NHD-7.0-800480FT-CSXV-CTP

7.0″ EVE TFT Module (SPI) – Supports: Display | Touch | Audio

NHD-	Newhaven Display
7.0-	7.0″ Diagonal
800480-	800xRGBx480 Pixels
FT-	Model
C-	On-board Controller
S-	High Brightness, White LED Backlight
X -	TFT
V-	Full View (MVA), Wide Temperature
CTP-	Capacitive Touch Panel

REACH
Compliant

RoHS
Compliant

Table of Contents

Additional Resources

- **Support Forum:** https://support.newhavendisplay.com/hc/en-us/community/topics

- **GitHub:** https://github.com/newhavendisplay

- **Example Code:** https://support.newhavendisplay.com/hc/en-us/categories/4409527834135-Example-Code/

- **Knowledge Center:** https://www.newhavendisplay.com/knowledge_center.html

- **Quality Center:** https://www.newhavendisplay.com/quality_center.html
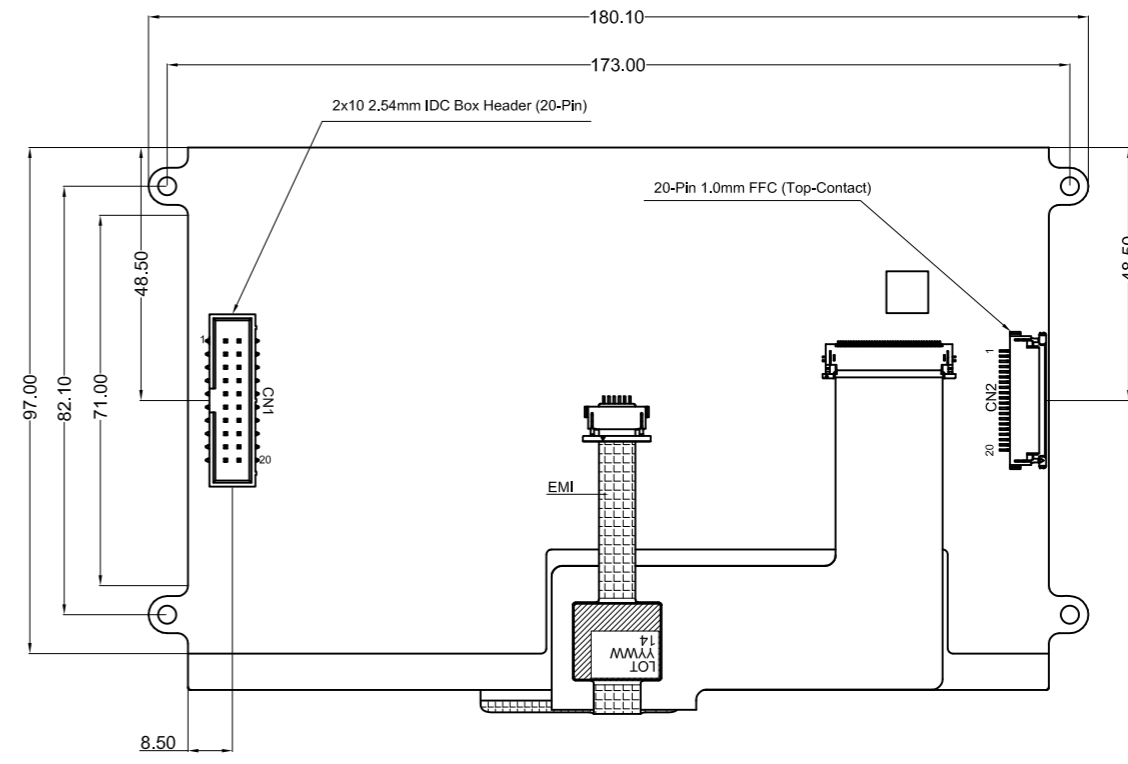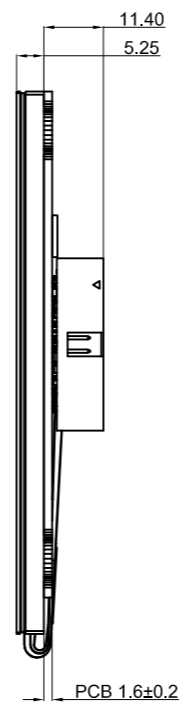
- **Precautions for using LCDs/LCMs:** https://www.newhavendisplay.com/specs/precautions.pdf

- **Warranty / Terms & Conditions:** https://www.newhavendisplay.com/terms.html

Document Revision History

Revision	Date	Description	Changed By
-	09/27/2017	Initial Release	PB, ML
1	10/25/2021	CTP IC updated to FT5426	ZP
2	08/30/2022	Updated Backlight PWM Frequency Range, Updated Schematic to show new LED driver IC and auxiliary components	JT
3	10/31/2022	Updated Luminance value, Mechanical Drawing, and CTP Material Characteristics. CTP Revision upgraded to Rev4A	JT
4	03/02/2023	Document Formatting Updated	KL
5	02/19/2024	Mechanical Drawing & Schematic Updated CTP Controller Upgraded from FT5426 to FT5426G	KL
6	04/01/2024	TFT Timing Characteristics Updated	KL
7	08/20/2024	Firmware ID Updated on Mechanical Drawing	KL

Mechanical Drawing

165.00
154.90 (CTP VA)
153.84 (TFT AA)
(80.82)
(7.01)
(7.26)

(6.05)
(6.89)
(49.70)

104.00 (CTP VA)
86.85 (TFT AA)
85.63 (TFT AA)

