

ANOTHER BOXSTER/TESLA EV CONVERSION

This is a short introduction into the project. I was having my daily driver serviced in 2020 when the garage owner and I started talking about electric cars. I told him that an older Boxster as a great doner vehicle. He stopped talking for a second and said, "Have I got a deal for you!" Another customer had just towed their 02 Boxster "S" into the shop with a blown water pump and told the garage owner to sell it. That's how I got the car in the picture below. It had 79,000 miles on it and the body was in great shape. Wheel, tires, stereo and lights are aftermarket. I got it towed to the house in mid-September. The following is a chronology of the teardown and EV build.



Figure 1 - Car Delivered

Sep 22

- Pulled carpets & plastic covers from frunk, trunk and engine compartment
- Missing bolts on plastic side covers in frunk
- Cable for left side of convertible roof broken
- Will need more plastic plugs for carpet
- Tow hook and black plug is in spare tire jack package with spare tire

Sep 23

- I picked up two 3-T support jacks and two 6-T jacks from Canadian Tire to lift car
- Removed 19" wheels
- Removed rear plastic bumper and bottom middle plastic skid plate



Figure 2 – Car with Wheels & Bumper Removed



Figure 3 - Exhaust System, Mufflers & Heat Shield

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Sep 24

- Took off exhaust piping, muffler & cat converter
- Started draining coolant - found some rust. Took Spoiler off
- Removed all rear wheel well fenders
- Needed to put bubble wrap over sharp edged of bumper supports. Lots of small cuts on head

Sep 25

- Removed the following:
 - Main black rear support arm under car off
 - Rear aluminium bar off
 - Marked play in drive shafts
 - Sway bar off
 - Rear triangular skid plate
 - Main rear heat shield



Figure 4 - Sway Bar & Engine Supports Removed

Sep 26

- Finished draining all coolant – looks clean now. Kept all rubber hoses as will probably have to reuse for revamping the cooling system for the motor and battery charger
- Removed small skid panels on left side to get to clutch hydraulic lines
- Draining hydraulic lines for clutch on left (drives) side - 19mm & 15 mm wrenches needed

Sep 27

- Took all hoses and hard plastic and metal lines off car (Clutch hydraulic, fuel, coolant)
- Removed all electrical cable bundle from trunk and pushed through fire wall
- Set lifting cart under motor. Cart is rated at 500# but I think motor and gearbox will exceed 600# so should be interesting

Sep 28

- With my son, we lowered motor & tranny onto cart – very heavy
- Still need to jack car up higher to roll cart out
- Tranny supports still need to be removed

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Figure 5 - Motor & Tranny Removal



Figure 6 - Close up of old ICE & Tranny

Sep 29

- Build a few wood platforms to put under jack stands to raise car
- Blocked up motor and replaced black lifting cart with smaller lower wood cart. Lowered motor onto wood cart and after a few more raises of the rear while lowering the front, got motor out of engine bay. Removed engine and tranny as one unit. The unit was probably 650 lbs.
- Need to weigh car shell. A normal Boxster S with 3.2L engine is 2,900#. With engine, tranny and exhaust gone, weight should drop by 750#.

Sep 30

- Removed **air filter?** and aux cooling fan from old engine bay
- Measured up open area old engine bay for new motor & battery packs (approx. 18" x 21" x 33")

Oct 01

- Researched gas tank removal
- Researched removing clips from front plastic skid plate. Two screwdrivers will do it

Oct 02

- Removed clips and front skid plate to remove fuel tank
- Looked under gas tank to see how to remove. Need to remove two cross beams and then start cutting gas tank. This was where the battery charger and 350V/12V converter were going
- Disconnected mass flow air sensor piping from white coupling on LHS under car
- Trying to disconnect clutch line (blue) – very tight. Looks like stripping some of the bronze fitting. Need to make sure this will not impact the brake reservoir.

Oct 03

- Started syphoning the gas from tank but there is a blockage in the tank and only drained off about 10L
- Removed stereo amp from Frunk. Marked all wiring so it can go back in again
- Removed last front carpet from Frunk
- Ordered oil pump for reverse operations from Zero EV in UK

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Oct 04

- Raised the front of the car up a bit and will be sliding the shop vac tub under car and drill a hole in bottom of tank to drain remaining 15 gallons of gas. Cleaned out shop vac tub so can reuse gas in other vehicles. Needed a big funnel and a 25L (6 gal) gas can.
- I found out that the fuel tank can be drained by putting jumper on the fuel pump relay and have the existing pump drain the fuel. I filled up the daily driver.
- Removed lower cross bracing for fuel tank, fuel tank straps and skid plate under tank.
- Removed fuel pump sender and fuel level gauge. Not much fuel left in tank. Will add water to tank and drill hole and drain remaining fuel

Oct 06

- Started removing fuel tank. Lots of cutting with Sawzall. See tank remnants in red circle of picture below.



Figure 7 - Comparing Old vs New Components

Oct 07

- Still working on fuel tank. Used a portable drill to cut a row of holes and then cut plastic between holes with Sawzall
- Removed gas filler pipe into gas tank and overflow hose at fuel filler on side of car

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Oct 08

- Found a strap on the front of the fuel tank and removed. This allowed the tank to move around a bit and was able to cut larger pieces of tank and finally got it all removed
- Removed all fuel lines from car

Oct 09

- Picked up the Tesla motor and battery pack. Motor is a 350KW "P" motor from a wrecked 2016 Tesla Model S. Battery pack and charger are from a 2015 KIA Soul EV with 20,000 miles on it. Unit is rated at 360VDC.
- The motor seller dropped a cherry picker off as well to assist with dismantling
- Removing cabin console to remove tranny shifter cables – going to an outside buyer

Oct 10

- Lowered rear of car two notches on jacks.
- Reinstalled rear aluminum and plastic bumper to confirm space for motor & batteries
- Removed plastic rear bumper again so I could remove heat shielding from aluminum bumper
- Reinstalled plastic bumper. Had one missing screw on driver's side just above wheel well but was able to find a spare and installed

Oct 11

- Put Tesla motor on lifting table and raised it into approx. position in engine bay. See below.
- Will need to relocate AC compressor from behind seat as hoses are in way of battery pack
- Another buyer is buying the old motor along with all exhaust system for \$1,100. He will pick it up at end of month



Figure 8 - General Placement of Tesla Motor in Engine Bay

Oct 14

- Test fit charger and JB into hole where fuel tank used to be. Very tight if keep unit horizontal. Will consult if I can mount unit vertically. May have to cut old battery cradle to get it to fit

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Oct 21

- Test fit (again) charger & JB. Will fit if mounted vertically. If charger goes in this area, then brake vacuum pump and PS hyd. pump may have to go into engine bay.

Oct 22

- Starting to look at how to power 12VDC motors for cooling, vacuum and PS.
- Need to see if I can get 350VDC/12VDC inverter to feed into existing 12VDC system or battery. I am worried that the Porsche electrical system relies on using the frame as a ground. I found out that 12VDC from the inverted do the same.

Oct 25

- Built an aluminum angle iron bracket to vertically hang the charger/JB from where the battery used to be. Had to drill some holes in the Boxster steel. It is a tight fit and I need to get all the pieces together (especially the electrical wiring) when it is installed because it will be very hard to get back in to make modifications once the skid plates are back on.
- Mounted the Charger contactor where the gas tank used to be. Had to drill a couple of holes here as well
- With this set up, there is room for the orange power cables and cooling water tubing.
- Will need to extend the line for the AC charger plug in as it is about 6" (150mm) too short.
- Need to confirm the environment is suitable for the charger and contactor equipment.

Oct 28

- Removed charger and battery from fuel tank area to confirm dimensions
- Have asked motor frame supplier what specific dimensions are so can confirm battery box width - no reply yet

Nov 01

- Bought a clamp on volt-meter on e-bay that goes to 200Amps on DC voltage - works good
- Built wooden box to possible dimensions of battery pack (35"L x 16"W x 18"T). This will be a tight fit for the batteries. Issue may be the parking brake cables which don't allow box to be pushed up against the car frame. Will need to confirm what others have done



Figure 9 - First wooden Battery Box Template

Nov 03

- Broke fuel door hinge as I walked past. Will need a new one either from wrecker or e-bay

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Nov 04

- Started removing the clutch hydraulic tubing
- Need to find out how to plug feed line that comes from brake reservoir

Nov 08

- Got blue hydraulic line removed without cutting. Need to open up an existing hole in the front driver wheel well to get fitting to pass through. Should not be a big deal.
- Next task was to removing clutch pedal. May have to remove driver seat. It turns out I left the clutch pedal fully depressed into the floor.

