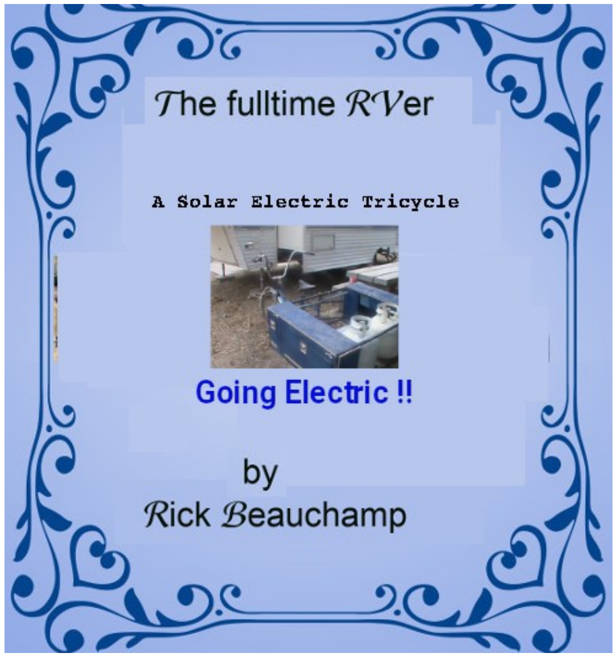
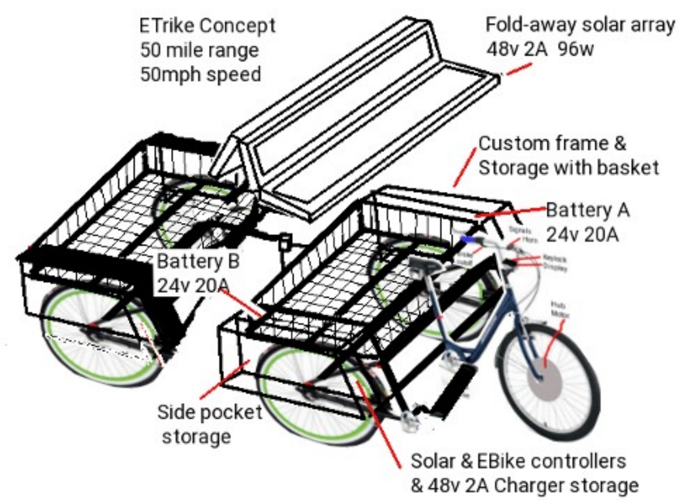


Making a Solar-Electric Tricycle

This project began as a means to supply transportation while also proving out concepts for EV construction. I live as a full time RV -er. Due to injuries I find it hard to walk 3 city blocks to get groceries or 4 city blocks to refill my propane. After my mom passed I had to give up my car to cover expenses since I no longer had her share. Her final requests were that I covert my Motor home into a full EV and pass on my knowledge to new generations.

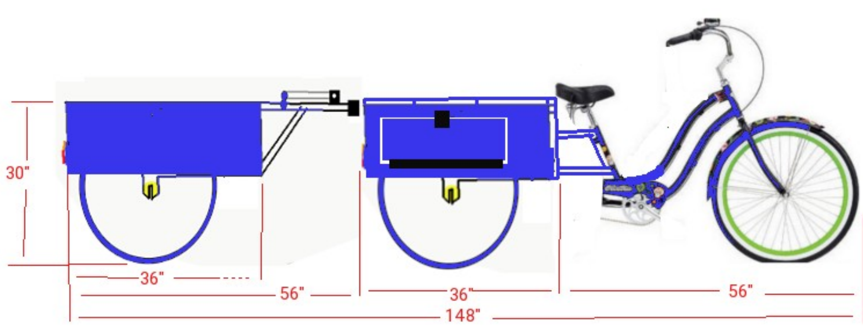
While she was alive I did start plans to make an EV-MotorCoach and wrote books on numerous topics to pass on what I know. This is my 10th book begun about 2 months after her passing.



This was my original concept. A tricycle run from battery charged by either solar or 120v and with a range of 50 miles (83.33km). It should be 4ft wide and have a basket 30" x 36" and have a trailer with a similar basket and fold away solar panels. I was hoping for maximum speed of 50mph or possibly 60mph.

As I got into planning I soon learned that an Electric Tricycle can not be above 4ft wide, can not travel faster than 30mph or it must be registered, licensed, and insured as a motor vehicle.

** I revised the plan **



The take away on this project is that it was designed as a 1440watt 48v with 2A to 4A solar built-in recharge and 120v AC built-in 10A charger can deliver fuel free transportation at 50kph with a range of 144kms. It's battery capacity can extend to 96 Ah up from 30 Ah which can provide for up to 580kms. I have provided plans for 4 EV-Trike versions. They all use the same Tricycle framework but now you have the option to do 48v FWD, 24v FWD, 24v Mid-Drive, or even use converted 24v wheelchair drive. Hope you find my offering of use.

Please be advised that I am still constructing my E-Tricycle so the Tricycle goes from actual photo's to artistic renditions.

The intention was to make a solid frame with a custom basket for the back. To mount the two rear triangles to the solid basket frame and secure it to the down pipes of the two outer down seat pipes and the inner Seat pipe such that the pedals could line up to make interconnection of the pedals. But, and there is always a but, to make it work, I found out that a tig welder would be needed (which is not locally available). Also, joining weldable steel to the carbon fiber or aluminum frame components would not be possible except by using bolts.

The bolt method would take a minimum of two bolts at each Down pipe and two bolts at each of the rear triangles. Then the cross brace at the back of the inner triangles would also need a bolted method to secure it. There is not much clearance for this brace to be fastened to a regular bike triangle at the back. The rear wheels also might be obstructed by the bolts. Looking into the topic a bit, I investigated what is available in carbon fiber or aluminum stock to make the frame if I invested in a tig welder and found the only way to get enough stock might be to obtain more bicycles to cut up.

I turned my attention to the wealth of left over pieces that would result from making this Trike. 3 bicycles have 3 front tires, 3 rear tires, 3 full frames, 3 pedal sets with sprockets. So it occurred to me that if I make the trailer instead of buying the small available one, I could possibly use up the excess materials. In a later chapter I detail the making of the trailer. And it was that trailer planning that came to solve my problem here. The trailer will use two discarded front tires with steel frame and basket with wheel dropouts designed to accommodate the front tires. A similar frame will make the back of the Trike. The difference being that the trike frame will have dropouts designed for the rear driveline wheels, and instead of the tow bar it will have the mounting for the three seat down pipes. Yes there will be 6 bolts needed (2 per down pipe) but the entire back can be welded as can the bolt nuts to make a very strong structure.

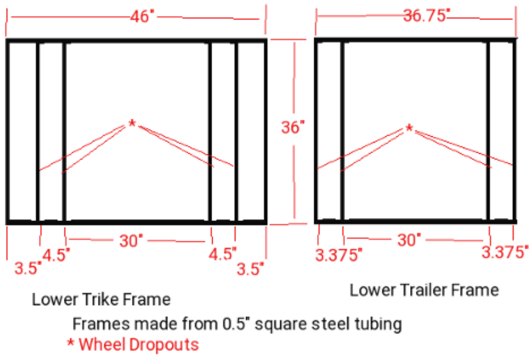
E Tricycle Construction

Rear assembly concept:

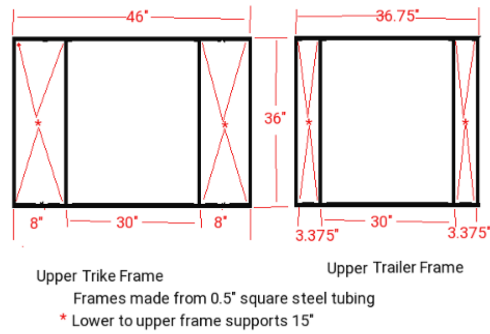
A new square tube steel framework will serve as our rear frame. We make a square lower frame 46" by 36". The wheel wells are now known at 4.5" width and we know the basket will be 30" x 36" so this leaves us 3.5" for side pockets. All framing is done with 0.5" square steel tubing.

With the Framing planned, it's time to visit the local welding shop and get the estimate for frame construction. Besides the metal square tubing, there will be 20 welds for the framing plus another 24 welds to join the top and bottom frames. If I include the optional 4 uprights between the Electrical and back storage another 8 welds will be needed. The estimate came in higher than expected at $500 for the trike and trailer.

Lower steel rear frame:



Upper steel rear frame:



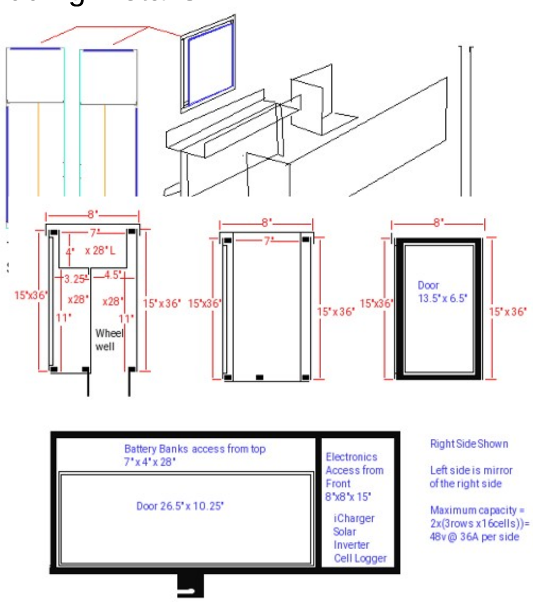
Framing:

- 0.5"x 46" 4pcs
- 0.5"x 35" 10pcs
- 0.5"x 15" 8pcs
- 0.5"x 15" 4pcs (optional)
- 0.25" x 2.5" x 2.5" Flat Steel dropouts

Dropouts are centered at 15" from the Back

For the upper frame we almost duplicate the lower frame only we don't need the inner wheel well piece. Between the lower and upper frames we put 15" supports at the corners indicated.

Adding metal skin:



Sheeting panels:

- Inside panel @ basket 46"x15" bent @ 8"
- Wheel well 23.5"x28"
- Upper storage 8"x28"
- Outer storage 36"x16"
- Equipment 8"x 31"
- Equip Front 8"x15"

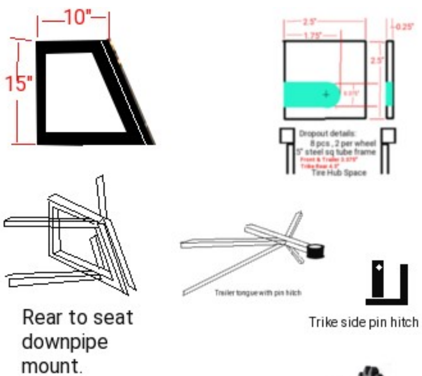
Doors and covers:

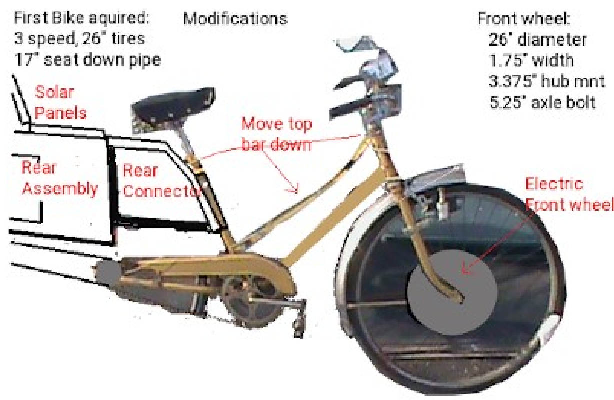
- Battery lid is 28"x8"
- Storage door is 10.25"x26.5"
- Electronics Door at the front is 13.5"x6.5"

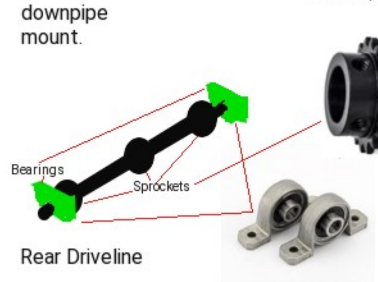
The idea here is that the back will have a cover over the battery compartment 8"x 24", and solid top 12" towards the front. Solid Back 8"x15" bent and running next to the basket all the way to the front. The outside will be solid along the 36" side and bent to form the front 8" width. Under the battery area we can either form a piece 4" down at 8"x 28" with 0.5" lip to secure it front back and sides with an 11" x 28" panel between the wheel well and the storage that raps under to seal in the storage area, or I could make piece 4" down bent in 4.5" and bent down 11" then bent under 3.5" as one piece with a 4" x 3" piece making the rest of the battery box as shown. At the electrical compartment separation, we would have an 8" width by 15" height that raps under to provide the bottom of the electrical compartment. The 26.5"x 10.25" door and 13.5"x6.5" door would be designed to inset into the panels 0.25" for a flush fit.

The upper frame has a Battery compartment 4" deep x 28" x 7" at the back and an electronics compartment 8"x7"x15" at the front, Wheel wells sit at 4.5" wide x 28"Long next to the basket, and a storage compartment 3.5"x28"x11" at the outside.   Other side gets same measurements for panels only reversed.

Mounting issues:







On the lower frame, We can mount 2 pillow block Bearings at the outside edge. Slide a solid steel rod at 1" diameter through the pillow block through 3 sprockets and into the other pillow block. Each of these will have a set of set screws to secure them to the rod. In this way we can assure positive alignment between the sprockets and the rear sprockets at the wheels and also with the center crank drive sprocket. At 23" on center will be our frame section to secure the front of the trike at the seat down pipe. Angle is yet to be determined. The top will be 10" between the seat down pipe and the rear frame. The height of this will be 15" to match the rear assembly. We do know the seat down pipe is 1" so a steel 1" 'U' (ID) will fit around the down pipe with 3 x class 5 bolts going through the down pipe to secure it. Top and bottom braces will prevent twist between the mount and the down pipe.

First bike acquired

The Bicycle would has

- 17" Seat down pipe to sprocket ... OK
- 26" Wheels with tires ... OK
- > 1.5" tire width ... Tire width 1.75"
- Front Hub spacing > 3" ... Hub spacing = 3.375"
- Axle mount length .... = 5.25"

This first bike is a 3 speed in good shape. It has all the necessities 17" Seat down pipe, 26" wheels, and a straight frame. Equipped with working front and rear brakes, a two beam single headlight, mirror which we can use in the build.

The top of the seat down pipe sits only 28.5" and the seat bottom is 31.5" our back section top of frame will be at 31.5" so we are fine with 12" down pipe to frame support. Due to the angle of the seat down pipe, the seat will overhang our mount by 5.5" which is also very fine. Under these specs, the bottom will be 11.5" from our frame.

To use this bike for the front assembly, we need to remove the top bar, side supports and add a support from the lower 12" frame section extending to the front forks for a more usable step thru design. The top might just be long enough to fit the lower support for this purpose. The rear wheel well fender can be re-used for the trailer on one side. So now we just need another bicycle to complete the structure.
Actually, all we need is just the rear wheel and fender and front wheel to make the Trike and trailer complete.

Time for measuring

With an actual bicycle to work with we can now measure things and set the values for making the rear assembly.

- Tire width front 1.75"
- Tire diameter front 26"
- Wheel Hub front spacing 3.375"
- Wheel axle front 5.25"
- Tire width rear 1.75"
- Tire diameter rear 26"
- Wheel Hub rear spacing 4.5"
- Wheel axle rear 6.625"
- Pedal sprocket diameter 7.5"
- Rear Gear diameter 3"
- Pedal movement radius 8.5"
- Seat Down Pipe 17"
- Seat height from ground 35.5"
- Seat Down Pipe angle ??
- Front fork Pipe angle ??
- Top pipe length
- Front Axle bolt diameter 0.375"
- Rear Axle bolt diameter 0.375"

Second bike options

With this arrangement, we just need a second bike for the needed Front wheel (for the trailer) and the Rear wheel with fender. We should also get the second rear brake.
As an alternative we could just obtain the two tires with wheels and fender and cable brake unit. I am finding a difficulty in sourcing just the parts. Fender found are in front/back pairs for $50 to $200, Pull cable brake calipers seem to be about $20 plus the cables for about $6, Standard front wheel without tire seems to be about $42 plus Tire about $17, Back coaster brake wheel is $72 plus tire at $17. But and there is always a but, mixing a coaster brake with 3 speed hub is problematic. Obtaining a rear hub wheel has 1000's of choices. An electric Trike should have the ability to have electric brakes but such was not found, they are all manual as cabled pinch pads, or manual drum brakes or manual disc brakes. Bummer!

Second bike donated to the cause.

A second donated bike made some serious changes to our plans. For starters, it had fat 2" grip wheels at 24" not the original planned 26". The front wheel was quick disconnect and the rear wheel was equipped with a 7 speed sprocket and a 2 speed front sprocket. To use such a bike I decided to attach the dropouts for the rear wheels as changeable. This means I can at a latter date go with 26" wheels if desired. I would drive only one rear wheel and use the front wheel as a rear wheel in idler mode. For manual pedaling I have a choice of which of the 7 sprockets to use. The sprocket chain itself is 3/8" instead of the 1/2" chain needed to mesh with the crank sprocket from the first bicycle. All this means is that when I employ the drive axle, I need a 1/2" 16 tooth sprocket to mate with the front drive gear and a 3/8" 15 tooth sprocket to mate with the drive wheel.

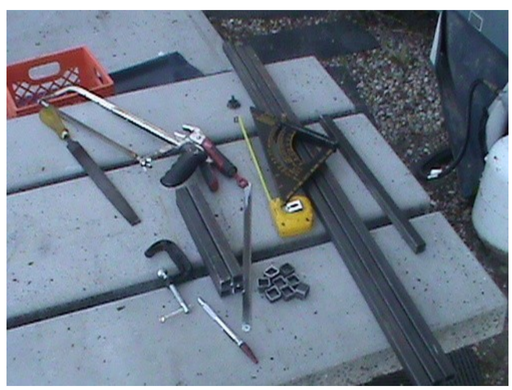
Rear assembly construction:

Faced with delays and other obstacles meant there needed to be compromises. Funds for the project were expected at $1689 over the year and became a mere $296. The cost estimate for material and welding came in at $500 for welding and $359 for materials just for the trailer and trike rear frames. The Trike would be made originally as a pedal version and latter to a full battery/solar/charger e-Trike. Due to delays in getting the project started and lower money available, it was decided to have the shop supply the square tubing and drive line components and use riveted custom brackets to make the frames. Each rivet has a shear stress of 150 lbs so in theory with two to five brackets at each joint and 4 rivets per bracket it should yield 300 to 750 lbs of shear at each joint. The overall weight limits of the rear frame is 1400 lbs and 2" x 24" Bike tires have a GVWR of 2400 lbs. More than a little overkill here as the trike is meant to carry 4 20lb propane tanks as its heaviest load, plus 100 lbs of battery and electronics and me (220lbs). Because 20 lb propane tanks are 40 lbs full we are at a total of 480 lbs. Our tires can support 150 lbs of frame + 480 lbs of load (1/4th of 2400 max). Our frame can handle the weight too 630 lbs ~1/2 of 1400 lbs so we are good to go.

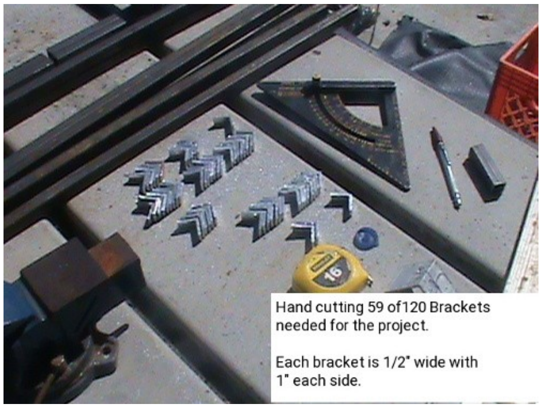
First things first. I ordered the square tubing as 25 pieces of 4' x 1/2" square tubing and immediately found that I could only obtain 3/4" or 1" square tubing not the intended 1/2" tubing. For my purposes this is not serious. Dimensions will have to be rearranged to compensate so that the total width remains at 46" and the basket of 30" width. Surprise surprise! Where I planned to cut all the 25 pieces to exact lengths and use the excess to make the uprights from the lower to upper frames, what I got was 23 pieces cut to exact lengths with no excess.

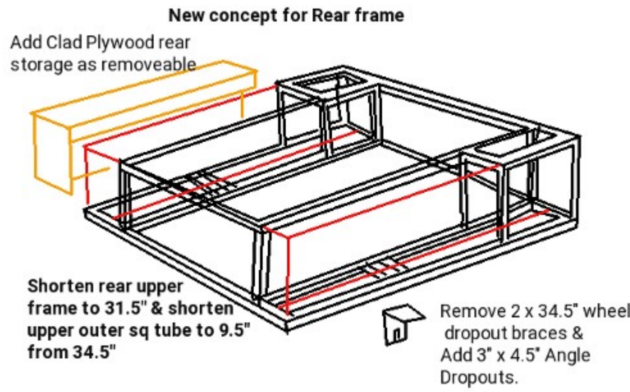
This presented me with new set of problems. The shop explained that doing my project they supplied the metal to the original planned lengths and due to lack of stock did their best and they are too busy right now to undertake more. The original plan was to construct the e-trike in April before they entered their busy season, have them weld it all. Now I would construct it with riveted custom brackets and weld latter.

Having less metal to work with meant some radical changes which actually turned out for the better.



I modified the design of the upper frame such that the two side compartments could be removed to service the brakes and wheels. This reduced the needed lengths to 8" on the outer - upper pieces and eliminated the two lower inside lengths to make upright material available.



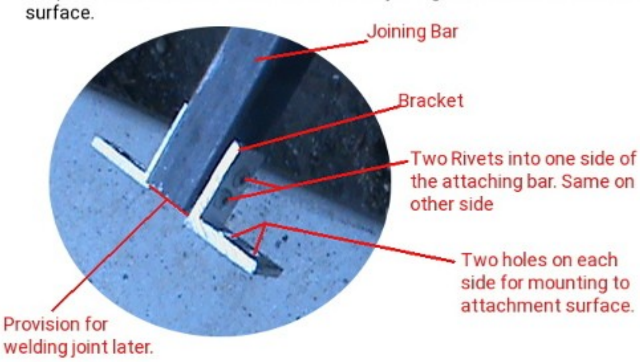


Using the layout above- right, I first trimmed the main pieces to exact size as some were longer by as much as 1.75". Using a piece of 1x1" 'L' channel I then cut by hand 120 brackets and drilled 4 1/8" rivet holes in each.

On the left we have the assembled lower frame 36" long by 46" wide with provisions for 8" pocket/wheel wells on each side and a 30" wide basket. To the right we are making the upper frame. The adjustments made to compensate for using 3/4" tubing instead of 1/2" tubing affects the length pieces not the width pieces. So for the bottom frame we have two 46" lengths and four 34.5" instead of six 35" front to back lengths.

The top becomes radically different. It still has a width of 46" at the front, but the back is shortened to 31.5" and instead of four 35" front to back pieces it now has two 34.5" lengths. At the front will be two 8" x 8" sub frames to make the electronic and battery compartments.

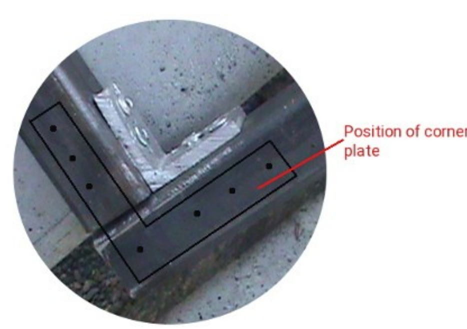
Each attaching piece of square tubing has brackets either side with two 150psi Blind rivets into each surface of the joining bar and the attachment surface.



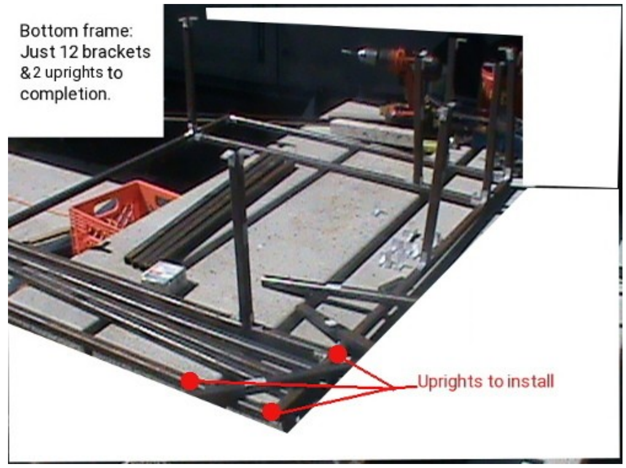
Effective joint strength = 60% of 1400psi = 840 lbs without weld.

Fully assembled lower frame has weight limit of 1200 lbs

Corner detail: One inside joint bracket with two rivets per surface and later will have both corner plate and welding.



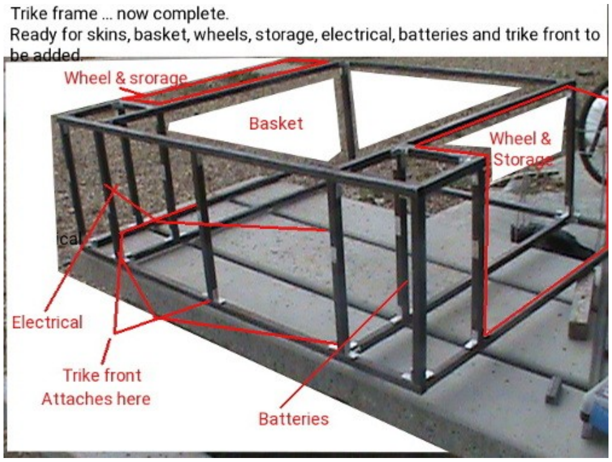
There are few mistakes here that are not critical. We need to handle 640 lbs and according to two different engineering computations one says maximum load is 1400 lbs but written on their site as 1400psi and due to using rivets it is safe to 60% of that limit. The question is raised as why is a welded structure designed for 1400 lbs only safe to 1200 lbs? Secondly, 1400 lbs load is far cry from 1400 lbs per square inch (1400psi). The other computation site gives the results of 1480 lbs for maximum load when welded and 960 lbs using rivets.



So placing the uprights onto the lower frame we are close to having the bottom finished. On the picture I incorrectly said only two uprights remained to be installed but as you can see there are three to do.

Rear Frame assembled:

Below we have the constructed frame for the rear of our tricycle. First we have the image with the highlighting of the features. It meets all the specs of our design with 4.5" x 28" x 10.5" wheel provisions, 4.5" x 28" x 5" battery packs above the wheels, 3" x 28" x 14.5" storage either side, 30" x 36" x 14.5" basket, and two 8" x 8" x 14.5" compartments for electronics and batteries. In essence we could have 90A @ 48v of batteries to triple our distance although I will be happy to have one 30A 48v pack.



Rear Skins construction:

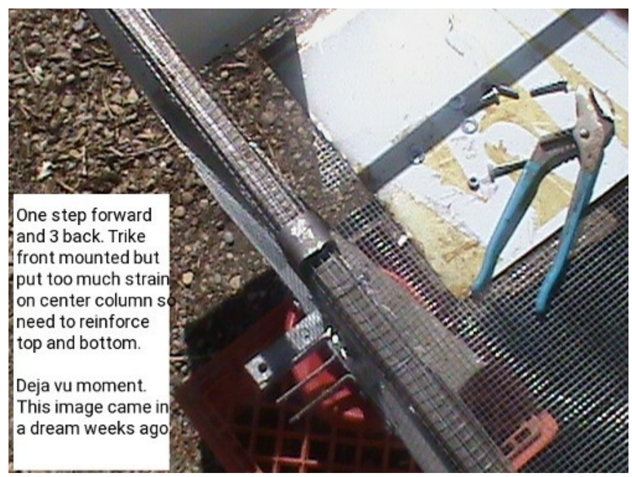
The Electrical and Battery compartments need to be enclosed. I made a valid change to the plans by deciding to move the front compartment doors to the sides. It simplifies making the side compartments as you will see. Using the repurposed metal skin from an old compact fridge I made two 8" x 22.5" pieces and riveted them on the front and bent around the bottom. Two more pieces 14.5" x 16" were formed to enclose the back and inside side of the compartments.

A few more rivets and the electrical and Battery eclosures are done. A few more cuts and the right side panel can be mounted.

We have the four angular views of the rear frame with enclosed compartments. The inside skins have to wait till the rear brakes are installed. These last inside skins also need to be removable to service the brakes.

Front of Trike construction

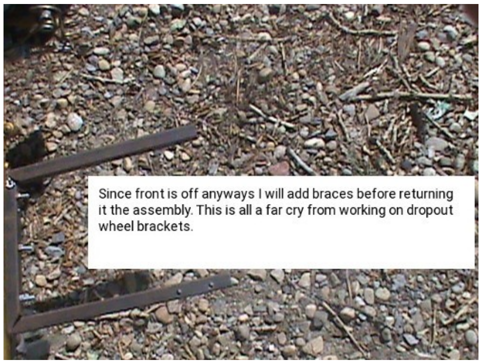
At this point we want to start preparing to add the front of our trike. So first we need to remove the back wheel section of the bicycle. A hacksaw made short work of cutting the back aluminum frame of the bike. I fashioned an attachment frame to connect the trike front to the rear assembly. It mounts to the back using four 2" brackets. two go on the center upright and the other two to the bottom frame.



It's been a long process dealing with very hot days, lots of sawing steel, occasional rain delays and all those 1/2" wide brackets. But it appeared the project was moving ahead. In retrospect, the shop said a cut and welded assembly was estimated at four hours and manually cut and riveted assembly took 30 days ... wow!

Reflections

The night after I installed the center post for mounting the front of the trike to the rear, I had this recurrence of a disturbing dream of attaching the front of the trike the rear and the center post busting out at the bottom frame and having to reinforce the post with straps top and bottom. The image shown is exactly what I had in my dream! So when I did attach the front to the back, it was no surprise that the strain did in fact break this center post free. Being bolted together I removed the front section and joiner off the back and took steps to put two 'U' shaped supports going over the top and bottom frame rails and secured solidly onto the center post.



This set back kinda delayed my intention to put the wheel dropouts into place right after attaching the front to the rear assemblies. Since I have the front off again anyways, it is an opportune time to also add the side bracing top and bottom before putting the front back on.

As just mentioned above, I installed two 'U' shaped metal straps top and bottom and bolted to the center post. Latter I will weld the center post so there will be no more issues.

Rear Basket assembly construction:

For our basket we will have a wired mesh front and back and on the bottom. The basket will be enclosed on the sides with metal skin and have a reinforced bottom with a center support and 4 wood straps. The intention here is to allow rain and snow and air to pass through the mesh rather than collect in the basket or add wind resistance.

The mesh was laid over the upside down frame and wrapped around the inner side rails, front and back uprights and front and back top rails. Using more thin wire the wrappings were stitched.

