Tode-SD23CF-1W

Hardware Development

Arduino-Mega Pro Mini + Ebyte RF 30db(1W)

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.

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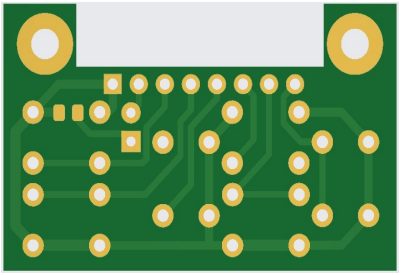
TOTAL TODE-UNIT BOM: $39.48
TOTAL BATTERY TRAY BOM: $ 1.73

2. Top Keypad & Display 231Q

2.1 Bill of Materials (BOM) $7

2.1.1 Parts $3.25

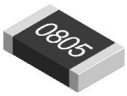
- 1.8 or 1.77 -Inch TFT LCD Display
  - Power-In: 5Vdc
  - Resolutions: 128 x 160dpi ST7735 RGB
  - Dimensions: 35mm x 56mm
  - Temp: -20C to 70C
  - (8)Pin-Order: GND,VCC,SCL,SDA,RES,DC,CS,BL
  - Pricing: $3.00/each



- 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 $1.74

(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

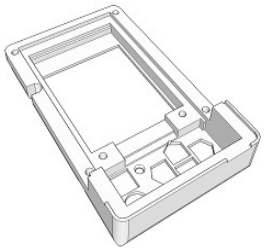
(2) M2x0.4-8 Flat Phillips Machine Screw & Nut
Display & Keypad to Cover
$0.10/pair = $0.20

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

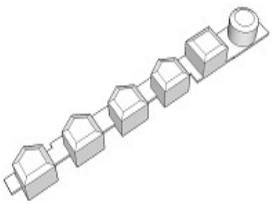
(1) 3mm Green LED
PCB-D1
$0.05/ea = $0.05

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

2.1.3 3D-Prints $0.32



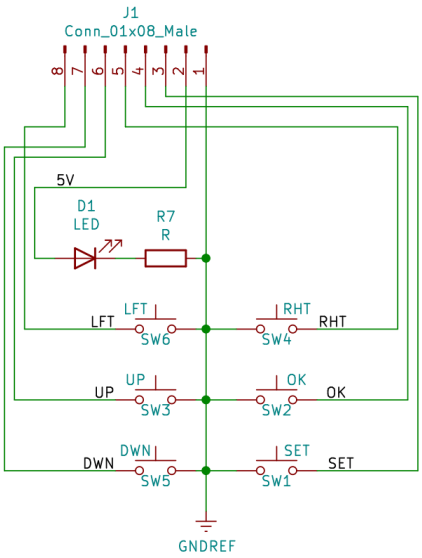
Tode-DispKB-Cover.stl
Folder: ./SD23CF/3DPrints/stl
Layer Height: 0.2mm
Infill Density: 100%
Supports: OFF
Plastic: 14-grams @ $0.02/g = $0.28
Printer-use: @ $0.0015/g = $0.021
Power: 2h 05m @ $0.01/hr = $0.02
TOTAL COST: $0.321



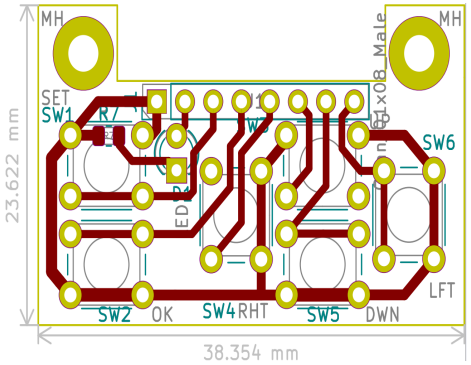
Tode-DispKB-Buttons.stl
Folder: ./SD23CF/3DPrints/stl
Layer Height: 0.1mm (Fine)
Infill Density: 100%
Supports: OFF
Plastic: 1-grams @ $0.02/g = $0.02
Printer-use: @ $0.0015/g = $0.0015
Power: 0h 22m @ $0.01/hr = $0.005
TOTAL COST: $0.0265