Nov 15

- Removed driver seat to access clutch slave cylinder.
- Removed wire clip on small blue hyd. tube that goes through firewall to clutch slave cylinder. Not a lot of room here to work
- Removed clutch slave cylinder from foot well. Very tight with 10mm wrench. Need to work on my back with feet towards back of car.
- Need to remove two relays to access screws for slave cylinder
- I will use the holes to run electric cables

Dec 15

- Took a few weeks off waiting for parts that were ordered in November
 - 3-piece plastic battery cover for frunk (didn't use as I already had these parts)
 - PS pump, Vacuum switch for brake booster & Fuel Door hinge from e-bay
 - Electrical parts for main Contactor Box from Gigavac & EV West
- Found out that for cooling, I should only use one radiator. Spent the day removing all the existing cooling tubing and hoses from front of car. Needed to remove front bumper to get a middle radiator. Will isolate the middle and RHS radiator and only run on the left radiator. Made a cooling schematic for clarity. Will make a mock up and test the pump and cooling system this week
- Also found out that the vacuum pump will interfere with the battery boxes in the engine bay so will be relocating this to the gas tank area. Will need to find a mounting location and power source for this. The power source needs to have ability to be activated by the garage charger and key ignition
- One of the Open Forum contributors has identified the 12V power sources that are available with the removal of the ICE. These can be repurposed for the Vacuum, Cooling and PS pumps.
- Bought a TDK DC-DC converter from a Ford Transporter for the car. Hopefully I will be able to use this with the existing equipment. If this doesn't work, I will probably buy the Stealth EV combination DC-DC Charger
- I was going to mount the DC-DC and charger in the old gas tank area but now that I will be having three (possibly 4) pumps in that area, I may move it to the Frunk.
- The build in England is being featured in the December issue of 911 and Porsche World magazine. I will get that as a Christmas present
- Ordered contactor directly from Gigavac as local EV company was too slow in responding to requests
- Found out that car has electric accelerator so it should be able to be wired directly into Tesla motor. Got accelerator wiring diagram from build in England

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Dec 31, 2020 – Jan 01, 2021

- Motor frame arrived from England so put motor in it and positioned in car.
- Assembled motor frame and installed motor for fitting only. I still need all the electrical wiring and contactor box to fit as well



Figure 10 - Looking from rear of new Motor Mount



Figure 11-Looking from top of Engine Bay with Tesla Motor

- Started building mock battery boxes. Very tight fit
- Disassembled 4 of the 8 battery modules. Marked all wire(s) and connection points
- When the batteries are installed, I will add a bus connection and add cable in between to make the cables to the BMS long enough



Figure 12 - Kia 8 Module Battery Bank

Jan 03

- Looks like I can get 6 batteries in front of motor and put 2 under trunk
- Ordered contactor box
- Broke small breather cap on Tesla motor. I will see if this is a major issue – still need to replace



Figure 13 - General Motor & Battery Arrangement

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Jan 10

- Ordered orange 2/0 cable, heater, end caps and heater contactor from EV West
- Modified wooded battery box to be 36" long (removed one inch) and overhung the top battery by 2.5". Just fits into the area between the bracket and firewall (13"). To get in in and out, needed to tilt top towards back of car and slightly angling the box so it just slides down between the two sides of the car frame. Used engine hoist to raise and lower box.
- Looked at the motor side mounting bracket. It doesn't appear to be very well machined, and I will be asking the vendor if this is ok. Still need to press the existing engine mount bushing into the new mounting bracket. Also the new bracket rubs against the screws on the gearbox casing.
- Getting the motor and battery box into the car will be a challenge. I may have to remove the bottom horizontal motor frame and hang and support the motor off the rear motor mount. This should give me enough clearance to position the battery box and install the cross arms of the motor frame. I could then swing the motor into position

Jan 12

- Called Air Conditioning (AC) guy to come and remove refrigerant from AC lines. If I decide to install AC, I will probably move compressor to gas tank area.
- Had to bleed the air out of the lifting table. Pump would not work all the time. This may be a reoccurring situation. Was able to quickly release the lowering handle which seemed to fix problem
- Tried to install battery box after installing motor but there is not enough room

Jan 13

- Used hoist, jack and lifting table to mount battery box and motor into car for fitting
- To install battery box (do first)
 - Raise car 2' to slide box upright under car
 - Make sure all motor cross framework is removed
 - Lift box using hoist perpendicular to car
 - When about 12" (300mm) off ground, shift box sideways with driver's side pointing back
 - Continue to lift and watch parking brake cable lines. Drivers side cable can be slipped onto the wider portion of the box
 - Tilt driver side of box up slightly to clear main structural frame. This should allow more lifting and the passenger side parking brake cable to pass by the wider side of the box
 - Once both sides of the parking brake cable are onto the larger side of the box, continue to lift until the brake cables go into their slots in the box
 - Lift until the top of the box hits the engine cover lip
 - From under the car (but not under the load) install the front motor bracket (4 bolts)
 - Swing bottom of the box towards the front & lower slowly so the box rests on bracket.
 - Push the box as far as possible towards the firewall
 - I still need to develop a fastening plan to secure the box to the car
- To install motor (do second)
 - Remove the bottom flat horizontal motor frame from the car
 - With motor in cradles on lifting table – measure height of rear motor bracket from table base. It should be about 8" (200 mm)
 - Roll motor under car from rear and lift with the rear motor bracket directly under the motor frame bracket

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- Lift motor $\frac{3}{4}$ way into position
- Loosen the 4 bolts holding the top flat horizontal motor frame to the car. Remove 2-3 bolts and lift motor so motor bracket fits into top horizontal frame
- Install large mounting bolt connection motor to frame
- Replace all top horizontal mounting frame bolts and tighten (70 NM)
- Moved hoist to back of car behind lifting table & hook onto front motor mount to take weight
- Position jack on gearbox side of motor so that it will not interfere with the installation of the bottom flat horizontal motor frame. Take the weight of the gearbox
- With motor connected at three points, slowly lower the lifting table 1" (25mm)
- Slide the bottom flat horizontal motor frame onto the lifting table along with the long aluminium cross arm and bolt it into place (4 bolts).
- Do same on other side
- Install long bolts for black cross arms from top of bottom flat horizontal motor frame
- Lower hoist and jack so the motor rests flat horizontal motor frame (Motor may be sitting on bolts)
- Remove hoist and lifting table from rear of car
- Reposition jack so it is directly under gearbox
- Install black cross arms from flat horizontal motor frame to front bracket where battery box is (4 bolts each side)
- Install front motor frame onto black cross arms
- Installed large bolt connecting front motor bracket to front motor frame. Very tight

Jan 15

- I needed to split the Tesla gearbox to install reverse oil pump and control board
- Stated by draining oil from bottom drain plug

Jan 16

- Removed every second bolt on out casing and using a small chisel to try and force halves apart
- Watched Doug's video on installing Quaif LSD to get some ideas on how to split case
- Found out there is a small electrical temperature line that runs from the inverter to the motor that cannot be pulled out. To split the casing, you need to wedge apart and then open up on an angle to keep from severing the temperature probe. See pics

Jan 18

- Case is split and removed old oil pump
- Lots of Permatex on flanges that will have to be removed before reassembling

Jan 19

- Disassembled old oil pump and installed old impeller in new oil pump. Had to force a couple of split pins out of old pump casing and install in new pump casing.