800(RGB)x480

4.5±0.5

4-R3.50±0.1

⚠ [read caution below]

11.40
5.25

PCB 1.6±0.2

180.10
173.00

2x10 2.54mm IDC Box Header (20-Pin)

20-Pin 1.0mm FFC (Top-Contact)

48.50
48.50

97.00
82.10
71.00

CN1
CN2

EMI

LOT YYWW 14

8.50
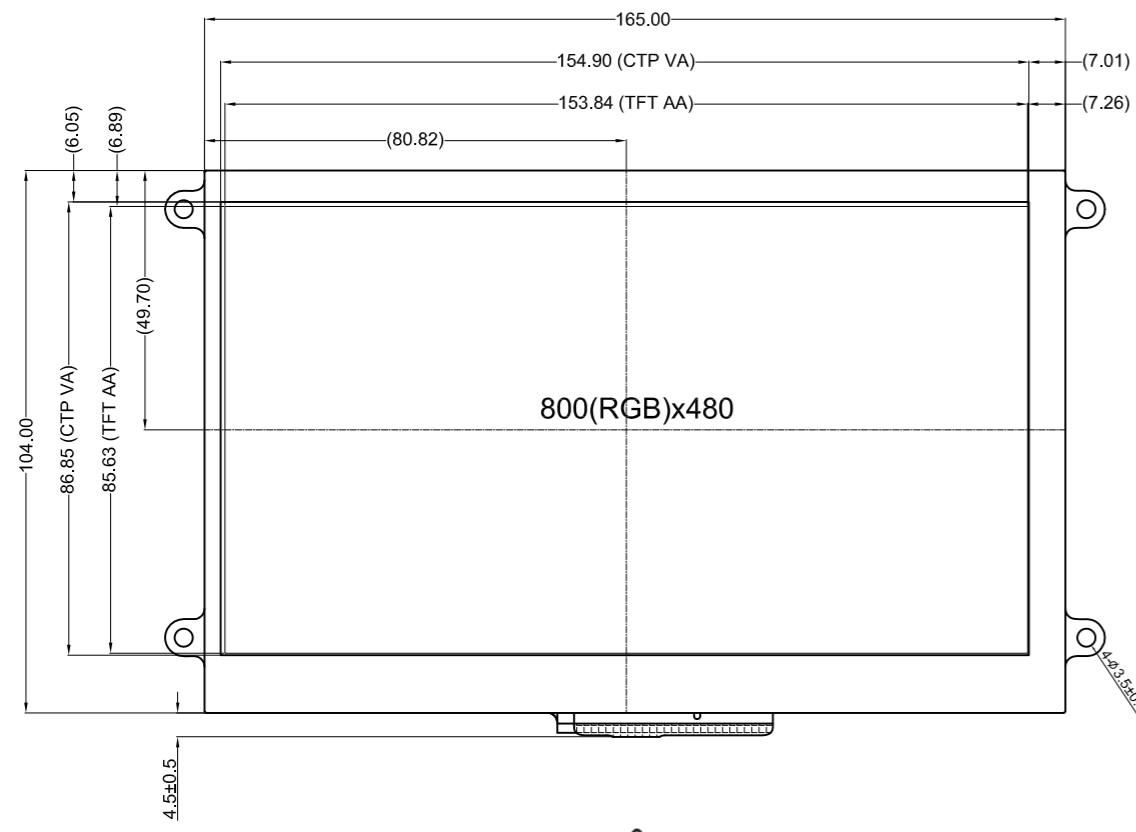
Pin Assignment

NO.	Symbol
1	VDD
2	GND
3	SCK
4	MISO/IO1
5	MOSI/IO0
6	/CS
7	/INT
8	/PD
9	AUDIO_L
10	NC
11	GPIO0/IO2
12	GPIO1/IO3
13	GPIO2
14	GPIO3
15	NC
16	NC
17	VBL
18	VBL
19	GND
20	GND

Product Description: 7" 800x480 Premium EVE TFT w/ Capacitive Touch

1. Driver IC: FT813

2. Interface: SPI, D-SPI, Q-SPI

3. Power Requirement: 3.3V EVE, 3.3V/760mA Backlight

4. Optical Features: Normally White, Transmissive, 680cd/m²
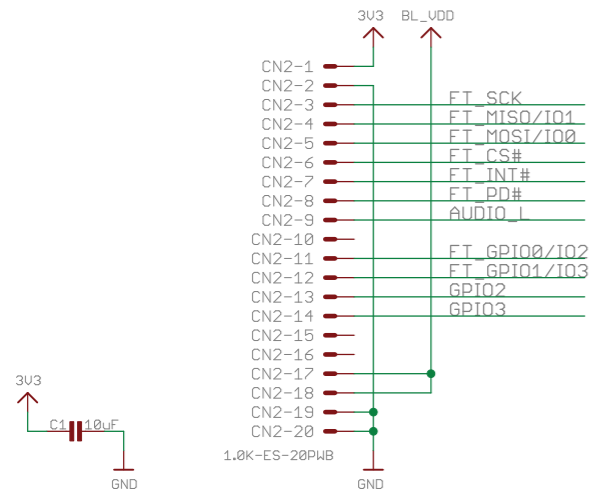
5. Recommended Cable:

    CN1: 2x10pin 2.54mm pitch IDC cable

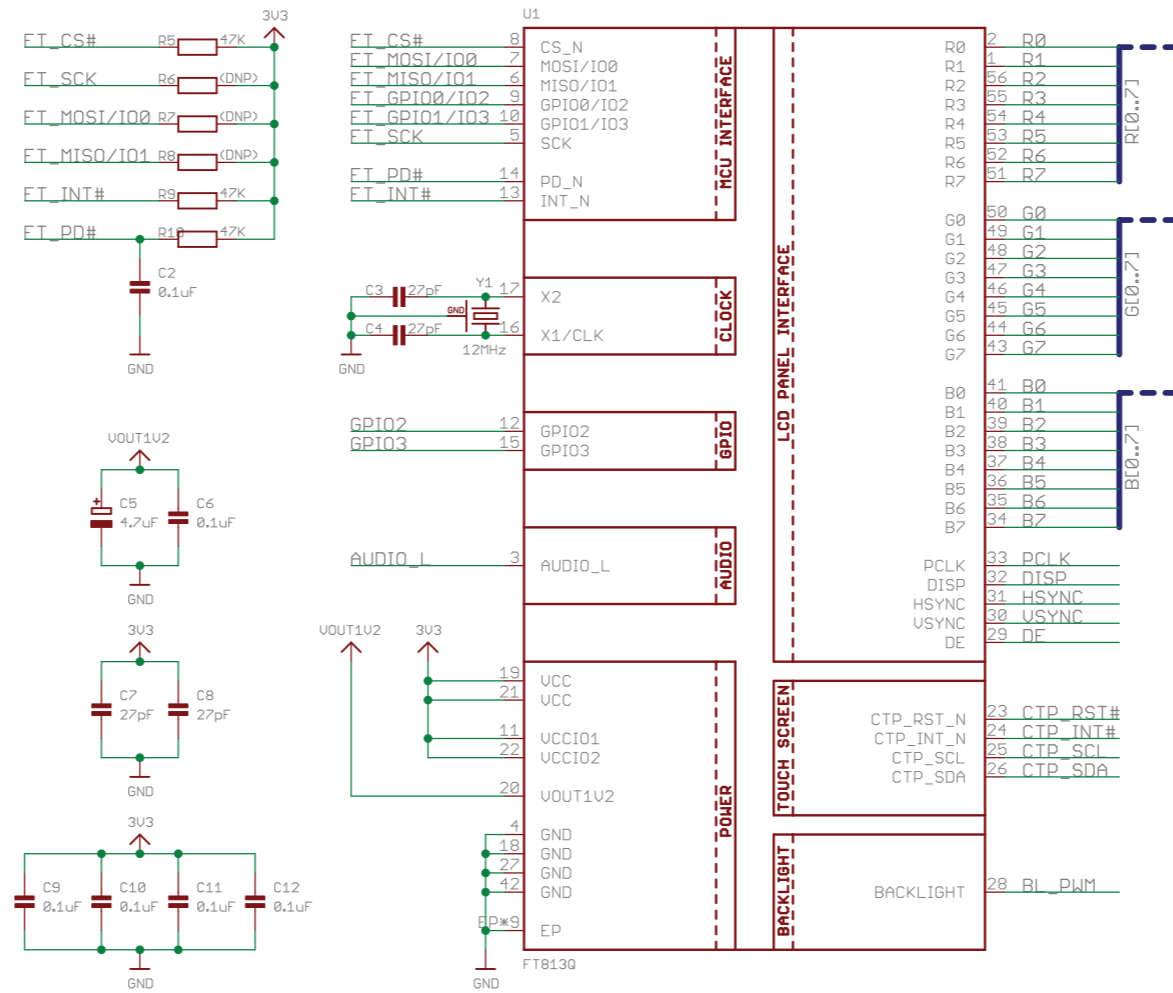   CN2: 20pin 1.0mm pitch FFC

6. EMI Shielded FPC

⚠ Improper handling of the FPC connections at the bottom edge of this module may cause damage resulting in display or touch failure. Take special care when handling this area of the display module to make sure these connections are never strained nor creased.

20-Pin 1.0mm FFC

3V3 BL_VDD

CN2-1
CN2-2
CN2-3   FT_SCK
CN2-4   FT_MISO/IO1
CN2-5   FT_MOSI/IO0
CN2-6   FT_CS#
CN2-7   FT_INT#
CN2-8   FT_PD#
CN2-9   AUDIO_L
CN2-10
CN2-11   FT_GPIO0/IO2
CN2-12   FT_GPIO1/IO3
CN2-13   GPIO2
CN2-14   GPIO3
CN2-15
CN2-16
CN2-17
CN2-18
CN2-19
CN2-20

3V3
C1 10uF
GND
1.0K-ES-20PWB
GND

2x10 2.54mm IDC Box Header (20 Pin)

BL_VDD 3V3
CN1

FT_SCK   1 2
FT_MOSI/IO0   3 4   FT_MISO/IO1
FT_INT#   5 6   FT_CS#
AUDIO_L   7 8   FT_PD#
FT_GPIO0/IO2 9 10
GPIO2   11 12 FT_GPIO1/IO3
             13 14 GPIO3
             15 16
             17 18
             19 20

301200312110
GND   GND

FTDI FT813Q (24 bit RGB Capacitive Touch)

3V3   U1

FT_CS#   R5 47K   8 CS_N
FT_SCK   R6 (DNP)   7 MOSI/IO0
FT_MOSI/IO0 R7 (DNP)   6 MISO/IO1
FT_MISO/IO1 R8 (DNP)   9 GPIO0/IO2
FT_INT#   R9 47K   10 GPIO1/IO3
FT_PD#   R10 47K   5 SCK