2.2 Schematic & Layout

SCHEMATIC



LAYOUT

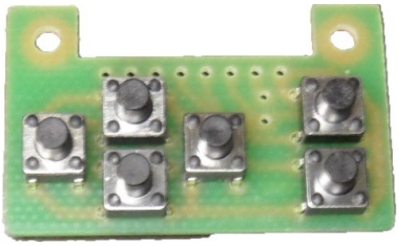


D1 = 3mm Round Green LED
R7 = 47Kohm 0805 SMT Resitor
- 5V/47K = 0.1mA LED current.
SW(1–6) = 6x6x7mm Tactical Switches

2.3 PCB Assembly

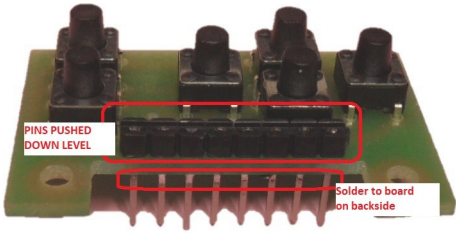
2.3.1 Push buttons

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



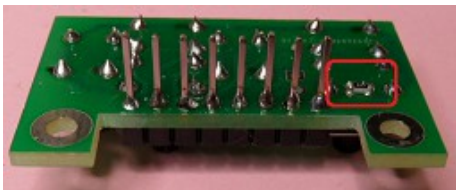
2.3.2 Pin Header

- 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 Casing Assembly

2.4.1 Heated Nuts Insert

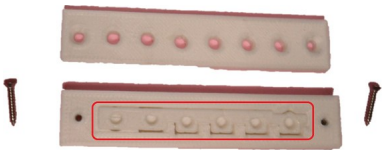
1. Thread a M2 nut onto just the very end of a long M2 Machine Screw (i.e. M2x0.04-20mm).
2. Heat the Nut with a heat gun.
3. Press the heated nut into the plastic as shown aligning the nuts shape with the shape in the casing.
4. Using a screwdriver, press and drive the screw in, to clear excess plastic 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



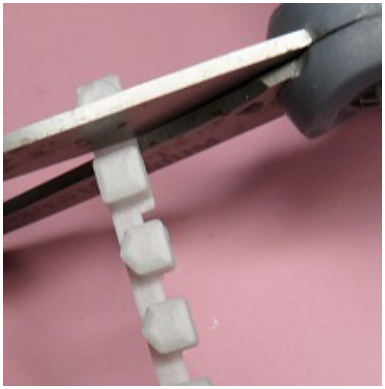
1. 3D-Print the **ButtonDrill-Template.stl** if not already done.
   1.2. Found in Folder: \SD23CF\3DPrints\Tools

