



一众显示科技有限公司

TEAM SOURCE DISPLAY TECH. CO, TD.

# TFT-LCD Module Specification

**Module NO.:** TST123HDKK-06

**Version:** V1.2

APPROVAL FOR SPECIFICATION

APPROVAL FOR SAMPLE

| For Customer' s Acceptance: |         |
|-----------------------------|---------|
| Approved by                 | Comment |
|                             |         |

| Team Source Display: |             |             |
|----------------------|-------------|-------------|
| Presented by         | Reviewed by | Approved by |
|                      |             |             |

| Version No. | Date       | Content                   | Remark |
|-------------|------------|---------------------------|--------|
| V1.0        | 2022-7-19  | Initial Release           |        |
| V1.1        | 2022-08-18 | Update optical parameters |        |
| V1.2        | 2024-06-05 | Update INTERFACE PIN      |        |

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# 1 GENERAL DESCRIPTION

## 1.1 Introduction

This is a color active matrix thin film transistor (TFT) liquid crystal display (LCD) that uses a-Si and transmissive TFT as a switching device with normal-black technology. It is composed of a TFT LCD panel, driver IC and back-light. The TFT LCD has 12.3 inch with 1920 x 720 resolution and RoHS directive.

## 1.2 Features

12.3 (8:3 diagonal) inch configuration

Landscape type

Fail detect function

Parallel RGB 8 bits (16.7M)

## 1.3 Applications

TFT LCD Monitor

Industrial Application

Amusement

Vehicle

## 1.4 General information

| Item                | Specification                             | Unit   |
|---------------------|---|--------|
| Diagonal Size       | 12.3                                      | Inch   |
| Resolution          | 1920 (H) × 720 (V)                        | pixels |
| Active area (mm)    | 292.03 (H) × 109.51 (V)                   | mm     |
| Pixel pitch (mm)    | 0.1521 (H) × 0.1521 (V)                   | mm     |
| Pixel Configuration | RGB Vertical stripe                       |        |
| Display mode        | Normally Black                            |        |
| Technology Type     | a-Si                                      |        |
| NTSC                | 70% (Min.) / 75% (Typ.)                   | %      |
| Surface treatment   | HC  |        |
| Border (U/D/L/R)    | 4.58 / 9.45 / 4.25 / 6.25                 | mm     |
| Back-light          | White LED                                 |        |
| Outline Dimension   | 302.53 (H) × 123.54 (V) × 6.51 (D) (Typ.) | mm     |
| Weight              | 327.64 +/- 5%                             | g      |

# 2 ABSOLUTE MAXIMUM RATINGS

## Environment Absolute Rating

| Item                  | Symbol           | Min.  | Max. | Time    | Note |
|-----------------------|------------------|-------|------|---------|------|
| Operating Temperature | T <sub>opa</sub> | -30°C | 85°C | 500 hrs |      |
| Storage Temperature   | T <sub>stg</sub> | -40°C | 90°C | 500 hrs |      |

### 3 OPTICAL CHARACTERISTICS

#### Optical specification

| Item  | Symbol        | Condition  | Min.            | Typ.     | Max.    | Unit     | Note |     |
|---|---------------|--|-----------------|----------|---------|----------|------|-----|
| View Angles                                       | $\Theta_{x+}$ | CR $\geq 10$<br>$\theta_x=0^\circ$ ,<br>$\theta_y=0^\circ$ | 80              | 85       | -       | Degree   | (4)  |     |
|   | $\Theta_{x-}$ |  | 80              | 85       | -       |          |      |     |
|   | $\Theta_{y+}$ |  | 80              | 85       | -       |          |      |     |
|   | $\Theta_{y-}$ |  | 80              | 85       | -       |          |      |     |
| Contrast Ratio                                    | CR            | $\Theta=0^\circ$   | 1200:1          | 1500:1   |         |          | (2)  |     |
| Response time                                     | Tg=25°C       |  | -               | -        | (30)    | ms       | (3)  |     |
|   | Tg=-20°C      |  | -               | -        | (250)   | ms       |      |     |
|   | Tg=-30°C      |  | -               | -        | (450)   | ms       |      |     |
| Only CF Color Chromaticity(CIE1931) Under C-light | White         | $W_x$  | Backlight is on | +/- 0.04 | (0.310) | +/- 0.04 | -    | (1) |
|   |               | $W_y$  |                 |          | (0.380) |          |      |     |
|   | Red           | $R_x$  |                 |          | (0.637) |          |      |     |
|   |               | $R_y$  |                 |          | (0.352) |          |      |     |
|   | Green         | $G_x$  |                 |          | (0.320) |          |      |     |
|   |               | $G_y$  |                 |          | (0.637) |          |      |     |
|   | Blue          | $B_x$  |                 |          | (0.155) |          |      |     |
|   |               | $B_y$  |                 |          | (0.086) |          |      |     |
| Uniformity  | U             |  | 80              | 85       | --      | %        | (1)  |     |
| NTSC  | --            |  | 70              | 75       | --      | %        | (1)  |     |
| Luminance   | L             | -  | 1000            | 1200     | --      | Cd/m     | (1)  |     |

Notes :

(1) The chromaticity coordinates specified in Table 5 should be calculated from the measurement spectrum of all pixels in red, green, blue, and white, which need to be converted to C-light standard light source, and should be measured at the center of the panel.

(2) Definition of Contrast Ratio (CR): The contrast ratio can be calculated by the

following expression,

Contrast Ratio (CR):  $CR=CR_wCRD$

CRW : Luminance of LCD module with full screen white pattern (255,255, 255)

at center point.

CRD : Luminance of LCD module with full screen Dark pattern (0, 0, 0) at center point.

The measure point of the Contrast Ratio is the center of the panel.

(3) Definition of Response time (RT):

The response time is defined as the LCD optical switching time interval between “Bright state” and “Dark state”, TR is the rise time between Luminance rate changed from 10% to 90%, TF is the fall time between Luminance rate changed

