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Application Note FAN4221

Working with the E43RB1-FW405-C (Part 1)

This application note will discuss the hardware requirements of driving the E43RB1-FW405-C TFT Display Module with an STM32H747I-DISCO microcontroller development board.

Contents

List of Figures

Working with the E43RB1-FW405-C MIPI Display (Part 1)

This series of application notes will discuss the hardware and software requirements of driving the E43RB1-FW405-C MIPI DSI TFT Display with an STM32H747I-DISCO microcontroller board from ST Microelectronics. Driving a MIPI DSI display with a microcontroller presents a few challenges. The STM32H747 has the required bandwidth and I/O pins but lacks enough internal SRAM for a full frame buffer. The DISCO board presented has an external SDRAM chip used for implementing the display frame buffer.

Part 1 (FAN4221) will walk through the hardware requirements and interfacing the display. Part 2 (FAN4222) will present a high-level overview of the firmware and project structure. In Part 3 of the series (FAN4223), modifications to the firmware will be made to support the E50RA-I-MW490-C TFT MIPI display.

Figure 1: E43RB1-FW405-C and adapter board connected to STM32H747I-DISCO

Introduction

The goal of this document is to provide an overview of the E43RB1-FW405-C MIPI display. Many microcontrollers (MCU) these days come with a MIPI peripheral included in their design. This feature allows the connection to higher-resolution displays. The MCU board STM32H747I-DISCO has this peripheral in conjunction with other subsystems allowing for the implementation of graphical user interfaces.

The E43RB1-FW405-C display used in this application is a 4.3” TFT with a 480 x 800 RGB pixel resolution from Focus LCDs. This display is interfaced over a 2-lane MIPI DSI protocol with a 20-pin FPC cable. An ST Microelectronics STM32H747XI microcontroller, specifically the Discovery Development Board, will drive the display.

The main features of the E43RB1-FW405-C are:

- 4.3-inch diagonal display, 480 x 800 RGB pixel resolution
- Up to 65K/262K/16.7M (24-bit) colors
- 2-Lane MIPI DSI interface with 20-pin FPC cable
- Transmissive/Normally Black display mode
- White LED Backlight
- ILI9806E Display Controller
- Capacitive Touch Panel (GT911) - Touch Mode: Five Points and Gestures
- Typical Operating Voltage 3.3V

Figure 2: Focus LCDs E43RB1-FW405-C TFT LCD

Hardware Requirements

STM32H747I-DISCO Board

The development board that will drive the display is an STM32H747I-DISCO Discovery Kit. The Kit comes with its own display but for this app note, the stock display will be replaced with the E43RB1-FW405-C.

The main features of the STM32H747I-DISCO are:

- Dual Cores – 1 x Cortex-M7 and 1x Cortex-M4
- 2 MB Flash and 1 MB RAM
- 2-Lane MIPI DSI Interface
- Integrated STLINK-V3E Debugger/Programmer
- Typical Operating Voltage 3.3V

Figure 3: STM32H747I Discovery Development Board

The MIPI DSI link on the development board (dev board) is through a 60-pin high-speed Samtec Q Strip Mezzanine connector. An adapter PCB is required to connect the Q Strip connector of the development board to the 20-pin FPC cable on the display.

Focus LCDs MIPI DSI Adapter Board

In this application, the Focus LCDs MIPI DSI Adapter Board v1.0 is used to adapt from the Q Strip connector to an FFC connector on the PCB. This adapter board is still in development. Contact Focus LCDs for more information.

The Samtec connector used on the adapter board is the QTH-030-02-F-D-A-K-TR. The mating connector is the QSH-030-01-F-D-A-K-TR. Both connectors can be sourced from Samtec or through a distributor, Digikey as an example.