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

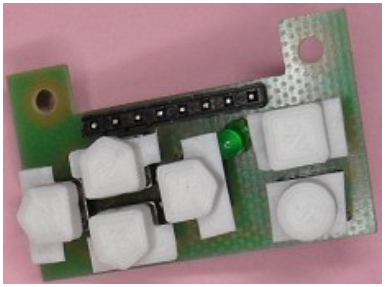
2.4.4 Cut-out Buttons



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

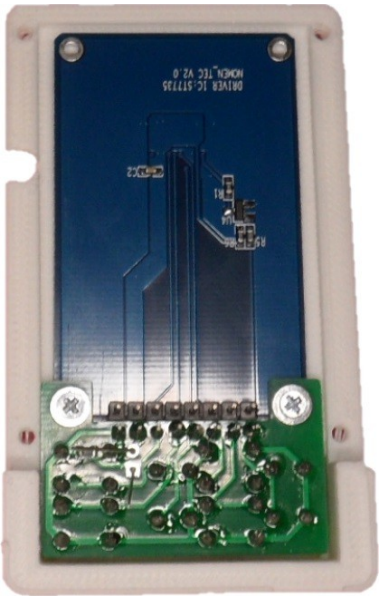


1. Place the arrow button with no top-plastic on UP position.
2. Place the rest of the arrow buttons

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

2.4.6 Fasten

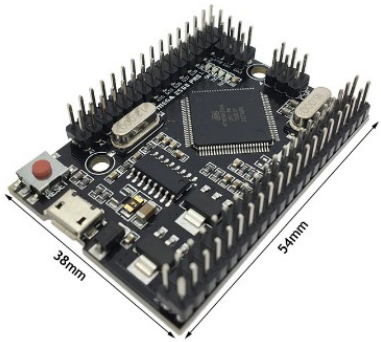
1. Place TFT display face-down on case first.
2. Place Keypad with Buttons over the top and align holes.
3. Fasten with **(2) M2x0.4 – 8mm** machine screws.
4. Align LED with hole in casing.
5. Solder the LED pins and clip excess off.



3. Center Arduino

3.1 Bill of Materials (BOM) $10.15

3.1.1 Parts $9.43



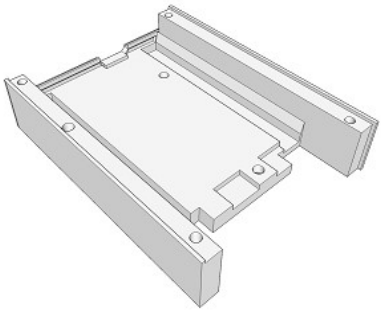
Arduino Mega Pro Mini [ATmega2560]

- 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

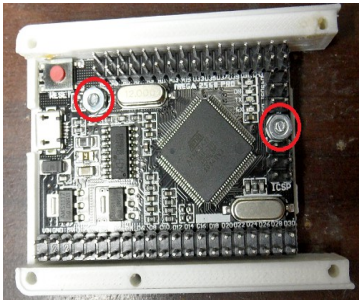
3.1.3 3D Prints $0.52



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 Casing Assembly



3.2.1 Casing

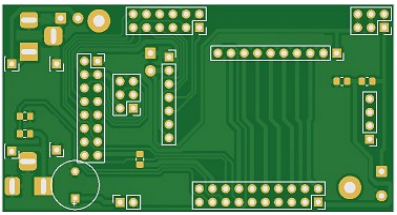
Fasten the Arduino Mega Pro Mini with Male Pin Headers into the 3D Printed case using **(2) M2.5x0.45 – 8mm** flat-head machine screws and nuts on Arduino side.

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

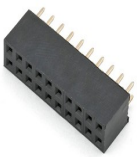
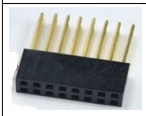
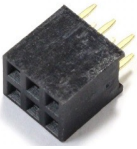
4. Back PCB-SD23F

4.1 Bill of Materials (BOM) $26

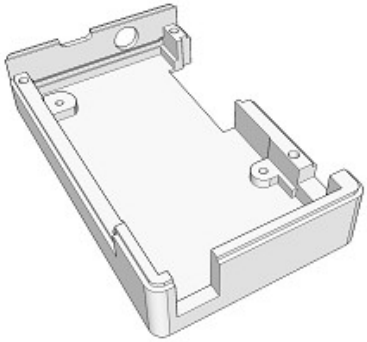
4.1.1 Parts $22.55

	**(1) Ebyte E32433T30D** (V8 is not reverse compatible) • Power In: 3.3Vdc to 5.2Vdc (+ = Damage) • Load Amps: Tx @ 106mA, Rx @ 15mA • Data Rate: 0.3Kbps to 19.2Kbps • Antenna Plg: SMA-K • Frequency: 410MHz to 441MHz • RF: Tx @ 30dBm, Rx @ -147dBm • Pricing: ~ $9.31/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 $2.85

