

Rainbow-7 Platform

7" 1024x600 Color Touchscreen

Development Platform

– USER MANUAL –

BRIEF

Rainbow-7 is a 7" diagonal, high resolution, 1024x600 color touchscreen complete demonstration and development system for the Iridescence Graphical Framework, designed to simplify user application development. The platform is based on the combination of a 2-Mbyte FLASH STM32H753 microcontroller with 32 Mbytes of SDRAM and 32 Mbytes of external QSPI flash memory. The system can be customized by Thornwave Labs to accommodate various customer needs both in terms of hardware and firmware.



FEATURES

- Based on the STM32H753BIT6, 480MHz, 32-bit ARM Cortex-M7 microcontroller with double-precision FPU
- 2 Mbytes of internal FLASH program memory
- 1 Mbyte of internal SRAM
- 32 Mbytes, 32-bit wide SDRAM that can be used for data storage, frame buffers or code execution
- 32 Mbytes of QSPI FLASH memory organized as two 16 Mbytes QSPI memories connected in dual flash mode (8-bit access) can be used for read-only data storage, code execution or read-write persistent storage, optional filesystem
- 256 Kbits (32 Kbytes) I²C EEPROM for data / configuration storage
- SD card slot with full SD 4-bit bus
- CR-2032 RTC backup battery
- 7" 1024 x 600 IPS color screen driven in RGB mode
- 7" I²C touchscreen capable of multiple finger touch
- Adjustable LCD backlight current, adjustable LCD VCOM voltage
- High-speed FDCAN bus transceiver with 2 RJ-45 CAN bus connectors and a Molex RV-C connector, capable of up to 5 Mbits/s data rate
- SSM2602 audio codec with stereo headphones and line outputs, and mono microphone input (3.5mm jacks) connected via I²S
- USB 2.0 high-speed PHY and mini USB-B OTG connector (can act as host or peripheral)
- 10-100 Mbits/s Ethernet PHY, magnetics and RJ-45 connector
- WFM200 based WiFi 802.11b/g/n transceiver connected via 4-bit SDIO
- Switching mode power supply capable of operating up to 32V
- Black plastic bezel, panel mountable (access from behind is required)
- Firmware source code provided for all drivers, FreeRTOS integration and demo/example applications
- Iridescence Graphic Framework provided with watermarking (for licensing, contact Thornwave Labs: sales@thornwave.com)
- Various demonstration applications are provided: a WAV file audio player, Iridescence Graphic Framework demo, picture frame, screen tester, and WiFi manager

SAFETY INSTRUCTIONS

Warning!

Read all the instructions and cautions before using the Rainbow-7 development platform. Thornwave Labs Inc does not assume responsibility for any injury or property damage caused by improper installation, bad wiring, or use of Rainbow-7 outside of its intended purpose. The device had not been evaluated by FCC. It should not be sold as a final product. The system was designed to be used as a development platform.

Warning!

The Rainbow-7 device should not be used for any medical purposes, life-sustaining equipment, safety applications, or any application where equipment failure can cause injury, death, fires, or any other hazard.

Warning!

The unit operates with voltages up to 36V which can be lethal or cause serious and permanent injury under the right conditions.

Warning!

Do not submerge under water or other liquids. The device is neither weatherproof nor waterproof.

OVERVIEW

Rainbow-7 is a 7", high resolution, 1024x600 color touchscreen development platform. It was designed to facilitate quick product and application development using the Iridescence graphical framework. The board contains a full range of peripherals and communication interfaces: SD card slot, CAN, Ethernet and WiFi as well as an external FLASH memory, EEPROM and SDRAM. The board is equipped with a 6-pin TAG-Connect ISP connector. This can be used with any debugger/programmer compatible with the STM32H7 microcontroller. We recommend the Firelink tool developed by Thornwave Labs or the J-Link tool.

Power supply. The development platform is designed to be powered by an external power source capable of providing 9V to 32V and at least 0.5A. Included with the kit is a 2 ft cable with a 2-pin Molex MiniFit Jr connector.

Debug tool. Either the FireLink debug tool or J-Link debug probe can be used for loading and debugging the firmware. Other tools will work as long as they support debugging the STM32H753 MCU via the SWD interface. The 6-pin TAG-Connect connector on board of the Rainbow-7 platform provides access to the 3.3V power rail, SWD debug lines, reset and the debug UART TX line. The FireLink debug tool provides 2 complete UARTs + one debug UART receive line, allowing the Rainbow-7 debug UART line to be monitored directly. Other debug probes may not provide support for reading the debug UART. For this reason, we recommend using the FireLink tool as it provides more features and less cable clutter.

