

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: 2024-02-23

Model #BD241S

Backside IO Access

Ebyte Radio T20D/T30D



Access to 46-IO pins.

(16) Analog-In

..or.. Digital-In/Out [A0-A15]

(30) Digital-In/Out [18-47]

Special Purpose pins

(1) Serial Data [18,19]

(3) Analog-Out PWM [44,45,46]

(4) HDW Interrupts [18-21]

NOTES

TOTALS

- ☒ Tode-RC Materials \$29.44
- ☒ Tode-RC Labor
- ☒ Shipping Materials:
- ☒ Shipping:
- ☒ Transaction Fees:

BUNDLE MATERIAL COST \$64.88

- ☒ (2) Tode-RC Materials \$29.44/ea = \$58.88
- ☒ (1) with Battery-Tray \$ 1.51/ea = \$ 1.51
- ☒ (1) with BIOPH \$ 4.49/ea = \$ 4.49
- ☒ Tode-RC Labor
- ☒ Shipping Materials:
- ☒ Shipping:
- ☒ Transaction Fees:

1. Table of Contents

Table of Contents


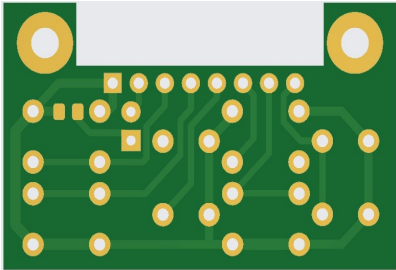
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2. Tode-RC \$29.44







2.1 Display & Keypad 231Q \$4.94

2.1.1 Materials

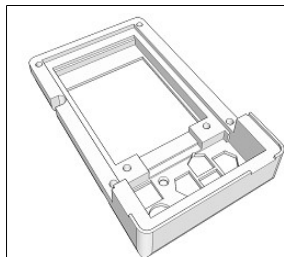
A. Parts \$3.25

 <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 (~4.38 to 2.64)	 <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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B. Supplies \$1.34

 <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>	 <p>(1) 47K 0805 SMT Resistors PCB-R7 \$0.01/ea = \$0.01</p>	 <p>(6) 6x6-7mm Push Buttons PCB-SW(1-6) DIP-4 Tacticle Through-Hole \$0.15/ea = \$0.90</p>
 <p>(2) M2x0.4-8 Flat Phillips Machine Screw & Nut Display & Keypad to Cover \$0.10/pair = \$0.20</p>	 <p>(1) 3mm Green LED PCB-D1 \$0.05/ea = \$0.05</p>	 <p>(1) M2x0.04-20mm Machine Screw Used as <i>Heating stem ONLY</i> \$0.10/ea = \$0.10</p>

C. 3D-Prints \$0.35

**Tode-DispKB-Cover.stl**

Folder: ./SD23CF/3DPrints/stl

Layer Height: 0.2mm

Infill Density: 100%

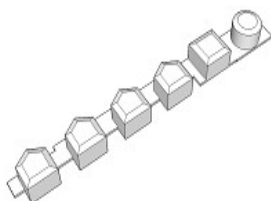
Supports: OFF

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%

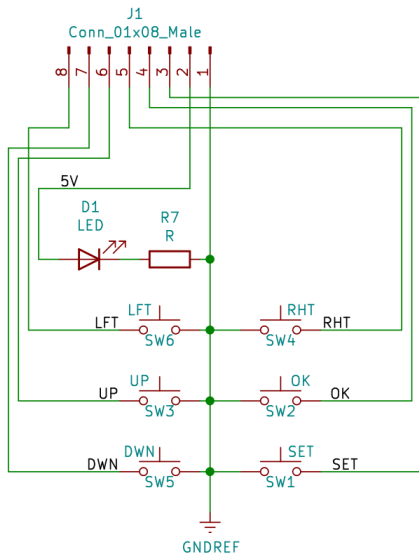
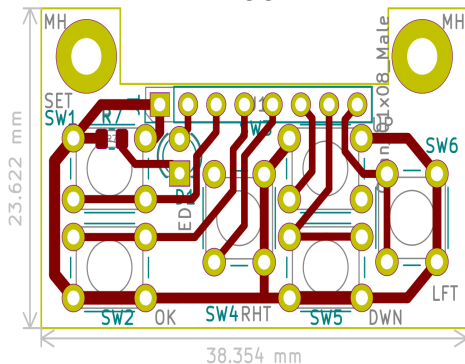
Supports: OFF

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

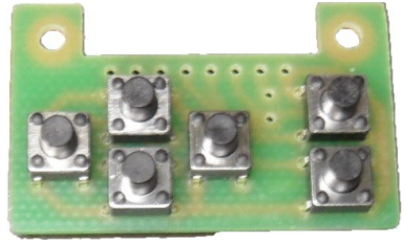
2.1.2 Schematic & Layout**SCHEMATIC****LAYOUT**

