

# PiTek

## Product Specification

1.63" COLOR AMOLED MODULE

MODEL NAME: D5' &\$' &\$5

<  >Preliminary Specification  
<  >Final Specification



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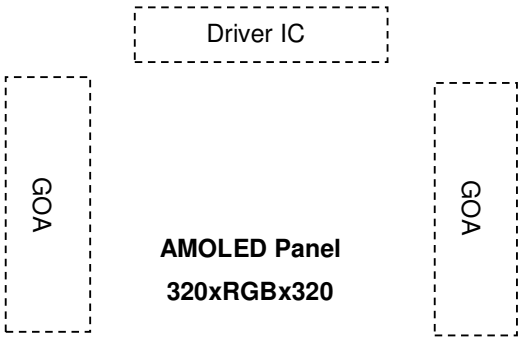
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### A. General Specification

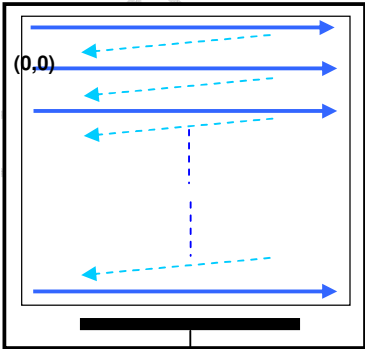
#### 1. Physical Specifications

|   | Item                         | Description                   | Remark    |
|---|------------------------------|-------------------------------|-----------|
| 1 | Screen Size (inch)           | 1.63"                         |           |
| 2 | Display Mode                 | AMOLED                        |           |
| 3 | Display Resolution (dot)     | 320xRGBx320                   |           |
| 4 | Active Area (mm*mm)          | 29.28 (H)×29.28(V)            |           |
| 5 | Display Color (M)            | 16.7                          |           |
| 6 | Brightness (nits)            | 300                           |           |
| 7 | Interface                    | MIPI DSI                      |           |
| 8 | Outline Dimension (mm*mm*mm) | 32.08 (H) × 36.48(V) × 0.7(T) | cell+foam |

#### 2. Module Block Diagram



#### 3. Panel Scan direction



Driver IC Side

## B. Electrical Specifications

### 1. Main FPC Pin assignment — AMOLED Panel Input/Output Signal Interface

Recommended connector: AXE520124 (Panasonic)

| FPC | Pin_name | I/O | Description  |
|-----|----------|-----|--|
| 1   | ELVSS    | P   | AMOLED power Negative  |
| 2   | ELVSS    | P   | AMOLED power Negative  |
| 3   | ELVSS    | P   | AMOLED power Negative  |
| 4   | VDD      | P   | Power supply for analog  |
| 5   | IOVDD    | P   | Power supply for Interface system except MIPI interface              |
| 6   | GND      | P   | GND  |
| 7   | TE       | O   | Vsync(vertical sync)signal output from panel to avoid tearing effect |
| 8   | MTP      | I   | MTP(need to indicate to connect GND or NC)                           |
| 9   | RESX     | I   | Device reset signal (0 : Enable ; 1: Disable )                       |
| 10  | SWIRE    | O   | SWIRE signal for PWR IC control                                      |
| 11  | ELVDD    | P   | AMOLED power positive  |
| 12  | ELVDD    | P   | AMOLED power positive  |
| 13  | ELVDD    | P   | AMOLED power positive  |
| 14  | GND      | P   | GND  |
| 15  | DSI_D0N  | I/O | MIPI data negative signal  |
| 16  | DSI_D0P  | I/O | MIPI data positive signal  |
| 17  | GND      | P   | GND  |
| 18  | DSI_CLKN | I   | MIPI strobe negative signal  |
| 19  | DSI_CLKP | I   | MIPI strobe positive signal  |
| 20  | GND      | P   | GND  |

Note: I = input ; O = output ; P = Power ; I/O = input / Output

## 2. Absolute maximum ratings

| Item                 | Symbol | Min. | Max. | Unit | Remark |
|----------------------|--------|------|------|------|--------|
| Digital Power supply | IOVDD  | -0.3 | 5.5  | V    |        |
| Analog Power supply  | VDD    | -0.3 | 5.5  | V    |        |
| ELVDD power supply   | ELVDD  | -    | 5.0  | V    |        |
| ELVSS power supply   | ELVSS  | -5.0 | -    | V    |        |

Note : If the module exceeds the absolute maximum ratings, it may be damaged permanently. Also, if the module operates with the absolute maximum ratings for a long time, the reliability may drop.

## C. Electrical Characteristics

### 1. DC Operating Conditions

| Item                  |         | Symbol   | Min.              | Typ.  | Max.              | Unit | Remark  |
|-----------------------|---------|----------|-------------------|-------|-------------------|------|---------|
| Digital Power supply  |         | IOVDD    | 1.65              | 1.8   | 1.95              | V    | Note1   |
| Analog Power supply   |         | VDD      | 2.8               | 3.0   | 3.1               | V    | Note1   |
| ELVDD power supply    |         | ELVDD    | 4.57              | 4.60  | 4.63              | V    | Note1,2 |
| ELVSS power supply    |         | ELVSS    | -3.35             | -3.40 | -3.45             | V    | Note1   |
| Input Signal Voltage  | H Level | $V_{IH}$ | $0.8 \cdot IOVDD$ | -     | IOVDD             | V    | Note1   |
|                       | L Level | $V_{IL}$ | 0                 | -     | $0.2 \cdot IOVDD$ | V    |         |
| Output Signal Voltage | H Level | $V_{OH}$ | $0.8 \cdot IOVDD$ | -     | IOVDD             | V    | Note1   |
|                       | L Level | $V_{OL}$ | 0                 | -     | $0.2 \cdot IOVDD$ | V    | Note1   |

Note 1: The operation is guaranteed under the recommended operating conditions only. The operation is not guaranteed if a quick voltage change occurs during the operation. To prevent the noise, a bypass capacitor must be inserted into the line closed to the power pin.

