“Wakie”

The No–Nap Alarm

Back2School Submission

Sidharth Annapragada; Northeastern University

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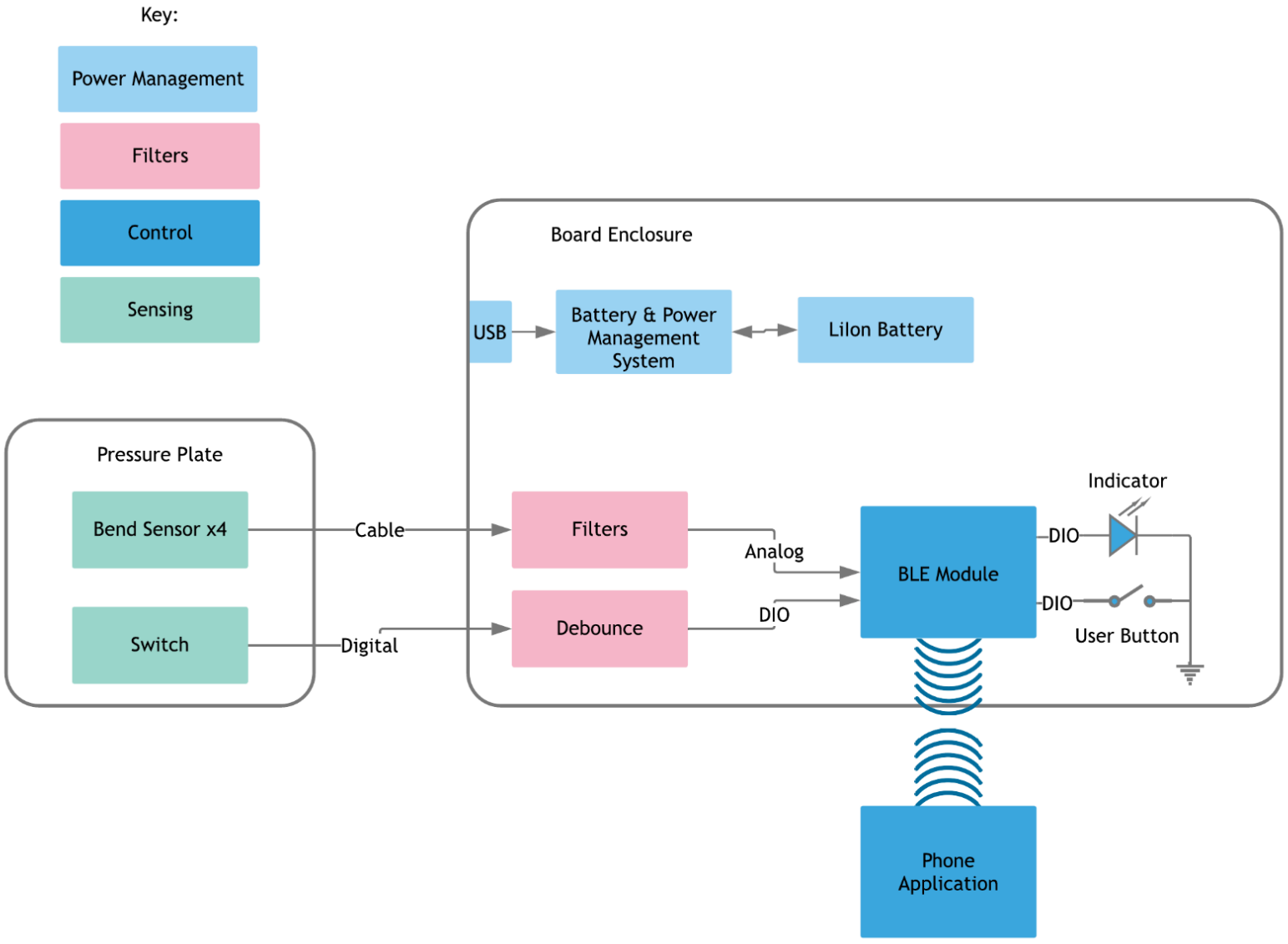
Project Description

A common problem that college students, myself included, face is waking up and *staying* up on time. This project aims to solve this problem by creating a novel alarm clock system. Dubbed “Wakie”, I have designed a Bluetooth connected pressure plate that connects to a phone app with an alarm on it. When the alarm goes off, the user will need to get up and complete a predefined series of exercise to disable it. These exercises can range from just standing in place, to jumping jacks, to stretches. The sensing of this motion is enabled by custom electronics, designed using *only* Digi-Key parts.

