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# Application Note FAN4208

## *Sunlight Readable TFTs*

Sunlight readable TFTs are transmissive TFTs with a high-powered backlight to compensate for bright ambient lighting. This application note will discuss the pro's and cons of sunlight readable TFTs.

## Focus LCDs Sunlight-Readable TFTs

Sunlight readable TFTs are transmissive TFTs with a high-powered backlight to compensate for bright ambient lighting. These TFTs are very bright and can range from 800-1100+ nits to illuminate the display. A non-sunlight readable TFT would have a much lower brightness and would look washed out or have limited visibility in a bright environment. Sunlight readable TFTs can maintain a detailed and colorful image in a variety of environments which make them a great solution for indoor and outdoor applications. This application note discusses the pros and cons of Focus LCD's sunlight readable TFTs.


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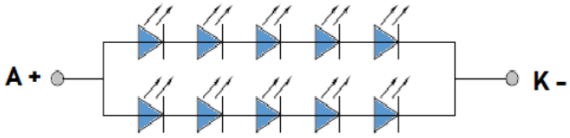
The display used in this application note is a 3.5" sunlight-readable TFT, E35KA-FW1000-N. This display is a transmissive TFT with 320x480 pixels and a 1000 nit backlight. The bright backlight requires 17V and 60mA to power the 10 white LEDs. Other notable features of this display are described below.

- 3.5", 48.96mm x 73.44mm
- 16-bit Parallel Interface
- 262k colors
- 1000 nits (cd/m²)
- All Viewing Angles
- Controller IC: ILI9488
- Sunlight Readable

## Example Lighting Environments

The backlight circuit has 10 white LED lights which require a forward current of 60mA in the constant current driving method. The maximum recommended voltage for this circuit is 14-16.5V and should not be exceeded for long periods to preserve the lifetime of the LEDs. The maximum current for high brightness mode is 120mA and should not be exceeded. The circuit diagram for the 10 backlight LEDs is seen below.




Backlight LED Circuit

Below are some sample lighting environments and the sunlight readable TFT at different backlighting levels. In full sunlight the backlight can be increased to 1000 nits while in darker environments the backlight can be reduced to conserve power and decrease eye strain. The power drain from the backlight in full brightness is a significant cost for sunlight readable displays. These displays would not be an ideal solution for battery powered devices.

| NO. | Ambient Condition | Ambient Brightness | Luminance | Example |
|---|---|---|---|---|
| 1 | Bright Indoor Lighting | 200-700 nits | 1000 nits |  |

| | | | | |
|---|---|---|---|---|
| 2 | | | 700 nits |  |
| 3 | Dark Environment | < 50 nits | 500 nits |  |
| 4 | | | 300 nits |  |

| | | | | |
|---|---|---|---|---|
| 5 | Full Sunlight | 3000-10000 nits | 1000 nits |  |
| 6 | | | 800 nits |  |

## Power Consumption

Backlights are often the biggest power drain for a display. There is a significant power cost when opting for a sunlight readable display. This example is using a 3.5-inch display with 10 backlight LEDs which require 14-16.5V and minimum 60mA of current to illuminate the display in transmissive mode. The power cost from the backlight becomes substantial in larger displays and TFT's that have brighter LEDs to compensate for bright environments.

Below is a table comparing the power consumption of different sunlight readable TFT's. For battery powered devices the battery is typically measured in milli-Watt hours (mWh) and milli-Amp hours (mAh). For reference, one AA battery at 1.5V provides 200-400 milli-Watt hours. The table represents the minimum forward current needed to illuminate the display.

| Display | Size (inch) | Brightness (nits) | # of LEDs | Voltage (V) | Current (mAh) | Power (mWh) | Power (kJ) |
|---|---|---|---|---|---|---|---|
| Sunlight Readable TFTs | | | | | | | |
| E35KA-FW1000-N | 3.5” | 1000 | 10 | 15 | 60 | 900 | 3.24 |
| E40RC-FS1000-C | 4.0” | 1000 | 12 | 18.6 | 40 | 744 | 2.68 |
| E43RG64827LW2M1000-R | 4.3” | 800 | 18 | 28.8 | 40 | 1152 | 4.15 |
| E50RG68048LWAM700-N | 5.0” | 700 | 16 | 25.6 | 40 | 1024 | 3.68 |

## Heat Emission of Sunlight Readable TFTs

The high brightness of the sunlight readable TFTs increases the power demand on the backlight, this can result in an increase of heat emission from the display. Sunlight readable TFTs have high currents running through the LEDs of the backlight, this is necessary to produce the high brightness of the display. For outdoor applications, heat emission should be considered and kept within the recommended operating temperature range of -20-70˚C. The display will have significant heat emission if the brightness is increased beyond its recommended luminance and operated in direct sunlight for long periods of time.

The lifetime of the backlight LEDs may be decreased if the temperature range is exceeded at higher than recommended operating conditions. Backlight LEDs have a typical half-life of 70,000 hours in normal operating conditions. This half-life represents the number of hours before the LED reaches half of its original brightness. If the display is operated past the specified brightness for long periods of time, the half-life of the LEDs can decrease to approximately 20,000 hours. The LED lifetime will not be affected if the backlight is operated within the specified requirements as noted in the display’s datasheet. These considerations are specified as a range of heat, brightness, current and voltage. For more information on minimum and maximum ratings of the display refer to the datasheet.

## Summary

Sunlight readable TFTs have great visibility in any lighting condition. Color vibrancy and contrast are maintained in very bright ambient lighting environments. The high brightness and luminance of the display make them a great option for outdoor and indoor applications. Considerations should be made when choosing a sunlight readable TFT such as power consumption and heat emission. When not in a bright environment the display’s backlight can be a lowered to avoid eyestrain and decrease power demand. There are many options available for sunlight readable TFTs perfect for a variety of applications. For more information visit FocusLCDs.com!

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