Crystal oscillators. The STM32 MCU contains a 32 MHz crystal oscillator used as the main clock source and a 32.768Hz RTC crystal oscillator. The audio codec, Ethernet PHY and USB PHY contain their own local crystal oscillator.

RTC backup battery. The development platform contains a CR-2032 lithium RTC backup battery. If the RTC or backup SRAM are not needed, the battery can be omitted.

Internal memories. The STM32H753BIT6 microcontroller contains 2 Mbytes of FLASH code memory and 1 Mbyte of SRAM for data. For more information on the microcontroller, please visit www.st.com

External FLASH. Two 16-Mbyte Quad-SPI FLASH memories are connected to the STM32 MCU quad memory controller in Dual-Flash-Memory (DFM) configuration, allowing 8-bit access to an extra 32 Mbytes of code memory with up to 133 Mbytes/s transfer rate. We provide the code to initialize and use the external QSPI FLASH memory.

External SDRAM. 32 Mbytes of SDRAM are connected to the FMC (Flexible Memory Controller) using a 32-bit data bus, offering plenty of memory that can be used for code execution, data storage, frame buffers or graphical resources. When not used, the SDRAM power can be switched off to save energy. The code to initialize the SDRAM controller is provided.

External EEPROM. An I²C 256-Kbits (32 Kbytes) EEPROM memory offers storage for configuration, encryption keys and so on. We also provide the code to initialize and access the EEPROM memory.

SD card slot. The on-board SD card slot connects straight to the STM32 MCU using all 4 data lines in SD mode. This allows SD cards to be accessed at up to 25MHz. The SD slot is equipped with insertion detection and a current-protected 3.3V power switch that can be controlled from the MCU.

LCD interface. The 7" 1024x600 IPS color touchscreen is connected to the MCUs LTDC controller using full 24-bit RGB color mode. All the required voltages are generated on-board and VCOM can be adjusted under software control. The backlight driver supports current adjustment allowing for brightness control by software.

Touchscreen interface. The touchscreen is based on the FT5x06 chipset and connected to the STM32 MCU via I²C.

USB 2.0 high-speed PHY. The development board includes a 480-MBit/s USB 2.0 PHY and a mini USB-B connector. Both the USB_ID pin and power delivery are supported allowing the Rainbow-7 platform to operate as either USB host or USB peripheral device. We are offering software for implementing USB peripheral devices.

FDCAN transceiver. Rainbow-7 includes a 5-Mbit FDCAN transceiver connected to 2 RJ-45 and one 4-pin Molex connector allowing connecting to a CAN bus via UTP twisted cable or RV-C bus.

Ethernet PHY. The KSZ8091RNACA, 100-Mbit/s RMII Ethernet PHY, allows connectivity to any physical LAN bus via twisted pair UTP cable. The PHY supports both 10 and 100 Mbits/s. The Ethernet driver is provided with the Rainbow-7 support firmware. The Ethernet PHY is clocked by a 25 MHz quartz crystal oscillator.

WiFi RF transceiver. The WFM200 chipset provides connectivity to WiFi (802.11b/g/n) at up to 72 MBits/s). The support firmware contains the WiFi drivers and a fully integrated TCP/IP stack (LwIP)

Audio CODEC. We also included the SSM2602CPZ stereo audio CODEC, connected to the STM32 microcontroller via the SAI interface. This offers an amplified headphones output, a line output and microphone input, all routed to 3.5mm connectors. The audio CODEC is wired to its own, dedicated, 24.576MHz crystal clock oscillator