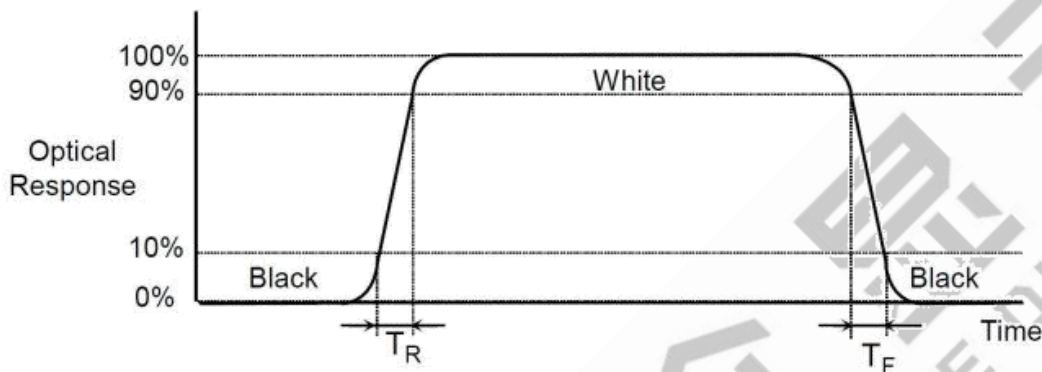


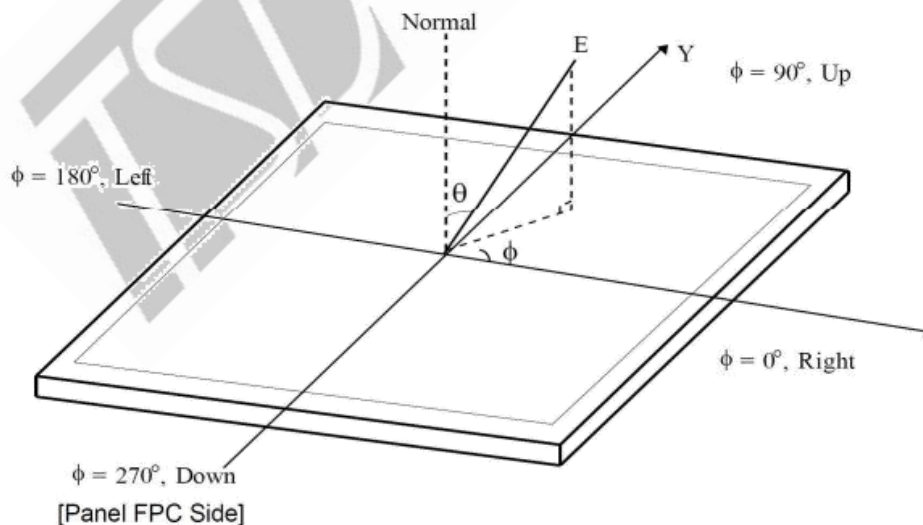
Figure 5. The definition of TR and TF

Measured response time is determined by rise time (TR) and fall time (TF), and shown in Figure 5.

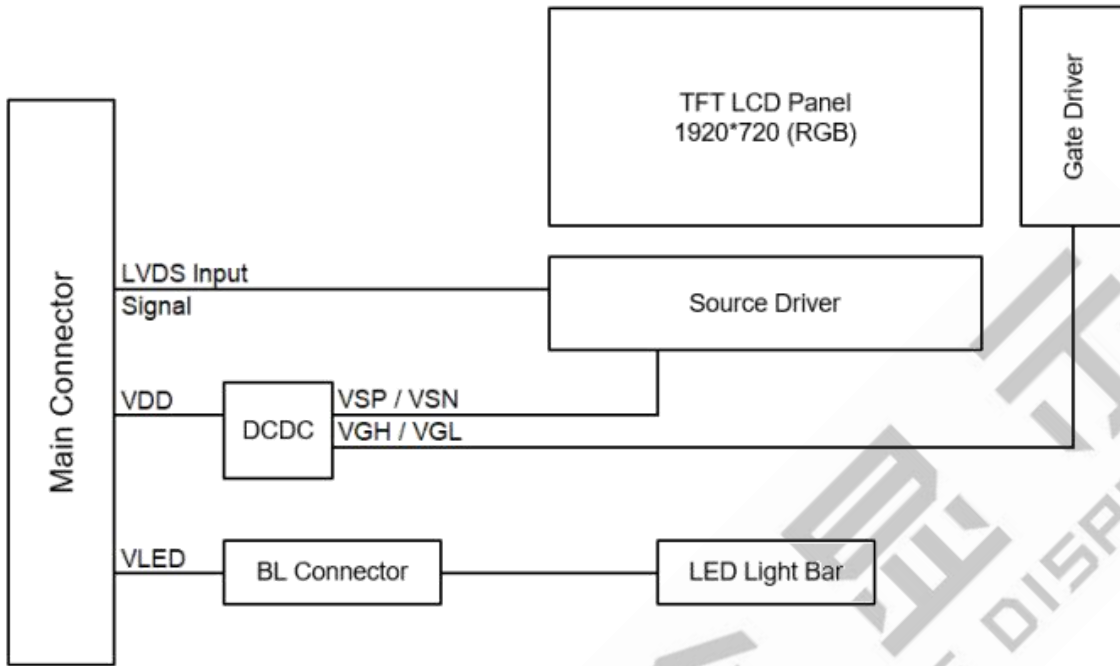
(4) Definition of Viewing angle:

As CR definition is stated in Note(2), the viewing angles are defined when the viewing angle is larger than 10° in four directions relative to the perpendicular direction of the HKC’s module (two vertical angles: up  $\theta_y+$  and down  $\theta_y-$ ; and two horizontal angles: right  $\theta_x+$  and left  $\theta_x-$ ).

The standard setup of measurement is shown in Figure 6.



## 4 BLOCK DIAGRAM



## 5 INTERFACE PIN CONNECTION

### 5.1 FPC Pin Assignment:

The electronics interface connector is 昶通 F05047-50P-U

| NO. | Symbol    | description  |
|-----|-----------|--|
| 1   | GND       | Digital ground   |
| 2   | BIST      | LCD Panel Self Test Enable,<br>When it is not used,<br>connecting to GND is recommended,<br>don't floating |
| 3   | VCC       | Digital Power/Vin =3.3V  |
| 4   | VCC       | Digital Power/Vin =3.3V  |
| 5   | GND       | Digital ground   |
| 6   | GND       | Digital ground   |
| 7   | OTP       | Serial interface OTP power   |
| 8   | NC        | No connector   |
| 9   | GND       | Digital ground   |
| 10  | ORXIN0-   | Negative LVDS differential data input(Odd data)  |
| 11  | ORXIN0+   | Positive LVDS differential data input(Odd data)  |
| 12  | ORXIN1-   | Negative LVDS differential data input(Odd data)  |
| 13  | ORXIN1+   | Positive LVDS differential data input(Odd data)  |
| 14  | ORXIN2-   | Negative LVDS differential data input(Odd data)  |
| 15  | ORXIN2+   | Positive LVDS differential data input(Odd data)  |
| 16  | ORXCLKIN- | Negative LVDS differential data input(Odd clock)   |
| 17  | ORXCLKIN+ | Positive LVDS differential data input(Odd clock)   |
| 18  | ORXIN3-   | Negative LVDS differential data input(Odd data)  |
| 19  | ORXIN3+   | Positive LVDS differential data input(Odd data)  |
| 20  | ERXIN0-   | Negative LVDS differential data input(Even data)   |