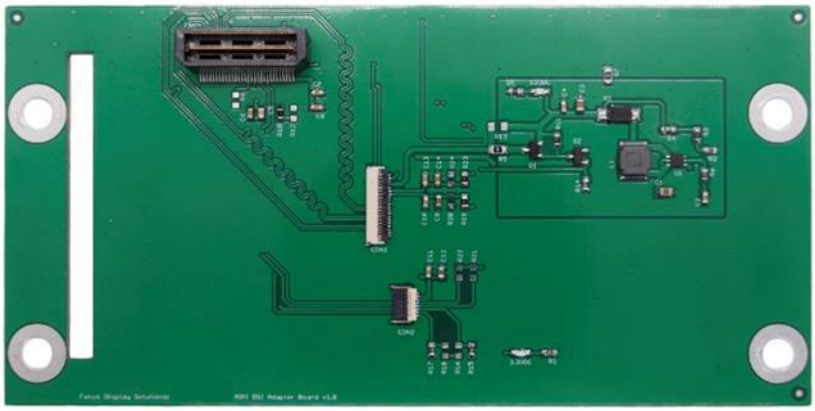

Figure 4: Focus LCDs MIPI DSI Adapter Board

The Focus LCDs MIPI DSI Adapter Board (adapter board) connects between the display and the development board. The MIPI differential signals are routed following high-speed design guidelines with controlled impedance and trace length matching, within tolerances. Power and ground planes were added to the inner layers with additional signals routed on the external layers. The additional signals include Reset, TE (tearing effect/enable), and the backlight anode/cathode pins.

Integrated on board is a switch mode boost power supply to provide power to the backlight.

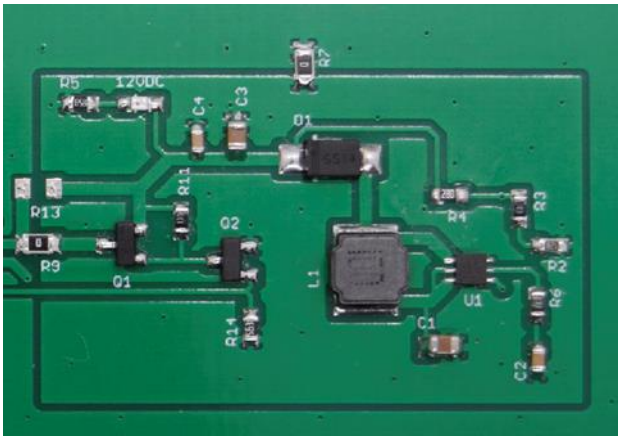

Figure 5: Backlight Switching Power Supply

Hardware Connections

The MIPI interface uses 3 differential pairs (6 signals), 2 control signals, and several power and ground pins that are required to interface between the display and MCU. On the adapter, the Q Strip connector plugs into the Discovery board while the FPC of the display plugs into its mating connector on the adapter. Figure 4 shows the connections on the MCU board, with Figure 5 showing the Adapter Board connections.

Schematic Diagrams

STM32H7 Discovery Board MIPI DSI Connector Schematic

Below is the schematic for the Q Strip connector on the MCU board.