Note 2 : TPS65631W Positive output voltage =  $4.6V \pm 0.8\%$  at  $-40^{\circ}C \leq Ta \leq +85^{\circ}C$

### 2. Display Current Consumption

| Item               |               | Symbol      | Condition   | Min. | Typ. | Max.  | Unit | Remark   |
|--------------------|---------------|-------------|-------------|------|------|-------|------|----------|
| <b>Panel Power</b> |               | $P_{NL}$    | ELVDD:4.6V  | --   | --   | 138.4 | mW   | Note1,2, |
|                    |               | $I_{NL}$    | ELVSS:-3.4V | --   | --   | 17.3  | mA   | Note1,2, |
| <b>IC</b>          | <b>Normal</b> | $P_{VDD}$   | VDD : 3.0V  | --   | 25.2 | 39.3  | mW   | Note2,   |
|                    |               | $I_{VDD}$   |             | --   | 8.4  | 13.1  | mA   | Note2,   |
|                    |               | $P_{IOVDD}$ | IOVDD :1.8V | --   | 18.0 | 19.8  | uW   | Note2,   |
|                    |               | $I_{IOVDD}$ |             | --   | 10.0 | 11.0  | uA   | Note2,   |
|                    | <b>Idle</b>   | $P_{VDD}$   | VDD : 3.0V  | --   | 12.0 | 15.3  | mW   | Note3,   |
|                    |               | $I_{VDD}$   |             | --   | 4.0  | 5.1   | mA   | Note3,   |
|                    |               | $P_{IOVDD}$ | IOVDD :1.8V | --   | 18.0 | 19.8  | uW   | Note3,   |
|                    |               | $I_{IOVDD}$ |             | --   | 10.0 | 11.0  | uA   | Note3,   |

Note 1: Based on L255 (300nits) full white pattern

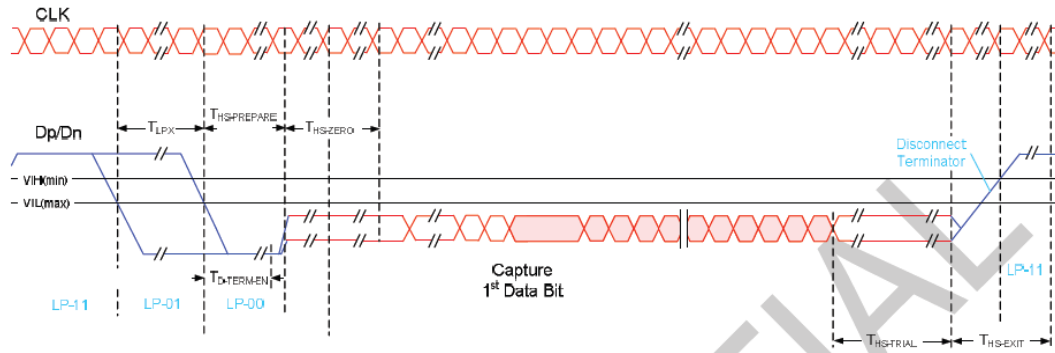
Note 2: Testing in MIPI-DSI frame rate 60Hz CMD mode.

Note 3: Testing in MIPI-DSI frame rate 30Hz CMD mode.

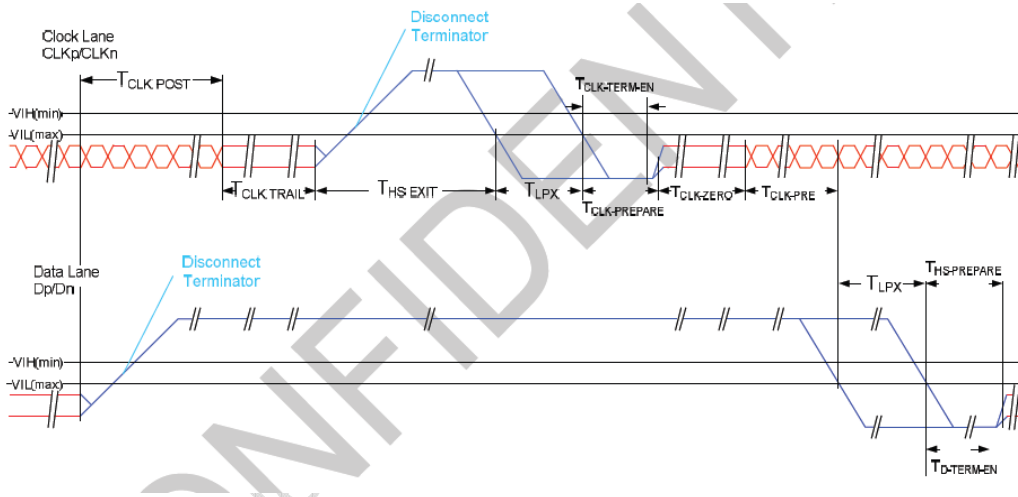
## D. AC Characteristics

### 1. MIPI Interface Characteristics

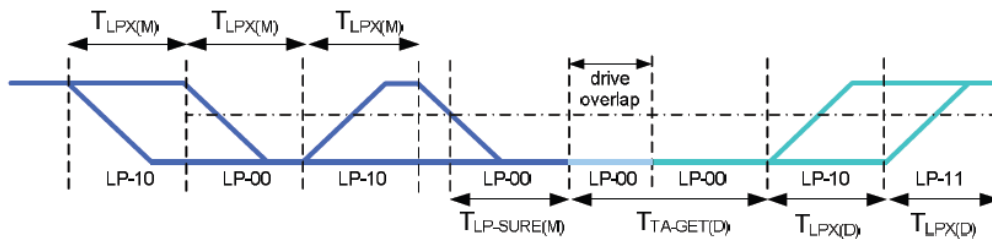
#### HS Data Transmission Burst



#### HS clock transmission



#### Turnaround Procedure





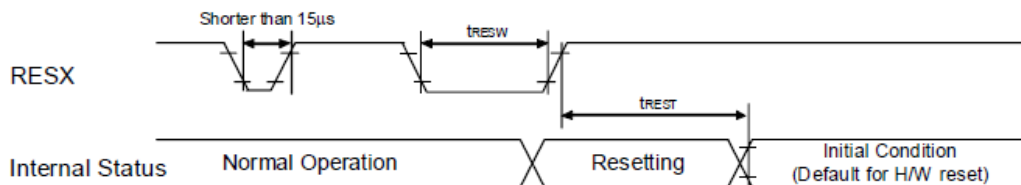
**Timing Parameters**

| Symbol                           | 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  | $40ns + 4*UI$                      |     | $60 ns + 6*UI$ | 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   | $96*UI$                            |     |                | ns   |
| $T_{LPX(M)}$                     | Transmitted length of any Low-Power state  | 100                                |     | 150            | ns   |

|                  |   |                  |  |                  |    |
|------------------|---|------------------|--|------------------|----|
|                  | period of MCU to display module   |                  |  |                  |    |
| $T_{TA-SURE(M)}$ | 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 |
| $T_{LPX(D)}$     | Transmitted length of any Low-Power state period of display module to MCU   | 50               |  | 150              | ns |
| $T_{TA-GET(D)}$  | Time that the display module drives the Bridge state (LP-00) after accepting control during a Link Turnaround.                  | $5 * T_{LPX(D)}$ |  |                  | ns |
| $T_{TA-GO(D)}$   | Time that the display module drives the Bridge state (LP-00) before releasing control during a Link Turnaround.                 | $4 * T_{LPX(D)}$ |  |                  | ns |
| $T_{TA-SURE(D)}$ | 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. Display RESET Timing Characteristics