|           |           |   |
|-----------|-----------|---|
| <b>21</b> | ERXIN0+   | Positive LVDS differential data input(Even data)  |
| <b>22</b> | ERXIN1-   | Negative LVDS differential data input(Even data)  |
| <b>23</b> | ERXIN1+   | Positive LVDS differential data input(Even data)  |
| <b>24</b> | ERXIN2-   | Negative LVDS differential data input(Even data)  |
| <b>25</b> | ERXIN2+   | Positive LVDS differential data input(Even data)  |
| <b>26</b> | ERXCLKIN- | Negative LVDS differential data input(Even clock) |
| <b>27</b> | ERXCLKIN+ | Positive LVDS differential data input(Even clock) |
| <b>28</b> | ERXIN3-   | Negative LVDS differential data input(Even data)  |
| <b>29</b> | ERXIN3+   | Positive LVDS differential data input(Even data)  |
| <b>30</b> | GND       | Digital ground                                    |
| <b>31</b> | FAULT     | FAULT signal output(normal=H,abnormal=L)          |
| <b>32</b> | RESET     | Global reset pin,active Low                       |
| <b>33</b> | STBYB     | Standby mode,active Low.                          |
| <b>34</b> | CSB       | Serial interface chip enable                      |
| <b>35</b> | SCL       | Serial interface clock input                      |
| <b>36</b> | SDAI      | Serial interface data input                       |
| <b>38</b> | SDAO      | Serial interface data output.                     |
| <b>38</b> | GND       | Digital ground                                    |
| <b>39</b> | GND       | Digital ground                                    |
| <b>40</b> | NC        | No connector                                      |
| <b>41</b> | LEDA      | LED power(Anode)                                  |
| <b>42</b> | LEDA      | LED power(Anode)                                  |
| <b>43</b> | LEDA      | LED power(Anode)                                  |
| <b>44</b> | NC        | No connector                                      |



|    |       |             |
|----|-------|-------------|
| 45 | LEDK  | Cathode1    |
| 46 | LEDK  | Cathode2    |
| 47 | LEDK  | Cathode3    |
| 48 | LEDK  | Cathode4    |
| 49 | NTC_A | NTC_Anode   |
| 50 | NTC_K | NTC_Cathode |

## 6 ELECTRICAL CHARACTERISTICS

### 6.1 Absolute Maximum Ratings

The followings are maximum values which, if exceed, may cause faulty operation or damage to the unit.

The operational and non-operational maximum voltage and current values are listed as below

| Parameter             | Symbol   | Min. | Max.           | Unit | Remarks |
|-----------------------|----------|------|----------------|------|---------|
| Power Supply Voltage  | $V_{DD}$ | -0.3 | 4              | V    | 1       |
| Logic Supply Voltage  | $V_{IN}$ | -0.3 | $V_{DD} + 0.3$ | V    | 2       |
| Operating Temperature | $T_{OP}$ | -30  | 85             | °C   | 3       |
| Storage Temperature   | $T_{ST}$ | -40  | 90             | °C   | 4       |

Note (1) All the parameters specified in the table are absolute maximum rating values that may cause faulty operation or unrecoverable damage, if exceeded. It is recommended to follow the typical value.

Note (2) All the contents of electro-optical specifications and display fineness are guaranteed under Normal Conditions. All the display fineness should be inspected under normal conditions. Normal conditions are defined as follow: Temperature: 25°C, Humidity: 55± 10%RH.

Note (3) Unpredictable results may occur when it was used in extreme conditions.  $T_a$ = Ambient Temperature,  $T_{gs}$ = Glass Surface Temperature. All the display fineness should be inspected under normal conditions.

Note (4) Temperature and relative humidity range are shown in the figure below. Wet bulb temperature should be lower than 57.8°C, and no condensation of water. Besides, protect the module from static electricity.

## 6.2 DC Electrical Characteristics

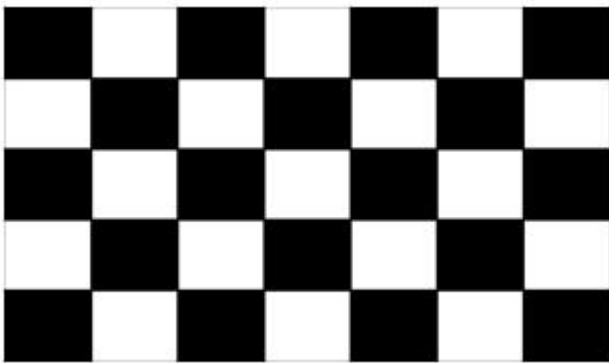
| Parameter                        | Symbol | Min. | Typ. | Max. | Unit | Remarks |
|----------------------------------|--------|------|------|------|------|---------|
| Power Supply Voltage             | VDD    | -    | 3.3  | -    | V    | 2       |
| Permissible Input Ripple Voltage | VRF    | -    | -    | 200  | mV   | -       |
| Power Supply Current             | IDD    | -    | -    | TBD  | mA   | 1       |
| Power Supply Inrush Current      | Inrush | -    | -    | 1.5  | A    | 2       |
| Power Consumption                | Mosaic | -    | -    | TBD  | W    | 1       |

Notes :

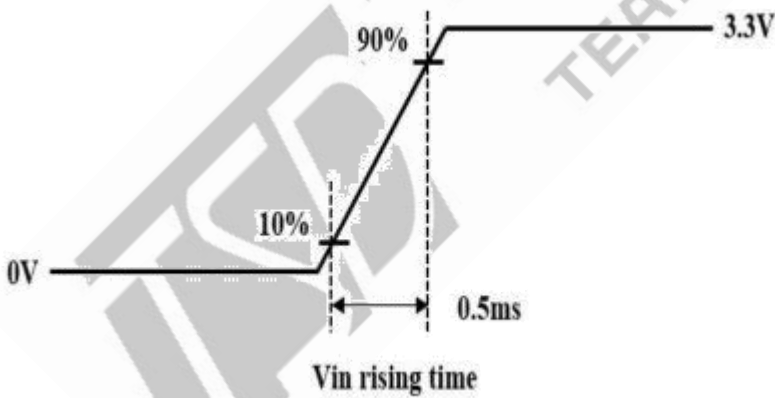
1. The supply voltage is measured and specified at the interface connector of LCM.

The current draw and power consumption specified is for 3.3V at 25 °C.