System Architecture

Back2School "Wakie" NoNap Alarm

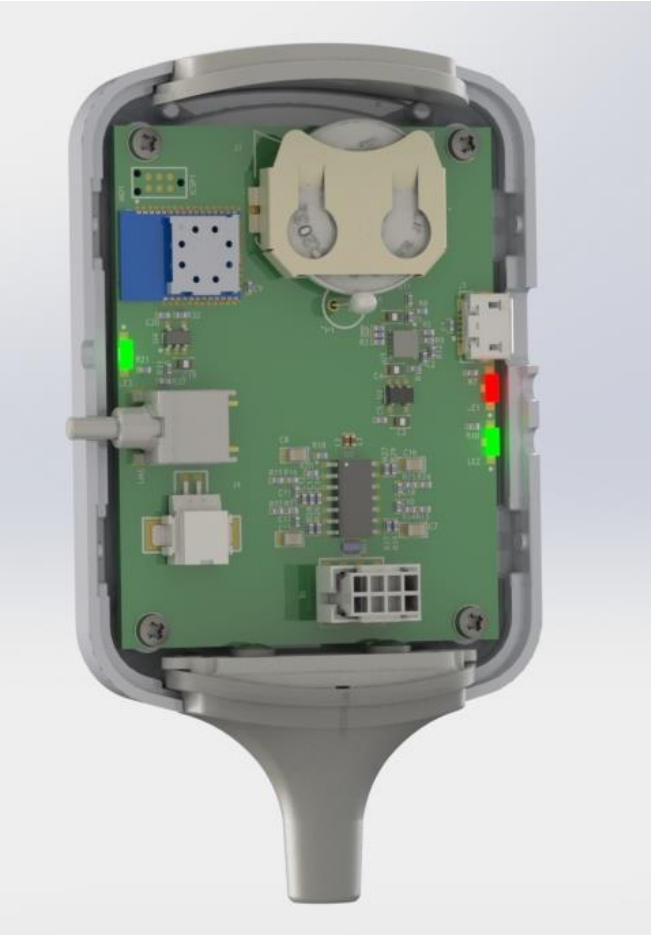
Sidharth Annapragada | Rev A., November 5th, 2020



System Details

Electronics

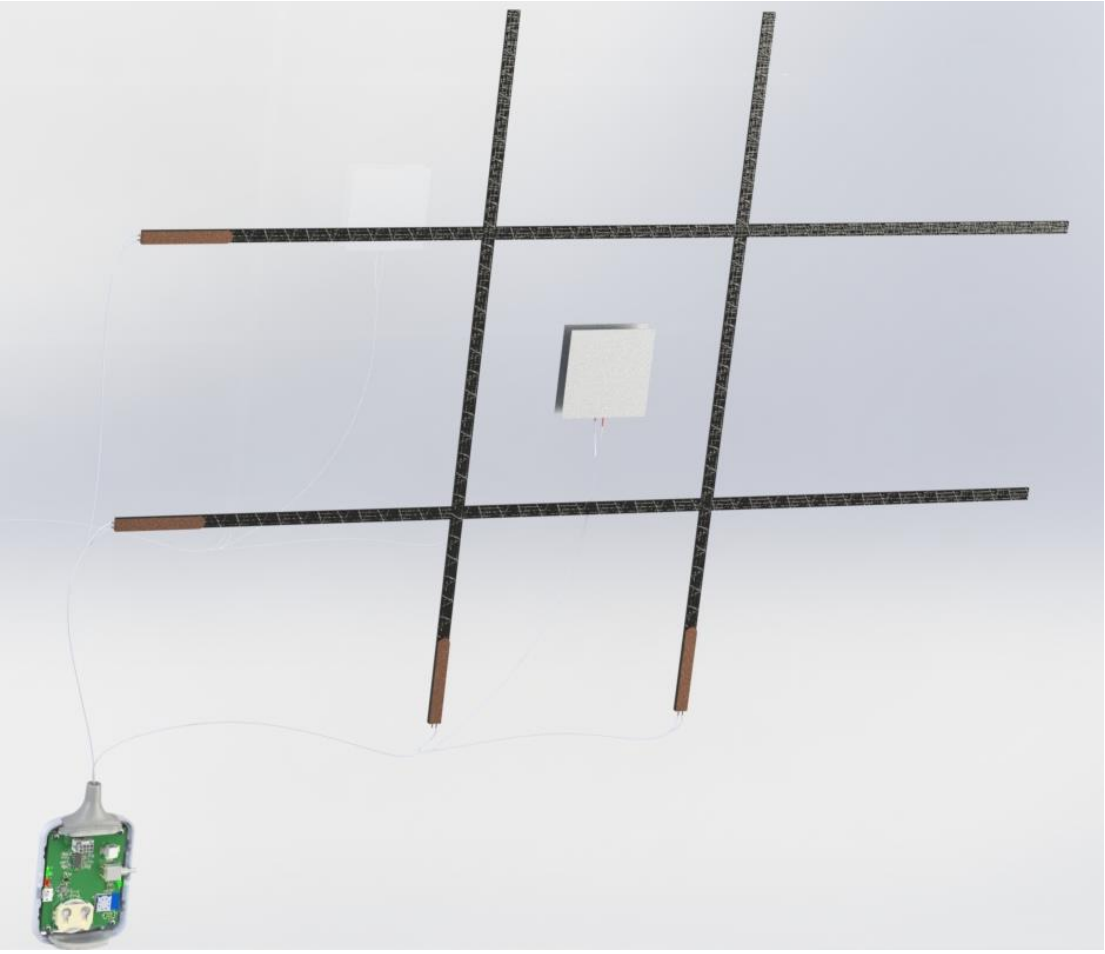
Custom PCB, housed in off-the-shelf enclosure. All parts on the PCB are sourced from Digi-Key.



