CutiPy™

User Manual

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(for use with Rev 1 Boards)

EMAC, inc.
EQUIPMENT MONITOR AND CONTROL
2390 EMAC Way, Carbondale, Illinois 62902
Phone: (618) 529-4525 Fax: (618) 457-0110
http://www.emacinc.com

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1 Introduction

This document describes EMAC's CutiPy Industrial IoT microcontroller. The CutiPy is a Low Power Industrial IoT device that was designed to simplify connecting devices and machines to the multitude of systems you find in the Industrial environment. This module is built around the STMicroelectronics STM32 microcontroller, which provides several of its key features.

The CutPy provides a number of features that are native to the board (Internal) and a number of features that are accessed through two 50 Pin Header Connectors that are referred to as External.

In addition to the features listed below, the CutiPy also features a fast 32-bit core, open source software support, and a wide range of controller I/O pins.

1.1 Features

- **Low Power Industrial IoT**
- **STMicroelectronics ARM Cortex-M4 168MHz**
- **Up to 1M of Flash**
- **192 Kbytes of SRAM**
- **1x microSD Card Slot**
- **1x CAN 2.0B Port (Internal provided w/Transceiver, External provided w/o Transceiver)**
- **2x USB 2.0 Ports (1x Internal Full Speed Device w/ PHY, 1x External Full-Speed Device)**
- **4x Serial Ports**
- 1x RS232 & 1x RS232/422/485 (Internal)
- 2x TTL (External)
- **1x SPI Port**
- **2x I2C Hardware Ports**
- **25x Timer/Counters/PWM/Capture**
- **RTC with on-board battery backup**
- **Internal Temperature Sensor**
- **External Li-Ion Battery with charging from USB or 5V Power Supply Header**
- **1x Reset Button**
- **13x A/D Channels with 12-bit Resolution (3 Unique A/Ds)**
- **2x D/A Channels with 12-bit Resolution**
- **16x External Dedicated GPIOs (64x fully allocated)**
- **8x High-Drive Open Collector Outputs**
- **2x 50-Pin Expansion Headers**
- **OS/Language: MicroPython or FreeRTOS**
- **Graphic 128x32 LCD with 4x pushbuttons & 4x LEDs (optional)**

- **Redpine RS9113/RS9116 (BT/wifi/Zigbee) with on board antenna (optional)**
  - **802.11 a/b/g/n Wi-Fi**
  - **802.15.1 Bluetooth (BT 4.0)**
  - **802.14.4 ZigBee & Thread (Note: The RedPine RS9113 WiseConnect Module does not support Thread)**

1.2 CutiPy Specifications

- **CPU:** STM32F407IGH6 ARM Cortex-M4 w/Math Coprocessor
- **Flash:** Up to 1MB of Flash
- **RAM:** 192 KB of SRAM
- **Flash Disk:** Micro SD Card Socket
- **System Reset:** Supervisor with external Reset Button provision
- **RTC:** Battery backed Real Time Clock
- **Timer/Counters:** 25x Timer/Counter/PWM/Capture
- **Digital I/O:** 16x External Dedicated GPIOs (64x fully allocated)
- **Analog I/O:**
  - 13x A/D Channels with 12-bit Resolution (3 Unique A/Ds)
  - 2x D/A Channels with 12-bit Resolution
- **Power:**
  - 5V Power Supply Header
  - USB Device Port
- **JTAG:** Processor JTAG Supporting Programming, Trace, and Boundary Scan

1.3 LCD

LCD – 36 x 12 mm LCD (NHD-C12832A1Z-FSW-FBW-3V3):

- **Display Type:** Film Super-Twisted Nematic
- **Resolution:** 128 x 32 pixels
- **Dot pitch:** 0.25mm x 0.25mm
- **Viewing Angle:**
  - **ϴ-right:** 40°
  - **ϴ-left:** 40°
  - **ϴ-top:** 20°
  - **ϴ-bottom:** 40°
- **Backlight:** White LED

1.4 Serial Interfaces

- **UARTS:** 1x RS232, 1x RS232/422/485, 2x TTL
- **SPI:** 1x SPI Ports
- **USB:** 2x USB 2.0 Ports
  - 1x Full-Speed Device terminating to a micro USB connector (Internal)
  - 1x Full-Speed Device terminating to a header connector (External)
- **I2C:** 2x I2C hardware Ports