FT_CS#   8
FT_MOSI/IO0   7
FT_MISO/IO1   6
FT_GPIO0/IO2   9
FT_GPIO1/IO3 10
FT_SCK   5

FT_PD#   14 PD_N
FT_INT#   13 INT_N

C2 0.1uF
GND

MCU INTERFACE

C3 27pF   Y1 17 X2
C4 27pF   16 X1/CLK
GND   12MHz
CLOCK

VOUT1V2
C5 4.7uF   C6 0.1uF
GND

GPIO2   12 GPIO2
GPIO3   15 GPIO3
GPIO

3V3
VOUT1V2
C7 27pF C8 27pF
GND

AUDIO_L   3 AUDIO_L
AUDIO

VOUT1V2 3V3
3V3
         19 VCC
         21 VCC
         11 VCCIO1
         22 VCCIO2
         20 VOUT1V2
C9 0.1uF C10 0.1uF C11 0.1uF C12 0.1uF
GND
POWER

          4 GND
         18 GND
         27 GND
         42 GND
        EP*9 EP
GND
FT813Q

LCD PANEL INTERFACE

R0   2   R0
R1   1   R1
R2 56   R2
R3 55   R3
R4 54   R4
R5 53   R5
R6 52   R6
R7 51   R7   R[0..7]

G0 50   G0
G1 49   G1
G2 48   G2
G3 47   G3
G4 46   G4
G5 45   G5
G6 44   G6
G7 43   G7   G[0..7]

B0 41   B0
B1 40   B1
B2 39   B2
B3 38   B3
B4 37   B4
B5 36   B5
B6 35   B6
B7 34   B7   B[0..7]

PCLK 33 PCLK
DISP 32 DISP
HSYNC 31 HSYNC
VSYNC 30 VSYNC
DE   29 DE

TOUCH SCREEN

CTP_RST_N 23 CTP_RST#
CTP_INT_N 24 CTP_INT#
CTP_SCL   25 CTP_SCL
CTP_SDA   26 CTP_SDA

BACKLIGHT

BACKLIGHT 28 BL_PWM

LCD Interface

3V3
LED_K
LED_A
LCD1

LED-K
LED-A
GND
VDD

7.0"
TFT DISPLAY
800 x 480
Pixels
24-bit Parallel RGB

R0 1 8 R0
R1 2 7 R1
R2 3 6 R2   RN2 33R
R3 4 5 R3
R4   R4
R5 1 8 R5
R6 2 7 R6   RN3 33R
R7 3 6 R7

G0 4 5 G0
G1 1 8 G1
G2 2 7 G2   RN4 33R
G3 3 6 G3
G4 4 5 G4
G5 1 8 G5
G6 2 7 G6   RN5 33R
G7 3 6 G7

B0 4 5 B0
B1 1 8 B1
B2 2 7 B2   RN6 33R
B3 3 6 B3
B4 4 5 B4
B5   B5
B6   B6
B7   B7

GND
PCLK R22 33R CLKIN
DISP   DISP
HSYNC 1 8   HSD
VSYNC 2 7   VSD   RN7 33R
      3 6   DEN
      4 5   NC
              GND
              NC(XR)
              NC(YD)
              NC(XL)
              NC(YU)

3V3
C20 0.1uF C21 27pF
GND

0.5K-AX-40PWB
GND

Exposed Pads to Ground TFT Bezel

PAD1
1
exposed copper

PAD2
1
exposed copper

GND
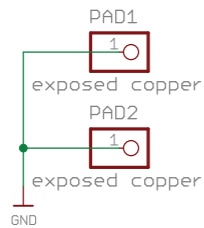
Mounting Holes 3.5mm Plated
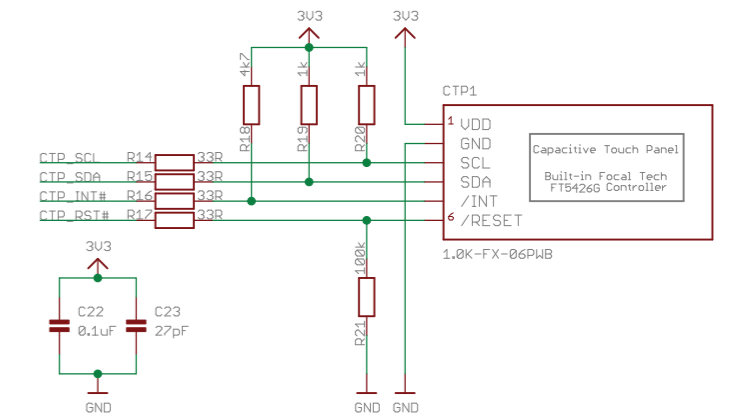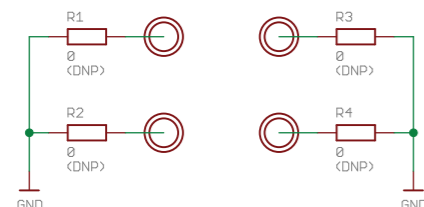
R1 0 (DNP)
R3 0

R2 0 (DNP)
R4 0 (DNP)

