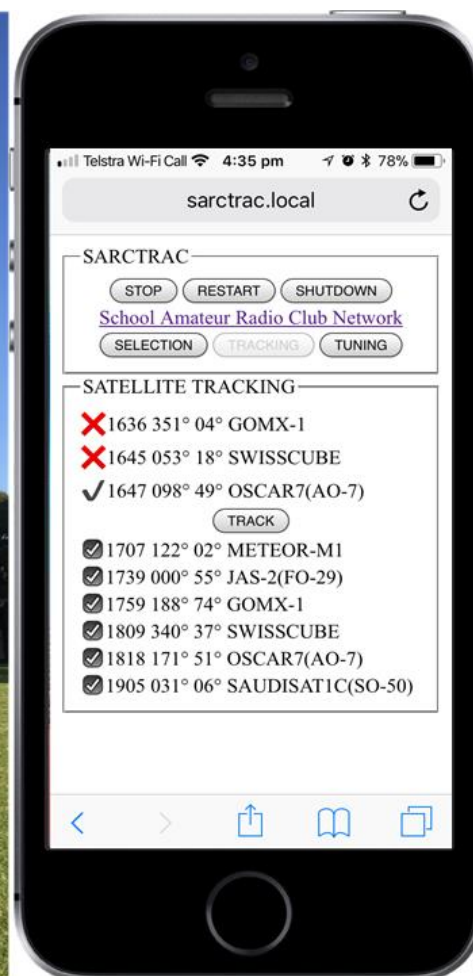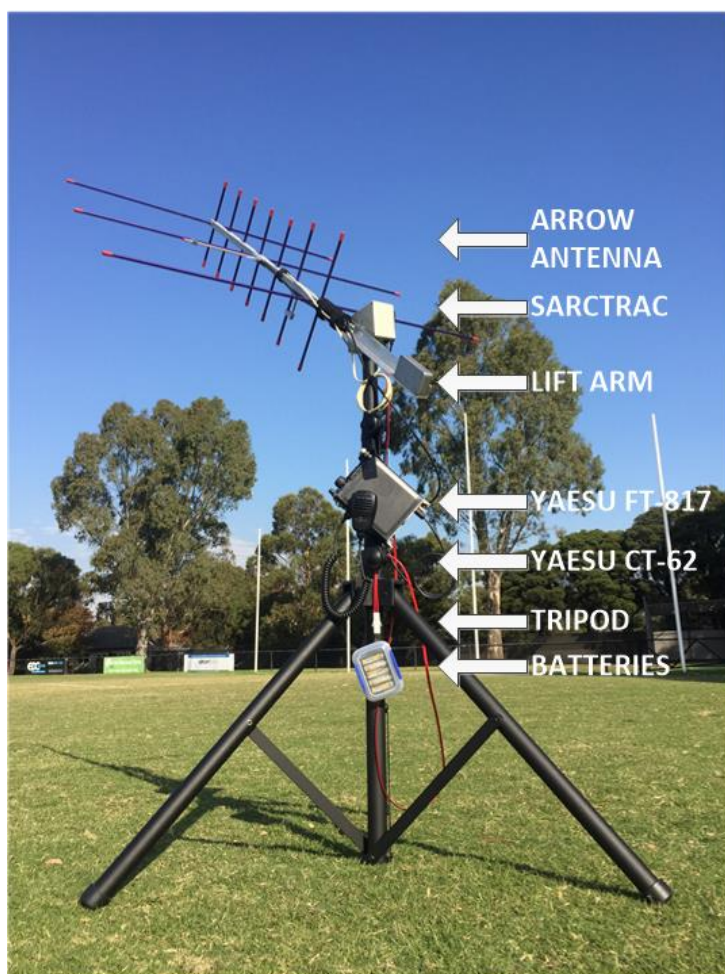**SARCTRAC**
Satellite **A**ntenna **R**otator **C**ontroller & **TRAC**ker
SCHOOL AMATEUR RADIO CLUB NETWORK
www.sarcnet.org

SARCTRAC Modification Procedure #1

Contents

Introduction

A few of our readers have reported the following symptoms after assembling a new SARCTRAC kit:

- The Motors do not drive at all, or drive continuously.
- The Heatsink temperature rises to over 50 degrees Celsius.
- The Raspberry Pi Zero (RPi0) does not boot.
- The 5V supply is low.
- The total current consumption is well over the normal 300mA

We have now completed an extensive investigation of this problem. Although we have many units which have been working for years without any problem, we have now observed the occurrence of this problems ourselves. The cause is a failure of the L910S Motor Driver module integrated circuits under what appears to be quite normal operating conditions.

Although the L901S is rated at 12VDC, we have seen one randomly fail at only 11VDC without any controller or motor connected! The failure sequence appears to be normal operation at start up, lasting for a minute or so, followed by a large jump in the L910S operating temperature and the current consumption. We cannot be sure if this is due to a bad design, a device specification error or a bad batch. Nevertheless, this failure then causes the LM2940, 12V, 1A, Regulator on the SARCTRAC heatsink to go into current/thermal limiting. The heatsink temperature rises to over 50 degrees Celsius. The voltage on the 5V supply is reduced, causing the Raspberry Pi Zero (RPi0) not to boot up.

As a result of this investigation we have now changed the Motor Driver which we provide in our SARCTRAC kit to a modified L298N Motor Driver. We recommend that existing users, who experience this problem, follow this modification procedure to retrofit the new module.