Added supports to basket bottom and treated with asphault undercoating

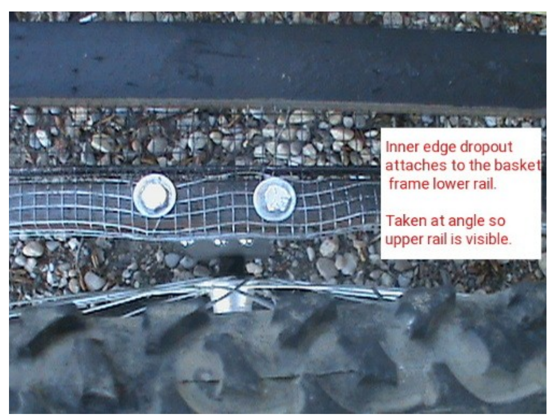
Here we see the reinforcing done. There is a center support and 1/2" x 1.5" x 34.5" slats mounted either side of the wire mesh. I took the opportunity to coat the slats with rubber undercoating. The container said rubber asphalt undercoating

Wheel dropouts:

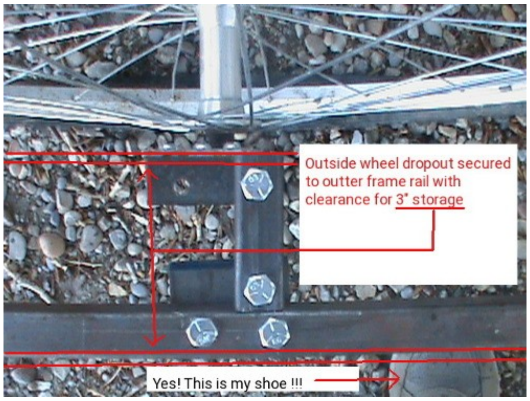
Hand bending metal into tight 90 degree straight angles is not so easy so I decided to use 1/2" 'L' channel bolted to flat iron plates to make the dropouts for the wheels and for the axle bearing blocks.

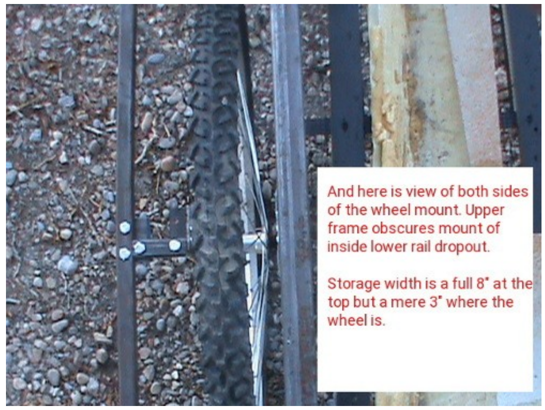
Wheel mounts and drive remedies:

Since bending the steel seems so unco-operative to bend alone straight lines, we will use 1/2" angle iron at the bend points. For the axle we will side mount the pillow bearing to vertical plates. The axle needs to be at least 5" nelow the frame so that sprocket and chain can clear the rear frame work.

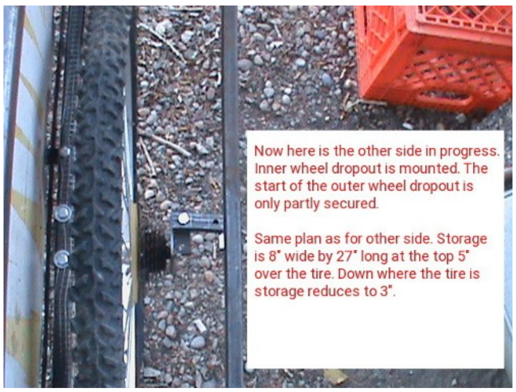


.25" bolts secure the brackets to the frame and 3 3/16s bolts secure the brackets to the plates. 5/8 holes centered at one end of each plate provide mounts for the wheel axles. These holes are then made into slots to make the dropouts.





For the outer mounts, we lack a mount frame so at the wheel axle we make an extension off the outer frame consisting of a plate some square tubing and the dropout bracket.



As can be seen, this worked quite well to mount the rear wheels and we have something that now looks like a tricycle!

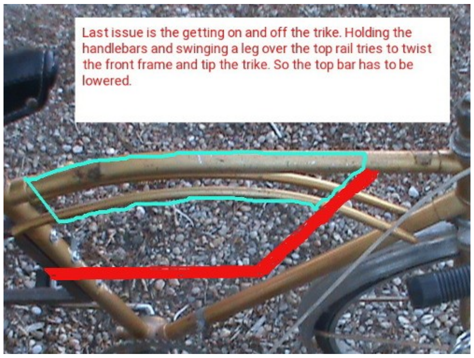
THE TRICYCLE: Push mode

With front end and wheels attached we have a tricycle that can't be used other than by pushing it. The angle is wrong between the front and back so the front of the back section is not even with the back of the back section. As a push vehicle it worked very well. I was amazed at how easy it was to push and control.

As seen in the last picture, it is a Tricycle with future provisions for Battery, electronics, and storage. It still has front bracing, driveline drop downs, back to front section level adjustment to be done.

Once the side bracing is in place, it would be prudent to weld this to make one rigid assembly. The seat down pipe is secured to the back by 3 bolts into the attachment frame. As I said earlier the back section is not level, so I will need to remount the front about 3 to 5 inches lower. In a short while you will see that I made an Oops with regards to this. An Oops I might add that could have been prevented had I made the change before testing out sitting on the unit.

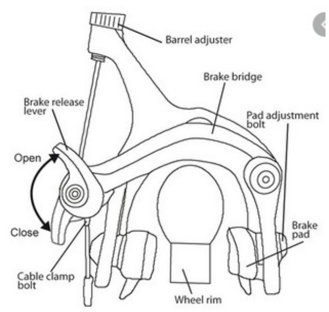
Making a step through

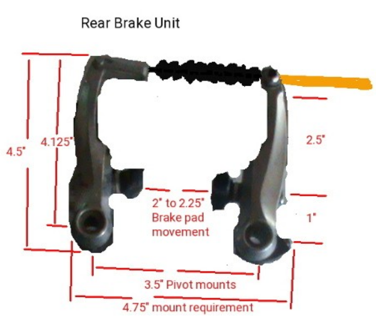


Here is the plan for making a step through frame on our Tricycle. In true fashion I tried to run before I learned to walk. I cut out the section of frame intended to be removed. But and there is always a but, I returned the seat onto the seat down pipe and immediately proceeded to see if I could step through the frame without it twisting. I didn't intend to actually sit on the seat but I did just that! The bottom of the rear mount frame at the seat down pipe abruptly bent and in no small way either. More on this later.

Brakes

Two types of brake are used. The 3speed had a top pull and retained for the front brake. The Back brakes come from the second donor bike and are of a side pull type shown. With limited space in the wheel wells at the back the side pull take less space than the top pull.





I will be running a new cable to the front brakes as the cable appears worn and because I will be using a high rise handle bar which means the cable will be too short. At the rear wheels we will have side pull brakes adapted from the second bicycle which will be run by servo behind the seat. Until we actually do the electric conversion the rear brake line will run from handle bars to the servo mechanism. The servo mechanism is modified to pull two cables going to each of the rear wheel calipers.

Look into other technologies

For years there has been a move to automated aids primarily targeted at the mobility impaired using automobiles. So I looked for the leaders and came back with undeniable source. **aevit automated vehicle integration technology**. This company is world class leader in technology to enhance mobility impaired individuals to control a motor vehicle. It starts with the primary functions of steering, acceleration and braking. Then further modification is used to add the secondary functions of turn signals, wipers, radio, phone, lights, horn and others. Basically any car or truck may be adapted without changing the original primary and secondary systems. As such, a vehicle can be operated by normal factory control systems or by the adaptive systems.

As adaptive systems go, there are a wide variety of add-ons. Automated door closers, wheelchair ramps and lifts provide for entry / exit needs. Various hand controls types are introduced to accommodate the special needs with primary focus on the three primary functions. Steering by the factory wheel, wheel with suicide knob, and Joystick in a number of designs to control servo's. Electronic Transmission shift coupled with a lever or joystick provide for direction movement (fwd/rev) , Acceleration in the set direction and braking. With the Joystick you can achieve steering and acceleration and braking all in one. For a vehicle these are a major step forward from the simple lever style push rods that merely pushed the gas and brake pedals using a floppy lever mounted at the steering wheel.

Power servos are controlled by Joystick and control circuit to physically turn the wheel for steering, regulate the amount for gas or brake to apply. Simple switches select the gear and direction of the transmission.

Ours being a tricycle means all we need is brake and accelerate. So for us we need a twist grip for accelerate and another for brake.

For a tricycle needs things to be light weight, steered by the rider, Accelerated and braked by some means. Typically, the right handle grip will have a thumb throttle or a twist grip throttle. Left and right brake levers control the front and rear brakes independently. In a car the brake pedal puts 40% to the front and 60% to the rear for braking, but bicycles can have 0-100% applied to either or both. This means if the front brake locks up you are going to stay in motion and suffer significant damage as you get tossed forward.

Standard bike brakes are either cable, or hydraulic. Cables stretch, fray, and snap. Hydraulics leak and get air bubbles. Calipers are either rim, disc, or drum. With E-bikes, regenerative braking and resistive braking were added. This adds up to 8 styles of braking for an E-Trike.
They each have there good and bad (15kph - 0):

- Cable-Rim Poor stopping, rapid heating, 3-4 car lengths
- Cable-Disc Better stopping, semi-rapid heating, 2-3 car lengths
- Cable-Drum Better stopping, /semi-rapid heating, costly, 2-3 car lengths
- Hydraulic-Rim Poor stopping, rapid heating, 3-4 car lengths
- Hydraulic-Disc Better stopping, semi-rapid heating, 2-3 car lengths
- Hydraulic-Drum Better stopping, semi-rapid heating, 2-3 car lengths
- Regenerative Poor stopping, rapid heating, 6-9 car lengths
  ** may overcharge the battery **
- Resistive Poor stopping, major rapid heating, 4-6 car lengths

Heat is the problem. hot brakes wear the pads fast, warp Discs, deal poorly with moisture. With Re gen and resistive braking you also get an issue of enormous reverse torque that can twist forks, strip axles and dislodge the wheel from the bike.

So in an E-Trike we need several things to happen. Firstly, we need to cut motor power or switch to re gen when brakes are pressed or throttle is released. The controller actually should do this already if brake handles have motor cut out switches. Secondly, we don't want to short the motor windings as in resistive braking as this damages the motor and creates heat more than it provides more stopping power. Thirdly we need standard braking run from the brake lever to the front wheel. It has become a bigger topic than I had planned for.

For this we need Twist grip accelerator pot to control the amount of pressure to apply electrically to a brake actuator. The Actuator can then apply push or pull action to the very short Cable at each wheel. Under such a system, the handlebar brake lever turns a potentiometer with auto return spring. A magnetic reed switch or hall-effect signals when brakes are applied. 4 wires from each brake lever go to a control circuit. The control circuit sends a brake applied signal to the E-Trike motor controller and the pots convert the resistive value into Voltage of a varying amount that powers the actuators at each wheel. Thusly, either brake lever can cause 3 wheel braking. Changing the voltage at the front and back actuators can allow for proper 40%/60% braking. A Pull actuator then pulls a short cable the distance based on the supplied voltage and the cable can now operate the pull caliper of a cable or hydraulic rim, disc, or drum brake.

In retrospect, the maximum force on the lever that a person feels comfortable at gripping for a long duration can be as little as 1-2kg for a child, 3-6kg for a woman and 5-7kg for men. This new pot type brake lever is highly sensitive with 0.2kg - 0.4kg so you do not get the back force of cable adding tension. The actuator is available with 10N - 2500N which compares with a typical man that has 7kg = 70N. As such you don't need a very powerful actuator to provide the cable stopping power of 70N applied to the calipers. This means we have replaced Manual Cables of 4' to 10' with electrical wiring and the actuators can mount as close as 4" from the calipers at each wheel. However for our purpose a mid mounted actuator still removes 5' of cable, cable routing, and modifying a caliper into a 'Y' configuration.

Going beyond the brakes:

So in normal E-bike design you have throttle, motor cut off on brake levers, battery, and motor control. Brakes are manual via brake levers and cable driven. Lights, horn, charging, and heads up display are after market add-ons.

Using after market add-ons it is possible to implement turn signals by wired connection or wirelessly, but these usually have a self contained battery that is low in power and lumins. Headlights can have built in horn if your lucky and of course their own activating switches. The brake lights are generally added by again wired or wireless with again internal battery and yet another switch. Some controllers have a display that gives speed, odometer, temp, battery status, but most do not. After market E-bike displays exist that mount at the handlebars with wired or wireless speed sensor down at the front wheel. Our handlebar can therefore become quite cluttered with Throttle, Key switch, two brake levers, Left/right turn buttons, Headlight switch, horn switch, brake switch, Info display. We need all these but there has to be a better way.

Above we talked about making an electric form of braking. Using a lever Potentiometer with micro switch or reed switch, we can have the switch do dual duty to both cut motor power and turn on the brake lights.

Lights

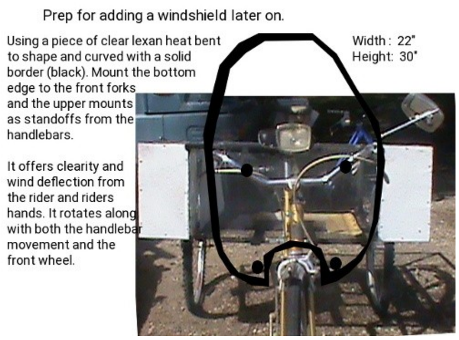
Making custom lights for turn signals, markers, and Brakes allows us to use our main battery and high lumin LEDS to give improved performance. A custom turn signal/horn switch places both in an easy to access location. Headlight, hazard flash, Key switch, display can be combined into a single unit with less demanding space requirements.

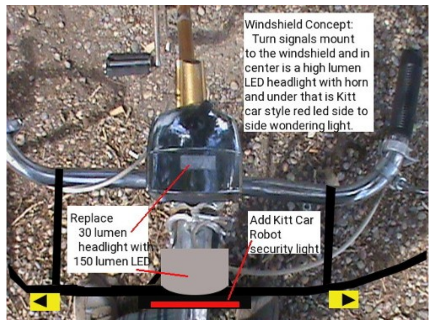
A lot of lights for bikes with handlebar switches for on/off/turns are either Bluetooth or wifi functional. These have internal battery for operation instead of direct wiring. As batteries wear down the lights become dimmer progressively so really not a preferred functionality. For our electric Trike we have a 30A 48v battery bringing 48V to the handlebar Key switch so supplying 48V to our lighting controls is not a problem and 48v LED lights for our signals headlight and brake lights are not a problem.

This brings us to neat modification. A regular 6v lamp as the donor bike has is only 30 lumens (dim) and at 48v we can go with 150 lumens (super bright) LED and add to that a simple robot light simulating the kitt car or cylon roaming light. In the future one could tie this light into a sensor and security system and people can be chased away with the feeling they are being watched (which they would be!). As we travel, the futuristic roaming red light up front on the windshield moves back and forth but when the Trike is parked and shut down, the roaming light goes out.

Windshield

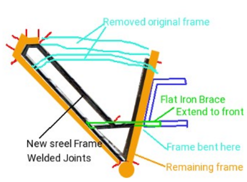
Next thing to think about is the windshield. We need it to rotate with the handle bar movement, support turn and marker lights, shield not only the face but also hands.

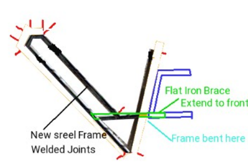


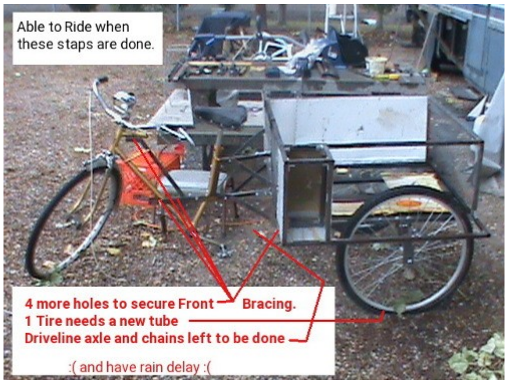


An OOPS! :

Sitting on the trike before we were ready was NOT a good plan. We had installed the upper twist preventing brace on our front to back joiner. The first picture shows the damage, the second one shows an idea to correct the bike in part. First we need to remove the front and straighten it, then build a sub frame, put in the lower brace and move the joiner frame down lower.





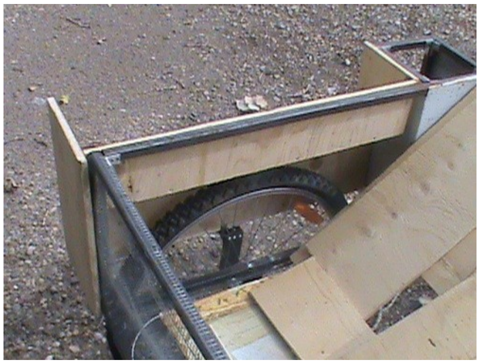


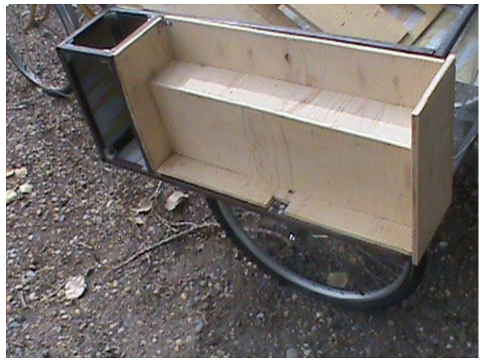
Side compartment construction:

To make the side compartments, I cut two 8.5" x 36.5" tops, two outer side panels 36.5" x 14.5" with the doors panels cut out. Then cut two each of front, back, storage bottoms, inner walls, upper storage , and basket side upper frame pieces.

Here we have the side compartments ready to be fit into place. As can be seen they form a kinda fender around the wheels. Ideally, it was intended for all surfaces to be cladded with metal but this didn't happen this year at least.


You will note that the side frames have notch outs where the wheels dropouts are. This needed to be done so that the frames could clear the mounting bolts which otherwise would prevent the compartments from sitting flush. On the trike frame itself, some adjusting is needed to make sure the compartments fit flush at all points. The compartments will secure to the trike frame using four bolts per compartment. Two are placed on the top basket bar and Two on the lower outer bar. The side door panel screws onto the compartment and into the front Battery/electrical compartment frames. And lastly, The compartment tops screw to the top of the compartment and also to the front Battery/electrical compartments. This provides us with a solid sealed side compartment assembly. Piano hinges secure the doors to the outer side panels and cam locks provide secure closure.





The dry fit has some tweeking to be done but this has to wait till spring.

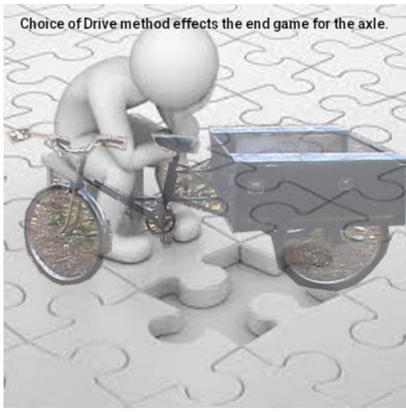
Spring has sprung and grass is griss

We left off with a lot of uncompleted jobs on the trike. We had all winter to think about what needs doing and how to do. I began by removing the front section for straightening. Removed the rear compartments and made the back section ready for the drive axle to be added. I had one rear tire that would not hold air so I replaced the tube and have a happy tire again.

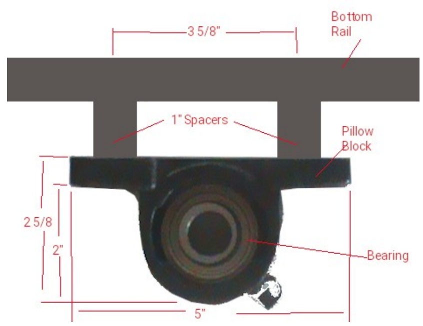
The driveline system:

As it turns out with the lower bracing in place the planned drop downs shown wouldn’t work. At the time of this writing, I am waiting for the machine shop to costruct 2 plates one for motor mount and one for bearing axle mount. The plates must be welded at the front basket edge and midway down the basket. Between these pillow blocks go two pillow hubs with their set screws that anchor into the pillow blocks. A steel axle shaft fits into the pillow assemblies and on this axle goes 3 sprockets. Two are freewheel sprockets for connecting up to the pedal crank and motor gear. Placement of the sprockets must line up with the drive gear at the crank and drive gear at the wheel. Set screws on the sprockets lock them in place.

The Drive Axle



My plan for the axle was thwarted by two braces I added to stabilize the trike front. A new plan was needed. The bracing took considerable effort to get it in place and now prevents the drop brackets for the axle pillow blocks to go on. Plan two is to place the pillow blocks horizontal to the rear frame at the inner basket rails. With 1" spacers between the pillow block and the rails there is enough room for the chain drive to work. So we remove 2 drop plates and 2 2" brackets and add 4 x 1" square tube spacers. Our square tubing frame is 3/4" with 1" brackets affixed to joints. The bolts are 3/8". With all this in mind, our pillow block mount holes must be 1-15/16 from the front edge on either side. The other mount holes are 3-5/8 farther than the first set.



As I soon found this method puts the axle 2-5/8ths below the basket and requites a degree of precision to align perfectly. I then acquired a 24v Wheelchair motor that would require lowering the pillow bearings so that chain clearance and path would allow drive gear to freewheel sprocket and freewheel sprocket to pedal crank would be in a straight line with sprocket to rear wheel sprocket also straight in line.

The decision was made to make two custom mount plates. One at the front of the basket welded so the axle is always in perfect line and one half way down the basket for the motor. I am still waiting for the shop to do this.

On the one side of the pillow block there are two grooves designed for the bearings to fit into the block and using a pry bar you rotate the bearings from horizontal to vertical against the guide grooves. The bearing must be rotated perfectly square with-in the block. The axle needs to pass through one bearing, then a lock collar is fit on and the center sprocket goes next. I should point out that the bearings can go into the pillow blocks with the locks either on the inside or outside. I chose both to be on the inside with the pillow blocks orientated to meet this specification. So we add the second lock collar before feeding the axle through the other pillow block. With a 36" axle and 1.5" pillow blocks centered on the inner basket rails, the axle is flush on the left side. This means that at the other end we have 36" - 30" basket - 1.5" (2 times .75" inside bearing blocks each end) = 4.5" for servicing the outer sprocket.

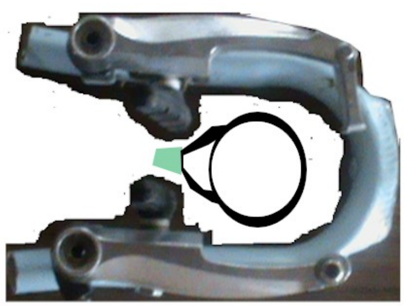
The lock collar is tightened in the direction of rotation. In our case, the main pedal sprocket rotates clockwise which turns the center sprocket clockwise and the shaft clockwise. At the outer end the sprocket likewise turns clockwise to turn the wheel drive gear clockwise (forward motion). When the wheel is free wheeling, no pedal motion is used and so the sprockets do not turn and the shaft / axle is idle. To put the locks in place, move the collars to the bearings, and rotate them in the direction of travel till they seat tight. Using a hex tool tighten down the set screws. At the wheel smaller sprockets turn the wheel faster per revolution of the axle and larger sprockets turn the wheel at a slower rate. When you have chosen the desired sprocket use an Allen wrench to secure the sprocket set screw.

I hope to re-use the driveline chain from the second bike by shortening it and using a chain link. Because we are not going to be switching drive sprockets the trike will act as a standard single speed bike and will have no derailer. A single speed bike chain requires about 1/2" up and down movement at the center point between the sprockets.

Rear brakes

There are tight constraints in the back wheel wells. Raw space of the wheel wells is 28" L by 5" W by 8" H. From the basket edge to outer frame is 8". The wheel drop outs are set 1/2" in from the inner frame and 3" in from the outer frame. 8" - 3.5" = 4.5" for the wheel. With the compartment in place, there is 5" max for the brake mechanism in width and 8" in height. On the original brake / frame it actually fit over the wheel at an angle.

24" rear wheels (12" radius) with 4.5" drop-outs places the bottom edge of the frame 16.5" from the ground and taking into account the frame is .75" thick, leaves 6.75" of wheel inside the wheel well. The rim is 0.5" and the tire is 1.5" to make the 2" of area of concern for braking. The bottom edge of the brake pad must rest 4.75" above the bottom rail if the brake mechanism is mounted vertical (perpendicular to the frame). As you move away from 90 degrees, the brake pad rotates forward and also closer to the frame.



I cut the brake mechanism from the rear assembly of the second bike frame. It has two parts. A solid 'U' shape mounting frame 6.5" H x 4.5" W x 1.5" D and brake levers 4.75" H x 4.5" W x 1" D. The overall assembly will occupy 6.5" H x 4.5" W x 2.5" D. Placing one leg of the 'U' mount frame on the inside rail and the bottom of the 'U' to a bracket off the back of the electronics bay or the battery bay on the other side will accommodate the brakes such that they clear the compartments. Cabling will come out into the basket on the left and through the compartment wall on the right, feeding through the electronics bay to end in the front to back joiner section.

Ideally, what is needed is two sand off brackets mounted at the inner and outer wheel wells such that the brake pads align with the rims. Something like this:

Why such would work is because the trike frame doesn’t move so the brake part next to the basket is permanent and the brake part next to the inner wheel well also never moves so with the wheel out you only need to line up the mounts and secure them them put the wheel back in place. It has to be noted that while one assembly has the cable coming out in the direction of the basket, the other will try to come out in the side storage. So you guessed right if you figured on reversing the mounts and heights of placement.

Installing the rear compartments

Our side compartments at the rear have a one piece door frame with two doors held on with piano hinges and embedded recessed keyed alike door latches. As luck would have it my paint ran out part way through the painting job. Using my Dremel with a variety of cutting wheels and determination I was able to fit the doors and latches into place. You will note that where the latches are I made metal strikers to facilitate a tight secure fit. In a perfect world, I would have preferred to metal clad the door frames and doors.

Nothing goes without a hitch! When trying to mount the side compartments, I first tried to use a tap-n-die with no success and had to switch to self tapping screws into the metal frame with better success. It took considerable pressure to get them in and had a tendency to try and pull right through the plywood. If I do it over, I would have pre drilled the pieces with better quality drills bits that don't snap, then tapped the screws into the metal and finished by then hand screwing the pieces into place.

The door frames were then secured to the compartments. I added 4 tie downs to the top of the sides so a tarp cover can be added to cover the basket and eventual solar panels. While I had the top covers and side panels off, I did pre wire for lights and electrical which is shown in the next pictures.

On the right side we have a 5 position barrier strip with GND-Brake-Right signal-Marker (-) - Marker (+), a 2 position barrier for side markers (-/+) and a 12 position barrier to handle lighting to both the front controller and the left side. Wiring passes through the electrical compartment and into a conduit to the front of the basket and into the battery compartment on the left side. This same conduit has 3 x 14:3 wires to the battery compartment and 2 (+/-) wires to the solar panels. A 5 position barrier strip inside the electrical compartment handles Gnd,+12v,+48v to the batteries and Gnd, +57v to the solar panels.

On the left side, the conduit enters the battery compartment and the lighting wires pass into the rear section with again a 2 position marker barrier strip and a 5 position tail light barrier strip. Ideally, I should also pass wires for a trailer but alas I didn't do this.

Restoring the front section

The front seat down pipe was carefully straightened. It had mount holes 7", 9-5/8", 11-5/8" and 12-1/8" from the bottom and taking into consideration for pedal clearance we can only lower the rear frame by 1" which is considerably less than the 2"++ I was hoping for. That rear brace support is once more in the way!

For maximum support against frame twisting, the lower brace must run from the bottom of the rear frame to the front edge of the frames joiner. Then for maximum support of the front frame against bending, it must carry forward to the front fork support. At the top of the fork down pipe we must brace down to the center of the forward running brace and add a solid steel support along the seat down pipe. The picture above left, is of the front reattached, and the right has the bracing put in place.

Two connected problems have to come to light in the design. The seat is higher than the handlebars which is not good. Since the vintage front forks don't support raising the steering bars, I need to lower the seat and or change the bars used on the front forks. I knew of this possibility from the start so had ordered high rise sissy-bars and a better seat.


I removed the seat pipe and cut off 1.5" and lowered the seat 2" which improved the relationship considerably. I have ordered a new handlebar which will look something like this when mounted.


We are now at a crossroad in the project. All the physical work so far is the same regardless of the drive method. But, and there is always a but. As is, I can just connect the crank set to the drive axle and have a manual only drive tricycle. I acquired 2 wheelchair motors @ 24v which I intend to use one on my tricycle. But for my readers there are decisions to be made. 1) The battery pack (24v or 48v) and 2) The drive mode (front wheel hub or mid frame drive).

I couldn't go with front hub as it wouldn't fit my front forks. On a 48v system the battery pack 48v, solar is 57v, charger will have 60v transformer, and LED light strings are for 48v. The headlight would high lumen 48v LED. On the 24v system the battery Pack is 2 banks of 24v, Solar is 28v, charger will have 30v transformer, and LED light strings are for 24v. The headlight would be high lumen LED 24v LED.

At 48v a range of 80 to 144 kms with a maximum speed of 50 kph. At 24v with a range of 60 to 100 kms with a maximum speed of 50kph. As fate would have it, I use a donated old electric wheelchair drive system that in fact would offer 80 to 144 kms on a modified axle with a speed of up to 130 kph.

The last option may sound ridiculous simply because why would a wheelchair travel so fast. A standard wheelchair is rated for 8mph on 10 inch direct drive tires. The motor with worm drive provides 268 rpm. On our application, we replace the 10" wheel with a 7 inch sprocket and chain to a 3.5 inch freewheel sprocket at the axle and the axle would drive the rear 24" wheel using the middle sprocket. At maximum speed, 268 rpm becomes 537 rpm at the axle. This results in an effective speed of 38+ mph (63kph). We would need to govern the speed to 30kph by lowering the maximum rpm's. Moving to the outer smaller sprocket at the wheel would result in 76+ mph (126 kph). The final hurrah! I have an almost ride-able trike ready for conversion to a fully electric unit.

In two years it has severed well as a push tricycle to carry 5 propane tanks (200lbs) for refilling.

The rest of this book deals with making a trailer, The front controller with detachable computer, the rear charger, solar charger, and battery packs.

Bill of Materials

Section	Item	Estimate$	E-Total$	Actual$	A-Total$
Basic Trike	**bike 1**	$0.00		$0.00	
	bike 2	$100.00		$9.98	
	bike 3	$100.00	$200.00	NLR	**$9.98**
	With the changes along the way I was able to acquire 2 donated bikes and reworked the design such that only 2 bikes were needed. The other bike had 24" fat wheels and became the rear wheels. One of these wheels needed a new tube.				
Trike Framing	**0.5" x 48" Sq Steel Tubing (25)**	$160.00		$195.00	
	20ga Metal skin ()	$230.00		$0.00	
	Welding $2/joint	$120.00			
	. . . **120 cut brackets**			$42.00	
	Compartment Locks (6)	$36.00		$0.00	
	Piano Hinge (8ft)	$12.00	$558.00	$9.00	$246.00
	Building the frame took considerable reworking. Firstly, the .5" square tubing got changed out to .75" square tubing, and instead of getting 25pcs x 48" I only received 23 pcs cut to almost exact lengths. Welding was replaced by 120 cut 0.5" x 1" 'L' brackets and 480 rivets. A set of donated keyed a-like recessed door locks completed the framework.				
Driveline	**1" x 48" Steel Rod (1pc)**	$8.55		$38.95	
	1" Pillow Bearings (2pcs)	$25.18		$25.18	
	15T Sprocket (3pcs) chngd (2pcs)	$46.48		$30.98	
	Chain (15ft)	$50.00	$130.21	$0.00	**$95.21**
	The steel rod was much more expensive than planned. We are only driving one rear wheel instead of both so sprockets become 2 not 3 and the existing chains are resized to work.				

