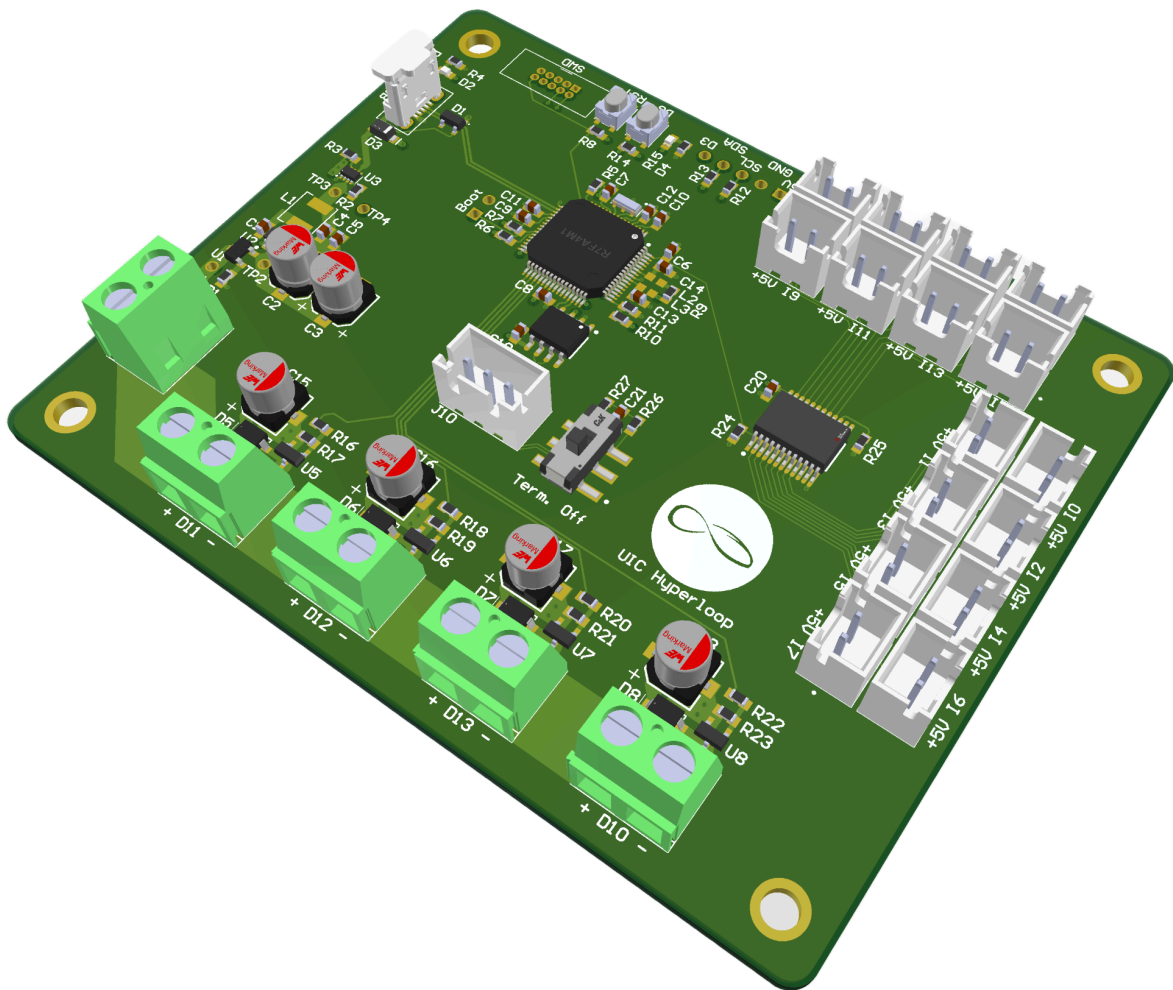


# Battery Temperature Control Unit

## Board Manual - Rev A

Written by Ephren Manning



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## 1. Pinouts:

Hardware Pin	Pin Name	Arduino Pin	Function
28	P304	D8	S3: Mux select bit 4, MSB
29	P303	D9	S2: Mux select bit 3
30	P302	D1	S1: Mux select bit 2
31	P301	D0	S0: Mux select bit 1, LSB
41	P107	D7	E: Mux enable, active low, pulled down
64	P000	A1	A1: Analog input from mux
34	P109	D11	RELAY1: Relay 1 enable, active high
35	P110	D12	RELAY2: Relay 2 enable, active high
36	P111	D13	RELAY3: Relay 3 enable, active high
37	P112	D10	RELAY4: Relay 4 enable, active high
45	P103	D4	CAN_RX: RX from CAN Trans.
46	P102	D5	CAN_TX: TX to CAN Trans.
42	P106	D6	D6: Connected to active-low button input
43	P105	D2	D2: Connected to user LED
44	P104	D3	D3: Connected to unused pin header
47	P101	A4/SDA	SDA: I2C broken out to unused pin header
48	P100	A5/SCL	SCL: I2C broken out to unused pin header

## 2. Overview

The Battery Temperature Control Unit, BTCU, is in charge of monitoring the temperature of 16 battery cells using NTC 100k thermistors and a 16:1 analog MUX. The thermistors are connected to the high side (+5V) of a resistor divider, with a 100k resistor on the low side. The resulting voltage is monitored by the microcontroller. The BTCU can react to over-temperature conditions by actuating 4 high voltage insulating relays which control the flow of battery current.

## 3. Power

The BTCU is designed to run off of 12V battery power. A buck converter regulates the input power to 5V for the microcontroller and other digital systems. A P-Channel MOSFET provides reverse polarity protection to the buck-converter. The relay switching circuit delivers the unregulated 12V input to the relays when switched on. The relays are designed to work within the range of 12V to 24V, so some variation is okay. The BTCU can also be powered by USB. There is a TPS2116 Load Switch which chooses between the buck output or VUSB if both are connected simultaneously.

## 4. Microcontroller

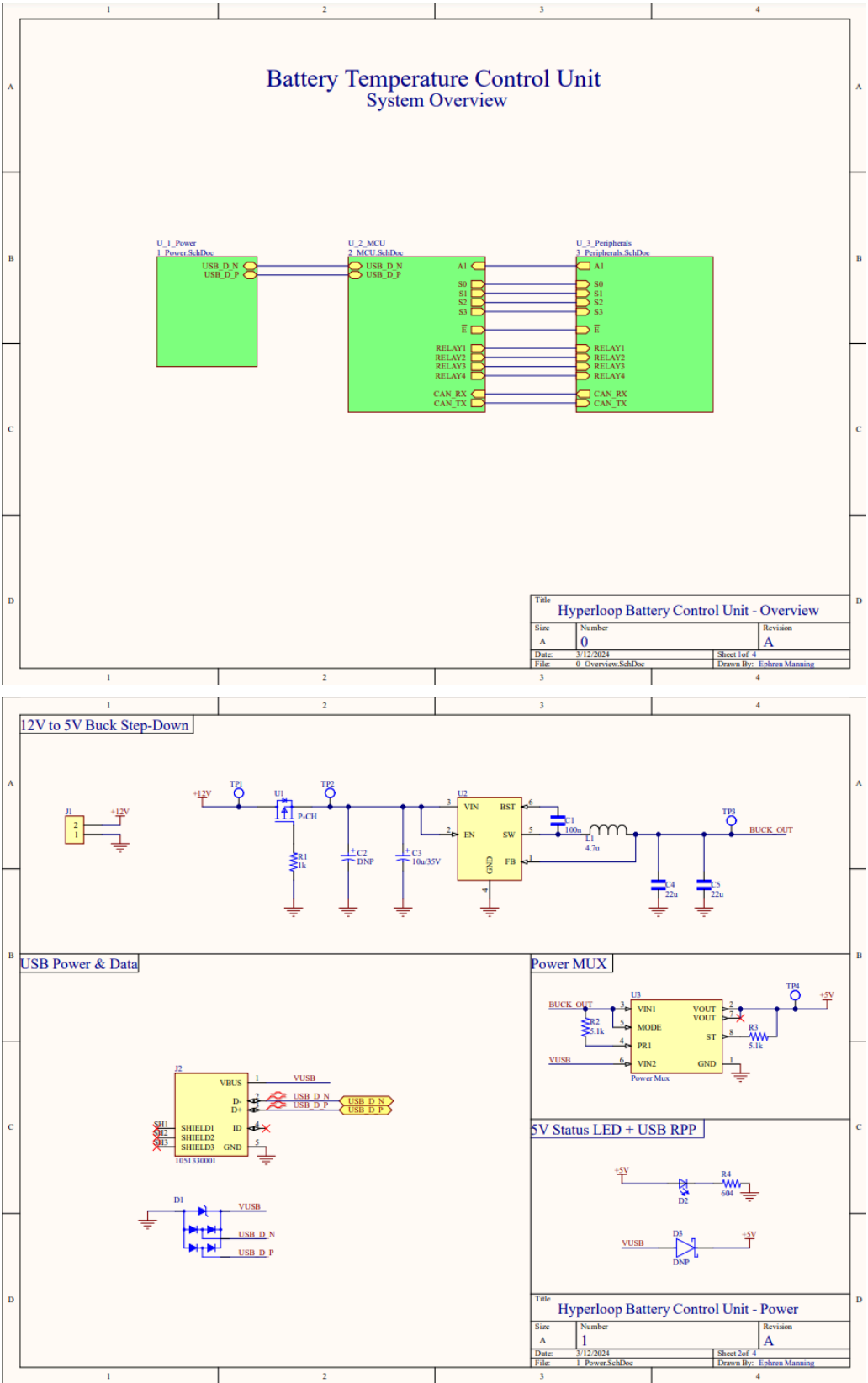
The BTCU uses a 32-bit Cortex-M4 R7FA4M1AB3CFM. This microcontroller is 5V capable and designed to use the Arduino software core and bootloader. The Arduino bootloader can be flashed by pulling the MD pin to ground and following the steps at this link: <https://docs.arduino.cc/tutorials/uno-r4-minima/cheat-sheet/#bootloader>. Alternatively, Renesas provides their own IDE called e2 Studio.