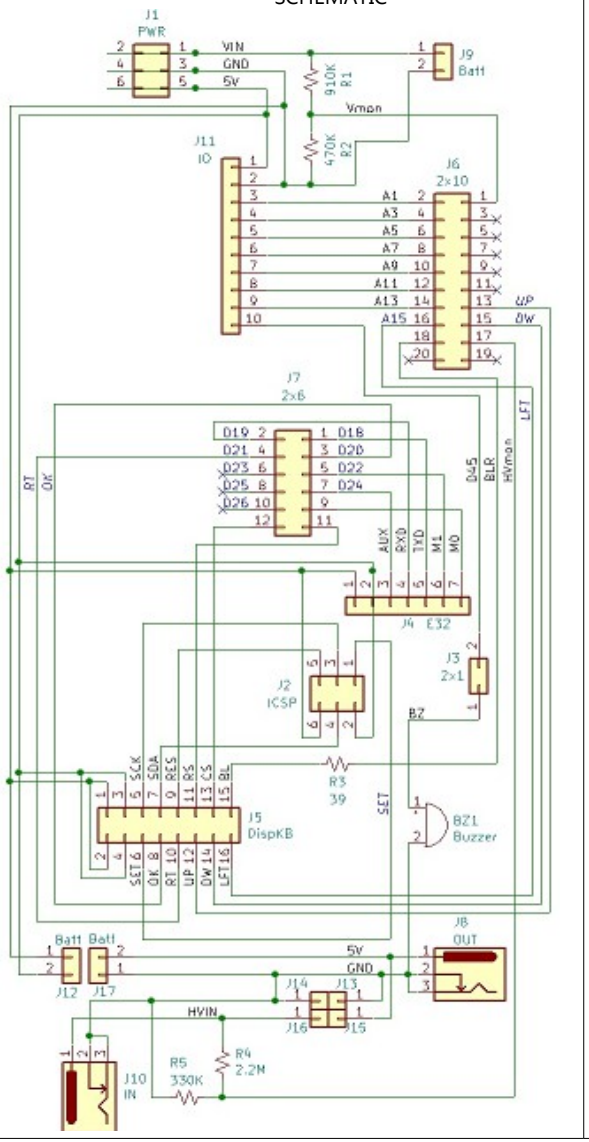
	**(1) 2x10P Pin Socket** Dupont 2.54mm-Pitch Arduino IO $0.18/ea = $0.18		**(1) 1x10P Pin Socket** Dupont 2.54mm-Pitch Side-IO $0.10/ea = $0.10
	**(1) 2x8P LONG-Lead Socket** Dupont 2.54mm-Pitch Keypad & Display Connect $0.15/ea = $0.15		**(1) 1x2P Pin Socket** Dupont 2.54mm-Pitch PWM & Buzzer connect $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) 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
	**(2) #2-1/4" Screw** PCB to Casing Phillips-Flat Sheet Metal Screw $0.10/each = $0.20		**22AWG Solid Colored Wire** PCB Power Supply Jumpers (1-inch) Red (1-inch) Black $0.10/ft = $0.02

4.1.3 3D-Prints $0.91

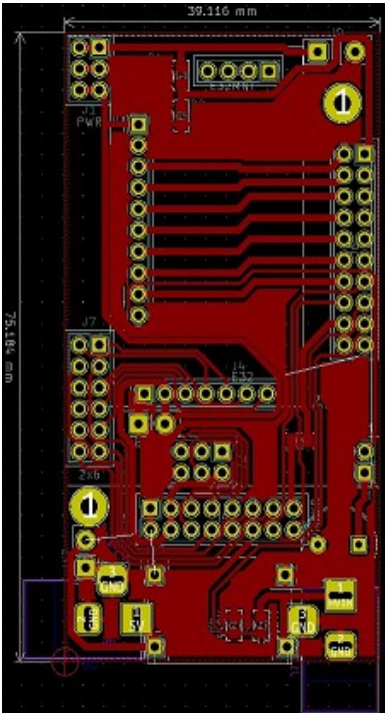
	**Tode-1WBackplane.stl** Folder: ./3DPrints/ 24-grams @ $0.02/g = $0.048 4h 50m @ $0.01/hr = $0.03 Printer Use $0.0015/g = $0.04 Power @ $0.01/hr = $0.05 TOTAL COST: $0.17

