OPEnS RTC
Version: 1.0
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Revision History:
1.0 - Complete overhaul from OPEnS Power v7 [mitch nelke]
1.1 - Edited labels, swapped JST pins, replaced barrel jack connector, removed redundant pullup resistor. Added bill of materials to documentation. [mitch nelke June 26 2019]

1. Overview

The OPEnS RTC is the full-feature power control board that combines many common OPEnS Project low-power functions. A MOSFET-based latch circuit accepts a high- and low-true interrupts to enable or disable the power from a 4.1V LiPo battery in addition to a 3.3-24V power source. A two position slide switch forces the device on in Override mode, detectable by an output signal for any microcontroller to read. A DS3231 real time clock is placed directly on the board and can communicate with the microcontroller over I2C. The power to the RTC is connected to the switching 4.1V supply. When the device is in the sleeping state, the RTC pulls power from a 2000uF capacitance source instead of the battery and can last up to 180 days without reconnecting to the battery. The footprint of the device allows any of Adafruit's Feather boards to directly snap into the OPEnS RTC, and digital signal pins can be reconfigured by unbridging their solder jumpers. The OPEnS RTC is able to switch off the connection from any source within the absolute limits and be placed in an ultra-low power, <10uA current draw state. It can reconnect the source upon multiple interrupt vectors. A total of 128kb of non-volatile FRAM storage can be used to store variables between shutdown cycles and can undergo over a billion write cycles.

2. Absolute Characteristics

Characteristic	Condition	Min	Max (steady state)
VCC (Low Voltage)			
VCC (High Voltage)			
I_{LOAD} (Low Voltage)	VCC_{LOW} = 4.2V T_A = 25C	-	3.0 A
I_{LOAD} (High Voltage)	VCC_{HIGH} = 10V T_A = 25C	-	3.8 A

3. Operating Range

Characteristic	Condition	Min	Max
V_{ALM_READ}	Logic High		
	Logic Low		
V_{OVR_READ}	Logic High		
	Logic Low		
V_{SHDN}	Logic High		
	Logic Low		
V_{INT+}	Logic High		
	Logic Low		
V_{BACKUP}	VCC_{LOW} = 4.2 V	2.3 V	4.2 V
$I_{STANDBY}$	V_{LATCH} = 4.1 V		10 uA

4. Hookup Guide

Board Connection	Purpose	External Connection
OVR_READ	High if latch is overriden, low if latch is in normal operating mode.	Feather pin 10 if SJ3 is bridged. Otherwise connect to any GPIO or high impedance logic input. Do not write to this pin.
ALM_READ	High if RTC alarm is false. Low if RTC alarm is true.	Feather pin A4 if SJ2 is bridged. Otherwise connect to any GPIO or logic input. Do not write to this pin.
SHDN	Power off the latch to disconnect Load_HV and Load_LV. High-true.	Feather pin A5 if SJ1 is bridged. Otherwise connect to any GPIO or logic output.
INT+	External high-true wakeup signal.	Connect ground and signal to respective pins on the INT+ JST connector.
HV	Always-connected high voltage power supply output.	Connect always-on low-voltage external load to LV JST connector.
LV	Always-connected low voltage 4.2V LiPo power supply output.	Connect always-on high-voltage external load to HV JST connector.
LOAD_HV	Latching high-voltage power supply output for external circuits.	Connect external load to Load_HV JST connector.
LOAD_LV	Latching low-voltage power supply output for external circuits.	Connect external load to Load_LV JST connector.
HV_IN	High voltage power supply input. Optional.	Connect high voltage power supply to HV_IN barrel jack.
LV_IN	Low voltage LiPo power supply input that supplies logic power. Mandatory.	Connect 4.2V LiPo battery to LV_IN JST connector.
V_BACKUP	Spare contact for testing voltage of RTC backup power source.	Connect to multimeter or other probe during testing.
RTC_ALM	Spare contact for probing logic of the RTC alarm.	Connect to multimeter or other probe during testing.
V_LATCH	Spare contact for probing logic of the latch circuit.	Connect to multimeter or other probe during testing.
GND	Spare contact for ground reference.	Connect to multimeter or other probe during testing.

5. Software Considerations

5.1. DS3231 Real Time Clock

The DS3231 Real Time Clock is operated like any DS3231 breakout board. No general purpose digital pins are connected to the clock for communication, but the alarm output is transparent to the A4 pin (ALM_READ) on an attached Feather board. The I2C address is set to the default value. The datasheet for the real time clock is linked in Appendix A.

5.2. FRAM non-volatile storage

The FRAM non-volatile storage is connected to the I2C bus. Its address is set to the default value. The datasheet for the storage is linked in Appendix A.