Jan 20

- Started to remove cover on Inverter to see if I can get more slack for motor temperature probe
- Still removing old Permatex from Tesla Gearbox

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- Will probably have to file down a couple of flange faces where chisel may have marked machine faces
- Cables from EV West arrived

Jan 22-24

- Still removing old Permatex from Tesla Gearbox
- Trying to find a JB that will fit between Battery Box and Opening for motor in car. I would like a plastic box but may have to settle for a metal one. Dimensions are 14"L x 8"W x 6"D

Jan 26

- All Tesla Gearbox Permatex gone
- Gave inside of gearcase a quick comp air spray and wipe to get all old gasket material out
- Confirmed with Doug how to put unit back together again
- Dressed all bolts on diff bearing retainer and casing bolts

Jan 27

- Assembled new oil pump. Needed to make existing hose 6mm shorter to fit into gearbox. New nozzle is slightly longer than OEM unit
- Installed oil pump in casing
- Installed diff assembly into casing. Not an easy fit. Needed to hammer side of large gear to get it to line up. Had to be careful not to stretch the temperature probe cable at one end of casing so was limited into how far the casing could be opened. It was more like a clamshell on a 45-degree angle. Once I got the retaining bolts into through the casing, I could put the nuts on and suck the bearing into its seat

Jan 28

- Pulled cover off inverter to see what it looked like. Quite an efficient compact engineering design. Found where the new control board will be installed

Jan 30

- Applied lots of new Permatex to gearcase flanges and put gearcase back together again. Added some transmission oil to make sure there were no leaks
- Next step is replacing the control board on the inverter
- Torqued casing bolts to 18 ft-lb



Figure 14 - Tesla Motor Single Stage Gearbox



Figure 15 - Tesla Motor Inverter

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Jan 31

- No oil leaks in casing so added 2.3L of tranny oil to casing – fill to top of filling hole
- Shortened bolt and countersunk casing so the new side engine mount bracket would fit. Installed bracket to ensure it would fit. This bracket to be installed when the motor is in the car.



Figure 16 - RHS Tesla Motor Mount

Feb 07

- Put the motor back in the car – under 40 min without electric cabling
- Looked at the side motor mount that interferes with the hyd brake line. Started grinding some of the mount to get it to fit. Probably need to relocate brake line. Will discuss with Doug

Feb 10

- Will visit Riddleworks to get a quote on the battery box and other machining work
- Doug dropped off some parts and pick up a few feet of 2/0 cable
- He took the hoist back

Feb 11

- Dropped battery box pattern off at Riddleworks along with side engine mount and new bracket. Old Tesla engine mount needs to be pressed out of old Tesla housing and into the new conversion mount

Feb 16

- Contactors from Gigavac arrived
- Measured contactor box opening again and will be able to install a 14" x 9" x 6" box. No one makes one this size so may have to build one myself or find a close alternative. Biggest obstacle is the 9'-10" between the battery box and the car frame

Feb 18

- Tore out old battery box – no use anymore
- Started build a new battery box that will have same dimensions as metal one
- Put tires back on car and lowered it to measure where the Tesla drive shafts need to be cut. See pics 2076 – 2080 & 2085

Feb 23

- New wooden battery box built. Need to modify battery box frame to accommodate motor mount support gussets. This required the box to be 36" long instead of 35". Either the battery box is modified as above or the gussets on motor frame need to be redone

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Feb 25

- Needed to increase vertical clearance between frame 1 and 2 to 7.5" from 7" to accommodate large battery installation and removal. Total height is 22" and total length is 36". Top tire (two batteries) are off-set 3". To accommodate top of fire wall curvature

Feb 26

- Fit new battery box into car. Still some mods need to be done

Feb 27

- Cut out foam insulation on fire wall to get battery box to fit tight against fire wall
- Fit new battery box in car along with mocked up contactor box
- Fit an actual battery into battery box while in car
- Yellow mark at the center left of motor frame is where the support gusset needs trimming

Mar 13

- Got battery box built in aluminium from RiddleWorks in Richmond
- Very good quality
- Needed to take it back and have adapter spacer for brake cables modified. Fits well now.
- Started build mock up controller for motor and battery



Figure 17 - New Main Battery Box for 6 of 8 Batteries

Apr 15

- Built mock-up controller and started doing bench tests on motor to try and get running. I made lots of mistakes in connecting the wiring to the contactors and motor. I needed to understand the parameters that were created by the Open Source developers. Doug was a big help, and I did lots of reading on how the unit is supposed to work. See Figure 18
- Had Juan and Josh over to measure stub shafts for drive shafts. Motor was in car and added 400# of weights to simulate batteries being in car
- Looked at the Tesla built in WIFI to see the parameters that are already stored in the unit and which ones could be changed.
- Hooked up the unit to 186VDC (1/2 the battery pack) and adjusted the udcmin to zero (0) for the test run. It still didn't work.
- Recalibrated the accelerator pedal as per Open Source instructions. Motor still wont run.

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Figure 18 - Motor & Accelerator Testing using 180 Volts

May 24

- Getting frustrated that the motor won't run. Relooked at all information relating to accelerator pedal calibration and wiring

May 27

- Started reconfiguring the wiring to the accelerator pedal and finally at 9PM got the motor to spin. This was truly a Eureka moment.
- Pic 2207 shows the proper configuration of the wiring to run the motor. This is the wiring for the Ford accelerator pedal. I will need to recalibrate the Porsche pedal in the car for the final install
- Noticed slow oil leak in Tesla drive unit. Oil seems to be coming from small bolts that hold the Quaff LSD. I will tighten these up when I take the motor out of the car to install the batteries.

Jun 02

- Now need to get batteries fitted into aluminium frame and start to connect the power cables and the BMS cables together in the battery frame



Figure 19 - New Battery Box fully loaded with 6 Batteries, BMS & HV Cables

Jun 03

- Put all controller components into permanent Controller Box. There is lots of room in here for additional components such as fuses and wiring for DC/DC converter.

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Figure 20 - Main HV Contactor Box with 700A fuse

Jun 05

- Getting aluminium frame ready for batteries
- Drive shafts are ready and did initial fitting. They are cut to size but not welded. LHS fits perfectly with lots of play.
- RHS drive shaft is too long. Took them back to machinist for him to take 1/8" (3mm) off Tesla side. If this still isn't enough clearance, I will get him to take 1/8" off Porsche cup side. The shafts are 5 1/4" long. EV West has Porsche/Tesla stub shafts that are 5" long (\$1,250 USD plus shipping for the pair). The repair should be ready next week
- Dropped off plans to the machinist for the under-trunk battery box



Figure 21 - Getting Stub Drive Hubs Machined



Figure 22 - Fully Welded Stub Drive Hub

Jun 13

- Fit all 6 batteries are in the aluminium frame. Needed to take a skim off the inside tubing of the middle frame as it was too tight for the batteries. Now the batteries can slide freely
- Starting to wire up the BMS wiring for the batteries. I will need to extend the BMS wires for the two batteries that will go under the trunk. All the other BMS wiring is long enough to be connected with the aluminum battery box.
- Need to confirm if I need to put the BMS wiring inside a plastic loom for safety
- Orange plastic loom are ordered and will arrive at end of month
- Started to splice wiring for under-trunk batteries BMS wiring. I am using the premade sleeves with built-in solder. Seems to work pretty well. I put a separate shrink wrap sleeve over this as well
- There are some BMS wiring to the bottom of the batteries that does seem to be connected to anything. I will ask Doug if these were ever connected

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- To connect all 6 batteries in series, I fabricated a few connects using the Enflex copper strips. . These seem to work well. I need to confirm if the power and BMS wiring needs to be isolated with a loom or Plexiglas. Not a lot of room in the area.
- I can't find a BMS wire for L3 Bottom. I tagged all wires before disconnecting and do not remember tagging that one
- There will be 7 sets of wires going to the secondary battery box under the trunk.
 - BMS L3 and L4
 - L3 Top A, L3 Top B, L3 Bot (If I can find it), L4 Top, L4 Bot

Jun 17

- I got the driveshafts back today. LHS is still tight and I have moved the motor as much to the RHS as I can. I will take out motor and see if I can use a smaller spacer on the RHS motor mount to pull the motor a little more to the RHS.
- Putting looms over all wiring in main battery box. I don't know if it is needed, but I will look nicer.
- Fabricated a 2/0 battery cable to get the battery in series configuration.
- Also have installed the Enflex copper strips to connect batteries together.



Figure 23 - Custom HV Wiring between Battery Modules

Jun 19

- Dropped the motor again to see if I can move it to over to get more clearance on the LHS drive shaft. With motor out I will tackle the following:
 - Water pump location and water and electrical connections. This will include hooking up the reservoir and fill tubes
 - Get power steering hoses out so I can custom make new ones to fit PS pump. Will also find location to mount PS pump
 - Mount Brake Booster vacuum pump and run all hoses and elect wiring
- May need to trim the suspension bolt beside the Tesla Harness. With the car on jacks, it was impeding removing the 23-pin connector. Had to lift motor separately to get clearance

Jun 20

- Starting to put loom on all wiring in the Battery Box. It is getting quite tight between the two rows of batteries
- Received the 1" heavy duty loom from EVT and stuffed all the cables going to the second Battery Box inside. This may be too stiff for this purpose. I may go with the lighter 1" loom.