1.5 Mechanical and Environmental

- **Dimensions:** 2.25" ×3.5" (57mm × 88mm)
- **Power Supply Voltage:** 5 Vdc
- **Power Requirements (typical):**
  - 5.0 Volts @ ##00mA (XXX watts)
  - Max current draw during boot process: TBD
  - Constant busy loop: TBD
  - Idle system: TBD
  - Idle system with Ethernet PHY disabled: TBD
  - APM sleep mode with Ethernet PHY disabled: TBD
  - APM sleep mode with Ethernet PHY enabled: TBD
- **Operating Temperature:** -40 ~ 85° C (-40 ~ 185 ° F)
  - LCD: -20 ~ 70° C (optional)
- **Operating Humidity:** 0% ~ 90% relative humidity, non-condensing

2 CutiPy Product Details

2.1 Jumper Configuration & Connector Descriptions

The CutiPy comes factory configured. In the event that jumpers need to be verified or modified, this section provides the information required including instructions on setting jumpers and connecting peripherals, switches, and indicators. Be sure to read all the safety precautions before you begin any configuration procedure. See Appendix A for connector pinouts and Appendix B for Jumper Setting descriptions.

Table 1: Jumpers

Label	Function	Default
JB1	Boot0 Source Selection	FLS
JB2	Boot1 Source Selection	ST Boot ROM
JB3	RTC & RAM Retention Battery	OFF
JB4	CAN Termination	TRM
JB5	UART3 Serial Port RS422/485 Termination	OFF

Table 2: Connectors

Label	Function
CN1	Main Battery Connector
CN2	Serial Port UART2
HDR1	I/O Header 1
HDR2	I/O Header 2
HDR3	Vin Power 4-Pin Male Header
HDR4	CAN 2.0 Port (CAN-1)
HDR5	Serial Port UART3
HDR6	JTAG Header
JK1	USB Connector
SOK1	MicroSD Card Socket

2.2 Power Connectors

The CutiPy provides one power connector. HDR3 is a TE Connectivity AMP 4-pin male floppy style connector (Part # 640456-4) and mates with TE Connectivity AMP 4-pin female socket (Part # 3-640600-3). As an alternative, the CutiPy can also be powered through the micro USB connector located at JK1. This connector is a Wurth Electronics right angle 5 pin receptacle connector (Part# 629105136821).

The CutiPy only requires 5Vdc to operate. Vin (HDR3 pin 4) is not utilized on the CutiPy and is simply routed to Expansion Connectors HDR1 & HDR2 (pin 5). However, the pullup option for the HiDrive Outputs is routed to HDR1 (pin 6) and therefore Vin can be used to pull-up HiDrive Outputs by connecting HDR1 pin 5 and pin 6 together.

Table 3: Power Connector Pinout (HDR3)

Pin	Signal
1	+Vin 5V
2	GND
3	GND
4	+Vin ~12V

2.3 Battery Operation and Charging

The CutiPy can be operated off of Lithium Ion Battery as a main power source or backup power source. The battery is to be connected to CN1 (connector type JST - S2B-PH-SM4-TB(LF)(SN)).

The Cutipy utilizes a Linear Technologies LTC4085 USB Power Manager & Lithium Ion Battery charger chip. This device seamlessly will take power from one of three power sources: USB, 5-volt (Mini-Floppy) power connector, or external Battery, and supply whichever power source is most appropriate to the rest of the CutiPy's internal power distribution.

Internal power can be visualized as a diode-OR arrangement where any one of three power sources can power the CutiPy so long as any one of them is active. The junction where all three meet may have a wide voltage variation from just at or below 5 volts, all the way down to 3 volts depending on conditions. The junction of all three power sources is had by intelligent switching of Mosfets and is fed to a boost-buck switching regulator that will buck voltages higher than 3.3 volts down or boost voltages lower than 3.3V up to the normal system voltage of 3.3 volts.

While functioning in boost mode the boost-buck switcher allows the system maximum "hang-time", when the system is running from an external battery whose voltage may be falling as the battery approaches discharge.

Internal power distribution priority is as follows:

Floppy 5V power 1st: 5V floppy power goes to LTC4085 Battery power manager and to Utility header's 5V I/O pins. 5 volts power can be provided through the Utility I/O just as easily as through the floppy power connector.

USB 5V power 2nd: if Floppy power is absent. This is not directly fed to the Utility Header's 5V I/O.

Battery power 3rd: if both Floppy and USB power is absent. This is also not directly fed to the Utility Header's 5V I/O.