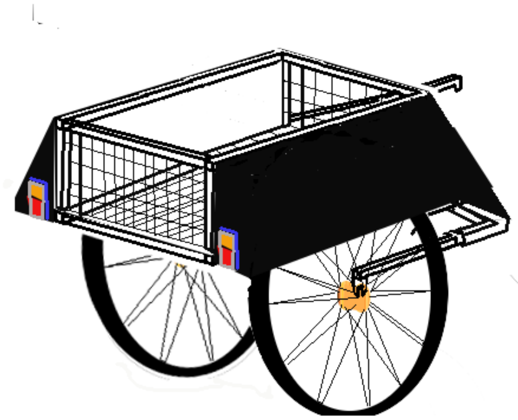
Brakes	**Brake F Caliper** **Brake L Caliper** **Brake R Caliper**	$26.00 $26.00 $26.00	$78.00 $966.00	$0.00 $0.00 $0.00	**$0.00** $351.19
	A little reworking and I was able to reuse the brakes from the donated bikes to facilitate the braking of the three wheels. The front brake remained unchanged. A transfer caliper then fed the two rear brake cables such that when the rear brake is applied it pulls on the middle caliper which in turn pulls two brake cables to the rear wheels that use the brakes from the second bike Now with electric braking the front brake cable to the center is gone as is the middle 'Y' caliper to be replaced with a pivot and servo.				
Other	**Pop Rivets** **Class 5 Bolts (7)** **Primer (3 cans)** **Blue Paint (3 cans)** Acetate glue Epoxy/ resin 8oz to 16oz	$3.49 $4.67 3 * $6.95 3 * $6.95 $5.49 $12.78	$68.13	$3.49 $4.67 3 * $6.95 3 * $6.95 $5.49 $12.78	$68.13
			$1034.13		$419.32

Adding things up:

For a total of **$419.32** for a full featured Adult Tricycle. It will be basically maintenance free and can be made fully electric. Not to shabby!

I'd say that is a far cry from using an ICE car for simple trip commuting at a monthly cost of $1000 per month for 5 yrs not including maintenance. Who'd of thought transportation costs of $60,000 over 5 years could be done for $400. Provide free local travel without need for insurance, fossil fuels, and high maintenance charges which aren't included in this report.

Why an E-Trailer?

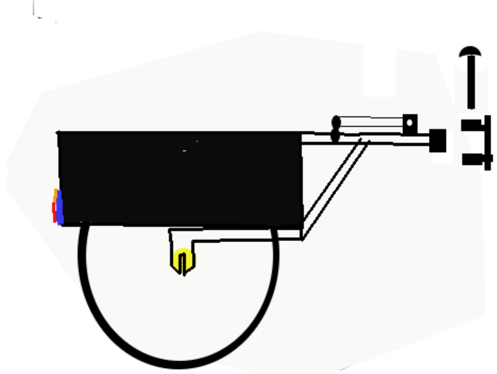


E-Trike Trailor

Frankly, being a frugal guy I like nothing to go to waste. We had it in the plans to buy a trailer for our E-Trike at $129 plus adding lights. The pre-made trailer was kinda lame at 21"sq basket. In making an E-trike we have 3 frames of carbon fiber or lite aluminum, 6 tires. 3 handle bars, 3 pedal sets, seats, chains, and sprockets. Surprisingly, I need one front of frame forks, 1 handle bar, 1 pedals sets, 3 Sprockets, and 2 tires. Remember the front wheel will be electric if I stick with the plan.

So basically most of the frames are waste, 2 seats and 2 handle bars too. Carbon Fiber and Lite aluminum can't be welded by most welding shops as they need a low power tig welder. So this got me to thinking what can I do with 4 extra wheels, and so much frame parts. The trailer I was going to buy was basically a 21 inch square basket with canvass cover, two smaller 14 inch wheels, and a pivot bar attaching to the seat-back.

Which came first the Trailer or the Trike??



E-Trike Trailor

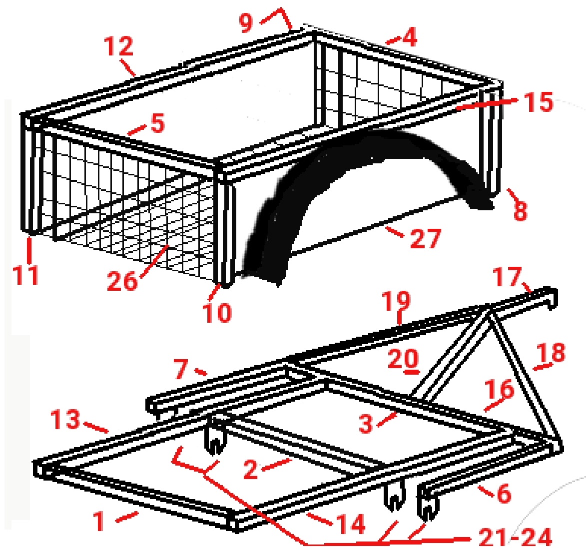
If you said Trike you made a mistake. Correctly, the Trailer comes before the Trike when designing things. This is important when you think about using front wheels as trailer wheels. Front wheels are designed to rotate smooth but have a different dropout spacing than rear wheels. Yes we can re-use the front forks but, and there is always a but, how can we weld them to the rest of the trailer framing!!

Solution is to Just make the frame out of nice weldable square tubing. For the dropouts, we can fashion them from 1/4th inch steel flat-bar and therefore have full control over how we make the flame. True we aren't re-using any of the bike parts yet. At this point I didn't even have one bike. We can re-use one handle bar on the trailer tongue to give us the ability to detach and use it as a hand truck.

The wheels are 26 inch so the hubs are at 13 inches and we need 2" clearance for attaching them. So for our design we have the base of the basket at 15 inches from the ground. The basket must extend up at least 12 inches so the top is clear of the top of the tire. So our trailer top must be at least 27 inches from the ground.

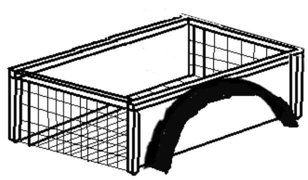
The trailer needs to be slightly narrower than the trike. So if the Trike is 46 inch wide we can make the trailer 10 inch narrower or 36 inches. With 3 inch wheel width compensation, the final basket can be set at 30 inch (wide) X 36 inch (long) x 12 inch

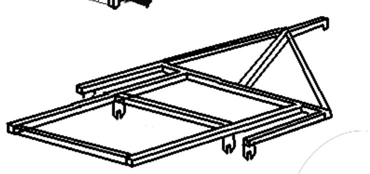
We can re-use one handle bar on the trailer tongue to give us the ability to detach and use it as a hand truck.. Wow! That matches the rough calculations I did for the Trike!!! I started thinking about the trailer for two reasons, one was to find a way to use up left over materials and the other was over concern over how to weld carbon fiber or aluminum. Now I have a better Trike solution too. Make two complete frames One will end life as the trailer. The other will become the main frame for the Trike with some custom mods to both attach the front forks and add the functionality.

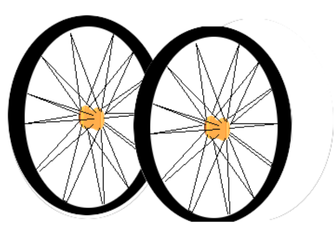


The Top of the basket is a steel frame exactly 30 inches by 36 inches outside dimension. To this frame we mount 4x 14 inch down columns (8-9-10-11). Using the 30 inch by 36 inch aluminum, cut 2 identical 15" x 36" panels and secure as (27). The front back and base of the basket is stiffened by the use of 1/8" aluminum rods weaved through mesh and bailing tied to the aluminum panels. This whole top section will then mount to the base assembly described to the left.

Looking at the chart above the most critical items are 21-24, 6-7, & 13-14. These pieces line up the wheel axles so they align straight. 1-2-3-13-14 must create a completely square frame 30 inches by 36 inches outside dimensions. Item 16 mounts flat against 3 with a 6 inch extension either side. When you know the exact clearance needed for the wheels, items 6 & 7 are secured to establish the spacing for the dropouts. Speaking of the drop outs. These you must hand manufacture out of the 2.5 inch by 2 inch flat iron. You need to know the exact diameter of the mounting bolt so a center slot can be made. We won't be mounting these dropouts until all other welding is done. That way they won't be in the way or get damaged.







So here is what we need for the trailer frame,

- 5 x 1/2 inch Steel square tubing 30 inch long. (1-5)
- 2 x 1/2 inch Steel square tubing 14.5 inches long (6-7)
- 4 x 1/2 inch Steel Square tubing 14 inches long (8-11)
- 5 x 1/2 inch Steel Square tubing 36 inch long (12 - 16)

For the tongue we need,

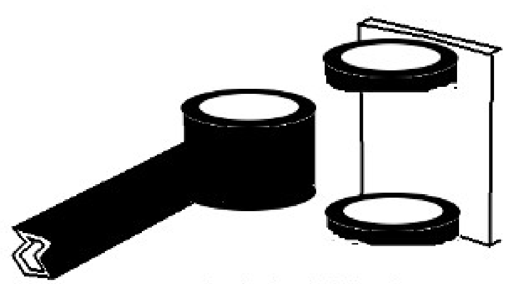
- 1 x 1/2 inch Steel Square tubing 20 inch long (17)
- 3 x 1/2 inch Steel Square tubing 20 inch braces (18 - 20)

To mount the wheels and misc. we need,

- 4 x 2 inch x 2.5 inch Flat metal (21 - 24)
- 1 x Handlebar to be fashioned into fold down handle.(25)
- 1 x 36 inch x 60 inch wire mesh (26)
- 8 x 1/8 inch x 4 ft aluminum rod
- 2 x 30 inch x 36 inch 1/16 inch aluminum (27)
- 2 x Trailer combo tail lights (led) (28 - 29)

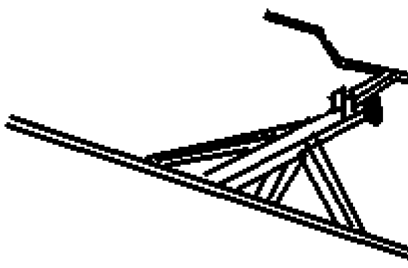
Hitch and Hand truck detail

Using a simple pin hitch is the easiest way to attach the Trailer to the bicycle. The part shown to right mounts on the Tricycle at the top of the Basket. The hitch ring is on the

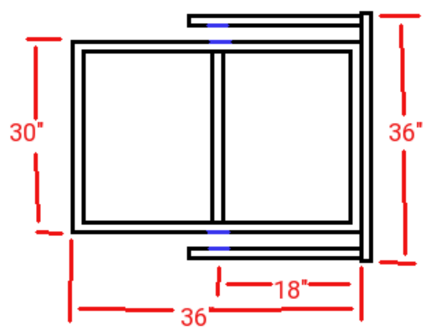


Simple Pin Hitch detail

end of the trailer tongue. This tongue lines up with the top of the trailer basket and mates with the top of the trike basket. And when not in use on the trike can be used as a hand truck.



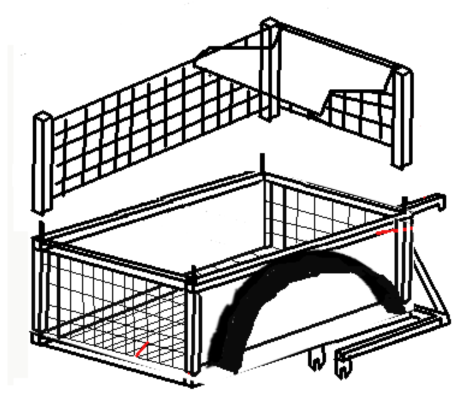
No welding of carbon fiber or aluminum needed. at 10 inches from the hitch, (where all the braces converge) we weld two flat iron tabs and drill a hole thru them. Then on the bar comes from the handle bars themselves we drill a matching hole in the end. A bolt goes through the holes and is nutted as a pivot. When we pivot the bar out into position we need a hole to line up with the hitch so we can drop a pin in place.



Frame Detail

The lower frame is 30 inches wide and 36 inches long with dropouts centered 18 inches. Two out riggers 20 inches long with dropouts centered at 18 inches are mounted to the front bar such that precise wheel spacing is accommodated.

The upper frame is a a basic 30" x 36" frame with the tongue mounted center at 15" with braces down to the outside lower corners.



Options:

With the construction of the trailer thus far, we have an open wire basket without a cover or flanges for tail lights.

- Use 2 Carbon fiber or aluminum top rods to make sliding cover for the basket
- Use 2 carbon fiber or aluminum top rods cut in half to make basket height extenders

The making of cover and extenders can take many forms. Here we have four (3 shown) with mesh or canvas between them and a roll-out canvas cover. If they were hinged instead of fitting over pins, they could act as a cover when closed or act as extenders when open.

Conclusion

With a little persuasion we were able to plan this trailer in a cost effective and feature rich way. We used two of the spare wheels, 2 top rods, 2 down pipes, and a handlebar. Waste was kept down to 1 handlebar, and 2 wheels (which might be just saved for another trailer) and two saddle seats. The original intended Trailer purchase was going to cost $129 for a 21" x 21" x 15" with 14 inch wheels bicycle trailer with 150 lb capacity and without a light package. For about $150 we can make this Trailer with the spare 26" wheels, give us a capacity of 30 inch x 36 inch x 15 inch with option to extend it to 30 inch height. Not bad! going from 5 cu feet to over 15 cu feet at double the load capacity.

Finishing Up

At this point we have the completed E-trike trailer with one exception. To be street legal we need full lighting package.
On the back of the trike, we must put a powered lighting connection and plug our trailer into this connector to supply lighting. Using the same tail light assembly with stop/signal/marker, our lighting is complete.

Bill of Materials

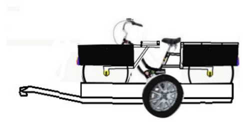
At the same time as we made the frame for the trike, we make the trailer frame so it's construction is covered with the trike.

Section	Item	Estimate$	E-Total$	Actual$	A-Total$
Basic Trailer	trailer	$0.00	$0.00	$0.00	$0.00
Lighting	(2) Brake light (2) Turn Light (4) Marker	$11.00 $10.00 $20.00 $20.00	$61.00	$ $ $0.00 $0.00	$
Other	Pop Rivets Primer (1 cans) Blue Paint (1 cans)	$3.49 $6.95 $6.95	$17.39		
			$78.39		$

Make a Flatbed Car Hauler

So for the true off the grid experience we have this wonderful Solar electric Motor home configured for 17500 lbs of GVWR and made an E-tricycle with trailer for short running about and obtained a car converted to an EV but now we can’t go any-wheres. We have no hauler that will fit both the trike and car or either of them. We only have 6500 lbs to work with. Our Tricycle is GVWR of 250lbs with proposed trailer of 190 lbs. The proposed car is a chevy malibu at 3154 lbs. So our weight without a hauler is 3599 lbs. The hauler weight would have to be less than 2900 lbs.

E-Trike and trailer



This trailer carries the E-Trike and trailer but has no option to carry the car. As a variation of a tow dolly it is about 650 lbs with a capacity of 1200 lbs. The GCWR runs 18,400 lbs. It is the only option that includes the Tricycle trailer.

Rooftop Carrier

Modifying the roof of a car to hold the 250 lb E-Trike would make it possible to carry the E-Trike on the roof. A Blu-Ox hitch or similar would allow towing the EV-car behind the motor home changing the GCWR to 21,904 lbs.

Tow Dolly Weight

A tow dolly or dinghy towing a vehicle usually weighs about 600 pounds without a vehicle hooked up. This option can work for a car with or without rooftop E-Trike carrier. The GCWR becomes about 22,500 lbs. The tongue of the dingy can store under the front end or back end of the Motor home when not in use.

Car Trailer Weight

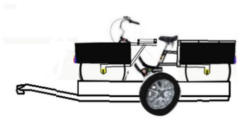
A car trailer can weigh anywhere from 1,500 to 2,800 pounds by itself. The average is 1,900 pounds. Again we can load the Trike onto the roof and load the car fully on the trailer. When at your campground the trailer needs a space of 36 ft to park. The weight of a car trailer largely depends on its construction, length and style. A bumper pull car hauler with length enough for one car may have a GVWR of 6,000 pounds. Additionally, aluminum car trailer weight and capacity will vary greatly from steel. On average, the load capacity for car trailers is 7,100 pounds.

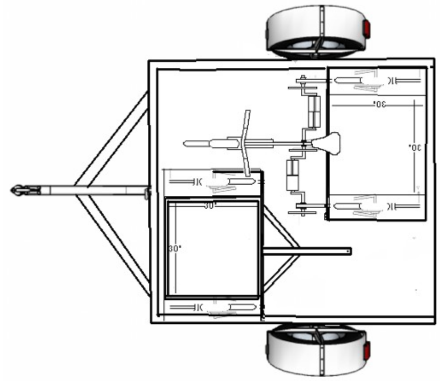
Large Flatbed Trailer Weight

Large flatbed trailers, such as car haulers, weigh anywhere from 1500 to 7,700 pounds, even when empty. Again we can load the Trike onto the roof and load the car fully on the trailer. When at your campground the trailer needs a space of >36 ft to park.

What follows is making 2 types of hauler. First one is an E-Trike Hauler and the second one is a flatbed E-Trike and Car Hauler.

Custom E-Trike Hauler

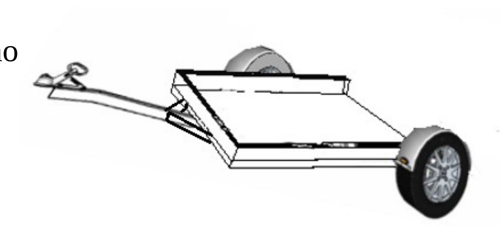




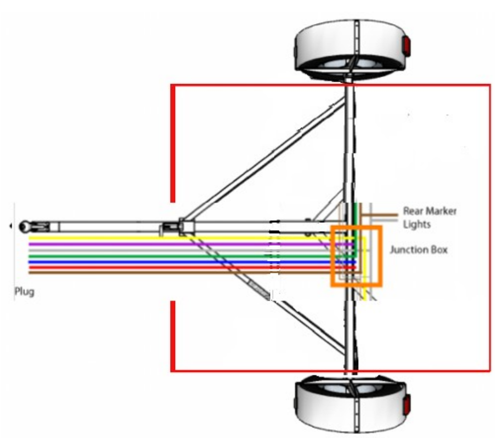
To be truly mobile we need to take all our stuff with us. So we need a Hauler to take our trike / trailer combo on the road. The trike and trike trailer are not that heavy so the hauler for them also does not need to be very heavy either. Seen to the right we have a basic flat bed trailer. We place the trike-trailer to the front and the E-Trike faces the opposite direction to the back on the opposing side. The handle bars would clear the trailer top so both fit on the small footprint trailer deck. Total weight would be under 400 lbs and likely would be closer to 300 lbs. Not shown is the required tie downs for the trike, trike trailer, and break-way chains to the tow vehicle.

Make a E-Tricycle Hauler

This one has no tilt feature but does have a lowered deck with small raised front and sides.



If you have never had or used a tow dolly, it is not for backing up the dolly or attached vehicle. In some places you can even get huge fines for trying to back up a dolly with a vehicle attached. You have been warned



While legally speaking most jurisdictions do not require brakes on the tow dolly, it is advisable to include electric drum brakes at the very minimum.

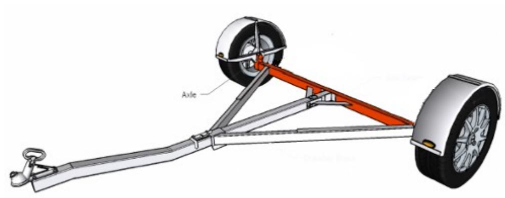
This is a serious project with safety in mind. Don't ask if you can Print it on your 3D Printer, unless you are making a tiny model to display.

They are simple looking, function in a simple manor but are engineered to be strong and safe. They require competent experienced welders to assure they are made right and safely.

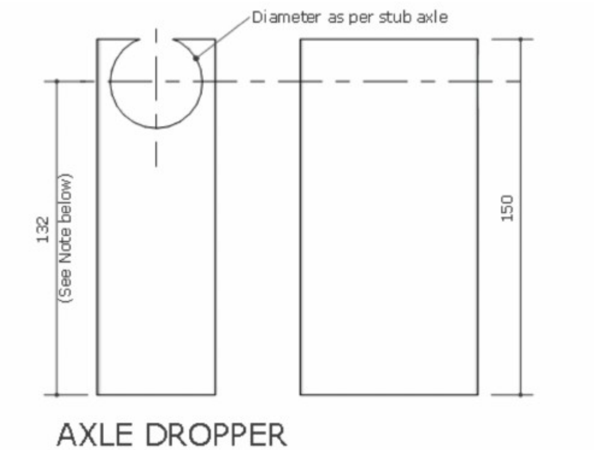
Once completed the tow dolly requires Wheel straps AND vehicle restraint chains to secure the towed vehicle. But since we are going to haul an E-Trike and E-Trailer on the deck, the restraints must be adequate to prevent the contents from coming off while in travel.

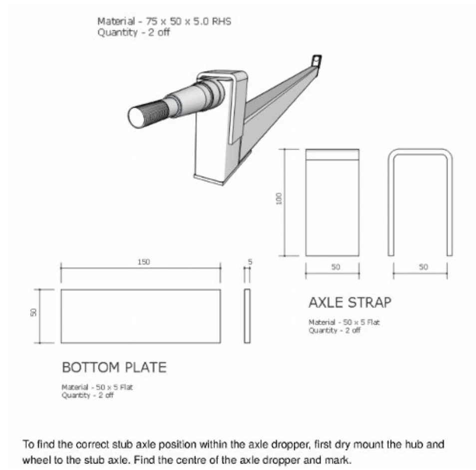
The preceding drawing were shown without the wheel straps (shown to the left) and the required safety chains. All dimensions are in millimeters (1" = 25.4mm)

Part one : Axle Setup

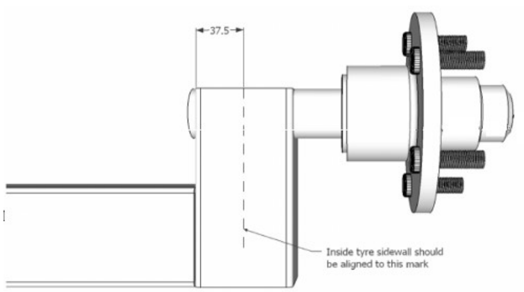


Setting up the axle takes a little bit of working out to ensure there is adequate clearance between the wheel guard and the top deck.
The details below are for a standard 39mm stub axle (1500kg) fitting which is in the majority of towing circumstances.
If using a larger stub axle check out and research using an overlay arrangement which among other things will require changing the axle dropper thickness from 5mm to 6mm.





To find the correct stub axle position with-in the axle dropper, first dry mount the hub and wheel to the stub axle. find the center of the axle dropper and mark it.



Slide the axle dropper over the stub axle and align the tire using a straight edge, until the inside wall of the tire is level with the mark on the axle dropper.

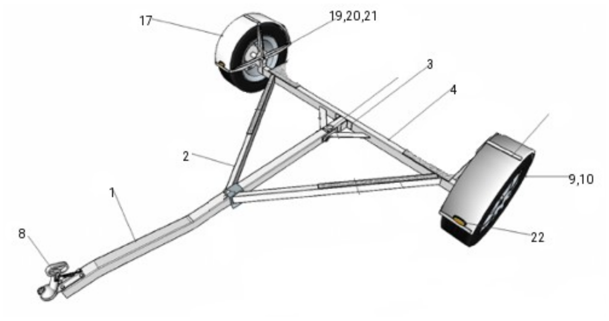
Mark or measure the axle stub position.

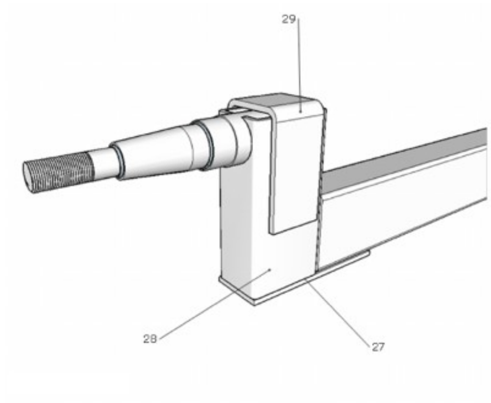
It may be necessary to trim the end of the stub axle so that a maximum of 10mm is protruding from the axle dropper.

Once the stub axle has been fully welded in position, fit the axle dropstrap and bottom plate and stitch weld to the axle.

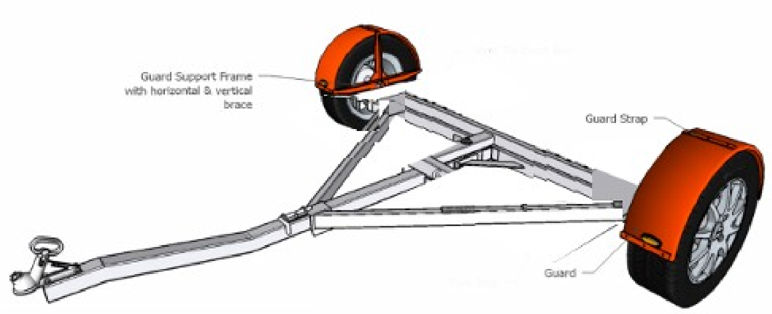
Part two : Materials breakdown

1. (1) Drawbar 65x65x5.0 SHS 2000mm before cutting and forming
2. (1) Drawbar Brace 65x35x5.0 Flat 1330mm
3. (2) Drambar angle 75x50x5angle 65mm
4. Axle Beam 75x50x5.0 RHS 1960mm
5. (2) Axle Bottom plate 50x5.0 Flat 150mm
6. (2) Axle Dropper 75x50x5.0 RHS 150mm
7. (2) Axle Strap 50x5 flat 250mm
8. Coupling 2500kg coupling 4 bolt
9. (2) Tires 14" 185R 850kg load rating
10. (2) Rims 14" with 30P offset
11. Hubs and stubs 1500kg capacity 12. (26 ft) 2" Sq Steel Tubing
13. (26 ft) 1" "L" steel
14. (10) 2"x 6"x 96" Deck boards Pressure treated
15. (3) 2"x 6"x 96" Side Wall boards Pressure Treated.
16. Deck Chains
17. (2) Guard 2mm MS Rolled guards
18. (2) Guard Straps 2.5x5.0 Flat 198mm
19. (2) Guard support frame 5mm MS Plate + 50x5 Flat
20. (2) Guard Horiz brace 25x5 Flat
21. (2) Guard Vertical Brace 25x5 Flat 22. (2) Front marker lamps
23. (2) Combo Brake/rev/signal/marker LED lights
24. (1) Trailer 7wire connector
25. (1) Junction box
26. (1) 12 pos Barrier Strip
27. (1) 14ga 7Core cable 5meters
28. (1) 14ga 2Core cable 2.5meters
29. (10) "P" clips 30. Chain 2500kg minimum rated 400mm long
31. Shackle minimum 2000kg rated
32. Shackle washer
33. Primer (3 cans)
34. Blue Paint (3 cans)





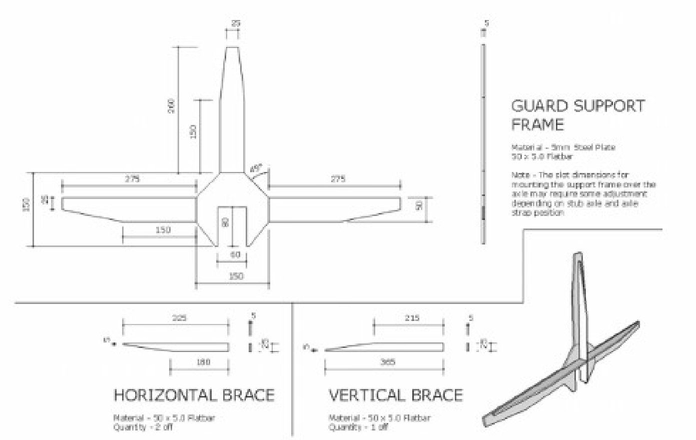
Section 1 : FENDER ASSEMBLY



The width of the guard needs to be as close to the tyre width as possible to prevent interference with the towed vehicle when the top deck has fully pivoted. The inside edge of the guard should be flush with the tyre sidewall.

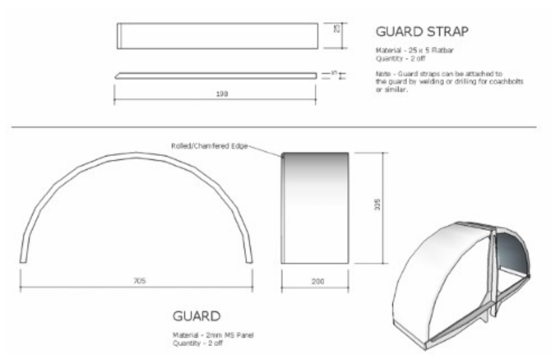
Setting up the guards is best done with the hubs and wheels fitted to the sub chassis. Because the trailer has no suspension to allow for, the clearance between the tire and the guard can be kept to a minimum.

The only requirement is that there is enough clearance for the lighting cables to run behind the guard with sufficient clearance to prevent contact between the tire and cable and to allow small rocks and stones to pass between the tire and the guard without jamming such that they damage the tire and / or guard. 30mm to 40mm should be sufficient.



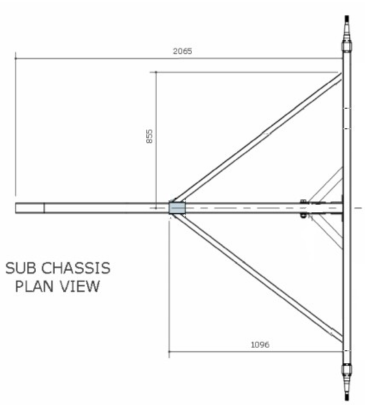
The guard support frame needs to be as strong as practical to prevent the guard from wobbling and deforming during normal use, as well as giving it strength from knocks and bumps.

The guard can be welded to the guard straps, but as the guard is most prone to getting damaged, it is recommended that the guard is bolted on for quick repair or replacement.

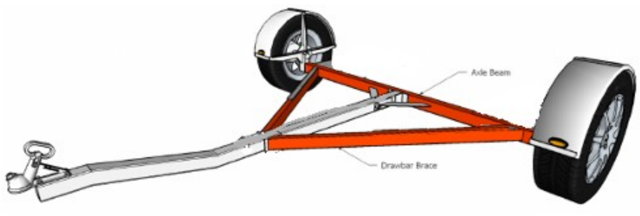


Some modifications to the guard support frame and both the horizontal and vertical brace may be required to fit correctly over the axle and to give even clearance between the tyre and guard.