4.2 Schematic & Layout

SCHEMATIC



LAYOUT



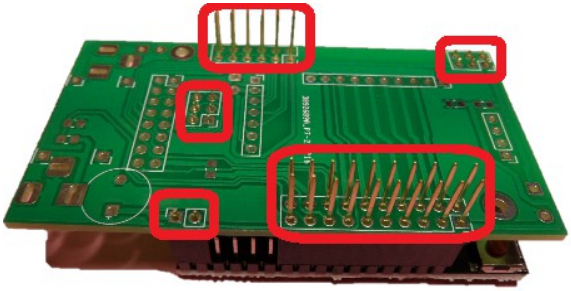
J1 – Arduino PWR – 2x3P Socket
J2 – Arduino ICSP – 2x3P Socket
J3 - D

4.3 PCB Assembly

4.3.1 Arduino Sockets

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

Refer to Shematic & Layout for specifics.

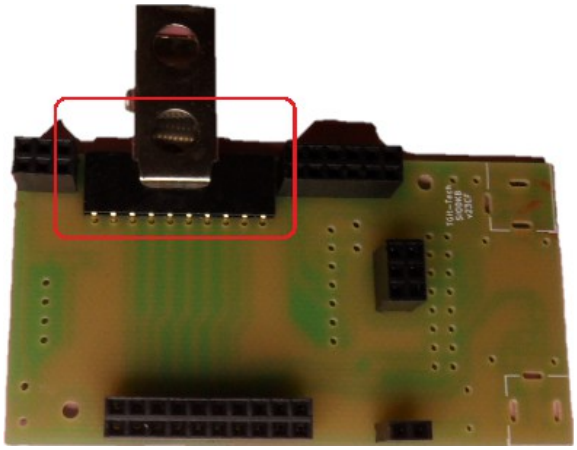


4.3.2 Side IO Socket

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.



