Tode-SD23CF-2W

Hardware Development

Arduino-Mega Pro Mini + Ebyte RF 33db(2W)

by TGit-Tech [http://www.TGit-Tech.com]

Build Version: 23CF / Last Updated: 2024-01-17

This guide covers everything needed to build the Left and/or Middle Units in the below picture.

1. Table of Contents

Table of Contents

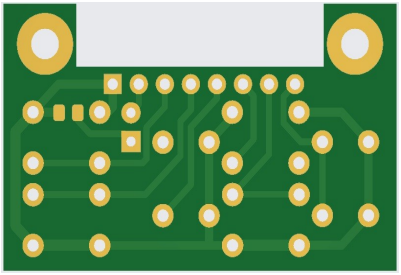
TOTAL TODE-UNIT BOM: $39.48
TOTAL BATTERY TRAY BOM: $ 1.73

2. Top Keypad & Display 231Q

2.1 Bill of Materials (BOM) $4.94

2.1.1 Parts $3.25

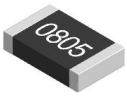
- 1.8 or 1.77 -Inch TFT LCD Color Display
  - Power-In: 5Vdc
  - Resolutions: 128 x 160dpi ST7735 RGB
  - Dimensions: 35mm x 56mm
  - Temp: -20C to 70C
  - (8)Pin-Order: GND,VCC,SCL,SDA,RES,DC,CS,BL
  - Pricing: $3.00/each



- Digital Keypad PCB version 231Q
  - Manufacturer: jlcpcb.com
  - Pricing Each: $0.25
  - Batch Price: $20.93 per 100
  - Zip Folder: JLCPCB-231Q-output

2.1.2 Supplies $1.34

(1) 1x8P Male Pin Header
PCB-J1, Dupont 2.54mm-Pitch
Cut from 40-Pin Male Pin Header
$0.01/pin = $0.08



(1) 47K 0805 SMT Resistors
PCB-R7
$0.01/ea = $0.01

(2) M2x0.4-8 Flat Phillips Machine Screw & Nut
Display & Keypad to Cover
$0.10/pair = $0.20

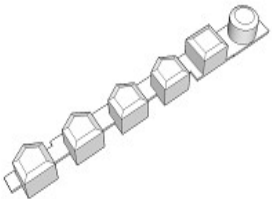
(6) 6x6-7mm Push Buttons
PCB-SW(1-6)
DIP-4 Tacticle Through-Hole
$0.15/ea = $0.90

(1) 3mm Green LED
PCB-D1
$0.05/ea = $0.05

(1) M2x0.04–20mm Machine Screw
Used as *Heating stem ONLY*
$0.10/ea = $0.10

2.1.3 3D-Prints $0.35

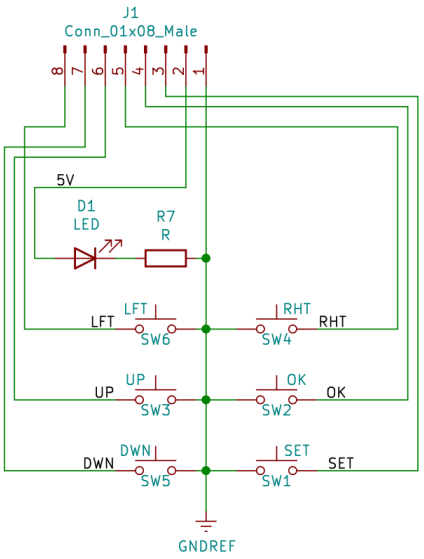
Tode-DispKB-Cover.stl
Folder: ./SD23CF/3DPrints/stl
Layer Height: 0.2mm
Infill Density: 100%
Supports: OFF
Plastic: 14-grams @ $0.02/g = $0.28
Printer-use: @ $0.0015/g = $0.021
Power: 2h 05m @ $0.01/hr = $0.02
TOTAL COST: $0.321



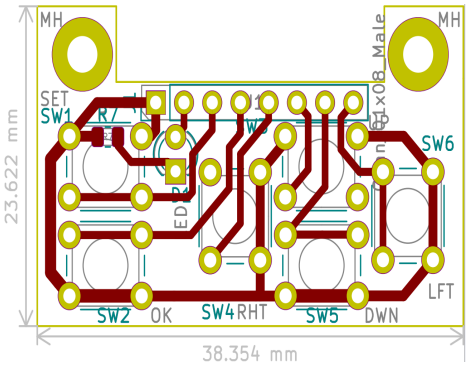
Tode-DispKB-Buttons.stl
Folder: ./SD23CF/3DPrints/stl
Layer Height: 0.1mm (Fine)
Infill Density: 100%
Supports: OFF
Plastic: 1-grams @ $0.02/g = $0.02
Printer-use: @ $0.0015/g = $0.0015
Power: 0h 22m @ $0.01/hr = $0.005
TOTAL COST: $0.0265