### Reset input timing



IOVDD=1.65 to 1.95V, VDD=2.8 to 3.1V, AGND=DGND=0V, Ta=-40 to 85°C

### Timing Parameters

| Symbol     | Parameter                 | Related Pins | MIN | TYP | MAX | Note                                     | Unit    |
|------------|---------------------------|--------------|-----|-----|-----|--|---------|
| $t_{RESW}$ | *1) Reset low pulse width | RESX         | 15  | -   | -   | -  | $\mu s$ |
| $t_{REST}$ | *2) Reset complete time   | -            | -   | -   | 5   | When reset applied during Sleep in mode  | ms      |
|            |                           | -            | -   | -   | 120 | When reset applied during Sleep out mode | ms      |

Note 1. Spike due to an electrostatic discharge on RESX line does not cause irregular system reset according to the table below.

| RESX Pulse                       | Action   |
|----------------------------------|--|
| Shorter than 5 $\mu s$           | Reset Rejected   |
| Longer than 15 $\mu s$           | Reset  |
| Between 5 $\mu s$ and 15 $\mu s$ | Reset starts<br>(It depends on voltage and temperature condition.) |

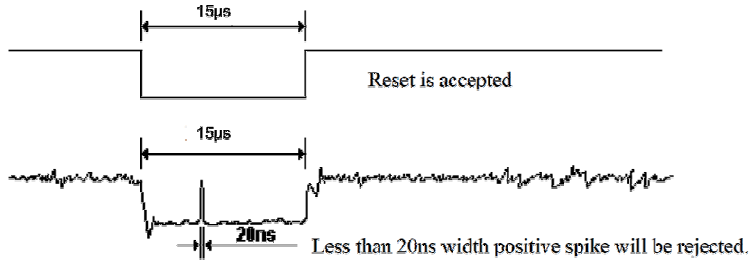
Note 2. During the resetting period, the display will be blanked (The display is entering blanking sequence, which maximum time is 120 ms, when Reset Starts in Sleep Out –mode. The display

remains the blank state in Sleep In –mode) and then return to Default condition for H/W reset.

Note 3. During Reset Complete Time, data in OTP will be latched to internal register during this period.

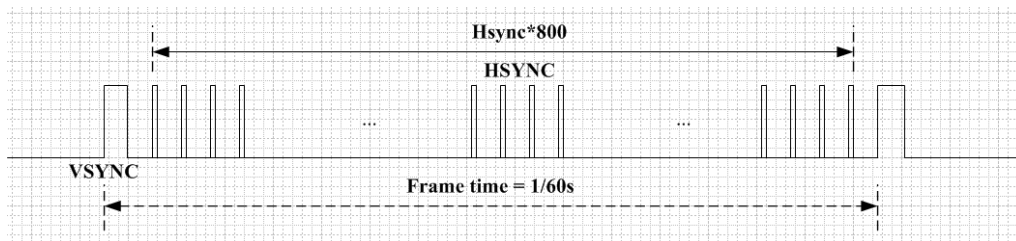
This loading is done every time when there is H/W reset complete time ( $t_{REST}$ ) within 5ms after a rising edge of RESX.

Note 4. Spike Rejection also applies during a valid reset pulse as shown below:



Note 5. It is necessary to wait 5msec after releasing RESX before sending commands. Also Sleep Out command cannot be sent for 120msec.