CONNECTIVITY

STM32 GPIO	Peripheral Connection	Notes
General		
PA15	DEBUG_TX	Wired to the TAG-Connect debug ISP connector. Used for outputting debug messages via UART7.
PA10	VCORE_EN	Active high, turns on the 1.2V core voltage regulator. Pull-down attached. Not required. If used it can lower the power consumption.
PA13	SWDIO	Wired to the TAG-Connect debug ISP connector
PA14	SWDCLK	Wired to the TAG-Connect debug ISP connector
External QSPI FLASH		
PF8	QSPI_D0	QSPI FLASH #1
PF9	QSPI_D1	QSPI FLASH #1
PF7	QSPI_D2	QSPI FLASH #1
PF6	QSPI_D3	QSPI FLASH #1
PH2	QSPI_D4	QSPI FLASH #2
PH3	QSPI_D5	QSPI FLASH #2
PG9	QSPI_D6	QSPI FLASH #2
PG14	QSPI_D7	QSPI FLASH #2
PG6	QSPI_CS	QSPI FLASH #1 & #2
PF10	QSPI_CLK	QSPI FLASH #1 & #2
SDRAM		
PD14	SDRAM_D0	
PD15	SDRAM_D1	
PD0	SDRAM_D2	
PD1	SDRAM_D3	
PE7	SDRAM_D4	
PE8	SDRAM_D5	
PE9	SDRAM_D6	
PE10	SDRAM_D7	
PE11	SDRAM_D8	

PE12	SDRAM_D9	
PE13	SDRAM_D10	
PE14	SDRAM_D11	
PE15	SDRAM_D12	
PD8	SDRAM_D13	
PD9	SDRAM_D14	
PD10	SDRAM_D15	
PH8	SDRAM_D16	
PH9	SDRAM_D17	
PH10	SDRAM_D18	
PH11	SDRAM_D19	
PH12	SDRAM_D20	
PH13	SDRAM_D21	
PH14	SDRAM_D22	
PH15	SDRAM_D23	
PI0	SDRAM_D24	
PI1	SDRAM_D25	
PI2	SDRAM_D26	
PI3	SDRAM_D27	
PI6	SDRAM_D28	
PI7	SDRAM_D29	
PI9	SDRAM_D30	
PI10	SDRAM_D31	
PF0	SDRAM_A0	
PF1	SDRAM_A1	
PF2	SDRAM_A2	
PF3	SDRAM_A3	
PF4	SDRAM_A4	
PF5	SDRAM_A5	
PF12	SDRAM_A6	
PF13	SDRAM_A7	
PF14	SDRAM_A8	
PF15	SDRAM_A9	
PG0	SDRAM_A10	
PG1	SDRAM_A11	
PG4	SDRAM_BA0	
PG5	SDRAM_BA1	

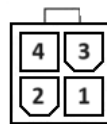
PE0	SDRAM_DQM0	
PE1	SDRAM_DQM1	
PI4	SDRAM_DQM2	
PI5	SDRAM_DQM3	
PH5	SDRAM_WE	
PF11	SDRAM_RAS	
PG15	SDRAM_CAS	
PH7	SDRAM_CLKE	
PH6	SDRAM_CS	
PG8	SDRAM_CLK	
PI8	SDRAM_POWER_EN	Active high turns on the SDRAM power switch.
EEPROM		
PB6	I2C_SCL	I ² C bus shared with audio CODEC
PB7	I2C_SDA	I ² C bus shared with audio CODEC
SD Card Slot		
PC8	SDMMC1_D0	
PC9	SDMMC1_D1	
PC10	SDMMC1_D2	
PC11	SDMMC1_D3	
PC12	SDMMC1_CLK	
PD2	SDMMC1_CMD	
PD5	SD_POWER	Active high, 3.3V SD card power enable
PD4	SD_FAULT	Active low FAULT signal from SD power switch. Requires internal pull-up
PD3	SD_DET	Active low DETECT signal from SD card slot. Requires internal pull-up.
LCD		
PI15	LCD_R0	
PJ0	LCD_R1	
PJ1	LCD_R2	
PJ2	LCD_R3	
PJ3	LCD_R4	
PJ4	LCD_R5	
PJ5	LCD_R6	

PJ6	LCD_R7	
PJ7	LCD_G0	
PJ8	LCD_G1	
PJ9	LCD_G2	
PJ10	LCD_G3	
PJ11	LCD_G4	
PK0	LCD_G5	
PK1	LCD_G6	
PK2	LCD_G7	
PJ12	LCD_B0	
PJ13	LCD_B1	
PJ14	LCD_B2	
PJ15	LCD_B3	
PK3	LCD_B4	
PK4	LCD_B5	
PK5	LCD_B6	
PK6	LCD_B7	
PK7	LCD_DE	
PI13	LCD_VSYNC	
PI12	LCD_HSYNC	
PI14	LCD_CLK	
PG3	LCD_DITH	Active high to enable dithering
PD11	LCD_RESET	Active low LCD reset signal
PC7	LCD_VCOM_ADJ	PWM output to adjust the VCOM voltage. Do not change.
PA4	LCD_BL_EN	Active high backlight power supply enable
PC6	LCD_BL_ADJ	PWM output to adjust the backlight current
PA6	LCD_POWER_EN	Active high LCD power switch enable
Touchscreen (FT5x06)		
PD12	TSC_SCL	Dedicated I ² C bus
PD13	TSC_SDA	Dedicated I ² C bus
PG2	TSC_INT	TSC Interrupt line (active low)
PG7	TSC_RESET	TSC reset line (active low)