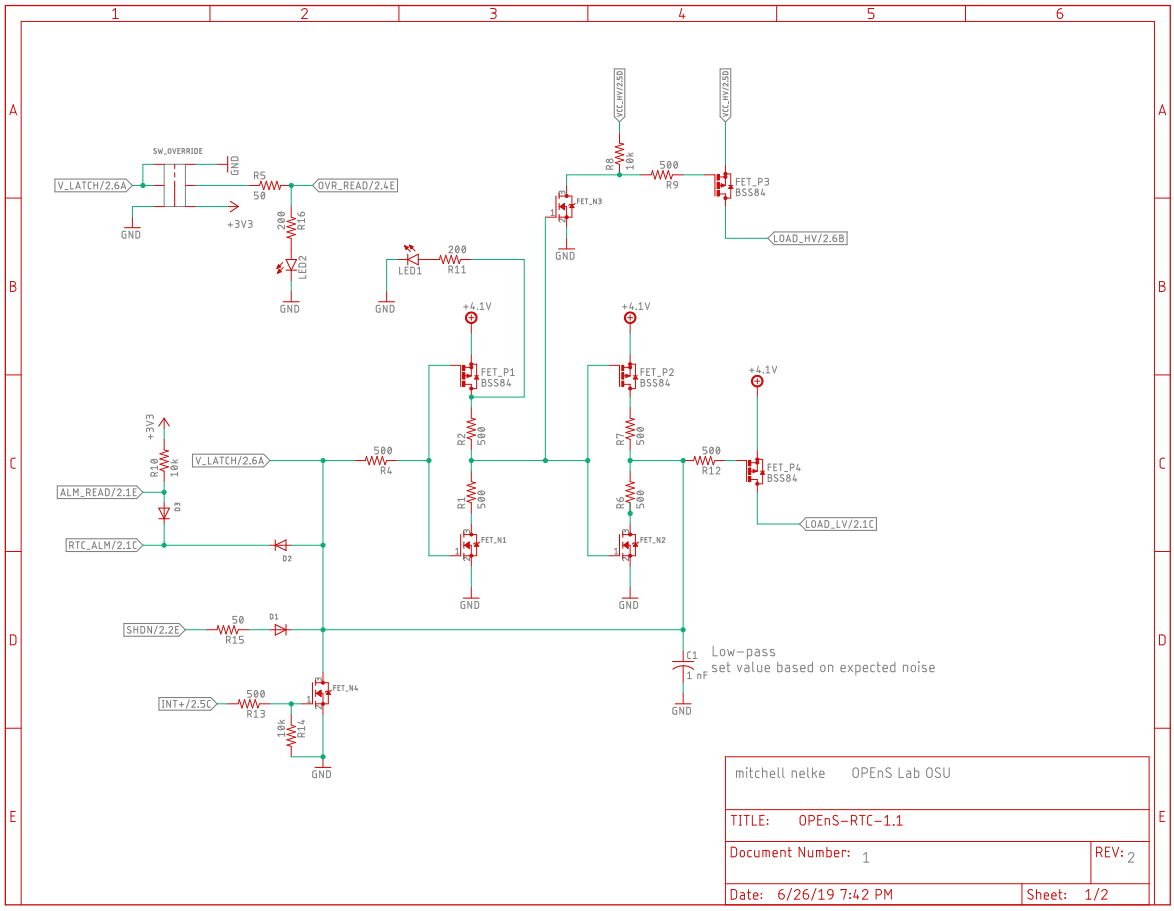
5.3. General Considerations

The OPEnS RTC fully shuts off the supplied power to the Feather microcontroller and any device being powered from the latching power outputs. This means any non-constant variables should be stored in a permanent storage that retains data without power before the device is shut down. The FRAM storage included in the board is meant for this purpose, but many microcontrollers also include some kind of non-volatile storage for variables. The RTC alarm should always be set before turning the device off.