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

2.1.3 PCB Assembly

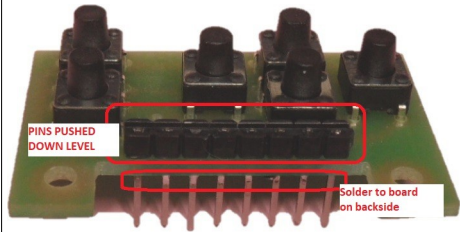
A. Push buttons

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



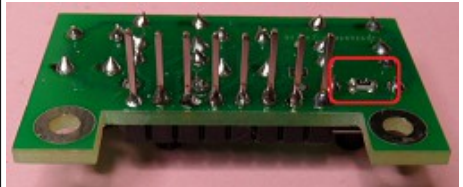
B. Pin Header

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



C. LED

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



2.1.4 Case Assembly

A. 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



B. 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.

C. Drill-out Buttons

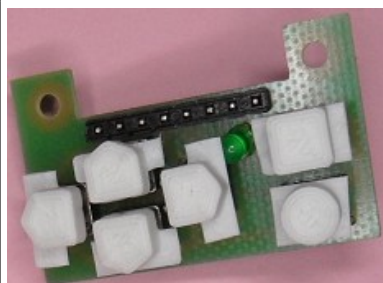
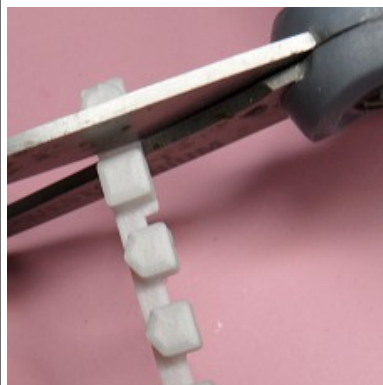
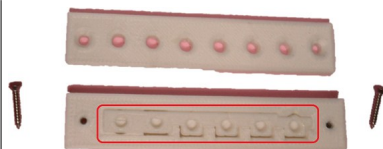
1. 3D-Print the **ButtonDrill-Template.stl** if not already done.
 - 1.2. Found in Folder: \SD23CF\3DPrints\Tools
2. Insert the Buttons into the Template base and use #4 screws to clamp the buttons with the Top-holes.
3. Use a 3.5mm bit and drill the button holes till the bit makes a slight mark on the depth-bottom of the hole.
4. Push Buttons onto tactile push-button switches as shown.
 - 4.2. Skinny legged arrow belongs on top

D. 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.

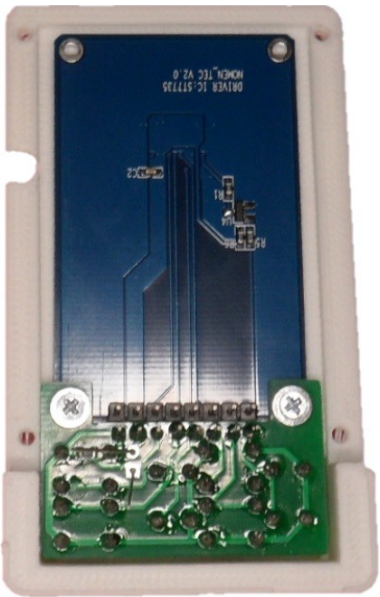
E. Mount Buttons

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.



F. Fasten

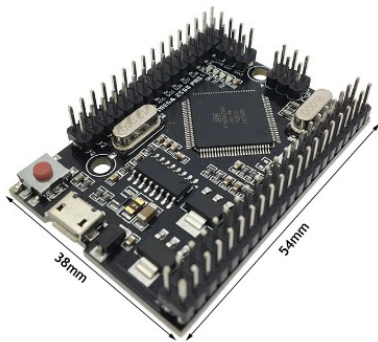
- 1. Place TFT display face-down on case first.
- 2. Place Keypad with Buttons over the top and align holes.
- 3. Fasten with **(2) M2x0.4 – 8mm** machine screws.
- 4. Align LED with hole in casing.
- 5. Solder the LED pins and clip excess off.



2.2 AMP-Center \$10.02

2.2.1 Materials

A. Parts \$9.43



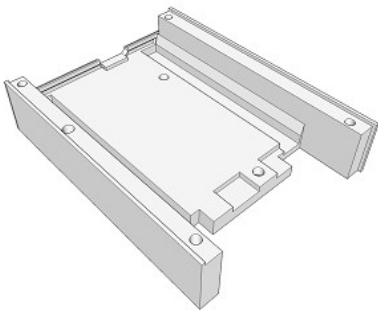
- Arduino Mega Pro Mini [ATmega2560]**
- Power In: 6Vdc to 9Vdc (Peek 18Vdc)
 - Power Out: 5Vdc @ 800mA + 3Vdc @ 800mA
 - Load Amps: 5Vdc @ 220mA
 - IO-Pins: 54-Digital, 16-Analog
 - Memory: 256kb RAM, 4kb EEPROM
 - Temp Rng: -40C to 85C
 - Pricing: ~ \$9.43/each
 - Web @ <https://robotdyn.com/mega-2560-pro-embed-ch340g-atmega2560-16au.html>

B. 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

C. 3D Prints \$0.39

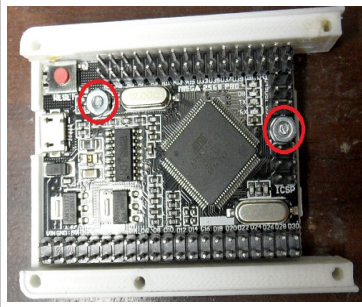


ALL-AMPCenter.stl
Folder: \All-3DPrints\stl

PLA Filament: 17g @ \$0.02/g = \$0.34
Printer-use: 17g @ \$0.0015/g = \$0.0255
Power: 2h 23m @ \$0.01/hr = \$0.025

TOTAL COST: **\$0.39**

2.2.2 Case Assembly



A. Arduino Mega-Pro in Casing

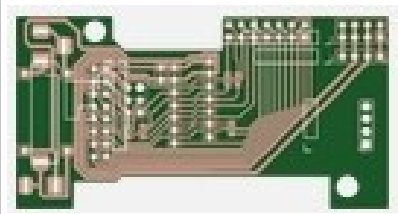
Fasten the Arduino Mega Pro Mini with Male Pin Headers into the 3D Printed case using **(2) M2.5x0.45 – 8mm** flat-head machine screws and nuts on Arduino side.

