

Tode-BD241S

Hardware Development

Arduino-Mega Pro Mini + Ebyte RF T20/30db

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

Build Version: 241S / Last Updated: 2024-02-09

Model #BD241S

Backside IO Access

Ebyte Radio T20D/T30D



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Table of Contents


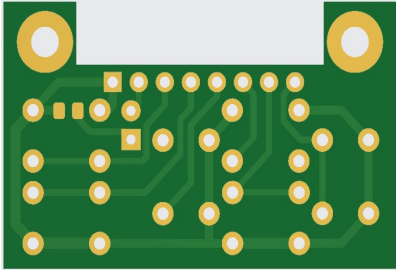
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TOTAL TODE-UNIT BOM: \$39.48
 TOTAL BATTERY TRAY BOM: \$ 1.73







2. Top Keypad & Display 231Q

2.1 Bill of Materials (BOM) \$7

2.1.1 Parts \$3.25

<div></div> <ul style="list-style-type: none">1.8 or 1.77 -Inch TFT LCD Display<ul style="list-style-type: none">Power-In: 5VdcResolutions: 128 x 160dpi ST7735 RGBDimensions: 35mm x 56mmTemp: -20C to 70C(8)Pin-Order: GND,VCC,SCL,SDA,RES,DC,CS,BLPricing: \$3.00/each	<div></div> <ul style="list-style-type: none">Digital Keypad PCB version 231Q<ul style="list-style-type: none">Manufacturer: jlcpcb.comPricing Each: \$0.25Batch Price: \$20.93 per 100Zip Folder: JLCPCB-231Q-output
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2.1.2 Supplies \$1.74

<div></div> <p>(1) 1x8P Male Pin Header PCB-J1, Dupont 2.54mm-Pitch Cut from 40-Pin Male Pin Header \$0.01/pin = \$0.08</p> <div></div> <p>(1) 47K 0805 SMT Resistors PCB-R7 \$0.01/ea = \$0.01</p> <div></div> <p>(2) M2x0.4-8 Flat Phillips Machine Screw & Nut Display & Keypad to Cover \$0.10/pair = \$0.20</p>	<div></div> <p>(6) 6x6-7mm Push Buttons PCB-SW(1-6) DIP-4 Tacticle Through-Hole \$0.15/ea = \$0.90</p> <div></div> <p>(1) 3mm Green LED PCB-D1 \$0.05/ea = \$0.05</p> <div></div> <p>(1) M2x0.04-20mm Machine Screw Used as <i>Heating stem ONLY</i> \$0.10/ea = \$0.10</p>
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2.1.3 3D-Prints \$0.32