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Jun 22

- Started to install the power cables into the main Battery Box. Needed to make two/three additional 2/0 short cables using the 90-degree cable ends from EVTV

Jun 23

- Decided to reroute the power cables in the main Battery Box so the cables going to the Contactor Box and secondary Battery Box come out of the top and back of the main Battery Box.
 - I was trying to connect the 6 batteries in the battery box in series. I mapped out the power cable wiring so the input and output of the battery box comes out the top two battery modules towards the back of the car. The motor was not connected and the battery box was outside the car
 - I labelled and connected all the BMS and temperature wiring for the modules in the battery box and wrapped looms around them
 - I custom made each power cable and labelled each end. Then I started connecting the batteries in series. I was connecting the last power cable from L1 to S3 when I heard the pop and there was a slight burning smell that seemed to come from the BMS box
 - I opened BMS and found a burned section in lower portion of circuit board. Doug said it looked like a burned input protection diode (Red circle in picture)



Figure 24 - Blown Diodes in BMS Circuit Board

- I know there are 2A fuses for each BMS wire in the top of each battery module. I removed all the cables and batteries from the battery box and checked all the 2A fuses in each battery. So far 19 of 22 fuses were blown in Modules S3 and S4. A couple of fuses were blown in L1 as well.
- The other two larger modules (L3 & L4) were not connected as these will be going under the trunk. These are the two batteries where I extended the BMS wiring by 7'. I was very careful to extend only one wire at a time to make sure nothing goes wrong. Each wire was soldered and shrink wrapped.
- It sent a note to Surtek in Burnaby to see if they can look/repair the board. If it cannot be repaired, I need to get an exact board from the same year to get the BMS to talk to the charger. If I cannot get an exact board, I will need to buy a new aftermarket BMS/DCDC/Charger System. There is one made by Stealth EV that looks promising.

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Jun 24

- Rear Battery Box is complete as are some of the panels for the main Battery Box. I picked them up. Still need to get the drive hubs welded
- Put main Battery Box in car for a fitting.



Figure 25 - Fabricated Rear Battery Box for Two Battery Modules

Jun 27

- Removed the heater tubing from car. Needed to remove the windshield wipers and front hood cover at the bottom of the windshield.
-



Figure 26 - Area for new 1500W Electric Cab Heater

- Removed the PS hoses from under front of car. I will get them together with the PS pump and get new hoses made 6' long should be good. Needed to remove front wheel to access HP socket head and clamp

Jul 01

- Working on the low voltage wiring inside the cab. This is the center console which houses the switches for the Motor Contactors, Power Steering Pump, Brake Booster Pump and Cooling Water Pump. The "transmission" is the Red/Green switch just below the "Boxster S" logo.

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Figure 27 - Cab Console to house Main Contactor Switches

Jul 15

- Installed the vacuum pump where the gas tank used to be. Connected the pump to a clear reinforced plastic hose and that hose to the existing vacuum piping going to the brake booster.
- Connected the cooling system hoses to all the components that need cooling. (motor, charger, DC/DC converter) and ran the motor. It draws 3 amps which is good. Some water was leaking from the coolant reservoir in the trunk, so I need to confirm what hoses need to be blocked off
- Ordered a new BMS from KIA. It should arrive in the middle of August, and I can start to prove out the full electrical system.

GET PICS of Water & Vacuum Pumps FROM STEVE

Aug 01

- Ran the power and control wiring for the vacuum brake booster. All seems to work well.
- Order 6 switches that will go in the console between the driver and passenger seats. They are supposed to be illuminated when turned on, but I haven't got that to work yet. It draws 7 Amps.

Aug 9

- Put the tires back on the car and spun the wheels. Very smooth running. I turned on the vacuum pump, spun the wheels and used the cars brakes to slow the car down. It seems to work. I tried it with the vacuum pump on and off. The brakes were definitely better when the vacuum pump was on.
- Next step is to have someone in the driver's seat and apply the brakes when the accelerator is pressed. This will be the first roll of the car under its own electric power

ANOTHER BOXSTER/TESLA EV CONVERSION

Aug 14

- Mounted contactor box on motor and modified Contactor 12V wires so can be easily disconnected. Hooked cooling up so it just runs to the motor. The care actually ran on its own power of 90V for 3 feet (1m) – Milestone

Aug 22

- Hooked up 180V batteries and ran car out of garage into alley and back in again. This was about a 20' roll under its own power – another milestone. Car seems more powerful with 180V. Just image 360V

Aug 23

- Ordered more HV cables so can get the BMS and charger hooked up
- Also ordered EBOII kit for android and apple products. I will need this to remove faults in car with CMS not connected
- Next step is to find the wire loom in the trunk for the Boxster accelerator pedal

Aug 28

- A good weekend on the car. I found the loom for the Boxster accelerator pedal and connected the wiring to the 23 Pin Tesla controller. Works well
- Replaced the old liquid heater in the front of the car with the new electric heater. This job was delayed because it involved removing lateral frame supports that had to be done with all 4 wheels on the ground. I am waiting for some 8-gauge wiring from EV West that power the battery with 300V. I have the connector and contactor for this.
- I was going to re-install the front air dam and windshield wipers but found that the air dam has some broken pieces around the mounting screws. Repaired the mounts with new plastic and I will get it ready to install soon.

Sep 02

- Rolled car into alley to confirm Porsche accel pedal works on Tesla motor. Very responsive
- Started cooling water pump and could hear liquid circulating around and dripping down inside radiator. I was concerned the pump would need to be primed before each run. I will try and add water to the reservoir to make sure it is topped up

Sep 03

- The looms from EVTV and the wires from EV West came via UPS. In the order was a small 8 wire fuse box that I will use for the low voltage wiring. It will be mounted inside the console storage area. There is heavy gauge 12V power cable running down the middle of the console that will supply power for the fuse box. This will all the following equipment to be fused:
 - 12V to Tesla Inverter (5A-10A)
 - 12V pre-charge relay (5A-10A)
 - 12V ignition contactor (5A-10A)
 - 12V main contractor (5A-10A)
 - 12V cooling water pump (5A-10A)
 - 12V vacuum booster (10A-20A)
 - 12V power steering (40A)
 - Electric cabin heater (10A)

ANOTHER BOXSTER/TESLA EV CONVERSION

- Redid the wiring with proper connectors on the pre-charge relays in the contactor box
- Redid the wiring connectors from the contactor box to the new fuse box. Use pre-built ones with pigtails from Amazon

Sep 10

- Put 4 batteries in the trunk to see what additional performance was – good

Oct 01

- Got a new plastic cover plate from Conan using a 3D Printer. Needed to expand slot size for the switches.

Oct 03

- Redid all the wiring for the switches and got all 6 switches into the revised 3D Printer.
- Put the Fwd/Rev switch into the top of the console in the shifter cover plate. Will try and get the light working
- Had to change the grounds for the Main and Pre as they were backwards. I'm not sure how it happened but it has been fixed.
- The 6 switches are 120VAC so the light probably wont work. I still need to grind out a bit more of the bottom of one corner as it interferes with the bottom of a switch.

Oct 12

- Steve Armstrong came over to video the car running up and down the alley.
- Removed the empty battery box from the car without removing the motor. Not a good idea as I had to disassemble the battery box to remove it.

Oct 20

- Put the two large batteries in the rear battery box and fitted it under the trunk. Still looking at the best way to run the power and BMS cables from the batteries to the contactor box.

Oct 21

- Bought thin gauge large dia. hole cutters for metal plate.
- Also bought stress relief cable gland for the battery boxes.
- Bought an automotive contactor box at HD. May need this for the disconnect switch or a separate connection.
- Cut holes in Battery Box and installed the cable glands to see if it would fit under the trunk. It did not fit. Will drill holes in a different location so the power and BMS cables can be run.

Oct 25

- Got the engine compartment out for fitting to see how much room there will be above the battery box. I need extra room to mount the BMS on top of the batteries.
- Fit all the batteries into the main battery box and connected the HV together. Checked voltage to be 250VDC. Add labels to power cables for future removals/replacements.
- Ground down the plastic feet that were slightly wider than the frame.
- Started to fit the battery box side covers. Will need to grind down sharp corners & edges.

ANOTHER BOXSTER/TESLA EV CONVERSION

Oct 26

- Start open the DCDC converter to get the proper cables. Unit is from a Ford Transporter Van.
- Found out that the extra wires coming out of the heater were for the OEM and are not needed.