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

2.3 Back-plane BD241S \$14.48

2.3.1 Materials



A. Parts \$13.05



- (1) BD241S PCB (Back-plane)**
- File Location: \kicad\JLCPCB-SD23F
 - Manufacturer: jlcpcb.com
 - Batch Price: \$46.11 per 75
 - Pricing: \$0.61/ea = **\$0.61**



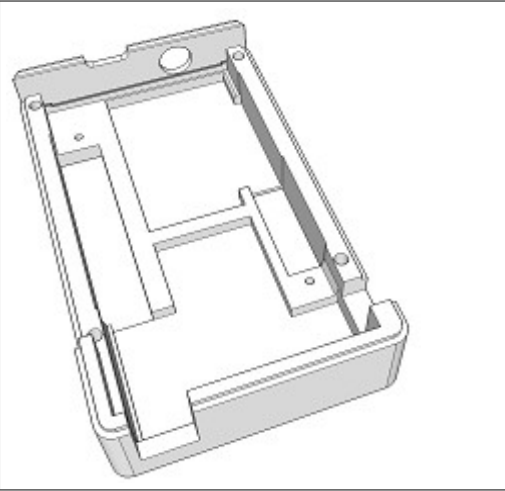
- (1) CN3903 DC-DC Buck Step-Down Board 5V@3A**
- Voltage: 5Vdc to 30Vdc Input to 5Vdc Output
 - Size: 17.5mm x 12mm x 4.3mm (LWH)
 - Max Output: 3A
 - Pricing: \$0.44/ea = **\$0.44**

	<p>(1) Ebyte Radio (Various T20D/T30D Options)</p> <ul style="list-style-type: none"> <input type="checkbox"/> E22-900T30D Pricing: \$10.77/ea <input type="checkbox"/> E22-400T30D Pricing: \$7.94/ea <input type="checkbox"/> E220-400T30D Pricing: \$10.07/ea <input type="checkbox"/> E32-433T30D Pricing: \$9.06/ea <input type="checkbox"/> E32-433T20D Pricing: \$6.44/ea <p>Estimated Price \$10.00/ea</p> <ul style="list-style-type: none"> • Website: https://www.cdebyte.com/Module-Lora
	<p>(1) SMA Aerial Antenna (Various Options)</p> <ul style="list-style-type: none"> <input type="checkbox"/> Omni 6cm 2dbi: \$1.09/ea <input type="checkbox"/> Omni-folding 11cm 3dbi: \$1.04/ea <input type="checkbox"/> Omni-folding 19cm 6dbi: \$2.26/ea <p>Estimated Price \$2.00/ea</p>

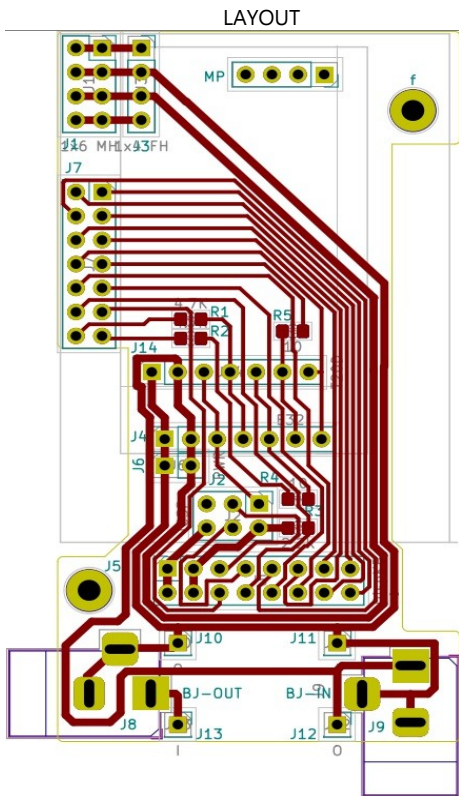
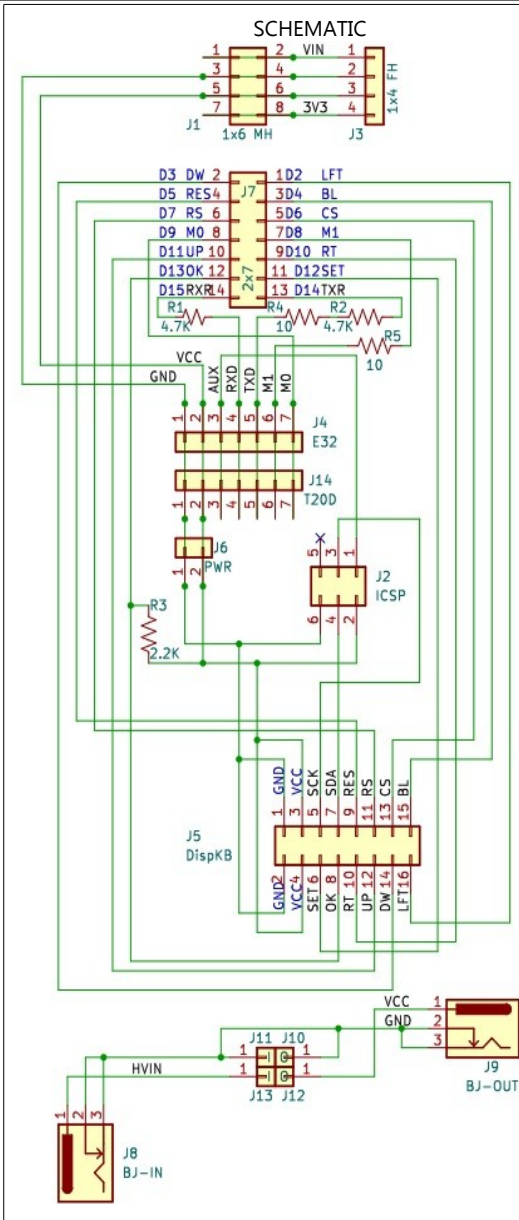
B. Supplies \$1.06