GND   GND

Backlight

BL_VDD
L1 10uH
D1 MBR0540
LED_A

U2
SGM3766YTN5G
VIN SW
FB
SHDN GND

R11 47K
BL_PWM

C15 1uF C16 1uF C17 (DNP)
D2 3SMAJ5935B-TP
GND

C13 10uF C14 27pF
GND GND

R12 3.3 1%   R13 1.69 1%
SJ1
LED_K

C18 0.1uF C19 27pF
GND GND GND GND

3V3 3V3 3V3
R18 4k7 R19 1k R20 1k

CTP1
Capacitive Touch Panel
Built-in Focal Tech
FT5426G Controller

1 VDD
2 GND
3 SCL
4 SDA
5 /INT
6 /RESET

1.0K-FX-06PWB

CTP_SCL   R14 33R SCL
CTP_SDA   R15 33R SDA
CTP_INT# R16 33R /INT
CTP_RST# R17 33R /RESET

R21 100k

3V3
C22 0.1uF C23 27pF
GND GND GND

Backlight Configuration

Current	SJ1
~60mA	Open
~181mA	Close

Pin Description

Pin No.	Symbol	External Connection	Function Description
1	VDD	Power Supply	Input Voltage for TFT and FT81x (3.3V)
2	GND	Power Supply	Ground
3	SCK	MCU	SPI Clock (Input)
4	MISO/IO1	MCU	SPI MISO (Output) / Quad-SPI mode: SPI data line 1
5	MOSI/IO0	MCU	SPI MOSI (Input) / Quad-SPI mode: SPI data line 0
6	/CS	MCU	SPI Chip Select (Input), Active LOW
7	/INT	MCU	Interrupt to host (Output), Active LOW
8	/PD	MCU	Power Down control (Input), Active LOW
9	AUDIO_L	Filter/Amplifier	Audio PWM out (Output)
10	N.C.	-	No Connect
11	GPIO0/IO2	MCU	General Purpose IO0 / SPI Quad mode: SPI data line 2
12	GPIO1/IO3	MCU	General Purpose IO1 / SPI Quad mode: SPI data line 3
13	GPIO2	MCU	General Purpose IO2
14	GPIO3	MCU	General Purpose IO3
15 - 16	N.C.	-	No Connect
17 - 18	VBL	Power Supply	Input Voltage for LED Backlight Driver (3.3V/5V)
19 - 20	GND	Power Supply	Ground

CN1: Male IDC Box Header - 20-Pin, 2x10, 2.54mm pitch.
CN2: FFC Connector - 20-Pin, 1.0mm pitch, Top-contact.

EVE Controller Information

This EVE TFT Module is powered by the FTDI/Bridgetek FT813 Embedded Video Engine (EVE).
https://support.newhavendisplay.com/hc/en-us/articles/6963170802839-FT81x

Display Information

TFT Panel Used	Display Type	Luminance Rating	Contrast Ratio	Optimal Viewing Angle	Touch Panel
NHD-7.0-800480EF-ASXV#-CTP	Premium MVA	660 cd/m²	400	70° all angles	PCAP

Electrical Characteristics

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Operating Temperature Range	T_{OP}	Absolute Max	-20	-	+70	^oC
Storage Temperature Range	T_{ST}	Absolute Max	-30	-	+80	^oC
Supply Voltage	V_{DD}	-	3.0	3.3	3.6	V
Supply Current	I_{DD}	$V_{DD} = 3.3V$	-	100	-	mA
"H" Level Input	V_{IH}	-	2.0	-	-	V
"L" Level Input	V_{IL}	-	-	-	0.8	V
"H" Level Output	V_{OH}	-	$V_{DD}-0.4$	-	-	V
"L" Level Output	V_{OL}	-	-	-	0.4	V
Supply Voltage for LED Backlight Driver	V_{BL}	-	2.8	3.3	5.5	V
Supply Current for LED Backlight Driver	I_{BL}	$V_{BL} = 3.3V$	-	760	-	mA
	I_{BL}	$V_{BL} = 5.0V$	-	440	-	mA
Backlight PWM Frequency	f_{PWM}	-	800	-	10000	Hz

Backlight Driver Configuration

The Backlight Driver Enable signal is connected to the FT81x backlight control pin. This signal is controlled by two registers: REG_PWM_HZ and REG_PWM_DUTY. **REG_PWM_HZ** specifies the PWM output frequency – the range available on the FT81x is 250 to 10KHz and the on-board backlight driver's PWM frequency is 800 to 100KHz. Therefore, for proper use of the PWM function available on this module, the PWM frequency should not go below 800 or exceed 10KHz.
REG_PWM_DUTY specifies the duty cycle – the range is 0 to 128. A value of 0 turns the backlight completely off, while a value of 128 provides maximum backlight brightness.

For the above register definitions, please refer to pages 80-81 of the official FT81x Series Programmers Guide:
http://www.ftdichip.com/Support/Documents/ProgramGuides/FT81X_Series_Programmer_Guide.pdf

Arduino Application

If using or prototyping this EVE TFT Module with the low-cost, widely popular Arduino platform we highly recommend using our Arduino shield, the NHD-FT81x-SHIELD. Not only does the NHD-FT81x-SHIELD provide seamless connectivity and direct software compatibility for the user, but it also comes with the following useful features on-board:
- logic level shifters to allow the 5V Arduino to communicate with the 3.3V FT81x
- regulators to allow the Arduino to output more current to the EVE TFT Module
- audio filter/amplifier circuit to utilize the EVE TFT Module's audio output signal
- microSD card slot, which allows expandable storage for data such as images, video, and audio to be stored.

Please visit the NHD-FT81x-SHIELD product webpage for more info.