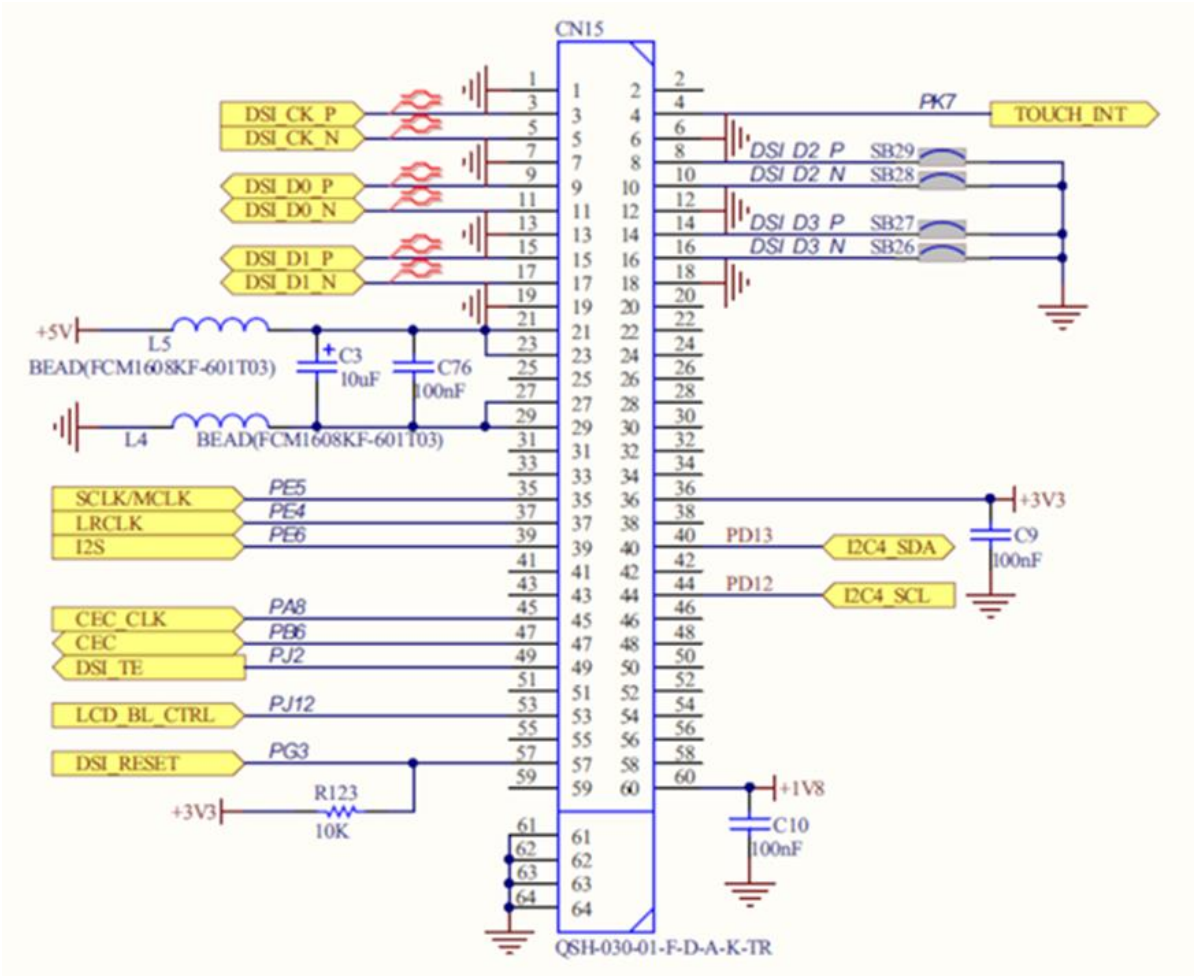

Figure 6: STM32H7 Discovery Board MIPI Connector Schematic

Focus LCDs MIPI DSI Adapter Board Connector Schematic

The adapter board is necessary to connect the display's 20-pin FPC cable to the 60-pin Q Strip connector on the MCU board. The MIPI signals are routed from the Q Strip connector to the 20-pin FFC connector.

Below is the schematic of the connections required for the adapter board.