Unfortunately, the new Motor Driver does not have on-board termination resistors on its PWM control inputs. Since the RPi0 Digital I/O pins power up in a high-impedance state, the motors would start running until the RPi0 boots up. Hence the unit must be modified to include the necessary terminating resistors. However, the new Motor Driver is rated at 35VDC and 4A, so there is no longer any need for the 12V Regulator. Due to the larger size of the Motor Driver, the existing heatsink needs to be modified and re-mounted in a new position

The new Motor Driver is also much larger than the existing unit so the assembly and wiring of the components within the SARCTRAC enclosure is changed. The SARCTRAC Manual has been updated as a result. The additional components required include the new driver module, hook-up wire, resistors, and hardware items. All the parts should be available on eBay or local electronics parts stores for under $10. This modification procedure is for an experienced builder with an already-assembled SARCTRAC kit. It includes a parts list and step-by-step instructions. If you have not already assembled your SARCTRAC kit, please obtain the additional components required and refer to the latest SARCTRAC Manual, available for download at https://www.sarcnet.org/products.html#SARCTRACkit.

Modification Procedure

Getting Started

1. Follow these instructions in order. Strike through the number, like this ~~1.~~, when complete.
2. Check off all the parts required for the modification as shown in Table 1.
3. Be sure to get the 35V, 4A version of the L298N Motor Driver as shown in Figure 5.
4. Place all the parts into a sealed container for safe-keeping during the assembly process.
5. Get ready all the tools and sundries required for assembly as shown in Table 2.

Removing the Heatsink Assembly

6. Remove the existing Heatsink assembly by unscrewing the self-tapping screw.
7. Remove the two Regulators from the Heatsink by unscrewing the two screws.
8. Remove the Motor Driver from the heatsink by unscrewing the two screws.
9. Save the Regulators, Heatsink and all nuts, bolts and washers in the sealed container.

Marking the Enclosure and Heatsink

10. Study the Enclosure drawings carefully, particularly the orientation of each face as shown in Figure 2.
11. Mark the enclosure to be machined very accurately. Sub-millimetre precision is required. We couldn't do it using a ruler or even self-adhesive 1:1 scale templates. The following works well:
12. Attach self-adhesive paper labels to the outside surfaces of the Enclosure covering the areas which will be machined as shown in Figure 2. One on the Front and one on the Left (lid).
13. Use the sharp points on a digital calliper to scribe construction lines on the labels as shown in Figure 2. Note that the Enclosure is chamfered and some measurements are from the top edge, while others are from the bottom edge. Use a set square on a level surface to extend these construction lines vertically as shown in Figure 4. Circle the final hole positions on the labels with a pen.
14. There are two new holes required on the Front side of the Enclosure as shown in Figure 7.
15. There is one new hole required on the Left side of the Enclosure as shown in Figure 8.
16. Use a pointed scribe to indelibly mark the centre positions of the new holes through to the outside surface of the Enclosure.
17. Similarly, attach self-adhesive paper labels to the outside surface of the Heatsink covering the areas which will be machined.
18. Use a digital calliper to scribe construction lines on the heatsink labels as shown in Figure 3.
19. There is one new hole required on the Heatsink as shown in Figure 10.
20. Use a pointed scribe to indelibly mark the centre position of the new hole through to the outside surface of the Heatsink.
21. Remove the paper labels.

Table 1 – Parts List

ITEM	DESCRIPTION	QTY	Checked
Motor Driver	L298N H-bridge Dual DC Motor Driver Board	1	
Resistors	10kΩ ¼W 5% Carbon Resistors	4	
10mm CSK Screws	M3 x 10mm Countersunk Pozi Nickel Bolt	3	
6mm CSK Screws	M3 x 6mm Countersunk Pozi Nickel Bolt	1	
1.5mm Heat-Shrink	Black 1.5mm Heat-Shrink Tubing	10cm	
3.0mm Heat-Shrink	Black 3.0mm Heat-Shrink Tubing	5cm	
Hookup wire	7/0.16 Tinned Light Duty Hook Up Cable: 2xBlack, 2xBrown and 1xRed	5x 150mm	
Cable-Ties	100mm x 2.5mm Nylon Cable Ties Black	2	

Item	Qty	Checked	Item	Qty	Checked
Pen or pencil	1		Hot air gun	1	
Parts container	1		PZ2 Screwdriver	1	
Large self-adhesive labels	5		Small, sharp, side-cutters	1	
Digital callipers	1		25W Soldering iron	1	
Pointed scribe	1		Heat Sink Compound	A/R	
Electric hand drill	1		12VDC bench power supply with voltmeter, ammeter and current limiting	1	
Drill bit 3mm – 1/8"	1				
Drill bit countersink	1				
Dremel tool with cutting bit	1		Rosin-cored solder, 1.5mm (Lead Free)	20cm	

Machining the Enclosure and Heatsink

22. Drill three new 3mm holes in the Enclosure, two on the Left side and one on the Front side.
23. Deeply countersink the two new 3mm holes on the Front side of the Enclosure. They will be used to mount the Motor Driver.
24. Deeply countersink the new hole on the Left side of the Enclosure. It will be used to mount the Heatsink.
25. Countersink the central Heatsink mounting hole on the rear of the Heatsink. It will be used to mount the Regulator.
26. Chamfer two edges of the heatsink as shown in Figure 3.
27. Drill one new 3mm hole in the heatsink as shown in Figure 3.
28. The Heatsink was mounted on a mounting post on the inside of the enclosure. Grind the post flush, ideally using a Dremel tool and a cutting bit, or carefully with a <u>very</u> slow 8mm drill bit.
29. Drill out the threads of the two Poly Nuts using a 3mm drill, so they can be used as spacers.