Mosaic 7\*5 pattern



2. Measure condition :



### 6.3 Measurement Conditions

The table below is the test condition of optical measurement

| Item                  | Symbol  | Value       | Unit               |
|-----------------------|---|-------------|--------------------|
| Ambient Temperature   | $T_A$   | $23 \pm 5$  | $^{\circ}\text{C}$ |
| Ambient Humidity      | $H_A$   | $50 \pm 20$ | % RH               |
| Supply Voltage        | $V_{CC}$  | 3.3         | V                  |
| Driving Signal        | Refer to the typical value in Chapter 3: Electrical Specification |             |                    |
| Vertical Refresh Rate | $F_V$   | 60          | Hz                 |
| Warm up time          | $T_{warm}$  | > 15 min    | Min                |
| Dark room             | ED  | < 1 Lux     | Lux                |

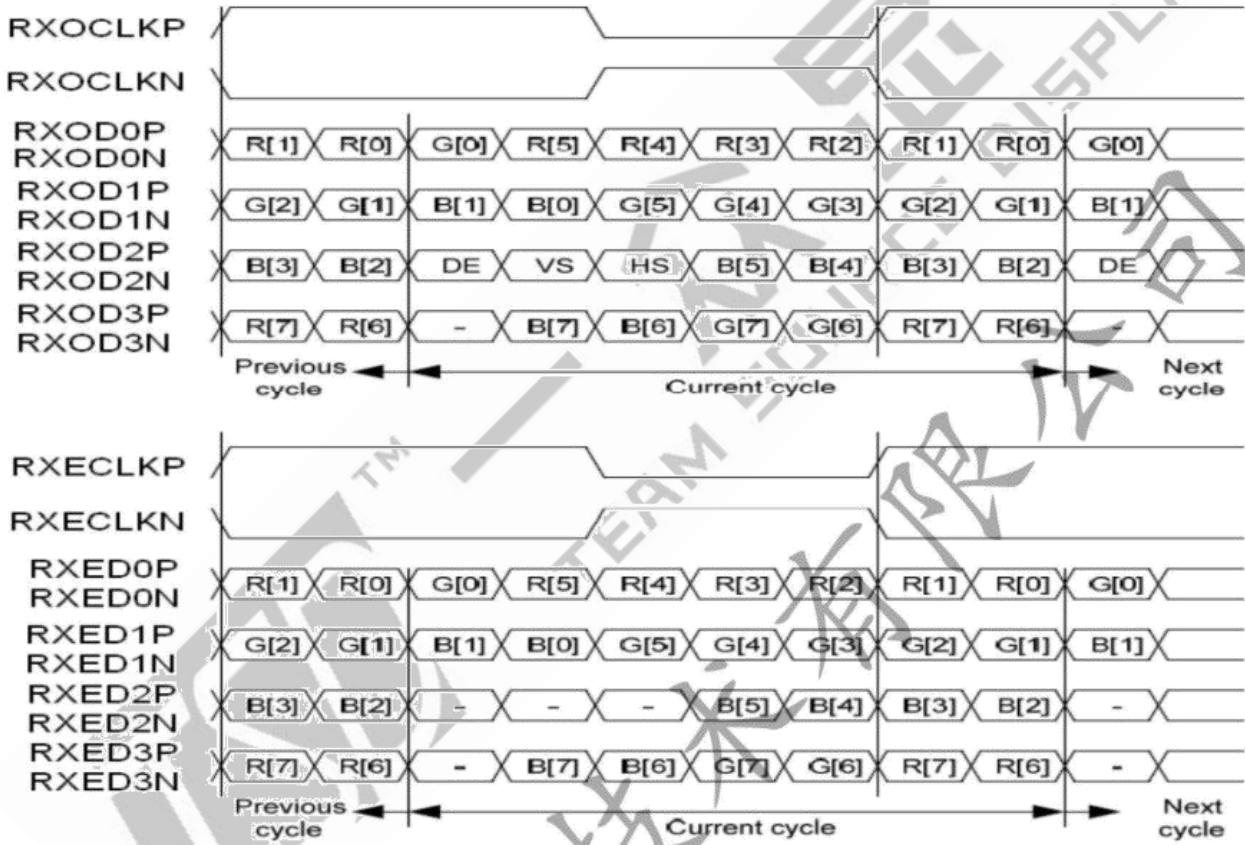
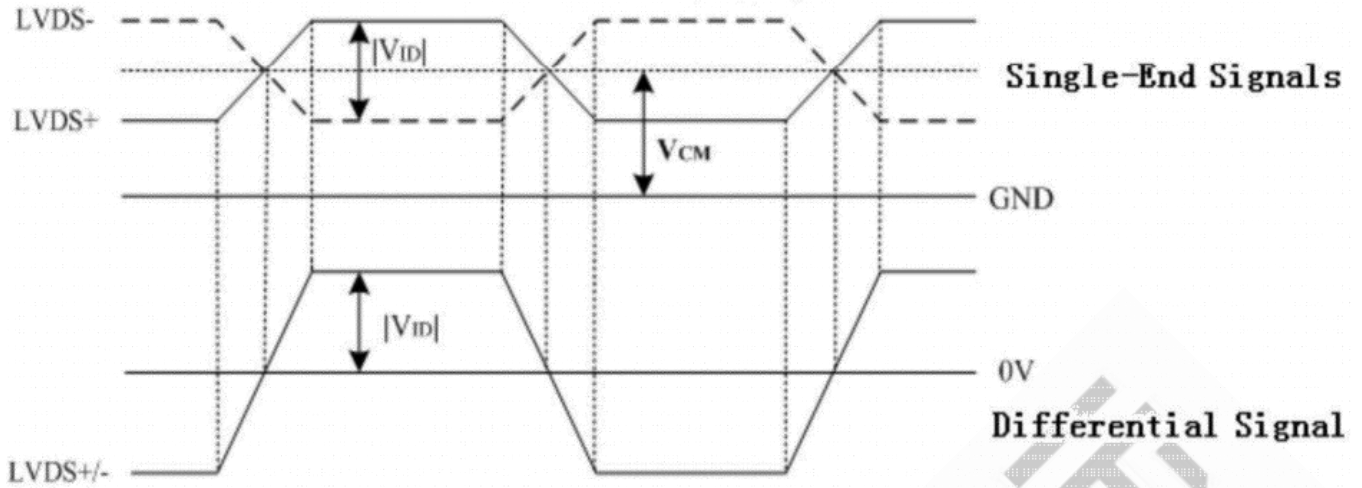
### 6.4 Signal Timing Specification

| Parameter             | Symbols | Panel Resolution     |      |      | Unit |
|-----------------------|---------|----------------------|------|------|------|
|                       |         | 1920RGB*720 (2 port) |      |      |      |
|                       |         | Min.                 | Typ. | Max. |      |
| DCLK frequency        | Fddk    | -                    | 45.3 | -    | MHz  |
| Horizontal valid data | Thd     | -                    | 960  | -    | DCLK |
| 1 horizontal line     | Th      | 1015                 | 1026 | 1248 | DCLK |
| Vertical valid data   | Tvd     | -                    | 720  | -    | H    |
| 1 vertical field      | Tv      | 730                  | 736  | 756  | H    |
| Frame rate            | FR      | -                    | 60   | -    | Hz   |

### 6.5 Signal Electrical Characteristics for LVDS Receiver

The built-in LVDS receiver is compatible with (ANSI/TIA/TIA-644 ) standard.