Tode-DispKB-Cover.stl

Folder: ./SD23CF/3DPrints/stl

Layer Height: 0.2mm

Infill Density: 100%

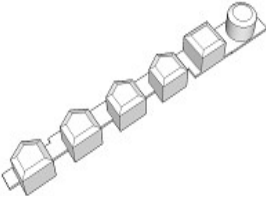
Supports: OFF

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

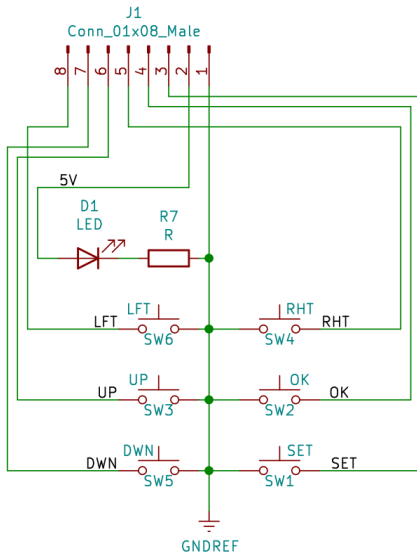
Plastic: 1-grams @ \$0.02/g = \$0.02

Printer-use: @ \$0.0015/g = \$0.0015

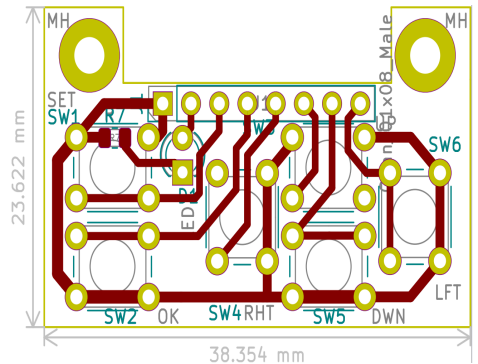
Power: 0h 22m @ \$0.01/hr = \$0.005

TOTAL COST: \$0.0265

2.2 Schematic & Layout



LAYOUT



D1 = 3mm Round Green LED

R7 = 47Kohm 0805 SMT Resistor

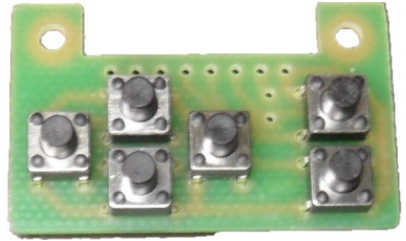
- $5V/47K = 0.1mA$ LED current.

SW(1-6) = 6x6x7mm Tactical Switches

2.3 PCB Assembly

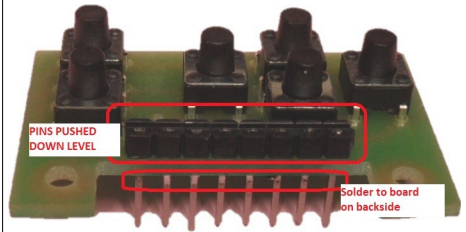
2.3.1 Push buttons

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



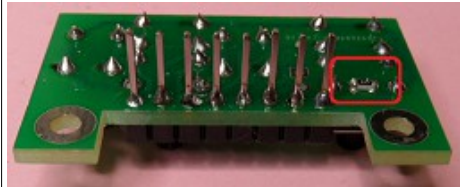
2.3.2 Pin Header

- 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.

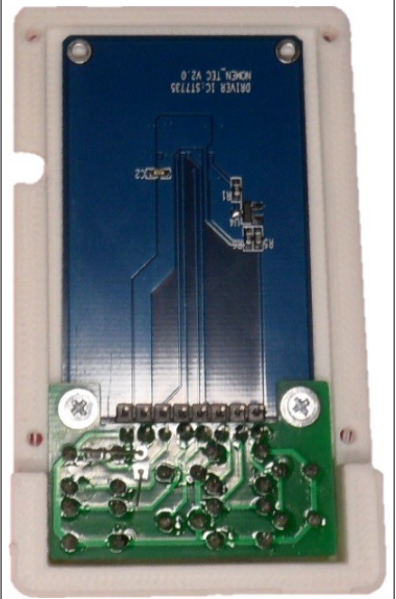
2.4.5 Mount Buttons

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

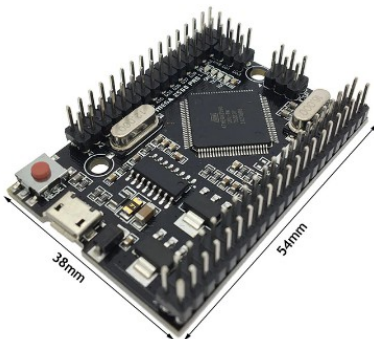
1. Place TFT display face-down on case first.
2. Place Keypad with Buttons over the top and align holes.
3. Fasten with **(2) M2x0.4 – 8mm** machine screws.
4. Align LED with hole in casing.
5. Solder the LED pins and clip excess off.



3. Center Arduino

3.1 Bill of Materials (BOM) \$10.15


3.1.1 Parts \$9.43



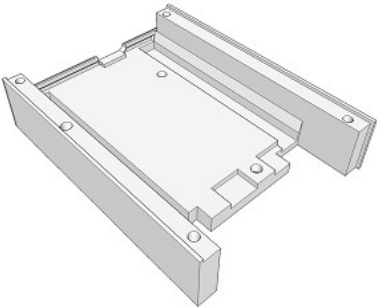
Arduino Mega Pro Mini [ATmega2560]