FT81x Block Diagram

FT81x with EVE (Embedded Video Engine) technology simplifies the system architecture for advanced Human Machine Interfaces (HMIs) by providing support for display, touch, and audio as well as an object oriented architecture approach that extends from display creation to the rendering of the graphics.
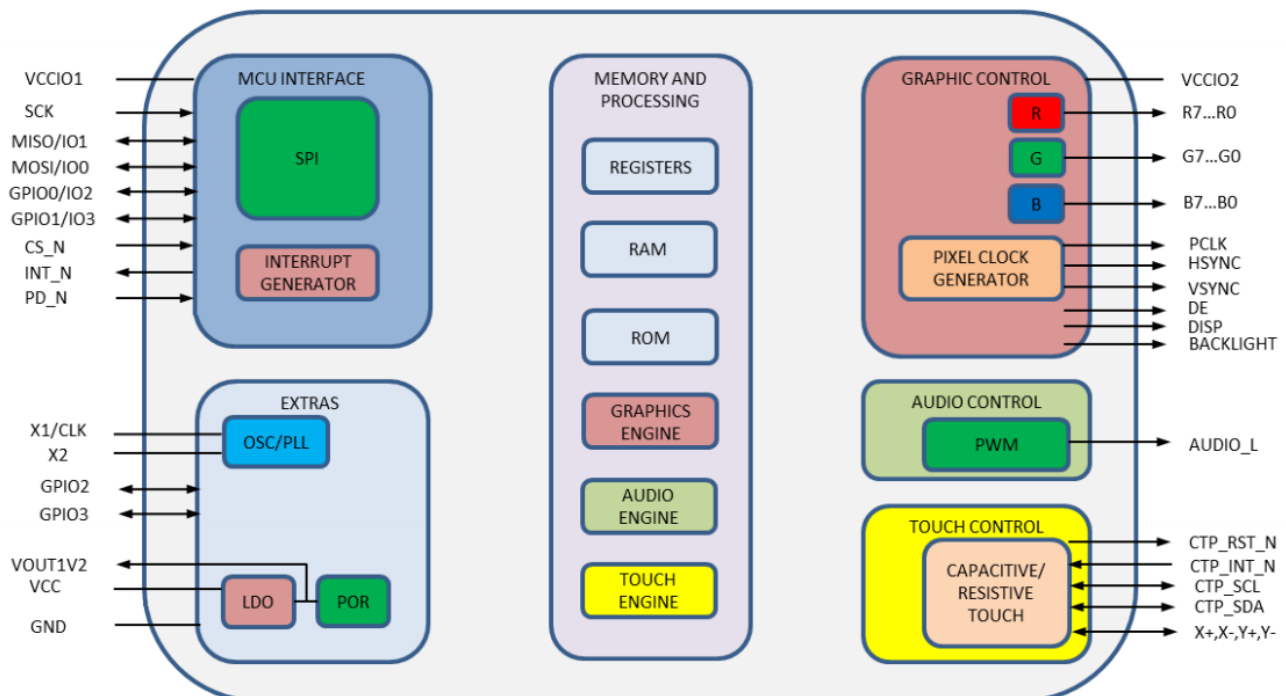
Serial Host Interface

By default the SPI slave operates in the SINGLE channel mode with MOSI as input from the master and MISO as output to the master. DUAL and QUAD channel modes can be configured through the SPI slave itself. To change the channel modes, write to register REG_SPI_WIDTH. Please refer to the table below:

REG_SPI_WIDTH[1:0]	Channel Mode	Data Pins	Max Bus Speed
00	SINGLE (default)	MISO, MOSI	30MHz
01	DUAL	IO0, IO1	30MHz
10	QUAD	IO0, IO1, IO2, IO3	25MHz
11	Reserved	-	-

For more details on the FT81x SPI interface, please refer to pages 13-15 of the official FT81x Datasheet:
https://support.newhavendisplay.com/hc/en-us/articles/6963170802839-FT81x

For the REG_SPI_WIDTH register definition, please refer to page 87 of the official FT81x Series Programmers Guide:
http://www.ftdichip.com/Support/Documents/ProgramGuides/FT81X_Series_Programmer_Guide.pdf

TFT Timing Characteristics

Shown below are the FT81x registers that control the TFT's timing (clock and sync signals), along with the values recommended to use for this EVE TFT Module:

Horizontal Timing

Register	Value
REG_HSIZE	800
REG_HCYCLE	928
REG_HOFFSET	88
REG_HSYNC0	0
REG_HSYNC1	48

Vertical Timing

Register	Value
REG_VSIZE	480
REG_VCYCLE	525
REG_VOFFSET	32
REG_VSYNC0	0
REG_VSYNC1	3

Clock Settings

Register	Value
REG_PCLK	2
REG_SWIZZLE	0
REG_PCLK_POL	1
REG_CSPREAD	0
REG_DITHER	1

Graphics Engine

The graphics engine executes the display list once for every horizontal line. It executes the primitive objects in the display list and constructs the display line buffer. The horizontal pixel content in the line buffer is updated if the object is visible at the horizontal line.

Main features of the graphics engine are:
- The primitive objects supported by the graphics processor are: lines, points, rectangles, bitmaps (comprehensive set of formats), text display, plotting bar graph, edge strips, and line strips, etc.
- Operations such as stencil test, alpha blending and masking are useful for creating a rich set of effects such as shadows, transitions, reveals, fades and wipes.
- Anti-aliasing of the primitive objects (except bitmaps) gives a smoothing effect to the viewer.
- Bitmap transformations enable operations such as translate, scale and rotate.
- Display pixels are plotted with 1/16th pixel precision.
- Four levels of graphics states
- Tag buffer detection

The graphics engine also supports customized built-in widgets and functionalities such as jpeg decode, screen saver, calibration etc. The graphics engine interprets commands from the MPU host via a 4 Kbyte FIFO in the FT81x memory at RAM_CMD. The MPU/MCU writes commands into the FIFO, and the graphics engine reads and executes the commands. The MPU/MCU updates the register REG_CMD_WRITE to indicate that there are new commands in the FIFO, and the graphics engine updates REG_CMD_READ after commands have been executed.