2.2 Schematic & Layout

SCHEMATIC



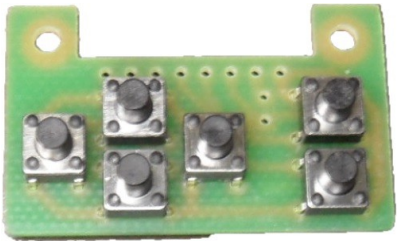
LAYOUT



2.3 PCB Assembly

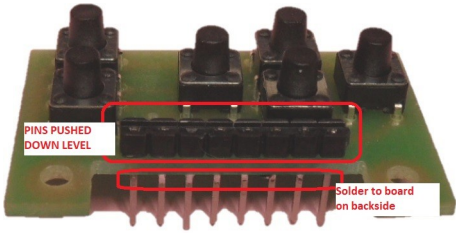
2.3.1 Push buttons

- Push (6) 6x6x7mm Tactile Push buttons into PCB.
- Solder the push buttons to the PCB



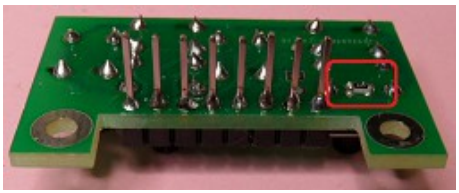
2.3.2 Pin Header

- Cut and Insert a 8P male header
- Push pins down flush with top
- Solder back-side of pins



2.3.3 LED

- Solder a 47K-ohm 0805 SMT resistor
- Insert a 3mm Green LED (do not solder yet)
  - Short-lead in square-pad hole (GND)



2.4 Display Casing

2.4.1 Heated Nuts Insert

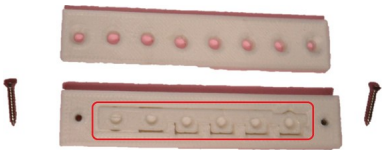
1. Thread a M2 nut onto just the very end of a long M2 Machine Screw (i.e. M2x0.04-20mm).
2. Heat the Nut with a heat gun.
3. Press the heated nut into the plastic as shown aligning the nuts shape with the shape in the casing.
4. Using a screwdriver, press and drive the screw in, to clear excess plastic out the back-side then unscrew completely.
5. Repeat for both nut locations under display opening

2.4.2 Face Decals (Optional)

- This step requires a cutting machine and special materials and design files.

- Contact Tgit-Tech if you'd like to purchase face stickers.
- DIY hobbyists can skip this step to create a unit without custom face stickers.

2.4.3 Drill-out Buttons



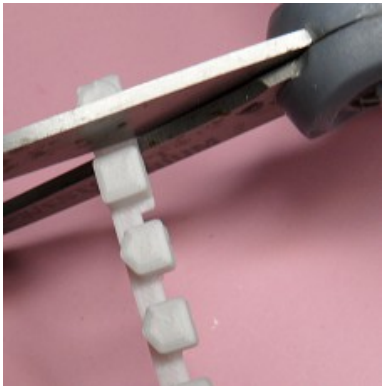
1. 3D-Print the **ButtonDrill-Template.stl** if not already done.
   1.2. Found in Folder: \SD23CF\3DPrints\Tools

2. Insert the Buttons into the Template base and use #4 screws to clamp the buttons with the Top-holes.

3. Use a 3.5mm bit and drill the button holes till the bit makes a slight mark on the depth-bottom of the hole.

4. Push Buttons onto tactile push-button switches as shown.
   4.2. Skinny legged arrow belongs on top

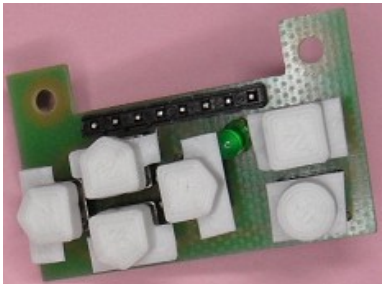
2.4.4 Cut-out Buttons



1. Remove the Buttons from the Drill-Template.

2. Using scissors divide each button separately cutting in the center of each pair.

2.4.5 Mount Buttons

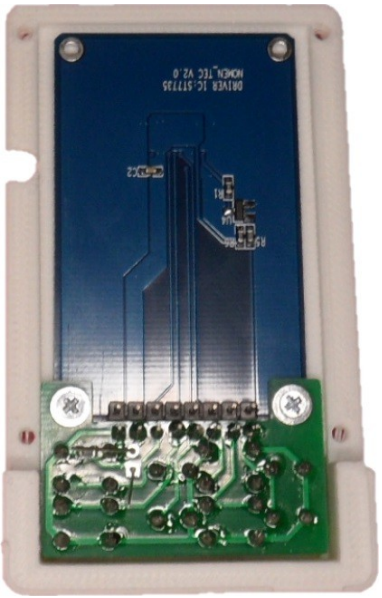


1. Place the arrow button with no top-plastic on UP position.
2. Place the rest of the arrow buttons

3. Square button on right-top.
4. Round button on right-bottom.

2.4.6 Fasten

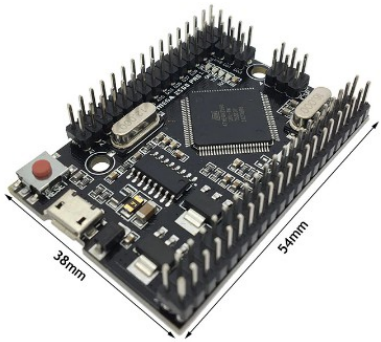
1. Place TFT display face-down on case first.
2. Place Keypad with Buttons over the top and align holes.
3. Fasten with **(2) M2x0.4 – 8mm** machine screws.
4. Align LED with hole in casing.
5. Solder the LED pins and clip excess off.