Section #2 : SUB CHASSIS ASSEMBLY

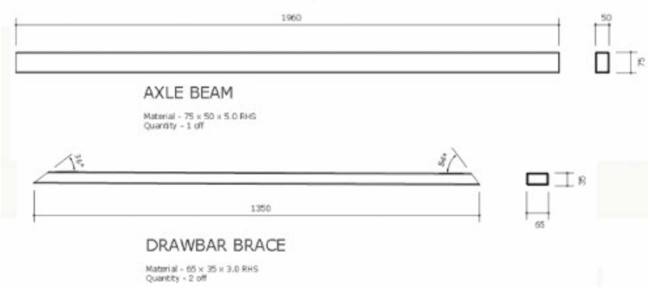


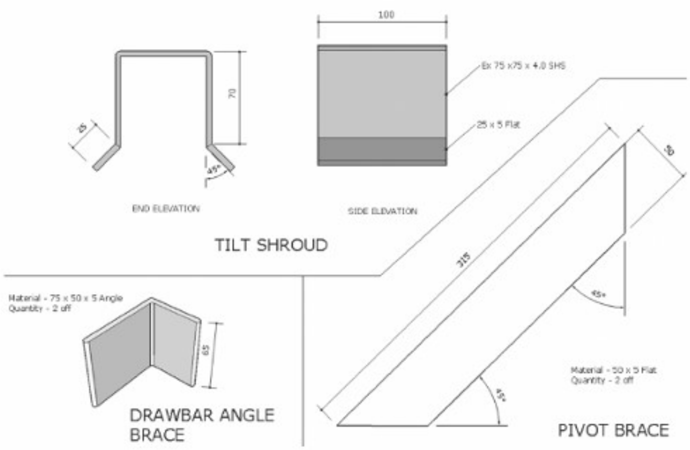
Set up all the sub chassis components as per the details to the left. Tack weld into place. Double check that the support tube is central and square to the axle tube. The Draw bar braces and the support tube top faces should be flush with the top of the axle tube. Be sure to fit the shroud end of the draw bar brace, flush with the draw bar and NOT the top of the shroud.



In a tow dolly we might make the dolly to fold for storage but since this will be a Flat deck trailer there is no tilt or fold and no ramps.

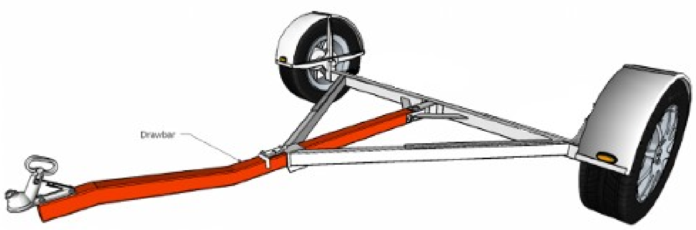
Cut the axle beam and drawbar braces as per the details below.



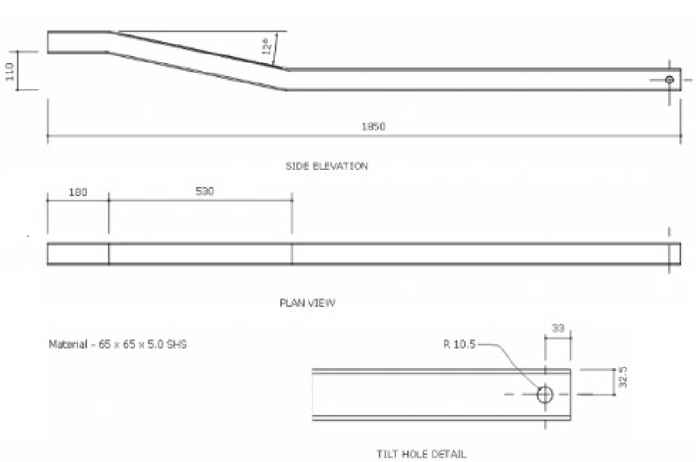


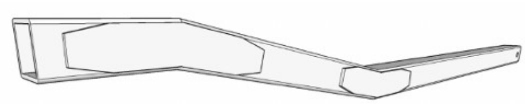
Due to the nature of this being a light duty trailer for E-Bike hauling, we don't need to make pivots, and really we don't even need the tilt shroud or the extra pivot braces. But for added strength here they are.

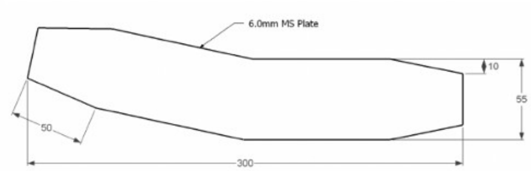
Fabricate the tilt shroud from a section of 75 x 75 x 4.0 SHS by cutting off one face



In this plan the tongue (draw bar) must be made correctly. If you lack the correct equipment to make it , it is preferable to get it professionally bent/rolled to ensure the integrity and strength of the hollow section is not compromised.





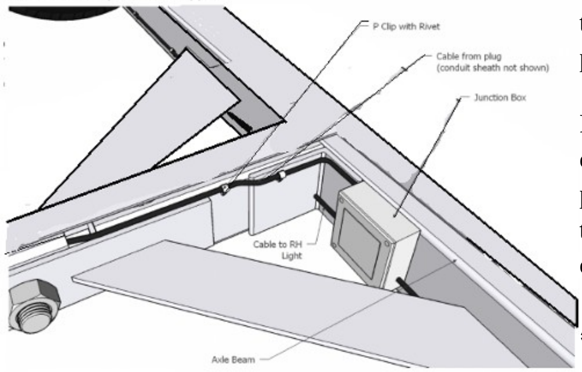


It is not recommended to cut and weld the drawbar to get the desired shape, but if there is no other option, strengthening side plates need to be fitted. See below for more details.

The side plates need to be fitted to both sides of the draw bar and stitch welded evenly around the plate. Stagger your welding to prevent any twisting or distortion of the drawbar from excessive weld heat.

Section #3 : LIGHTS

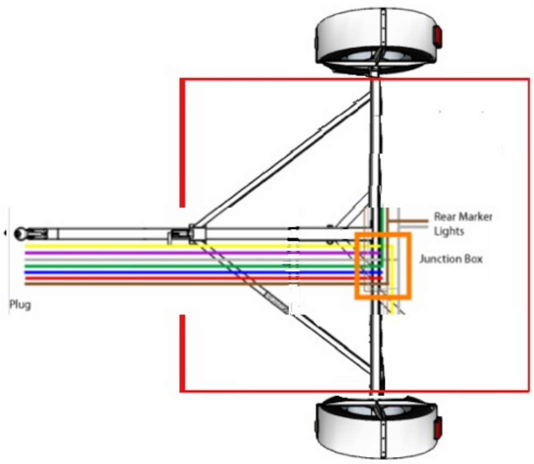
Note - Before doing any cable fitting, it is advisable that the trailer is fully prepared and painted (/information/painting/) or galvanized (/information/galvanising/) and at the bare minimum, has a primer coat applied.



From the front of the trailer slide a semi rigid section of mild steel pull wire down the draw bar until it comes out at the end of the draw bar. Tape the trailer 4 lead cable (6 or 7 lead it fitting for electric brakes) to the end of the pull wire and pull from the tongue end until the cable comes through.

Pull the cable over the top of the tongue and cut once you have about 18" of cable protruding. Slide a section of flexible conduit sheath over the cable and pass it back over and into the gap between the tongue and the pivot support tube. Tape or heat shrink the conduit into place. This conduit will protect the cable from chafing on the steel under normal use.

** We are not making a pivoting or folding trailer but, and there is always a but, this is adapted from a folding tow dolly. In our case, we are not using the fold feature but can use the fact that where it was supposed to pivot (we are welding permanent), there is a gap available for wiring.**



Drill a thru hole through the draw bar angle brace to allow cables to be threaded through to the right hand lights.

Mount a small junction box on the axle tube as shown in the drawing above and drill cable holes. Where possible use the correct size grommets to help seal the junction box from water and dust or dirt and to prevent chafing of the cables. Once the cables have been connected, use some silicon to fully seal around the cables.

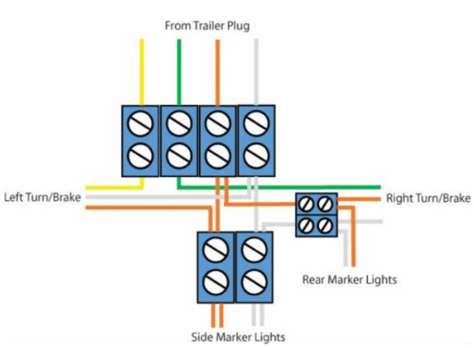
Drill thru the back of the junction box to run a cable for the rear center marker lights (triple set)

"p" clip the cables to the axle beam and braces.

Fitting lights

Make sure that your number plate light is in the correct position and that the light will shine on the plate. Keep your lights as far to the outside edge of the guard as possible.

Mark out your light positions on the guards and drill cable holes as indicated for your lights.



There are a number ways of joining wires together in a junction box but using a strip connector or barrier strip inside the junction box is one of the simplest and best way to keep connections secure and weather tight and also gives the option of easily changing lights should they becomes damaged.

Other options include soldering and using insulation (electrical) tape or heat shrink tubing. Using crimp connectors and covering again with heat shrink. They take less time but lack the ease of service if things go amiss.

Side Marker Lights

For side marker lights, an additional two lengths of 2 lead cable need to be run from the junction box. Take the cable along the same route as the main lighting cable, along the guard brace and behind the front of the guard. "P" clip the cable in appropriate hidden positions to prevent the cable from being snagged by either the tire or debris flung up from the road.

Crimp connectors are the most convenient method for joining the wires to sealed lights with attached wiring.

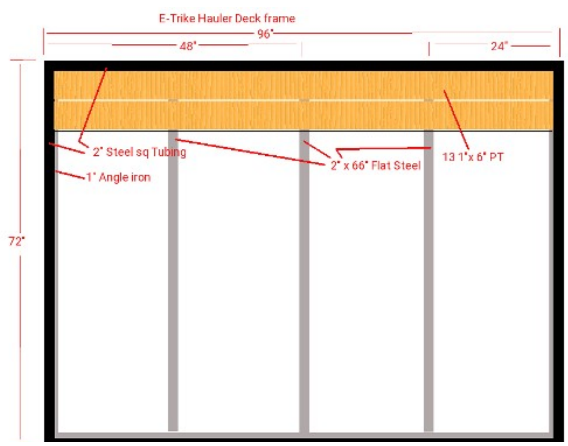
Pass the plug and cable through the hole drilled in the side of the draw bar and slide a suitable sized rubber grommet over the cable to prevent any chafing of the cable where it passes through the draw bar.

Trim the length of cable so that the cable can move with the trailer without being stretched or kinked but not so long that it might touch the ground.

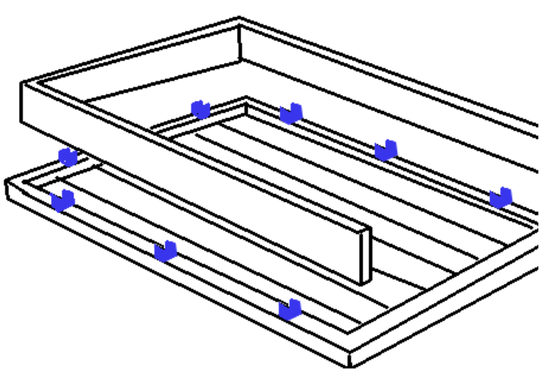
Slide any plug sleeve or casing that came with the plug over the cable, then strip each end of the plug wires leaving about 10mm bare wire, fold the bare wire ends in half and enter them into the plug connector in the correct sequence as per the chart to the left. Tighten the screws snugly. Screw the cable clamp down to prevent the cable from pulling out.

Check all your lights by connecting them to the tow vehicle trailer plug. Lights can be finicky, make sure the wiring on the tow vehicle is actually working before trying to solve trailer light issues.

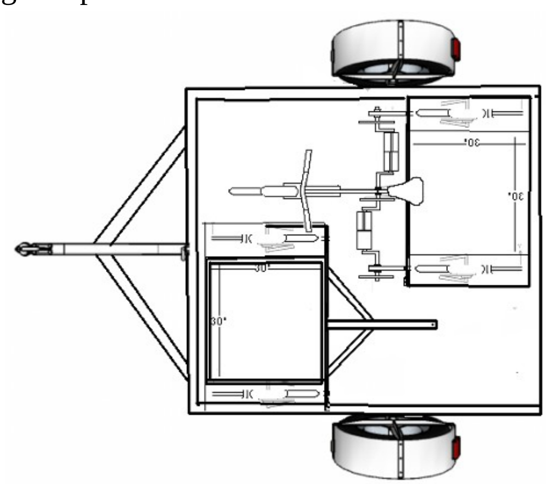
Section #4 : TOP DECK FRAMING



The top deck is Constructed of 2" Square tubing built to a perfect Rectangle measuring 8 ft x 6 Ft. The 6ft width goes between the wheel wells. To the 2 " sq tubing mount a 1" angle iron flush with the bottom of the frame. At 24", 48", and 72" weld 2" Flat iron as shown. Do not mount the 13 1" x 6" pressure treated deck boards yet. Place the Deck Frame such that the center Flat Steel (@ 48") is aligned with the axle Beam and centered between the Wheel wells. Clamp in place and when you are sure the frame is square, weld the Flat iron straps to the Tongue, Draw bar Braces, and Axle Beam.



The Deck Fence is 2 x 8Ft 2x6 PT Lumber and 1 x 6Ft Trimmed to fit 2x6 PT Lumbar. They are mounted to Deck Frame as shown using 2" x 2" x 1" U-Channel spaced evenly. It is appropriate not to install the Fence until it is light sanded and painted. Also the deck boards should be finished with rubber coat and not installed until the frame is painted and wiring complete.



Section #5 : FINISHING

Fit the tilt bolt and nylock nut and secure tighten.
Grease and fit the bearings, hubs and wheels and torque the stub nuts up to these settings.
Torque settings for wheel nuts:
7/16" UNF 110Nm or 80 ft-lbs
1/2" UNF 125Nm or 90 ft-lbs

Fit amber reflectors to the side of the draw bar brace and fit safety chains and shackles to the front of the draw bar. Mount the coupling using good quality bolts and ensure they are torqued as per the suppliers recommendations.

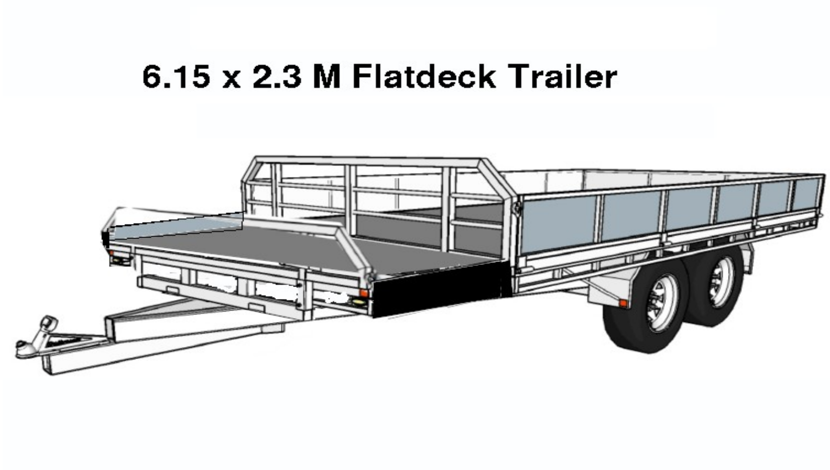
Put a dab of grease on the tow ball and hook the trailer up to the tow vehicle and double check that all the lights are working. Grab a new vehicle registration from your local DMV or vehicle registration center, fill it out and license your new trailer. Attach your new license plate to your trailer and book the trailer in for a certificate of fitness if required. Once the trailer is licensed and certified it is ready for loading!

After about 100 miles perform a check of all couplings and bolts, wheel nuts and guard strap screws. Do regular maintenance checks every 3 months of use.

Bill of Materials

Section	Item	Estimate $	E-Total$	Actual $	A-Total$
Framing	1. (1) Drawbar 65x65x5.0 SHS 2000mm before cutting and forming 2. (1) Drawbar Brace 65x35x5.0 Flat 1330mm 3. (2) Drambar angle 75x50x5angle 65mm	$23.00 $14.32 $3.49	$40.81	$ $ $	$
Driveline	4. Axle Beam 75x50x5.0 RHS 1960mm 5. (2) Axle Bottom plate 50x5.0 Flat 150mm 6. (2) Axle Dropper 75x50x5.0 RHS 150mm 7. (2) Axle Strap 50x5 flat 250mm 8. Coupling 2500kg coupling 4 bolt 9. (2) Tires 14" 185R 850kg load rating 10. (2) Rims 14" with 30P offset 11. Hubs and stubs 1500kg capacity	$25.31 $4.16 $5.55 $11.21 $92.00 $124.00 $96.00 $76.00	$434.23	$ $ $ $ $ $ $ $ $	$
Deck	12. (26 ft) 2" Sq Steel Tubing 13. (26 ft) 1" "L" steel 14. (10) 2"x 6"x 96" Deck boards Pressure treated 15. (3) 2"x 6"x 96" Side Wall boards Pressure Treated. 16. Deck Chains	$48.00 $27.00 $30.00 $9.00 $19.65	$133.65	$ $ $ $ $	$
Wheel Guard	17. (2) Guard 2mm MS Rolled guards 18. (2) Guard Straps 2.5x5.0 Flat 198mm 19. (2) Guard support frame 5mm MS Plate + 50x5 Flat 20. (2) Guard Horiz brace 25x5 Flat 21. (2) Guard Vertical Brace 25x5 Flat	$8.00 $8.00 $8.00 $8.00 $8.00	$40.00	$ $ $ $ $	$
Lighting	22. (2) Front marker lamps 23. (2) Combo Brake/rev/signal/marker LED lights 24. (1) Trailer 7wire connector 25. (1) Junction box 26. (1) 12 pos Barrier Strip 27. (1) 14ga 7Core cable 5meters 28. (1) 14ga 2Core cable 2.5meters 29. (10) "P" clips	$12.45 $20.76 $7.95 $9.65 $1.23 $5.00 $3.00 $2.40	$62.44	$ $ $ $ $ $ $ $ $	$
Other	30. Chain 2500kg minimum rated 400mm long 31. Shackle minimum 2000kg rated 32. Shackle washer 33. Primer (3 cans) 34. Blue Paint (3 cans)	14.55 8.95 3 * $6.95 3 * $6.95	$73.36		$
			$784.49		$

Custom E-Trike and Car hauler



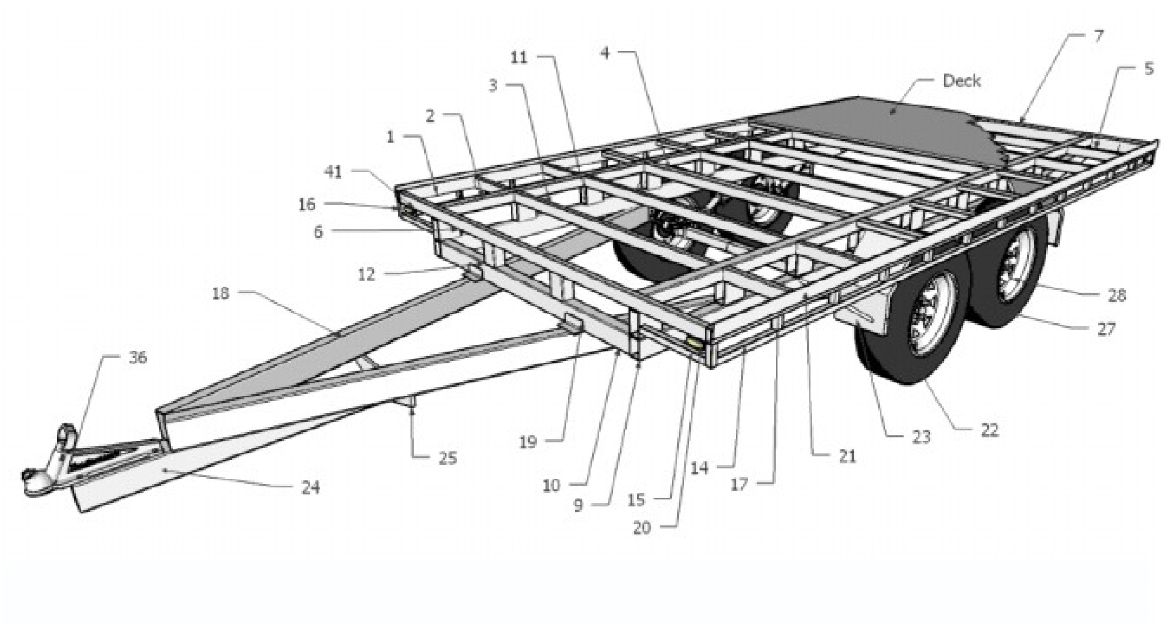
I have the plans for a 3.6M x 2M flatdeck trailer. Which I plan to modify to the image to the right. The original specs say 3.6M x 2M deck with 1100lb capacity if unbraked. 3500Lb capacity if braked.

As the plans state, it has folding sides, folding tailgate, removable headboard. The deck needs to be increased from 11.7ft x 6.5ft to 20ft x 7.5ft to accommodate a car and the e-trike.

The reason for the length increase is so we can have a 4 ft space for the trike and a 16 ft space for the car. Width increase is because the Tricycle is 8 ft long and 4 ft wide (front wheel needs be turned a bit to close gate) and having only 3" to step on when car is loaded is not enough so for safety we will now have 9".

Specifications:

- **Deck Size 3.6 (142") x 2m (79")** **increase 220" x 80"**
- Tandem axle 14" wheels
- Oscillating load sharing suspension
- Fully welded steel chassis
- 17mm (11/16") Plywood decking
- Full length tie rails
- Fully protected front and rear lights
- Optional removeable headboard permanent
- Optional folding and removable sides and tailgate
- Tare weight unbraked 530kg (1170lbs)



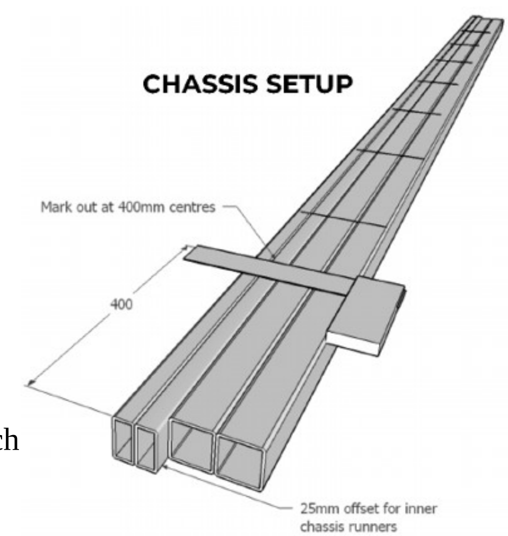
Item 18 draw bar is 2500mm before modification, 3300mm for car mod only and 4100mm for car & E-trike modification. Items 1,2,9 increase by 1200mm, item 3 =9 qty, Item 5 qty +6 and 6" longer, item 6 & 7 is 12" longer.

Cutting List / Parts Detail

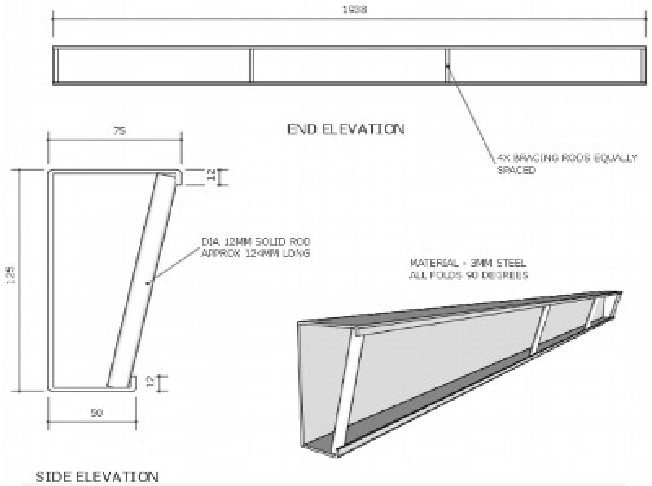
3.6 x 2.0m Flatdeck Trailer - Basic Trailer (Does Not include Headboard, Sides or Tailgate)

	Part	Material	Length (mm)	Quantity
1	Outer Chassis Runners	50 x 25 x 2.5 RHS	3600	2
2	Inner Chassis Runners	50 x 50 x 3.0 SHS	3500	2
3	Central Crossmembers	50 x 25 x 2.5 RHS	1250	6
4	Central Crossmembers	50 x 50 x 3.0 SHS	1250	2
5	Outer Crossmembers	50 x 25 x 2.5 RHS	294	16
6	Front Crossmember	50 x 25 x 2.5 RHS	1988	1
7	Light Channel	3mm Steel Panel	1938 x 275 Unfolded	1
8	Light Channel Braces	12mm solid rod	125	4
9	Sub Chassis Runners	75 x 50 x 3.0 RHS	2900	2
10	Sub Chassis Front Crossmember	75 x 50 x 3.0 RHS	1250	1
11	Main Chassis Packers	100 x 50 x 3.0 RHS	100	16
12	Front Chassis Packers	75 x 50 x 3.0 RHS	100	2
13	Sub Chassis Angle Brace	75 x 50 x 3.0 RHS	700 before trimming	2
14	Tie Rails	25 x 25 x 2.5 SHS	3550	2
15	Front Tie Rails	25 x 25 x 2.5 SHS	294	2
16	Corner Uprights	25 x 25 x 2.5 SHS	75	4
17	Uprights	25 x 5 Equal Angle	50	22
18	Drawbar	100 x 50 x 4.0 RHS	2500	2
19	Drawbar Gusset	40 x 5 Equal Angle	100	2
20	Front Marker Light Mount	2mm Steel Panel	100 x 50	2
21	Deck Edge Plate	50 x 6 Flatbar	3600	2
22	Guards	2mm Steel Panel	285 x 460 Unfolded	4
23	Guard Brace	12mm solid rod	400 before trimming	4
24	Coupling Mount	90 x 90 x 5.0 SHS	900	1
25	Coupling Mount Brace	100 x 12 Flatbar	420	1
26	Coupling Compression Tubes	15NB Med Pipe	80	4
27	Tyres	14" 185R commercial	750kg load rated per tyre, can be upgraded	4
28	Rims	14"	Galvanised or painted, stud pattern to suit hubs	4
29	Hubs and stubs	1500kg Capacity studded to suit rims	can be upgraded to 2000kg hubs/stubs	4
30	Axle	50 x 50 x 5.0mm SHS	******	2
31	Springs	4/5 leaf, 50mm wide - 1500kg rated		4
32	Spring hardware	U brackets and slippers	50mm wide to suit springs	2 pr
33	Spring Plates	12mm thick plates to suit springs		4
34	Square U bolts	M12 minimum		8
35	Spring Oscillator/Rocker Ass.	As per supplied - check unit will fit your spring width & type		1 pr
36	Coupling	as per required for brakes		1
37	Chain	2000kg rated	minimum 400mm long	1
38	Shackle	2000kg rated		1
39	Shackle washer			1
40	Lights	100mm high LED or bulb		2
41	Front Marker lamps	LED Sealed		2
42	Front Marker lamp mounts	2mm Steel Panel	To suit light dimensions	2
43	5 or 7 Core Cable	14 gauge	Approx 15.0 metres	
44	2 Core Cable	14 gauge	Approx 12.0 metres	
45	Decking	17mm H3 Treated Plywood Decking CD Grade or better	3x sheets 2400 x 1200mm	3
46	"P" Clips		Diameter to suit cable	20
47	Deck Fastenings	8G x 30mm Galvanised self tapping countersunk screws		80
		NB - Components for un-braked trailer		*REV E*

Top Chassis set-up

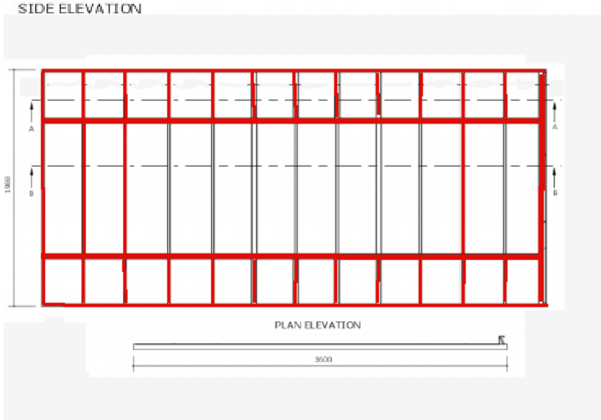


Outer runners increased to 16 ft from 11.7 ft
Inner runners increased to 16 ft – 50mm and offset 25mm at each end. Mark off 400mm centers for cross members.

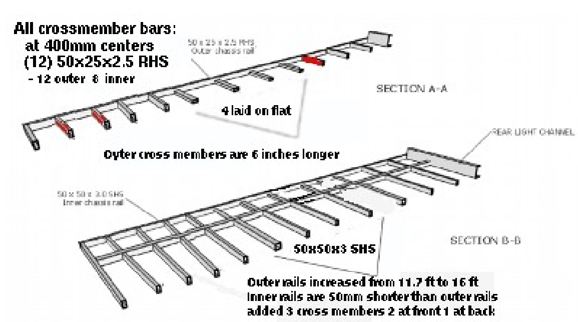


Cut and fold up light channel, as per the drawing, and pre drill for your lights if you already have then on hand.
Fit rod braces to the light channel, one each flush with the ends and the other2 equally spaced along it's length.
On a flat surface, Lay out the chassis runners, front cross member and light channel and tack weld into posistion. Check the frame for squareness and adjust.

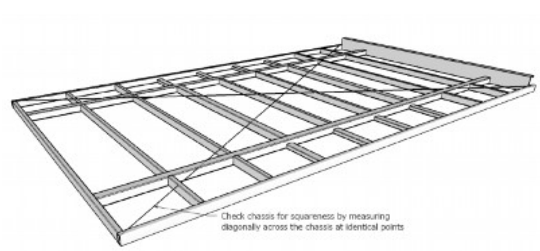
Once the frame is square sandbag or clamp the frame to prevent any accidental movement (25kg bags of cement are perfect for this.) Fit all outer and inner cross members, centering them against the 400mm markings on the chasis runners.



Where the outer cross members may reduce wheel clearance with the chassis, lay the RHS on it's widest edge flush with the bottom of the chassis runners. See the cross section picture left. Due to changing the width from 6.5 ft to 7.5 ft the outer cross members are 6" longer on each side. Due to changing the length from 11.7 ft to 16 ft the inner and outer rails were lengthened. For the inner cross members, note the position of the two 50x50 sections. These are used for joining decking material based on 1200mm centres. if your proposed decking material is different widths, you may need to alter the 50x50 SHS positions to suit.

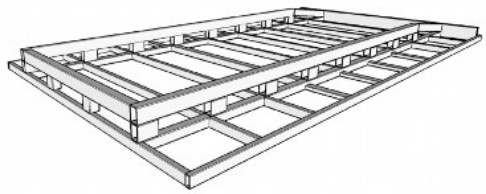


Once all the cross members are in position tack weld in place checking the squareness of the frame. Measure diagonally corner to corner from identical positions



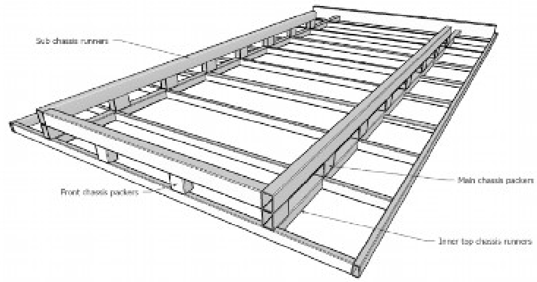
Where one measurement is longer, divide the difference between the two measurements and gently knock the longest corner of the frame to match the shortest side plus the difference in measurement.
For example:
if the shortest reading is 4100mm and the longest is 4120mm, 20mm is the difference. divide 20/2 to get 10mm knock the longest length till the tape reads 4110mm. Keep adjusting till they both are identical. Clamp in place and sandbag until ready to weld.