- 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>

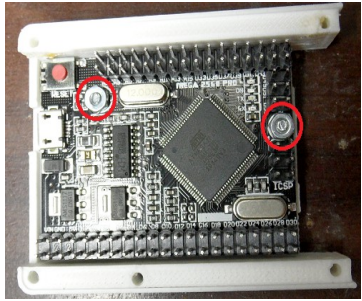
3.1.2 Supplies \$0.20

	<p>(2) M2.5x0.45 x 8mm Phillips-Flat Machine Screw & Nut</p> <p>Arduino Mega Pro Mini to Casing</p> <p>\$0.20/pair = \$0.20</p>
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3.1.3 3D Prints \$0.39

	<p>ALL-AMPCenter.stl</p> <p>Folder: \All-3DPrints\stl</p> <p>PLA Filament: 17g @ \$0.02/g = \$0.34</p> <p>Printer-use: 17g @ \$0.0015/g = \$0.0255</p> <p>Power: 2h 23m @ \$0.01/hr = \$0.025</p> <p>TOTAL COST: \$0.39</p>
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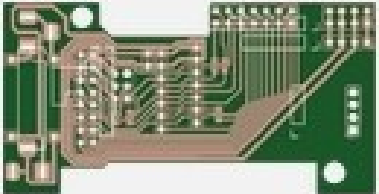



3.2 Casing Assembly

	<p>3.2.1 Casing</p> <p>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.</p> <p>Be sure not to damage components next to the top nut while tightening.</p>
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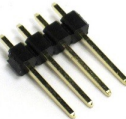
4. Back PCB-BD241S

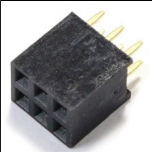



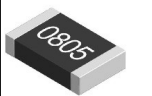
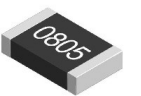
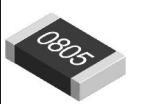
4.1 Bill of Materials (BOM) \$2.48

4.1.1 Parts \$1.05 (+Radio & Ant)

	<p>(1) BD241S PCB (Back-plane)</p> <ul style="list-style-type: none"> File Location: \\kicad\\JLPCB-SD23F Manufacturer: jlpcb.com Batch Price: \$46.11 per 75 Pricing: \$0.61/ea = \$0.61
	<p>(1) CN3903 DC-DC Buck Step-Down Board 5V@3A</p> <ul style="list-style-type: none"> Voltage: 5Vdc to 30Vdc Input to 5Vdc Output Size: 17.5mm x 12mm x 4.3mm (LWH) Max Output: 3A Pricing: \$0.44/ea = \$0.44
	<p>(1) Ebyte Radio (Various T20D/T30D Options)</p> <ul style="list-style-type: none"> E22-900T30D Pricing: \$10.77/ea E22-400T30D Pricing: \$7.94/ea E220-400T30D Pricing: \$10.07/ea E32-433T30D Pricing: \$9.06/ea E32-433T20D Pricing: \$6.44/ea <p>Website: https://www.cdebyte.com/Module-Lora</p>
	<p>(1) SMA Aerial Antenna (Various Options)</p> <ul style="list-style-type: none"> Omni 6cm 2dbi: \$1.09/ea Omni-folding 11cm 3dbi: \$1.04/ea Omni-folding 19cm 6dbi: \$2.26/ea