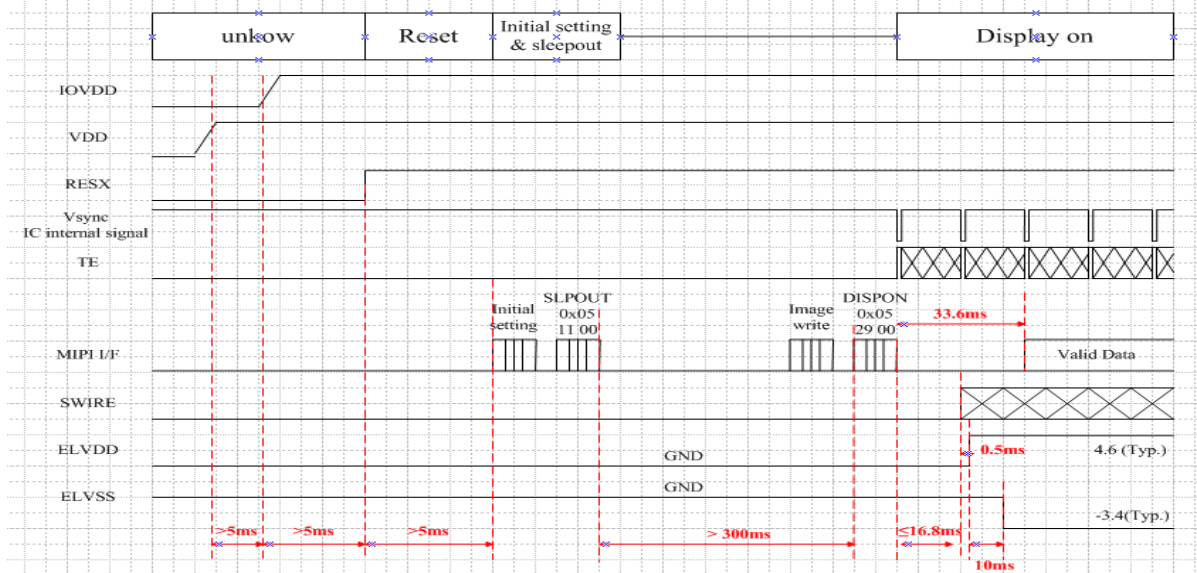
### 3. TE Timing Characteristics



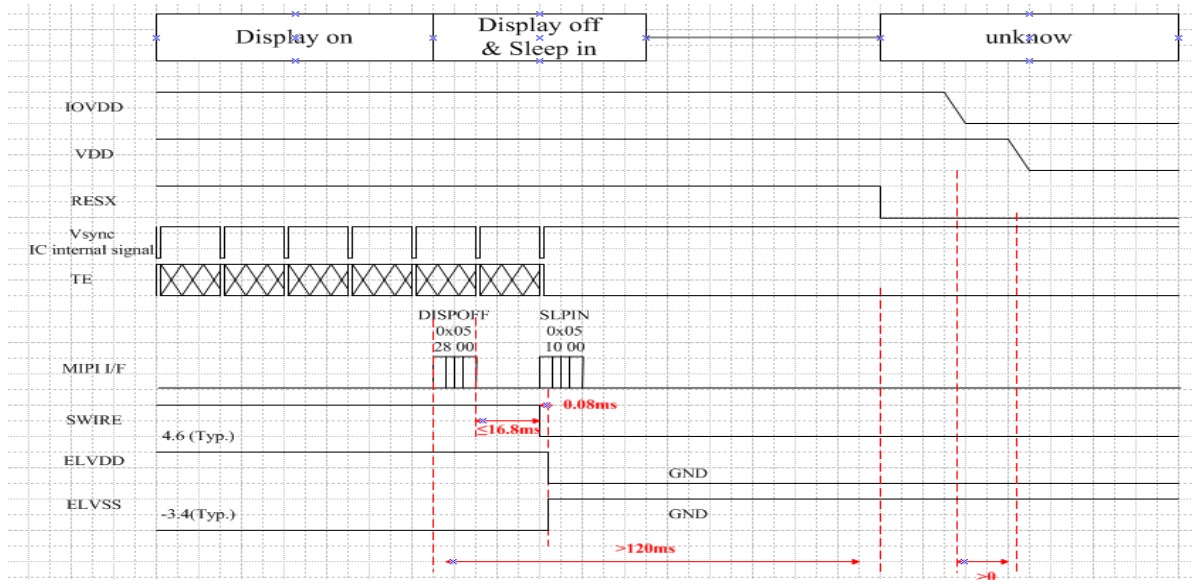
## E. Recommended Operating Sequence

### 1. Display Power on / off Sequence

#### Power on sequence



#### Power off sequence



## 2. Display Initial code

| Recommended Power on Initial Sequence |                            |            |     |                |         |        |           |               |
|---------------------------------------|----------------------------|------------|-----|----------------|---------|--------|-----------|---------------|
| Step                                  | Instruction/Parameters     | Delay time | R/W | MIPI Data Type | Address |        | Data hex. | Description   |
|                                       |                            |            |     |                | MIPI    | Others |           |               |
| 1                                     | Turn on V <sub>VDD</sub>   |            |     |                |         |        |           | VDD=2.8V~3.1V |
| 2                                     | Turn on V <sub>IOVDD</sub> |            |     |                |         |        |           | IOVDD=1.8V    |
| 3                                     | Delay                      | no limit   |     |                |         |        |           |               |
| 4                                     | REST pin low               | 20us       |     |                |         |        |           |               |
| 5                                     | REST pin high              |            |     |                |         |        |           |               |
| 6                                     | Delay                      | 5 ms       |     |                |         |        |           |               |
| 7                                     |                            |            | W   | 0x39           | F0      | F000   | 55        |               |
| 8                                     |                            |            | W   |                |         | F001   | AA        |               |
| 9                                     |                            |            | W   |                |         | F002   | 52        |               |
| 10                                    |                            |            | W   |                |         | F003   | 08        |               |
| 11                                    |                            |            | W   |                |         | F004   | 00        |               |
| 12                                    |                            |            | W   | 0x39           | BD      | BD00   | 01        |               |
| 13                                    |                            |            | W   |                |         | BD01   | 90        |               |
| 14                                    |                            |            | W   |                |         | BD02   | 14        |               |
| 15                                    |                            |            | W   |                |         | BD03   | 14        |               |
| 16                                    |                            |            | W   |                |         | BD04   | 00        |               |
| 12                                    |                            |            | W   | 0x39           | BE      | BE00   | 01        |               |
| 13                                    |                            |            | W   |                |         | BE01   | 90        |               |
| 14                                    |                            |            | W   |                |         | BE02   | 14        |               |
| 15                                    |                            |            | W   |                |         | BE03   | 14        |               |
| 16                                    |                            |            | W   |                |         | BE04   | 01        |               |
| 12                                    |                            |            | W   | 0x39           | BF      | BF00   | 01        |               |
| 13                                    |                            |            | W   |                |         | BF01   | 90        |               |
| 14                                    |                            |            | W   |                |         | BF02   | 14        |               |
| 15                                    |                            |            | W   |                |         | BF03   | 14        |               |
| 16                                    |                            |            | W   |                |         | BF04   | 00        |               |
| 12                                    |                            |            | W   | 0x39           | BB      | BB00   | 07        |               |
| 13                                    |                            |            | W   |                |         | BB01   | 07        |               |
| 14                                    |                            |            | W   |                |         | BB02   | 07        |               |
| 17                                    |                            |            | W   | 0x39           | C7      | C700   | 40        |               |
| 18                                    |                            |            | W   | 0x39           | F0      | F000   | 55        |               |
| 19                                    |                            |            | W   |                |         | F001   | AA        |               |
| 20                                    |                            |            | W   |                |         | F002   | 52        |               |
| 21                                    |                            |            | W   |                |         | F003   | 08        |               |

|    |  |   |      |    |      |    |  |
|----|--|---|------|----|------|----|--|
| 22 |  | W |      |    | F004 | 02 |  |
| 23 |  | W | 0x39 | FE | FE00 | 08 |  |
| 24 |  | W |      |    | FE01 | 50 |  |
| 25 |  | W | 0x39 | C3 | C300 | F2 |  |
| 26 |  | W |      |    | C301 | 95 |  |
| 27 |  | W |      |    | C302 | 04 |  |
| 28 |  | W | 0x15 | CA | CA00 | 04 |  |
| 29 |  | W | 0x39 | F0 | F000 | 55 |  |
| 30 |  | W |      |    | F001 | AA |  |
| 31 |  | W |      |    | F002 | 52 |  |
| 32 |  | W |      |    | F003 | 08 |  |
| 33 |  | W |      |    | F004 | 01 |  |
| 34 |  | W | 0x39 | B0 | B000 | 03 |  |
| 35 |  | W |      |    | B001 | 03 |  |
| 36 |  | W |      |    | B002 | 03 |  |
| 37 |  | W | 0x39 | B1 | B100 | 05 |  |
| 38 |  | W |      |    | B101 | 05 |  |
| 39 |  | W |      |    | B102 | 05 |  |
| 40 |  | W | 0x39 | B2 | B200 | 01 |  |
| 41 |  | W |      |    | B201 | 01 |  |
| 42 |  | W |      |    | B202 | 01 |  |
| 43 |  | W | 0x39 | B4 | B400 | 07 |  |
| 44 |  | W |      |    | B401 | 07 |  |
| 45 |  | W |      |    | B402 | 07 |  |
| 46 |  | W | 0x39 | B5 | B500 | 03 |  |
| 47 |  | W |      |    | B501 | 03 |  |
| 48 |  | W |      |    | B502 | 03 |  |
| 49 |  | W | 0x39 | B6 | B600 | 53 |  |
| 50 |  | W |      |    | B601 | 53 |  |
| 51 |  | W |      |    | B602 | 53 |  |
| 52 |  | W | 0x39 | B7 | B700 | 33 |  |
| 53 |  | W |      |    | B701 | 33 |  |
| 54 |  | W |      |    | B702 | 33 |  |
| 55 |  | W | 0x39 | B8 | B800 | 23 |  |
| 56 |  | W |      |    | B801 | 23 |  |
| 57 |  | W |      |    | B802 | 23 |  |
| 58 |  | W | 0x39 | B9 | B900 | 03 |  |
| 59 |  | W |      |    | B901 | 03 |  |
| 60 |  | W |      |    | B902 | 03 |  |

