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Application Note FAN3204

Transflective Graphic LCDs

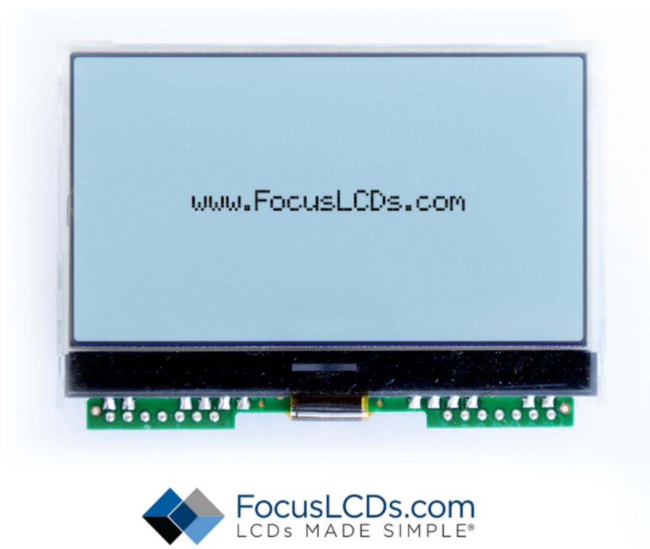
Transflective displays can be used with or without a backlight by combining transmissive and reflective modes to illuminate the display. Transflective Graphic LCDs are a great solution for conserving power by removing the demand of the backlight. This application note will review the different aspects of using Focus LCDs transflective graphic LCDs in different environments and at different operating conditions.

Focus LCDs Transflective Graphic LCDs

Transflective displays can be used with or without a backlight by combining transmissive and reflective modes to illuminate the display. Transflective Graphic LCDs are a great solution for conserving power by removing the demand of the backlight. These transflective LCDs maintain great pixel contrast and display a clear image with and without the backlight. Monochrome graphic LCDs are especially favorable for transflective use because of the pronounced contrast of the black pixels from the background color.

This application note will review the different aspects of using Focus LCDs transflective graphic LCDs in different environments and at different operating conditions. The display used in this application is a 128x64 dot graphic LCD G126FLGFGSW64T33XAR with a transflective polarizer. Below is a summary of the display and its properties.

- 128x64 dots
- 80.00x57.0mm
- Transflective Polarizer
- ST7565P Controller IC
- White LED backlight
- FTSN positive
- Serial interface
- 6 o'clock viewing



Another bonus of transflective graphic LCDs is the use of internal voltage regulators and boosters. Graphic LCDs, transflective or otherwise, typically have internal driver ICs that can adjust voltage and currents provided to display the pixels. This is beneficial because it allows you to increase or decrease the contrast of the pixels to the background without having to add external components. This feature can be used to adjust the contrast depending on environment and which transflective property is being utilized. The voltage provided to the pixels can be increased using the voltage boosting circuit or decreased using the voltage divider circuit.

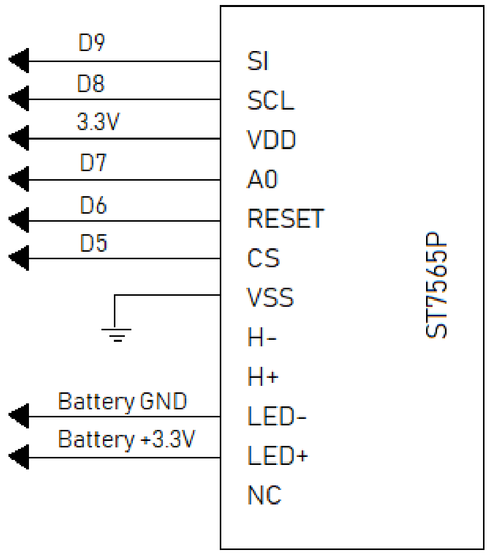
Pin Assignments

Pin definitions and connection points are described in the table below. We will use the 4-wire serial interface for this example to save data pins on the microcontroller. There are established 4-wire SPI pins labelled on the microcontroller. Any alternative pins used must be declared in code when programming the device. A more in-depth description of each of the pins can be found on the datasheet. All unused pins are connected to ground.