The Sub Chassis



Building the Sub Chassis

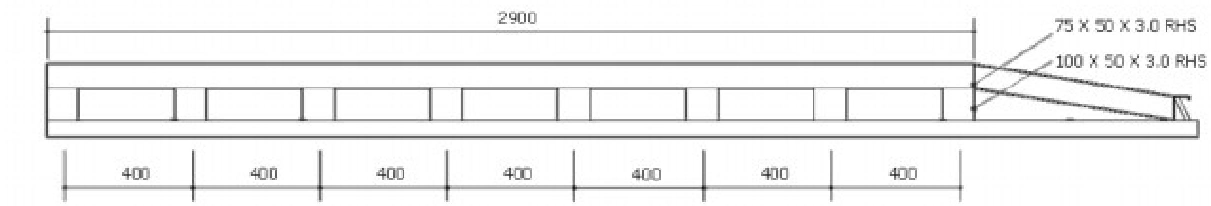
Cut and lay the main chassis packers at 400mm centres along the inner top chassis runners from the front of the trailer. Tack weld in position.



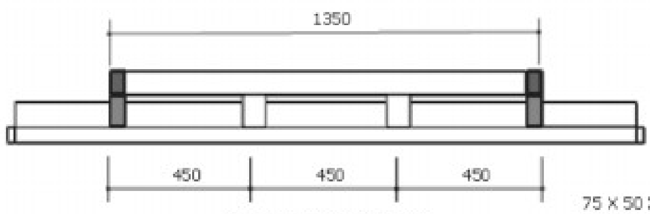
Fit and clamp the sub chassis runners to the main packers and tack weld in position.

Repeat with the front chassis packers and front sub chassis cross member keeping all parts flush with the front of the trailer.

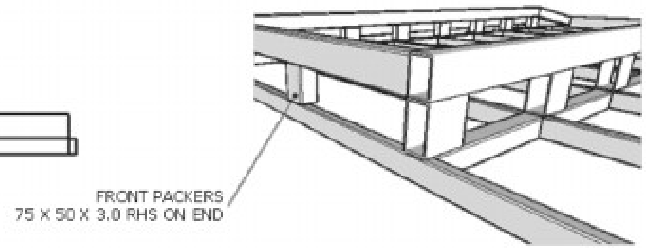
The sub chassis rails remain the same width as before to line up with the inner rails of the decktop the length of the rails changes from about 11.7 ft to 16 ft overall. We will now 24 spacer block instead of 18.
Cut and lay the main chassis packers at 400mm centers along the inner top chassis runners from the front of the trailer. Tack weld in position.



SIDE ELEVATION

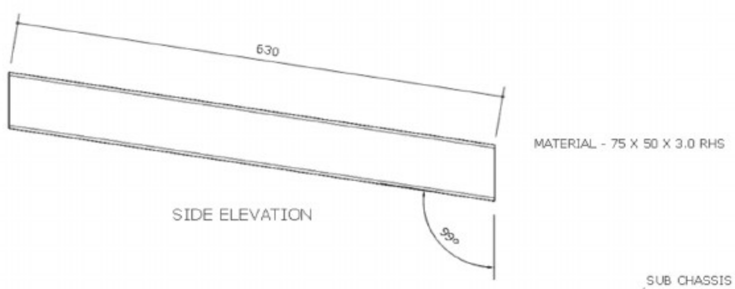


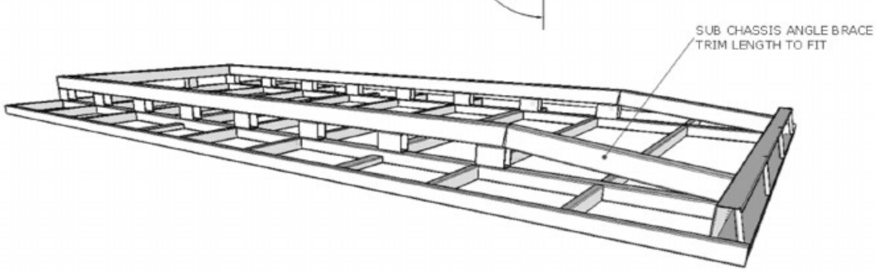
FRONT ELEVATION



FRONT CORNER DETAIL

Trim the rear angle braces to fit between the sub chassis runners and the light channel and tack weld into position.



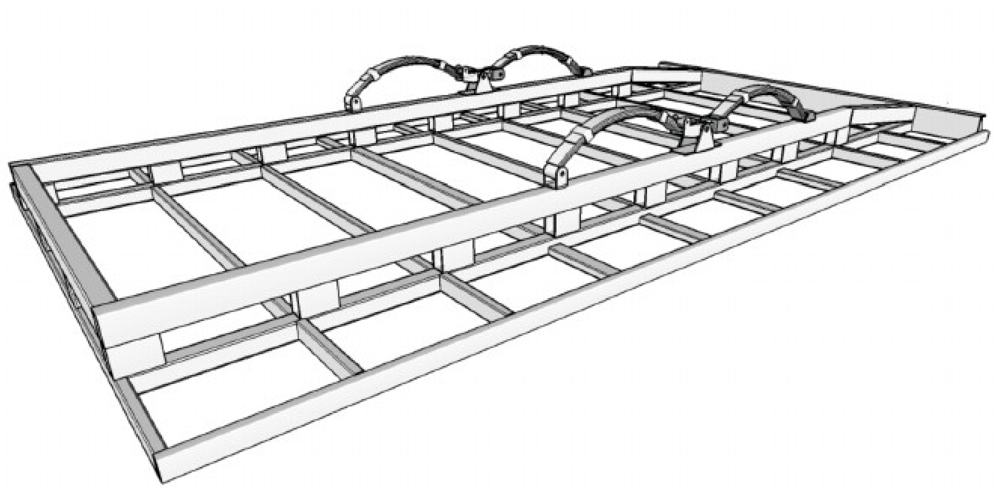


This isn't to scale because we added 3 cross members and adjusted the size of deck. Note the last cross member has no spacer (pack).

The wheelwell / suspension is moved 1 cross member towards the front.

There is still a bit of work yet before we start welding up the chassis. The next section covers fitting the suspension.

3.6 X 2.0M FLATDECK TRAILER: SPRINGS

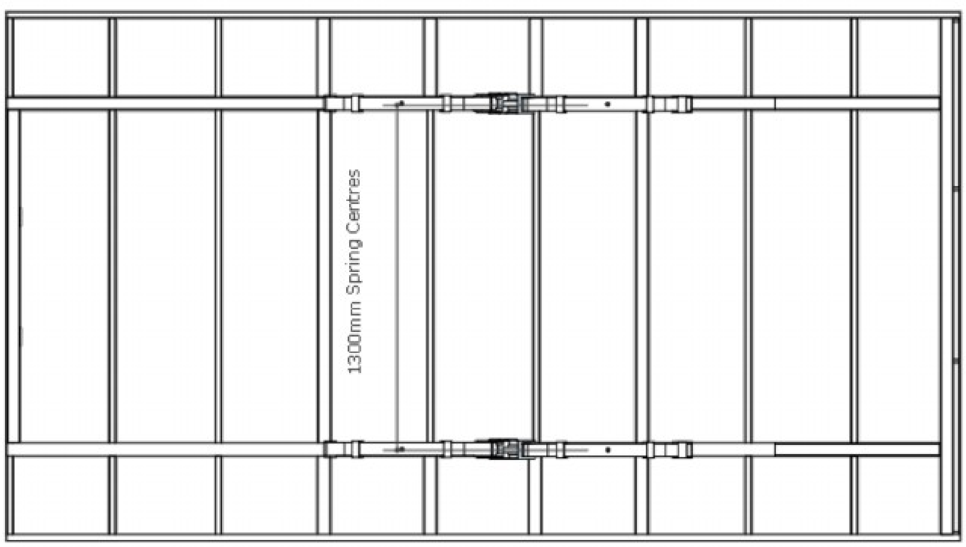


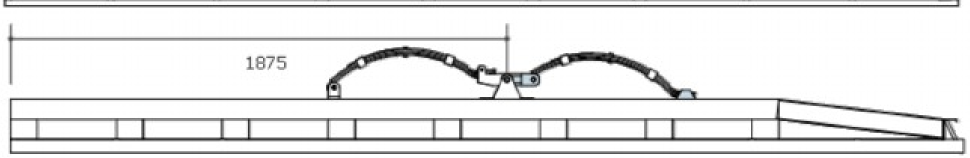
For 16ft trailer use 2675mm not 1875mm for center of oscillator rocker.

For 20 ft trailer use 3475mm not 1875mm

Spring Setup

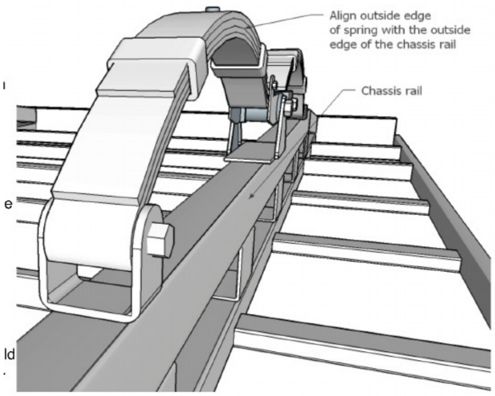
From the front of the trailer, mark 1875mm for the centre of the oscillator/rocker unit. This suspension offset is 75mm back from centre and unless you are fitting heavy rear hinging ramps or have a typical load which will add excessive weight to the rear of the trailer, this offset will suit most applications.

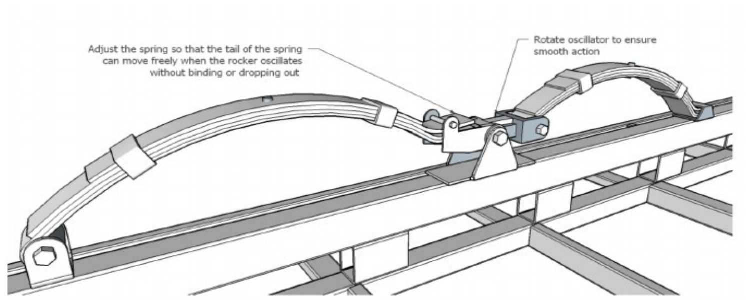




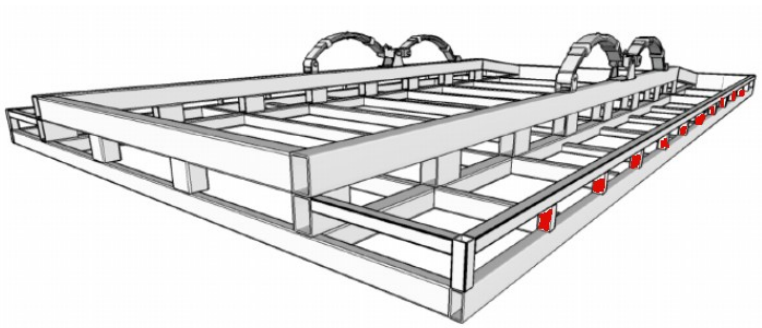
Set up your suspension rocker so the main rocker bolt centre is lined up with the

Adjust the spring so that the tail of the spring can move freely when the rocker oscillates without binding or dropping out.
Make sure that the outside edges are flush with the outside edge of the chassis rail and once double checked, tack weld the spring hanger and suspension rocker to the chassis rail.
Once this is completed on both sides, position the slippers over the spring rails allowing for clearance between the spring and the slipper for the spring to move in and out when loaded.



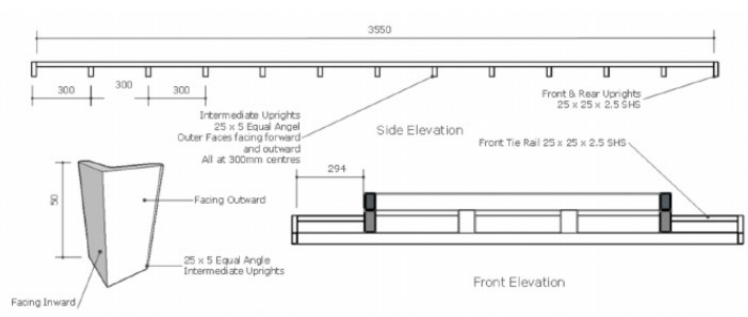


Again make sure the outside edge of the spring is flush with the outside edge of the rail and tack weld the slipper in place.
Once all components are in position, remove the spring and fully weld around the hanger, rocker and packers.



Now is a good time to measure up your axles.

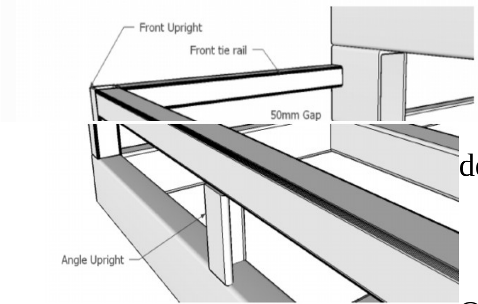
Fitting up the tie rails:
Tie rails are small angle iron pieces welded to the outer rails.



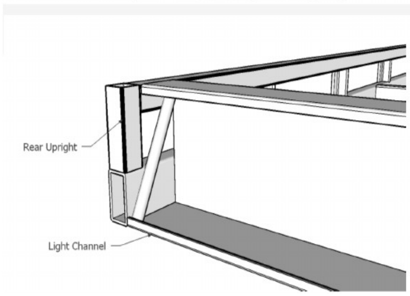
Measure and mark out along the outer chassis rails. 300mm centres starting 12.5mm in from the front of the deck to compensate for the first upright.

Fit the 25x25 SHS uprights and tack into position.

Position the 25mm angle uprights at the marked positions with the outer face flush with the outside edge of the chassis rail and the other facing the front. Tack weld onto the chassis rail.



Lay the tie rail between the end uprights and tack weld into position. Adjust the intermediate uprights to ensure a nice straight and level tie rail. Fit the front tie rails between the front upright and the chassis packer. Make sure the tie rail is level and flush with the front of the deck and tack weld into position.



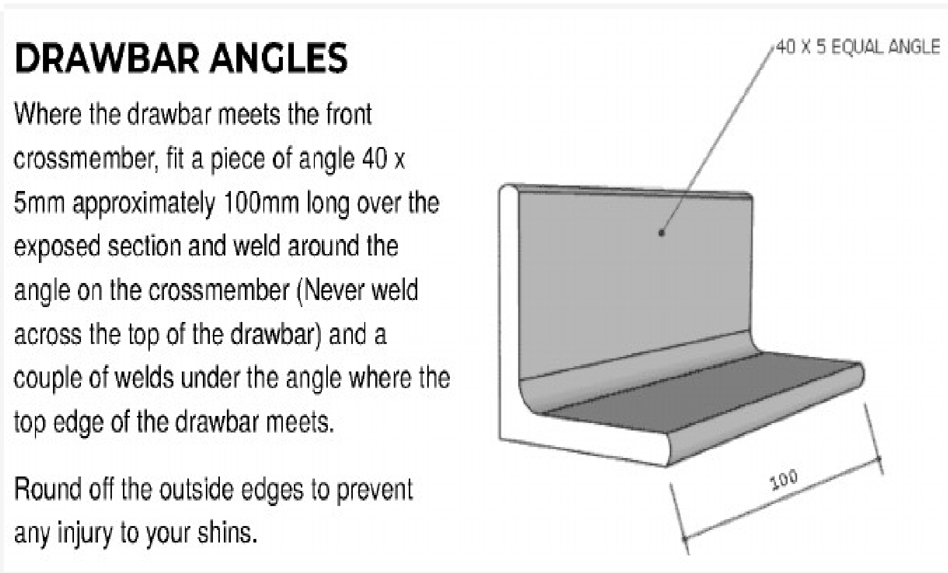
Once everything is tack welded into position, check for square and looking as it should.

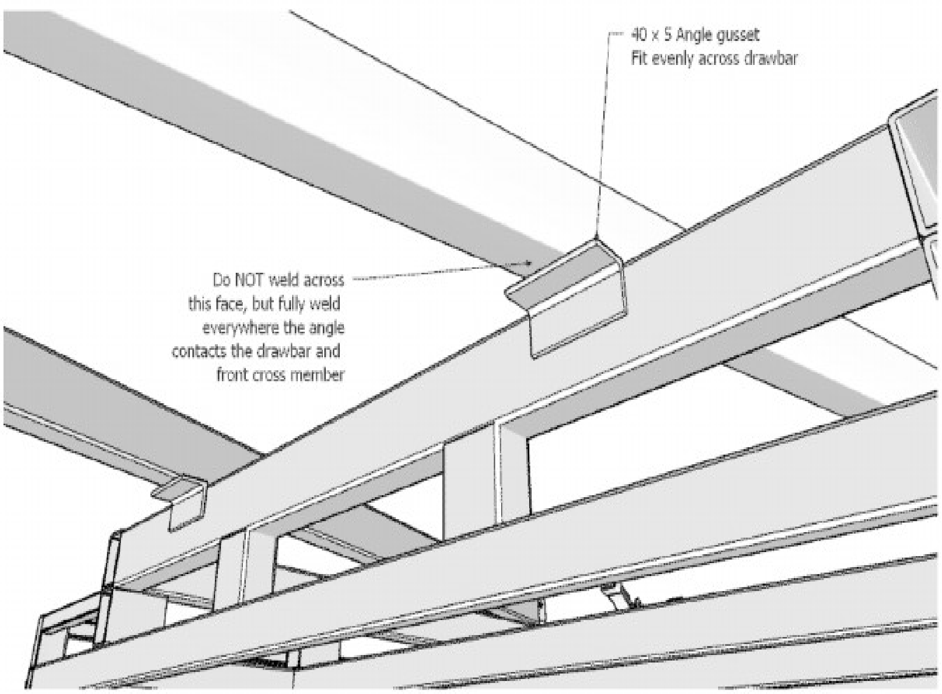
Fully weld up all visible components of the top chassis. It can’t be flipped over until the draw bar is in place.

3.6 x 2.0 M Flatdeck Trailer tongue Components

This section covers the all important angle gussets which provide additional strength to the draw bar as well as preventing metal fatigue as the draw bar does it's work.

With the flatdeck trailer there are a couple of coupling mounting options and these are detailed below.





The angle will give the drawbar and chassis a stronger and stiffer structure at this point

Coupling Mount

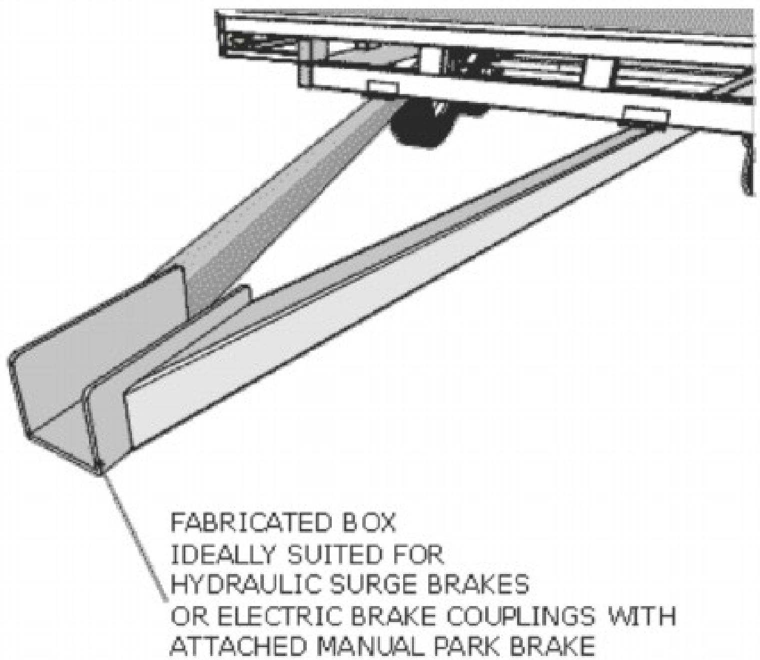
There are a couple of methods of mounting the coupling to the draw bar and due to The
Coupling Mount
There are a couple of methods of mounting the coupling to the draw bar and due to The
way the trailer is built, the coupling base needs to be level to the base of the drawbar to accommodate a standard towing height of 450mm.

The mounting method is determined by the type of braking the trailer is to have - hydraulic surge (/equipment/trailer-brakes/) or electric (/equipment/trailer-brakes/).

The fabricated box is ideally suited for hydraulic surge braking or electric brake couplings with an attached manual park brake lever.

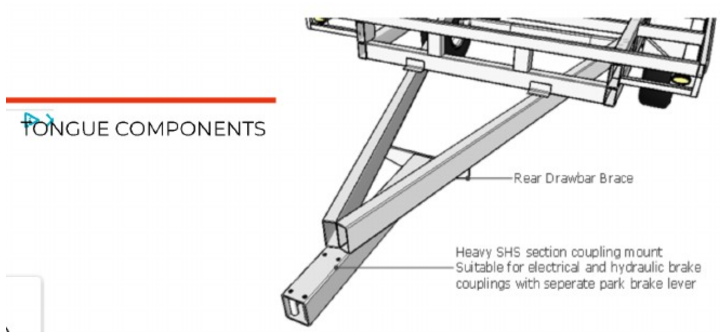
It gives reasonable protection from knocks to the hydraulic master cylinder, but does take a bit of effort to line up and fit to the drawbar.

The coupling box can be either folded or fabricated from 3 plates.



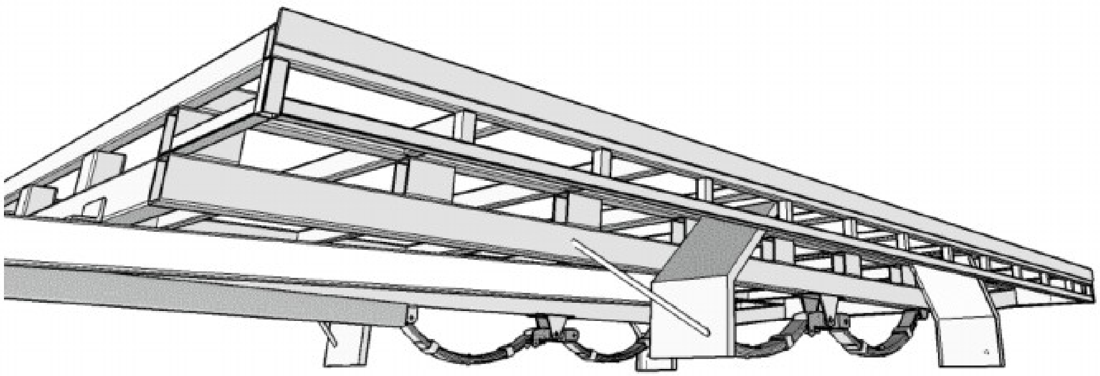
Accurate alignment of the box within the drawbar is critical and time should be taken to check and double check measurements prior to cutting the drawbar.

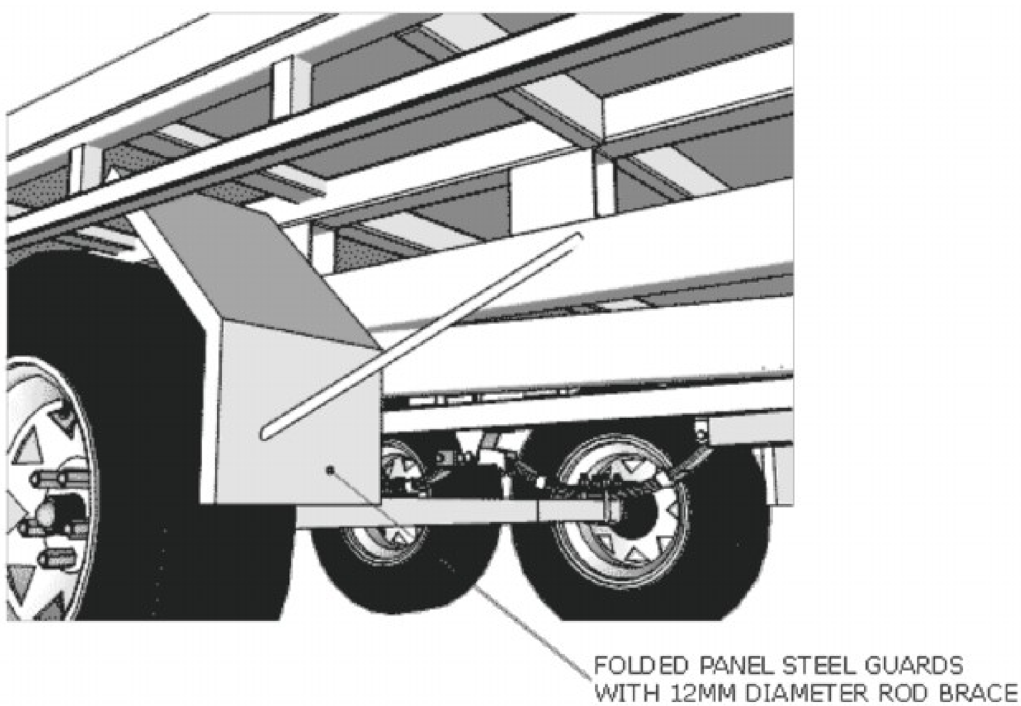
The second more commonly used option is fitting a section of 90x90x5 SHS under the draw bar, and mounting the coupling on top.
This setup is suitable for both unbraked and hydraulic braked couplings, as well as electric couplings with a separate park brake lever.
This style coupling mount is very quick and easy to build and fit, but care does need to be given to good quality welding.
Compression tubes need to be fitted with-in the cavity of the coupling mount to prevent the deformation of the SHS when the coupling bolts are tightened. A rear draw bar brace gives added strength.
Blanking off the open ends of the draw bar make for a nicer looking trailer.



3.6 x 2.0 M Flatdeck Trailer Fenders

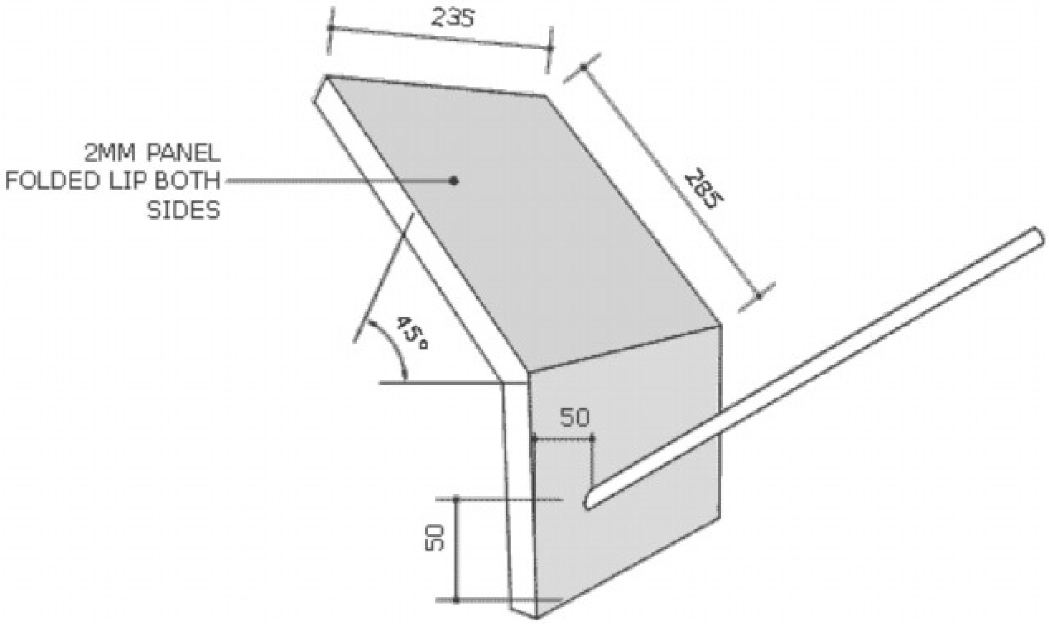
Fabricating & Fitting Guards
Get several friends to help flip the Flatdeck over onto jack stands It is very heavy with many sharp edges.
Once flipped, finish welding the top of the chassis and add the suspension and axles.
Fit the wheels and tighten all nuts and bolts on both the suspension and hubs.

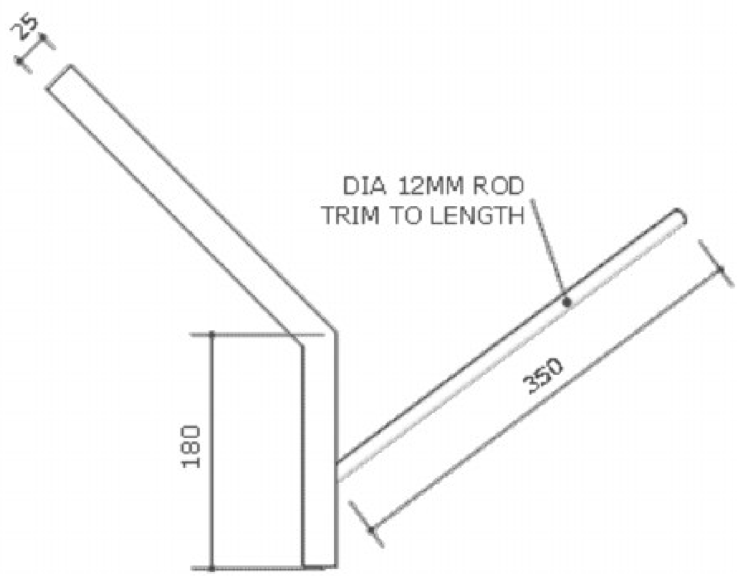




Fold up 4 guards as per the diagram below using 2mm panel, notch out the lips where the guard bends, fold, and weld together at 45 degrees.

Because we increased the deck width on both sides by 6" the guards must be placed against the inner rails . They should be welded across the top to the nearest cross member by using scrap metal if necessary.





Position guard so that there is good clearance around the tyre - 75mm is a good guideline.

It is an advantage if you are able to get the top edge of the guard to contact a cross member.

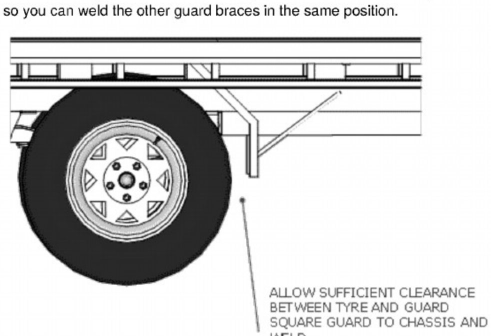
If this is not possible, cut and weld a couple of tabs to secure the top of the guard to the nearest cross member.

Clamp the guard in place, check your measurements, stand back and eyeball the guard both from the side and front/back to make sure all looks good and square.

