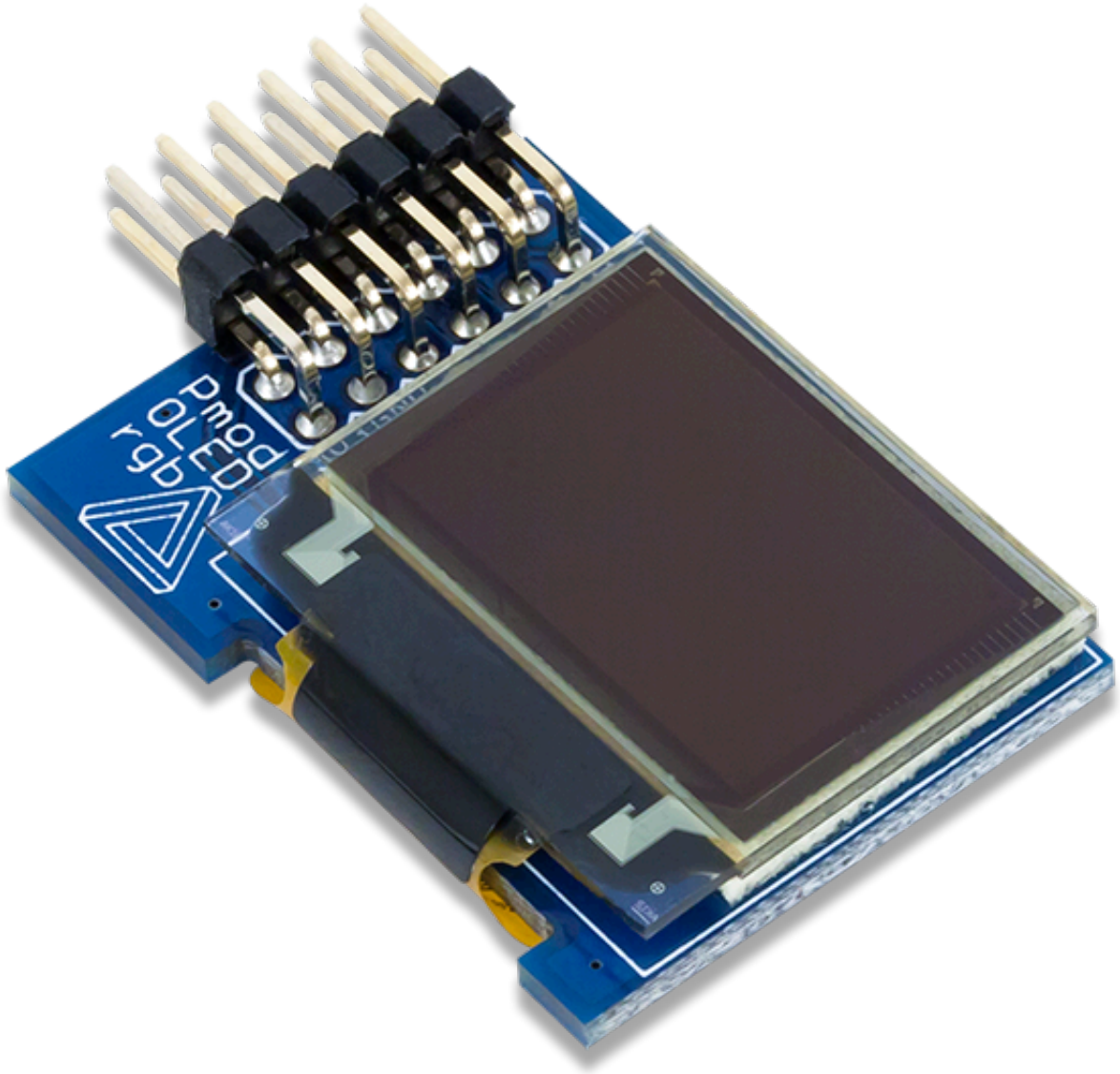
PmodOLEDrgb Reference Manual

The Digilent PmodOLEDrgb (Revision B) is an organic RGB LED module with a 96×64 pixel display capable of 16-bit color resolution.



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Features

- 96×64 pixel RGB OLED screen
- 0.8″ x 0.5″ graphical display
- 16-bit color resolution

- Two low-power display shutdown modes
- 12-pin Pmod connector with SPI interface

Functional Description

The PmodOLEDrgb utilizes a Solomon Systech SSD1331 display controller to receive information from the host board and display the desired information on the OLED screen.