3. Center Arduino

3.1 Bill of Materials (BOM) $10.15

3.1.1 Parts $9.43



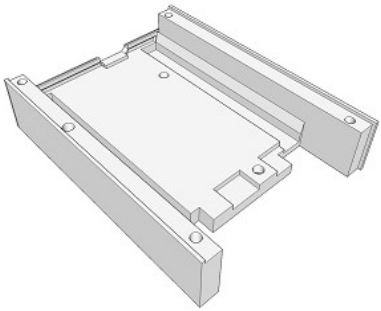
Arduino Mega Pro Mini [ATmega2560]

- Power In: 6Vdc to 9Vdc (Peek 18Vdc)
- Power Out: 5Vdc @ 800mA + 3Vdc @ 800mA
- Load Amps: 5Vdc @ 220mA
- IO-Pins: 54-Digital, 16-Analog
- Memory: 256kb RAM, 4kb EEPROM
- Temp Rng: -40C to 85C
- Pricing: ~ $9.43/each
- Web @ https://robotdyn.com/mega-2560-pro-embed-ch340g-atmega2560-16au.html

3.1.2 Supplies $0.20

(2) M2.5x0.45 x 8mm Phillips-Flat Machine Screw & Nut
Arduino Mega Pro Mini to Casing
$0.20/pair = $0.20

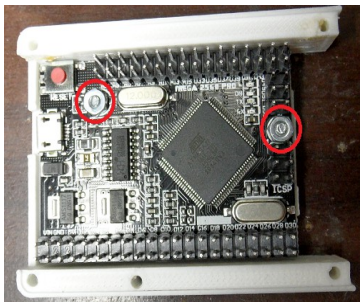
3.1.3 3D Prints $0.52



Tode-Handheld-AMPCenter.stl

17-grams @ $0.02/g = $0.34
2h 30m @ $0.01/hr = $0.025
Printer Use $0.0015/g = $0.0255
Power @ $0.01/hr = $0.125
TOTAL COST: $0.52

3.2 Assembly



3.2.1 Casing

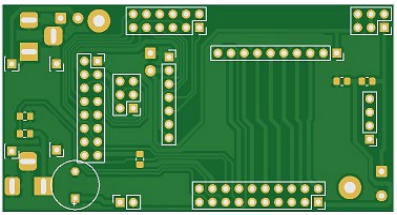
Fasten the Arduino Mega Pro Mini with Male Pin Headers into the 3D Printed case using **(2) M2.5x0.45 – 8mm** flat-head machine screws and nuts on Arduino side.

Be sure not to damage components next to the top nut while tightening.

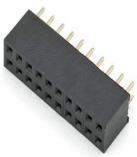
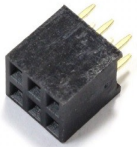
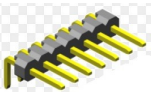
4. Back PCB-SD23F

4.1 Bill of Materials (BOM) $23.16

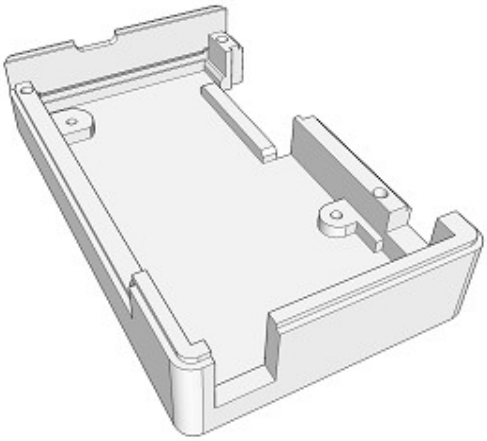
4.1.1 Parts $19.81

	**(1) Ebyte E22-400T33D** • Power In: 3.3Vdc to 5.5Vdc (+ = Damage) • Load Amps: Tx @ 1.2A, Rx @ 15mA • Data Rate: 2.4Kbps to 62.5Kbps • Antenna Plg: SMA-K • Frequency: 410MHz to 493MHz • RF: Tx @ 33dBm, Rx @ -147dBm • Size: 37x60mm • Pricing: ~ $16.00/each • Web @ https://www.ebyte.com
	**(1) SIODKB 23CF PCB (Back-plane)** • File Location: \kicad\JLCPCB-SD23F • Manufacturer: jlcpcb.com • Pricing: $0.37/ea • Batch Price: $183.23 per 500
	**(1) CN3903 DC-DC Buck Step-Down Board 5V@3A** • Input Voltage: 5Vdc to 30Vdc • Output Voltage: 5Vdc • Max Output: 3A • Pricing: $0.44/ea
	**(1) 433M SMA Aerial Antenna** • Various Models may be used ranging from $1 to $5/ea • Price estimate at $3/ea