	<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>		

C. 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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2.3.2 Schematic & Layout



- J1 – Arduino PWR – 2x3P Socket
- J2 – Arduino ICSP – 2x3P Socket
- J3 – Generic Test-Points
- J4 – Ebyte T30D Radio Connections
- J5 – DispKB Connections
- J6 – PWR Test-Points
- J7 – Arduino Radio, Key, TFT Connections
- J8 – Input Barrel Jack (7-30Vdc)
- J9 – Output Barrel Jack (5Vdc)
- J10, J11, J12, J13 – CN3903 Power Supply
- J14 – Ebyte T20D Radio Connections
- R1,R2 - 4.7KΩ Rx,Tx Resistors
- R3 – 2.2KΩ Arduino D13 Pull-up on OK keypad.
- R4,R5 – 10Ω Jumpers

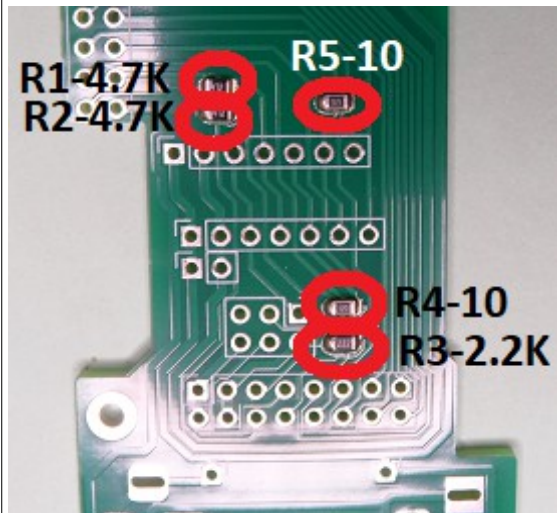
2.3.3 PCB Assembly

A. Resistors

Solder Resistors on PCB

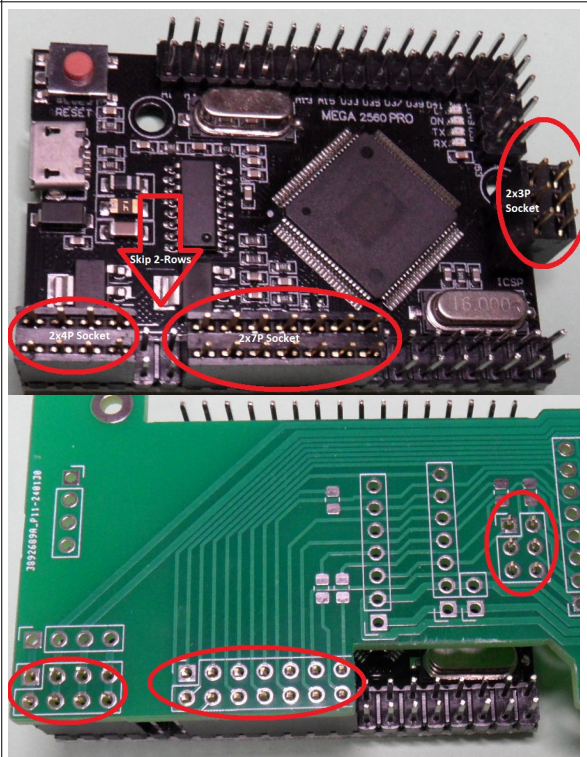
- ☑ R1 = 4.7K Ω above Ebyte-J14
- ☑ R2 = 4.7K Ω above Ebyte-J14
- ☑ R3 = 2.2K Ω side of ICSP Bottom
- ☑ R4 = 10 Ω side of ICSP Top
- ☑ R5 = 10 Ω above Ebyte-J14, Right-side

Refer to Schematic & Layout for specifics.



B. 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.



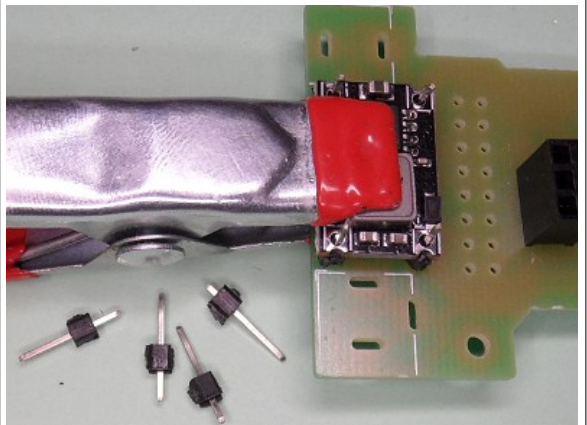
C. Radio

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.