Whichever of (or all three) power sources are present, they are seamlessly switched by Mosfets to a single, combined power supply node which feeds a LO-drop Lo-quiescent current switching Regulator, a Texas Instrument's TPS63070. This boost-buck switching regulator takes whatever actual voltage is present at the combined power supply node (3 to 5 volts) and provides a regulated 3.3 volts to the CutiPy's main power bus.

If a charged external battery is present at header connector CN1 the LTC4085 will charge this battery from either the USB power or the Mini-Floppy connector; HDR3. The flexibility provided with the LTC4085 along with the low basic power requirements of the Cutipy allow the system to be powered by the USB alone if only a USB host is powering the unit.

If a stand-alone 5-volt power source is present and connected to the +5 and GND pins of HDR1, the LTC4085 will preferentially take power from it instead, which normally takes precedence over the USB power source.

The USB power input is set by the LTC4085 to limit the input current to no more than 500 mA total, as 500 mA is the usual current limit providable by a USB Host. This internal limit prevents overloading of a typical USB port. Should the load current taken by the CutiPy plus the battery charge current attempt to exceed the 500 mA USB limit, the battery charge current will be automatically reduced to compensate, keeping the USB port current below 500 Ma. This will of course increase the time required for full battery recharge.

The Mini-Floppy provided 5 volts has essentially higher limit for those rare cases where a Cutipy might be connected to a larger system that uses higher currents, but this is an exceptional case. The Mini-Floppy power input is limited to 1.1 amps with a polyfuse.

EMAC can provide a a 3.7 volt @ 1.2 Amp-hour Lithium-Ion rechargeable battery (EMAC Part#: PER-PWR-0101PR0). This battery also has a 2mm pitched two position receptacle the perfectly mates to the External Battery connector CN1. Because the Cutipy and the LTC4085 can and expects to charge a Li-Ion battery, only an Li-Ion battery should ever be connected to the External Battery connector CN1. Although Li-Ion batteries similar to PER-PWR-0101PR0 (Li-Ion single cell) with higher or lower Amp-Hour capacities can be used, **never connect a battery of different voltage or another kind of rechargeable or primary battery to CN1!**

PER-PWR-0101PR0, does not have any internal battery protection circuitry, which is recommended for production use. However, the LTC4085 Battery Charger chip does automatically reduces the Battery charge current such that the sum of the load current and charge current does not exceed the programmed input current limit (the battery charge current goes to zero when load current exceeds the programmed input current limit) and has Current Limit & Charger Undervoltage Lockouts.

The LTC4085 has been programmed to recharge the external battery (when used) with a current of 250 mA, given the PER-PWR-0101PR0's 1200 mAHr (1.2 Amps) capacity a typical recharge from near dead to fully charged takes around 4 and ¾ hours for this battery. If another Li-Ion battery of different capacity is used instead, one can easily recalculate that battery's charge time by dividing the battery capacity in mAhr by 250.

The LTC4085 will terminate the battery charge cycle when the battery reaches 4.2 volts. Logic pins are connected to the CutiPy's MPU so the CutiPy can know the status of the charge cycle.

Temperature monitoring of the battery is not provided by the CutiPy.

A voltage measurement analog point is provided by other CutiPy circuitry to measure the external battery's voltage, it can be used to predict battery charge lifetime.

Table 4: Power Connector Pinout (CN1)

Pin	Signal
1	Battery +
2	Battery -

2.4 Serial Ports

The CutiPy is equipped with four serial ports. One RS-232 terminates to a male DB9 connector (UART2), one RS-232/422/485 terminating to 10-pin header connectors (UART3), and two TTL accessed through Utility I/O header 2 (HDR2).

- The RS-232 serial port (UART2) terminates to a male DB9 connector located at CN2. The RS-232 Transceiver (U7) limits the maximum throughput to 250 kb/s. The transceiver can be placed in standby mode by holding GPIO PE1 low. In standby mode the transceiver will typically draw 1µA. When the device is powered down the receivers remain active and the drivers are placed in a high-impedance state.

- RS-232/422/485 (software-configurable) serial port (UART3) terminates to a 10-pin header located at HDR5. By default, the RS-232 transceiver (U11) and the RS-422/485 transceiver (U10) are in standby mode. In standby mode the RS-232 transceiver typically draws 1µA and the RS-422/485 transceiver typically draws 0.1µA. Both devices' driver and receiver output(s) will be high-impedance while in standby mode. To configure RS-232 mode, PE2 should be held high. The maximum throughput for RS-232 is 250 Kb/s. To configure RS-422/485 mode, PF11 should be held high and the maximum throughput in this mode is 2.62Mb/s (Oversampling by 16) and 5.25 Mb/s (Oversampling by 8).