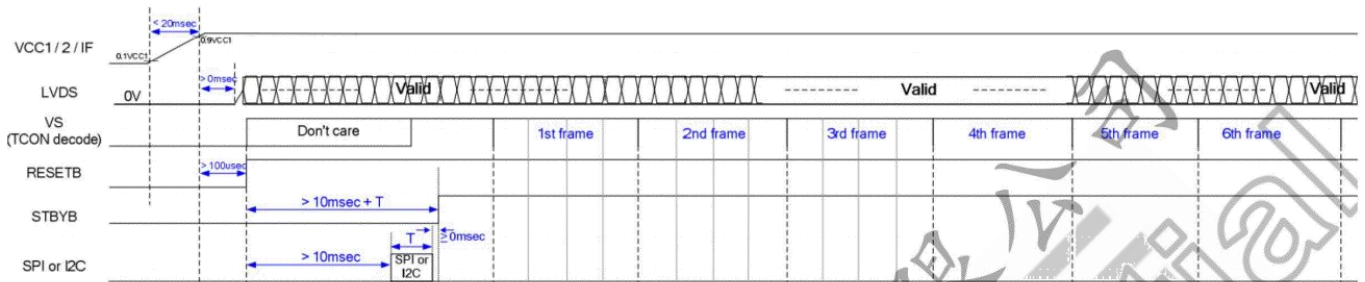
| Parameter                                 | Symbol      | Condition       | Specification |      |                      | Unit |
|---|-------------|-----------------|---------------|------|----------------------|------|
|   |             |                 | Min.          | Typ. | Max.                 |      |
| Differential input high Threshold voltage | $V_{th}$    | $V_{cm} = 1.2V$ | 0.1           | -    | -                    |      |
| Differential input low Threshold voltage  | $V_{tl}$    | $V_{cm} = 1.2V$ | -             | -    | 0.1                  |      |
| Differential input common Mode voltage    | $V_{CM}$    | -               | 1             | 1.2  | $1.7 -  V_{id}  / 2$ |      |
| LVDS input voltage                        | $V_{INLV}$  | -               | 0.7           | -    | 1.7                  |      |
| Differential input voltage                | $ V_{id} $  | -               | 0.1           | -    | 0.6                  |      |
| Differential input leakage current        | $I_{lveak}$ | -               | -10           | -    | 10                   |      |



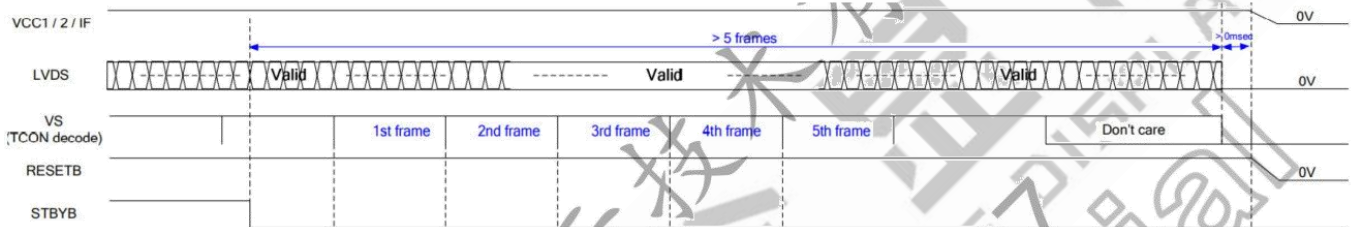


## 6.6 POWER SEQUENCE

prevent a latch-up or DC operation of the LCD module, the power on/off sequence shall be as shown in below.



Power-on Sequence



Power-off Sequence

## 6.7 DC Characteristics Backlight Driving

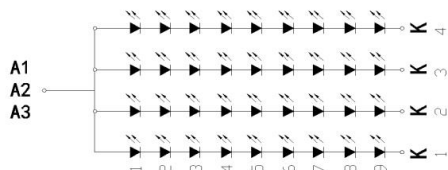
| Parameter     | Symbol | Min   | Typ | Max  | Units | Condition                                   |
|---------------|--------|-------|-----|------|-------|---|
| LED Current   | $I_F$  | -     | 360 | -    | mA    | $T_a=25^\circ\text{C}$                      |
| LED Voltage   | $V_F$  | 24.3  | 27  | 30.6 | Volt  | $T_a=25^\circ\text{C}$                      |
| LED Life-Time | N/A    | 30000 | --  | --   | Hour  | $T_a=25^\circ\text{C}$<br>$I_F=90\text{mA}$ |

Note (1) LED life time (Hr) can be defined as the time in which it continues to operate under the condition:  $T_a=25\pm 3^\circ\text{C}$ , typical  $I_L$  value indicated in the above table until the brightness becomes less than 50%.

Note (2) The “LED life time” is defined as the module brightness decrease to 50% original brightness at  $T_a=25^\circ\text{C}$  and  $I_L= 360\text{ mA}$ . The LED lifetime could be decreased if operating  $I_L$  is larger than 360 mA. The constant current driving method is suggested.

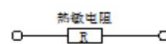
Note (3) LED Light Bar Circuit 9 S4P = 3 6 pcs LED

