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Display Interface Board
Product Datasheet

SEA0009

HDMI Interface Board for RGB Displays

Revision	Description	Date
A1	PRW: Initial Release	03/13/2019
A2	PRW: Corrected typo, p.11	8/19/2019
A3	Updated assembly drawing	5/18/2020

MH MANUFACTURING   Displaytech   HDP POWER & BATTERY

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Table of Contents

SEACOMP

1 Features

- HDMI receiver
  - Supports pixel rates up to 165 Mhz
  - Supports display resolutions up to 1080p in 24-bit true-color pixel format
- On-board re-programmable EDID EEPROM, I²C compatible
- I²C Capacitive touch interface
- 40-pin RGB-TTL interface
- Optional display backlight PWM control

2 Applications

Provides RGB display data for Raspberry Pi, Beagle Bone, other embedded applications that supply HDMI video input.

3 Acronyms

DVI - Digital Visual Interface
EDID - Extended Display Identification Data
EEPROM - Electrically Erasable Programmable Read-Only Memory
FPC - Flexible Printed Circuit
HDMI - High-Definition Multimedia Interface
I²C - Inter-Integrated Circuit
LCD - Liquid Crystal Display
LED - Light Emitting Diode
MCU - Microcontroller Unit
PCAP - Projected Capacitive Touch
PWM - Pulse Width Modulation
RGB - Red, Green, Blue
RPi - Raspberry Pi
SBC - Single Board Computer
TFT - Thin-Film Transistor
TTL - Transistor Transistor Logic

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4 Product Description

The SEA0009 is a display format converter board designed for use with an RGB TFT display, such as the Displaytech DT050ATFT-PTS. It translates HDMI input to 24-bit true-color RGB and has an I²C interface for capacitive touch capability. The board allows for operation with an HDMI input, provided by a video source such as an SBC, Raspberry Pi, Personal Computer. There is a programmable on-board EEPROM that provides the video source with an EDID through the HDMI interface, supplying the video source with the display resolution configuration.

5 External Interfaces

The SEA0009 supports driving the DT050ATFT's Ilitek IL6122 TFT source driver via 24-bit RGB interface. Video input is received via a Type A HDMI receptacle and the resulting RGB data is relayed to the LCD's flex connector through an RGB-TTL 40-pin interface.
Capacitive touch I²C interface signals are passed through from the display's capacitive touch controller directly to an MCU interface (CN3), with internal pull-ups at each signal.
The display's on/off control signal (STBYB) is also passed through to this interface for optional MCU control. The interface also provides access to the board's power connections, and pads for installation of a second (vertical) header are available depending on the user's mechanical needs.
The board provides pads for optional installation of a 4-pin header (CN6) which provides access to the on-board EDID EEPROM.

5.1 MCU Interface, CN3

A 0.1" 10-pin right angle header provides an interface between the SEA0009 and the MCU device.
The SEA0009 does not contain a video scaler, so display resolution must properly scaled on the MCU. In addition, a driver with the appropriate device address is needed for I²C communication between the MCU master and the display's capacitive touch controller (slave).

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MCU Interface, Pin Descriptions, CN3				
Pin	Signal Name	Type	Description	Comments
1	+5V	PWR	+5V power supply	If using RPi, supplied from I/O header.
2	NC			
3	P-RST	I	Touch reset, active LOW	Pass-through from capacitive touch on display (CN5) to MCU.
4	P-INT	I/O	Touch interrupt/wakeup, active LOW	Pass through from capacitive touch on display (CN5) to MCU.
5	P-SDA	I/O	I2C touch data input/output	Pass through from capacitive touch on display (CN5) to MCU.
6	P-SCL	I	I2C clock input	Pass through from capacitive touch on display (CN5) to MCU.
7	BKLT-PWM	I	PWM input to backlight driver	Optional
8	STBYB	I	Display On/Off (HIGH = On, LOW = Standby)	This pin is not used in normal operation. See Section 5.1 for jumper options and usage details.
9	GND	PWR	Ground	
10	NC			

* NOTE: Active High/Low assumes use of Displaytech DT050ATFT-PTS display.

* NOTE: The user has the option to install a vertical 10-pin 0.1" header at CN2. The connections to CN2 are identical to those to CN3. See Section 12 for recommended connector.

5.1.1 Pass-Through Signals

The following signals are passed directly to/from the display, with pull-up resistors on the I²C capacitive touch signals (see Section 4.4 for resistor values).