| 61                                  |                           |            | W   |                |         | BA00   | 03        |               |
|-------------------------------------|---------------------------|------------|-----|----------------|---------|--------|-----------|---------------|
| 62                                  |                           |            | W   | 0x39           | BA      | BA01   | 03        |               |
| 63                                  |                           |            | W   |                |         | BA02   | 03        |               |
| 64                                  |                           |            | W   |                |         | BE00   | 32        |               |
| 65                                  |                           |            | W   | 0x39           | BE      | BE01   | 30        |               |
| 66                                  |                           |            | W   |                |         | BE02   | 70        |               |
| 70                                  |                           |            | W   |                |         | CF00   | FF        |               |
| 71                                  |                           |            | W   |                |         | CF01   | D4        |               |
| 72                                  |                           |            | W   |                |         | CF02   | 95        |               |
| 73                                  |                           |            | W   | 0x39           | CF      | CF03   | EF        |               |
| 74                                  |                           |            | W   |                |         | CF04   | 4F        |               |
| 75                                  |                           |            | W   |                |         | CF05   | 00        |               |
| 67                                  |                           |            | W   |                |         | CF06   | 04        |               |
| 67                                  |                           |            | W   | 0x15           | 35      | 3500   | 01        |               |
| 68                                  |                           |            | W   | 0x15           | 36      | 3600   | 00        |               |
| 69                                  |                           |            | W   | 0x15           | C0      | C000   | 20        |               |
| 70                                  |                           |            | W   |                |         | C200   | 17        |               |
| 71                                  |                           |            | W   |                |         | C201   | 17        |               |
| 72                                  |                           |            | W   | 0x39           | C2      | C202   | 17        |               |
| 73                                  |                           |            | W   |                |         | C203   | 17        |               |
| 74                                  |                           |            | W   |                |         | C204   | 17        |               |
| 75                                  |                           |            | W   |                |         | C205   | 0B        |               |
| 76                                  | Turn on peripheral packet |            |     | 0x32           |         |        |           | Video Turn On |
| 77                                  | Sleep out (SLPOUT)        |            | W   | 0x05           | 11      | 1100   | 00        |               |
| 78                                  | Delay                     | 300 ms     |     |                |         |        |           |               |
| 79                                  | Display on (DISPON)       |            | W   | 0x05           | 29      | 2900   | 00        |               |
| Recommended Power off Mode Sequence |                           |            |     |                |         |        |           |               |
| Step                                | Instruction/Parameters    | Delay time | R/W | MIPI Data Type | Address |        | Data hex. | Description   |
|                                     |                           |            |     |                | MIPI    | Others |           |               |
| 1                                   | Display off (DISPOFF)     |            | W   | 0x05           | 28      | 2800   | 00        |               |
| 2                                   | Sleep in (SLPIN)          |            | W   | 0x05           | 10      | 1000   | 00        |               |
| 3                                   | delay                     | 120ms      |     |                |         |        |           |               |
| 4                                   | Power off                 |            |     |                |         |        |           |               |

## F. Brightness Control

| Recommended Power on Initial Sequence |            |     |                |         |        |           | Description                 |
|---------------------------------------|------------|-----|----------------|---------|--------|-----------|-----------------------------|
| Step                                  | Delay time | R/W | MIPI Data Type | Address |        | Data hex. |                             |
|                                       |            |     |                | MIPI    | Others |           |                             |
| 1                                     |            | W   | 0x39           | F0      | F000   | 55        | CF00 control Max Brightness |
| 2                                     |            | W   |                |         | F001   | AA        |                             |
| 3                                     |            | W   |                |         | F002   | 52        |                             |
| 4                                     |            | W   |                |         | F003   | 08        |                             |
| 5                                     |            | W   |                |         | F004   | 01        |                             |
| 6                                     |            | W   | 0x39           | CF      | CF00   | FF        |                             |
| 7                                     |            | W   |                |         | CF01   | D4        |                             |
| 8                                     |            | W   |                |         | CF02   | 95        |                             |
| 9                                     |            | W   |                |         | CF03   | EF        |                             |
| 10                                    |            | W   |                |         | CF04   | 4F        |                             |
| 11                                    |            | W   |                |         | CF05   | 00        |                             |
| 12                                    |            | W   |                |         | CF06   | 04        |                             |

| Address |        | Data hex. | Gray Level |
|---------|--------|-----------|------------|
| MIPI    | Others |           |            |
| CF      | CF00   | 00        | L0         |
| ⋮       | ⋮      | ⋮         | ⋮          |
| CF      | CF00   | 80        | L128       |
| ⋮       | ⋮      | ⋮         | ⋮          |
| CF      | CF00   | FF        | L255       |