4.1.2 Supplies $2.75

	**(1) 2x10P Pin Socket** Dupont 2.54mm-Pitch Arduino IO $0.18/ea = $0.18		**(1) 1x10P Pin Socket** Dupont 2.54mm-Pitch Side-IO $0.10/ea = $0.10
	**(1) 2x8P LONG-Lead Socket** Dupont 2.54mm-Pitch Keypad & Display Connect $0.15/ea = $0.15		**(1) 1x2P Pin Socket** Dupont 2.54mm-Pitch PWM & Buzzer connect $0.09/ea = $0.09
	**(1) 2x6P Pin Socket** Dupont 2.54mm-Pitch Radio, Buttons & IO $0.18/ea = $0.18		**(1) 1x4P Pin Header** Dupont 2.54mm-Pitch Radio Ground Stubs $0.01/pin (from 40-pin cut) = $0.04
	**(2) 2x3P Pin Socket** Dupont 2.54mm Pitch ICSP and Power $0.10/ea = $0.20		**(1) 1x7P Right-Angle Pin Header** PCB-J4 | E32 Radio Connection Dupont 2.54mm-Pitch $0.01/pin (from 40-pin cut) = $0.07
	**(1) 5.5x2.1-9mm DC Barrel Jack PCB** Female PCB Mount 3-Terminal $0.08/ea = $0.16		**(1) 9x4.2mm Piezo Buzzer** Optional) | for handheld alarm [0942] Ultra-Thin 2-Lead, 5Vdc, Ultra-Thin $0.50/ea = $0.50
	**(1) 5.5x2.5-9mm DC Barrel Jack PCB** Female PCB Mount 3-Terminal $0.08/ea = $0.16		**22AWG Solid Colored Wire** PCB Power Supply Jumpers (1-inch) Red (1-inch) Black $0.10/ft = $0.02
	**(1) 7P Female Dupont Cable** Female,Female Dupont 15cm Price $0.10/wire = $0.70		**(2) #2-1/4" Screw** PCB to Casing Phillips-Flat Sheet Metal Screw $0.10/each = $0.20

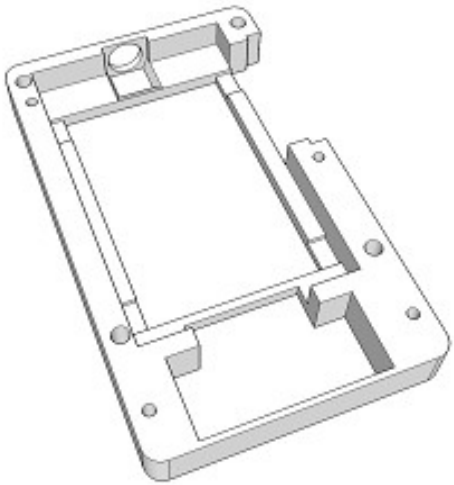
4.1.3 3D-Prints $0.60



Tode-2WBackplane.stl
Folder: ./SD23CF/3DPrints/stl

Layer Height: 0.2mm
Infill Density: 100%
Supports: OFF

Plastic: 14-grams @ $0.02/g = $0.28
Printer-use: @ $0.0015/g = $0.021
Power: 2h 12m @ $0.01/hr = $0.0225
TOTAL COST: $0.3235



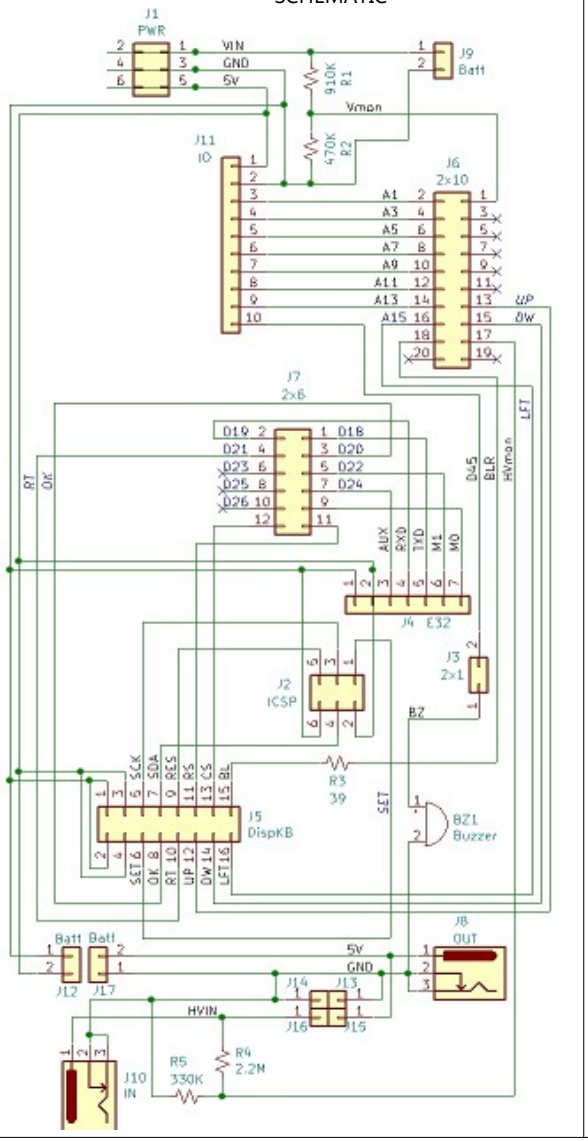
Tode-2WRadioCase.stl
Folder: ./SD23CF/3DPrints/stl