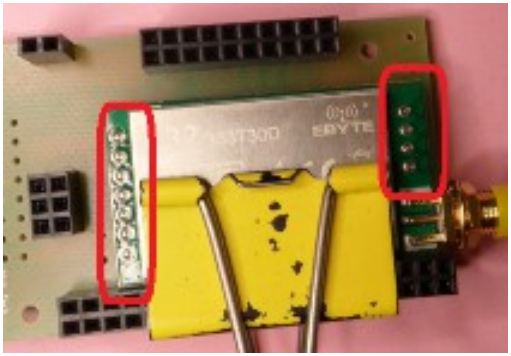
4.3.3 Radio

Solder the Ebyte E32 Radio to the PCB

1. Cut a 4P Male Header and Insert at the top for alignment
   a) The red circle in the picture

2. Insert Ebyte E32 RF Module into the AMPE32T30 PCB (as shown)

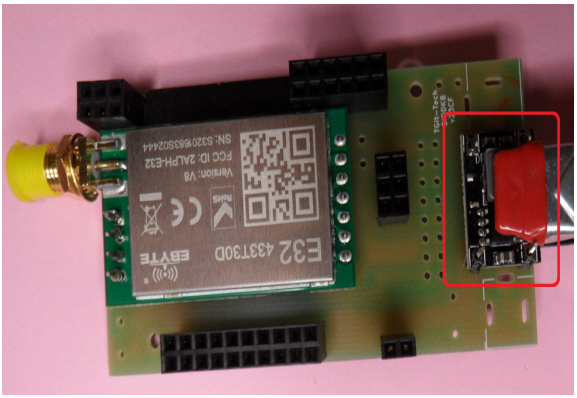
3. Solder Pins that attach to the PCB



4.3.4 CN3903 Power Supply

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

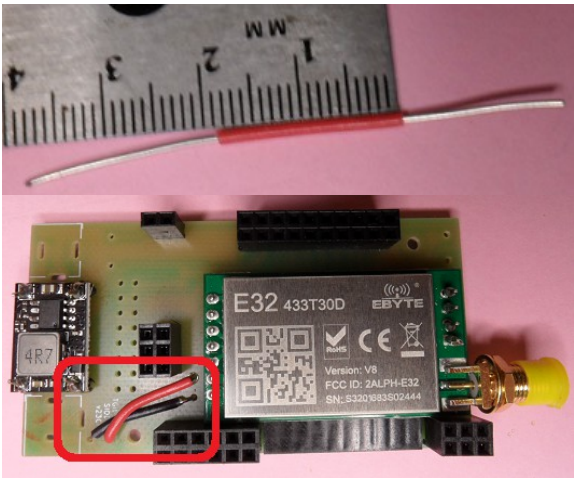
Place the CN3903 Power Supply on pins and clip and solder both sides.



4.3.5 Power Jumper Wires

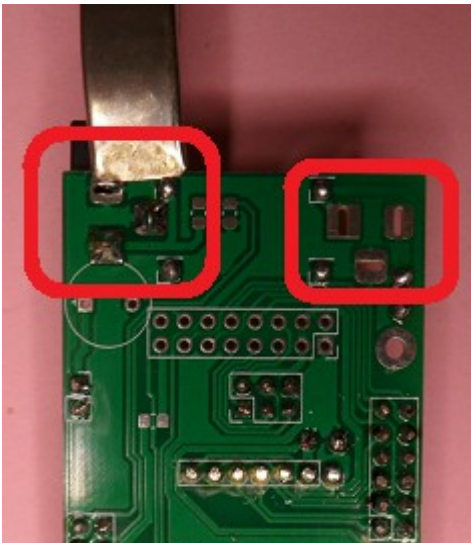
Cut (1) Black and (1) Red solid 22awg solid wire and strip off both ends leaving 18mm of insulation.

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



4.3.6 DC Barrel Jacks

Align and solder (1) Barrel Jack pointing down and (1) Barrel Jack pointing to the side.

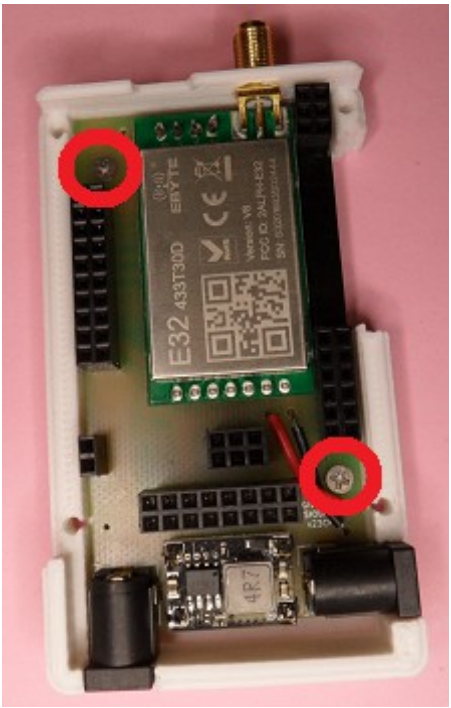


4.3.7 Buzzer (Optional)

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

4.3.8 Casing

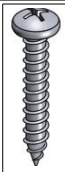
Place PCB inside case as shown and use #2-1/4 screws to secure.