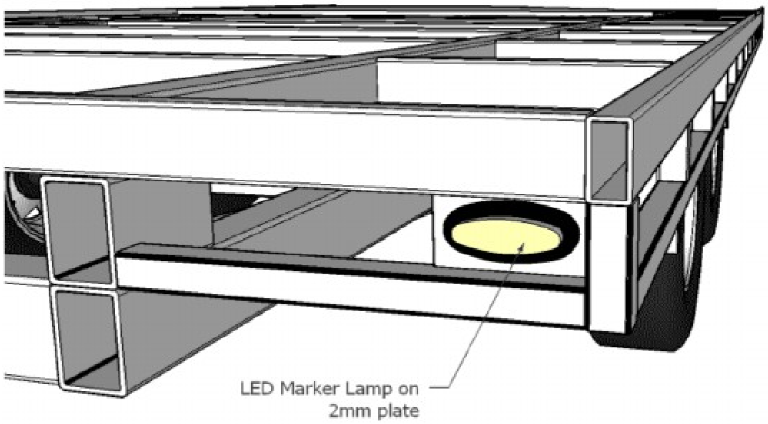
Tack weld in position.

Mark the guard where the bracing rod will sit. Trim the rod brace to fit. Once happy with the brace and its angle, cut the other 3 to match.

Tack weld the brace in position and take a couple of measurements of its position on the chassis so you can weld the other guard braces in the same position.



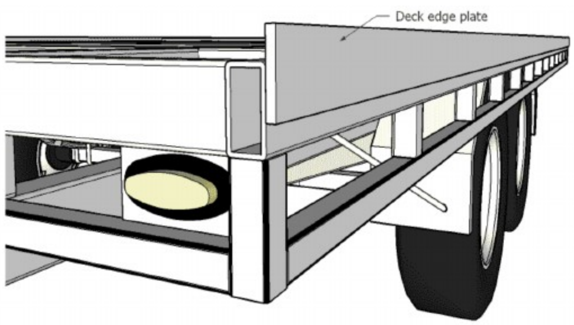
3.6 x 2.0 M Flatdeck Trailer Trim



Marker lights

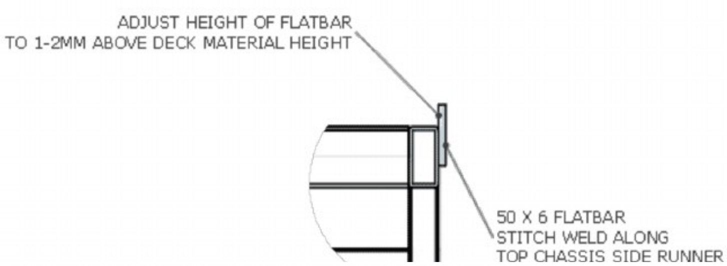
Cut out a couple of marker light plates to suit the size of your marker lights.
2mm Plate is suitable and can be pre-drilled for screws and wiring.

Weld the plate into position along the back side of the front tie rail and cross member for maximum protection of the light.

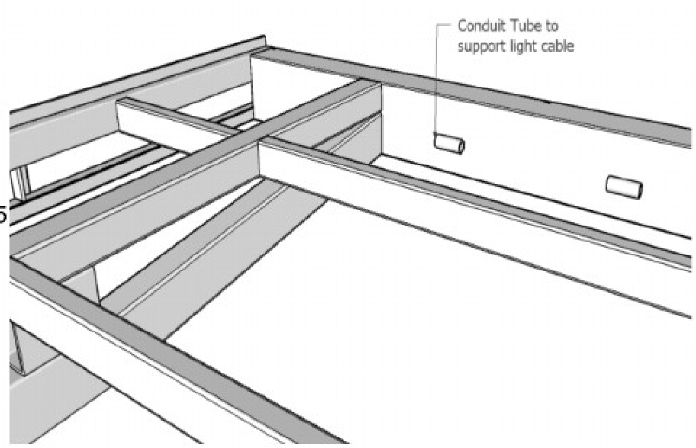


DECK EDGE PLATE

The deck edge plate gives protection to the decking material and gives a welding surface for hinges and the like. It should be 1-2mm higher than the decking and stitch welded it's full length.



CONDUITS

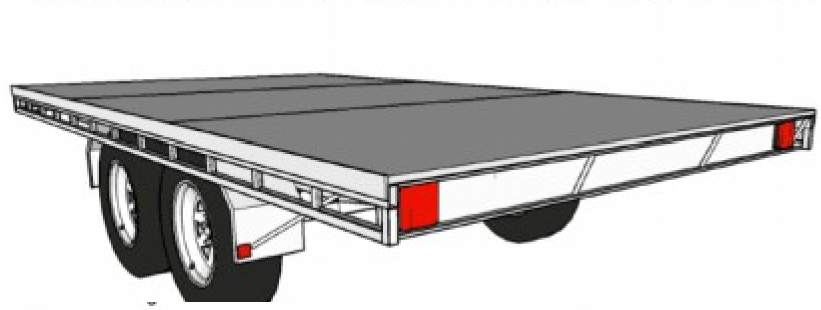


To help support the cable along the back side of the light channel, weld, at regular spacing, 3 or 4 tubes (1/2" pipe or 25 x 25 SHS or similar).

Before welding to the trailer, remove all burrs and sharp edges.

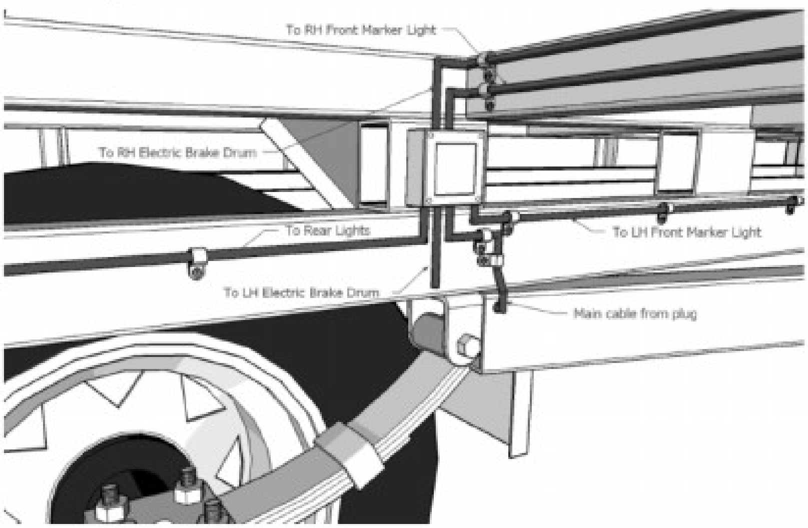
Prior to fitting the cable, glue in a split section of plastic gardening hose with silicon sealant or similar to prevent any chafing of the cable against the steelwork

3.6 X 2.0M FLATDECK TRAILER: LIGHTS & WIRING



Note

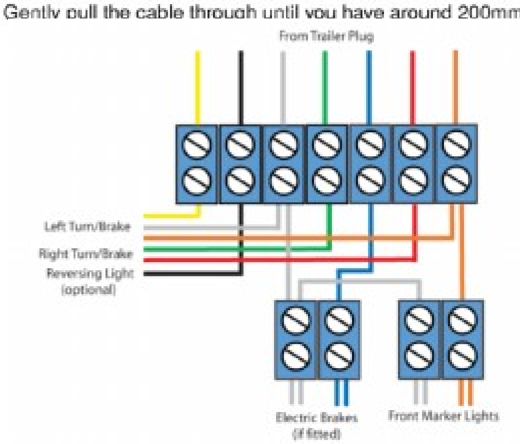
Before doing any cable fitting or wiring you must not have deck installed, chassis should be sanded, primed and painted. Once cabling is complete add decking material and finish deck.



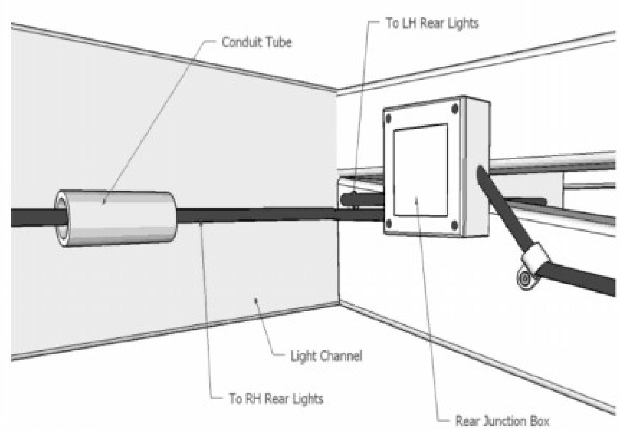
Gently pull the cable through until you have around 200mm free cable.

Running the light cable

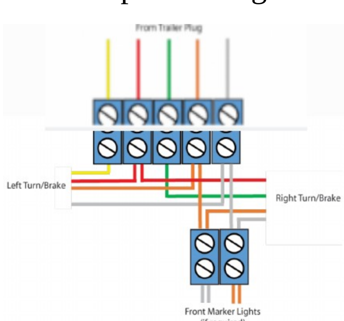
From the front of the trailer slide a semi-rigid section of mild steel pull wire down the draw bar until it comes out an oversized hole drilled on the inner side in the draw bar close to the spring end. attach your 5 or 7 wire cable with tape. 7 wire is for use with electric brakes. Pull the cable through the draw bar until 200mm is available at the front.



Allow another 600mm at the coupler end for wiring the plug. Fit a juction box just above the spring hanger and wire in the main cable. Run a 5 core cable from the junction box to the rear light channel and tee off (Lh & Rh) cable in another junction box.



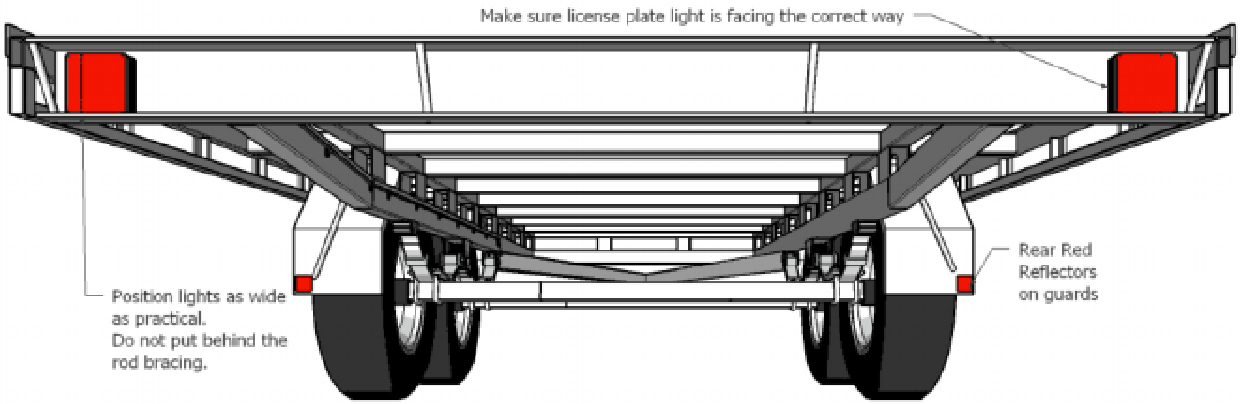
Drill through any cross member or chassis runners not already drilled to allow clear passage of the cable. From the rear junction box the cable can pass through conduit to the rear lights.



Whenever any cable passes through any steel work, apply silicon sealant, heat shrink, etc. to prevent cable chaffing.

Fitting Lights

Make sure that your number plate light is in the correct position and that the light will shine on the plate. Keep your lights as wide as possible in the light channel, but do not place lights directly behind the rod bracing.



Mark out your light position on the light channel and drill the mounting and cable holes as per your lights instructions or template.

There are a couple of ways of joining the wire together behind the left hand light. Using a strip connector inside a sealed junction box is one of the best ways of keeping the join secure and weather tight and also gives the option of easily changing lights should they get damaged, etc.

Other options include soldering the wires together and sealing with insulation tape and a heat shrink tube or using crimp connectors and covering again with heat shrink tube. These options take less time to do than the first option, but will cause a bit of a headache

FRONT MARKER LIGHTS

For front marker lights, an additional two lengths of 2 core cable need to be run from the junction box, back along to the length of the trailer to the front marker light positions. The "P" clips used for the main cable can be used to support these cables.

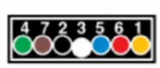
Crimp connectors are the most convenient method for joining the wires to sealed lights with attached wiring.

7 Pin Plug and Socket Wiring

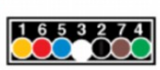
7 Pin Plug

7 Pin Socket

PIN No.	CIRCUIT	COLOUR
1	Left-hand turn	Yellow
2	Reversing signal	Black
3	Earth return	White
4	Right-hand turn	Green
5	Service brakes	Blue
6	Stop lamps	Red
7	Rear lamps, clearance & side marker lamps	Brown



7 Pin Plug



7 Pin Socket

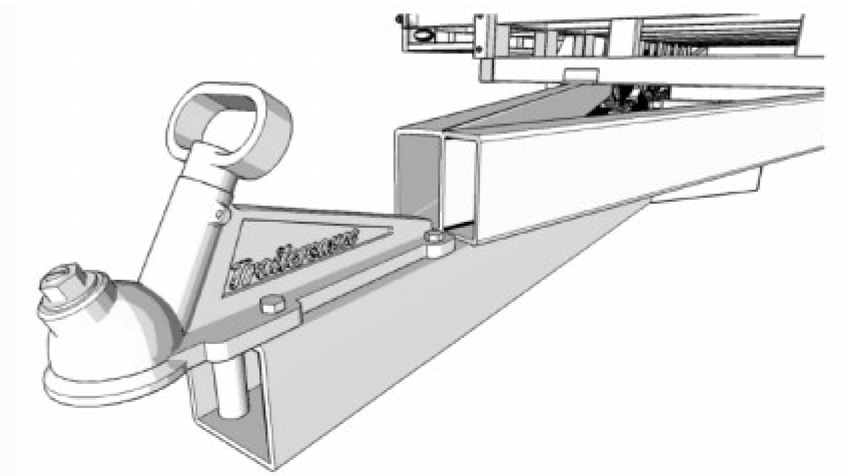
PLUG

Pass the plug end cable through the cable hole drilled in the top or side of the drawbar and slide a suitable sized rubber grommet over the cable to prevent any chafing of the cable where it passes through the drawbar.

Trim the length of cable so that the cable can move with the trailer behind the tow vehicle without being stretched or kinked, but not too long that it will dangle too close to the ground.

Slide any plug sleeve or nut, that came with the plug, over the cable, then strip each end of the plug wires leaving approximately 10mm bare wire, fold the bare cable in half and enter them into the plug connector in the correct sequence as per the chart above. Tighten the screws snugly but do not over-tighten. Screw the cable clamp down to prevent the cable from pulling out and fit any sleeves, nuts or covers that came with the plug.

If possible, check all your lights by hooking the trailer plug up to your tow vehicle. If you don't have a mate to help you check your brake lights, grab a mirror and position it behind the trailer where you can see it from the tow vehicle.



Double check your spring hanger bolts and "U" bolts on the axle that they are secure and tight and the wheels to the trailer.

Hand tighten the stud nuts to help align the rim on the hub and tighten the nuts in sequence as below. Ideally use a torque wrench to ensure that the nuts are tightened adequately.

Torque Settings for wheel nuts are

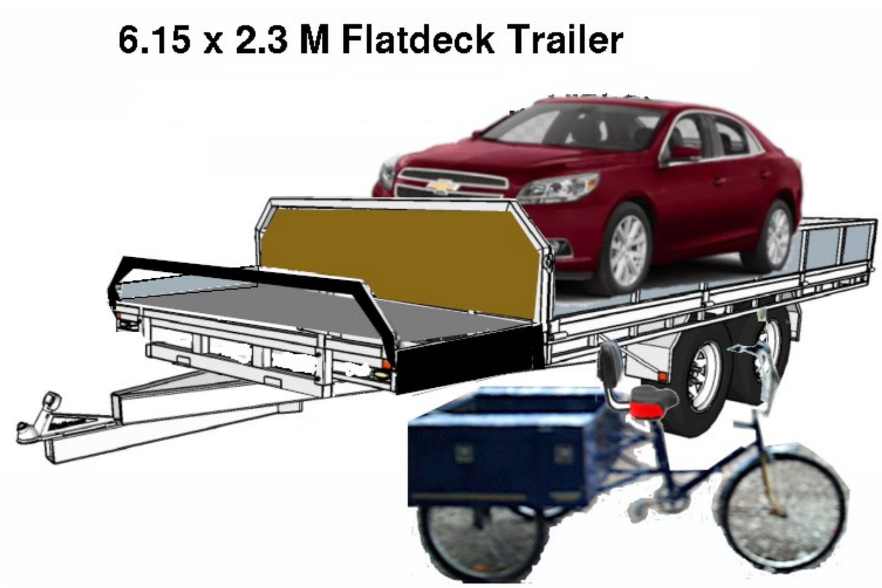
7/16" UNF 110Nm or 80 Ftlbs

1/2" UNF 125Nm or 90 Ftlbs

Ok if you made it this far you have a trailer with a deck 16ft x 7.5 ft or a trailer unfinished with a deck 20 ft x 7.5 ft. For your 16 ft x 7.5 ft version you just need optional headboard and sides and ramps for loading and unloading. For the 20 ft version you will note that the draw bar is 2ft shorter protruding from the deck front. This is because to include the 4 ft of Tricycle storage up front we needed to come an extra 2 ft over the draw bar space. In the original the draw bar was connected at the front of the chassis and back at front of the spring at the frame.

With the new car hauler trailer the draw bar is 800mm longer and attaches to the front of the deck which is also 800mm longer with deck size 1200mm longer than the original. The new dual purpose trailer shown below has a deck 2419mm longer than the original 3566mm and a draw bar which is 1600mm longer fastened back at the rear axles, at the front of the 16ft section and at the front of the 20 ft deck.

To complete the trailer we need to install U brackets at the front of the 16ft section and front of the 4ft section and along the back side of the 4ft section. The U brackets are 2” x 2” and will at the very least will support 2x6 or 2x10 pressure treated lumber to close in the space. A 2x6 hinged gate closes in the Tricycle area.



With the second trailer complete
we can turn attention back to the Tricycle electronics.

Solar Electric Tricycle

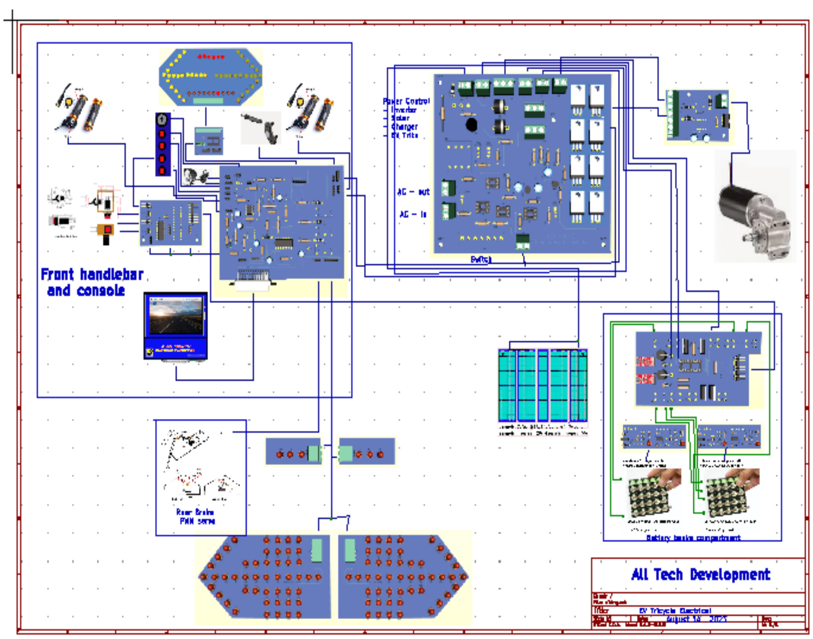
The solar electric E-trike is a complex machine as tricycles go. While on the surface it has front forks, 3 wheels, basket and pedals driving sprockets, ours has electric brakes at the rear, totally new controls at the handle bars, a charge inverter, solar panels, Lithium Battery packs, drive motor and controller and the main control console. That's 8 major systems added. Here we will be discussing the Main controller at the handles bars.

The main controller is a two part system. Part A is a Raspberry Pi 3b credit card sized computer that is detailed later. Part B is the control part. When the part A is connected to part B by it's 25 pin D-Sub connector the trike becomes operational. Part B has at the front, a signal light assembly with Left turn, Right turn, Marker lights, and even a robotic eye. The console extends in a sloped fashion towards the back. On the face of the console is an insert cavity for the Raspberry pi to fit. At the back of the console is DB25 female connector. The console mounts to the handlebar supports and the headlight mounts beneath the console. All wiring enters from below the console to prevent moisture entering the system.

Up front we have front brake lever, rear brake twist grip, turn signal switch with horn switch, Accelerator twist grip, speed sensor at the front wheel all coming into the controller. On the face of the controller is left and right turn LEDs and cylon / kitt car roaming eye. On the top next to the computer is the key switch, headlight hi and lo beam switches, hazard switch, and marker light switch. From the controller going to the back we have Power, Battery monitor and Battery bank control, rear brake control, rear lights, and motor drive control. I am doing a 24v Solar Electric Tricycle with an adapted wheelerchair motor.

EV-Tricycle Electronics

Tricycle operation is done by computer control up at the handlebars which will be explained in this document.



There are 7 related systems to the Tricycle:

1. Front controllers
2. Raspberry PI Computer
3. Power Inverter
4. Motor Drive
5. Brake servo & lights
6. Solar array
7. Battery Management.

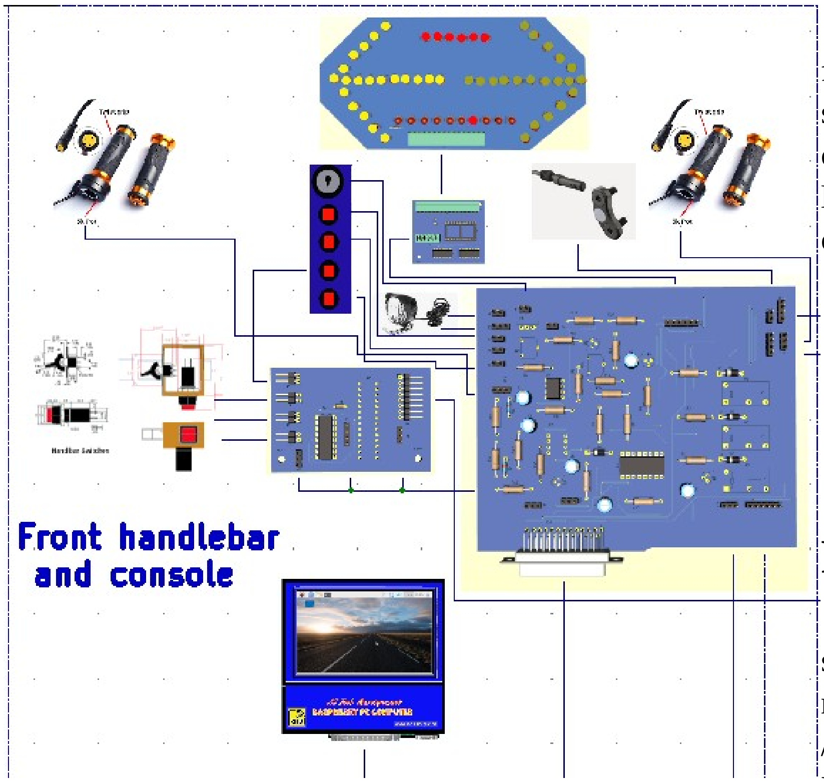
Above is the full plan for the Tricycle electrical system.

The tricycle has 2 x 24v battery banks. While you are driving using one bank, the other can be charging.

There is also shore charger and 120v ac inverter modes available.

Front control system

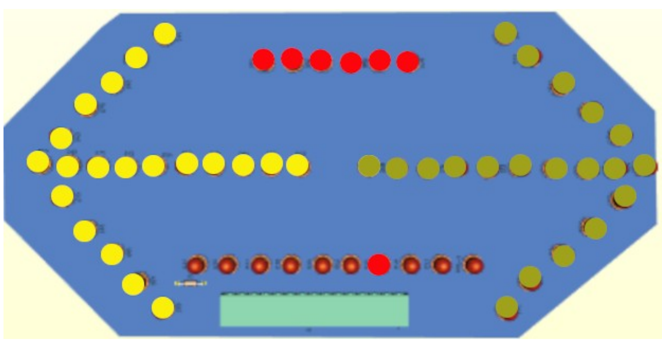
The front console

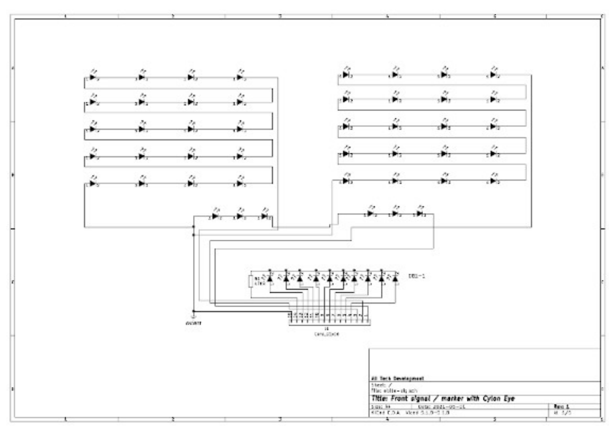


The front console collects all input signals from switches, brake levers, twist grips, and sensors. It passes these onto associated circuits which direct actions to take, lighting, signals, motor drive, braking, and charging.

Front signal system

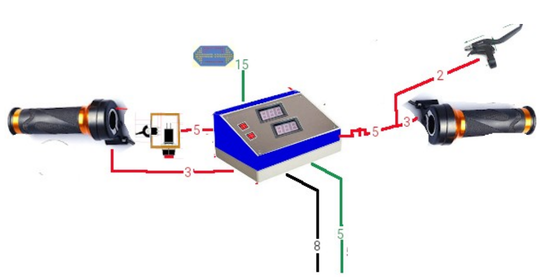
The front signal system is an LED panel shown below. The LED strings for left or right turn draw .02A during on/lit. The cylon / kitt eye also draws .02A as does the marker Lights.





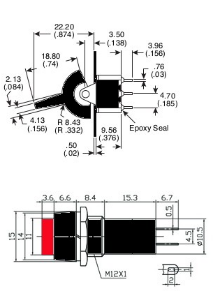
Brake, Accelerate, speed, and signaling

These devices are used to feed info to the front control console.

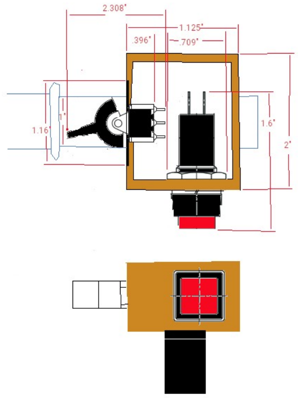


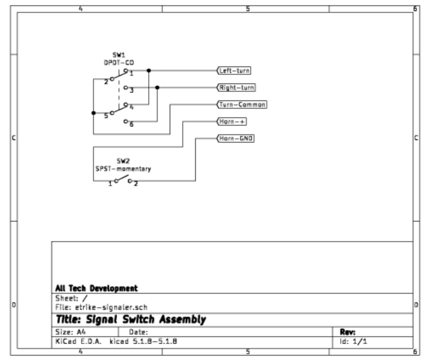
A left side accelerator acts as a brake for the rear brakes, and a right side brake lever sends signal for front brakes. Motor acceleration control is on the right side and signaling from the signal / horn control on the left.

The custom signal / horn unit is below.



Handlbar Switches

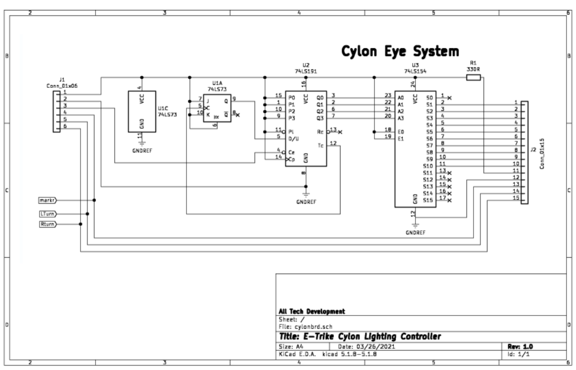


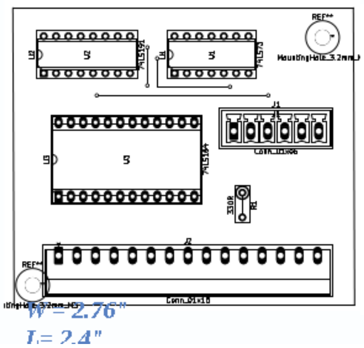


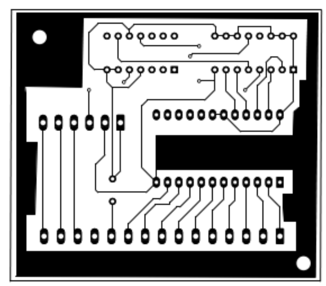
The signal light switch is positioned close to the left hand grip for easy activation of left turn, right turn, and horn.

The CYLON EYE

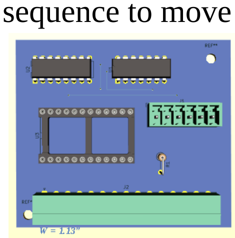
The cylon eye moving a light back and forth while the tricycle is in use is much like the nightrider kitt car. The front signal system board described earlier is powered by a cylon control board which passes the turn signal lites on or off when needed, displays the marker lights when needed and sequences 10 LED's to turn on and off in a back and forth motion. This board mounts in the front display behind the signal board.

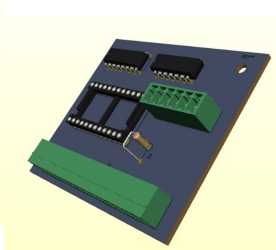






A simple 6 wires provide power, clock pulse, marker and light control. The pulse feeds a 74ls191 up down counter which in turn feeds a 1 of 16 decoder that selects which light to turn on. Each time the counter hits terminal count it gets it's direction changed which cause the light sequence to move back and forth.