Layer Height: 0.2mm
Infill Density: 100%
Supports: OFF

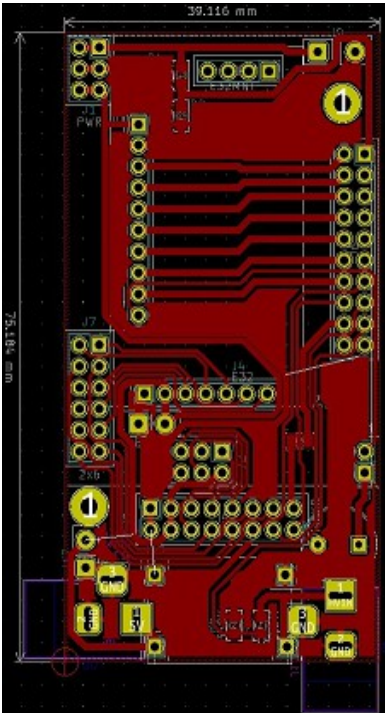
Plastic: 12-grams @ $0.02/g = $0.24
Printer-use: @ $0.0015/g = $0.018
Power: 1h 52m @ $0.01/hr = $0.02
TOTAL COST: $0.278

4.2 Schematic & Layout

SCHEMATIC



LAYOUT

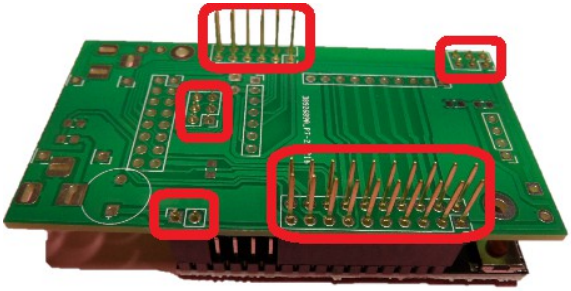


4.3 PCB Assembly

4.3.1 Arduino Sockets

Install Female Pin Sockets as Shown through PCB board.
(2) 2x3P
(1) 2x6P
(1) 2x10P
(1) 1x2P
Plug in Arduino (bottom in pic) for proper pin alignment before Soldering pins.

Refer to Schematic & Layout for specifics.

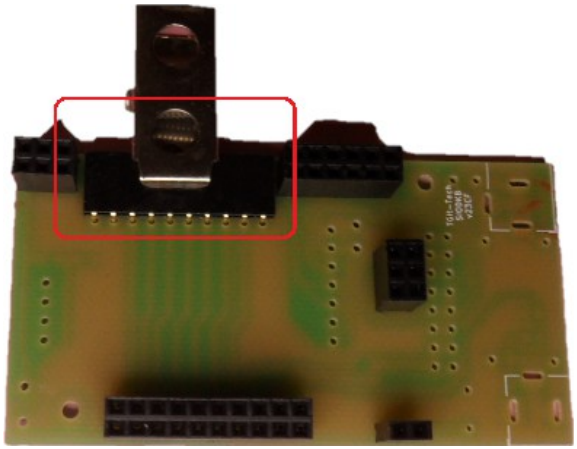


4.3.2 Side IO Socket

Unplug the Arduino Mega Pro from PCB
Press header pins on a flat surface; bend to 90-deg.

(1) 1x10P Female Header w/bent pins
Insert as shown.

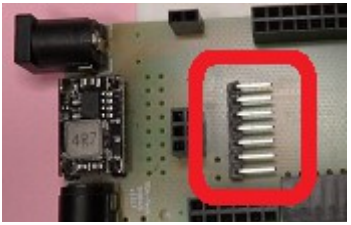
Be sure face is parallel with edge of board
Use a Clip to hold in place while soldering the pins to the PCB.



4.3.3 Radio Header

1. Solder a 7P Right-Angle Male Pin Header where 1W Radio fits.

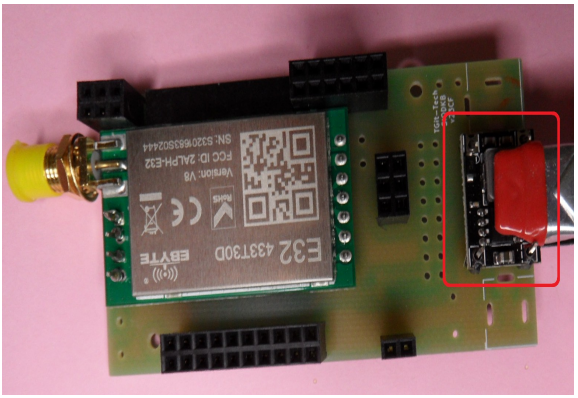
2.



4.3.4 CN3903 Power Supply

Cut (4) Male Dupont Headers and insert into 4-corners of bottom center of PCB.

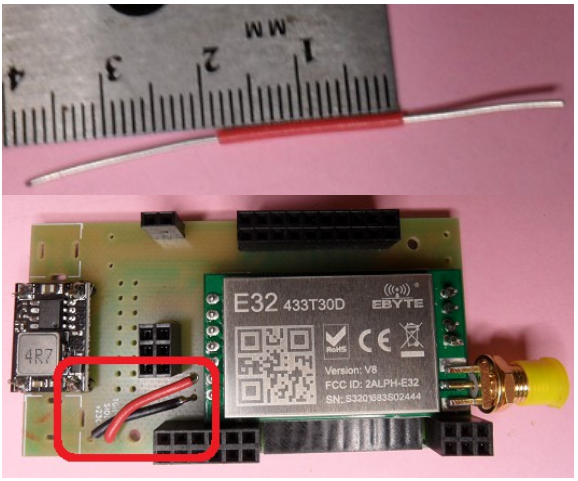
Place the CN3903 Power Supply on pins and clip and solder both sides.