CAN Bus (TJA1057GTK/3Z)		
PA11	CAN_RX	
PA12	CAN_TX	
PA9	CAN_S	
USB 2.0 High-Speed PHY (USB3318C-CP)		
PA0	ULPI_RST	
PA3	ULPI_D0	
PA5	ULPI_CLK	
PB0	ULPI_D1	
PB1	ULPI_D2	
PB5	ULPI_D7	
PB10	ULPI_D3	
PB11	ULPI_D4	
PB12	ULPI_D5	
PB13	ULPI_D6	
PC0	ULPI_STP	
PH4	ULPI_NXT	
PI11	ULPI_DIR	
Audio CODEC (SSM2602CPZ)		
PB6	I2C_SCL	I ² C bus shared with EEPROM
PB7	I2C_SDA	I ² C bus shared with EEPROM
PE3	AUDIO_OUT	SSM2602: RECDAT
PE4	AUDIO_LRC	SSM2602: PBLRC & RECLRC
PE5	AUDIO_BCLK	SSM2602: BCLK
PE6	AUDIO_IN	SSM2602: PBDAT
Ethernet PHY (KSZ8091RNACA)		
PA1	ETH_CLK	
PA2	ETH_MDIO	
PA7	ETH_CRS_DV	
PB9	ETH_INT	
PC1	ETH_MDC	
PC4	ETH_RXD0	
PC5	ETH_RXD1	
PG10	ETH_RESET	

PG11	ETH_TXEN	
PG12	ETH_TXD1	
PG13	ETH_TXD0	
WiFi Transceiver (WFM200S022XNA3)		
PA8	WIFI_LPCLK	WFM200: 32,768Hz low power mode clock
PB3	SDMMC2_D2	WFM200: SDIO_D2
PB4	SDMMC2_D3	WFM200: SDIO_D3
PB8	WIFI_WUP	WFM200: WAKEUP (WUP)
PC13	WIFI_RESET	WFM200: RESET
PB14	SDMMC2_D0	WFM200: SDIO_D0
PB15	SDMMC2_D1	WFM200: SDIO_D1
PD6	SDMMC2_CLK	WFM200: SDIO_CLK
PD7	SDMMC2_CMD	WFM200: SDIO_CMD