4.1.2 Supplies \$1.06

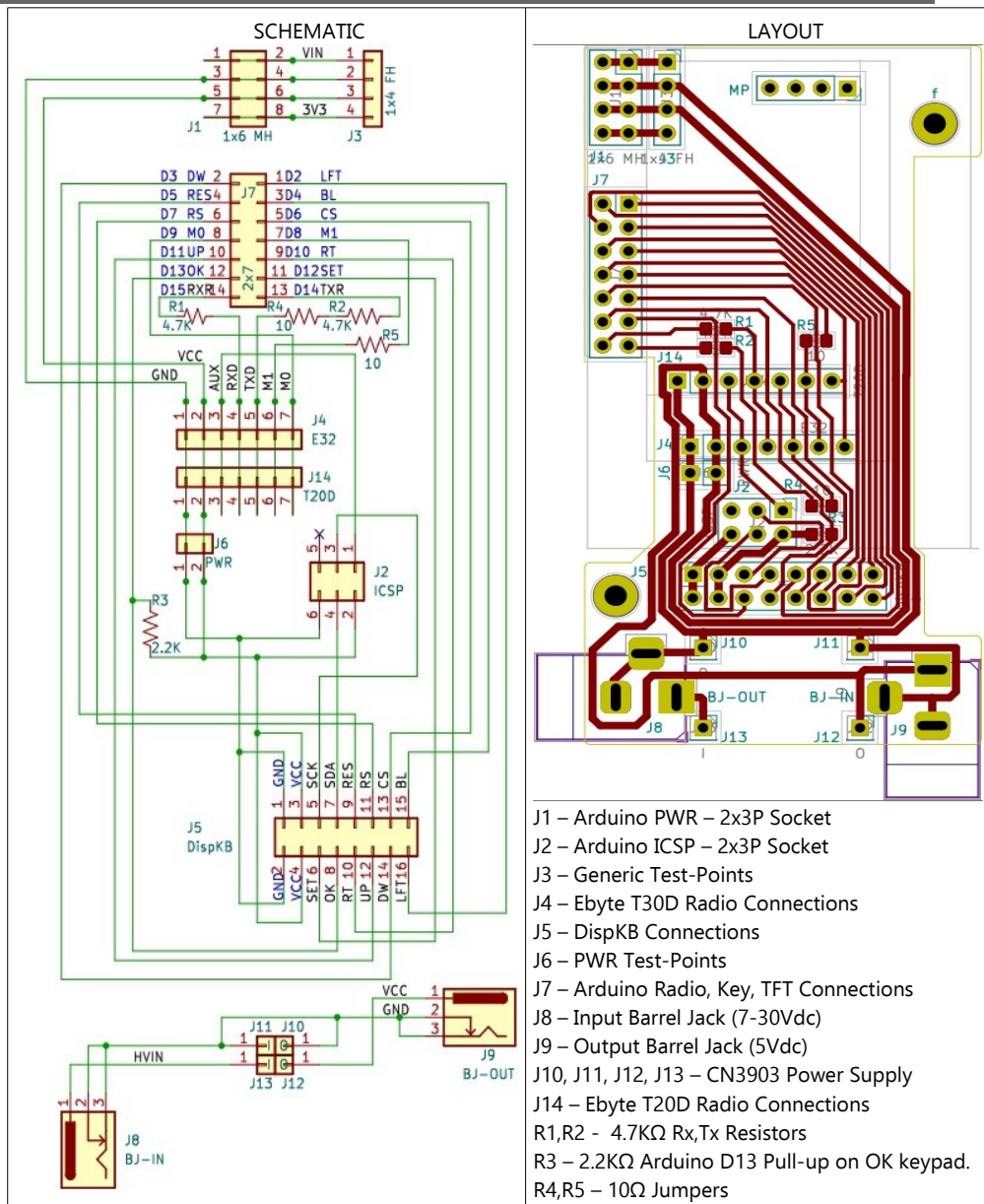
	<p>(1) 2x7P Pin Socket Dupont 2.54mm-Pitch Backplane PCB \$0.18/ea = \$0.13</p>		<p>(1) 2x8P LONG-Lead Socket Dupont 2.54mm-Pitch Keypad & Display Connect \$0.15/ea = \$0.15</p>
	<p>(1) 2x4P Pin Socket Dupont 2.54mm-Pitch Radio, Buttons & IO \$0.17/ea = \$0.17</p>		<p>(1) 1x4P Pin Header Dupont 2.54mm-Pitch Radio Ground Stubs \$0.01/pin (from 40-pin cut) = \$0.04</p>

 <p>(1) 2x3P Pin Socket Dupont 2.54mm Pitch ICSP and Power \$0.10/ea = \$0.12</p>	 <p>(4) 1x1P Pin Header Dupont 2.54mm-Pitch Radio Ground Stubs \$0.01/pin (from 40-pin cut) = \$0.04</p>
 <p>(2) #2-1/4" Screw PCB to Casing Phillips-Flat Sheet Metal Screw \$0.10/each = \$0.20</p>	 <p>(2) 5.5x2.1-9mm DC Barrel Jack PCB Female PCB Mount 3-Terminal, 9mm Connector Depth. \$0.08/ea = \$0.16</p>
 <p>(1) 2.2KΩ 0805 SMT Resistor PCB-R3 \$0.01/ea = \$0.01</p>	 <p>(2) 4.7KΩ 0805 SMT Resistors PCB-R1 & R2 \$0.01/ea = \$0.02</p>
 <p>(2) 10Ω 0805 SMT Resistors PCB-R4 & R5 \$0.01/ea = \$0.02</p>	