Wiring and Assembly

Wires and Cables

30. Cut the 1.5mm Heat-Shrink into ten 1cm pieces.
31. Cut the 3mm Heat-Shrink into two 2.5cm pieces.
32. Unscrew the Motor wires from the Motor Driver terminals.
33. Unsolder the Hook-Up wires from the Motor Driver PCB.
34. Unsolder the link joining the 12V Regulator to the 5V Regulator.
35. Unsolder the Hook-Up Wires to the 12V Regulator and the 5V Regulator.
36. Keep the 5V Regulator with the Tantalum Capacitor attached.
37. Unsolder the Power Cable and the Diode from the 12V Regulator.
38. Unsolder the Diode from the Power Cable.
39. Cut the Power Cable to 8cm long from the Sleeved Grommet on the inside the Enclosure.
40. Strip both ends of the new Wires and the Power Cable to 2mm with side cutters and tin the ends with the soldering iron.
41. Solder the anode of the Diode to the positive lead of the Power Cable as shown in Figure 9.
42. Solder a new Brown Wire to the cathode (ring-end) of the Diode as shown in Figure 9.
43. Solder a new Black Wire to the negative lead of the Power Cable as shown in Figure 9.
44. Shrink 3.0mm Heat-Shrink over the Power Cable as shown in Figure 9.

Regulator

45. Solder a new Brown, Black and Red wire to the Regulator as shown in Figure 9.
46. Shrink 1.5mm Heat-Shrink over the Regulator pins as shown in Figure 9.
47. Apply a smear of Heat Sink Compound to the rear of the Regulator.
48. Mount the Regulator on the Heatsink using a 6mm CSK Screw, a Metal Washer and a Metal Nut as shown in Figure 10.
49. Mount the Regulator to the Enclosure Lid using one 6mm CSK Screws, a Metal Washer and a Metal Nut as shown in Figure 12.

Controller

50. Cut off the Cable Tie between the Controller assembly and the Motor Driver.
51. Unscrew and remove the Controller assembly.
52. Unsolder the Red wire to Pin 2 of the Hub Hat.
53. Solder the Red Wire from the Regulator to pin 2 on the USB Hub Hat as shown in Figure 11.
54. Secure a small cable-tie around the Wires at the USB Hub Hat end as shown in Figure 12.
55. Re-mount the Controller assembly to the Enclosure using three 6mm CSK Screws.

Motor Driver

56. Remove all three jumpers from the Motor Driver as shown in Figure 5.
57. Solder 4x10kΩ 1/4W Carbon resistors to pins IN1-IN4 on the rear of the Motor Driver as shown in Figure 6. Use one of the resistor pigtails to connect the other side of all resistors to Ground.
58. Slip 1.5mm Heat-Shrink over the Orange, Blue, Purple and Grey Wires.
59. Solder the Orange Wire to the IN1 pin on the Motor Driver.
60. Solder the Blue Wire to the IN2 pin on the Motor Driver.
61. Solder the Purple Wire to the IN3 pin on the Motor Driver.
62. Solder the Grey Wire to the IN4 pin on the Motor Driver.
63. Shrink the Heat-Shrink in place using the hot air gun.
64. Re-install all three jumpers on the Motor Driver.
65. Solder the Brown Wires from the Regulator and Power Cable together in parallel to avoid them pulling out of the Motor Driver screw terminals.
66. Connect the Brown Wires to the +12V terminal on the Motor Driver.
67. Solder the Black Wires from the Regulator, Power Cable and RPi0 together in parallel to avoid them pulling out of the Motor Driver screw terminals.
68. Connect the Black Wires to the GND terminal on the Motor Driver.
69. Secure a small cable-tie around the Wires at the Motor Driver end as shown in Figure 12.
70. Connect the Black Wire from the AZ Motor to the OUT1 terminal on the Motor Driver.
71. Connect the Brown Wire from the AZ Motor to the OUT2 terminal on the Motor Driver.
72. Connect the Black Wire from the EL Motor to the OUT3 terminal on the Motor Driver.
73. Connect the Brown Wire from the EL Motor to the OUT4 terminal on the Motor Driver.
74. Mount the Motor Driver to the Enclosure using two 10mm CSK Screws, two Poly Nuts as spacers, two Fibre Washers as spacers and two Metal Nuts. The order of assembly is: Screw, Enclosure, Poly Nut, Fibre Washer, Motor Driver and Metal Nut.

SARCTRAC Checkout

75. Make sure SARCTRAC is powered down.
76. In preparation for testing SARCTRAC, lay it on one of its flat sides on the desk, so that the shaft hubs are clearly visible and are not touching anything.
77. Make sure the 3D Sensor, GPS Receiver and USB CAT cable (optional) are connected to SARCTRAC.

> **IMPORTANT:** Always power-down SARCTRAC before plugging in or removing any USB devices. Not doing so will likely reset the RPi0.

78. Connect the SARCTRAC power cable to a 12VDC Power Supply and power it up. Note: A bench Power Supply with voltmeter, ammeter and current limiting is recommended. Set the current of the Power Supply to 500mA. Verify during testing that the current limit is never exceeded.
79. The total current draw should be around 300mA and the motors should not move at start up.
80. Check that the RPi0 boots up – Check the Green activity LED.
81. Check that the Regulator output is 5VDC.
82. If the current or voltage is not correct, recheck each step of this modification procedure.
83. Wait for SARCTRAC to beep according to Table 3. If the beeps occur, they occur in the order shown. If SARCTRAC does not beep at all after a few minutes: See the Troubleshooting section of the SARCTRAC Manual. If it indicates that the 3D Sensor, GPS Receiver or USB CAT cable is not connected when they are connected: See Troubleshooting.