The PCB has a rechargeable coin cell, USB charging circuit, Bluetooth module with user interface elements, connectors for interfacing with the pressure plate sensors, and four low-pass Sallen-Key filters to help filter user movements from noise. All parts were sourced from DigiKey. The schematic, layout, and BOM are attached to the bottom of the file. Note that this is a non-minimal design. There are elements that could be removed for a final product, which I chose to keep in for the spirit of the competition.

Mechanics

Four bend sensors are arranged in a lattice, with an aluminum switch in the center. These are embedded inside of the foam mat (not pictured). Cables are shown as well.



The mechanical design consists of two parts: the electronics housing and the pressure plate. For the housing an off-the-shelf enclosure was used from OKW enclosures. The part number is in the bill-of-materials at the end of the document. This housing also includes cut-outs for the LEDs, user button, and USB port and a cable gland to hold the wires from the pressure plate in place.

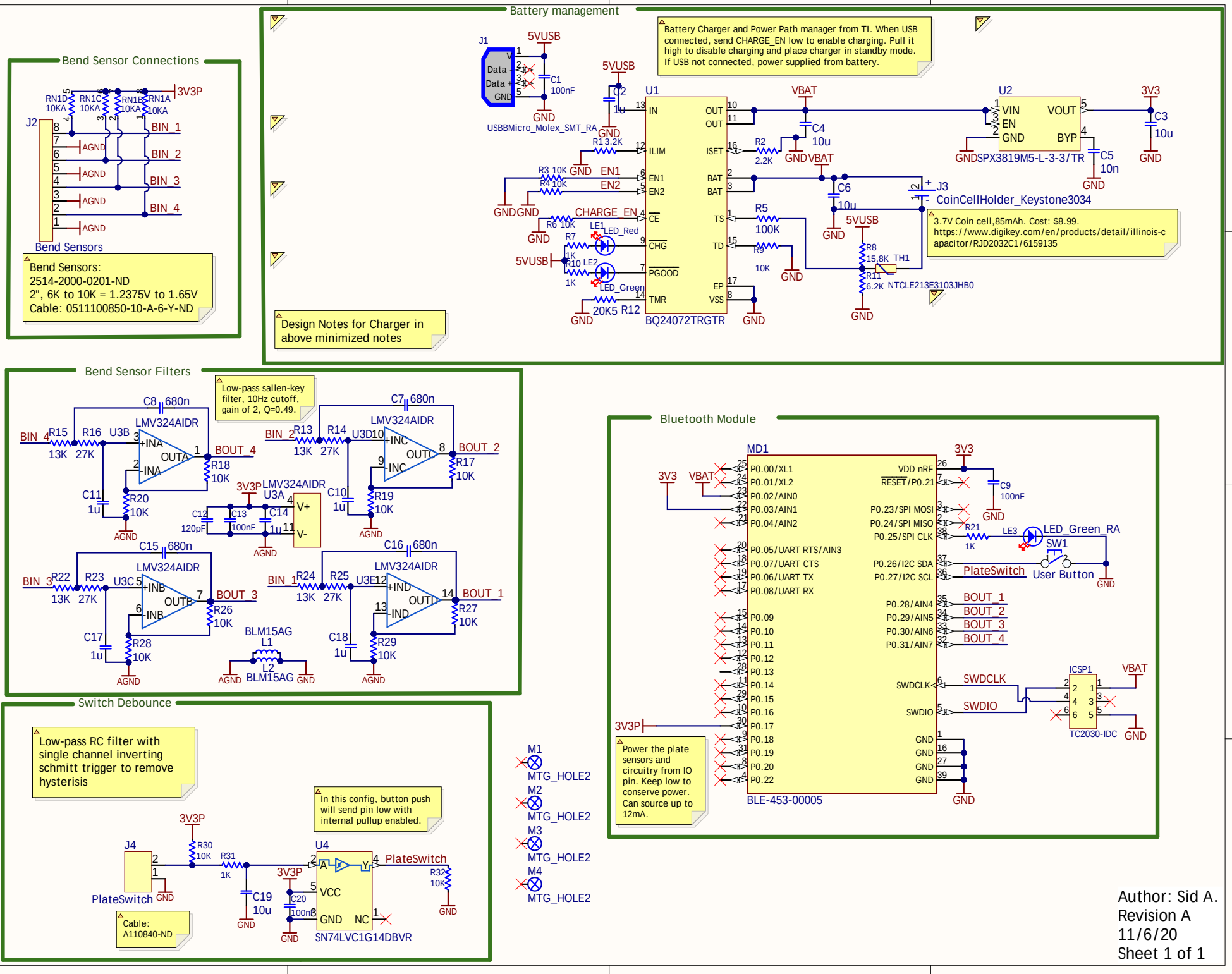
The pressure plate consists of four bend-sensors (sourced from Digi-Key, P/N in BOM at bottom of document), a “switch” made out of two pieces of aluminum

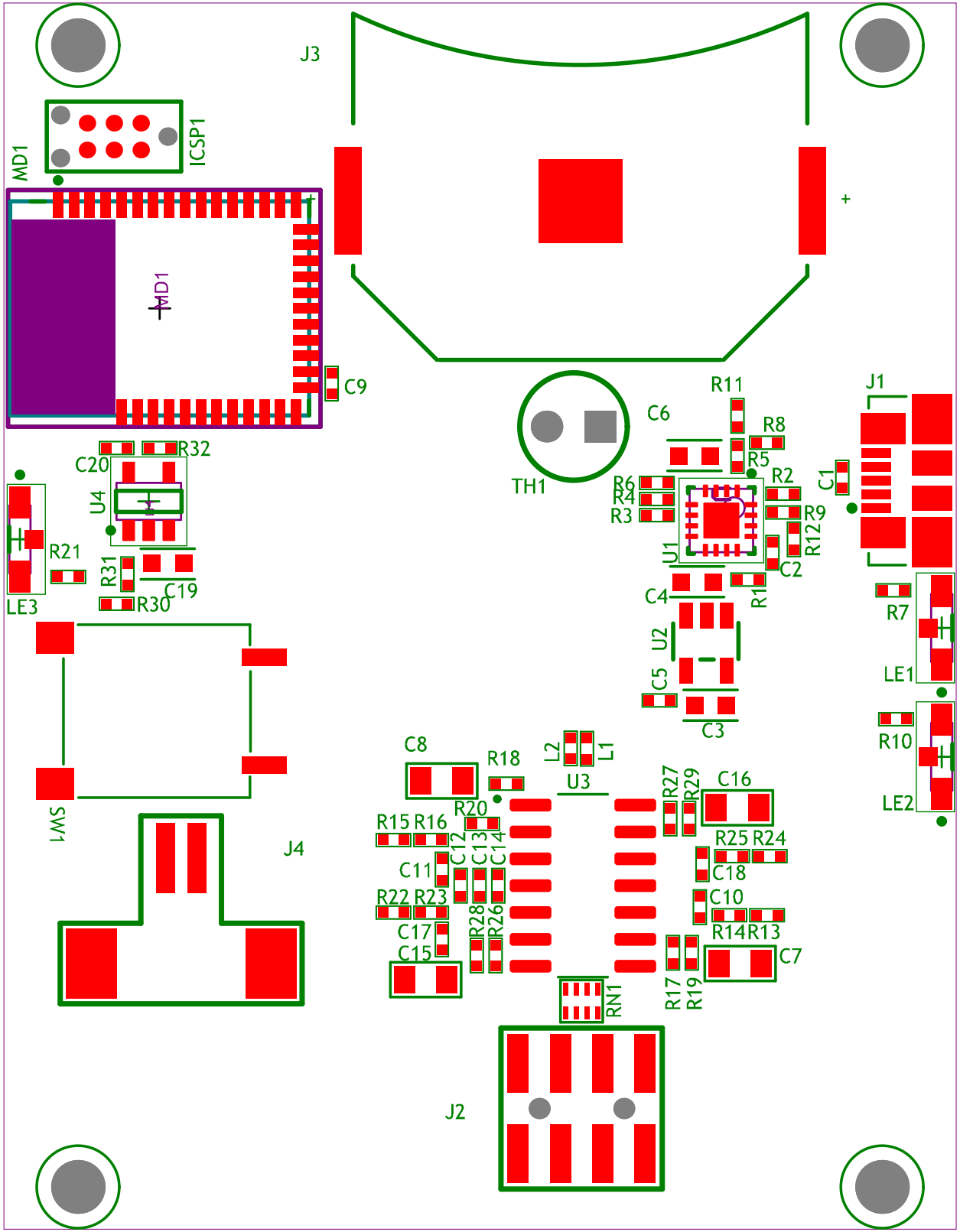
tape, and cables, also sourced from Digi-Key. All of these are embedded in a foam mat that the user steps on. The bend-sensors have fiberglass supports attached to reinforce them.

