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Application Note FAN4208

Transflective TFTs for Battery Conservation

In this application note we will discuss how battery power can be conserved when using a transflective display in direct sunlight.

Transflective TFTs for Battery Conservation

In this application note we will discuss how battery power can be conserved when using a transflective display in direct sunlight. Transflective displays are a great option for applications that have access to bright ambient lighting. In these environments transflective displays can turn off the backlight LED's and use the bright lighting to illuminate the display. This is a great way to save power as backlights can be the most significant energy drain on a display.

Reflective + Transmissive = Transflective

Introduction

In this example, we will be using a 240x320 transflective TFT display and a STM-Nucleo microcontroller to feature the applications of the E20RB-FW345-N display module. As for any display, be sure the check the data sheet to determine the pin out, voltage ratings and driver of the module. Below is an overview of the display used in this project (datasheet). An overview of the significant features of this display are as follows:

- 2-inch, 35.80 x 52.10mm
- 240x320 pixels
- VA Transflective
- ST7789V Controller IC
- White LED backlight, 4 LEDs
- 65k/262k colors
- Parallel and Serial interfaces
- 345 NITS

Pin Assignments

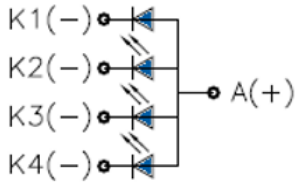
Pin definitions and connection points are described in the table below. We will use the 4-wire serial interface for this example to save data pins on the microcontroller. There are established 4-wire SPI pins labelled on the microcontroller. Any alternative pins used must be declared in code when programming 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.	Pin Name	Description	Connection
1	GND	Ground	Ground
2	VCI	Supply voltage (3.3V)	3.3V
3	IOVCC	Supply voltage (1.65V-3.3V)	3.3V
4	IM2	MCU parallel interface bus and serial interface selection bus. '110', for 4-wire SPI select.	High
5	IM1		High
6	IM0		Low
7	RESET	Reset signal	D8
8	CS	Chip select input pin.	D10
9	RD(SPI_SCL)	Display data/command in parallel interface. Clock signal in serial interface.	D13
10	WR(SPI_RS)	Write enable n parallel interface. Second data pin the 4-wire serial interface.	D9
11	RD	Read signal for parallel MCU interface.	GND
12	VSYNC	Frame synchronizing signal for RGB interface.	GND
13	HSYNC	Linen synchronizing signal for RGB interface.	GND
14	ENABLE	Data enable signal for RGB interface.	GND
15	DOTCLK	Dot clock signal for RGB interface.	GND
16	SDA	SPI interface input signal.	D12
17-34	DB0-DB17	18-bit parallel bi-directional data pins for RGB interface.	GND
35	SDO	SPI interface output signal.	D11
36	LEDA	Anode pin of the backlight	3.3V (80mA) Battery +
37	LEDK1	Cathode pin of the backlight	Battery GND
38	LEDK2	Cathode pin of the backlight	Battery GND
39	LEDK3	Cathode pin of the backlight	Battery GND
40	LEDK4	Cathode pin of the backlight	Battery GND
41	XR	Touch panel right glass terminal	NC
42	YU	Touch panel top film terminal	NC
43	XL	Touch panel left glass terminal	NC
44	YD	Touch panel bottom film terminal	NC
45	GND	Ground	GND

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.

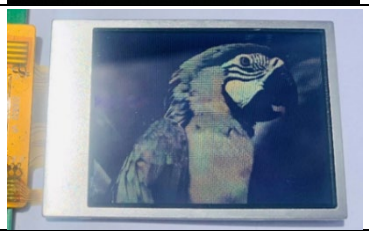
Example Lighting Environments

The forward voltage of the backlight LEDs has a typical value of 3.2-3.3V and the current can be adjusted to increase or decrease the backlight of the display.



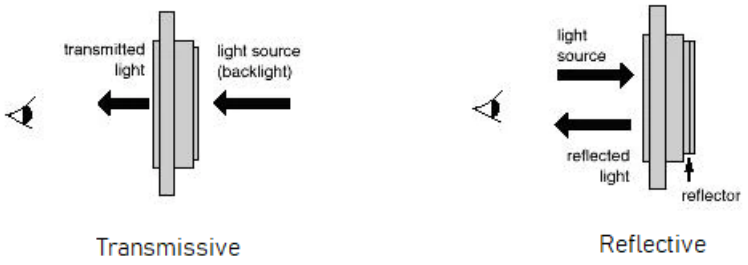
Backlight LED Circuit

This example will demonstrate the power consumption of the 4 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 off. Below are various lighting conditions and their corresponding backlight power. The table also specifies which aspect of the transflective TFT is dominant, transmissive or reflective.

NO.	Ambient Condition	Backlight Power	Transmissive or Reflective	Example
1	Bright Indoor Lighting	100%	**Transmissive**	
2		0%	**Reflective**	
3	Dark Environment	100%	**Transmissive**	
4	Full Sunlight	100%	**Transmissive & Reflective**	

5		0%	**Reflective**	

At full backlight power in a dark room the display will appear more vibrant and colorful. This is making use of the fully transmissive mode of the transflective display. In very bright sunlight the transflective display will reflect the sunlight to illuminate the image. It can be seen in both images of the transflective display in full sunlight that the backlight makes little difference as the display will always reflect the bright sunlight.



The reflective and transmissive properties are inherent to the transflective display. These modes specify the type of polarizer within the display and therefore they cannot be “turned on” or “turned off”. The transflective display will use the reflective mode when in very bright light while in darker environments the transmissive mode will be used.

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 a 2-inch display with 4 backlight LEDs which require 3.3V and 80mA of current to illuminate the display in the 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 sizes of transflective 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.

Display	Size (inch)	Brightness (nits)	# of LEDs	Voltage (V)	Current (mAh)	Watts (mWh)	Power (kJ)
Transflective TFTs							
E20RB-FW345-N	2.0”	345	4	3.0	80	240	0.95

E24RB-FW360-N	2.4”	360	6	19.2	20	384	1.39
E35RC-FW115-N	3.5”	115	6	18.6	20	372	1.34

Summary

Transflective TFT’s are a great option for applications that have bright ambient lighting available. Reflecting the ambient lighting to illuminate the display has the added benefit of conserving power. Backlights can have a wide range of power consumptions and typical increase with the size of the display. A non-transflective TFT would be washed out by bright lighting and have limited visibility. An alternative solution for bright environments is to opt for a sunlight readable TFT. These displays increase the backlight to high levels to compensate for the bright lighting. This comes at the cost of high-power demand on the backlight thus decreasing energy efficiency. For more on sunlight readable TFT’s and how they compare to transflective TFT’s visit FocusLCDs.com.

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