4.1.3 3D-Prints \$0.37

	<p>BD241S-Backplane.stl Folder: \BD241S\3DPrints\stl</p> <p>PLA Filament: 16g @ \$0.02/g = \$0.32 Printer Use: 16g @ \$0.0015/g = \$0.024 Power: 2h 18m @ \$0.01/hr = \$0.025</p> <p>TOTAL COST: \$0.37</p>
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4.2 Schematic & Layout



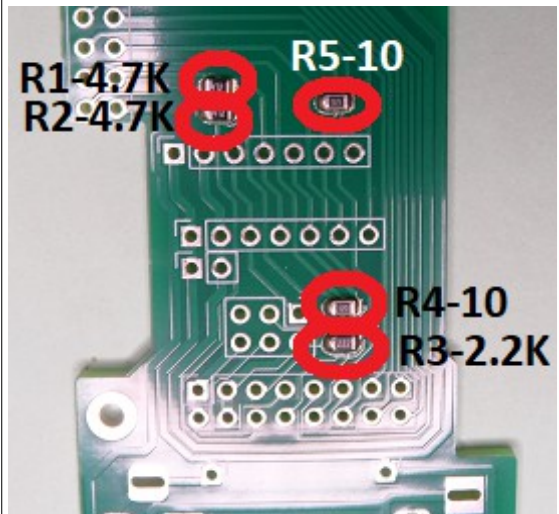
4.3 PCB Assembly

4.3.1 Resistors

Solder Resistors on PCB

- ☑ R1 = 4.7K Ω above Ebyte-J14
- ☑ R2 = 4.7K Ω above Ebyte-J14
- ☑ R3 = 2.2K Ω side of ICSP Bottom
- ☑ R4 = 10 Ω side of ICSP Top
- ☑ R5 = 10 Ω above Ebyte-J14, Right-side

Refer to Schematic & Layout for specifics.



4.3.2 Arduino Sockets

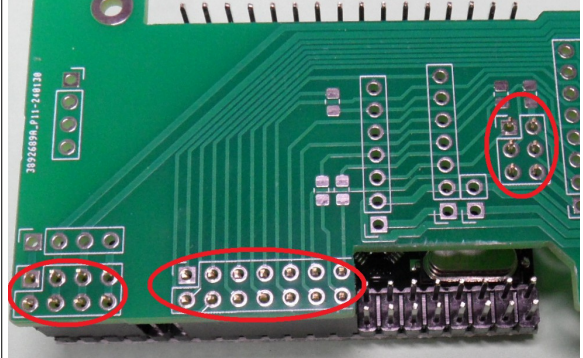
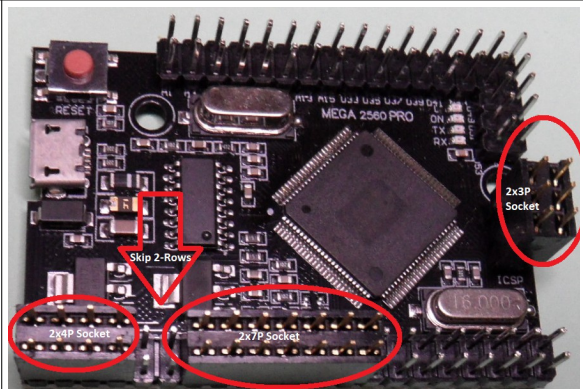
1. Attach Dupont Sockets to Arduino

- ☑ J1 = (1) 2x4P Left-Top Arduino
- ☑ J7 = (1) 2x7P Left & 7-Rows down
- ☑ J2 = (1) 2x3P on Arduino ICSP Header