Specifications

Parameter	Min	Typical	Max	Units
Power Supply Voltage	2.7	3.3	3.5	V
Parameter	**Value**			**Units**
Dark Room Contrast	>1000:1			
View Angle	>160			degrees
Number of Pixels	96 x 64			
Panel Size	25.70 x 22.20 x 1.50			mm
Active Area	20.14 x 13.42			mm
Pixel Pitch	0.07 x 0.21			mm
Pixel Size	0.05 x 0.19			mm
White Screen Current Consumption[1]	75.5			mA

Note[1] - All pixels set to white at maximum brightness

Interfacing with the Pmod

The PmodOLEDrgb communicates with the host board via the SPI protocol. By driving and keeping the Chip Select (CS) line at a logic level low, users may send both commands and data streams to the display controller based on the state of the Data/Command (D/C) pin. The display controller operates in SPI Mode 3 (clock idles on logic high, data is captured on the clock rising edge, and data is transferred on the clock falling edge) and with a minimum

clock cycle time of 150 ns (as per table 21 of the SSD1331 datasheet). The embedded display only supports SPI write, so users will not be able to receive any information back from the display over SPI.

As a graphical display interface, users may light up any individual pixel on the OLED, display predefined characters, or even load bitmaps onto the screen. Each pixel can be set to one of the 65,535 colors that are available in a 5-6-5 bit RGB format. The OLED display has a specific power-up and power-down sequence to ensure the longevity of the device.

There are two field-effect transistors (FETs) that control the display's two power supplies. The VCCEN control (**pin 9**) toggles the positive voltage supply to the screen itself and the PMODEN control (**pin 10**) toggles the power supply ground to the display. Users may turn off either one of these controls to reduce the power consumption of the PmodOLEDrgb to approximately 200 nA.

Power-on Sequence where the bytes provided are in the format of (command, data)

1. Bring Data/Command control (**pin 7**) logic low
2. Bring the Reset pin (**pin 8**) logic high
3. Bring the Vcc Enable (**pin 9**) logic low
4. Bring Pmod Enable (**pin 10**) to logic high and delay 20 ms to allow the 3.3V rail to become stable
5. Bring RES (**pin 8**) logic low, wait for at least 3 us, and then bring it back to logic high to reset the display controller
6. Wait for the reset operation to complete; this takes a maximum of 3 us to complete
7. Enable the driver IC to accept commands by sending the unlock command over SPI – 0xFD, 0x12
8. Send the display off command – 0xAE
9. Set the Remap and Data formats – 0xA0, 0x72 for setting the orientation

of how the controller interfaces with the display. Page 29 of the datasheet lists the 7 options that are affected by this command.

10. Set the Display start Line – 0xA1, 0x00 to set the starting line in the upper left corner

11. Set the Display Offset – 0xA2, 0x00 for no offset

12. Make it a normal display – 0xA4 for a normal display, i.e. no funky settings like all pixels being on/off or the color inverted

13. Set the Multiplex Ratio – 0xA8, 0x3F to enable all of the common pins

14. Set Master Configuration – 0xAD, 0x8E to force bit 0 of this register to be a zero after a reset to make the datasheet happy

15. Set Power Saving Mode – 0xB0, 0x0B to disable power saving mode

16. Set Phase Length – 0xB1, 0x31 to set the period of the display clock (DCLK) where the lower four bits set the period of phase 1 in units of DCLK to discharge the previous charge in an OLED pixel and the upper four bits set the period of phase 2 in units of DCLK to charge an OLED pixel to an initial pre-charge voltage. See page 26 of the datasheet for more details

17. Set the Display Clock Divide Ratio and Oscillator Frequency – 0xB3, 0xF0 to set the oscillator frequency to the maximum value in the upper four bits (Figure 28, pg 26 of the datasheet for an approximate value) and set the display clock divide ratio to 1 via the lower four bits (clock divider calculated by lower four bits + 1 for a divide ratio between 1 and 16)

18. Set the Second Pre-Charge Speed of Color A[1] – 0x8A, 0x64 to set the period of phase 3 to drive color A, red by default, to a target driving voltage