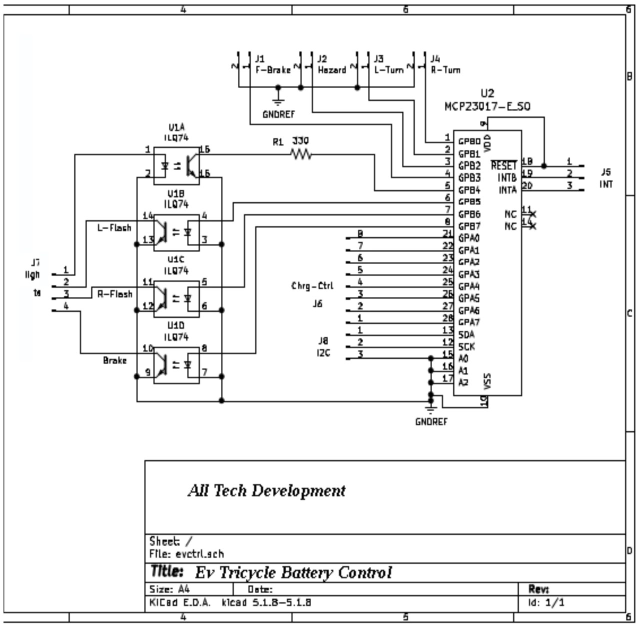


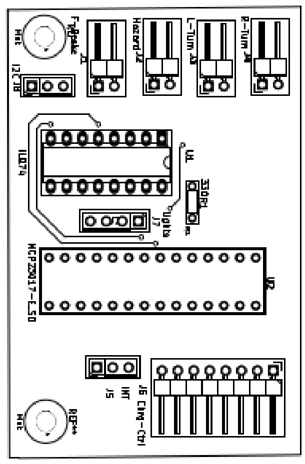


The board is 2.26" x 2.4"

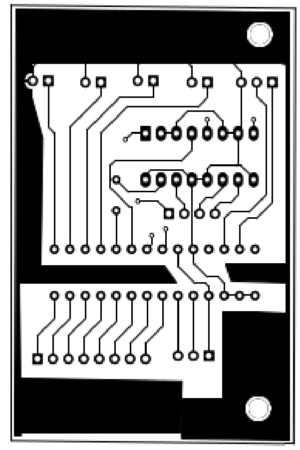
The front controller Input and battery controller

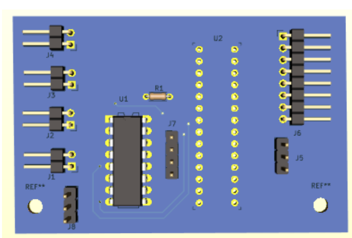
This board fits in the front main controller space above the main board. It uses I2C 2 wire communication and a mcp 23017 16 bit i/o expander to gather switch information from the L/R turn switches, hazard switch, and front brake lever. It sends for L/R flash when needed, brake on when needed, samples the pol and int pulses from two Battery banks for determining charge and discharge rates and controls which bank to run the drive from and which bank to charge. When parked, It can also handle 120V AC out from an inverter and shore charging of the batteries.

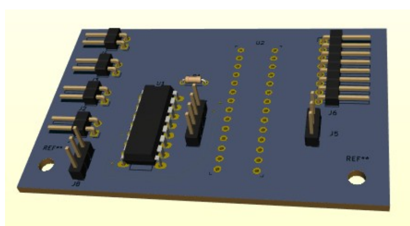




EV Battery Control
W = 1.85 " x L = 2.82 "

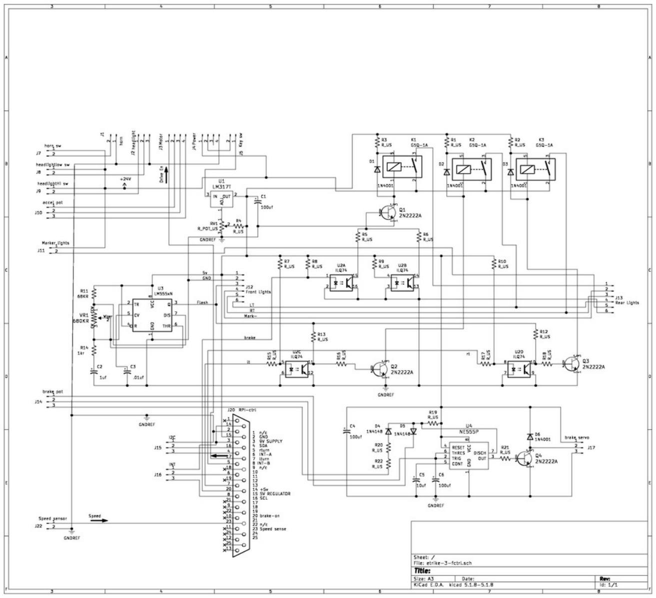






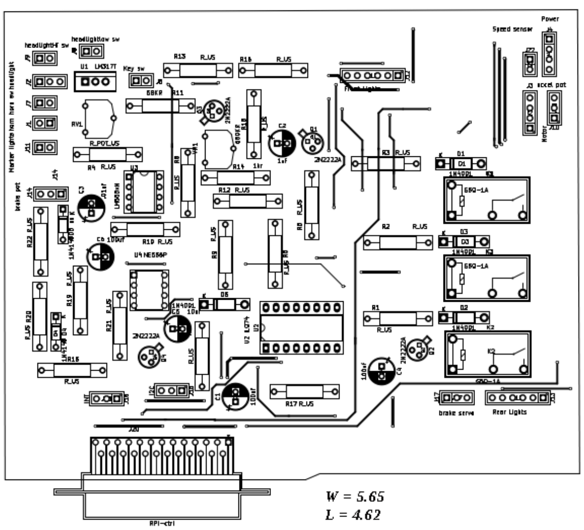
You will note I use optic couplers to prevent over loading the computer drive lines.

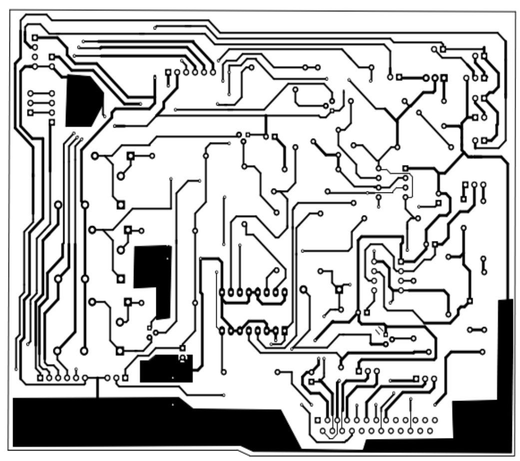
The controller main board

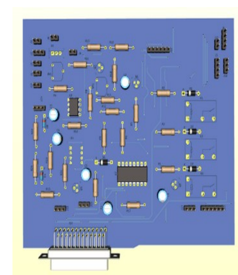


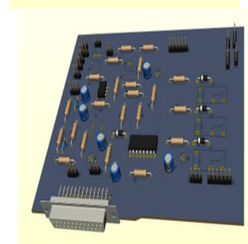
As a means of keeping things as compact as possible the main board handles the analog stuff and the board last reviewed handles the digital stuff.

Analog switches on the front top of the unit for high and low beem headlights, horn, accelerate and decelerate twist grips come into the controller on the left. At the top we have the key switch, headlight connection, horn connection, and power from the Battery compartment. In the main body we have a multivibrator circuit for signals and cylon eye, a PWM circuit for operating rear brakes, driver circuits for the rear lights and computer connection.

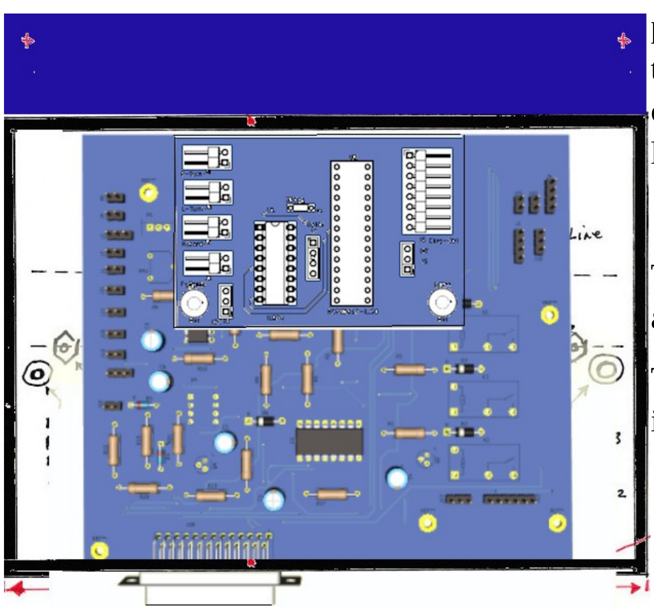








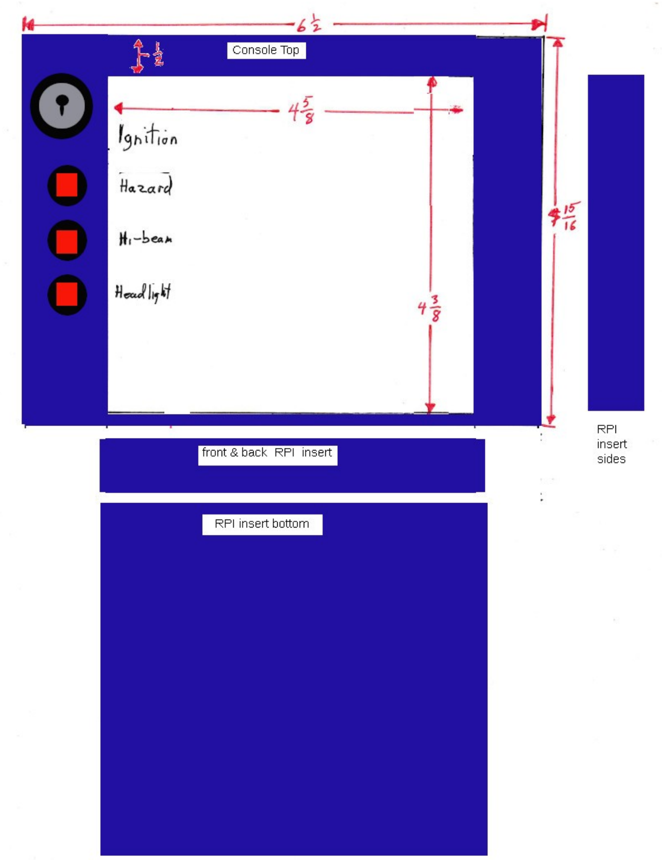
From the front controller there is a 25 pin D connector to the computer, 3 power connections to the battery banks, an 8 pin ribbon cable to the battery compartment for charge run control and wiring to the rear lights.



The front lights are in the blue area at the top. Also in that area is the cylon eye circuit.

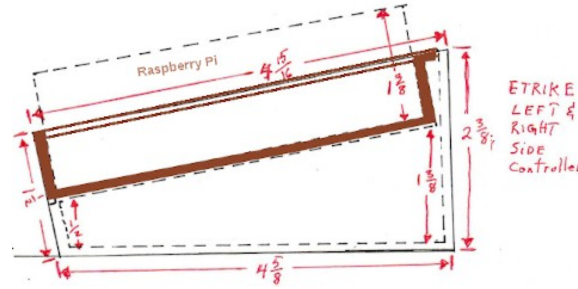
The two boards that make up the control circuit fit nicely in the main compartment.

Solar Electric E-trike Controller Construction

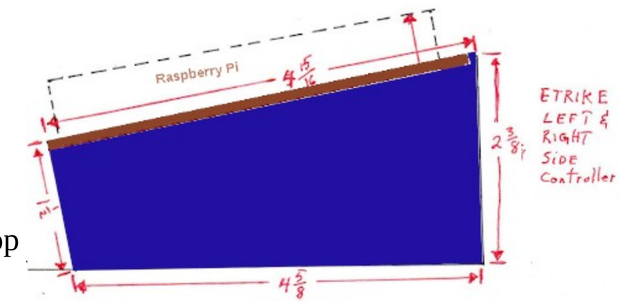


Seen to the left we have our front console top plate. Around the edges of the hole we glue four side pieces and to the bottom we glue a base piece to form a recess box for the Raspberry Pi to fit.

Note that the back of this box must have drain holes in case water collects in the cavity.



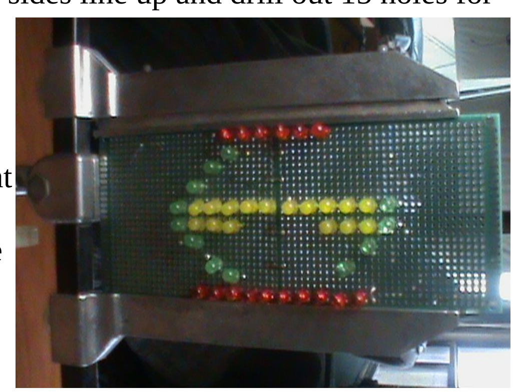
In the above side view I show the placement of Raspberry Pi into the top form. The top form then fits onto the front, back, and sides of the console as below.

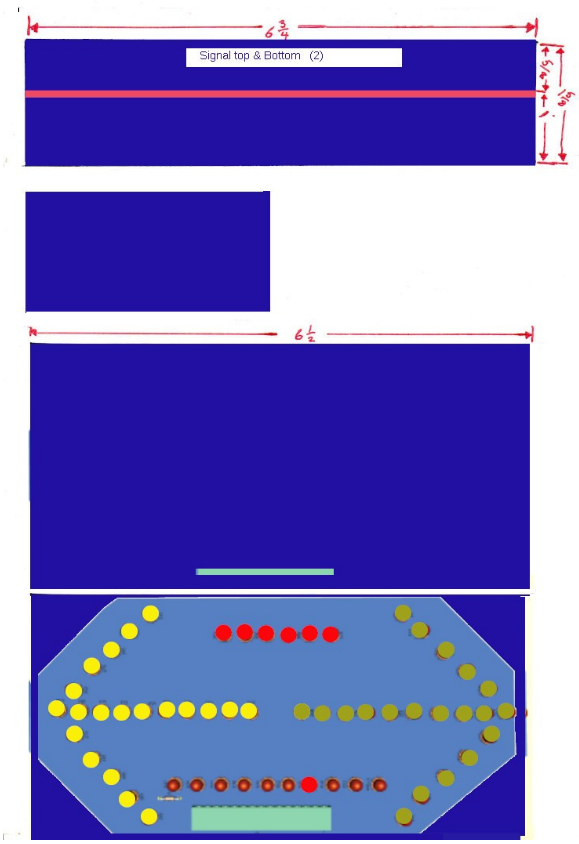


I set the top of the console aside and move onto the signal light section. The signal light section is a 1-5/8” four sided box with a central insert to make a front and rear 5/8 in cavity. The front cavity will the LED signal lights and cylon type robot eye and will be sealed in clear epoxy. The rear cavity has the lighting electronics and back mount panel. The back mount panel makes it possible to fit against the back console.

First things first. We need to align the center piece along the length of the top piece shown in pink at the left. Then we secure the two sides line up and drill out 15 holes for the display wires.

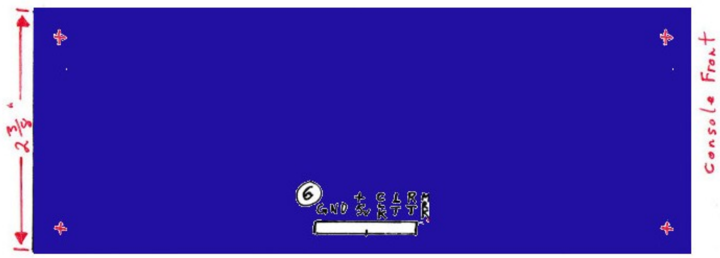
I then place the pre-wired LED display in the front cavity such that it’s wires protrude through the holes.

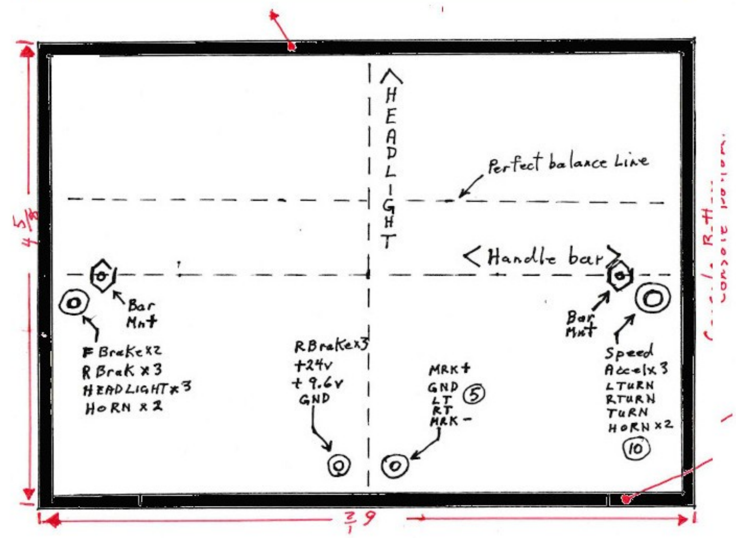


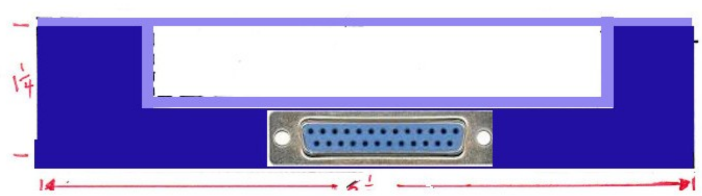


Making a pre-wired signal array.

So with my pre-wired LED signal assembly placed, I fill in around the wires, mix up some clear epoxy and pour over the pcb and fill the front cavity and let set and harden into a solid sealed light assembly. Next up is the control circuit that will mount to the back of the central divider.







The use of connectors are optional. Ribbon cables work just as well. As a final step to this we glue two mounting strips either side at the back. I then set this section aside to concentrate on the lower console.

Shown left top is the front console piece that will mate with the tabs of the LED assembly. It mates with the console base along the top edge in black.

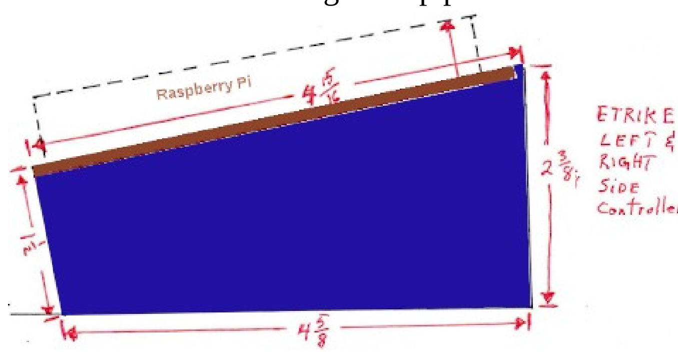
The console bottom has the position of the handle bar and headlight alignment indicated along with placement for 2 mounting nuts.

There are four grommets indicated for wiring to left and right handle bars and 2 for wires going to the rear of the tricycle.

The back panel is notched to facilitate the box under the top cover and is secured to the base along the line in black.

The back also has the DB25 connector for connecting the Raspberry Pi 3b computer.

The last part of the case assembly is the two side panels as shown. The side panels need mounting lobes in the inside to enable securing the top panel down.



With the case now complete it is time to feed the cables into the grommets under the case.

Of course this means the case will need mounting on the Tricycle handle bar. As far as wires go we have the following :

- Left handle bar brake lever 2 wires (front brakes).
- Left mounted horn switch 2 wires
- Left mounted turn signals (Rturn,Lturn) 3 wires
- Left brake throttle 3 wires
- Right handle bar brake 2 wires (optional)
- Speed sense 3 wires
- Right Acceleration throttle 3 wires
- horn 2 wires
- Headlight 3 wires

We only need 1 brake lever for the front brake and it is paired with the brake decelerate brake throttle on the Left side, The front brake caliper is cable driven from the Left brake lever. The horn and headlight are one piece mounted to the underside of the controller.

Going to the back of the tricycle we have +24v, +9.6v, PWM brake servo 3 wires, and Gnd. Then we have Lturn, Rturn, Marker, 24v, Gnd. So 11 wires going to the back. So it is time to add the contol board to the system.

On the handlebars we have Rear brake twist grip, front brake squeeze lever, turn signal and horn switches on the left. Central is the console and at the right is accelerate twist grip. Down at the front wheel is a speed sensor. The console itself has headlight below it with horn, left right turn signals at the front face with marker lights and robotic cylon eye. On the top of the console is the key switch, headlight hi and lo switches, hazard switch, and marker switch. A removable Raspberry Pi computer also fits into the top. Three circuit boards fit inside the console. One powers the robotic cylon eye to move back and forth. Another gathers information from the switches and enables the computer to both monitor and control battery banks. The last circuit board connects to the computer and controls braking, rear lights, and battery management.

Portable Raspberry Pi Computer

The Raspberry Pi 3b is a credit card size computer. In my application, I will be adding it to a 4.3 inch display and housing it in a custom case. The computer will be used in 4 modes of operation. The first mode is stand alone mode. Under this mode it will have external power, keyboard, touchpad, Camera, Harddrive, and optionally hdmi display and breadboard features. The second mode is as an E-trike control module that can run a Solar Electric Tricycle. Mode 3 is as a CNC controller for milling and 3D printing and finally mode 4 is as a 3D scanner.

Mode 1:

Applications:

- Desktop apps Word processing, spreadsheets, presentations, Gimp, Programming
- Internet browsing, emails, online banking
- Electronic Design and breadboard testing
- RFID tag processing for event sign-in , entry, exits

Device use:

- USB-c power to unit using 2A wall xfmr
- CSCM attached 4.3in touch screen display
- USB-1 keyboard / touchpad doggle to remote keybrd
- USB-2 Printer
- USB-3 2TB external hard drive
- USB-4 unused
- WIFI internet / cell phone link
- Cvid webcam
- ETH0 network
- GPIO20 Breadboard connect
- RFID tag reader

Modec2:

Applications:

- ETRIKE charge, Solar, Battery, Inverter, controller

Device use:

- CSCM attached 4.3in touch screen display
- GPIO20 Etrike

Mode 3:

Applications:

- CNC drill, shape, router, sander
- Octipi 3D Print

Device use:

- CSCM attached 4.3in touch screen display
- GPIO20 CNC machine

Mode 4

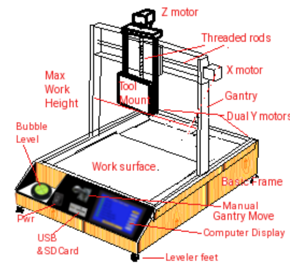
Applications:

- Scan-It-3D

Device use:

- CSCM attached 4.3in touch screen display
- GPIO20 3Dscanner

Moving Gantry 26"W x 30"L x 38"H



Case construction:

The case is made from blue Plexiglas pieces cut to size and bonded together using acetate glue. Careful placement of access holes to features allow it to fit into the Etrike, CNC, and 3Dscanner frames.

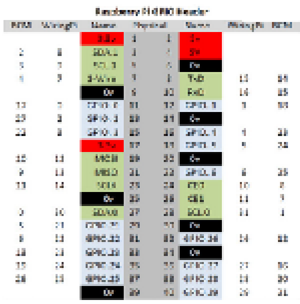
Fully assembled the unit is 4.88 x 4.95 x 1.5 inches. In the E-Trike application the top HDMI and PWR and Right side ETHO USB1-4 are hidden from access by the frame it fits into. The CNC and 3Dscanner have provisions to allow access.

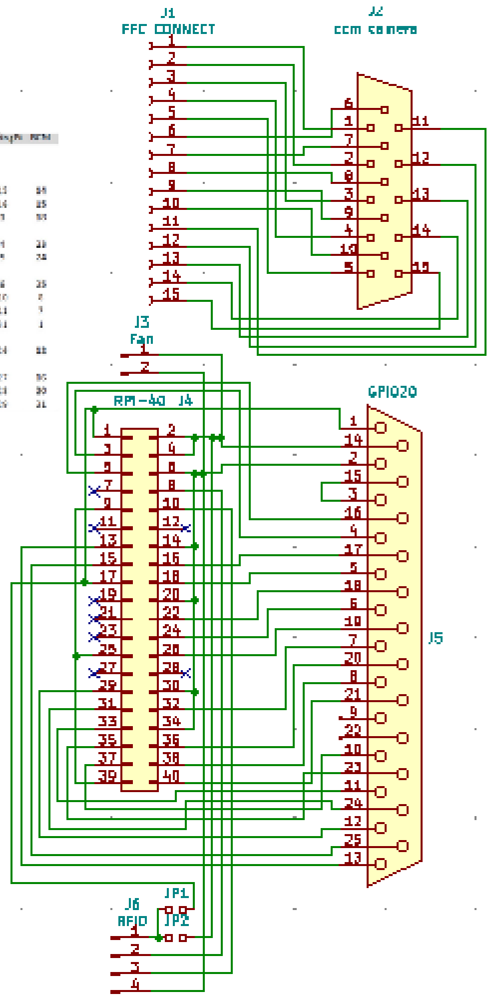
Special note: The image edges closest to the top mount to the top along the black lines. In this way the vents , GPIO and CAMERA are above mounting frames and all others are obscured by the frames.

Wiring the RPI is fairly simple. A40 pin GPIO connector connects to a breakout board. This breakout board has 2 pins to power the cooling fan, 3 wires to the RFID pcb with loop antenna and a 25 pin D socket. A 15p FFC cable comes to an ffc socket on another pcb with a 15p D socket for a ccm camera.

Everything to wire this up fits in the case as shown except the ffc breakout module. To make this module fit it has to turn vertical because the inner wall is in the way of it fitting horizontal. The perf board to interconnect the wiring also will need trimming around the fan.

To complete the portable raspberry pi 3b computer, we add a base plate with edge tabs for screwing it into place.





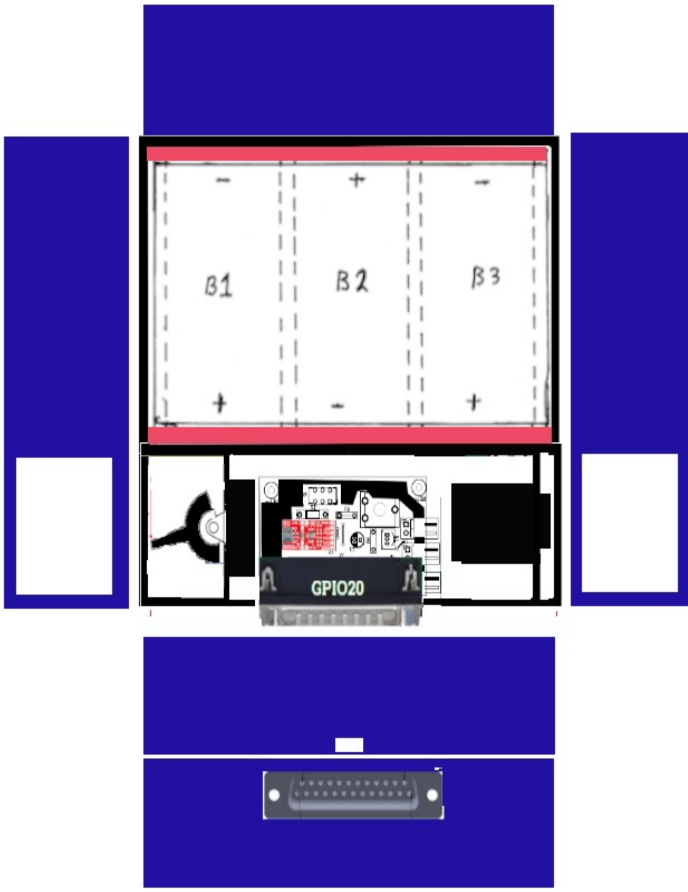
To the left is the wiring chart and schematic diagram for the system. At the top we need to convert the ffc-f cable into a 15pin camera connector. Below that we have the GPIO20 (GENERAL PURPOSE INPUT OUTPUT connector) wired to a 25pin d connector and to a fan tap and rfid connector.

<u>Bill of materials</u>:

1 Raspberry pi 3b **https://www.amazon.ca**
1 32GB microSD with noobs Raspbian preloaded **https://www.amazon.ca**
1 4.3” TFT touch screen display **https://www.amazon.ca**
1 1.3” case fan
1 RFID-uart board with ring antenna **https://www.amazon.ca**
1 ffc breakout board **https://www.amazon.ca**
1 DB15hd-F connector board **https://www.winford.com/products/pbc15hd.php**
1 DB25-F connector **https://www.winford.com/products/pbc25.php**
2 12” square blue plexiglas **https://www.amazon.ca**
1 bottle acetate glue **https://www.amazon.ca**
1 sheet rub on letra-set letters

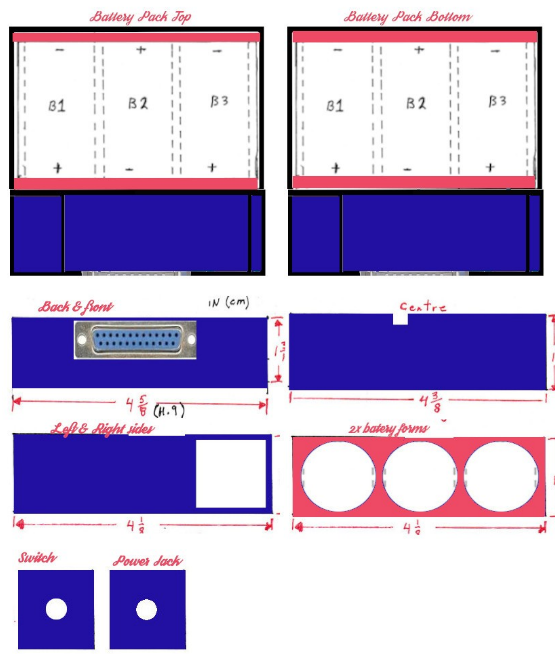
Portable RPI battery pack

The Raspberry Pi portable computer needs a battery pack to be really functional.

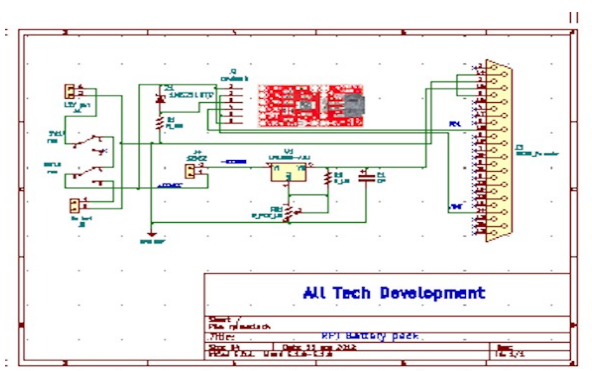


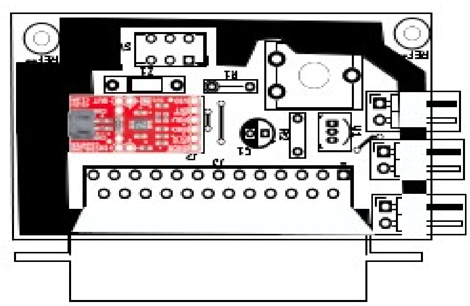
The case matches the RPI case in size and pieces only this time 3 batteries 32700 type lithium with their mounting take the place of the RPI and display. In the lower connection section we have an on-off-on switch, a power jack and the DB25 female connector.

The circuit of the lower section contains a coulomb counter, and regulated power supply.

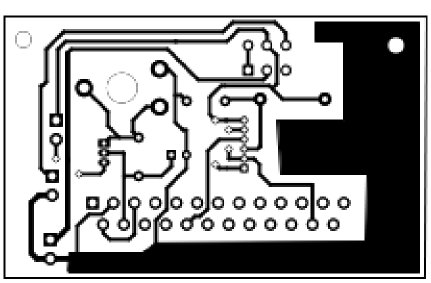


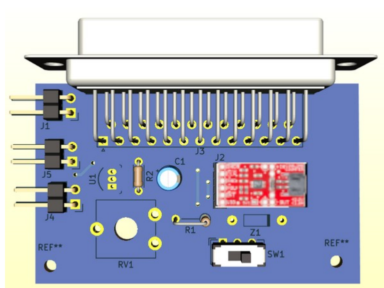
At the right we have the piecing layouts to make the battery cabinet. Once we have the enclosure we have to populate it with the electronics. Below left is the circuit diagram and to the right the circuit board.