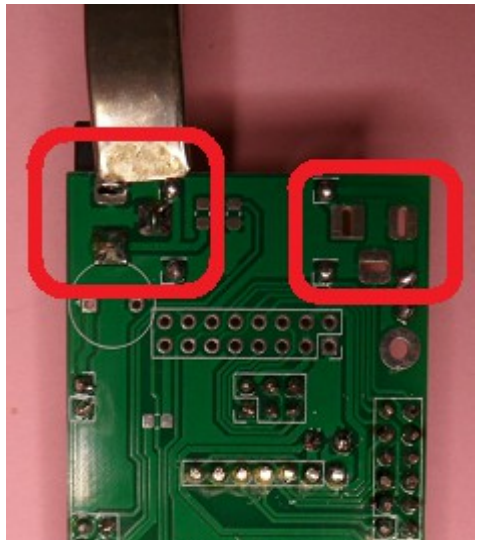
D. CN3903 Power Supply

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



E. DC Barrel Jacks

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



2.3.4 Casing

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

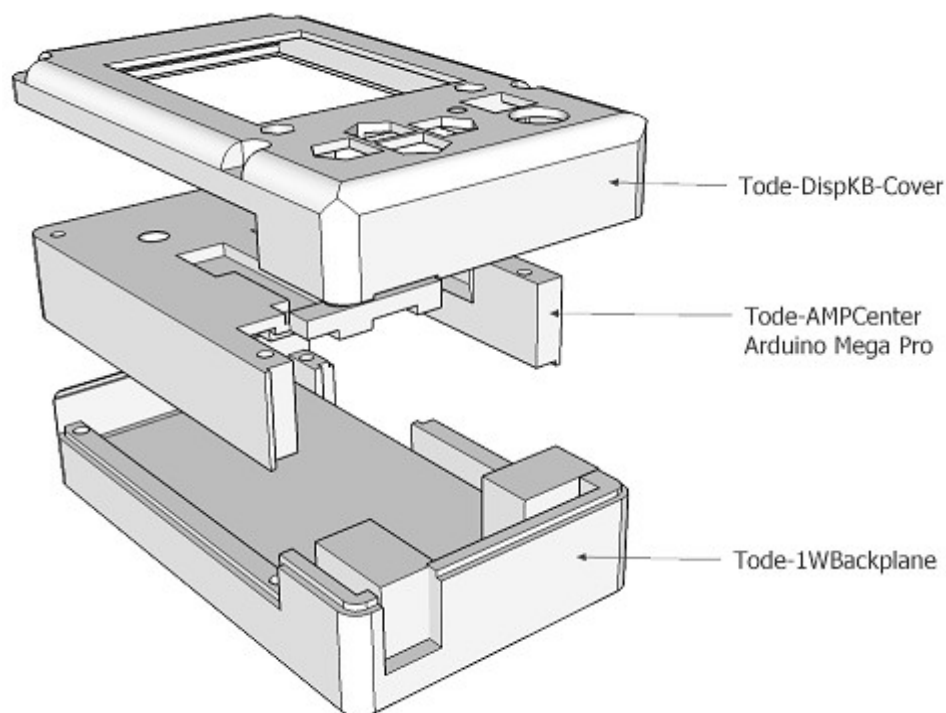
2.4 Final Assembly \$1.23

2.4.1 Materials

A. 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>(4) #2 x 1/2" Screw Backplane to Center Phillips-Flat Sheet Metal Screw Sheet Metal Screw Price \$0.06/ea = \$0.24</p>	 	<p>Aluminum Foil Approximately 1/2sqft \$0.06/sqft = \$0.03</p> <p>2-Inch Clear Packing Tape Aluminum Foil Insulation</p>
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2.4.2 Diagram



2.4.3 Casing Assembly

A. PCB in Case

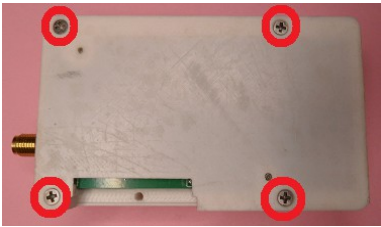

Place PCB inside case as shown and use #2-1/4 screws to secure.



B. 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.



<div>C. Back-side Fasteners</div> <div>7. Plug the AMP (Arduino Mega Pro) Center to the 1W-Backplane assuring correct pin alignment.</div> <div>8. Using (4) #2-1/2" Phillips-Flat Screws fasten the Backplane (back-side) to AMPCenter.</div>	
<div>D. Display Fasteners</div> <div>9. Plug the DispKB into the (front-side) Backplane assuring correct pin alignment and casing alignment with Center.</div> <div>10. Using (4) #2-3/8 Phillips-Pan Screws fasten the Display Casing to the Top.</div>	
<div>E. Antenna</div> <div>Attach an antenna to the SMA-K connector.</div>	

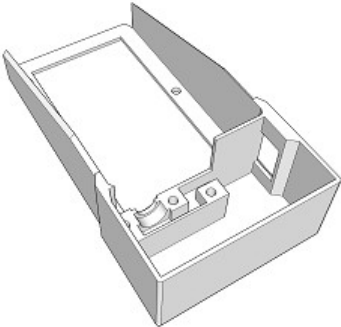
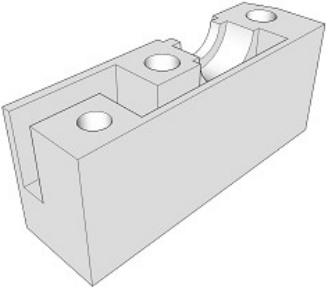
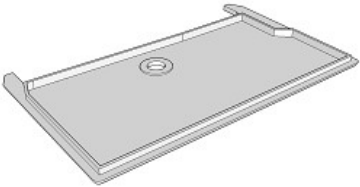
3. Battery-Tray Option \$1.51