19. Set the Second Pre-Charge Speed of Color B[1] – 0x8B, 0x78 to set the

period of phase 3 to drive color B, green by default, to a target driving voltage

20. Set the Second Pre-Charge Speed of Color C[1] – 0x8C, 0x64 to set the period of phase 3 to drive color C, blue by default, to a target driving voltage

21. Set the Pre-Charge Voltage – 0xBB, 0x3A to set the precharge driving voltage referenced multiple times previously to approximately 45% of Vcc

22. Set the VCOMH Deselect Level – 0xBE, 0x3E to set the deselection voltage level of the common pins to 83% of Vcc

23. Set Master Current Attenuation Factor (0x87, 0x06 to set a scaling factor of 6 to control the amount of reference current for the segment current drivers. See page 23 of the datasheet for the equation and more details.

24. Set the Contrast for Color A – 0x81, 0x91 to set a contrast value of 0x91 (out of 0xFF) for color A (default red) effectively setting the brightness level. See page 23 of the datasheet for the equation and more details.

25. Set the Contrast for Color A – 0x82, 0x50 to set a contrast value of 0x50 (out of 0xFF) for color B (default green) effectively setting the brightness level. See page 23 of the datasheet for the equation and more details.

26. Set the Contrast for Color A – 0x83, 0x7D to set a contrast value of 0x7D (out of 0xFF) for color C (default blue) effectively setting the brightness level. See page 23 of the datasheet for the equation and more details.

27. Disable Scrolling – 0x2E

28. Clear the screen – 0x25, 0x00, 0x00, 0x5F, 0x3F to send the clear window command and then define the window size (col start, row start,

col end, row end)

29. Bring VCCEN (**pin 9**) logic high and wait 25 ms
30. Turn the display on (0xAF) and wait at least 100 ms before further operation

Note[1] – when changing any of the second pre-charge speeds, all three registers must be updated sequentially with 6 bytes total (address A, value A, address B, value B, address C, value C), even if their values do not change.

Power-off Sequence

1. Send Display Off command – 0xAE
2. Bring Vcc Enable (**pin 9**) logic low and delay 400 ms
3. Disconnect the positive voltage supply to the Pmod OLEDrgb

Graphics funtions The SSD1331 display controller comes with a number of predefined graphical commands for the user to take advantage of and Digilent provides a few additional graphics functions (such as the displaying of ASCII characters and setting the cursor location) for use. The commands and associated parameters for the predefined functions are nicely outlined on pages 33 and 34 of the datasheet. The Digilent made commands can be found under Example Projects in the Pmod OLEDrgb Resource Center

A pinout table of the PmodOLEDrgb is provided below.

Pinout Description Table

Header J1					
Pin	**Signal**	**Description**	**Pin**	**Signal**	**Description**
1	CS	Chip Select	7	D/C	Data/Command Control
2	MOSI	Master-Out-Slave-In	8	RES	Power Reset
3	NC	Not Connected	9	VCCEN	Vcc Enable

4	SCK	Serial Clock	10	PMODEN	Vdd Logic Voltage Control
5	GND	Power Supply Ground	11	GND	Power Supply Ground
6	VCC	Power Supply (3.3V)	12	VCC	Power Supply (3.3V)

Although users are welcome to create their own interface code for the PmodOLEDrgb if they so desire, pre-constructed libraries that provide functions for initializing the display and rendering simple text and graphics onto the screen exist. They are available on the PmodOLEDrgb example code page and can be used as-is or as a starting point for a more sophisticated graphics library.

Any external power applied to the PmodOLEDrgb must be within 2.7V and 3.5V; however, it is recommended that Pmod is operated at 3.3V.

Physical Dimensions

The pins on the pin header are spaced 100 mil apart. The PCB is 1.4 inches long on the sides parallel to the pins on the pin header and 1 inch long on the sides perpendicular to the pin header.

Additional Information

The schematics of the PmodOLEDrgb are available here. Additional information about the display controller including communication modes and specific timings of the chip can be found by checking out its datasheet here. Similarly, the datasheet for the display can be found here.

More specific information about how to use the PmodOLEDrgb can be found by checking out our user guide. Example code demonstrating how to get information from the PmodOLEDrgb can be found here.

If you have any questions or comments about the PmodOLEDrgb, feel free to post them under the appropriate section (“Add-on Boards”) of the Digilent Forum.