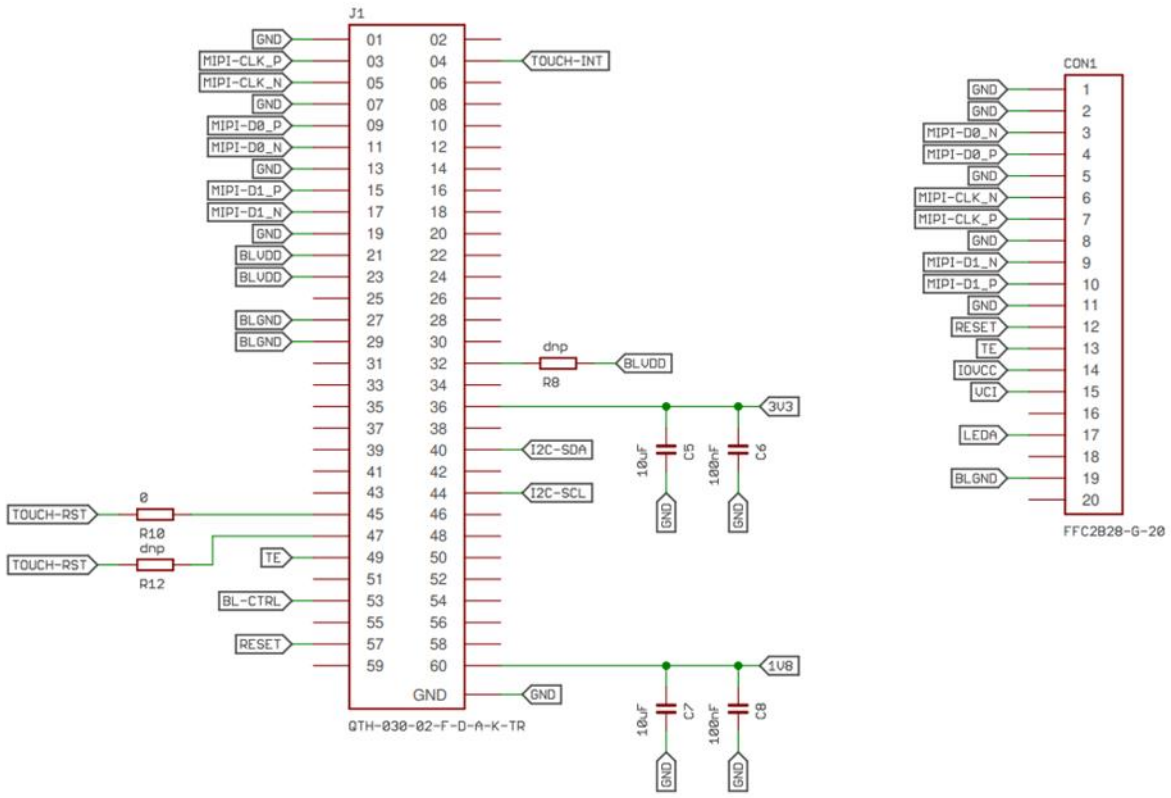

Figure 7: Focus LCDs Adapter Board

Connecting the Display, Adapter, and MCU Boards

Remove the MB1166 Display from the MCU Board

Before we can mount the Adapter Board, we need to remove the MB1166 board that is already connected with the STM32H747I-DISCO board. Once that is complete, the DISCO board is ready to be connected to the Adapter Board.

Figure 8: STM32H747I-DISCO Board with Display Removed

Connect Display to Adapter Board

Now to connect the Adapter Board with the E43RB1-FW405- C Display, look at the two cables on the display. The 20-pin cable is the MIPI DSI interface. The 8-pin cable is the touch interface.

Gently lift the back locks on the 2 FFC connectors on the Adapter board.