Main features supported are:
- Drawing of widgets such as buttons, clock, keys, gauges, text displays, progress bars, sliders, toggle switches, dials, gradients, etc.
- JPEG and motion-JPEG decode
- Inflate functionality (zlib inflate is supported)
- Timed interrupt (generate an interrupt to the host processor after a specified number of milliseconds)
- In-built animated functionalities such as displaying logo, calibration, spinner, screen saver and sketch
- Snapshot feature to capture the current graphics display

For a complete list of graphics engine display commands and widgets, please refer to Chapter 4 of the official FT81x Series Programmers Guide:
http://www.ftdichip.com/Support/Documents/ProgramGuides/FT81X_Series_Programmer_Guide.pdf

Touch-Screen Engine

The Capacitive Touch Screen Engine (CTSE) of the FT813 communicates with the external Capacitive Touch Panel Module (CTPM) through an I2C interface. The CTPM will assert its interrupt line when there is a touch detected. Upon detecting CTP_INT_N line active, the FT813 will read the touch data through I2C. Up to 5 touches can be reported and stored in FT813 registers.

For more details on the FT813 Touch-Screen Engine, please refer to pages 32-35 of the official FT81x Datasheet:
https://support.newhavendisplay.com/hc/en-us/articles/6963170802839-FT81x

Audio Engine

The FT81x provides mono audio output through a PWM output pin, AUDIO_L. It outputs two audio sources, the sound synthesizer and audio file playback.
This pin is designed to be passed into a simple filter circuit and then passed to an amplifier for best results. Please refer to the example schematic in the Audio Filter and Amplifier Reference Circuit section on the next page.

Sound Synthesizer
A sound processor, AUDIO ENGINE, generates the sound effects from a small ROM library of waves table. To play a sound effect listed in Table 4.3, load the REG_SOUND register with a code value and write 1 to the REG_PLAY register. The REG_PLAY register reads 1 while the effect is playing and returns a '0' when the effect ends. Some sound effects play continuously until interrupted or instructed to play the next sound effect. To interrupt an effect, write a new value to REG_SOUND and REG_PLAY registers; e.g. write 0 (Silence) to REG_SOUND and 1 to PEG_PLAY to stop the sound effect.

The sound volume is controlled by register REG_VOL_SOUND. The 16-bit REG_SOUND register takes an 8-bit sound in the low byte. For some sounds, marked "pitch adjust" in the table below, the high 8 bits contain a MIDI note value. For these sounds, a note value of zero indicates middle C. For other sounds the high byte of REG_SOUND is ignored.

Audio Playback

The FT81x can play back recorded sound through its audio output. To do this, load the original sound data into the FT81x's RAM, and set registers to start the playback. The registers controlling audio playback are:

REG_PLAYBACK_START:	The start address of the audio data.
REG_PLAYBACK_LENGTH:	The length of the audio data, in bytes.
REG_PLAYBACK_FREQ:	The playback sampling frequency, in Hz.
REG_PLAYBACK_FORMAT:	The playback format, one of LINEAR SAMPLES, uLAW SAMPLES, or ADPCM SAMPLES.
REG_PLAYBACK_LOOP:	If '0', the sample is played once. If '1', the sample is repeated indefinitely.
REG_PLAYBACK_PLAY:	A write to this location triggers the start of audio playback, regardless of writing '0' or '1'. Read back '1' when playback is ongoing, and '0' when playback finishes.
REG_VOL_PB:	Playback volume, 0-255.

The mono audio formats supported are 8-bits PCM, 8-bits uLAW and 4-bits IMA-ADPCM. For ADPCM_SAMPLES, each sample is 4 bits, so two samples are packed per byte, the first sample is in bits 0-3 and the second is in bits 4-7.
The current audio playback read pointer can be queried by reading the REG_PLAYBACK_READPTR. Using a large sample buffer, looping, and this read pointer, the host MPU/MCU can supply a continuous stream of audio.

For more details on the FT81x Audio Engine, please refer to pages 30-32 of the official FT81x Datasheet:
https://support.newhavendisplay.com/hc/en-us/articles/6963170802839-FT81x

