals.
- D. Do not apply voltage which exceeds the absolute maximum rating.
- E. Store the products in an anti-electrostatic bag or container.

11.4 Storage

- A. Store the products in a dark place at $+25^{\circ}\text{C} \pm 10^{\circ}\text{C}$ with low humidity (40% RH to 60% RH). Don't expose to sunlight or fluorescent light.
- B. Storage in a clean environment, free from dust, active gas, and solvent.

11.5 Cleaning

- A. Do not wipe the touch panel with dry cloth, as it may cause scratch.
- B. Wipe off the stain on the product by using soft cloth moistened with ethanol. Do not allow ethanol to get in between the upper film and the bottom glass. It may cause peeling issue or defective operation. Do not use any organic solvent or detergent other than ethanol.

11.6 Cautions for installing and assembling

- A. Bezel edge must be positioned in the area between the Active area and View area. The bezel may press the touch screen and cause activation if the edge touches the active area. A gap of approximately 0.5mm is needed between the bezel and the top electrode. It may cause unexpected activation if the gap is too narrow. There is a tolerance of 0.2 to 0.3mm for the outside dimensions of the touch panel and tail. A gap must be made to absorb the tolerance in the case and connector.
- B. In order to make the display assembly stable and firm, DLC recommends to design some supporting at the display backside, especially for the display with tape-attached touch panel, such supporting is important and essential, or else, the display may drop-off from front after some period of time.
- C. Do not display the fixed pattern for a long time because it may develop image sticking due to the LCD structure. If the screen is displayed with fixed pattern, use a screen saver.