Table 3 – SARCTRAC Audible Alerts

Order	Alert tone	Meaning	Type
1	One short 100ms beep	USB CAT cable not connected	ERROR
2	Two short 100ms beeps	GPS not connected	ERROR
3	Three short 100ms beeps	3D Sensor not connected	ERROR
4	One long 3-second beep	ABOUT TO MOVE	WARNING
5	Five short 100ms beeps	Started tracking new satellite	INFORMATION

84. Connect to SARCTRAC using a web browser.
85. The SARCTRAC SELECTION page should be displayed.
86. Press the START button, the Motors should start moving. If not: See the Troubleshooting section of the SARCTRAC Manual.
87. When the motors start moving: See if you can control them with the 3D Sensor.
    a. Hold the 3D Sensor in your hand with the flat side down and the front side (opposite the cable) pointing North.
    b. Point the 3D Sensor upward: The EL Motor hub should turn counter-clockwise.
    c. Point the 3D Sensor downward: The EL Motor hub should turn clockwise.
    d. Point the 3D Sensor to the East: The AZ Motor hub should turn counter-clockwise*.
    e. Point the 3D Sensor to the West: The AZ Motor hub should turn clockwise*.
    f. *Note the AZ Motor may turn in the opposite directions if the Anti-Windup function has engaged. In this case. Keep the 3D Sensor facing North. Cycle power to SARCTRAC, wait for it to beep, then try East and West again. If the motors consistently move in the wrong direction, simply reverse the Motor wire connection to the Motor Driver terminals.

88. Check the SYSTEM STATUS and START-UP LOG for any errors as shown in the Troubleshooting section of the SARCTRAC Manual.

89. Note: The system status may change over time. Press the browser refresh button to update the display.

> **IMPORTANT:** Refreshing an old web page on a browser after a system RESTART or a SHUTDOWN will just resend the last command again – which will, of course, be RESTART or SHUTDOWN. In this case you should always close the web page first then reopen it.

90. This concludes the modification procedure. Please contact us by email at info@sarcnet.org if you have any further problems.