### LED Source(CIRCUIT DIAGRAM)



LCD 电路图

村田: NCU15XH103F6SRC



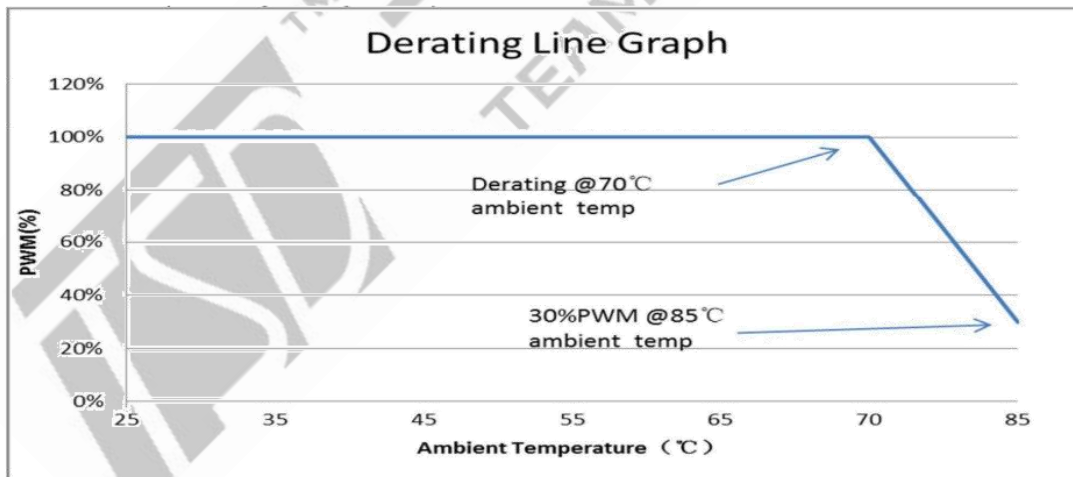
NTC 电路图

**Pin assignment for Back light :**

| NO. | Symbol | Description                        |
|-----|--------|------------------------------------|
| 1   | A1     | Power LED anode power supply (+)   |
| 2   | A2     | Power LED anode power supply (+)   |
| 3   | A3     | Power LED anode power supply (+)   |
| 4   | NC     | No connection                      |
| 5   | K1     | Power LED cathode power supply (-) |
| 6   | K2     | Power LED cathode power supply (-) |
| 7   | K3     | Power LED cathode power supply (-) |
| 8   | K4     | Power LED cathode power supply (-) |
| 9   | NTC1   | Thermistor(+)                      |
| 10  | NTC2   | Thermistor(-)                      |

**NTC information :**

| Item                                | Value           | Remark    |
|-------------------------------------|-----------------|-----------|
| Part number                         | NCU15XH103F6SRC | Murata    |
| Resistance / Tolerance              | 10kΩ+/- 1%      | Ta = 25°C |
| Permissive Operating Current (Max.) | 0.31 mA         |           |