6. Theory of Operation

7. Full Schematic

7.1. Schematic Page 1



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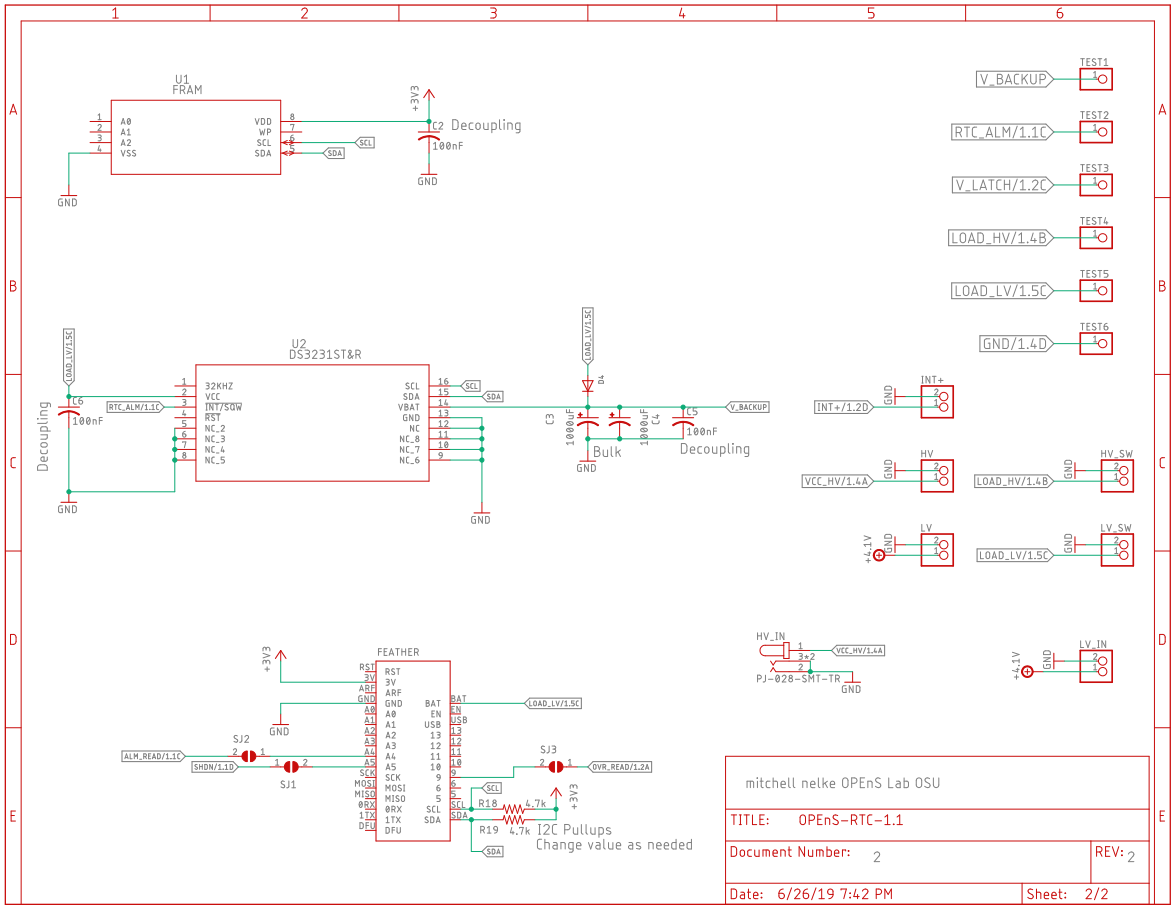
7.2. Schematic Page 2



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8. Bill of Materials

Component	ID	Footprint	Board ID	QTY	Source
DC Barrel Jack	PJ-028-SMT-TR	SMT 0.9x3.2mm	HV_IN	1	Digikey
Diode	1N4148W-TP	SOD-123	D1-4	4	Digikey
JST 2pin	B2B-PH-SM4-TB(LF)(SN)	SMT 2mm spacing	Hv, HV_SW, INT+, LV, LV_IN, LV_SW	6	Digikey
LED Red	LTST-C150CKT	SMT 1206	LED1	1	Digikey
LED Green	LTST-C150GKT	SMT 1206	LED2	1	Digikey
MOSFET - N channel	DMG3406L-13	SOT23	FET_N1-4	4	Digikey

MOSFET- P channel	DMP3099L-7	SOT23	FET_P1-4	4	Digikey
Capacitor	1 nF	0805	C1	1	Digikey
Capacitor	100 nF	0805	C2, C5, C6	3	Digikey
Capacitor	1000 uF RL80J102MDN1KX	8x8 / 3.5mm	C3, C4	2	Digikey
Resistor	50	0805	R5, R15	2	Digikey
Resistor	200	0805	R11, R16	2	Digikey
Resistor	500	0805	R1, R2, R4, R6, R7, R9, R12, R13	8	Digikey
Resistor	4.7k	0805	R18, R19	2	Digikey
Resistor	10k	0805	R8, R10, R14	3	Digikey
Real Time Clock	DS3231		U2	1	Digikey
FRAM	MB85RC128APNF-G-JNE1		U1	1	Digikey
Switch - 2 Position, double throw	JS202011JCQN		SW_OVERRIDE	1	Digikey

9. Soldering Instructions

10. Testing Procedure