SEA0009 Pass-Through Signals			
Signal Name	CN3 Pin	CN4 Pin	CN5 Pin
P-SCL	3		2
P-SDA	4		3
P-INT	5		4
P-WAKE	6		5
STBYB	8	31	
3.3V		4	1

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5.2 HDMI Interface, CN1

The HDMI video signal is supplied by the SBC (Raspberry Pi or equivalent) via a 19-pin Type-A HDMI connector. The SEA0009 was designed with the 800x480 DT050ATFT-PTS display in mind but can convert any resolution up to 165MHz, including 1080p, and is DVI compliant.

5.3 RGB Display Interface, CN4

24-bit RGB display data is delivered to the display via a 40-pin FPC connector.
See Section 12 for connector details.

Pin Descriptions, RGB Display Interface, CN4			
Pin	Signal Name	Type	Description
1	LED-K	PWR	Backlight voltage supply, cathode
2	LED-A	PWR	Backlight voltage supply, anode
3	NC		
4	3.3V	PWR	3.3V Supply
5-12	R0~R7	DO	Red pixel output.
13-20	G0~G7	DO	Green pixel output.
21-28	B0~B7	DO	Blue pixel output.
29	GND	PWR	Ground
30	PIXCLK	DO	Output data clock. All pixel outputs (1 pix/clk), DISPEN, HSYNC, VSYNC synchronized to this clock.
31	STBYB	DO	Sync detect. Monitors state of DISPEN to determine activity. High = Active, Low = Inactive See Section 5.1 for jumper options.
32	HSYNC	DO	Horizontal sync output
33	VSYNC	DO	Vertical sync output
34	DISPEN	DO	Output data enable. Used to indicate time of active vs non-active display time. High: Active display time - Only pixel data transmitted. Low: Non-active display time - Only HSYNC & VSYNC transmitted.
35	NC		
36	GND	PWR	Ground
37	NC		
38	NC		
39	NC		
40	NC		

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5.4 Capacitive Touch I²C Interface, CN5

I²C capacitive touch signals from the display's capacitive touch controller are passed through to the MCU interface via a 6-pin FPC connector (CN5). Pull-up resistors are installed at each PCAP connection (see table below for resistor values).

Pin Descriptions, I²C Interface, CN5			
Pin	Signal Name	Type	Description
1	3.3V	PWR	3.3V capacitive touch controller power supply
2	P-SCL	O	I²C Clock Output
3	P-SDA	I/O	Capacitive touch data from I²C slave device
4	P-INT	I/O	Interrupt request from I²C slave device
5	P-WAKE	O	Capacitive touch external Reset/Wake
6	GND	PWR	Ground

The I²C interface includes internal pull-up resistors on each of the capacitive touch signals.The following table lists the resistor values:

Capacitive Touch I²C Interface, Pull-up Resistor Values	
Signal Name	Pull-up Resistor Value (Ω)
P-SCL	10K
P-SDA	4.7K
P-INT	100K
P-WAKE	4.7K

5.5 EDID Interface, CN6

The user has the option to program the on-board EDID EEPROM by installing a 0.1" 4-pin header at CN6 and using an off-the-shelf serial EEPROM programmer.
The 2Kb EEPROM is organized as a block of 256x8 bit memory with a 2-wire serial interface.
This device must be controlled by a master which generates the serial clock, controls bus access, and generates start and stop conditions while the EEPROM acts as slave. The master and slave can both act as transmitter or receiver, but the master must determine which mode is activated.

Please refer to the EEPROM manufacturer datasheet, part number 24LC024B.

EDID EEPROM Interface, Pin Descriptions, CN6			
Pin	Signal Name	Type	Description
1	HDMI-5V	PWR	EEPROM +5V power supply
2	GND	PWR	EEPROM Ground
3	SCL	I	EEPROM serial clock
4	SDA	I/O	EEPROM serial data in/out

* See Section 12 for recommended connector.

6 Display Backlight Power

An on-board LED driver provides power to the display backlight, with jumper options for multiple current requirements.
By default resistors R12 and R13 are installed, providing 60mA backlight current. Resistor R13 may be added/removed if an increase/decrease in current is required. Pads are available for installation of a third resistor of the user's choosing. See the table below for current values provided by the various resistor options.

Resistors Installed	I_{BKLT} (mA)
R12, R13 (Default)	60
R12	40
R12, R13, R20	300/R20 + 60

The following table provides examples of R20 resistor values needed for various current requirements (provided that all three resistors are installed).

R20 Resistance (Ω)	I_{BKLT} (mA)
60	65
30	70
20	75

Backlight LED dimming can optionally be controlled by application of a PWM signal at CN3, Pin 7 (BKLT-PWM).