Nov 01

- 4 side of main battery box are installed with self taping screws. I still need to get the front fabricated and get the bottom edge of the back trimmed off. I could do it with a mini grinder.
- Fit two batteries into the rear battery box and connected it with 3 batteries in the trunk. This give about 210V of power and it feels like it
- Need to buy an android phone to get instrumentation to work on the BMS through Kia spyware

Nov 05

- Extended temp. probe cables 10' from BMS to rear battery box. I hope this is enough.
- Extended cables for charging unit so the actual plug in can fit the old gas filler door. Had to do a crimp splice to add 42" of length to existing cables.
- Shortened the cables from the black contactor box to the charger to save room.
- Fitting charger and DC/DC converter into frunk. Lots of room but I am trying to find the best orientation for everything to fit at the lower possible height. It looks like having the charger cooling water connections point back is the best way. Will need some plastic elbows to eliminated possibility of hoses being crimped and reducing cooling water flow.

Nov 09

- 4 guys from A&R Motor Works came by to see the progress. They were impressed with the progress and how quiet the vehicle is. They may want me to join them in electrifying high end older Porsche 911s, or just consult for them.

Nov 11

- General clean up
- Ordered three new contactors and fuses for the 360VDC power accessories. Shipping should be in mid-December
- Looked at using an electronic power brake system instead of the vacuum pump (noisy). There are some good forum posts on an i-version

Nov 20

- Got Riddleworks to fab the back plate for the main battery box. They also made the plate for the Contactor Box to sit on and the cover plate for the EV plug in. Everything looks good.

Nov 30

- Steve came by to take a few more pics of the car running up and down the alley

Dec 04

- Drilled two holes for the cooling water into the Frunk. These holes are higher up than I first wanted but there was no access to bottom of the Frunk.
- Looking for best way to run charging cable from external EV plug to charger in Frunk. Looks like I may need a 2 ½" dia. hole to get head through.

ANOTHER BOXSTER/TESLA EV CONVERSION

- Cleaned up some of the cooling water lines from the radiator so they are tucked into the main tunnel under car.
- Need to length inlet hose to water pump so hose can fit into Porsche existing clamps.

Dec 06

- Got the DC/DC converter working with 260VDC (large battery pack). It has a constant output of 13.7VDC which is perfect to connect to the battery, so it is continually being charged as needed
- Connected the cab heater to the 250VDC battery pack for testing. It only drew about 2 Amps which is about 500W (1/3 of the available 1,500W). Called EV West to ask why and they said the heater needs air flow to work. Currently the car is showing numerous faults because of the removed engine. I need to cancel these faults and then I can get a constant air flow across the heater. Even at 500W, I could feel warm air coming into the cab.



Figure 28 - DC/DC Converter from Ford Transporter

Dec 07

- Starting to look at the **PS** pump location beside the water pump. It will fit but I need to shorten the hoses I had built. They are currently 6' long and should be cut down to about 3'. I have tried to get the pump to run but I think it needs fluid in the reservoir to work. That is the next thing to check.



Figure 29 - Power Steering Pump from Volvo (actually Ford)

- Got Riddleworks to make the cover plate for the EV plug in where the old gas filler was.

ANOTHER BOXSTER/TESLA EV CONVERSION



Figure 30 - EV Cover Plate in old Gas Filler Door

- Starting to think about permanent location and orientation for the charger and DC/DC converter. Needed to modify the cooling water hose route so it comes into the Frunk higher than I originally planned. Will need a couple of elbows to route cooling water to Charger. I may not cool the DC/DC converter at this time. Let's see how hot it gets. See Figure 35 below.
- The elephant in the room is the charging system and BMS connections. I tried to fit the BMS and associated cables on top of the large battery box, but with the large and inflexible cables, it may not fit. Need to extend the wires on two of the BMS connectors so the majority of the cables and the KIA Hack box are in the Frunk, where there is more room. I will try again to stuff everything into the big battery box top but I am not hopeful.

Dec 09

- A fellow dog owner came by the alley asking how the project was going. He was impressed with the progress and wanted my contact info to let his other Porsche owners in the PCA know what was going on.

Dec 10

- Properly replaced the driver's seat and the Air Back connection
- Installed the aluminium plate on firewall to see how it would fit with existing cables. Looks good
- I may need to reroute or extend the cables coming from the 23-pin connector as it currently goes through the cavity where the big battery box will go.

Dec 11

- Took Wayne for a 30 sec ride in the alley
- Removed the 3 batteries for trunk and Rear Battery Box so I could assemble complete package and test charger and BMS



Figure 31 - Full 8 Module Battery Pack ready for final testing

ANOTHER BOXSTER/TESLA EV CONVERSION

Dec 12

- Extending 18AWG wiring on BMS connector for module S1 to give more room to connect into BMS box
- Drilled holes in wall between old gas tank and Frunk for PS pump location. Added a small rubber pad to bottom of PS pump as it will be sitting on top of the Rack & Pinion Steering Housing
- Connected all batteries and BMS together to do final BMS, Voltage, Temp checks before installing both battery boxes into the car.
- Still need to connect charger to battery and see if charging system works

Jan 10, 2022

- I'd connect the charger direct to the battery and use a collision sensor to cut 12V power to the contactors. If you follow what the OEM's do you can't go far wrong
- AC Delco D1876D Inertia Switch to in the past, they are often used as fuel cut-off switches on OEM vehicles
- I'm considering installing an HV contactor in-line with my Volt charger (it's already fused) which is connected directly to the battery. This is because the charger is at the front of the car behind the bumper and in the event of a fender bender there will be no danger of the HV shorting out. The idea is that it'll close upon activation of my charger and open when not in use

Feb 24

- Still waiting for contactors from EV West. They were ordered in Nov '21. This is holding up the final installation of the charger.
- Got confirmation from Doug that the Charger needs to be connected directly to the 360V battery or at least to the battery side of the Main (+) and Ignition (-) contactors. This will allow the battery to be charged without Main and Ignition contactors closed
- The actual 360V loads on the battery (Tesla Motor, Heater, DC/DC Converter, etc.) will be connected to the other side of the Main (+) and Ignition (-) contactors. I will set it up so that the 360V (+) cable coming off the main 700Amp fuse goes to a manual disconnect in the truck. All 360V loads will be connected to the other side of the manual disconnect. This will allow work on the load equipment without disconnecting the battery.
- Still waiting for the revised console cover plates in the cab for the new green switches. Need to follow up with Mabel.
- Working on location for the Disconnect switch and HVJB in the trunk. Looks like the rear right corner will be the ideal location to be out of the way but still easily accessible. Trying to decide if the HVJB should be painted black.
- Looked at You Tube video to see the proper hose orientation for the brake booster. I may need a new switch as the pump runs all the time.
- Ordered new 8G wire for HV cables for Charger & Load items. For the Charger, these will run in tunnel under car from front HVJB to Main & Ignition contactors. For the Loads, these will run from the front HVJB to the new Manual Disconnect HVJB in trunk.
- I bought a Samsung S8 phone to test the Charger and BMS. Will get Greg over to assist.
- Heard a strange clicking noise when I ran the Tesla motor for a demo. I checked underneath and the drive shaft CV boot clamp had come off and there was some grease on the outside of the boot. Luckily there were no cuts in the boot.

ANOTHER BOXSTER/TESLA EV CONVERSION

Mar 01

- The 4 only 8G wire arrived on Mar 01 and I ran it from the front of the car to the main Contactor Box. Two (one red & one black) will be for the Charger and the other 2 will be for the other Aux equipment (heater, A/C, DC/DC converter)
- The (+) Charger wire will connect to the battery side of the Main Contactor and the (-) wire will connect to the battery side of the Ignition contactor. This will ensure the charger will be energized without the Main Contactor closing. This is needed because the charger is not considered a load.
- The (+) Aux wire will be connected downstream of the main fuse so it will only be energized when the main contactor is closed. The (-) Aux wire is connected to the output side of the Ignition Contactor so it will only work when the Ignition Contactor is closed. This is needed because the Aux equipment is considered a load. The Tesla motor is also considered a load and connected the same way.
- Installed the Main Disconnect Switch in the passenger side of the trunk. Si it is accessible but still out of the way. Very tough running cables from the motor and contactor box to this location. Note the foam floorboard is installed



Figure 32 - Main HV Disconnect Switch in Trunk

- I ordered some new orange split sleeves to cover the cable as the heavy duty ones are too hared to manipulate. Needed to order 100'.