3.1 Materials

A. Supplies \$0.86			
   	<p>(1) 5.5x2.1mm Barrel Plug 9mm Insert (!NO Longer!) \$0.11/ea = \$0.11</p> <p>(2) #4 x 3/4" Screws Barrel Plug Clamp Phillips-Pan Sheet Metal Screw \$0.10/ea = \$0.20</p> <p>(1) #4 x 3/8" Screw Battery Cover Phillips-Flat Sheet Metal Screw \$0.10/ea = \$0.10</p>	  	<p>(1) 9V Battery Clip Hard Plastic Side-Exit Wires \$0.35/ea = \$0.35</p> <p>(1) KCD11 3A Rocker Switch SPST 10x15mm \$0.10/ea = \$0.10</p> <p>(Optional) Belt Clip 2-Inch Metal Spring Clamp \$0.30/ea = \$0.30</p>

	(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
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B. 3D-Prints \$0.65

  	<p>Tode-1WBattTray.stl Folder: ./SD23CF/3DPrints/1WBatteryPack/stl</p> <p>Layer Height: 0.2mm Infill Density: 100% Supports: OFF</p> <p>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</p> <p>Tode-1WBattClamp.stl Folder: ./SD23CF/3DPrints/1WBatteryPack/stl</p> <p>Layer Height: 0.2mm Infill Density: 100% Supports: OFF</p> <p>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</p> <p>Tode-1WBattCover.stl Folder: ./SD23CF/3DPrints/1WBatteryPack/stl</p> <p>Layer Height: 0.2mm Infill Density: 100% Supports: OFF</p> <p>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</p>
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3.1.2 Assembly

Prepare 9V Battery Clip

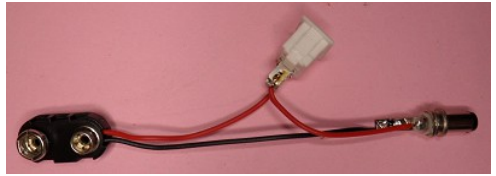
1. Cut Red wire 50mm long.
2. Cut Black wire 80mm long.
3. Cut a piece of Red wire 50mm long.



Strip, Clamp and Solder the black wire to the Barrel Plug's long lead.

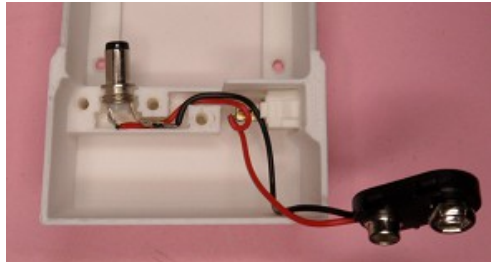


Solder the Battery Clip Red wire to one of the rocker switches terminal.



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

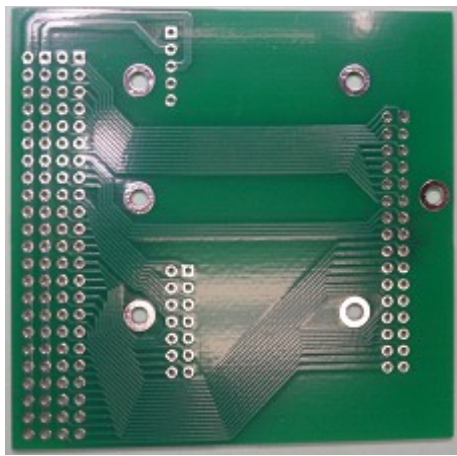
Using **(1) #2 - 3/8" Phillips-Flat** Screw attach the Cover over the battery.



4. BIOPH Option \$4.49

4.1.1 Materials \$3.67

A. Parts \$0.93



- IO-Access 23BF PCB
- Design Software: Kicad
- Folder: \Tode-IO\Tode-BIO\kicad\IO-ACCESS\SIQST
- Manufacturer: jlcpcb.com
- Batch Price: \$46.43 per 50
- Pricing: \$0.93/ea

B. Supplies \$1.14



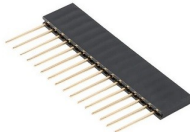
(2) 2x40P Male Pin Header
Dupont 2.54mm-Pitch
PCB Pin-Header Array
@\$0.21/ea = \$0.42



(1) 2x3P Long Leg Socket
Dupont 2.54mm-pitch
PCB Digital-IO Tode-Side
@0.12/ea = \$0.12



(4) #4 x 3/8" Phillips-Flat Screw
Front-Side to Back-Side
\$0.03/ea = \$0.12



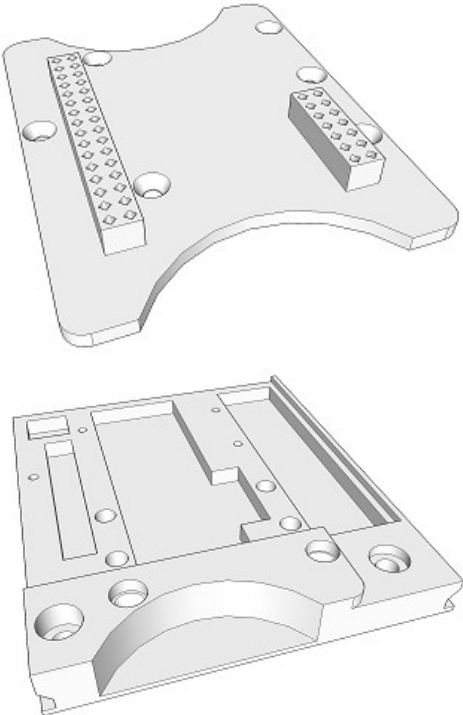
(2) 1x16P Long Leg Socket
Dupont 2.54mm-pitch
PCB Analog-IO Tode-Side
@0.17/ea = \$0.34