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7 Jumper Options

The SEA0009 provides the following custom jumper options:

7.1 Display On/Off Control (STBYB)

By default the display's on/off control (STBYB) is handled by the SEA0009 and requires no input from the user. If the user wishes to independently control the STBYB signal's behavior (CN3-8) they can do so by removing the R24 jumper. Alternatively, a 10K ohm resistor can be installed at R25 to keep the display permanently in the on state.

7.2 Pixel Clock Polarity

By default, output data to the display is latched on the rising edge of the SEA0009's pixel clock. By removing the R3 resistor and jumper at R18, this can be reversed so that data is latched on the falling edge of the clock.

7.3 Output Drive Strength

The SEA0009 allows for selectable output drive strength on the data, control, and clock outputs. The default setting is the High drive strength, but can be changed to Low drive strength by removing the R2 resistor and installing R17. See the table below for the current drives provided by each mode.

Digital I/O Electrical Characteristics							
Output Drive Current Mode	Parameter	Symbol	Min	Typ	Max	Unit
N/A	High-level digital input voltage	VIH	2		VDD	V
N/A	Low-level digital input voltage	VIL	0		0.8	V
High	High-level output drive current	IOH	5	10	14	mA
	Low-level output drive current	IOL	10	13	19	mA
Low	High-level output drive current	IOH	3	6	9	mA
	Low-level output drive current	IOL	5	7	11	mA

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8 Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit
Power Supply Voltage	V_{IN}	-0.3	6	V
Operating Temperature	T_{OP}	0	70	°C
Storage Temperature	T_{ST}	-55	150	°C
EDID Supply Voltage	V_E		6.5	V
EDID Clock Frequency	f_{CLE}		400	kHz
EDID I/O Voltage	V_{EIO}	-0.3	V_E+1	V
Backlight Supply Voltage	V_{BKLT}	-0.3	40	V
Backlight PWM Voltage	V_{PWM}	-0.3	7	V

9 Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power Supply Voltage	V_{IN}		5		V
EDID Supply Voltage	V_E		5		V
Backlight PWM Frequency	f_{PWM}	100		2000	Hz

10 Electrical Characteristics

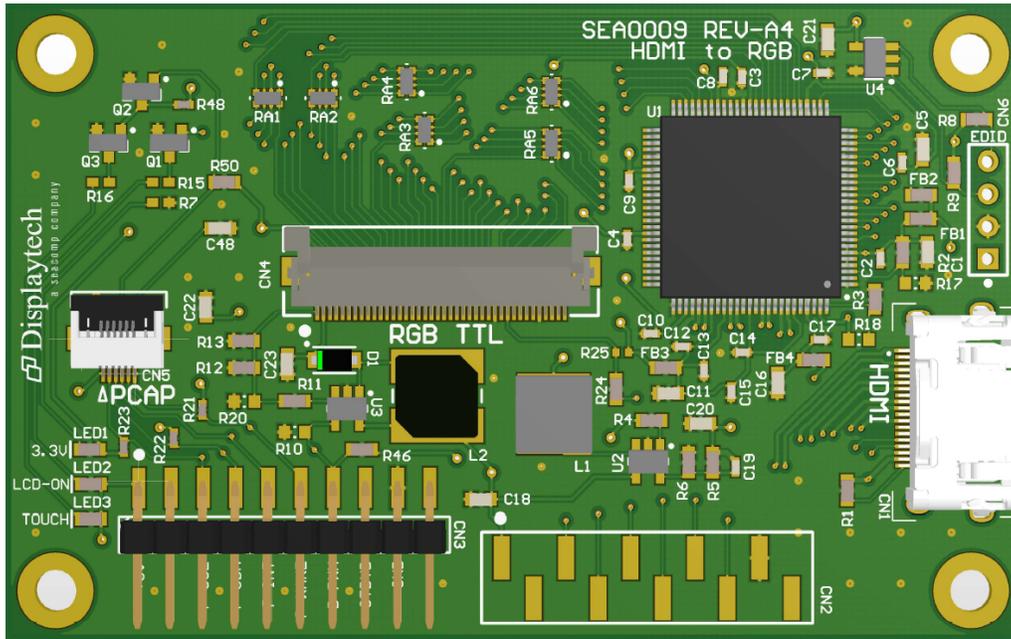| Parameter	Symbol	Min.	Typ.	Max.	Unit
Power Supply Voltage	V_{IN}	2.7		5.5	V
EDID Supply Voltage	V_E	2.5		5.5	V