- The TTL serial ports (UARTs 1 & 6) terminates to Utility I/O header 2 (HDR2). UART1 provides for bidirectional communication offering Tx and Rx lines with a maximum bit rate of 10.5 Mb/s. UART6 provides for bidirectional communication offering Tx, Rx, CTS, RTS, and CK lines with Synchronous Mode and Hardware Flow Control Mode. The maximum bit rate for this is 10.5Mb/s. These also support LIN, Smartcard Protocol, and IrDA.

Table 5: Serial Port-UART2 (CN2)

Pin	DB9 Connector: Description
1	NC
2	RXD
3	TXD
4	NC
5	GND
6	NC
7	RTS
8	CTS
9	NC

Table 6: Serial Port-UART3 (HDR5)

Pin	10-Pin Header: Description (RS-232)	10-Pin Header Description (RS-485/422)
1	NC	TX-
2	NC	NC
3	RXD	TX+
4	RTS	NC
5	TXD	RX+
6	CTS	NC
7	NC	RX-
8	NC	NC
9	GND	GND
10	NC	NC

Table 7: Serial Port-UART1 & UART6 TTL (HDR2)

Pin	Utility I/O 2 Pinout
38	USART1_TXD_3V
39	USART1_RXD_3V
40	USART6_CLK_3V
41	USART6_TXD_3V
42	USART6_RXD_3V
43	USART6_CTS_3V
44	USART6_RTS_3V

2.5 USB Ports

The CutiPy provides for two USB 2.0 ports. One port is a USB 2.0 Full-Speed (FS) Device and can be accessed via a micro USB 2.0 connector located at JK1. This USB Full-Speed port supports 12Mb/s transfers in device mode. The other port is a USB 2.0 High-Speed (HS) OTG Port which can also be used as a Full Speed OTG Port and is accessed through the Utility I/O header 1 located at HDR1. To use the HS USB as a Full-Speed Port all that is required is the connection of a USB Connector to pins 45 – 48 (see below). However, to use the HS USB as High-Speed Port an external HS USB PHY is required as well as a USB Connector. This port could be used as OTG (Device or Host), but would require external VBUS switch circuitry. Both USB Ports support the Sessions Request Protocol (SRP) and soft disconnect features.

The Table below calls out the necessary connections for the USB_HS_OTG Port.

Table 8: USB HS Port Pin Assignments (HDR1 & HDR2)

Pin	CutiPy Pin Name	USB ULPI Pin Name
HDR2: 34 or 15	PI11 or ADC123_IN12 (PC2)	OTG_HS_ULPI_DIR
HDR2: 16 or 24	ADC123_IN13 (PC3) or I2C2_SCL (PH4)	OTG_HS_ULPI_NXT
HDR2: 14	ADC123_IN10 (PC0)	OTG_HS_ULPI_STP
HDR2: 21	DAC_OUT2 (PA5)	OTG_HS_ULPI_CK
HDR2: 7	ADC123_IN3 (PA3)	OTG_HS_ULPI_D0
HDR2: 18	ADC12_IN8 (PB0)	OTG_HS_ULPI_D1
HDR2: 19	ADC12_IN9 (PB1)	OTG_HS_ULPI_D2
HDR1: 16	TIM2_CH3 (PB10)	OTG_HS_ULPI_D3
HDR1: 17	TIM2_CH4 (PB11)	OTG_HS_ULPI_D4
HDR2: 32	SPI-1_MOSI (PB5)	OTG_HS_ULPI_D7
HDR1: 45	USB_OTG_HS_ID (PB12)	*OTG_HS_ID / OTG_HS_ULPI_D5
HDR1: 46	USB_OTG_HS_VBUS (PB13)	*OTG_HS_VBUS / OTG_HS_ULPI_D6
HDR1: 47	USB_OTG_HS_D_N (PB14)	*OTG_HS_DM
HDR1: 48	USB_OTG_HS_D_P (PB15)	*OTG_HS_DP

* indicates Full-Speed lines

2.6 MicroSD Card Socket

The CutiPy provides a high capacity MicroSD socket. This socket is hot-swappable and can accept a wide variety of Flash Cards. A card that is written to by the CutiPy can be read by another computer using a MicroSD card reader. The MicroSD interface is compatible with Standard and High Capacity MicroSD cards.