SARCTRAC - **S**atellite **A**ntenna **R**otator **C**ontroller and **TRAC**ker

ANTENNA

3D SENSOR

ANTENNA CABLE

EL MOTOR

AZ MOTOR

0.1uF x 4

MOTOR DRIVER

PIEZO BUZZER

RPI ZERO HEADER PIN NUMBERS SHOWN ON WIRES

5V REG
LM2940
-T5

+22uF*

*CAPACITOR IS ESSENTIAL

1N5812

TO 12VDC

SARCTRAC
MICRO SDHC
CARD

SanDisk 8GB

GPS

USB HUB HAT

RASPBERRY PI ZERO WH

WiFi

YAESU CT-62 CABLE

AMATEUR RADIO TRANSCEIVER – YAESU FT-817

MOBILE DEVICE WEB BROWSER

4G

WiFi
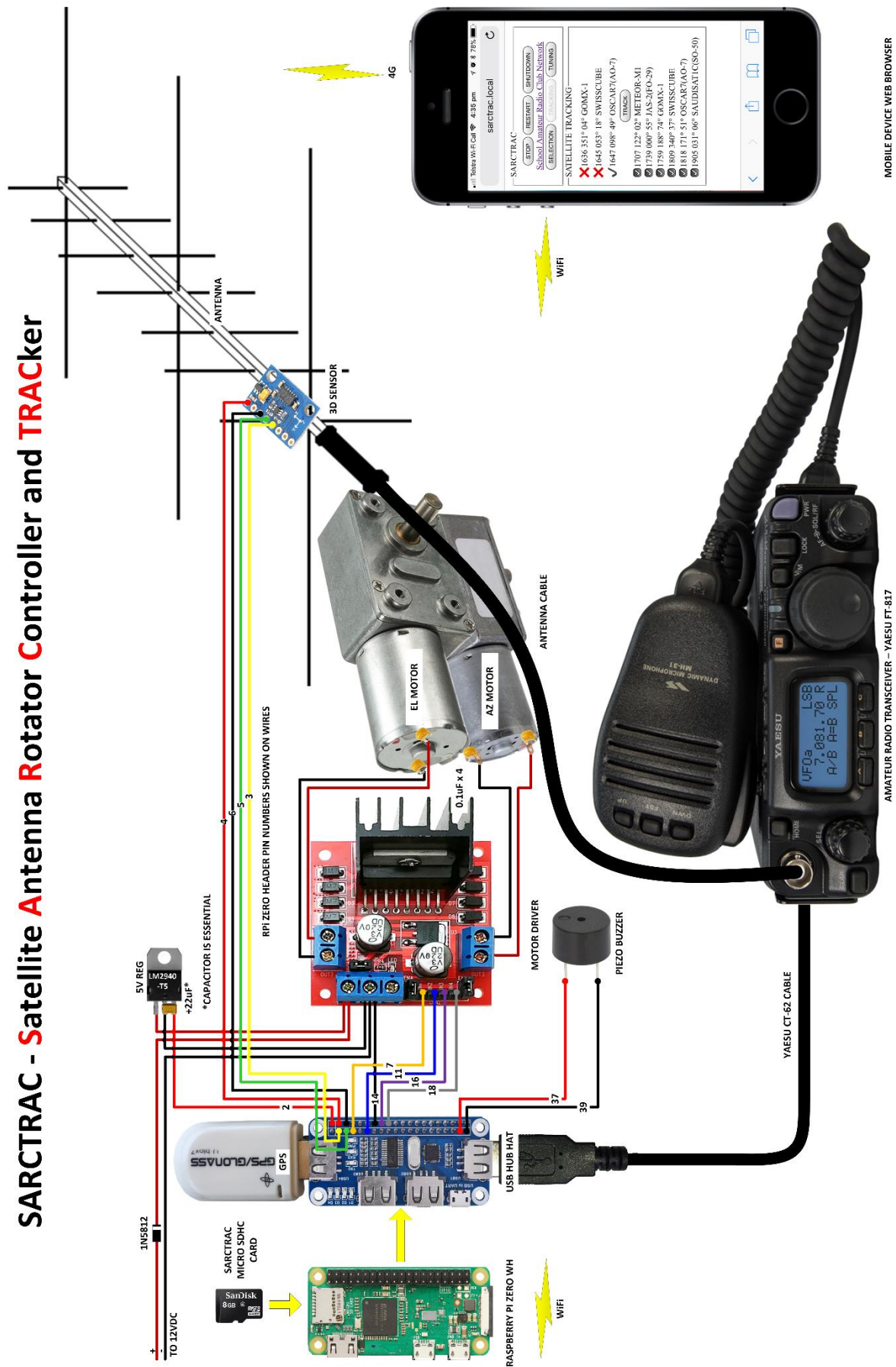
Figure 1 – Pictorial Schematic

Figure 2 – Enclosure drawings
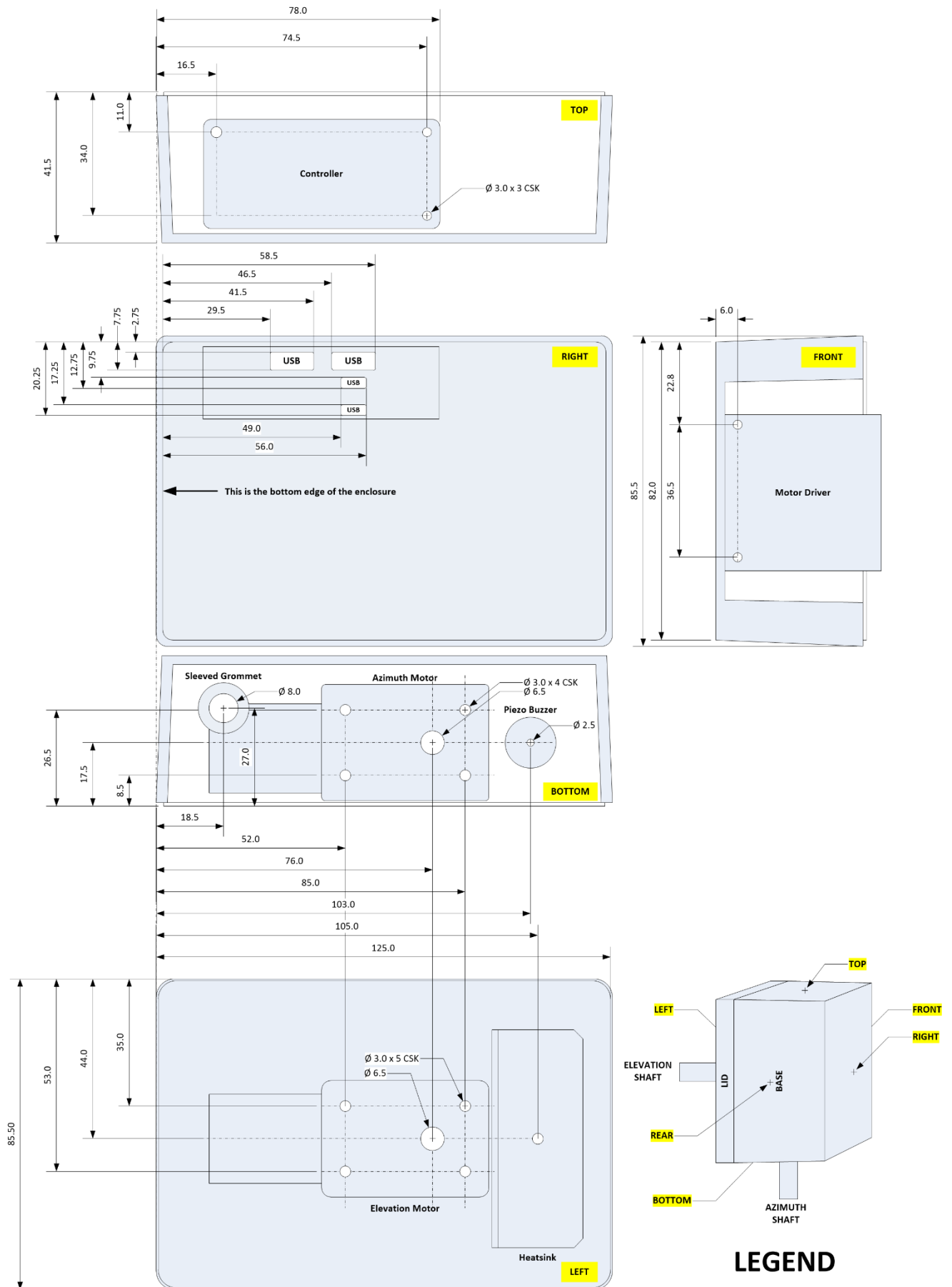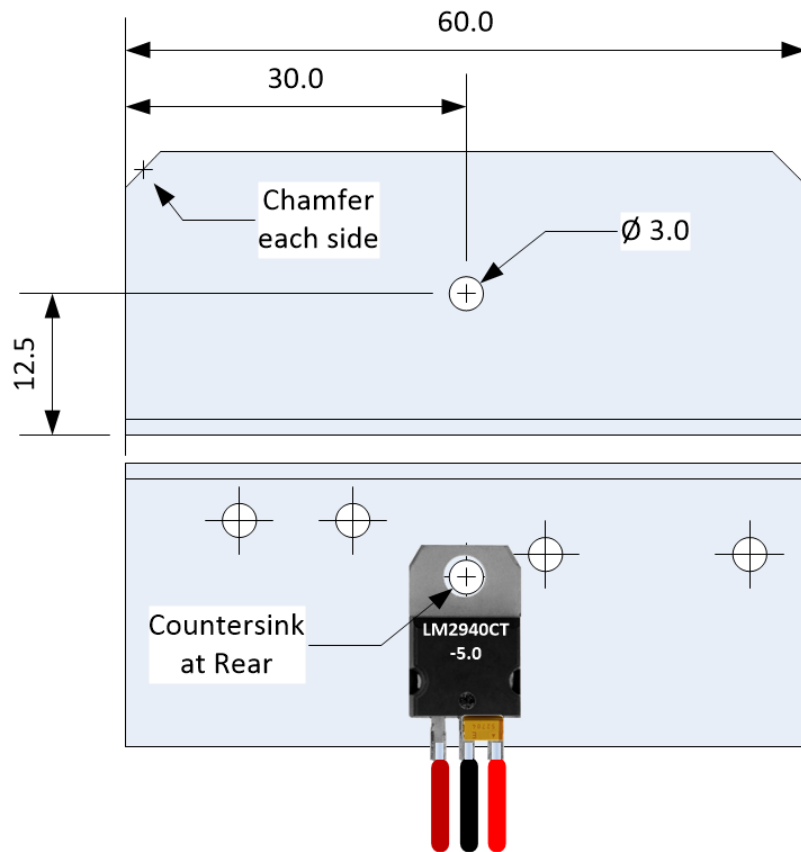
Figure 3 – Heatsink drawing