Backlight PWM Voltage,
    High threshold
    Low threshold
	V_{PWM}	
		
		0.4
			
			0.8
			0.7
				
				1.5
					
					V

Backlight Forward Voltage	V_{BKLT}		19.8		V
Backlight Supply Current	I_{BKLT}	57	60	63	mA

11 Example Software

Raspberry Pi sample software is available from Displaytech upon request. Please contact Displaytech at
sales@displaytech-us.com

12 Mechanical Drawing

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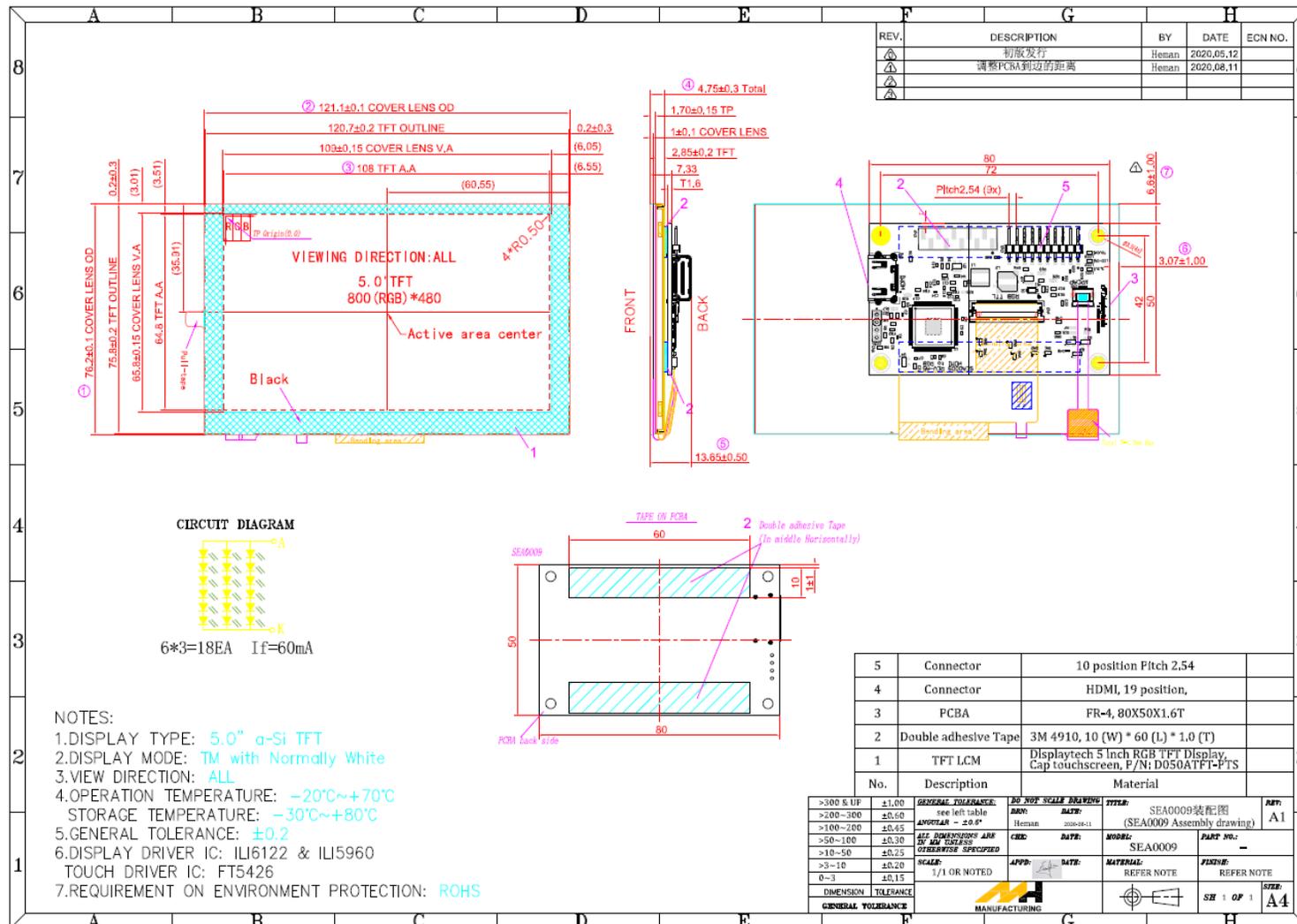
12.1 SEA0009 Top View

12.2 SEA0009 Bottom View