Pin No.	Symbol	Description	Connection
1	SCL	Serial clock input	D8
2	SI	Serial data input	D9
3	VDD	Power supply 3.3V	3.3V
4	A0	Register select signal	D7
5	RESET	Controller reset	D6
6	CS	Chip select signal	D5
7	VSS	Power ground	GND
8	H-	Heater panel resistance	NC
9	H+		
10	LED-	Backlight power supply ground	GND
11	LED+	Backlight power supply 3.3V	3.3V
12	NC	Not connected	NC

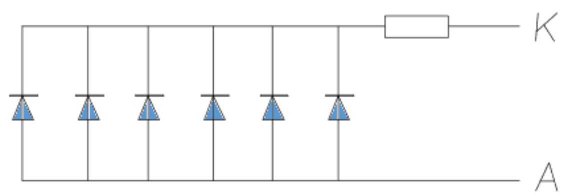
The backlight LED’s are connected to an external battery and are separate from the 3.3V logic voltage. The voltage that is applied to the backlight LEDs can be adjusted through variable resistors, such as a potentiometer or through programming if connected to an additional PWM pin on the microcontroller.

Below is a diagram representing the pin connections to the microcontroller in accordance with the table above. The pins labeled ‘D’ represent the digital pin terminals on the microcontroller. All unused pins are connected to ground. The diagram represents the 4-wire serial communication interface between the microcontroller and the displays internal IC controller. The backlight LED circuit is connected to an external battery and not powered by the microcontroller. An additional variable resistance can be added between the backlight terminals to adjust the backlight current to dim or brighten the LEDs.



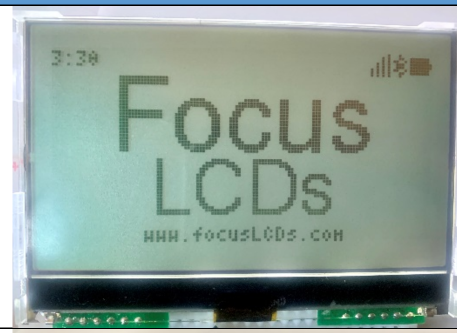
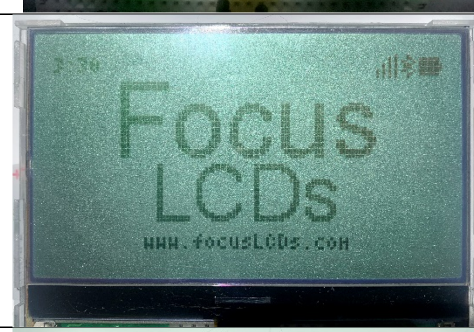
Example Lighting Environments

The forward voltage of the backlight LEDs has a typical value of 3.3V and the current can be adjusted to increase or decrease the backlight of the display.



Backlight Circuit LEDs

This example will demonstrate the power consumption of the 6 backlight LEDs at different lighting levels. In an outdoor application the backlight could be turned off and in indoor applications the backlight can be turned on. Below are various lighting conditions and their corresponding backlight power.

<table>
<tr><th>NO.</th><th>Ambient Condition</th><th>Backlight Power</th><th>Transmissive or Reflective</th><th>Example</th></tr>
<tr><td>1</td><td rowspan="2">Bright Indoor Lighting</td><td>100%</td><td>Transmissive</td><td></td></tr>
<tr><td>2</td><td>0%</td><td>Reflective</td><td></td></tr>
<tr><td>3</td><td>Dark Environment</td><td>100%</td><td>Transmissive</td><td></td></tr>
<tr><td>4</td><td rowspan="2">Full Sunlight</td><td>100%</td><td>Transmissive & Reflective</td><td></td></tr>
<tr><td>5</td><td>0%</td><td>Reflective</td><td></td></tr>
</table>

Energy Efficiency

Backlights are often the biggest power drain for a display. By turning off the backlight in outdoor environments energy can be conserved. This example is using 6 backlight LEDs which require 3.3V and 50mA of current to illuminate the display in the transmissive mode. The power cost from the backlight becomes substantial in larger displays that have brighter LEDs to compensate for bright environments.

Below is a table comparing the power consumption of different sizes of transflective graphic LCDs. 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.

Display	Size (dots)	# of LEDs	Voltage (V)	Current (mAh)	Watts (mWh)	Power (kJ)
G126FLGFGSW64T33XAR	128x64	6	3.3	50	165	0.594
G126GLGFYSY6WT	128x64	8	4.7	80	376	1.35
G160BLGFGSW6WTC3XAM	160x100	3	3.3	60	198	0.712

Summary

In summary transflective graphic displays are a great option for battery powered devices. Transflective graphic displays can display high contrast images with or without the backlight. In bright environments the display will use the ambient lighting to create this contrast. This gives the option to conserve backlight power when the bright ambient lighting is available. In dark environments the backlight can be turned on to display the image. Graphic displays have the additional benefit of having built in DC-DC voltage circuits to control the contrast of the display. This gives the option of adjusting the backlight and pixel contrast through the program without having to add external voltage adjusting circuits. This makes transflective graphic LCDs a great solution for a variety of lighting environments and gives extended control over power consumption of the display.

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