Only three parts haven't been sourced from Digi-Key, and two of these haven't been sourced at all: the enclosure from OKW, the fiberglass reinforcing the sensors, and the foam mat (last two not sourced).

Firmware/Software

I haven't implemented any of the firmware or software. The idea behind it is that the user would set up the alarm and shut-down sequence on an app. When the alarm goes off, the app would send a wake-up signal to the Bluetooth module in Wakie. This would activate the device which would then wait for the given exercise before sending an ok to the app to shut off the alarm.


Bend Sensor Connections
Bend Sensors:
2514-2000-0201-ND
2", 6K to 10K = 1.2375V to 1.65V
Cable: 0511100850-10-A-6-Y-ND
Battery management
Battery Charger and Power Path manager from TI. When USB connected, send CHARGE_EN low to enable charging. Pull it high to disable charging and place charger in standby mode. If USB not connected, power supplied from battery.
BQ24072TRGTR
SPX3819M5-L-3-3/TR
CoinCellHolder_Keystone3034
3.7V Coin cell,85mAh. Cost: $8.99.
Design Notes for Charger in above minimized notes
Bend Sensor Filters
Low-pass sallen-key filter, 10Hz cutoff, gain of 2, Q=0.49.
Switch Debounce
Low-pass RC filter with single channel inverting schmitt trigger to remove hysterisis
In this config, button push will send pin low with internal pullup enabled.
Cable: A110840-ND
SN74LVC1G14DBVR
Bluetooth Module
BLE-453-00005
Power the plate sensors and circuitry from IO pin. Keep low to conserve power. Can source up to 12mA.
TC2030-IDC
Author: Sid A.
Revision A
11/6/20
Sheet 1 of 1


J3
ICSP1
MD1
MD1
C9
TH1
R11
C6
R8
R5
R6
R4
R3
R2
R9
R12
C2
R1
U1
C4
U2
C5
C3
J1
C1
R7
LE1
R10
LE2
C20
R32
U4
R21
R31
C19
R30
LE3
SW1
J4
C8
R18
L2
L1
U3
R20
R15
R16
C12
C13
C14
C11
R22
R23
C17
C15
R28
R26
R27
R29
C16
R25
R24
C18
C10
R14
R13
C7
R17
R19
RN1
J2