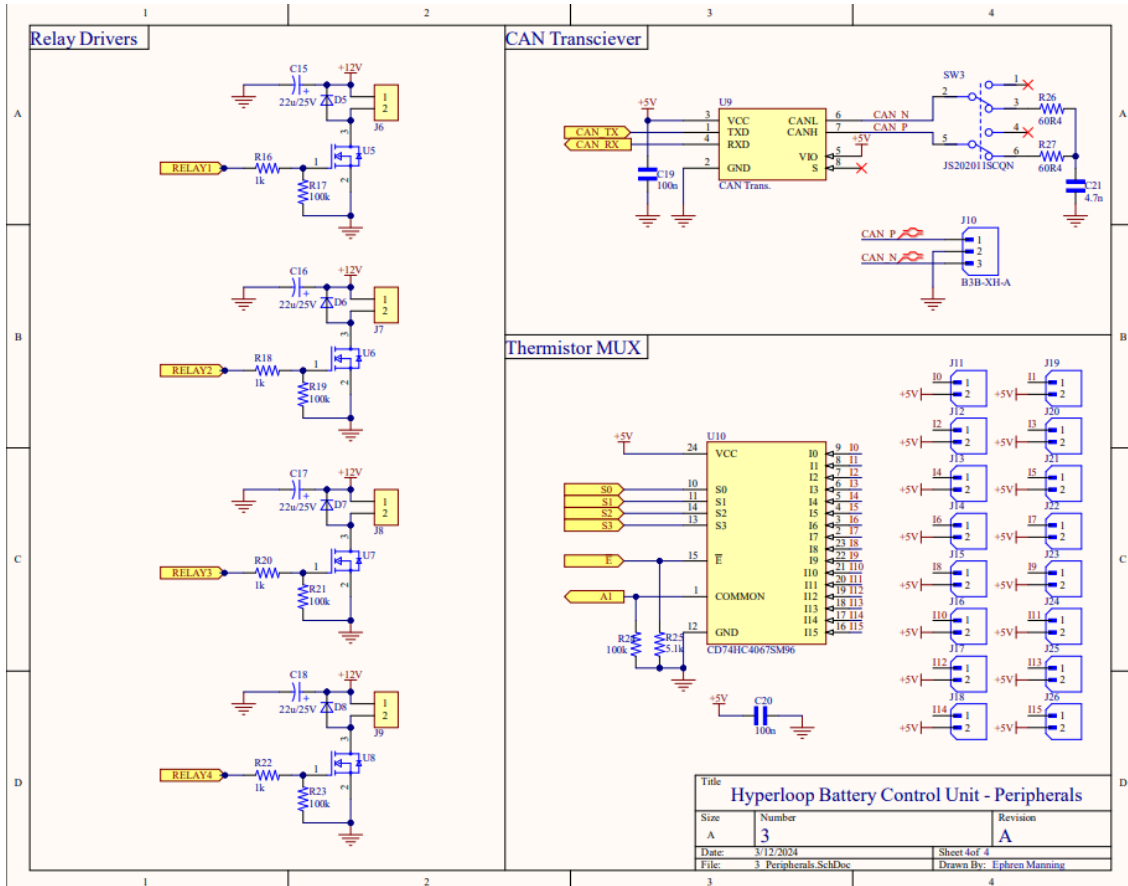
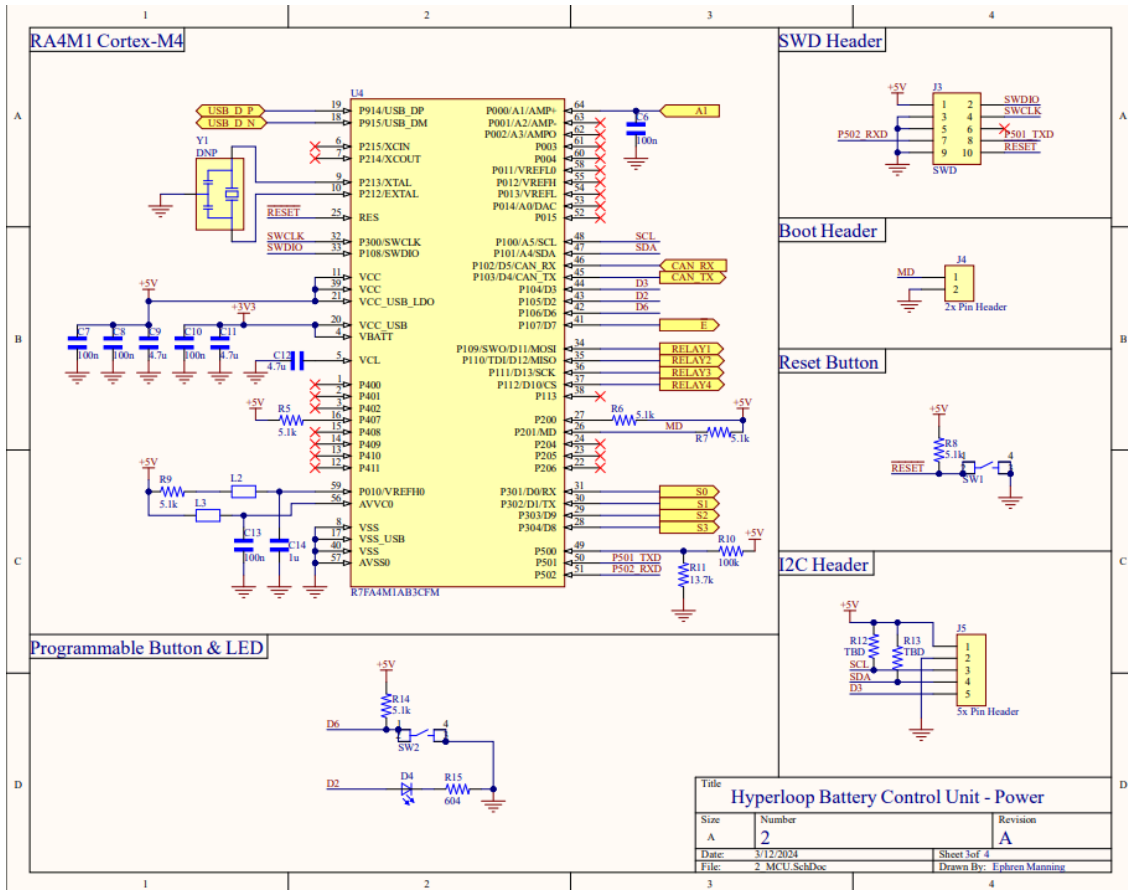
## 5. Peripherals

The 16:1 analog MUX is controlled by digital outputs S3-S0 to select one of 16 inputs. For example, S3S2S1S0 = 1010 results in COMMON -> I10.

There are also 4 active high relay control circuits, controlled by digital pins D10 to D13. BTCU also contains a TJA1051T/3 CAN Transceiver, with switchable 120 ohm termination. This is connected to the MCU's on-chip CAN controller.

6. Schematics





## 7. Top-Down Copper View

