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Application Note FAN4211

Backlight Control Using a TFT HDMI Module

This application note will discuss how to adjust the backlight of a TFT using an HDMI connector module

Backlight Control Using a TFT HDMI module

This application note will discuss how to adjust the backlight of a TFT using an HDMI connector module. The HDMI connector board is useful when connecting a display to a controller such as a Raspberry Pi. An HDMI board serves two primary functions. One is the conversion of the RGB interface to HDMI, which removes the need for individual GPIO connections. The second is for the purpose of adjusting the backlight on a TFT display. This will be the primary focus of this application note and will highlight the functionality of this module.

Introduction

The display used in this application note is a 4.3" TFT with 480x272 pixel resolution. Additional features of this display are below. Part number: E43RG34827LW2M320-N

- 8/16/18/24-bit RGB interface
- 16.7M colors
- Controller IC: ILI6480
- White LED backlight
- 320 nits

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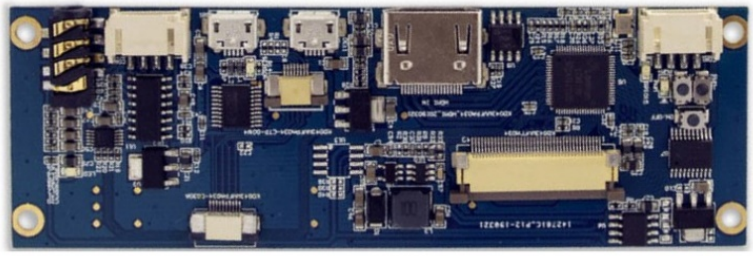
The HDMI module referenced in this application note is part M_E43RB_HD and is seen below.
Key features of this module are:

- Dimensions: 37.27 x 113.0 x 8.21 mm
- Compatibility:
  - Windows 7/8/10
  - Android
  - Raspberry Pi
  - Ubuntu



Adjusting the Backlight

There are two options for dimming or illuminating a display. The options are to modify the backlight power or to adjust the contrast. It is important to note the difference between apparent brightness and the backlight brightness of a display. The apparent brightness of the display can be modified by changing the color gamut, gain, luminance, and contrast ratio through software. The backlight brightness can be adjusted by the power delivered to the LEDs through analog current control.

Adjusting the brightness of LEDs in connection to the Raspberry Pi can become complicated over an HDMI interface because there is not direct access to the backlight LED circuit. The HDMI connector module is a solution for backlight adjustments and has variable resistance to control the power provided to the backlight. This control is done conveniently through push buttons on the front of the board.

Connection to the Raspberry Pi

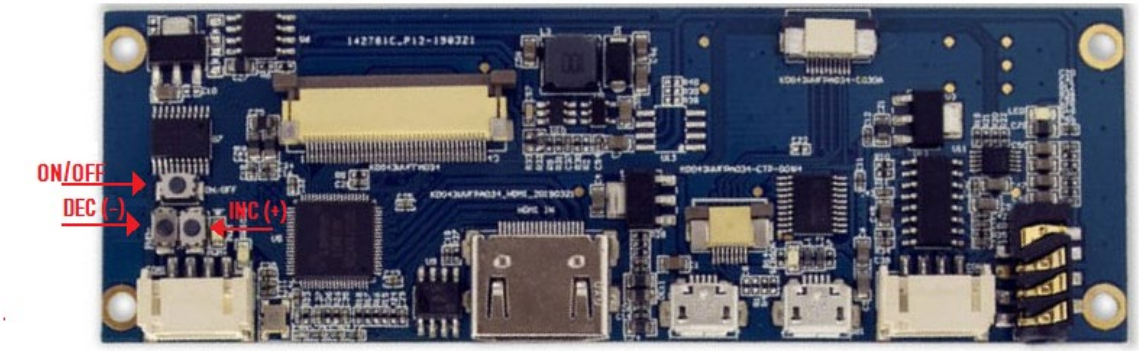
The TFT display has an FPC cable with 40 pin connections. This FPC cable should be placed in the connection port available on the HDMI connector module. The HDMI module takes the display's 24-bit RGB data signals and converts them into an HDMI interface. This makes connecting to the Raspberry Pi as easy as connecting an HDMI cable between the two devices.

You will also need to connect a power supply to both the Raspberry Pi and the HDMI module. The Raspberry Pi requires 5V and 2A. The display requires 3.3V for the digital input voltage supplied by the Raspberry Pi and 25.6V, 20mA for the backlight which can be supplied by an external power cord.