4.3.5 Power Jumper Wires

Cut (1) Black and (1) Red solid 22awg solid wire and strip off both ends leaving 18mm of insulation.

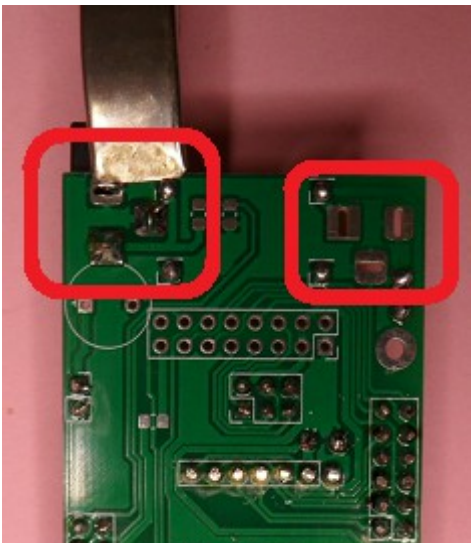
Insert the wires as shown in the picture, solder and clip excess wire;



4.3.6 DC Barrel Jacks

1. Align and solder (1) 5.5x2.1mm Barrel Jack pointing down.

2. Align and solder (1) 5.5x2.5 Barrel Jack pointing to the side.

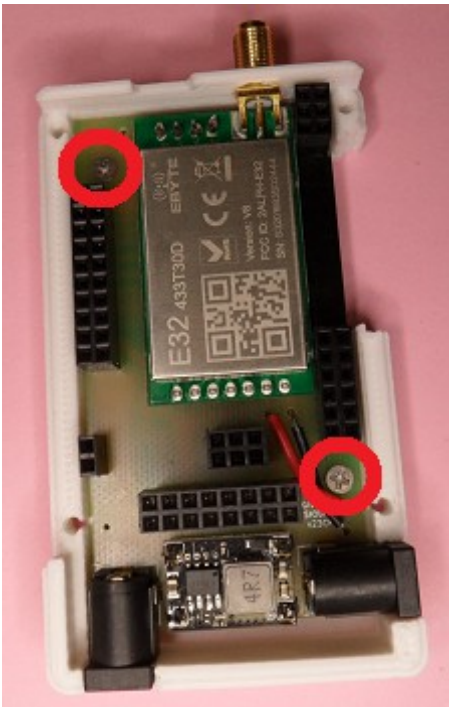


4.3.7 Buzzer (Optional)

On units used for hand remotes a buzzer for alarms can be attached in the circle part of the PCB.

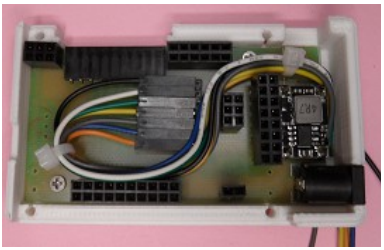
4.3.8 Casing

Place PCB inside case as shown and use #2-1/4 screws to secure.



4.3.9 Radio Connections

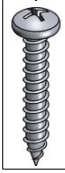
Connect 15cm F/F dupont wires and route through bottom casing hole. As shown.