Figure 4 – Scribing construction lines on self-adhesive paper labels
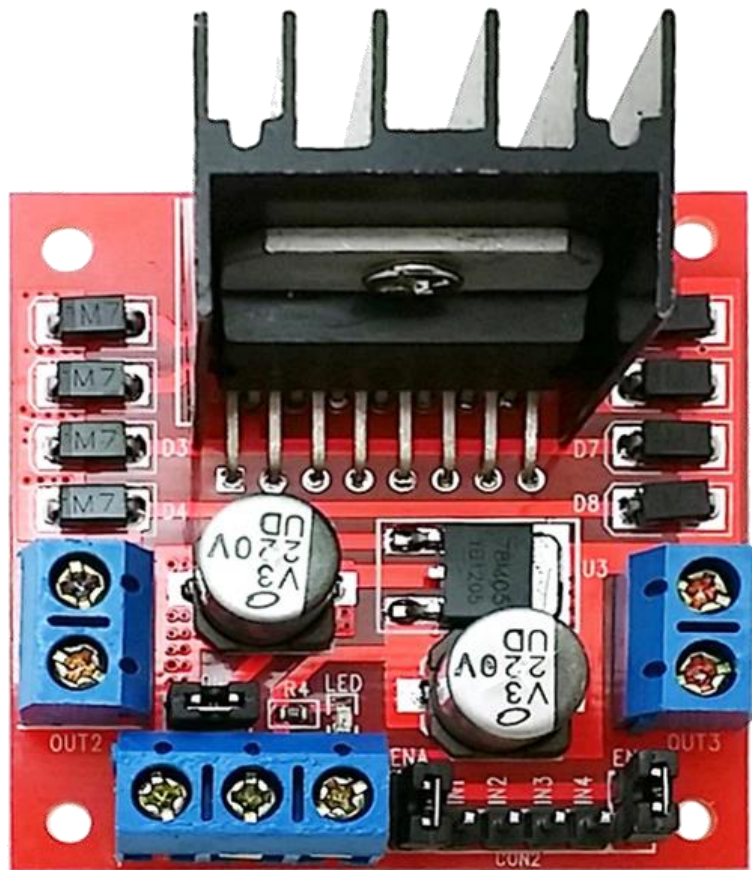
Figure 5 - L298N Motor Driver
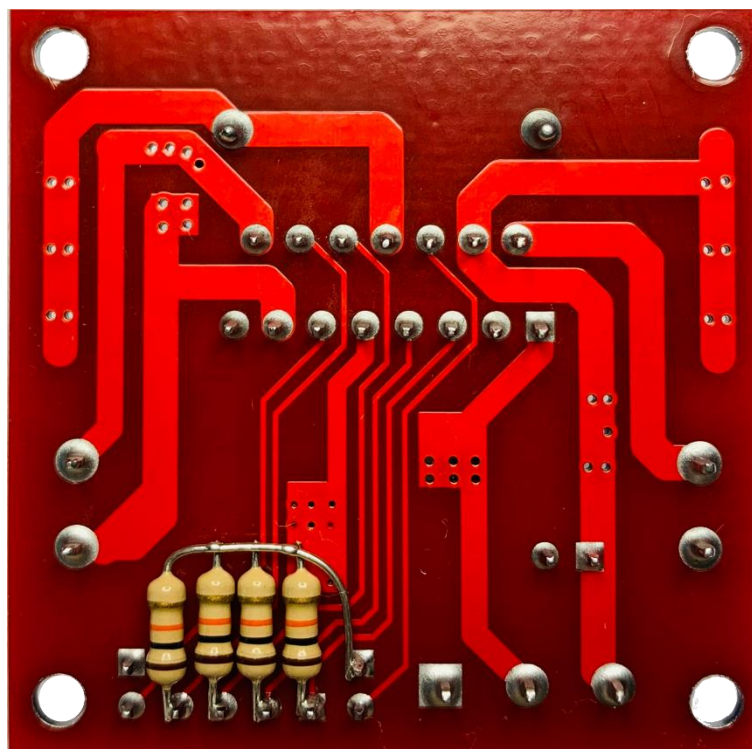
Figure 6 – Modifying the L298N Motor Driver