Once connected and powered the display should boot up into the operating system. The NOOBS bootup sequence should recognize the display and calibration parameters. If the display is not recognized you can adjust the configuration file "config.txt" further detailed HERE. The display in this application does not have a touch interface. Capacitive touch is supported by the Raspberry Pi and can be connected through a micro-USB cable on the HDMI connector module.

Push Buttons for Backlight Control

To adjust the brightness of the backlight you can use the right and left push buttons on the HDMI module. This will increase or decrease the current provided to the backlight LEDs thus brightening or dimming the light emitted from the display. There are three total push buttons on the board and their location on the module is highlighted below.



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The left button will decrease the backlight power and the right will increase it. The top button is an on and off switch for the backlight. The option to dim or turn off the backlight is beneficial for battery powered devices as the backlight has the largest power consumption of the device. These three buttons on the board control the power through analog variable resistance. The push buttons provide a convenient solution for backlight adjustment with an HDMI interface without the need to reprogram the device.

Programming for Backlight Control

The other options for adjusting the brightness of the display is to modify the color gamut or use the adaptive brightness control functions of the display's IC driver. Changing the color through gamma encoding will change the perceived brightness of the display. The pulse width modulation will change the on and off cycles of the backlight LEDs. The Raspberry Pi and the display are connected via an HDMI interface, so the controller is not directly changing the backlight power. Instead, the backlight power is adjusted by programming the display driver and implementing the content adaptive backlight control functions. More information on these commands can be found in the controller datasheet.

The functions provided by the display's driver IC provide the option for pulse width modulation, or PWM, of the backlight. The PWM can adjust the backlight by specifying the duty ratio and on cycle length of the on and off cycles of the LEDs. This method adjusts the backlight brightness by cycling through the on and off states of the backlight LEDs. A longer "ON" pulse width will result in a brighter display, while a longer

"OFF" pulse will result in a dimmer display. The PWM duty cycle can be in a range from 50% to 90% with the default value being 70% unless otherwise specified. The frequency of the cycle is defined in a range from 31.37kHz to 137Hz.

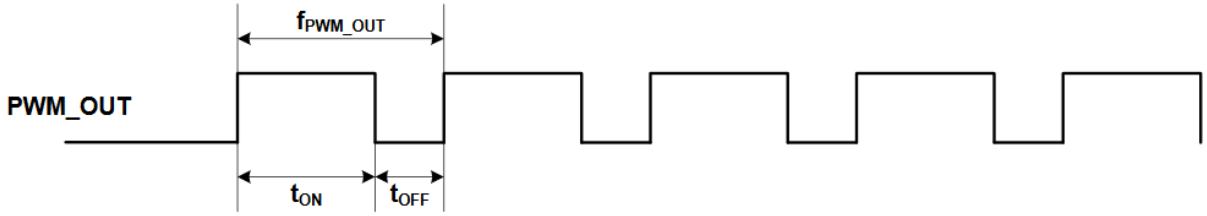

Figure 1.1: Backlight Pulse Width Modulation Timing Diagram

Another method is to adjust the gamma of the display. This method does not change the backlight power. Instead adjusting the gamma of the RGB signals will change the difference between the dark and light pixels which will give the perception of a lighter or darker image. The display driver has a register for changing the gain of each of the red, blue, and green values of the pixels. The gamma is related to voltage by the following equation:

$$Vout = AVin^{\gamma}$$

Where Vout is the output voltage adjusted by a defined gamma, A is a constant (TYP. 1), Vin is the input voltage, and γ is the gamma. The display's gamma decoding occurs in the display's driver IC through a digital to analog converter. Below is a reference of an image at different gamma values.

Figure 1.2: Gamma Adjustment for Apparent Brightness Control (1)

The gamma is adjusted through register commands sent to the display driver. Higher gamma values will result in darker and more contrasted images. Lower gammas will produce a less contrasted and brighter image. Refer to the display driver IC datasheet for the acceptable gamma adjustment values.

Summary

The HDMI connector board M_E43RB_HD is a convenient solution for quickly connecting to a microprocessor. The module converts the RGB interface signals to the HDMI interface to make connection to a Raspberry Pi as easy as attaching an HDMI cord between the two devices. There is an additional benefit to having analog push buttons on the device to adjust the power supplied to the backlight LEDs. These buttons can increase or decrease the brightness of the display. Adjusting brightness through the Raspberry Pi can become complicated through the HDMI interface. The display in this application has an embedded driver IC that allows for pulse width modulation of the backlight LEDs and registers for gamut decoding. The use these features you must program the functions through the connected microprocessor. For more information on these products visit FocusLCDs.com!

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Reference: (1) https://en.wikipedia.org/wiki/Gamma_correction