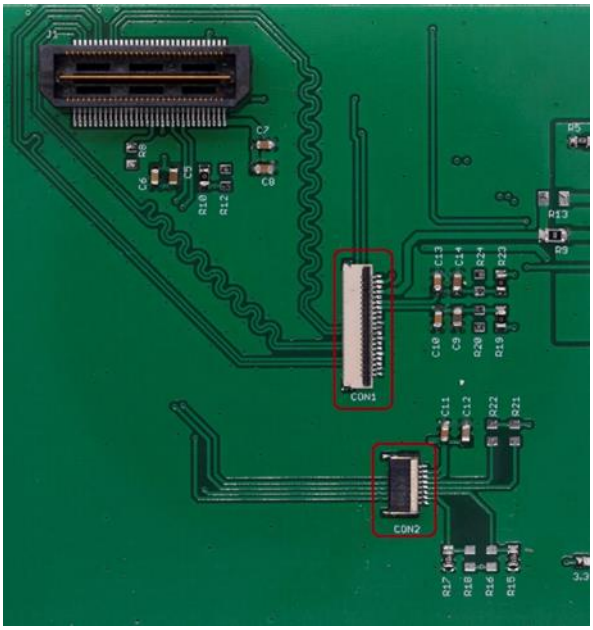

Figure 9: Display Connectors with Back Locks Up

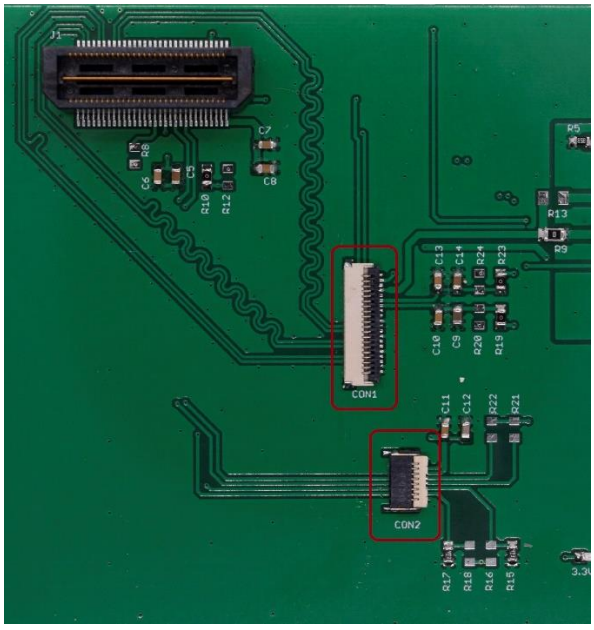

Figure 10: Display Connectors with Back Locks Down

Carefully pass the 2 cables through the slot in the Adapter Board. Slide the 20-pin FPC cable into the 20-pin FFC connector, making sure that at least 2 to 3 mm of the cable enters the connector. Repeat this procedure with the 8-pin FPC cable and 8-pin FFC connector. Once the cables have been connected, gently push the back locks down to secure the cables.

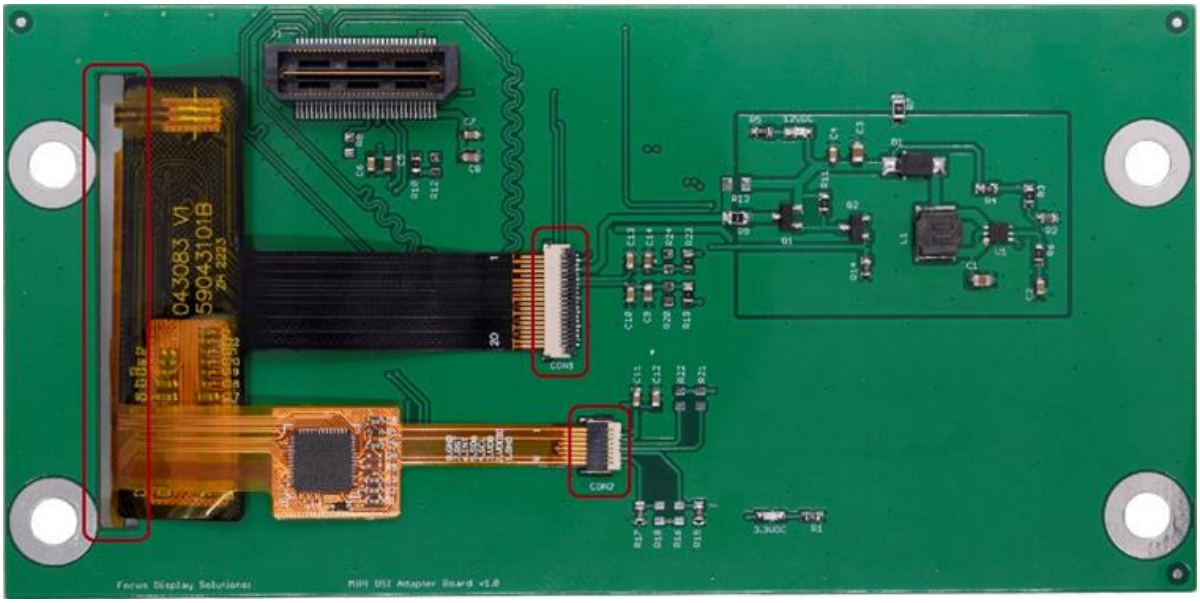

Figure 11: Adapter Board with Display Cables Attached and Locked

The display can be secured to the Adapter Board with double-sided adhesive tape.