Mar 05

- Contactor parts finally came from EV West that were order in Nov '21.
- Started to put contactors and fuses in front HVJB.



Figure 33 - Frunk HV Junction Box for Charger, DC/DC & Heater

ANOTHER BOXSTER/TESLA EV CONVERSION

- Drained the cooling system so I could lengthen one $\frac{3}{4}$ " hose that feeds the pump.
- Wired up the BMS to the OBD2 Torque Tester to ensure I am getting proper cell temperatures. See Word doc "BMS OBD2" for explanation. Still need to connect the other side of BMS to the actual battery cells.

Mar 12

- Building a new floor plate in the Frunk to bolt the charger to. Cut holes in the felt liner to allow cooling system hoses and HV wiring to come through. See pic 2653. Plate for Charger is the original Al plate from Doug that he had on his Charger dolly. Used an angle piece of metal that was screwed to the vertical firewall in the Frunk with $\frac{1}{2}$ " SS screws. The front of the plate is supported directly on the Frunk floor with medium density runner pads. 6mm bolts and nuts secure the plate to the supports. 30mm long at the firewall and 50mm long at the front. The Charger will be bolted to the plate using 4 only 6mm x 35mm through bolts. There is enough of a gap under the plate to get a wrench on the nuts. The black junction box will be bolted directly to the top of the Charger using existing bolt holes & threads. This will allow the black JB to be connected easily to the Charger and to the Front HVJB.



Figure 34 – Frunk Area showing DC/DC Converter, Charger & Frunk HVJB

Mar 16

- Also added a bracket to mount the DC/DC Converter in the front right corner of the Frunk. The DC/DC Converter will be mounted vertically with the cooling water nozzles on the bottom. Securing the Converter will have the bottom Velcroed to the angle bracket and a bungee cord wrapped around the middle. This will allow easy access to the HVJB connections and the 12VDC connection to the battery.
- The more flexible $\frac{3}{4}$ " orange split Loom arrived today and was immediately installed in the $\frac{5}{8}$ " dia. HV cables. All HV cables in the motor bay and trunk are sheathed in orange split loom. I am working on getting the Frunk HVJB sheathed as well.
- Opened up the hole in the Firewall to allow the 110VAC Charger plug in to pass through the firewall. Currently have a 60mm firewall plug covering it.
- Bought more $\frac{1}{2}$ " stress relieve connection for the frunk HVJB. For the first trial, I will only have the wiring, contactors and fuses for the heater, DC/DC and Charger. The A/C can be added later.
- Next step is to run the 12V wiring from the console switches in the cab to the Frunk HVJB contactors. This will be done on Mar 17th

ANOTHER BOXSTER/TESLA EV CONVERSION

Mar 20

- Ran all the 12V wiring from the switches to the Frunk. When I reconnected the batteries some of the switches didn't work. This was because I combined the INV and the IGN switched together. I needed to separate them again and run a new 12V wire from the cab fuse box to the switches and to the Frunk for the A/C, Heater, Charger, PS. This work took 2 days.
- Took some time to see how the carpets in the Trunk & Frunk are going to fit with new equipment added. For the Trunk, the Main Disconnect is tucked in the back right rear corner behind the cooling water reservoir. It is very tight, but I was able to pull the vertical and floor mats into place. Some minor trimming around the cooling water reservoir was needed. I think I will need to punch holes in the floor carpet to allow the bolts holding the rear battery box under the trunk. This will allow the rear battery box to be removed without pulling up the trunk carpet.
- In the Frunk, I needed to cut slots in the firewall (back) vertical carpet for the Charger mounting plate. I also needed to cut a hole where the HV wiring from the battery/motor area comes from. For the front carpet, I needed to cut holes for the Charger mounting plate and a slot for the DC/DC converter mounting.

Mar 28

- Greg came over and we got the "Torque App" working on the Samsung phone. It can measure a number of parameters for the BMS and batteries. (See pic 2724) The 8 battery temperatures work well. The overall voltage is showing a very high value that I need to investigate. The readings in the pic were taken when connection one of the two blown BMS modules. I will be adding the individual battery cells voltages to Torque to see what cell(s) are reading incorrectly.



Figure 35 - Torque App showing Battery Voltage & Temperatures

Mar 30

- Added the individual battery voltages to Torque App. Also installed the newest BMS to the battery pack. Now all 96 individual battery cell voltages and temps are given. With all the cells reading voltages, the overall battery voltage works.
- Connected all the wiring for the charger to see if it works. Not yet
- There is a blue indicator light that is flashing which means there is a problem
- Sent info to Doug to get some advice. He thinks it could be the VIN on the BMS or the latest BMS has updated firmware that may not be providing the original "Hack" with the information to let the unit charge.

ANOTHER BOXSTER/TESLA EV CONVERSION

Apr 05

- I have been trying different sequences to get the charger working. Doug says he cannot remember the actual sequence needed to have the charger work.
- Doug sent over a page from his notes showing what wiring changes were made to the charger. I checked them all and found some colour coding difference between the notes and the charger wiring, but everything looked good.

Apr 11

- Started to search for something obvious with the wiring or the sequencing.

Apr 17

- Rented an engine hoist to so I could lift the battery box in place and confirm it fits – it does but it's tight. Needed to make 5 test runs with an empty battery box to make sure everything could fit. Had to cut part of the square tubing on the top and back so the box could be raised up and clear the existing structure. I will have to reduce the width to 35" from 36" to allow better clearance.
- Used the red straps to lift the box from the ground into place. Need to make customised lifting lugs for the front of the box so it can clear the existing structure. Make sure the rear straps are slightly shorter than the front straps so the box hang a little front heavy. This is needed to clear the brake cable.



Figure 36 - Lifting Main Battery Box into car



Figure 37 - Lifting Straps from Main Battery Box

Apr 18

- Installed the motor today and Steve Armstrong took some pics & videos. Still need to connect all ancillary equipment such as cooling hoses, Contactor Box, wiring, etc.
- Saved small piece of wood to assist with the passenger side motor mount. It is the correct length to wedge between the bracket and back of brake housing to get lowest bolts into hole.
- To get passenger side motor mount installed. Take the bracket apart and line up the left (back) bracket so the top hole is in the centre of the threaded hole. Temporarily tighten the left bracket into position using the bottom screw. This will allow you to line up the top hole with the spacer. Watch the oil line so it doesn't get damaged or kinked.

ANOTHER BOXSTER/TESLA EV CONVERSION

Apr 21

- Doug Yip came over and we trouble shot the charging system for a couple of hours. We made some progress, but it still looks like the BMS is not happy with the codes we have been providing. Either we upload new codes or buy a new BMS, Charger & DC/C converter.

Apr 24

- Installed the rear battery box with the final 2 batteries. Fits well behind the motor. Next time I will install the sway bar after the battery box. All the cables from the BMS to the 2 rear batteries are too long. For this test, I simply pulled them out of the way, but I will need to shorten them for the final install. I still want to put the BMS on top of the 6 battery modules but there will still be cables that need to be wrapped in the same area. Motor spun up really nicely.



Figure 38 - Rear Battery Box Installation

Apr 26

- Rewired the Main Disconnect so it is in between the battery and Contactor Box, instead of between motor & Contactor Box. This was needed to allow contactor box to be worked on without being powered up. Now Motor wont run.
- When I was finished new disconnect wiring, I checked the Main, Ignition and Pre-charge Contactors. Main and Ignition worked well. Pre-Charge relay would not close for a while. I may have got high voltage inrush into Inverter when Main Disconnect closed before Pre-Charge had trickled some current into the Inverter. This may be the issue, but I need to find out what impact that had on the Inverter. I also heard a "click" 5 sec after the Main Contactor was closed. I'm hoping it is just a switch in the Inverter that needs to be reset.
- Got out laptop and checked wifi in inverter. It shows no voltage coming into the inverter. I can see motor and ambient temperature changes when I hit refresh. I can see the FWD and REV works when I use the switch in the cab. I am getting full voltage through the Main, Ignition and Pre-Charge Contactors. Sent Doug what I found and am waiting.
- One post on Open Source Forum mentioned that after awhile, their Pre-Charge resistor failed and was replaced. I need to test this and also confirm if I am supposed to open the Pre-Charge relay once the Main Contactor is closed.