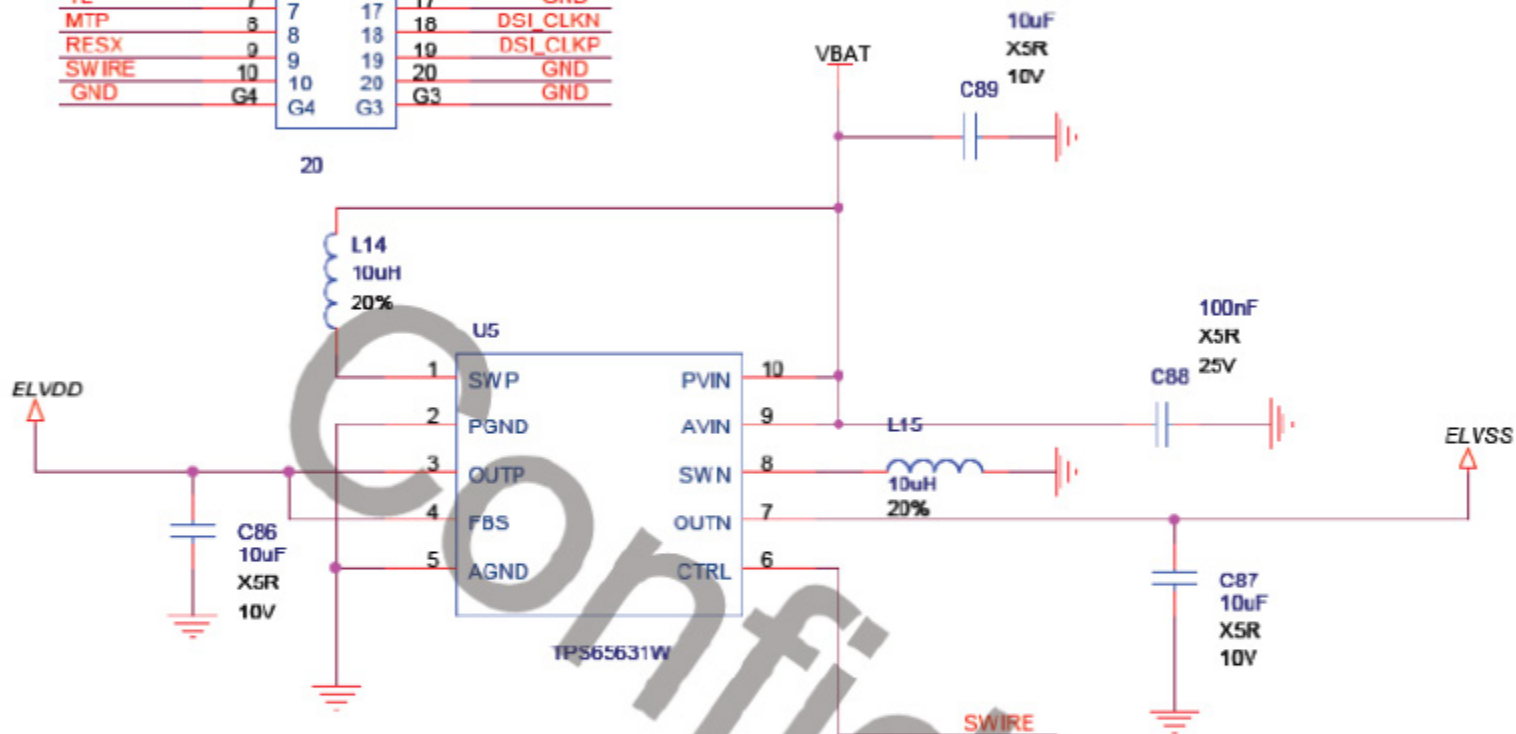


# G. Application Circuit

Version 0.0

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| U3    |    |    |          |
|-------|----|----|----------|
| GND   | G1 | G2 | GND      |
| ELVSS | 1  | 11 | ELVDD    |
| ELVSS | 2  | 12 | ELVDD    |
| ELVSS | 3  | 13 | ELVDD    |
| VDD   | 4  | 14 | GND      |
| IOVDD | 5  | 15 | DSI_D0N  |
| GND   | 6  | 16 | DSI_D0P  |
| TE    | 7  | 17 | GND      |
| MTP   | 8  | 18 | DSI_CLKN |
| RESX  | 9  | 19 | DSI_CLKP |
| SWIRE | 10 | 20 | GND      |
| GND   | G4 | G3 | GND      |



OLED POWER IC  
 Input: VBAT (2.9~4.4V)  
 Output: ELVDD, ELVSS

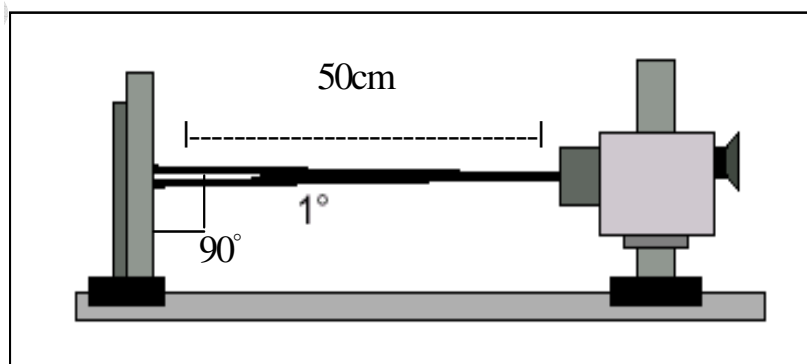
## H. Specifications

| Item   | Abbr.            | Min.      | Typ.  | Max.  | Unit  | Remark |         |
|--|------------------|-----------|-------|-------|-------|--------|---------|
| Optical Characteristic<br>( w/o Cover Lens ) | Brightness       | 270       | 300   | 330   | nits  | Note 3 |         |
|  | Wx               | 0.275     | 0.305 | 0.335 |       |        |         |
|  | Wy               | 0.290     | 0.320 | 0.350 |       |        |         |
| Contrast ratio                               | @25deg           | 10000     | --    | --    |       | Note 4 |         |
| Brightness Uniformity                        | 300nits          | 75%       | --    | --    |       | Note 5 |         |
| Viewing angle<br>CR>1600                     | Top              | 80°       | --    | --    | deg   | Note 6 |         |
|  | Bottom           | 80°       | --    | --    | deg   |        |         |
|  | Left             | 80°       | --    | --    | deg   |        |         |
|  | Right            | 80°       | --    | --    | deg   |        |         |
| Color  | Red              | CIE1931 x | 0.645 | 0.675 | 0.705 | Red    | Note 7  |
|  | Red              | CIE1931 y | 0.295 | 0.325 | 0.355 | Red    |         |
|  | Green            | CIE1931 x | 0.186 | 0.236 | 0.286 | Green  |         |
|  | Green            | CIE1931 y | 0.661 | 0.711 | 0.761 | Green  |         |
|  | Blue             | CIE1931 x | 0.090 | 0.130 | 0.170 | Blue   |         |
|  | Blue             | CIE1931 y | 0.025 | 0.065 | 0.105 | Blue   |         |
| NTSC   | CIE x , y        | 90        | 100   | --    | %     |        |         |
| Life time                                    | T50              | 25°C      | --    | 50K   | --    | hr     | Note 8  |
| Crosstalk                                    | 300nits          | Vertical  | --    | --    | 5.0   | %      | Note 9  |
| Flicker                                      |                  |           | --    | --    | -30   | db     | Note 10 |
| Optical Switching Time                       | +25°B/W(Tr+Tf)/2 |           | --    | --    | 1     | ms     | Note 11 |
| Gamma  | $\gamma$         | 2.0       | 2.2   | 2.4   |       |        |         |

Note 1: Ambient temperature =25 °C±2 °C

Note 2: To be measured in the dark room.