– OR –
(2) 2x8P Long Leg Sockets
@0.15/ea = \$0.30




(1) 2x4P Long Leg Socket
Dupont 2.54mm-pitch
PCB Digital-IO Tode-Side
@0.14/ea = \$0.14

C. 3D-Prints \$0.78


	<p>BIOPH-FrontSide.stl Folder: ./Tode-IO-Options/Side-IO Commercial Box/3DPrints/stl Layer Height: 0.2mm Infill Density: 100% Supports: OFF Plastic: 9-grams @ \$0.02/g = \$0.18 Printer-use: @ \$0.0015/g = \$0.0135 Power: 1h 43m @ \$0.01/hr = \$0.0175 TOTAL COST: \$0.21</p> <p>BIOPH-BackSide.stl Folder: ./Tode-IO-Options/Side-IO Commercial Box/3DPrints/stl Layer Height: 0.2mm Infill Density: 100% Supports: OFF Plastic: 25-grams @ \$0.02/g = \$0.50 Printer-use: @ \$0.0015/g = \$0.0375 Power: 3h 07m @ \$0.01/hr = \$0.03 TOTAL COST: \$0.57</p>
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4.1.2 DIN-Mount Materials \$0.82

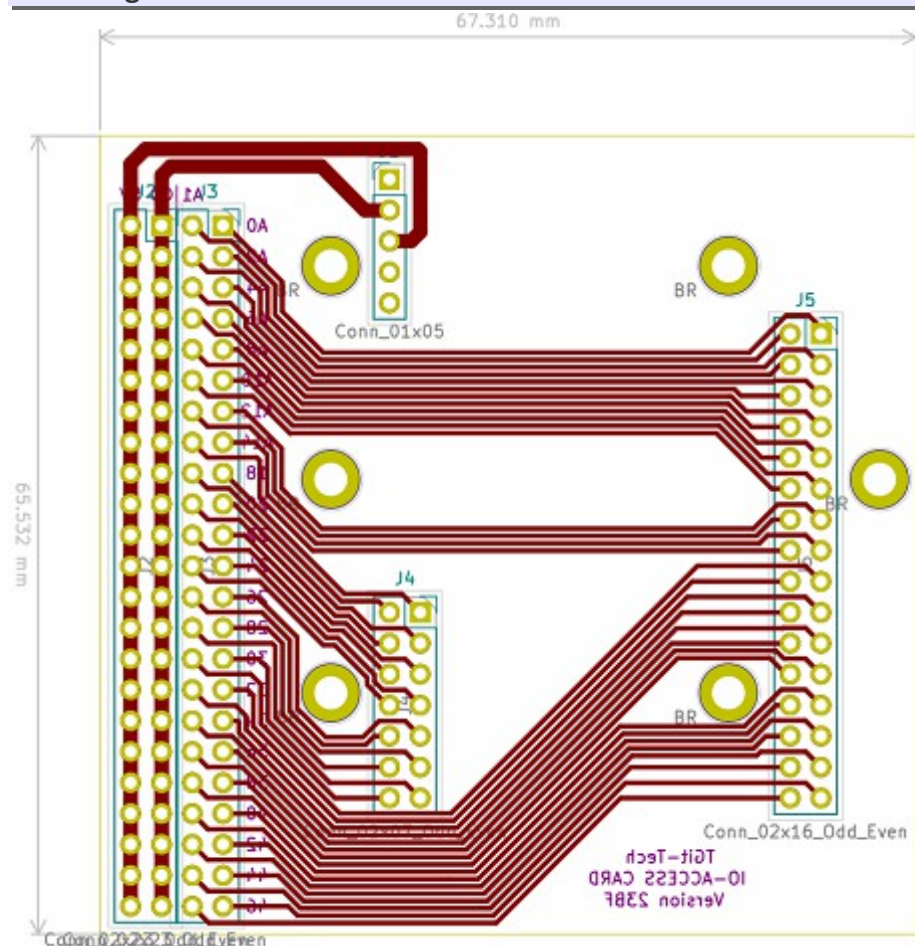
A. Parts \$0.66

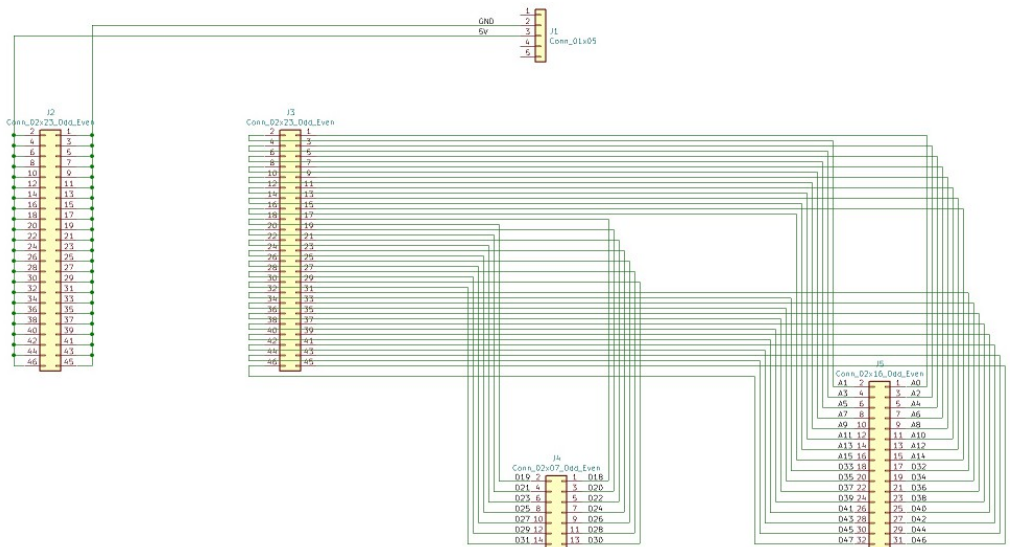
	<p>(2) DIN Mount Brackets DRG-01 for 35 x 7.5mm DIN Rail Pricing: \$0.33/ea = \$0.66</p>
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B. Supplies \$0.16

	<p>(4) #4 x 5/8"Phillips-Flat Screw Standoff-Label \$0.04/ea = \$0.16</p>		
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4.1.3 Diagram