Attaching the Display/Adapter to the MCU Board

Review the below figures for the mating connectors. The Q Strip connector on the STM32H7 development board should be facing up. The mating connector on the Adapter board should face down. Align the 2 connectors and slowly press the 2 boards together.

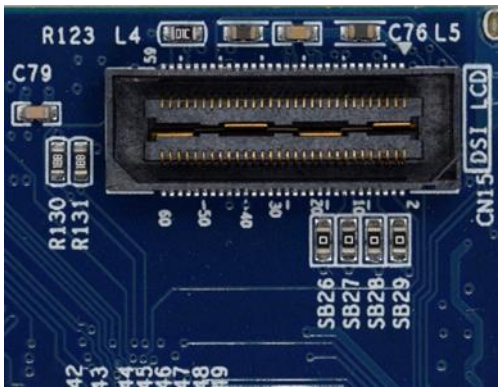

Figure 12: DISCO Board Connector

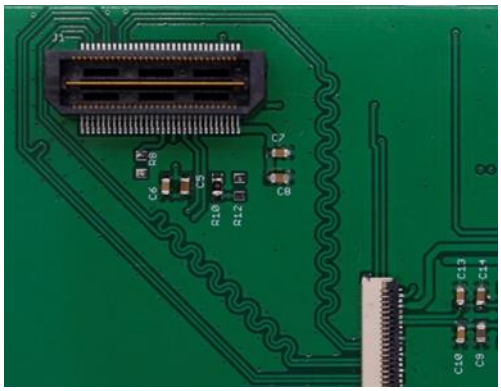

Figure 13: Adapter Board Connector

Powering the Hardware

To test the setup, power needs to be provided through a micro-USB cable. Plug the micro-USB cable into the STLINK-V3E micro-USB connector. Once power is applied a green LED (LD8) should turn on. See the image below.

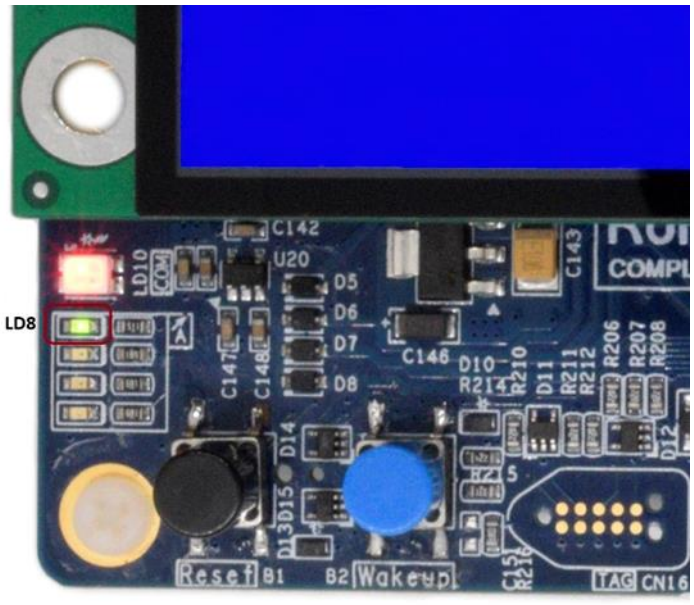

Figure 14:LD8 Lit on MCU Board

A demo application has been loaded onto the STM32H747I-DISCO board. The image below shows the board powered and the demo application running.

Figure 15: E43RB1-FW405-C Display on Adapter/MCU Board Assembly Running the Demo

Basics of MIPI DSI

Many devices today use high-speed MIPI DSI interface. The Display Serial Interface (DSI) is a serial communication protocol created by the Mobile Industry Processor Interface Alliance (MIPI). It is a low EMI interface with excellent performance and low power data transfer. The interface has a reduced pin count to ease the tasking of connecting to different systems.