Note 3: The brightness measurement shall be done at the center of the display with a full white image. The brightness shall meet the following spec, at 100% check.

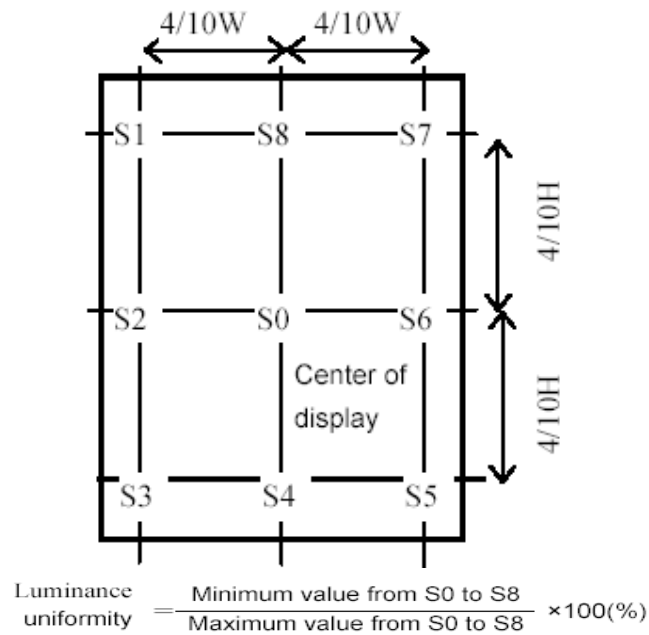


Note 4: Definition of contrast ratio:

Contrast ratio is calculated with the following formula:

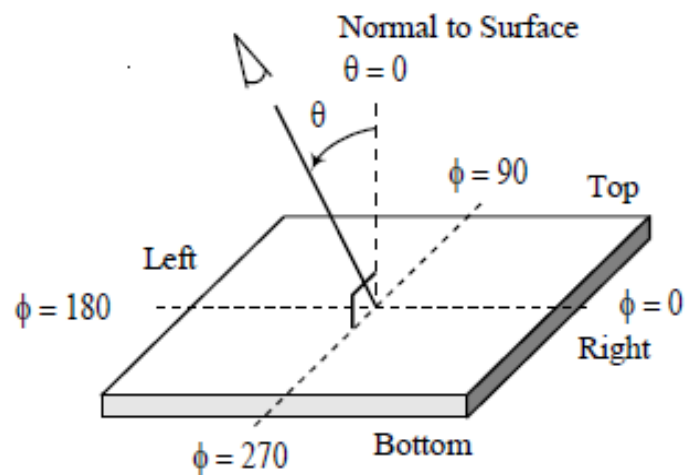
$$\text{Contrast ratio (CR)} = \frac{\text{Photo detector output when OLED is at "White" state}}{\text{Photo detector output when OLED is at "Black"}}$$

Note 5: Uniformity. Refer to figure as below



Note 6: Definition of viewing angle :

The optical performance is specified as the driver IC located at  $\approx 270^\circ$



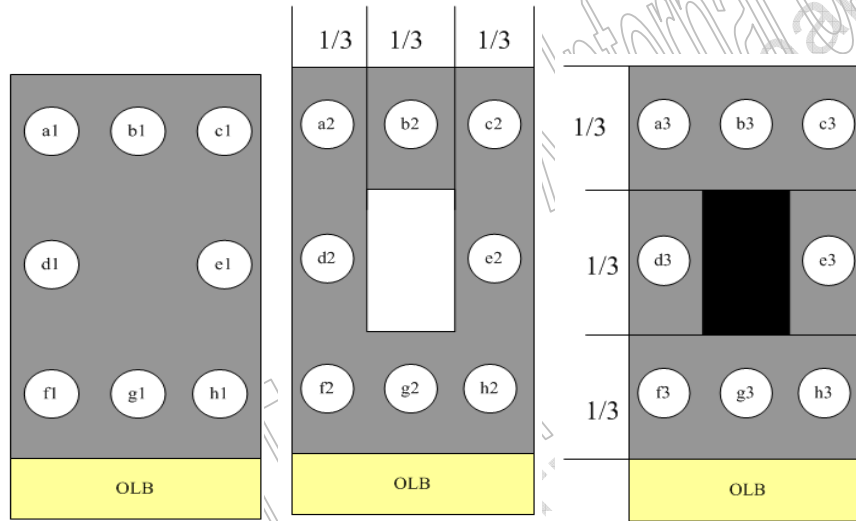
Note 7: The color chromaticity should be based on sample performance because new OLED material should be verified later.

Note 8: Time to 50% Luminance 25°C 30 Loading

Life Time (Typ) : 250 cd/m<sup>2</sup> 10K hrs , Life Time :170 cd/m<sup>2</sup> 20K hrs , Life Time :140 cd/m<sup>2</sup> 30K hrs

Life Time (Typ) : 125 cd/m<sup>2</sup> 40K hrs . Life Time :100 cd/m<sup>2</sup> 50K hrs ,

Note 9: Cross-talk



$$CrossTalk\_White = \left[ \begin{array}{l} 1 - \left( \frac{b2}{a2} + \frac{b1}{a1} \right) \times 100\%, 1 - \left( \frac{b2}{c2} + \frac{b1}{c1} \right) \times 100\%, \\ 1 - \left( \frac{d2}{a2} + \frac{d1}{a1} \right) \times 100\%, 1 - \left( \frac{d2}{f2} + \frac{d1}{f1} \right) \times 100\%, \\ 1 - \left( \frac{e2}{c2} + \frac{e1}{c1} \right) \times 100\%, 1 - \left( \frac{e2}{h2} + \frac{e1}{h1} \right) \times 100\%, \\ 1 - \left( \frac{g2}{f2} + \frac{g1}{f1} \right) \times 100\%, 1 - \left( \frac{g2}{h2} + \frac{g1}{h1} \right) \times 100\% \end{array} \right]$$

$$CrossTalk\_Black = \left[ \begin{array}{l} 1 - \left( \frac{b3}{a3} + \frac{b1}{a1} \right) \times 100\%, 1 - \left( \frac{b3}{c3} + \frac{b1}{c1} \right) \times 100\%, \\ 1 - \left( \frac{d3}{a3} + \frac{d1}{a1} \right) \times 100\%, 1 - \left( \frac{d3}{f3} + \frac{d1}{f1} \right) \times 100\%, \\ 1 - \left( \frac{e3}{c3} + \frac{e1}{c1} \right) \times 100\%, 1 - \left( \frac{e3}{h3} + \frac{e1}{h1} \right) \times 100\%, \\ 1 - \left( \frac{g3}{f3} + \frac{g1}{f1} \right) \times 100\%, 1 - \left( \frac{g3}{h3} + \frac{g1}{h1} \right) \times 100\% \end{array} \right]$$