Figure 7 – Front side of the Enclosure
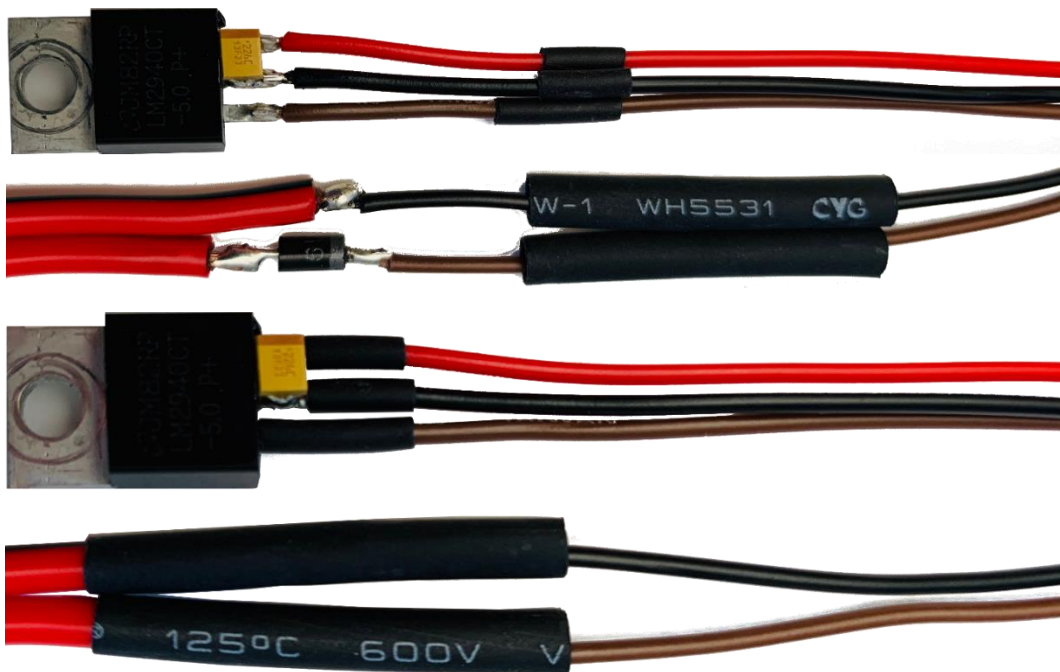

Figure 8 – Left side of the Enclosure
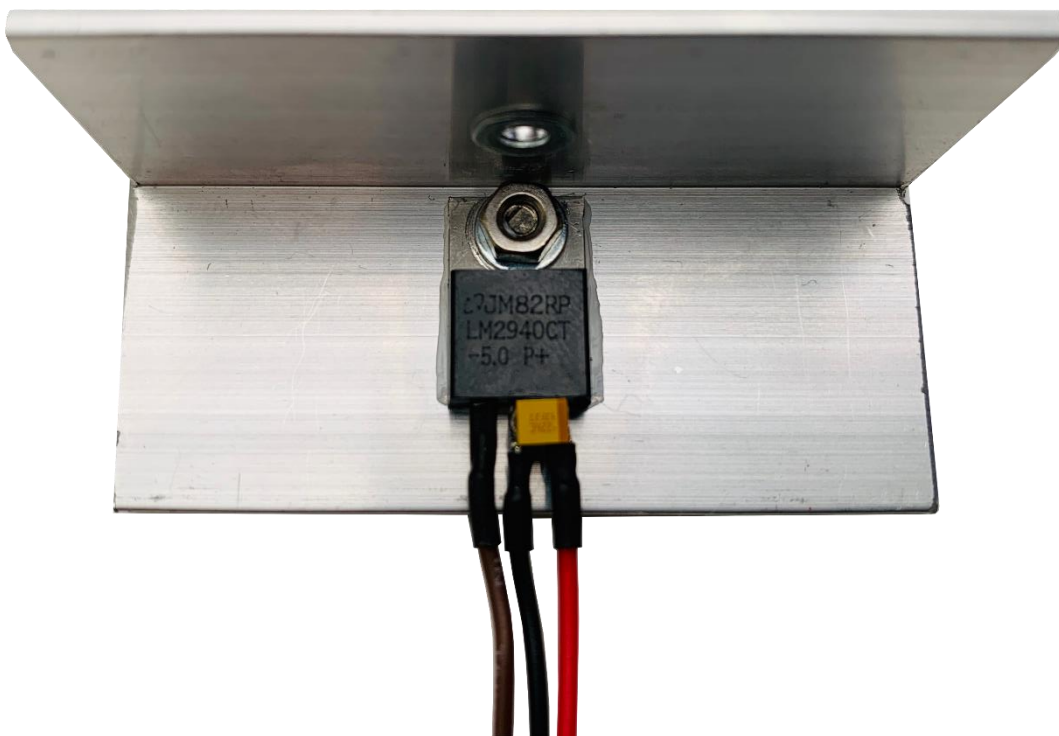
Figure 9 – Regulator and Power Wire Preparation.