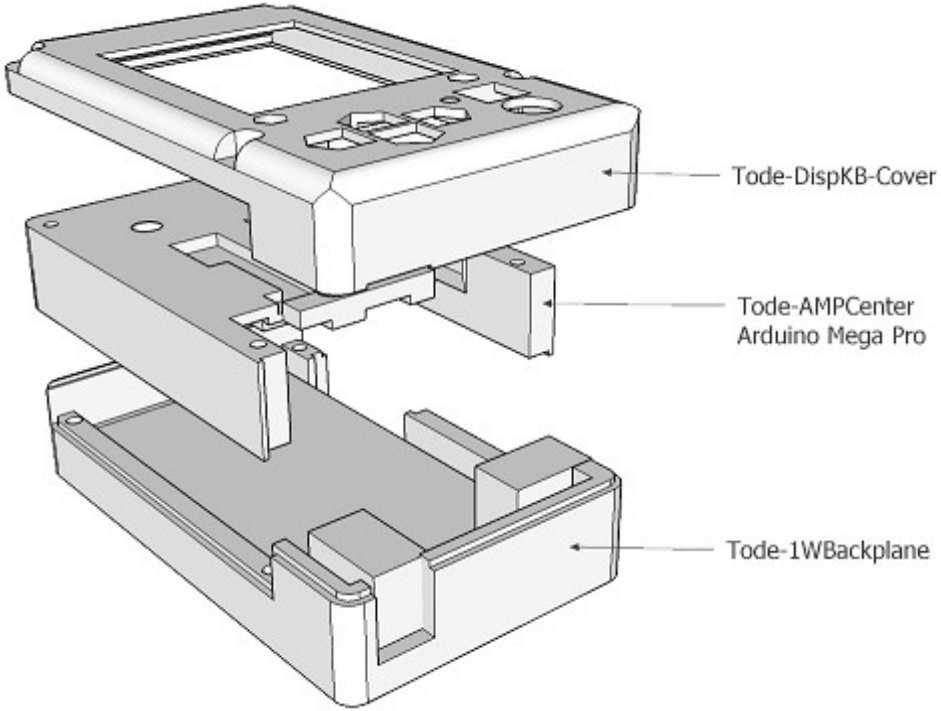
5. Final Assembly

5.1 Bill of Materials (BOM) $1.23

5.1.1 Supplies $1.23

	**(4) #2 x 3/8" Screws** Display to Center Phillips-Pan Sheet Metal Screw $0.10/ea = $0.40		Aluminum Foil Approximately 1/2sqft $0.06/sqft = $0.03
	**(4) #2 x 1/2" Screw** Backplane to Center Phillips-Flat Sheet Metal Screw Sheet Metal Screw Price $0.06/ea = $0.24		**2-Inch Clear Packing Tape** Aluminum Foil Insulation

5.2 Diagram


Tode-DispKB-Cover
Tode-AMPCenter
Arduino Mega Pro
Tode-1WBackplane

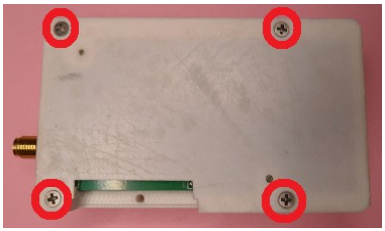
5.3 Casing Assembly

5.3.1 Radio Foil

1. Cut a rectangle of **Aluminum Foil 27mm x 48mm**.
2. Cut a section of **2-Inch Clear Packing Tape** at least 100mm long.
3. Place the rectangle of Aluminum Foil on the sticky-side bottom end of the 2-Inch Packing Tape.
4. Wrap the tape completely around the Aluminum Foil
5. Cut/Trim the Tape edge a hair away from the Aluminum edge to prevent any aluminum exposure.
6. Place the tape-insulated aluminum foil over the Ebyte Radio as shown to prevent High-Power transmits from causing Arduino reboots.

5.3.2 Back-side Fasteners

7. Plug the AMP (Arduino Mega Pro) Center to the 1W-Backplane assuring correct pin alignment.
8. Using **(4) #2-1/2" Phillips-Flat Screws** fasten the Backplane (back-side) to AMPCenter.



5.3.3 Display Fasteners

9. Plug the DispKB into the (front-side) Backplane assuring correct pin alignment and casing alignment with Center.
10. Using **(4) #2-3/8 Phillips-Pan Screws** fasten the Display Casing to the Top.