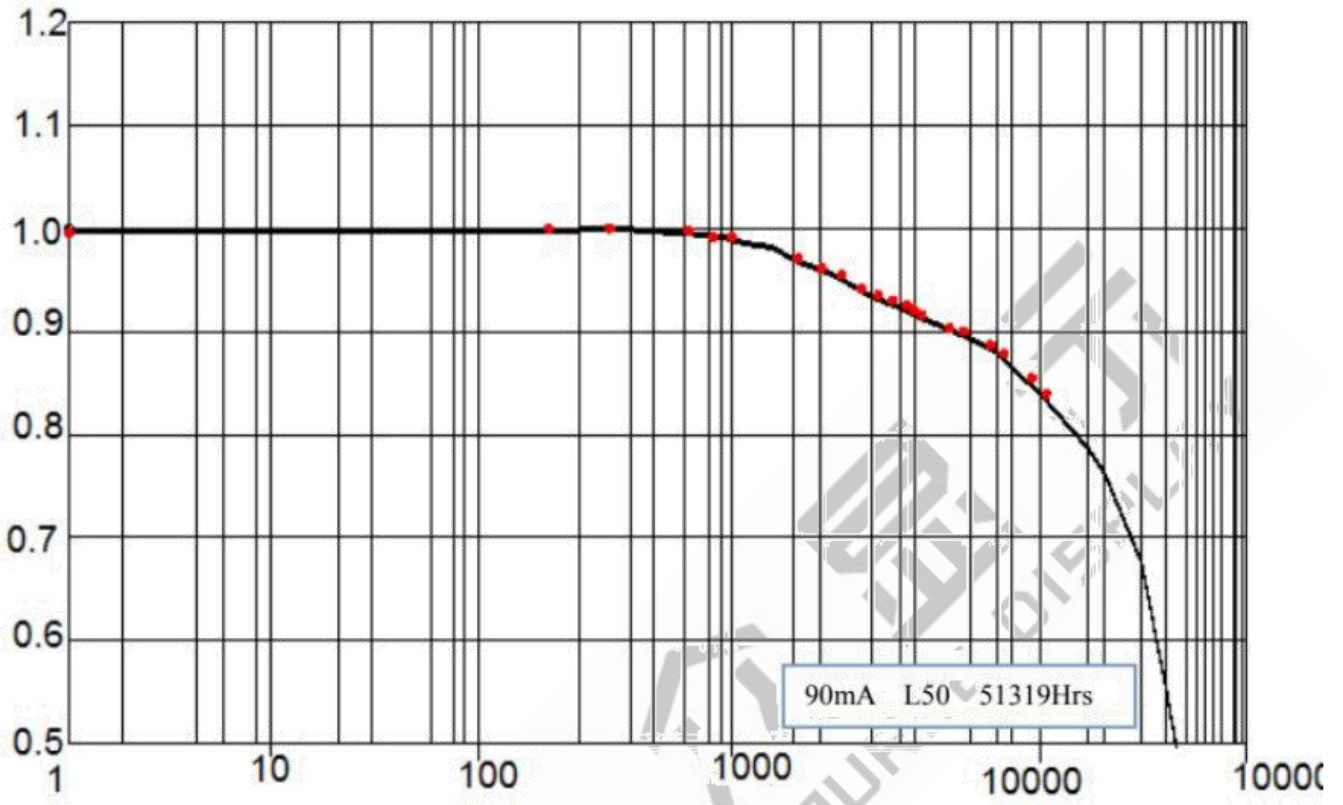
## Thermistor Description

| TEMP.<br>(deg.C) | R-center<br>(k ohm) | TEMP.<br>(deg.C) | R-center<br>(k ohm) | TEMP.<br>(deg.C) | R-center<br>(k ohm) | TEMP.<br>(deg.C) | R-center<br>(k ohm) | TEMP.<br>(deg.C) | R-center<br>(k ohm) |
|------------------|---------------------|------------------|---------------------|------------------|---------------------|------------------|---------------------|------------------|---------------------|
| -40              | 195.652             | -2               | 29.689              | 36               | 6.707               | 74               | 1.981               | 112              | 0.722               |
| -39              | 184.917             | -1               | 28.423              | 37               | 6.475               | 75               | 1.925               | 113              | 0.705               |
| -38              | 174.845             | 0                | 27.219              | 38               | 6.253               | 76               | 1.870               | 114              | 0.688               |
| -37              | 165.391             | 1                | 26.076              | 39               | 6.039               | 77               | 1.817               | 115              | 0.672               |
| -36              | 156.513             | 2                | 24.988              | 40               | 5.834               | 78               | 1.766               | 116              | 0.656               |
| -35              | 148.171             | 3                | 23.951              | 41               | 5.636               | 79               | 1.716               | 117              | 0.640               |
| -34              | 140.330             | 4                | 22.963              | 42               | 5.445               | 80               | 1.669               | 118              | 0.625               |
| -33              | 132.958             | 5                | 22.021              | 43               | 5.262               | 81               | 1.622               | 119              | 0.611               |
| -32              | 126.022             | 6                | 21.123              | 44               | 5.086               | 82               | 1.578               | 120              | 0.596               |
| -31              | 119.494             | 7                | 20.267              | 45               | 4.917               | 83               | 1.535               | 121              | 0.583               |
| -30              | 113.347             | 8                | 19.450              | 46               | 4.754               | 84               | 1.493               | 122              | 0.569               |
| -29              | 107.565             | 9                | 18.670              | 47               | 4.597               | 85               | 1.452               | 123              | 0.556               |
| -28              | 102.116             | 10               | 17.926              | 48               | 4.446               | 86               | 1.413               | 124              | 0.544               |
| -27              | 96.978              | 11               | 17.214              | 49               | 4.301               | 87               | 1.375               | 125              | 0.531               |
| -26              | 92.132              | 12               | 16.534              | 50               | 4.161               | 88               | 1.338               | 126              | 0.519               |
| -25              | 87.559              | 13               | 15.886              | 51               | 4.026               | 89               | 1.303               | 127              | 0.507               |
| -24              | 83.242              | 14               | 15.266              | 52               | 3.896               | 90               | 1.268               | 128              | 0.496               |
| -23              | 79.166              | 15               | 14.674              | 53               | 3.771               | 91               | 1.234               | 129              | 0.485               |
| -22              | 75.316              | 16               | 14.108              | 54               | 3.651               | 92               | 1.202               | 130              | 0.474               |
| -21              | 71.677              | 17               | 13.566              | 55               | 3.535               | 93               | 1.170               | 131              | 0.464               |
| -20              | 68.237              | 18               | 13.049              | 56               | 3.423               | 94               | 1.139               | 132              | 0.454               |
| -19              | 64.991              | 19               | 12.554              | 57               | 3.315               | 95               | 1.110               | 133              | 0.444               |
| -18              | 61.919              | 20               | 12.081              | 58               | 3.211               | 96               | 1.081               | 134              | 0.434               |
| -17              | 59.011              | 21               | 11.628              | 59               | 3.111               | 97               | 1.053               | 135              | 0.424               |
| -16              | 56.258              | 22               | 11.195              | 60               | 3.014               | 98               | 1.026               | 136              | 0.415               |
| -15              | 53.650              | 23               | 10.780              | 61               | 2.922               | 99               | 0.999               | 137              | 0.406               |
| -14              | 51.178              | 24               | 10.382              | 62               | 2.834               | 100              | 0.974               | 138              | 0.397               |
| -13              | 48.835              | 25               | 10.000              | 63               | 2.748               | 101              | 0.949               | 139              | 0.389               |
| -12              | 46.613              | 26               | 9.634               | 64               | 2.666               | 102              | 0.925               | 140              | 0.381               |
| -11              | 44.506              | 27               | 9.284               | 65               | 2.586               | 103              | 0.902               | 141              | 0.373               |
| -10              | 42.506              | 28               | 8.947               | 66               | 2.509               | 104              | 0.880               | 142              | 0.365               |
| -9               | 40.600              | 29               | 8.624               | 67               | 2.435               | 105              | 0.858               | 143              | 0.357               |
| -8               | 38.791              | 30               | 8.315               | 68               | 2.364               | 106              | 0.837               | 144              | 0.350               |
| -7               | 37.073              | 31               | 8.018               | 69               | 2.294               | 107              | 0.816               | 145              | 0.342               |
| -6               | 35.442              | 32               | 7.734               | 70               | 2.228               | 108              | 0.796               | 146              | 0.335               |
| -5               | 33.892              | 33               | 7.461               | 71               | 2.163               | 109              | 0.777               | 147              | 0.328               |
| -4               | 32.420              | 34               | 7.199               | 72               | 2.100               | 110              | 0.758               | 148              | 0.322               |
| -3               | 31.020              | 35               | 6.948               | 73               | 2.040               | 111              | 0.740               | 149              | 0.315               |



LED forward current should follow the De-rating curve.

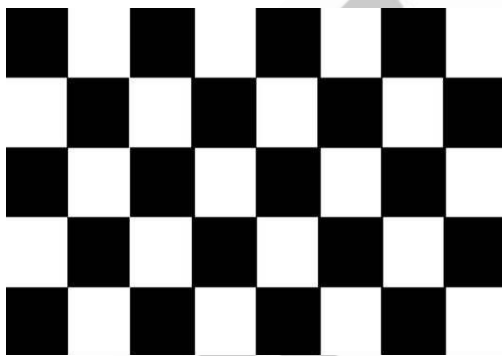
MK-4014 Life Curves



## 7 RELIABILITY TEST ITEMS

| NO. | TEST ITEM                    | TEST CONDITION   | INSPECTION AFTER TEST  |
|-----|------------------------------|--|--|
| 1   | High Temperature Storage     | 90°C/500 hours   | Inspection after 2~4 hours storage at room temperature and humidity.<br>The condensation is not accepted.<br>The sample shall be free from defects:<br>1. Air bubble in the LCD<br>2. Seal leak<br>3. Non-display<br>4. Missing segments<br>5. Glass crack |
| 2   | Low Temperature Storage      | -40°C/500 hours  |  |
| 3   | High Temperature Operating   | 85°C/500 hours   |  |
| 4   | Low Temperature Operating    | -30°C/500 hours  |  |
| 5   | Temperature Cycle            | -40°C ~ 25~ 85°C × 100 cycles<br>(30 min.) (5min.) (30min.)  |  |
| 6   | Damp Proof Test              | 60°C ±5°C × 90%RH/500 hours  |  |
| 7   | Vibration Test               | Frequency 10Hz~55Hz<br>Stroke: 1.5mm<br>Sweep: 10Hz~150 Hz~10Hz 2 hours<br>For each direction of X, Y, Z |  |
| 8   | Packing Drop Test            | Height: 60 cm<br>1 corner, concrete floor  |  |
| 9   | Electrostatic Discharge Test | C=150pF, R=330 Ω<br>Air: ±8KV 150pF/330Ω 30 times<br>Contact: ±4KV,20 times                              |  |
| 10  | Image Sticking               | 25°C,60%RH (ref.to Remark(1))/30 minutes   |  |

**Remark (1):** Switch the image to Grey 127 after displaying the 5\*8 chess pattern for 30 minutes, the afterimage disappears within 10 seconds.