2. Place 241S PCB on Socket Pins.

3. Solder Dupont Sockets to PCB.

4. Unplug the PCB from Arduino.



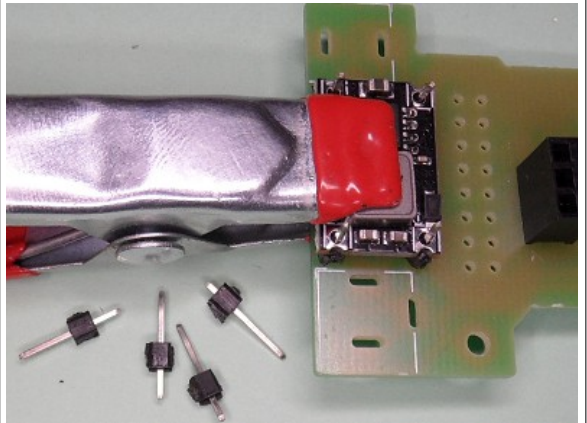
4.3.3 Radio

1. Place Pin Header into Top of PCB.
 - 1.2. For T20D radios use 1x3P Header
 - 1.3. For T30D radios use 1x4P Header
2. Place Radio onto PCB.
3. Solder Radios 7-Pins to PCB.
4. Solder the 1x3P or 1x4P Pins to PCB.
5. Trim excess Pin Length from back PCB.



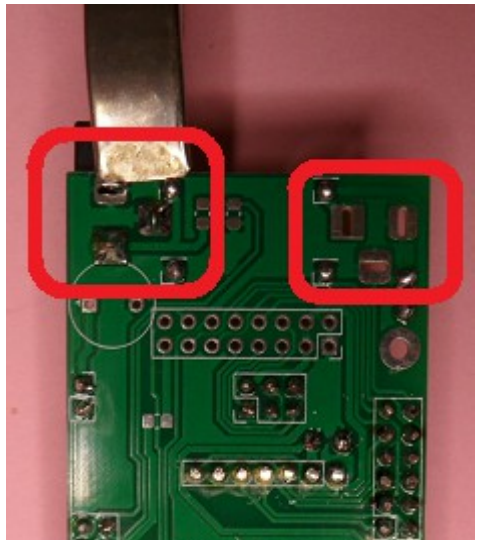
4.3.4 CN3903 Power Supply

1. (4) 1x1P Headers into Bottom of PCB.
2. Place CN3903 Power Supply Module.
3. Solder Pins to PCB and Power Supply.