Apr 30

- Ordered new Orion2 BMS from Ewert Electric. 6-week delivery

May 02

- Got price & Delivery for the combo Charger/DCDC Converter from Cascadia Motion in Portland

ANOTHER BOXSTER/TESLA EV CONVERSION

May 04

- Replaced Open Inverter Board with original Tesla Board to test if Inverter is fried

May 11

- Gave PO to Cascadia Motion to purchase combo Charger & DC/DC Converter
- Doug came over with his CANBUS set up to see if the problem is with the inverter or Open Source Board. We were able to read the bus voltage as 357V as well as a lot of errors. We also switched the encoder wires #10 & #16 in the 23-pin connector back to the original Tesla locations. If I stick with the original Tesla board, I will need a new accel. Pedal and a DPDT brake switch to eliminate some of the codes.
- Doug noticed the 12V voltage was only 10V which is a minimum for electrical services. He thinks the problem could be the voltage is too low. He suggested getting a fully charged 12V battery and put the Open Source Board back in and read the UDC voltage. I tried this and voila, I got the full 357V reading. I switched it to FWD and the motor turned slowly and had a grinding sound. This was expected with the encoder wires wrong. Next steps are to reverse the encoder wires (again) and retest. Failing that, I will need a new motor/inverter.
- This should give me time to get the rest of the aux. equipment in the Frunk installed & working.

May 12

- Switched the Encoder wires around and the motor spins up fine
- Started to look at the PS pump again to see if it just needed higher voltage to run. Plugged the new 12V battery for the Xterra in and the PS pump ran without the start/stop issues it had before
- Started getting the DC/DC converter installed so I can run 13+VDC off the main 360V battery pack. When I did this, all the car 12V worked properly so it was the lower voltage in the existing battery that was causing the flickering lights issue

May 14

- Put the car back onto its wheels and did a few test runs in the back alley. Car ran flawlessly and the MPH and RPM dash displays work. I still need to cancel the faults in the system but this is not causing any driving concerns
- I have wrapped some duct tape around the rear driver side CV joint to stop grease from splattering out from the rip in the boot. This will need to be replaced at some time

May 18

- Gave Angela's father and uncle a ride in the alley with the car. They were thrilled and comments on the car's torque and quietness

May 19

- I was connecting the HV heater to its contactor in the Frunk HVJB. I was using the inverter interface to ensure there was pre-charge voltage going to the DC/DC Converter. I then switched on the heater before closing the Main Contactor. The result was high current was sent through the Pre-Charge resistors in the Main Contactor Box and burned out one of the resistors. I ordered 2 new ones from Zero EV in England because I couldn't find one in stock in North America. The new resistors will be here on May 27th

ANOTHER BOXSTER/TESLA EV CONVERSION

May 20 & 21

- Did more testing on PS Pump and it is back to its old habit of starting and stopping. I will wait until I get the DC/DC converter running again before I try again

May 28

- New resistors arrived and only needed to install one. The other one (lower) was still good
- Did a permanent install of the DC/DC converter and all low voltage electrical problems went away as the DC/DC converter puts out 13.7V.
- Looked at all the lights to see what bulbs need replacing. Found out that the main headlights were loose and had either been replaced or were in the process of being replaced. I connected them up again and locked the headlight casing into the car and everything works. When I got the car, there was a box of electrical stuff that I thought was for the stereo but were actually for the lights. The headlight on the drivers side was not connected so I connected it and it works.
- It looks like the tail-lights are also an LED aftermarket and some don't work. This is a secondary problem.
- With the DC/DC converter working, I connected the PS pump again and it works perfectly. I connected the LV wiring to the switch in the cab. Connected the high pressure & low pressure lines to the car and tested it. Works fine and only draws 5 amps. The high & low pressure lines are both too long but I stuffed them where the old fuel tank was to do a test drive. Works well. I then pulled the pump out of the car to shorten the low pressure line. The high pressure line needs to be shortened but it is functional. Permanently installed the PS pump in the car.
- With lights, PS, PB, & cooling on, the 12V system draws about 40 amps which is 480W. The only other major draw will be the stereo when it gets connected.

Jun 8

- Insured the car.
- Did a couple more test runs around the neighbourhood – runs well.
- Adjusted UDCMIN on Open Inverter back to 200V from Zero. It was at Zero for bench testing motor and batteries with lower than full pack voltages.

June 10

- Took Andre out for a test run in the car. It ran well until we stopped at a stop sign. When I accelerated slowly, the car bucked a couple of times and then stopped working. I needed to get it towed back to the garage. Still investigating what happened. The DC/DC converter is working and getting the full 350VDC but the inverter is not showing any power going to it. Getting ready to drop the motor to see what the problem is.

June 14

- Pulled rear battery pack and motor out. Tested all components with Inverter cover off and everything works again. 2 green and one red LED. You can hear a faint hi pitch sound when the car is put into FWD or REV. There is no sound when it is in "N"
- Connected DC/DC converter to water cooling

ANOTHER BOXSTER/TESLA EV CONVERSION

June 16

- Replaced Inverter cover and put motor back into car. Now it doesn't work. I heard a slight sizzling or crackling sound when the Pre-Charge Relay kicked in. I have full 348V in battery pack but when I close the Pre-Charge Relay, it stays at 1.3V so no power is getting to the Inverter.

June 18

- Put my comments on Open Inverter Chatroom to see if anyone else had same issues. Some good suggestions.

June 20

- Pulled motor out of car & removed Inverter cover (again) and hooked everything up externally.
- I adjusted UDCMIN back to zero to see if that was the issue.
- Did a test spin up and everything worked well the first time. When I did it again, the Pre-Charge came on and showed 250V (good) and then it quickly dropped voltage back to 20V. I have never seen that before. I took all HV power off hoping it would reset and tried it again – no luck.

June 21

- I did tighten up a slightly loose HV nut on the Main contactor and squeezed the Pre-Charge wires coming from the pre-charge relays. No more crackling sound. Looked over the entire system again and tried to spin the motor. Everything worked fine. Ign, Pre-Charge, Main all showed proper results. Motor was able to spin up in both FWD and REV.

June 22

- Measured some components in the Inverter. Battery Voltage – 349V, Voltage at bus into inverter – 349V, Voltage on Inverter Phases – 342V, 338V, 344V, 3-Phase motor voltages between phases were 0 (this is not possible). Talked to an electrician doing another build and he is willing to come over on the weekend to take a look.
- Spun motor up in both FWD and REV again with no issues.
- When measuring the 3 Phase motor voltage under the orange tab, I accidentally touched the connector with the aluminum housing. There was a small spark and the faint high pitch sound stopped. When I pressed the accelerator again, nothing happened. I opened the Main, Pre, Ign. contactors, shut off the inverter and then initiated the restart sequence. Everything powered up as it should, the faint hi pitch sound returned when I put it in FWD and the motor spun up. I'm not sure what I did here.

Jun 29

- I had one of Dylan's electricians come over to see if I had done anything wrong and he could not find any issues.
- Put the motor & rear battery box back into the car and tested it. No issues.
- Did a few more test runs around the neighbourhood but am getting close to the low voltage limit of 275VDC

July 15

- BMS and Charger DC/DC Converter Combo arrived in Pt Roberts. Picked them up and paid about \$600 in duties and GST

ANOTHER BOXSTER/TESLA EV CONVERSION

- In looking at the specs on the Charger, I will need a CANbus controller which is not what I had planned. I called the supplier and I cannot return the unit. I will try and sell (ebay or ??)
- The BMS can operate with or without CANbus
- Doug had suggested a long time ago that I look at a non-CANbus Elcon chargers but I didn't listen
- In the Inverter software on laptop, reduced OCURLIM from -10,000 to -2,500. There was no impact on performance.

July 30

- Did a few more test runs around the neighbourhood but am getting close to the low voltage limit of 275VDC
- Steven Armstrong is going to release the video of the EV build.
- I was able to lower the rag top down and get the windows working. I hadn't reconnected the switches in the cab. It's starting to look like a regular car again.



Figure 39 - Battery Box & HV cables on car

Aug 08

- Took Jeanny's sister Donna for a quick test drive in alley. battery level is getting low (under 270V)
- Picked up the dumb charger from Doug to get the battery charged to find the driving range of the car. It plugs directly into the 50Amp socket in the garage.

Aug 15

- Took Chloe for a quick drive in the alley but the battery is getting really low now. (260V)

Aug 23

- I needed to buy a couple of Anderson Connectors to connect to it but once it was hooked up, it charged the battery to 400V.
- With battery charged, I will do more test runs.