5\*8 chess pattern



Gray127



## 9 About Image Sticking

### 9.1.1 What is Image Sticking?

If you remain a fixed image on LCD Display for a long period of time, you may experience a phenomenon called Image Sticking. Image Sticking - sometimes also called “image retention” or “ghosting” - is a phenomenon where a faint outline of a previously displayed image remains visible on the screen when the image is changed. It can occur at variable levels of intensity depending on the specific image makeup, as well as the amount of time the core image elements are allowed to remain unchanged on the screen. In POS applications, for example, a button menu which remains fixed, or in which the “frame” elements (core image) remain fixed and the buttons may change, may be susceptible to image sticking. It is important to note that if the screen is used exclusively for this application, the user may never notice this phenomenon since the screen never displays other content. It is only when an image other than the “retained” image is shown on the screen that this issue becomes evident. Image sticking is different that the “burn-in” effect commonly associated with phosphor based devices.

### 9.1.2 What causes Image Sticking?

Image sticking is an intrinsic behavior of LCD displays due to the susceptibility to polarization of the interior materials (liquid crystals) when used under static, charged conditions (continuously displaying the same image). The individual liquid crystals in an LCD panel have unique electrical properties. Displaying a fixed pattern - such as the POS menu described above - over prolonged periods can cause a parasitic charge build-up (polarization) within the liquid crystals which affects the crystals’ optical properties and ultimately prevents the liquid crystal from returning to its normal, relaxed state when the pattern is finally changed. This effect takes place at a cellular level within the LCD, and the effect can cause charged crystal alignment at the bottom or top of a crystal cell in the “z” axis, or even crystal migration to the edges of a cell, again based on their polarity. These conditions can cause image sticking over an entire area, or at boundaries of distinct color change respectively. In either case, when the liquid crystals in the pixels and sub-pixels utilized to display the static image are polarized such that they can not return fully to their “relaxed” state upon deactivation, the result is a faint, visible, retained image on the panel upon presentation of a new, different image. The actual rate of image retention depends on variation factors such as the specific image, how long it is displayed unchanged, the temperature within the panel and even the specific panel brand due to manufacturing differences amongst panel manufacturers.

### 9.1.3 How to Avoid Image Sticking?

- Try not to operate the LCD with a “fixed” image on the screen for more than 1 hours.
- If you are operating the monitor in an elevated temperature environment and with a displayed image which is contrary to the recommendations in “For Software Developers” below, image stick can occur in as little as 30 minutes. Adjust your screen saver settings accordingly.
- Power down the unit during prolonged periods of inactivity such as the hours a store is closed or a shift during which the piece of equipment isn’t used.
- Use a screensaver with a black or medium gray background that is automatically set to come on if the device is inactive for more than 5-10 minutes.
- Avoid placing the monitor in poorly ventilated areas or in areas that will create excess heat around the monitor for software developers.
- In defining the icons, buttons, or windows in the screen, try to utilize block patterns instead of distinct lines as borders for dividing the display into distinct areas.
- If it is necessary to display a static image, try to use colors that are symmetric to the middle grey level at the boundary of two different colors, and slightly shift the borders line once in a while.
- Try to utilize medium gray hues for those areas that will have prolonged display times or remain static

as other menu elements change.

### 9.1.4 How to Fix the Image Sticking?

Unlike the usually irreversible “burn-in” effects commonly associated with direct view phosphor display devices such as CRTs, an image retained on an LCD display can be reversed – often to a point of total invisibility. However, the severity of the underlying causes (as described above) of the image retained on a specific display, as well as the variation factors (see “For Software Developers” above) under which the retained image was created, will dictate the final level of retention reversal. One way to erase a retained image on a panel is to run the screen (monitor “on”) in an “all black” pattern for 4-6 hours. It is also helpful to do this in an elevated temperature environment of approximately 35° to 50° C. Again, utilizing a dynamic screen saver with an all black background during prolonged idle display periods is a good way to avoid image retention issues.

### 9.1.5 Is Image Sticking Covered by TSD RMA Warranty?

Image sticking is a phenomenon inherent to LCD Display technology itself, and as such, the occurrence of this “ghosting” effect is considered normal operation by the manufacturers of the LCD display modules which are integrated into today’s monitor solutions. TSD does not warrant any display against the occurrence of image sticking. We strongly advise that you follow the operating recommendations listed above to avoid the occurrence of this phenomenon.

## 9.2 Others

1. Issues that are not defined in this document shall be discussed and agreed with both parties. (Customer and supplier)
2. Unless otherwise agreed upon in writing, the criteria shall be applied to both parties. (Customer and supplier)

## 10 Suggestions for using LCD modules

### 10.1 Handling of LCM

1. The LCD screen is made of glass. Don't give excessive external shock, or drop from a high place.
2. If the LCD screen is damaged and the liquid crystal leaks out, do not lick and swallow. When the liquid is attach to your hand, skin, cloth etc, wash it off by using soap and water thoroughly and immediately.
3. Don't apply excessive force on the surface of the LCM.
4. If the surface is contaminated, clean it with soft cloth. If the LCM is severely contaminated, use Isopropyl alcohol/Ethyl alcohol to clean. Other solvents may damage the polarizer. The following solvents is especially prohibited: water , ketone Aromatic solvents etc.
5. Exercise care to minimize corrosion of the electrode. Corrosion of the electrodes is accelerated by water droplets, moisture condensation or a current flow in a high-humidity environment.
6. Install the LCD Module by using the mounting holes. When mounting the LCD module make sure it is free of twisting, warping and distortion. In particular, do not forcibly pull or bend the I/O cable or the backlight cable.
7. Don't disassemble the LCM.
8. To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.
  - Be sure to ground the body when handling the LCD modules.
  - Tools required for assembling, such as soldering irons, must be properly grounded.
  - To reduce the amount of static electricity generated, do not conduct assembling and other work under dry conditions.
  - The LCD module is coated with a film to protect the display surface. Exercise care when peeling

off this protective film since static electricity may be generated.

9. Do not alter, modify or change the the shape of the tab on the metal frame.
10. Do not make extra holes on the printed circuit board, modify its shape or change the positions of components to be attached.
11. Do not damage or modify the pattern writing on the printed circuit board.
12. Absolutely do not modify the zebra rubber strip (conductive rubber) or heat seal connector
13. Except for soldering the interface, do not make any alterations or modifications with a soldering iron.
14. Do not drop, bend or twist LCM.

## 10.2 Storage

1. Store in an ambient temperature of 5 to 45 °C, and in a relative humidity of 40% to 60%. Don't expose to sunlight or fluorescent light.
2. Storage in a clean environment, free from dust, active gas, and solvent.
3. Store in antistatic container.

## 11 Limited Warranty

1. Our warranty liability is limited to repair and/or replacement. We will not be responsible for any consequential loss.
2. If possible, we suggest customer to use up all LCD modules as soon as possible. If the LCD module storage time over twelve months, we suggest to recheck it before being used.
3. Any product issues must be feedback to TSD within 12 months since delivery, otherwise, we will not be responsible for the subsequent or consequential events.