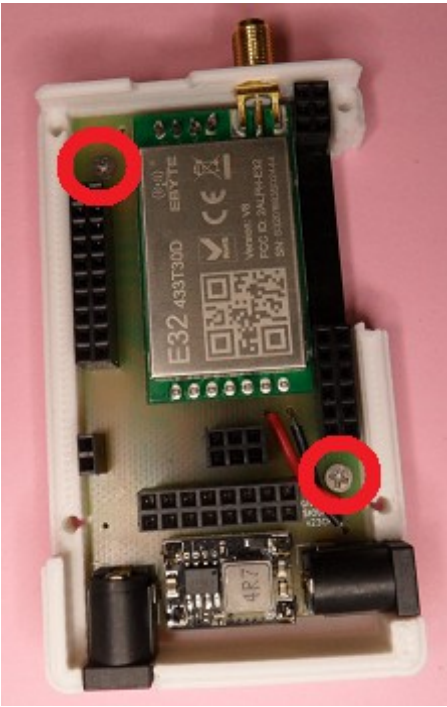
4.3.5 DC Barrel Jacks

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



4.3.6 Casing

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



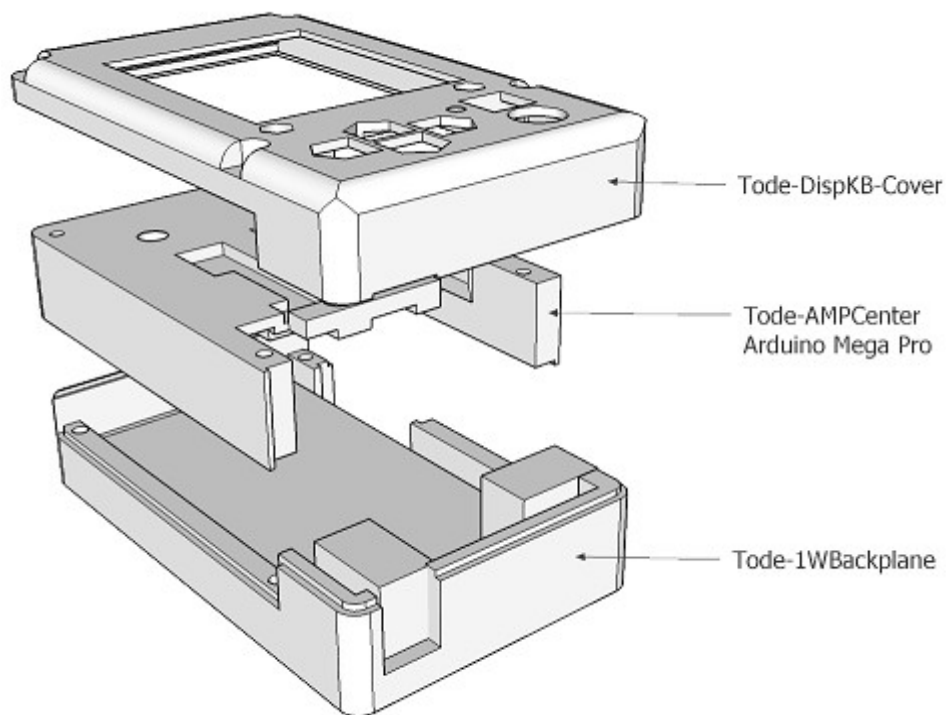
5. Final Assembly

5.1 Bill of Materials (BOM) \$1.23

5.1.1 Supplies \$1.23

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

5.2 Diagram



5.3 Casing Assembly

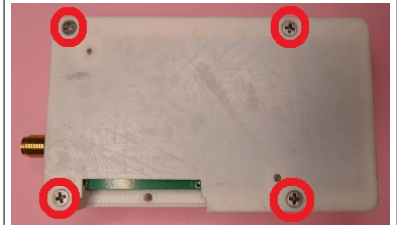
5.3.1 Radio Foil

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.



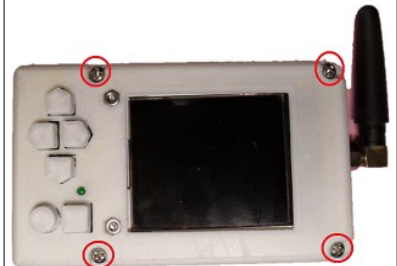
5.3.2 Back-side Fasteners

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.

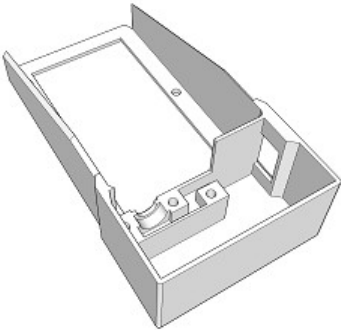
6. Battery Tray

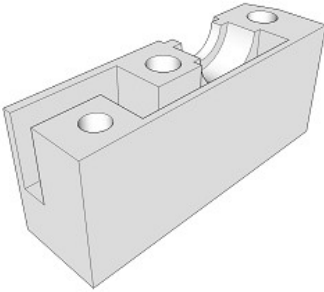
6.1 Bill of Materials (BOM) \$1.51

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
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Tode-1WBattClamp.stl

Folder: ./SD23CF/3DPrints/1WBatteryPack/stl

Layer Height: 0.2mm

Infill Density: 100%

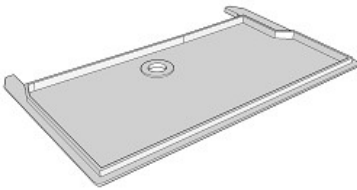
Supports: OFF

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 Plug's long lead.

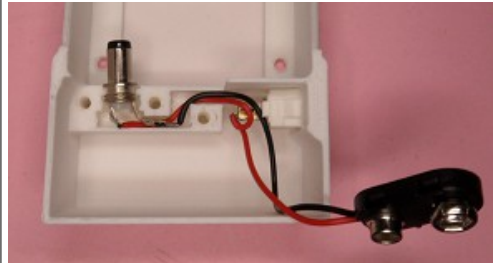
Solder the Battery Clip Red wire to one of the rocker switches terminal.

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.