5.3.4 Antenna

Attach an antenna to the SMA-K connector.

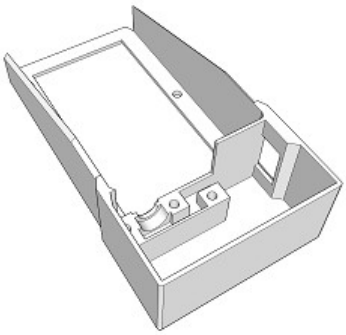
6. Battery Tray

6.1 Bill of Materials (BOM) $1.51

6.1.1 Supplies $0.86

	**(1) 5.5x2.1mm Barrel Plug** 9mm Insert (!NO Longer!) $0.11/ea = $0.11		**(1) 9V Battery Clip** Hard Plastic Side-Exit Wires $0.35/ea = $0.35
	**(2) #4 x 3/4" Screws** Barrel Plug Clamp 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** Battery Cover 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

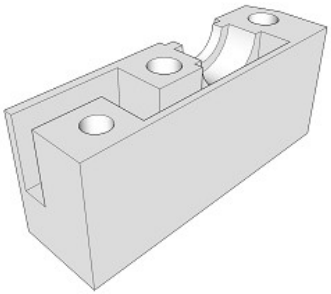
6.1.2 3D-Prints $0.65



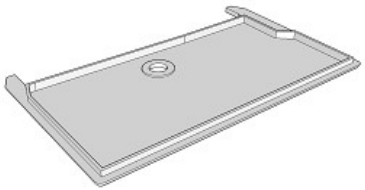
Tode-1WBattTray.stl
Folder: ./SD23CF/3DPrints/1WBatteryPack/stl

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

Plastic: 21-grams @ $0.02/g = $0.42
Printer-use: @ $0.0015/g = $0.0315
Power: 3h 15m @ $0.01/hr = $0.0325
TOTAL COST: $0.484



Tode-1WBattClamp.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 39m @ $0.01/hr = $0.0075
TOTAL COST: $0.0935



Tode-1WBattCover.stl
Folder: ./SD23CF/3DPrints/1WBatteryPack/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 23m @ $0.01/hr = $0.005
TOTAL COST: $0.0695

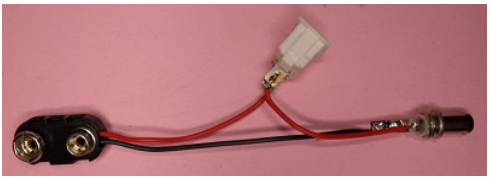
6.2 Casing Assembly

Prepare 9V Battery Clip
1. Cut Red wire 50mm long.
2. Cut Black wire 80mm long.
3. Cut a piece of Red wire 50mm long.

Strip, Clamp and Solder the black wire to the Barrel Plugs long lead.

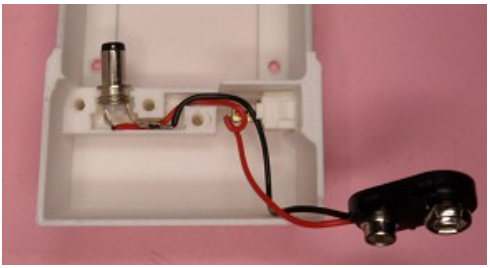
Solder the Battery Clip Red wire to one of the rocker switches terminal.

Solder the piece of 50mm Red wire (3.) to the other switches terminal on one end and the Barrel plug short lead. to the other end. Putting the switch in the Red wires path as shown.



Route the Barrel Plug and Battery Clip through the switch hole and push the switch into the casing.

Put the barrel plug in the casing and route wires as shown.



Using **(2) #4 - 3/4" Phillips-Flat** Screws attach the Clamp to hold the Barrel Plug into place.

Clip on a battery and stuff the wires in the pocket over the switch.

Install the

Using **(1) #2 – 3/8" Phillips-Flat** Screw attach the Cover over the battery.