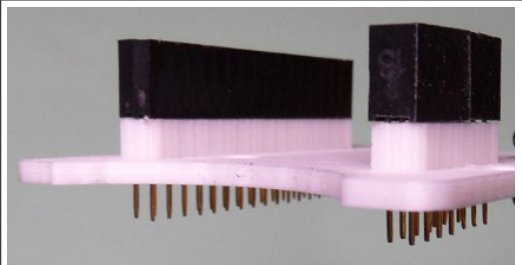




4.1.4 Assembly

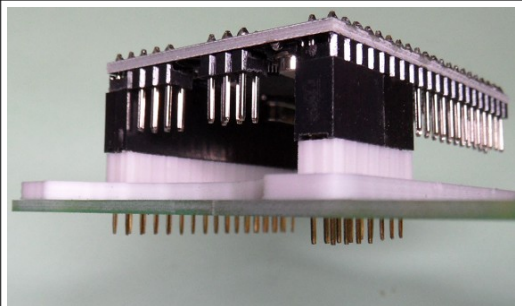
A. Sockets in Front-Side

- Press (2) 1x16P Long Leg Sockets into Front-Side 3DPrint.
- Insert (1) 2x3P and (1) 2x4P Long Leg Dupont Sockets into Front-Side 3DPrint.
- 5.2. Sand the socket ends for a proper fit.



B. Front-Side on PCB

- Press Front-Side with installed Pin Sockets into the PCB holes.
- Plug in an Arduino Mega-Pro for correct plug alignment.
- Solder the Sockets to the PCB.
- Trim excess Pin Length



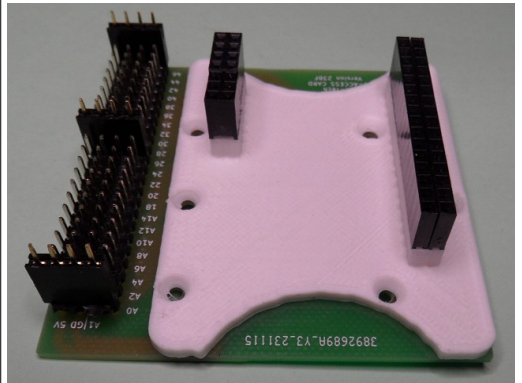
C. Pin Headers

10. Cut (2) 2x40P Pin Headers to 32-Pin Lengths to fit the Pin Header Array.



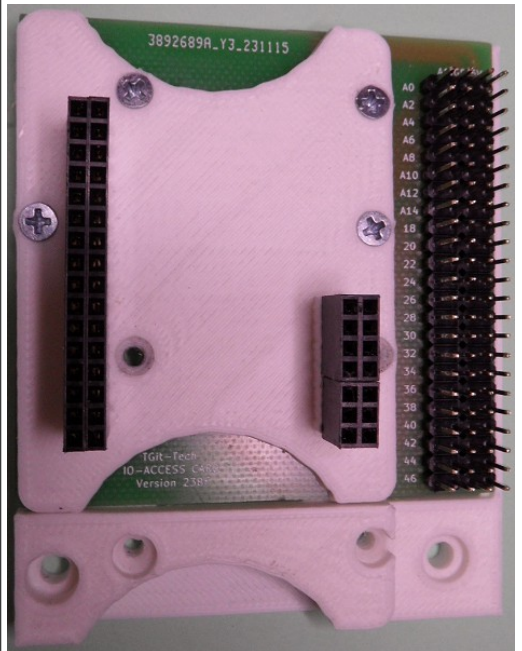
D. Solder Pin Header Array

11. Install the (2) 2x23-Pin Headers into the PCB.
12. Using (3) 1x4P Sockets keep Pin Header array pins straight.
13. Solder all pins to PCB.



E. Attach Back-Side

14. Place Front-Side assembly on Back-side 3D Print as pictured.
15. Fasten with (4) #4 x 3/8in Flat-Head SMS screws.



F. (OPTION) Screw on DIN Brackets

1. Using (4) #4 x 5/8in Flat-Head SMS screws attach the DIN brackets with their pry-release tabs facing the bottom to the BIOPH Assembly.
2. Attach to desired DIN Rail.