2.7 LCD (Optional)

The CutiPy can be equipped with an LCD that includes 4x user pushbuttons and LEDs on the top side of the board. The LCD is a 128x32 pixel Newhaven Display Intl NHD-C12832A1Z-FSW-FBW-3V3 with 4-Line SPI MCU interfaces.

2.8 CAN Port

The CutiPy provides a CAN 2.0B port utilizing the TI TCAN334GDCNT Transceiver chip. The CAN port is accessible via a 3-pin header located at HDR4 (TE Connectivity PN 640456-3). Jumper JB4 should be placed in the TRM position to allow CAN accessibility.

Table 9: Pinout for the CAN-1 2.0 Port (HDR4)

Pin	Signal
1	CAN1_HI
2	CAN1_LO
3	GND

2.9 Real-Time Clock

The CutiPy is equipped with an external battery (B1) for backing up the Real-Time Clock (RTC). Drivers to access the RTC are included in the operating systems. Jumper JB3 should be placed in the ON position in order to retain system time when powered down.

2.10 Temperature Sensor

The CutiPy is equipped with an internal temperature sensor located in the STM32 microcontroller that can be used to measure the ambient temperature of the device. ADC1_IN16 channel is used to convert the sensor output voltage to a digital value.

2.11 Reset

The CutiPy is equipped with a reset button located at PB5. Pressing this button will cause the system to reset.

2.12 Wireless (Optional)

The CutiPy provides an onboard Wi-Fi/Bluetooth antenna which utilizes the on-board Redpine Signals of the RS9113/RS9116 Wireless Module. This module by default integrates a chip antenna and a U.FL connector for external antenna connection with an option to select either one of them. EMAC can provide an antenna kit that plugs into the chip's antenna U.FL jack.

The Redpine Wireless Module offers high throughput and extended range along with Wi-Fi and Bluetooth (BT) coexistence in a power-optimized design.

2.13 I/O Expansion

The CutiPy provides access to a number of I/O lines on connectors HDR1 and HDR2. The 50-pin dual row headers contain GPIO lines, USB, UART, SPI bus, I²C bus, CAN bus, A/D lines, interrupts, high drive outputs, and power pins. The tables below list the pinouts and the corresponding signals for both I/O headers.

Table 10: I/O Header (HDR1)

Pin#	Signal	Pin#	Signal
1	GND	**2**	GND
3	3P3_VCC	**4**	5V_JACK
5	12V_VIN	**6**	V_HIDRV
7	TIM1_ETR	**8**	TIM1_CH1N
9	TIM1_CH1	**10**	TIM1_CH2N
11	TIM1_CH2	**12**	TIM1_CH3N
13	TIM1_CH3	**14**	TIM1_CH4
15	TIM1_BKIN	**16**	TIM2_CH3
17	TIM2_CH4	**18**	TIM3_CH2
19	TIM4_CH2	**20**	TIM4_ETR
21	TIM4_CH3	**22**	GND
23	TIM5_CH1	**24**	TIM4_CH4
25	TIM5_CH3	**26**	TIM5_CH2
27	TIM8_CH3N	**28**	TIM8_CH2N
29	TIM8_CH1	**30**	TIM8_BKIN
31	TIM8_CH3	**32**	TIM8_CH2
33	HD_PG1	**34**	HD_PG0
35	HD_PG3	**36**	HD_PG2
37	HD_PG5	**38**	HD_PG4
39	HD_PG10	**40**	HD_PG6
41	PF12	**42**	PF13
43	PF14	**44**	PF15
45	PB12	**46**	PB13
47	USB_FS_D_N	**48**	USB_FS_D_P
49	GND	**50**	GND

Table 11: I/O Connector (HDR2)