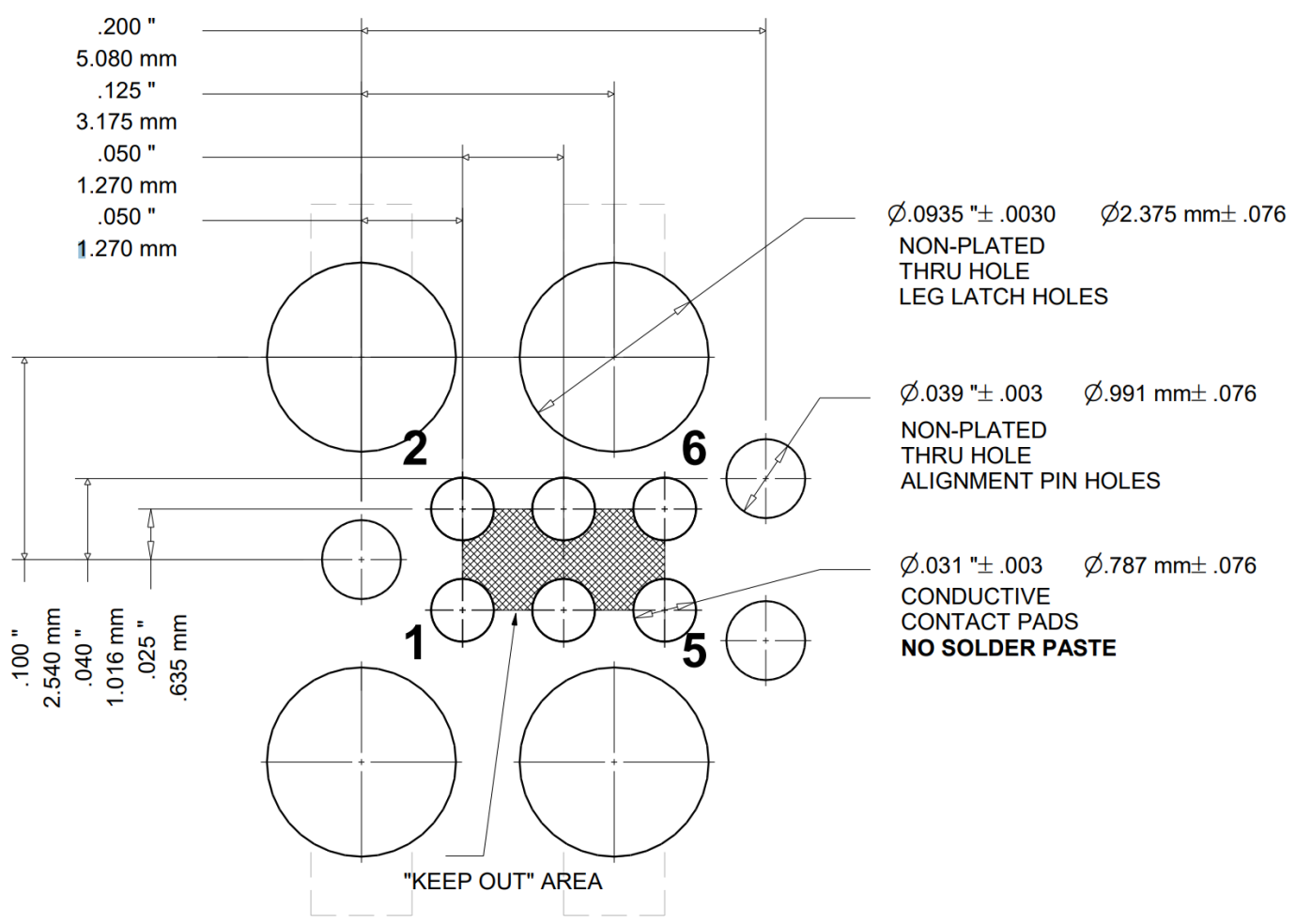
CAN Bus - RJ45 Pin	Description
1,3,5	GROUND
2,4,6	VPWR (9 ~ 32V)
7	CAN+
8	CAN-



2 and 4-pin Molex Mini-Fit Jr. Female Sockets

RV-C Connector Pin	Description
1	CAN+
2	CAN-
3	GROUND
4	VPWR (9 ~ 32V)

PWR Connector Pin	Description
1	GROUND
2	VPWR (9 ~ 32V)



TAG-Connect 6 Pin Debug Connector

Debug Connector Pin	Description
1	3.3V
2	SWDIO
3	RESET
4	SWDCLK
5	GROUND
6	DEBUG

FIRMWARE QUICK START

We advise using Ubuntu 24.04 LTS or the earlier 22.04 LTS. It is possible to use Windows but we do not provide support in this case. To build the demo firmware, some tools must be installed.

1. Download and install the ARM GCC compiler. It can be downloaded from here:
<https://developer.arm.com/downloads/-/gnu-rm>

2. Extract the archive to **/opt**.

```
cd /opt
```

```
tar -xvf <path to ARM gcc archive just downloaded>
```

3. Create a symlink pointing to the ARM GCC compiler folder

```
ln -sf <name of the folder just extracted> gcc-arm-none-eabi
```

4. Install a few required tools.

```
apt install build-essential srecord git
```

5. Follow the instructions provided here

https://files.thornwave.com/docs/iridescence/iridescence_latest/html/index.html to install the Iridescence tools.

6. Retrieve the demo firmware.

```
git clone ssh://git@git.thornwave.com:29418/thornwave/rainbow7_fw.git
```

```
cd rainbow7_fw
```

```
git submodule update --init
```

7. Build the fonts

```
cd fonts
```

```
make -j32
```

8. Build the firmware demo

```
cd build
```

```
make
```

9. The following Makefile targets are valid: **clean, flash, erase, reset**.

10. The following Makefile variables can be defined: **RELEASE=yes, DEBUG=yes, USE_FIRELINK=yes**

11. The Iridescence library provided with the demo firmware is watermarked. A pre-built firmware image without watermarking is located inside the **images** directory.

ORDERING

Part Number	Description
Rainbow-7	7" 1024x600 Color Touchscreen Development Platform based on STM32H753