Line #	Name	Description	Designator	Quantity	Manufacturer	MPN	Manufacturer Lifecycle 1	Vendor	VPN	Vendor Unit Price	Supplier Subtotal 1
	USBMicro_Molex_SMT_RA		J1	1	Molex	0473461001	Manual Solution	Digi-Key	WM11228CT-ND	0.83	0.83
	1K	1K 0402 1% resistor.	R7, R10, R21, R31	4	Yageo	RC0402FR-071KL	Volume Production	Digi-Key	311-1.00KLRCT-ND	0.014	0.14
	1u	1uF, X5R, 25V	C2, C10, C11, C14, C17, C18	6	Murata	GRT155R61E105KE01D	Volume Production	Digi-Key	490-12263-6-ND	0.18	1.08
	BQ24072TRGTR	1.5 A USB-Friendly Li-Ion Battery Charger and Power-Path Management IC, 4.3 V, -40 to 85 degC, 16-pin QFN (RGT), Green (RoHS & no Sb/Br)	U1	1	Texas Instruments	BQ24072TRGTR	Volume Production	Digi-Key	296-27328-6-ND	2.21	2.21
	PlateSwitch	1.5 MINI CT SGL H SMT W/O BOSS	J4	1	TE Connectivity	292228-2	Volume Production	Digi-Key	A101007DKR-ND	0.58	0.58
	2.2K	2.2K 0402 1% resistor.	R2	1	Panasonic	ERJ-2RKF2201X	Volume Production	Digi-Key	P2.20KLCT-ND	0.1	0.1
	3.2K	3.5K resistor, 0402, 0.5%	R1	1	Yageo	RT0402DRE073K2L	Volume Production	Digi-Key	311-2283-6-ND	0.17	0.17
	CoinCell_20mm_3.7V_85mAh	3.7V Lilon Rechargable 20mm Coin Cell	BAT1	1	Illinois Capacitor	RJD2032C1	Manual Solution	Digi-Key	1572-1617-ND	8.99	8.99
	6.2K	6.2K ohm 0402 resistor, 1%, 63mW, 50V	R11	1	Yageo	RC0402FR-076K2L	Volume Production	Digi-Key	311-6.20KLRDKR-ND	0.1	0.1
	10K	10K 0402 0.1% resistor.	R17, R18, R19, R20, R26, R27, R28, R29	8	Panasonic	ERA-2AEB103X	Volume Production	Digi-Key	P10KDCCT-ND	0.278	2.78
	10KA	10K, 5% matched resitor array, CTS 741 series	RN1	1	CTS	741C083103JP	Volume Production	Digi-Key	741C083103JPDKR-ND	0.16	0.16
	10n	10n, X7R, 10%, 25V	C5	1	Murata	GCM155R71E103KA37D	Volume Production	Digi-Key	490-6043-6-ND	0.1	0.1
	10u	10u, X5R, 20%	C3, C4, C6, C19	4	TDK	C1608X5R1E106M080AC	Volume Production	Digi-Key	445-9015-1-ND	0.82	3.28
	13K	13K, 0402, 0.1%,1/16W	R13, R15, R22, R24	4	Panasonic	ERA-2APB133X	Volume Production	Digi-Key	P13KCNDKR-ND	0.64	2.56
	15.8K	15.8K 0402 resistor, 1%. 100mW, 50V.	R8	1	Panasonic	ERJ-2RKF1582X	Volume Production	Digi-Key	P15.8KLDKR-ND	0.1	0.1
	20K5	20.5K 0402 resistor, 1%. 100mW, 50V.	R12	1	Yageo	RC0402FR-0720K5L	Volume Production	Digi-Key	YAG3052DKR-ND	0.1	0.1
	27K	27K 0402 0.1% resistor	R14, R16, R23, R25	4	Panasonic	ERA-2AEB273X	Volume Production	Digi-Key	P27KDCDKR-ND	0.39	1.56
	100K	100KOhm 0402 resistor, 1%, 100mW, 50V	R5	1	Panasonic	ERJ-2RKF1003X	Volume Production	Digi-Key	P100KLCT-ND	0.1	0.1
	100nF	100nF, X7R, 10%, 25V	C1, C9, C13, C20	4	TDK	CGA2B3X7R1E104K050BB	Volume Production	Digi-Key	445-6902-1-ND	0.12	0.48
	120pF	120pF, C0G, 5%, 50V	C12	1	Murata	GRM1555C1H121JA01D	Volume Production	Digi-Key	490-1292-6-ND	0.1	0.1