Pin#	Signal	Pin#	Signal
1	GND	**2**	GND
3	3P3_VIN	**4**	5V_JACK
5	12V_IN	**6**	NC
7	ADC123_IN3	**8**	ADC3_IN4
9	ADC3_IN5	**10**	ADC3_IN6
11	ADC3_IN7	**12**	ADC3_IN8
13	ADC3_IN9	**14**	ADC123_IN10
15	ADC123_IN12	**16**	ADC123_IN13
17	ADC12_IN6	**18**	ADC12_IN8
19	ADC12_IN9	**20**	DAC_OUT1
21	DAC_OUT2	**22**	GND
23	AVDD	**24**	I2C2_SCL
25	I2C2_SDA	**26**	I2C2_SMBA
27	I2C3_SCL	**28**	I2C3_SDA
29	I2C3_SMBA	**30**	SPI-1_SCK
31	SPI-1_MISO	**32**	SPI-1_MOSI
33	SPI-1_NSS	**34**	PI11
35	PI10	**36**	PH2
37	PH3	**38**	USART1_TX
39	USART1_RX	**40**	USART6_CK
41	MDM_TXD_3V	**42**	MDM_RXD_3V
43	MDM_CTS_3V	**44**	MDM_RTS_3V
45	CAN1_AUX_TX	**46**	CAN1_AUX_RX
47	WKUP	**48**	RTC_TAMP/TS
49	GND	**50**	GND

2.14 I2C

The CutiPy provides for two I2C hardware ports located on I/O header 2 (HDR2). Both can support a bit rate up to 100 kb/s (Standard mode) and 400 kb/s (Fast mode) with 7/10 bit addressing mode and a 7-bit addressing mode (as slave). By default, the I2C interface operates in Slave mode.

Table 12: I2C-2 (HDR2)

Pin#	Port Line	Description
24	I2C2_SCL	I2C2 Clock signal
25	I2C2_SDA	I2C2 Data signal
26	I2C2_SMBA	I2C2 System Management Bus Alert signal
27	I2C3_SCL	I2C3 Clock signal
28	I2C3_SDA	I2C3 Data signal
29	I2C3_SMBA	I2C3 System Management Bus Alert signal

2.15 SPI

The CutiPy is equipped with one Serial Peripheral Interface bus communicating up to 42 Mbits/s. This provides for half/full duplex synchronous transfers with external devices with an 8 or 16-bit transfer frame format selection.

Table 13: Serial Peripheral Interface SPI-1

Pin#	Port Line	Description
30	SPI-1_SCK	SPI 1 Serial Clock
31	SPI-1_MISO	SPI 1 Master In Slave Out
32	SPI-1_MOSI	SPI 1 Master Out Slave In
33	SPI-1_NSS	SPI 1 Slave Select

2.16 Analog to Digital Converter

The CutiPy has 13 A/D input channels with unique A/Ds available on the Utility I/O header 2 (HDR2). Voltages applied to the inputs must be in the range of 0 - 3.3V with reference to ground. For additional information please reference the STM32F407IGH6 User Manual. See Table 9 in the I/O Expansion section for pinout details.

2.17 Digital to Analog Converter

The CutiPY comes equipped with 2 D/A converters. These converters run directly from the ST Processor and are routed to Utility header 2 (HDR2). The output of the converters is 0 to 3.3V depending on digital count written to the D/A converter. For additional information please reference the STM32F407IGH6 User Manual. See Table 9 in the I/O Expansion section for pinout details.

2.18 Timers/Counters

The CutiPy is equipped with 25 timers and counters and are located on Utility I/O header 1 (HDR1). TIM1 and TIM8 are advanced control timers that are 16-bit auto-reload counter driven by a programmable prescaler. TIM2 - TIM5 are general purpose timers that consist of 16-bit or 32-bit auto reload counter driven by a programmable prescaler. These timers can be used for generating output waveforms or for measuring pulse lengths of input signals and are completely independent and do not share any resources. See Table 10 in the I/O expansion section for pinout details.

2.19 Timers/JTAG/SWD

The CutiPy provides for JTAG/SWD capabilities through the STM32 MCU. A 10-pin male connector located at HDR6 provides access to the JTAG/SWD lines which is a Sullins Electronics GRPB052VWVN-RC. This connection will allow the ability to program and debug software.

Table 14: JTAG/SWD (HDR6)

Pin#	Port Line	Description
1	3P3_VCC	3.3 Volts
2	SWDIO	Serial Wire Data Input/Output
3	GND	Ground
4	SWDCLK	Serial Wire Clock
5	GND	Ground
6	SWO	Serial Wire Output
7	GND	Ground
8	TDI	JTAG Test Data Input
9	GND	Ground
10	nRESET	JTAG Test nReset

3 Software

The CutiPy offers the ability to use different operating systems to meet different customer needs. There is an available board support package for the CutiPy from EMAC that uses FreeRTOS. Middleware has been added to compliment the already available middleware supplied by the developers at STM and to make these packages available for easy integration into user developed applications targeted for the CutiPy.