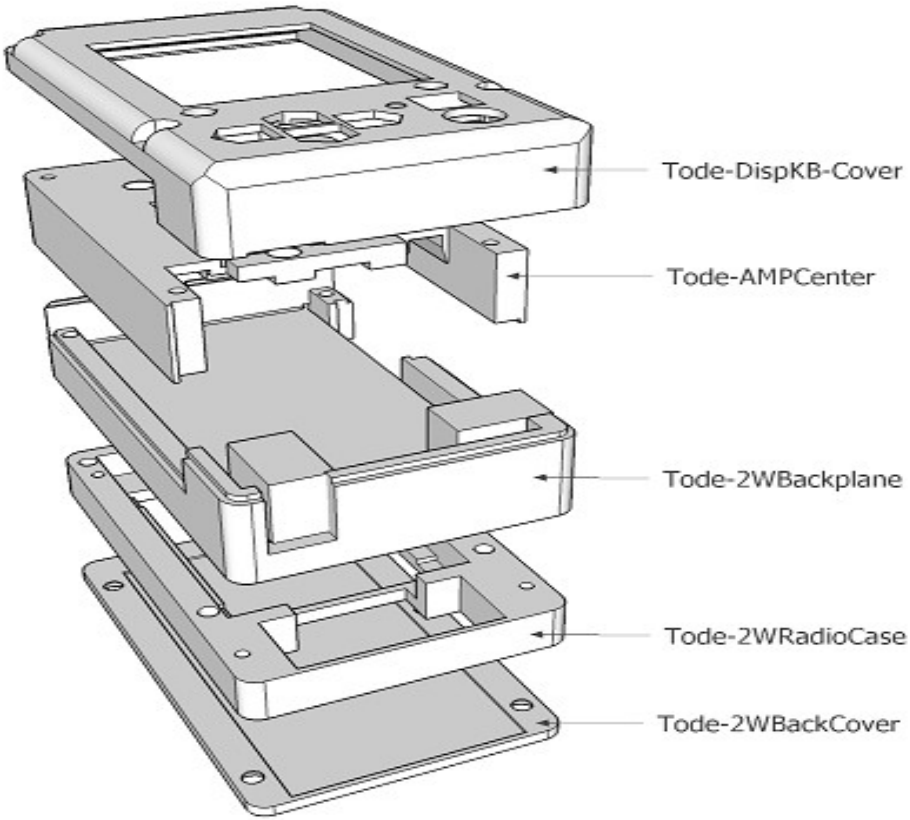
5. Final Assembly

5.1 Bill of Materials (BOM) $1.23

5.1.1 Supplies $1.23

	**(4) #2 - 3/4" Screw** Radio-Casing to Back-plane Phillips-Pan Sheet Metal Screw Sheet Metal Screw Price $0.10/ea = $0.40		**(4) #2 - 3/8" Screw** Cover to Center-Arduino Phillips-Flat Sheet Metal Screw Sheet Metal Screw Price $0.10/ea = $0.40
	**(4) #2 x 3/8" Screws** Phillips-Pan Sheet Metal Screw $0.10/ea = $0.40		Aluminum Foil Approximately 1/2sqft $0.06/sqft = $0.03

5.2 Diagram

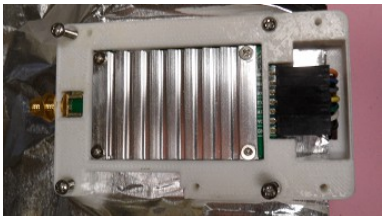


5.3 Assembly

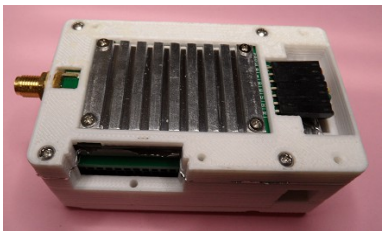
1. Bend pins to point down from module
2. Install Module in Casing

1. With antenna nut loosened and bottom of radio module pushed slightly out of it's casing; attach 15cm F/F dupont wires in correct order on Radio Module.

1. Put cooking aluminum foil on Backplane casing then radio on top.
2. Using **(4) #2-3/4" Phillips-Pan screws** tighten the Radio onto the Backplane casing.

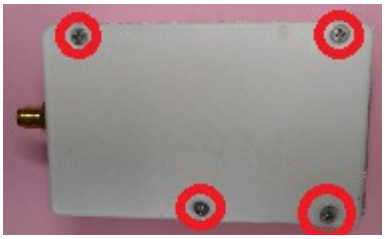


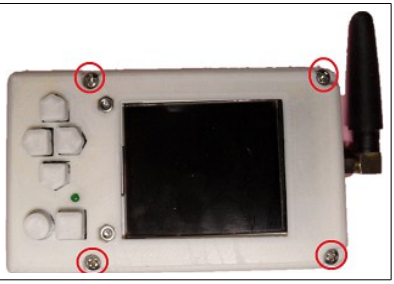
1. Using X-O knife trim the aluminum foil to the edge of the casing.



1. Add another piece of cooking aluminum foil to the backside of the Radio Module

1. Using **(4) #2-3/8" Phillips-Flat Screws** tighten the Back-Cover and trim excess aluminum foil using a knife.



1. Using **(4) #2-3/8 Phillips-Pan Screws** tighten the Display Casing to the Top.	

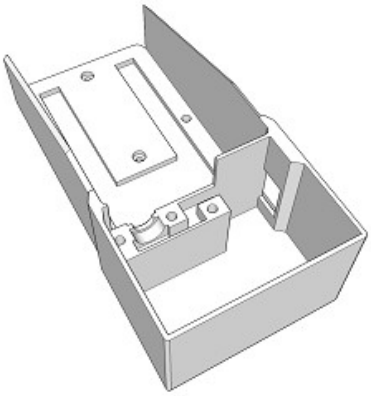
6. Battery Tray

6.1 Bill of Materials (BOM) $3.01

6.1.1 Supplies $1.91

	**(1) 5.5x2.1mm Barrel Plug** 9mm Insert (!NO Longer!) $0.11/ea = $0.11		**(2) 9V Battery Clip** Hard Plastic Side-Exit Wires $0.35/ea = $0.70
	**(2) #4 x 3/4" Screws** Phillips-Pan Sheet Metal Screw $0.10/ea = $0.20		**(1) KCD11 3A Rocker Switch** SPST 10x15mm $0.10/ea = $0.10
	**(1) #4 x 3/8" Screw** Phillips-Flat Sheet Metal Screw $0.10/ea = $0.10		**(Optional) Belt Clip** 2-Inch Metal Spring Clamp $0.30/ea = $0.30
	**(2) #2-56 - 5/16" Screw** Belt Clamp Phillips-Pan Machine Screw $0.10/ea = $0.20		**(2) #2-56 Nylon Lock Nut** Belt Clamp $0.10/ea = $0.20