Aug 26

- Installed 30A fuse from DC/DC converter to battery. With lights, PS, PB & Cooling on, the fuse blew. Replaced fuse & holder with an 80A fuse. No issues now.

ANOTHER BOXSTER/TESLA EV CONVERSION

- Tried to take some pics of the charger in action. When I connected the Anderson Connectors together with the main power on, and charger switch in cab on, the 30A fuse in Frunk HVJB blew. I think the issue is that the charger needs to be at a higher voltage than the battery. To ensure this happens, always follow the steps below.
- When charging battery – always use this sequence.
 - Without connecting battery to charger, connect charger to 240VAC source and have it run through its start up sequence. Charger should show over 400V.
 - Disconnect charger from 240VAC source
 - Turn on battery main disconnect switch
 - Connect charger to battery using Anderson Connectors
 - Turn on switch in car
 - Plug charger into 240VAC source
 - Watch battery voltage go up
 - Watch current – should be 20A

Aug 28

- With new 80A fuse installed, took car out for another test run
- Over past 3 days, I have travelled 6.5 miles (10.5 km) and used 9.59VDC. From linear extrapolation, this is 1.09 km/VDC. If the battery use is linear, and we can go from 400V to 275V, this would provide a range of $(400V - 275V) * 1.09\text{km/VDC} = 136\text{KM}$ range.

Sep 01

- More road testing out to Dunbar and back. Mileage seems to have increase a bit to about 1.2km/VDC. Took trip out to UBC along 16th Ave. Only issue was jerking or bucking when starting on a steep hill. I think I need to adjust the accelerator parameters to smooth this out. I also may need to do a firmware update.

Sep 02

- Took a neighbour out to UBC along SW Marine Drive. I got up to 50 MPH (80 KPH) and was just touching the accelerator pedal. Motor temp never got above 50C during whole trip

Sep 03

- I connected the radio/CD tuner and amp to the speakers. It sounds good but I think there may be some speaker wiring issues. The unit is tied into the ignition. The radio good and better with X-BASS. CD sounds better than radio. Need to confirm the electrical load the tuner has on the battery.
- I installed and tightened the 5th lug onto each wheel so there are the full 5 lugs on each wheel.

Sep 04

- Installed the rear sway bar on the car to see if this makes any difference. Seems tighter.
- I found that some of the nuts on the rear battery box were loose and one was missing. I don't remember them being loose before, but I tightened them up again.
- I found oil spraying around the Tesla gearbox. There is also a growing pool under the car. It's not an issue yet but during the winter, I will look at this. It may be the seals on the gearbox output.

ANOTHER BOXSTER/TESLA EV CONVERSION

- The left rear (driver's side) drive shaft has a split C/V boot and will need replacing. I will buy a new one with the boot already installed and when I install it, I will replace the boots on the one I took out.
- Tested out the heater that was installed a long time ago. On the first test, the 10A fuse blew. I put in a 30A fuse, and it survived. The inrush current when the Heater is turned on is about 12A.
- I found out that the climate control in the car still works. When you set the temperature in the cab to a low setting (70F or 20C), the car will adjust the heater to accommodate. When you set the temp higher, the car will automatically increase the heater output. This is a complete surprise as I thought it would need manual controls.
- Over this winter, I plan to install the 300V A/C compressor and I will see how that works.
- Did an overall calculation of the estimated mileage. I have travelled about 40 miles (62KM) since the charge and have used about 45VDC. This gives 1.36KM/VDC. If the battery usage is linear, this would give me 170KM range.

Sep 8

- Took car down to the beach at 6:30AM to get some sun rise pics.



- I did notice a substantial drop in battery life. Before sunrise, it was cold so I turned on the heater. This kept the cab warmer even though I had the top down. I also had the radio on which probably added electrical load. When I left the garage, I had 330VDC of battery power. When I got to the beach it was down to 300VDC, after a trip of 5-6 KM. When I got back to the garage, the voltage was down to 230VDC. I charged the battery back to 400VDC on the charger but actually only 397VDC went into the battery. I did a short test run and the voltage dropped to 383VDC. This may be the standard characteristic Lithium Ion battery but it was a little unnerving as it substantially reduced my estimated driving range.
- I may be able to charge the batteries to a higher voltage as the manual says that each cell has a range of between 1.5V – 4.8V. I won't try this before confirming with Doug.

Sep 9

- Took car out to do some errands. In total used 6.41V and drove 6.61KM. It seems the battery use follows the Lithium-Ion profile of a steep drop at the beginning, a relatively long higher voltage hold, and then a steep drop at the end. I need to be careful when the voltage drops to 300V.
- I measured sound system energy use to be 1.3A which is quite low at 18W. Increasing the volume brings it up to 1.6A (22W)

ANOTHER BOXSTER/TESLA EV CONVERSION

- With normal car electric devices on (radio, cab fan, door lights, misc.), the DC/DC Converter output was 5.8A (81W). This does not include the heater which is on a 300V circuit. The 12V battery output was 6.3A (88W)
- With the radio and cab fan off, the DC/DC converter output drops to 3A (42W)
- I replaced the DC/DC Converter output fuse from 80A to 60A. The max it ever showed (lights, radio, cab fan, PS, PB, etc.) so far has been 34A (476W)

Sep 11

- I have driven the car 106 miles with electric power. I put it up on the hoist today to see if anything was getting loose.
 - Screws from cab to battery box were loose. Added a rubber gasket between the battery box and sheet metal.
 - 19mm nut for the front motor mount was loose. Tightened
 - There were a few metal screws holding the bottom SS sheet to the frame.
 - I found two broken electrical wires coming from the driver side rear brake to a transducer. I also noticed a light on the display showing check brake wear. The light could be because of the broken wire
 - Lots of transmission oil leaking from the passenger side of the Tesla gearbox. I think the seal is gone.
 - The drivers side drive shaft that had some duct tape around it probably ripped off the wire for the brake. I don't think there is much grease left in the boot and I will order a new one to replace this one and then replace the boots on the drive shaft.

Sep 12

- Took a run out to UBC to check battery use. I was able to get 1.34km/VDC which is pretty good.
- The battery was getting down to 350VDC so I decided to charge it again. I still need to follow the procedure I mentioned before to get the charger to flow electrons. When I tried it Doug's way, no current went into the battery. I was reading 405VDC on the Anderson Connector when I turned off the charger. 1 hr later the battery voltage was down to 394VDC.
- I also found out that the Charger contactor is fused closed. I discovered this when I was check battery voltage on the Charger Anderson Connector. I can detect battery voltage even with the switch in the cab being off. This is not a big deal as I can always remove the 30A fuse to keep the Anderson Connector cold.
- I also put the filter and battery covers back on in the Frunk. Looks quite finished.
- I also put the heavy carpet behind the driver & passenger seats to give it more insulation.

Sep 13

- I've been driving around for a few days and things are good as nothing is broken or leaks.
- It takes about 2.5 hrs to charge the battery from 300V – 400V

Oct 10

- Took a couple of friends out for a test ride. Chirped the tires at any speed. Car has incredible torque.

ANOTHER BOXSTER/TESLA EV CONVERSION

Oct 14

- Charged the battery from 300V – 405V and then took car out for a drive. There was a definite smell of nail polish remover in the air. Contacted Doug Yip and he said here may have been some overheating and to check the individual cells. Found one with 0.84V while all others were around 4.00V. Doug said do not drive car & get BMS hooked up. May need to replace the cell or the whole module. Looks like the winter plans just got moved up to the fall plans. Motor and batteries will come out this weekend to find the low voltage cell.



Figure 40 - Torque App showing low voltage cell

- In total ran the car just under 300 miles (500KM) as an EV with very little problems. All the problem I have encountered were due initially connecting the batteries out of sequence.

The car is back up on blocks to allow for upgrades and replacement of a few components that are showing signs of wear. The main item is to find a replacement battery cell or module for the main battery pack. I received a note from KIA Parts that they may sell individual modules, but they have a 3-4 month delivery. Stay tuned. In the meantime, I would like to thank the following people who bestowed their knowledge for this build:

- Doug Yip – EV Power Racing
- Josh – Riddleworks Fabricating
- Juan – Juans Automotive
- Steve Armstrong – Repairs 101
- All contributors at Open Forum for their advice & experience.

If you hadn't seen it before, the link below is a 7-minute video of the EV build.

<https://www.youtube.com/watch?v=8mOt7hnALxM>