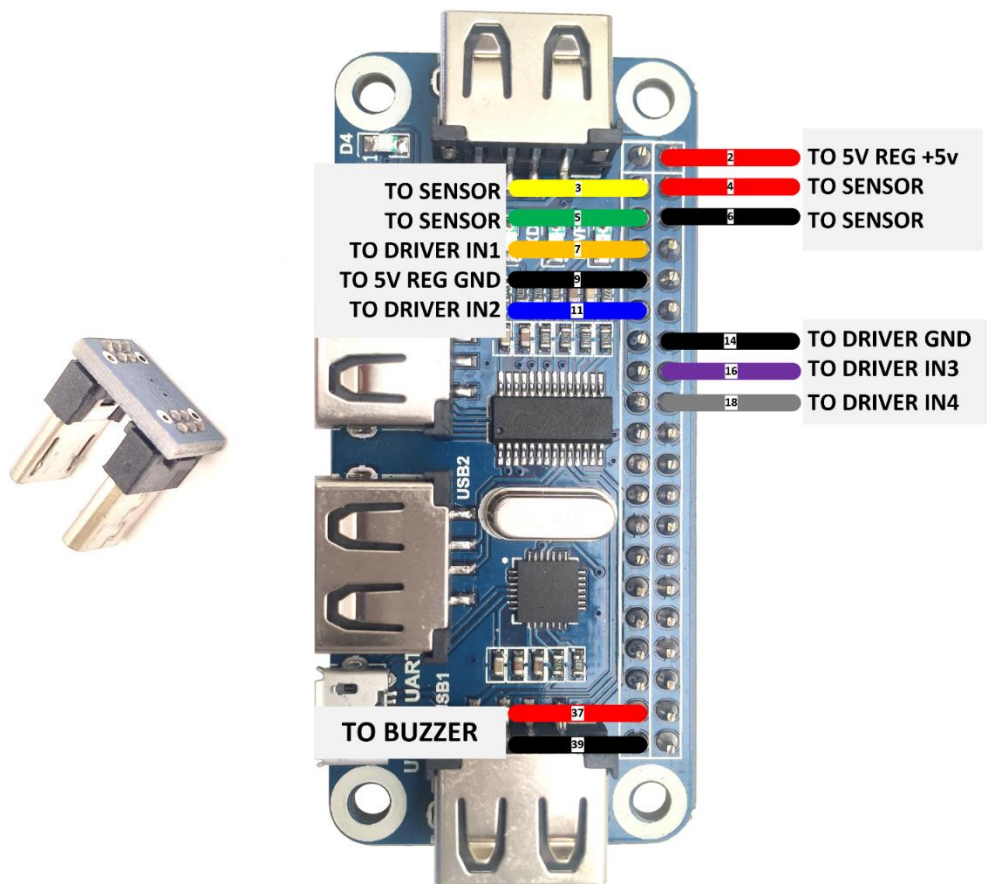*Figure 10 – Mounting the Regulator on the Heatsink*
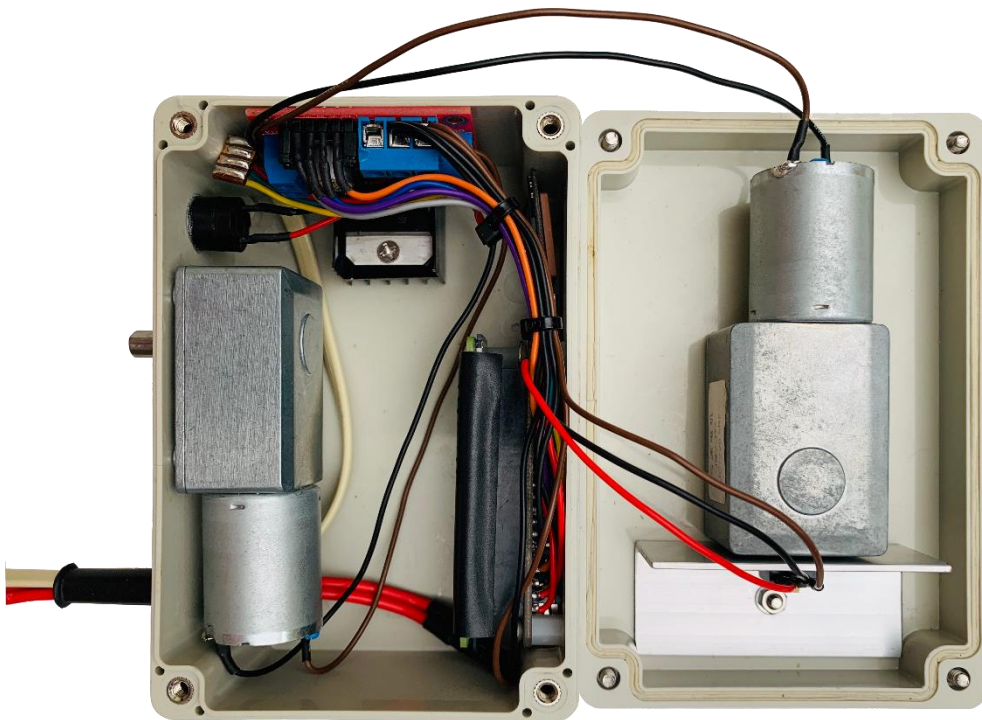
Figure 11 - USB Joiner and USB Hub Hat

Figure 12 - Wiring and assembly complete