MCUs can communicate with MIPI DSI displays in one of two modes command and video. These modes are determined by the location of the frame buffer. Video mode is used when the display has no internal frame buffer. This is to optimize the display cost. This application will discuss how to drive a MIPI DSI video mode display with a microcontroller.

The MIPI DSI video mode is ideal for large and high-resolution displays because it does not require the display to provide internal memory. Streaming the pixel data by implementing the video mode offers a cost-effective solution for handling large amounts of display data. High-resolution displays do not typically provide internal RAM for graphics data due to cost optimization.

Video mode streams over the high-speed link the RGB data and framed by video synchronizing events directly generated by the LTDC. The streaming starts as soon as the DSI Host and the LTDC are enabled. This continuous refresh is how to interface with a display without Graphics RAM. The MIPI DSI video mode operates similarly to the RGB DPI protocol as the MCU provides the pixel data and sync events.

The pixel data is controlled by the host processor and requires the MCU to provide memory and have enough bandwidth to supply pixel data to the display. In the case of the STM32H7 an external memory is required to double buffer the frame buffer.

MIPI has two layers of communication:

- Low-level - handled at interface layer
- High-level - handled at packet layer

While the interface layer shows the display's speed and power settings, the packet layer plays a role when sending image data to the DSI display in either short 4-byte or large (6 to 64,451-byte) packets. Both layers can function in interface-level low-speed or high-speed data rates.

STM32 DSI Host

STM32H747 has a Display Serial Interface (DSI) Host peripheral. It provides the communications interface with external MIPI DSI displays. The DSI interface supports Command and Video modes with its two data lanes and supports a 500 Mbps data rate for each lane giving a theoretical maximum data rate of 1 Gbps.

The DSI Host is deeply integrated with the LCD-TFT display controller (LTDC) to ease application development and porting. The LTDC is used to provide an interface to a variety of parallel digital RGB LCD and TFT display panels. The LTDC generates the parallel digital RGB signals and the related control signals (horizontal and vertical synchronizations, Pixel Clock and Data Enable).

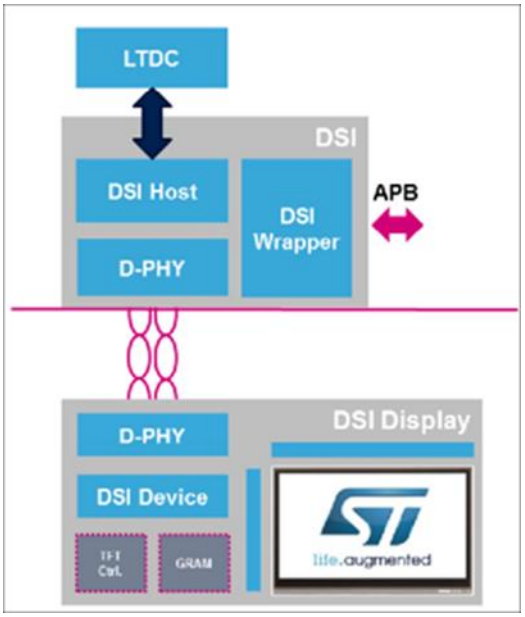

Figure 16:Showcase of DSI Host on STM32H7

Summary

In Part 1, the hardware requirements for a MIPI display demo were presented. How to assemble the hardware was shown. Finally, a brief overview of the MIPI DSI interface and the STM32 DSI Host peripheral were discussed.

In Part 2, the development tools, project structure, and a firmware overview will be discussed.

In the final Part 3 of the series, how to modify the code for the E50RA-I-MW490-C will be shown.

LCD Handling Precautions

- Do not store the TFT-LCD module in direct sunlight, best stored in a dark place.
- Do not leave it exposed to high temperature and high humidity for a long period of time.
- Recommended temperature range is 0 to 35 °C, relative humidity should be less than 70%.
- Stored modules away from condensation as formation of dewdrops may cause an abnormal operation or failure of the module.
- Protect the module from static discharge.
- Do not press or scratch the surface and protect it from physical shock or any force.

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