For more information on software support, please visit the EMAC Wiki Software Section at:

http://wiki.emacinc.com/wiki/Micropython

3.1 STM32CubeMX

EMAC utilizes the code generation tool STM32CubeMX to configure the processor for the CutiPy board. This tool allows for the configuration of all processor pins as well as adding, removing, and configuring middleware packages that are available through the STM32CubeMX code generation tool. The CutiPy board support package includes the STM32CubeMX project that can be used to tailor the FreeRTOS build to the customer's exact needs. One of the benefits of using the code generation tool is that it will automatically pull in and use the most current software updates from the upstream repository. Some of the middleware packages that are available and are supported by the CutiPy are as follows;

- FatFS
- FreeRTOS
- LwIP
- MBEDTLS
- USB Device
- USB Host
- Redpine APIs

http://www.st.com/en/development-tools/stm32cubemx.html

3.1.1 FreeRTOS

FreeRTOS is one of the many packages available for application development that can be included when using the STM32CubeMX code generation tool. Optionally, the FreeRTOS package can be downloaded from https://www.freertos.org/. FreeRTOS has their own board support package for many of the available STM32 development platforms. When using the STM32CubeMX code generator, a wrapper is provided for most of the FreeRTOS functionality to make development even more simple.

https://www.freertos.org/FreeRTOS-Plus/BSP_Solutions/ST/index.html

Amazon provides Amazon Web Services (AWS) cloud support for FreeRTOS. For further information go to:
https://aws.amazon.com/freertos/getting-started/

3.1.2 STM32CubeMX Expansion Software

Additional software and expansion packs are available through STMicro for use with the STM32CubeMX code generation utility. Software expansion packs may need to be tailored specifically to work with the CutiPy board, however, they are a useful starting point for incorporating various sensors and peripherals to the CutiPy board.

http://www.st.com/en/ecosystems/stm32cube-expansion-software.html?querycriteria=productId=SC2005

3.2 Atollic TrueSTUDIO for STM32

EMAC has targeted the board support package for specific use with the IDE available from Atollic that is geared specifically towards the STM32 processor. All the tool chains required to begin development right away are available for free with the Attolic TrueSTUDIO for STM32 IDE. The IDE provides programming and debugging using either the ST-LINK, SEGGER J-LINK, or SEGGER J-TRACE. Atollic TrueSTUDIO includes many useful features for debugging multiple cores as well as real time applications. The IDE also has revision control built in using SVN, Git, and CVS. For additional information on Atollic TrueSTUDIO for STM32 visit the web page below.

https://atollic.com/truestudio/

4 Appendix A: Connector Pinouts

4.1 Main Battery Connector (CN1)

Pin	Signal
1	BATT_VOLT
2	GND

4.2 Serial Port UART2 (CN2)

Pin	DB9 Connector: Description
1	NC
2	RXD
3	TXD
4	NC
5	GND
6	NC
7	RTS
8	CTS
9	NC

4.3 I/O Header 1 (HDR1)

Pin#	Signal	Pin#	Signal
1	GND	2	GND
3	3P3_VCC	4	5V_JACK
5	12V_VIN	6	V_HIDRV
7	TIM1_ETR	8	TIM1_CH1N
9	TIM1_CH1	10	TIM1_CH2N
11	TIM1_CH2	12	TIM1_CH3N
13	TIM1_CH3	14	TIM1_CH4
15	TIM1_BKIN	16	TIM2_CH3
17	TIM2_CH4	18	TIM3_CH2
19	TIM4_CH2	20	TIM4_ETR
21	TIM4_CH3	22	GND
23	TIM5_CH1	24	TIM4_CH4
25	TIM5_CH3	26	TIM5_CH2
27	TIM8_CH3N	28	TIM8_CH2N
29	TIM8_CH1	30	TIM8_BKIN
31	TIM8_CH3	32	TIM8_CH2
33	HD_PG1	34	HD_PG0
35	HD_PG3	36	HD_PG2
37	HD_PG5	38	HD_PG4

39	HD_PG10	**40**	HD_PG6
41	PF12	**42**	PF13
43	PF14	**44**	PF15
45	PB12	**46**	PB13
47	USB_HS_D_N	**48**	USB_HS_D_P
49	GND	**50**	GND