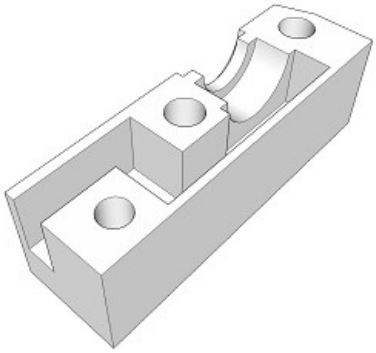
6.1.2 3D-Prints $1.10



Tode-2WBattTray.stl
Folder: ./SD23CF/3DPrints/2WBatteryPack/stl

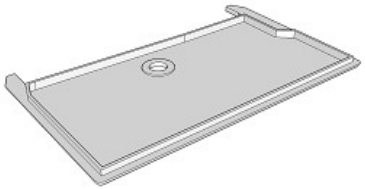
Layer Height: 0.2mm
Infill Density: 100%
Supports: OFF

Plastic: 41-grams @ $0.02/g = $0.82
Printer-use: @ $0.0015/g = $0.0615
Power: 5h 35m @ $0.01/hr = $0.055
TOTAL COST: $0.9365



Tode-2WBattClamp.stl
Folder: ./SD23CF/3DPrints/2WBatteryPack/stl

Layer Height: 0.2mm
Infill Density: 100%
Supports: OFF
Plastic: 3-grams @ $0.02/g = $0.06
Printer-use: @ $0.0015/g = $0.0045
Power: 0h 33m @ $0.01/hr = $0.005
TOTAL COST: $0.0695

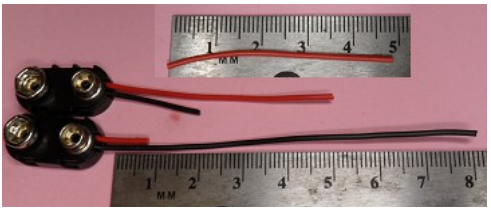


Tode-2WBattCover.stl
Folder: ./SD23CF/3DPrints/1WBatteryPack/stl
Layer Height: 0.2mm
Infill Density: 100%
Supports: OFF
Plastic: 4-grams @ $0.02/g = $0.08
Printer-use: @ $0.0015/g = $0.006
Power: 0h 29m @ $0.01/hr = $0.005
TOTAL COST: $0.091

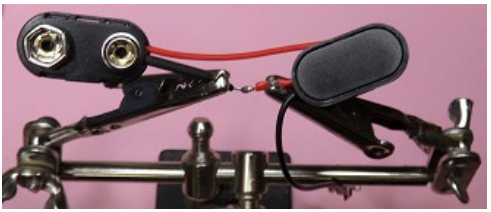
6.2 Assembly

Prepare (2) 9V Battery Clips

1. Cut wires on **1st** Battery Clip
   1.2. Red wire at 50mm long
   1.3. Black wire at 20mm long
2. Cut wires on **2nd** Battery Clip
   2.2. Red wire at 10mm long
   2.3. Black wire at 80mm long
3. Cut a piece of Red Wire 50mm long.



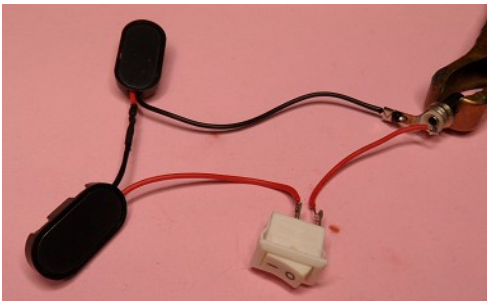
Slide heat-shrink onto 1st Battery Clip's Black wire (cut at 20mm) and solder to 2nd Battery Clip's Red wire. Slide heat-shrink into place and heat.



Cut a 50mm Red Wire and solder it from the rocker switch to the barrel plug short center lead.

Solder #2 Clip Black (80mm) wire to the barrel plug long outer-shell lead.

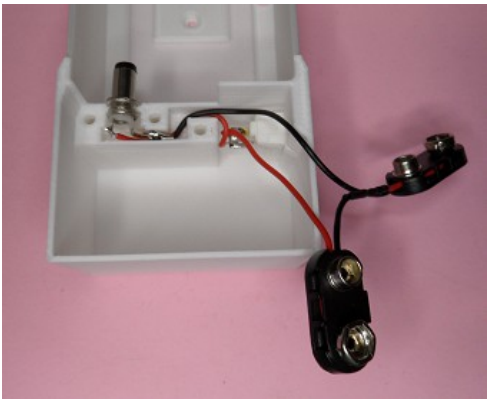
Solder #1 Clip Red (50mm) to the rocker switch center pin.



Stuff the Battery Clips and Barrel Plug in through the switch hole of the casing.

Put the Barrel plug in the casing spot and route the wires as shown in the picture

Push the rocker switch into it's hole putting the ON position in the center and OFF position to the back-edge.



Using **(2) #4 – ¾ inch long Phillips-Flat** screws attach the Clamp over the Barrel Plug and Tighten.

Insert (2) 9V Batteries one on top of the other and tuck the wires in the hole to the left of the switch.

Using **(1) #4 – 3/8** inch long Phillips-Flat screw attach the Cover.