$$CrossTalk = MAX\{CrossTalk\_White, CrossTalk\_Black\}$$

## Note 10: Flicker

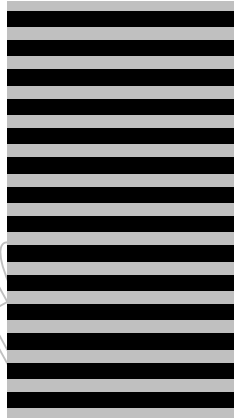
The flicker level is defined using Fast Fourier Transformation (FTT) as follows:

$$Flicker = 20 \log_{10} \left( 2 \frac{f_{FFTC}(n)}{f_{FFTC}(0)} \right) + FS(Hz) \quad (dB)$$

where  $f_{FFTC}(n)$  is the  $n$ th FFT coefficient, and  $f_{FFTC}(0)$  is the 0th FFT coefficient which is DC component.  $FS(Hz)$  is the flicker sensitivity as a function of frequency.

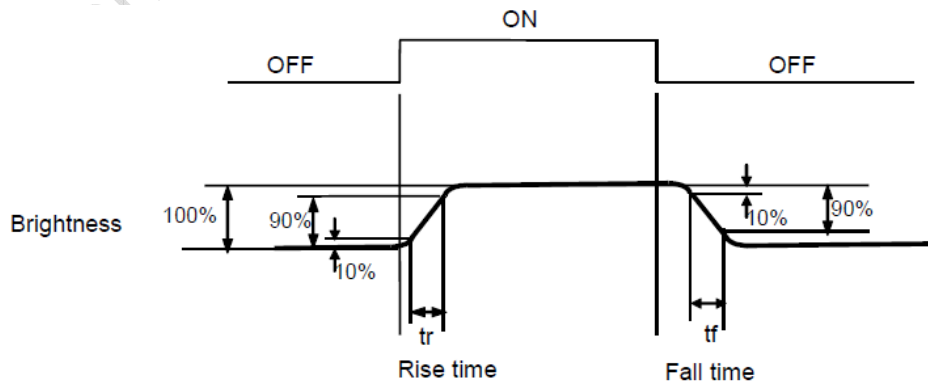
The flicker level shall be measured with the test pattern in below.

The gray levels of test pattern is 128.



## Note 11: Optical Switching Time:

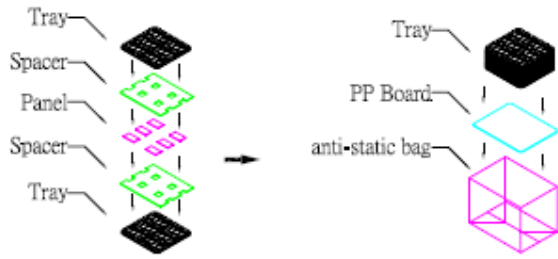
The optical switching time measurements should be performed at driven BLACK and driven WHITE at typ. brightness setting by the driving techniques specified. The luminance should be measured with the emitting display and the detector at  $\theta=0^\circ$  and  $\psi=90^\circ$ . The rise time  $t_r$  is the time between a 10% optically response of the display and a 90% optically response of the display. The fall time  $t_f$  is the time between a 10% optically response of the display and a 90% optically response to the display. The response time is defined as the average of the rise time and the fall time.



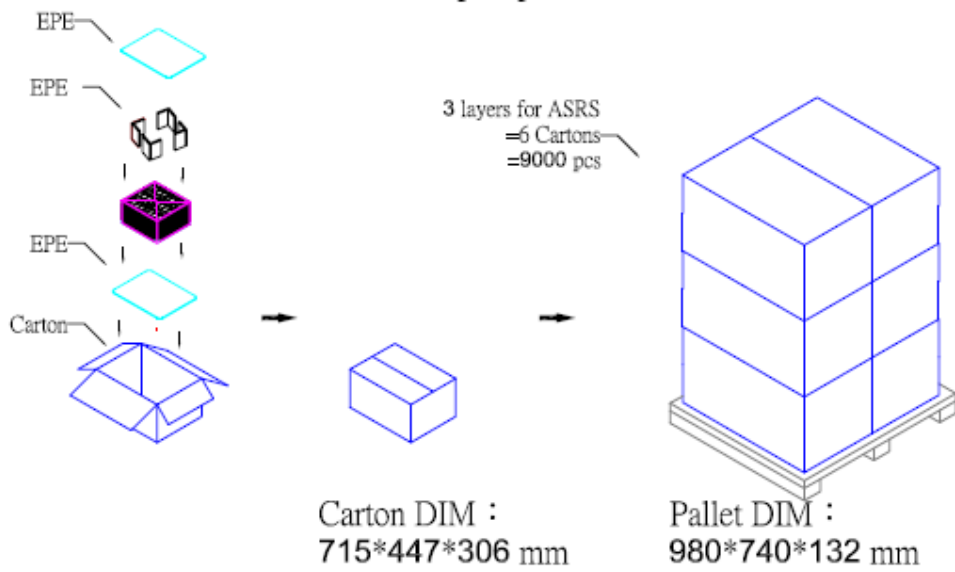
## I. Reliability Test Items

| Category                     | No. | Test items                 | Conditions                               | Remark                   |
|------------------------------|-----|----------------------------|--|--------------------------|
| Reliability<br>(Environment) | 1   | High Temp. Operation       | Ta= 80°C 168hrs                          | Ta: Ambient temperature. |
|                              | 2   | High Temp. Storage         | Ta= 80 °C 168h                           | Non-operation            |
|                              | 3   | Low Temp. Operation        | Ta= -40 °C 168hrs                        |                          |
|                              | 4   | Low Temp. Storage          | Ta= -40 °C 168hr                         | Non-operation            |
|                              | 5   | High Temp./Humi. Operation | Ta= 40 °C. 95% RH 168hrs                 |                          |
|                              | 6   | Thermal Shock              | -40 °C ~80 °C, Dwell for 30 min. 30 cycl | Non-operation            |
|                              | 7   | Vibration test             | Random 1.5G,10~200Hz,30min/axis          | Non-operation            |

## J. Packing



1 tray for 60 pcs Panels    1 set for 25+1 pcs trays  
 =1500 pcs panels



Confidential

Only

# K. Outline Dimension (Tentative)