	680n	680n, X8L, 2.5%, 25V	C7, C8, C15, C16	4	KEMET	C0805C684J3NACTU	Volume Production	Digi-Key	399-5769-6-ND	0.46	1.84
	PlateSwitchTape	Aluminum Tape for Switch plate	PLT1	1	3M	1/2-5-3380	Manual Solution	Digi-Key	3M10456-ND	1.84	1.84
	MiniCT_2pos_CustomCable	Custom 2pos MiniCT cable	CC2	1	TE Connectivity	2058706-1	Manual Solution	Digi-Key	A110840-ND	1.35	1.35
	MilliGrid_8pos10"Cable	Custom 8pos MilliGrid Cable	CC1	1	Molex	0511100850-10-A-6-Y	Manual Solution	Digi-Key	0511100850-10-A-6-Y-ND	9.28	9.28
	BLM15AG	Ferrite, 500mA, 120Ohms@100MHz	L1, L2	2	Murata	BLM15AG121SN1D	Volume Production	Digi-Key	490-1005-6-ND	0.1	0.2
	Standard Bend Sensor	FlexPoint Bend Sensor	B1, B2, B3, B4	4	FlexPoint	2000-0201	Manual Solution	Digi-Key	2514-2000-0201-ND	8.73	34.92
	CoinCell Holder_Keystone3034	Holder Battery; Coin Battery; 1 Cell; Tab; 0.787 in. Dia.	J3	1	Keystone Electronics	3034	Volume Production	Digi-Key	36-3034-ND	0.33	0.33
	LED_Green, LED_Green_RA	LED Uni-Color Green, 78 mW, 30 mA, -40 to 85 degC, 3-Pin SMD, RoHS, Tape and Reel	LE2, LE3	2	Broadcom Avago	HSMG-C110	Volume Production	Digi-Key	516-1452-1-ND	0.35	0.7
	LED_Red	LED Uni-Color Red 660nm 2-Pin Chip LED T/R	LE1	1	Broadcom Avago	HSMH-C120	Volume Production	Digi-Key	516-3546-1-ND	0.57	0.57
	LMV324AIDR	LMV324A, Quad Low-Voltage Rail-to-Rail Output Operational Amplifier 14-SOIC -40 to 125	U3	1	Texas Instruments	LMV324AIDR		Digi-Key	296-51365-6-ND	0.42	0.42
	Bend Sensors	MGRID HDR SHRD SMT /LCK/CAP BCKT	J2	1	Molex	0878320826	Volume Production	Digi-Key	WM20536-ND	0.73	0.73
	BLE-453-00005	nRF52810 BLE Module with integrated antenna	MD1	1	Laird - Wireless & Thermal Systems	453-00005		Digi-Key	453-00005DKR-ND	4.99	4.99
	NTCLE213E3103HB0	NTC THERMISTOR 10K OHM 5% BEAD	TH1	1	Vishay BCcomponents	NTCLE213E3103HB0	Volume Production	Digi-Key	BC2960-ND	0.76	0.76
	Enclosure w Accessories	Plastic Enclosure for Electronics	ENC1	1	OKW Enclosures	B2832107	Manual Solution	OKW Enclosures	B2832107	10	10
	10K	Res Thick Film 040210K ohms 1%	R3, R4, R6, R9, R30, R32	6	Panasonic	ERJ-U02F1002X	Volume Production	Digi-Key	10-ERJ-U02F1002XDKR-ND	0.1	0.6
	SPX3819M5-L-3-3/TR	SPX3819 Series 3.3 V 500 mA Fixed Output SMT LDO Regulator SOT-23-5	U2	1	MaxLinear	SPX3819M5-L-3-3/TR		Digi-Key	1016-1873-6-ND	0.5	0.5
	User Button	SWITCH PUSH SPST-NO 0.4VA 20V	SW1	1	ITT C&K	EP11SD1SA1BE	Volume Production	Digi-Key	CKN9465CT-ND	5.71	5.71
	SN74LVC1G14DBVR	TEXAS INSTRUMENTS SN74LVC1G14 DBVR - IC, SCHMITT TRIGGER INVERTER, SMD	U4	1	Texas Instruments	SN74LVC1G14DBVR	Volume Production	Digi-Key	296-11607-1-ND	0.29	0.29