Audio Filter and Amplifier Reference Circuit
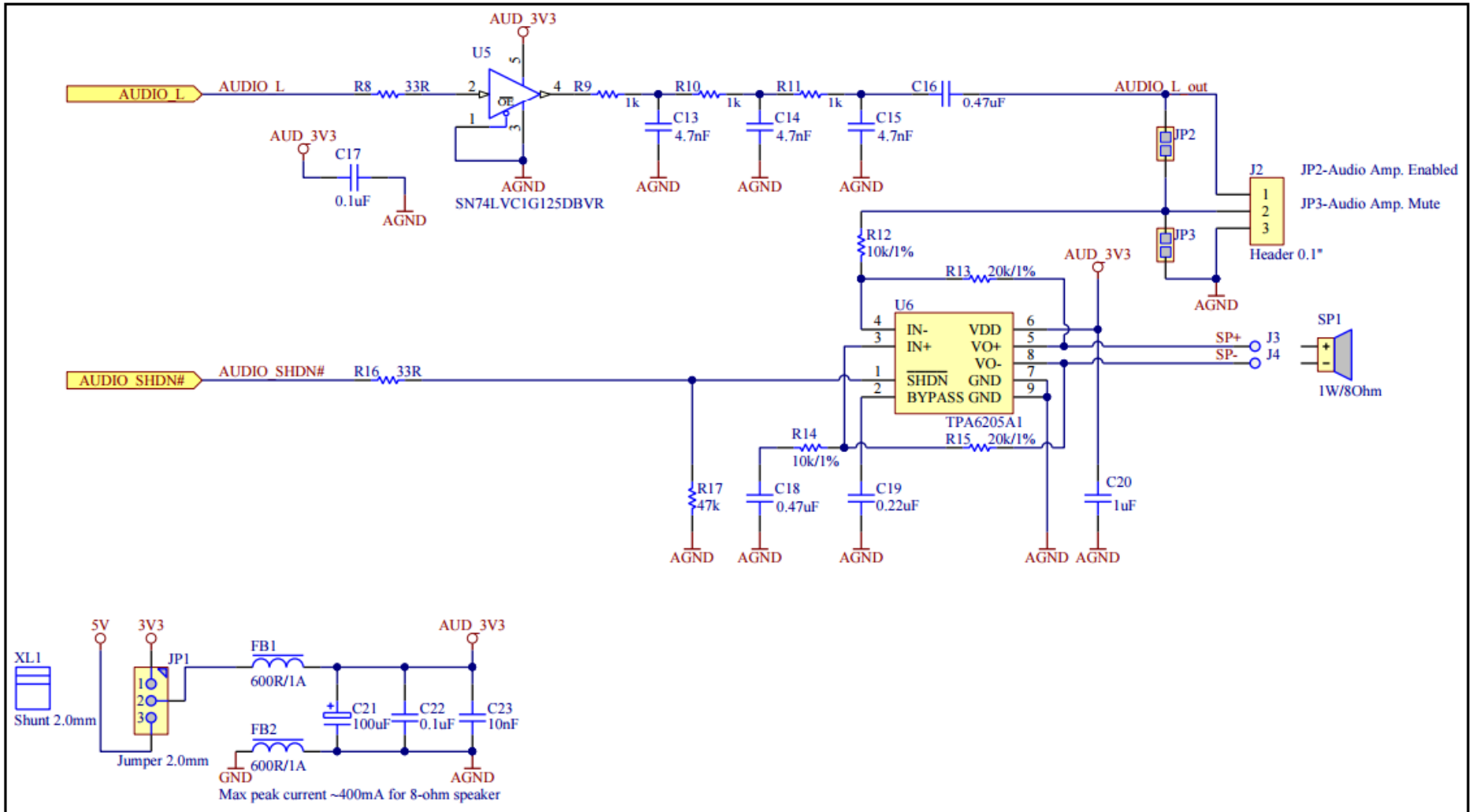
This is a reference schematic from FTDI, which can be used to successfully filter and amplify the audio signals coming from the NHD EVE TFT Module.

Additional EVE Resources

FT81x Datasheet:

FTDI/Bridgetek FT81x Embedded Video Engine (EVE)
https://support.newhavendisplay.com/hc/en-us/articles/6963170802839-FT81x

Programmers Guide:

FT81x Series Programmers Guide
http://www.ftdichip.com/Support/Documents/ProgramGuides/FT81X_Series_Programmer_Guide.pdf

NHD GitHub Page:

NHD EVE TFT Module Example Projects
https://github.com/NewhavenDisplay/EVE-TFT-Modules

EVE Software Examples:

FT81x Example Projects
http://www.ftdichip.com/Support/SoftwareExamples/FT800_Projects.htm

FTDI/Bridgetek Utilities:

Screen Designer
http://www.ftdichip.com/Support/Utilities.htm#ESD3

Image Converters
http://www.ftdichip.com/Support/Utilities.htm#EVEImageConverters

Audio Converter
http://www.ftdichip.com/Support/Utilities.htm#EVEAudioConverter

Font Converter
http://www.ftdichip.com/Support/Utilities.htm#EVEFontConverter

FT80x to FT81x Migration Guide:

FT80x to FT81x Migration Guide
http://www.ftdichip.com/Support/Documents/AppNotes/AN_390%20FT80x%20To%20FT81x%20Migration%20Guide.pdf

Quality Information

Test Item	Content of Test	Test Condition	Note
High Temperature storage	Endurance test applying the high storage temperature for a long time.	+80°C , 96hrs	2
Low Temperature storage	Endurance test applying the low storage temperature for a long time.	-30°C , 96hrs	1,2
High Temperature Operation	Endurance test applying the electric stress (voltage & current) and the high thermal stress for a long time.	+70°C , 96hrs	2
Low Temperature Operation	Endurance test applying the electric stress (voltage & current) and the low thermal stress for a long time.	-20°C , 96hrs	1,2
High Temperature / Humidity Operation	Endurance test applying the electric stress (voltage & current) and the high thermal with high humidity stress for a long time.	+60°C , 90% RH , 96hrs	1,2
Thermal Shock resistance	Endurance test applying the electric stress (voltage & current) during a cycle of low and high thermal stress.	-20°C,30min -> 25°C,5min ->70°C,30min = 1 cycle 10 cycles	
Vibration test	Endurance test applying vibration to simulate transportation and use.	10-55Hz , 1.5mm amplitude. 60 sec in each of 3 directions X,Y,Z For 15 minutes	3
Static electricity test	Endurance test applying electric static discharge.	VS=800V, RS=1.5kΩ, CS=100pF One time	

Note 1: No condensation to be observed.
Note 2: Conducted after 4 hours of storage at 25°C, 0%RH.
Note 3: Test performed on product itself, not inside a container