4.4 I/O Header 2 (HDR2)

Pin#	Signal	Pin#	Signal
1	GND	**2**	GND
3	3P3_VIN	**4**	5V_JACK
5	12V_IN	**6**	NC
7	ADC123_IN3	**8**	ADC3_IN4
9	ADC3_IN5	**10**	ADC3_IN6
11	ADC3_IN7	**12**	ADC3_IN8
13	ADC3_IN9	**14**	ADC123_IN10
15	ADC123_IN12	**16**	ADC123_IN13
17	ADC12_IN6	**18**	ADC12_IN8
19	ADC12_IN9	**20**	DAC_OUT1
21	DAC_OUT2	**22**	GND
23	AVDD	**24**	I2C2_SCL
25	I2C2_SDA	**26**	I2C2_SMBA
27	I2C3_SCL	**28**	I2C3_SDA
29	I2C3_SMBA	**30**	SPI-1_SCK
31	SPI-1_MISO	**32**	SPI-1_MOSI
33	SPI-1_NSS	**34**	PI11
35	PI10	**36**	PH2
37	PH3	**38**	USART1_TX
39	USART1_RX	**40**	USART6_CK
41	MDM_TXD_3V	**42**	MDM_RXD_3V
43	MDM_CTS_3V	**44**	MDM_RTS_3V
45	CAN1_AUX_TX	**46**	CAN1_AUX_RX
47	WKUP	**48**	RTC_TAMP/TS
49	GND	**50**	GND

4.5 Vin Power Header (HDR3)

Pin	Signal
1	+Vin 5V
2	GND
3	GND
4	+Vin 12V

4.6 CAN 2.0 Port (HDR4)

Pin	Signal
1	CAN1_HI
2	CAN1_LO
3	GND

4.7 Serial Port UART3 (HDR5)

Pin	10-Pin Header: Description (RS-232)	10-Pin Header Description (RS-485/422)
1	NC	TX-
2	NC	NC
3	RXD	TX+
4	RTS	NC
5	TXD	RX+
6	CTS	NC
7	NC	RX-
8	NC	NC
9	GND	GND
10	NC	NC

4.8 JTAG/SWD Header (HDR6)

Pin#	Port Line	Description
1	3P3_VCC	3.3 Volts
2	SWDIO	Serial Wire Data Input/Output
3	GND	Ground
4	SWDCLK	Serial Wire Clock
5	GND	Ground
6	SWO	Serial Wire Output
7	GND	Ground
8	TDI	JTAG Test Data Input
9	GND	Ground
10	nRESET	JTAG Test nReset

4.9 USB OTG Port (JK1)

Pin	Signal
1	USB_OTG_VBUS/ USB_DCIN
2	USB_OTG_D_N
3	USB_OTG_D_P
4	USB_OTG_ID
5	GND
6	FRAME_GND
7	FRAME_GND

4.10 MicroSD Card Socket (SOK1)

Pin	Signal
1	SDIO_D2
2	SDIO_D3
3	SDIO_CMD
4	3P3_VCC
5	SDIO_CLK
6	GND
7	SDIO_D0
8	SDIO_D1
9	CARD_DET
10	GND

5 Appendix B: Jumper Settings

5.1 JB1 (Boot Mode 0 Selection)

Jumper	Position	Setting
Pins 1 & 2	RXM	Select RXM
Pins 2 & 3*	FLS	Select FLS

*Default Setting

5.2 JB2 (Boot Mode 1 Selection)

Jumper	Position	Setting
Pins 1 & 2	RAM	Select RAM
Pins 2 & 3*	ROM	Select ROM

*Default Setting

When JB1 is in the RXM position and JB2 is in the ROM position the system will Boot from the ST bootloader. This bootloader will allow the programming of the Main Flash Memory by a number of various serial peripherals (USART, CAN, USB, I2C, SPI, etc.). Care must be exercised when using this jumper option as any program currently in Flash can be erased or corrupted. For additional information please reference the STM32F407IGH6 User Manual.

5.3 JB3 (RTC & RAM Retention Battery)

Jumper	Position	Setting
Pins 1 & 2	ON	Enable Battery
Pins 2 & 3*	OFF	Disable Battery

*Default Setting

5.4 JB4 (CAN Termination)

Jumper	Position	Setting
Pins 1 & 2*	TRM	Line Pulled HI
Pins 2 & 3	OPN	Line Pulled LO

*Default Setting

5.5 JB5 (UART3 Serial Port RS422/485 Termination)

Jumper	Position	Setting
Pins 1 & 2*	TRM	Enable
Pins 2 & 3	OFF	Disable

*Default Setting