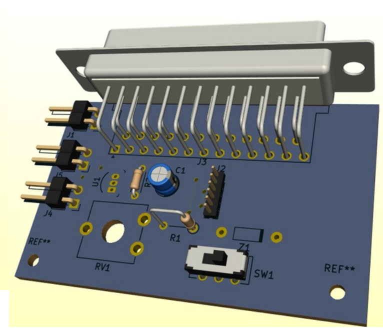




w = 2.2"
D = 1.43"

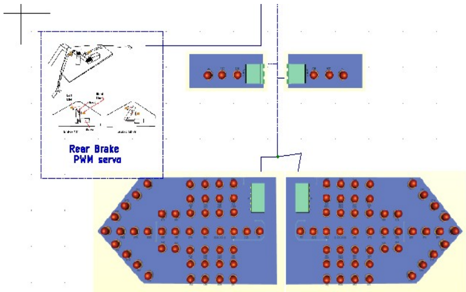




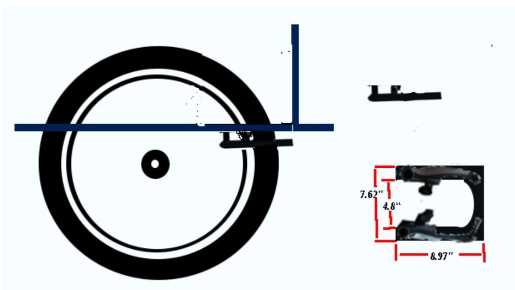


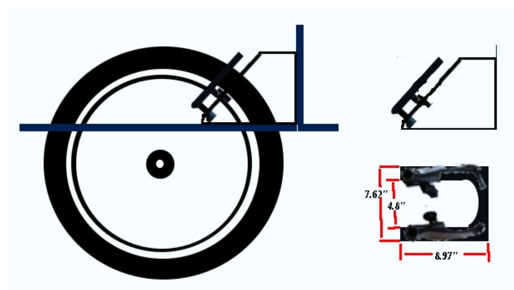
PWM Brake System

Brakes and lighting

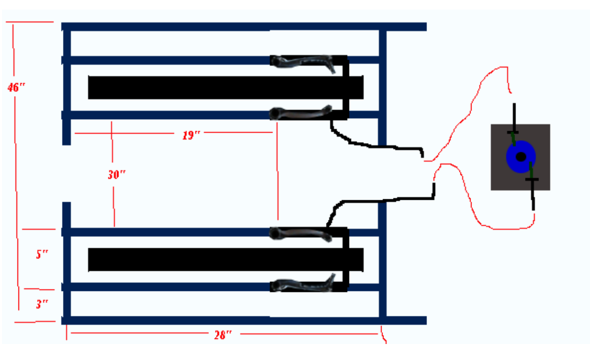


A PWM signal from the console adjusts rear brake pressure to a servo during braking. All lighting is LED and on either side of the box is a marker light. At the rear is left and right turn, brake, and marker lights.
The rear brakes operate from a PWM signal sent by the front console when the brake grip is used. Normally the handlebar grip is twisted back towards you to achieve acceleration and that is how the right one functions. The left one rotates the opposite direction or twisted forward to achieve braking.

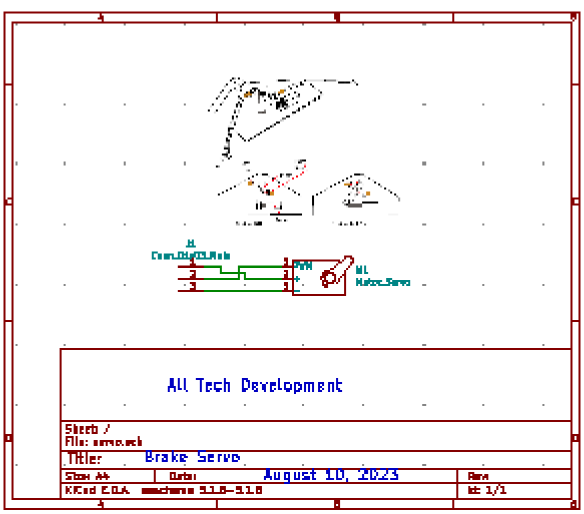




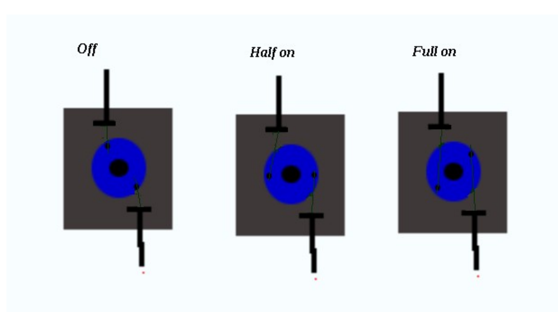
If we look at the two rear wheel depictions above, the one on the left sits below the frame and the one on the right sits inside the frame. The brakes salvaged from the second donor bicycle are identical which means the cables when they are mounted in the back exit both on the same side. This bad since an in frame mount would have one cable entering the basket area but the other would exit into the storage and pass through the battery compartment. If we mount below the frame neither cable pass into the basket or storage or battery compartment.



Brakes and lighting
A PWM signal from the console adjusts rear brake pressure to a servo during braking. All lighting is LED and on either side of the box is a marker light. At the rear is left and right turn, brake, and marker lights.



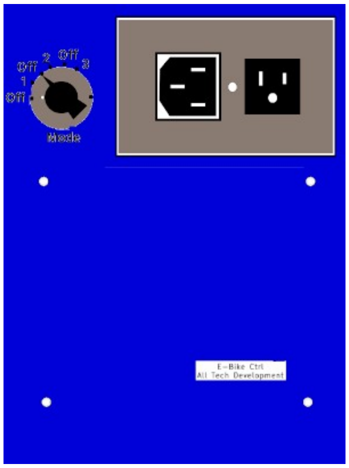
This depiction shows an in frame mount feeding to the servo that rotates a round disc with the cable ends secured such that when the disc rotates it applies pressure to the brakes.

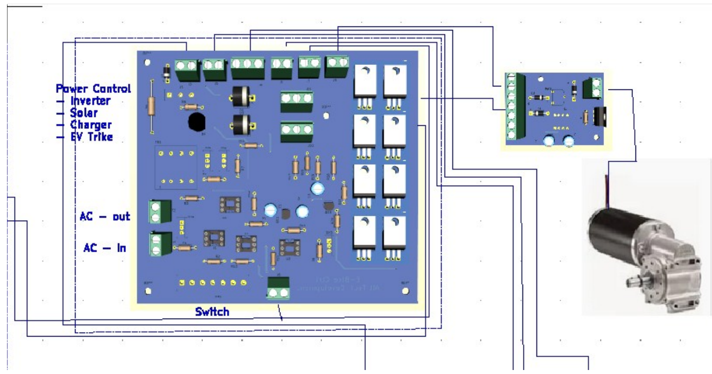


The servo rotates based upon the pulse width given so Ideally the handlebar grip at rest is sending position -90°, half on is position 0° and full on is sending +90°. In our case -90° has 0 load and +90° has both brake pads engaged on the rim.

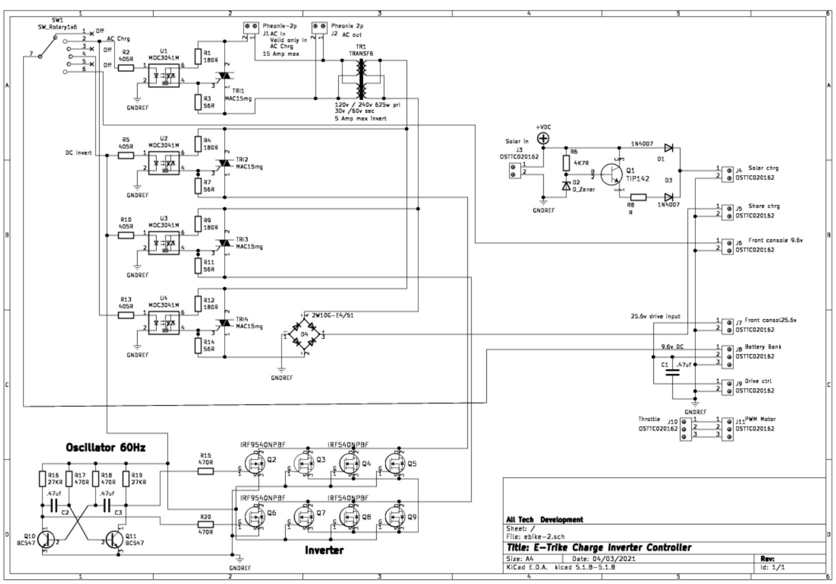
Solar Electric Tricycle Charge Inverter

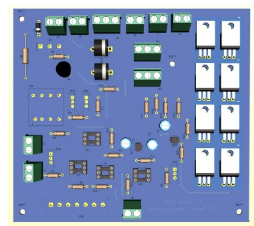
The tricycle as designed, has a built-in shore charger, 120 V AC power inverter, solar charge panels and Motor drive control.

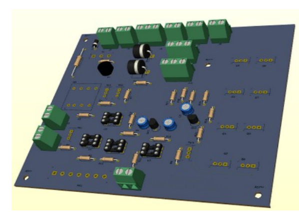




On the right side rear is the electronics compartment. It has covered outlets for charge cable and AC inverter output. There is a mode switch just to the left of that. Lower on face of the compartment is the charge inverter unit. Inside the cabinet is a 5 amp circuit breaker and the motor control board & charge control board.







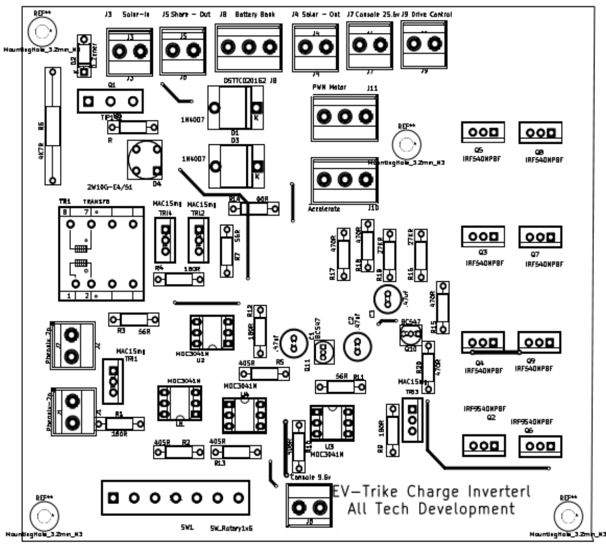
Power control

The power control center selects the mode of operation. The modes are Shore charge, Power inverter and EV-Trike. The 120vac outlet runs from shore power in shore charge mode or from battery during inverter mode. The solar panels provide 30v DC charge when deployed and the shore charge circuit can also provide 30v DC charge when in shore charge mode. Tne EV-Trike mode the motor is driven under control of the front console.

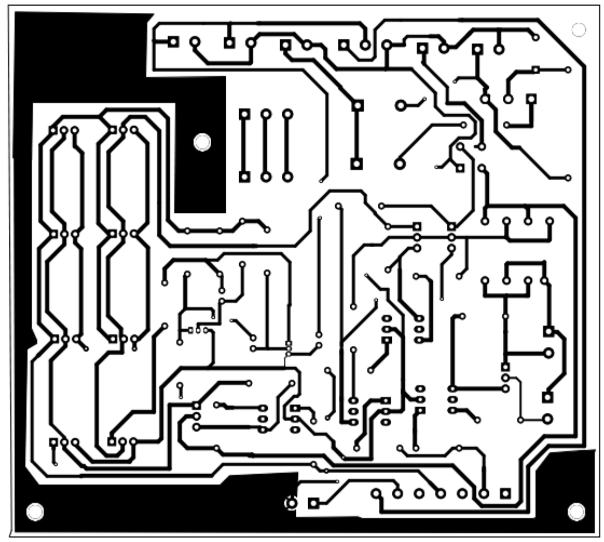
On the right is the battery management system. There are two banks of battery. Each bank has two blocks in series with each block consisting of 4 rows of 5 parallel cells. So we have 8 rows making 25.6v at 30A per bank. To keep the batteries happy we use 4 dual row BMS boards that protect against over charging the cells. At the top we have the BMS controller which monitors charge and discharge of the battery banks and reports this to the computer up front. The controller also sets which bank to charge and which to run from by instructions from the computer.

The function switch has off, shore charge, inverter, and Etrike modes. The e-trike can still charge from solar even if shore charge is not set to on. The connection top left is raw solar 30v input that goes through
current limiting and a pair of blocking diodes to prevent batteries from being drained if there is insufficient sunlight.

Moving right we have the Shore chrg, Battery Bank, Solar chrg, 25.6v to the front console, Drive control and accelerate / PWM Motor just below that. Solar -in connects to the solar panels, Shore Chrg, Solar Chrg, and Battery go to the Battery



W = 5.47"
L = 4.85"



compartment, 25.6v supplies the front console. Drive control, PWM Motor go to the Motor controller. Down at the bottom of the board we have connection to the switch, and the 9.6v to the front console. Over on the left bottom is 120v AC in and 120v AC out.

Mode 0 : The whole Tricycle is off even if the key switch up front is on.
Mode 1 : The on board transformer and rectifier bridge supplies power to the Battery charger to provide 5A charge to a selected battery bank , it also supplies 120V AC to the AC output connection. As such the Tricycle can run a drill, saw, router, or even portable tv or even cell phone charge in this mode.
Mode 2 : The onboard transformer and Inverter circuit is configured to draw power from the Battery banks to provide 120V AC out. As such the Tricycle can run a drill, saw, router, or even portable tv or even cell phone charge in this mode when no shore line is available.
Mode 3 : Enables the Tricycle to operate as a mode of transportation. The Computer and front circuit controls all operations.

The function switch determines the mode by placing 9.6v onto 3 of 4 switch positions. The first position is off (no connection). The second position powers an optic-triac to drive power triac which enables the ac in line to feed the external AC out receptacle and the primary of a 120v to 25v AC transformer which in turn passes the 25v to the output rectifier. The rectifier then powers the charge circuit in the battery compartment.

The third position powers two optic-triacs to drive two power triacs that reverse the transformer to power the AC output as the destination. The source of this transformer is an inverter driven by a 60 hz full wave saw tooth oscillation. The DC 9.6v becomes 19.2v AC multiplied by 5 =

96v AC which is sufficient for cell phone charge, some simple power tools but not recommended for Powering digital electronics like a PC or tablet except to recharge them.

The final position provides the 9.6v Battery power to the front controller. There the circuit takes the 9.6v to a key switch which then sends the voltage to the computer interlock. If the key switch is off, or the computer is not attached nothing gets power. With key switch on and computer attached, a 5v regulator is powered which powers the computer and upon initialization of the tricycle program the trike comes to life.

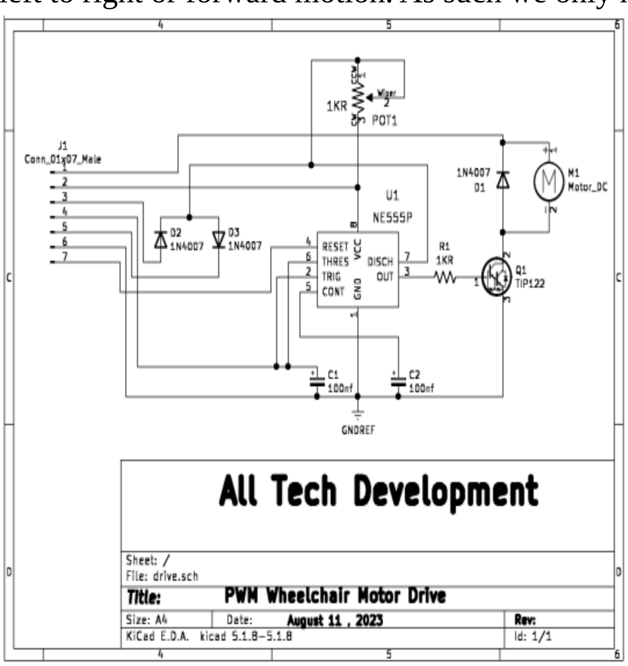
The Solar input is simply current limited and fed to the Solar output with blocking diodes so the batteries can’t back feed into the solar cell array when there is lack of sunlight. The 25.6v battery run output feeds both the charge converter here and the front controller, and drive controller. The accelerator hand grip comes into this board and is passed to the drive controller. In the Battery compartment the circuit takes information from the computer to determine which battery pack gets charged and which battery bank does the motor running.

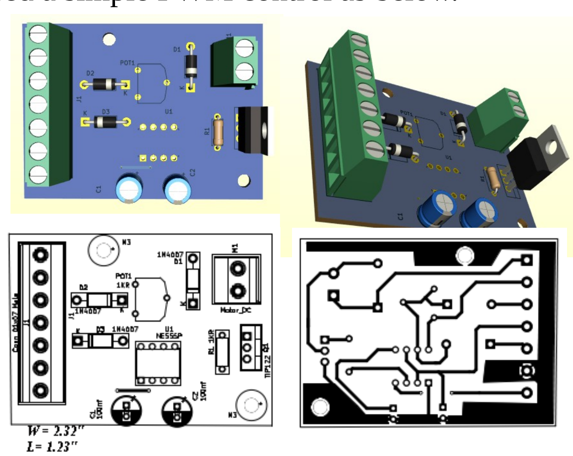
EV Tricycle Drive System

The Tricycle uses a salvaged wheelchair Motor as it's means of movement. This type of motor is a DC motor with an Electric permanent magnet brake. The brake actually draws a fair bit of power to disengage it to move. In our application, the brake simply stops movement of the drive gear but allows the freewheel gears and axle to still function so it really does nothing. In the original purpose, two motors propel a wheelchair with 300 lb occupant up to 8mph for 10 hours from two 12v @ 25A batteries in series. A full 1A per hour is used to disable the brake and 1.5A per hour to move. So step 1 is to remove the magnetic brake from the motor. This is a very strong real earth magnet that can easily do real damage to fingers. As powerful as it is, with effort you can still push the wheelchair with the brake on. We loosen the rear screws and slide a piece of plastic between the magnet and the metal friction plate. Once fully blocked from mating we can finish unscrewing the back and remove it. Take the magnet out of the backing and safely store or dispose of it. Re-install the backing.

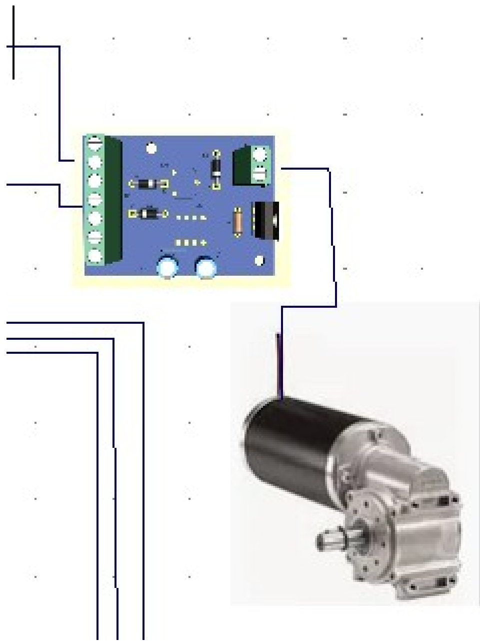
The Motor now needs a mounting bracket on the Tricycle with at least 8 inches below the basket. The original design had the motor attached to a 10" wheel and will now be attached to a 7 inch sprocket with a chain to a 3 inch freewheel. The 10 inch wheel travels 31.465 inches (2.62 ft) per rotation. At 8 mph it makes 16,110 rotations per hour. By changing to a 7 inch sprocket we have changed the distance to 1.835 ft per rotation but not changed the maximum rotations per hour. The 7 inch sprocket drives a 3 inch freewheel gear 2.33 times faster so this does alter the rotations per hour to 37,588. The freewheel gear rotates an axle and a 3" drive sprocket connects by chain to a sprocket at one rear wheel. The wheel is 24 inch traveling 37,588 rotation per hour. The 24 inch rear wheel travels 75.516 inches per revolution (6.29 ft) so at 37588 rotations per hour the maximum speed is 44.8 mph (72.66 kph). To be both safe and legal we must not allow speed higher than 30mph (50 kph). With 37,588 rph we get 626.47 rpm (rounds per minute) or 10.44 rps. We need to trim the maximum 37588 back to 25865 or 431rpm or 7.18 rps. This can be done by adjusting the input reading of the accelerator hand grip.

The wheelchair uses a controller with both forward and reverse H-bridge drives to two two independent motors which provide for 360 degree rotation and full range forward and back movement. We only need forward movement since the tricycle drive design doesn't allow backwared motion and the handlebars govern left to right or forward motion. As such we only need a simple PWM control as below.





The Motor is driven from the 24v main line. The PWM circuit is driven from the 5v line. The next 3 connections are the (+), (sense), and (-) of the handgrip accelerator. We then have ground and reset (brake applied).



The wiring is straight forward. The motor connects to the 2 terminal connection. If the motor turns the wrong way reverse the wires.

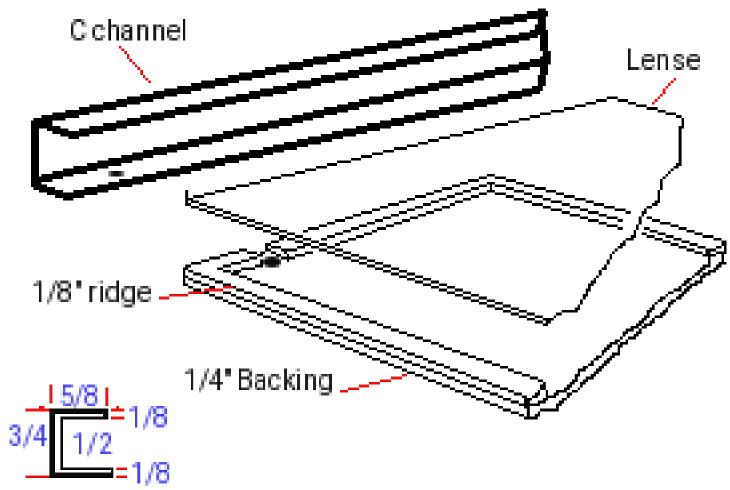
The 7 terminal connections are:

- 24v DC
- 5v DC
- (+) handgrip
- (sense) handgrip
- (-) handgrip
- GND
- Brake (0 = on 5v = off)

Motor is disabled when brake is on.

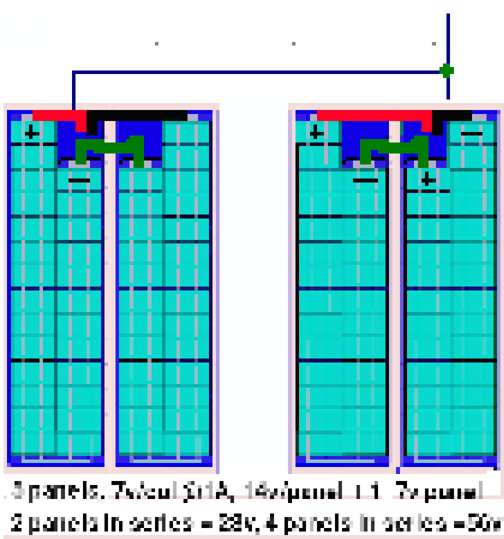
The Solar EV Tricycle Array

Above The wheelwells on either side of the Tricycle are two 9.5” fold out solar panels. Each panel set provides 30v @ 1A if sunlight is sufficient. Each panel consists of 0.25” x 35.75” x 9.25” plywood backing with a 0.125” x 0.5” edge trim and a 0.125” lens.



A 0.625 x 0.75 u-channel encloses the edges to seal the panels. The u-channel is chrome trim and the two panels on each side are connected by piano hinge such that when not in use they cover each other with the lens facing each other.

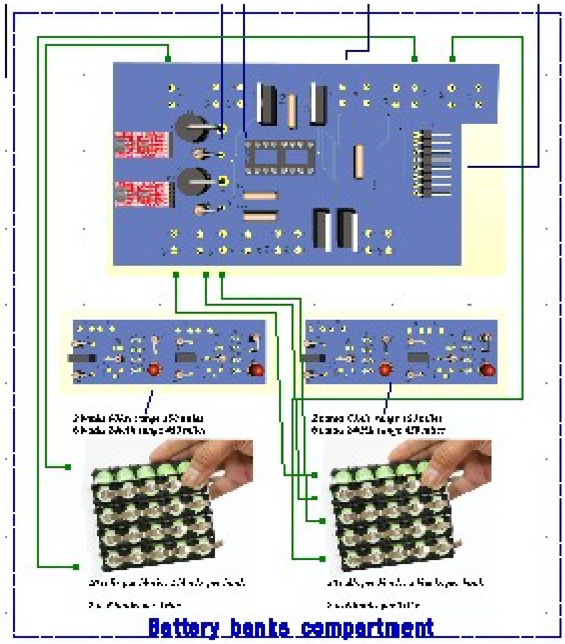
Surface area for the solar cells is 34.75” x 8.25” due to the chrome boarder. The cell width for 2 columns per panel is 8.195”. We have one column of 16 cells and one of 14 cells which means we need 32” for 16 cells plus 2.125” of separation between cells = 34.125” total length. One panel on each side mounts over the wheel well with the hinged panel folding over the basket area. All cells in each panel are wired in series with panel one row 1 (+) top left (-) bottom left with 16 cells, row 2 is (+) bottom right (-) top right with 14 cells. The adjoining panel has 14 cells in the first row with (+) top left and connects to the first panel row 2 top right. Once more (-) bottom left connects to row 2 bottom right (+) and (-) top right passes back into panel 1. (+) row 1 panel one goes to the electronics bay solar in. (-) row 2 panel 2 goes to the electronics bay (-) or ground. The panels on the other side are wired the same but this time panel 4 mounts above the wheel well and the wires pass into the electronics bay from panel 4. (-) panel 4 row 2 goes to ground and (+) from panel 3 row 1 comes into panel 4 and connect to (+) solar in of the electronics bay.



Cells are 4” wide by 2” high
30v = 60 cells in series 1A
2 sides in parallel = 30v 2A

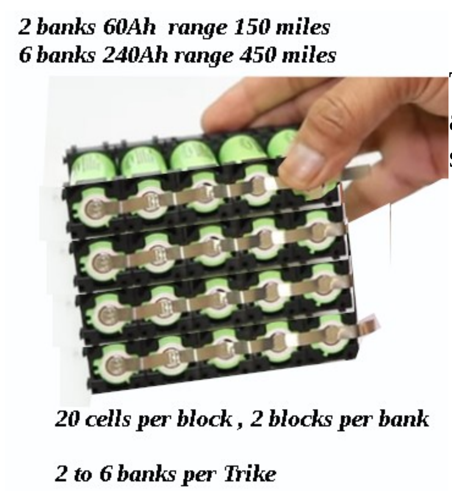
the cells deliver between 1A and 2A and I have gone with the lower figure with my calculations

EV – Tricycle Battery Management system

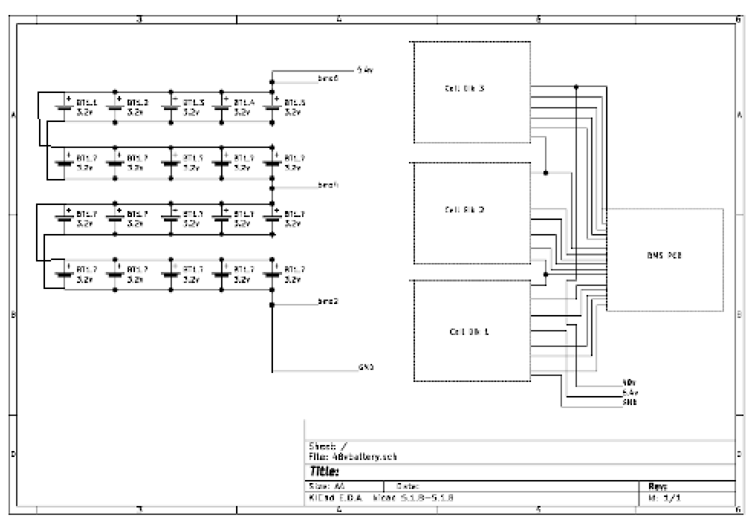


The Solar Electric tricycle battery management system consists of two 30A x 24V lithium Ion battery banks which are switchable. While one bank is operating the drive system, the other can be solar charging under computer control. Each bank has it’s own bms and switchover controller. The banks themselves have 5 parallel batteries making 30 A and 8 series batteries making 25.6V out of the 40 cells per bank. Cells are 32700 series lithium ion phosphate at 3.2v @ 6A during run operations and 4v @ 2A during charge operations. There is an important consideration here. While maximum draw is 6A for one hour, the actual draw is between 1.5A and 2.5A depending on speed and surface (hills, valley’s, flat). Ideal gives 2.5 hours travel time so Rockyford to Strathmore at 25 miles is 0.8 hours one way on just one bank of batteries. With two banks maximum distance is 150 miles in 4.8 hours. The solar charge or inverter charger provide for 2A to 4A charge @ 30V. With 8 cells in series each cell see’s 3.8V @ 2 to 4 A. But since each series cell has 5 cells in parallel, the individual cells get 0.4A to 0.8A so the recharge will take 7.5 to 15 hours to recharge from empty.

In our scenario of going Rockyford to Strathmore we use 1/3 our power getting there in 0.8 hours and it will take 2.5 hours to recharge bank 1 while we shop for 2.5 hours using bank 2. Bank 1 is fully recharged and bank 2 has seen maybe 0.2 hours use. We switch to bank 1 & recharge bank 2 on the run home. On a bright sunny day we return home with only 2.5 hours needed to recharge bank 1. On an overcast or dark day we use 2/3 power on bank 1 and ¼ power on bank 2. When we get home we plug in and charge bank 1 for 1.25 hours and bank 2 for 0.5 hours and again are good to go.



Using 4 blocks of 5x4 cells we get two banks of 30Ah each. The EV-Tricycle has available space for 12 blocks of 5x4 cells == 240Ah total and as such the range becomes 150 miles to 450 miles, even farther if using solar charging.

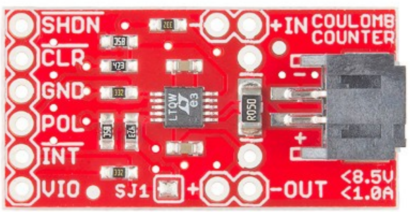


While the schematic to the right isn’t quite correct, it does show 10 cells in parallel by 2 series strings but that yields 6.4V @ 60Ah.

We want 5 cells in parallel by 4 series strings for 12.8V @ 30 Ah. Do 4 of these blocks and we get 2 banks each at 25.6V @ 30Ah.

Charge vs Drain

The battery system has two systems in place. The first is a BMS that safe guards cells from over charging and the second is a coulomb counter that reads charge in and out of the battery bank. The computer reads coulombs coming out of the bank vs coulombs going into the bank. When the computer sees 20% left it warns that you must switch banks to continue and when it sees 90% charge it cuts off charging a bank. For coulomb counting to work we need to sample up to 8.5V @ 1A maximum and here-in lies the problem our drain voltage is 25.6V @ 2.5A nominal and our charge is 30V @ 2 to 4 A. Using an artificial ground 5V below the charge discharge voltage the coulomb counter is happy since it always has 5v and has no idea it is operating from a 25.6v or 30v supply. Using an external shunt resistor and measuring 50mv across it when 5A passes through it we can compensate for the 1A maximum such that 50mv/1000mA = .05 milohms and 50mv/5000mA = .01 milohms. The computer gets 1 tick every .1765 A on the original and now gets 1 tick every .0353 A .

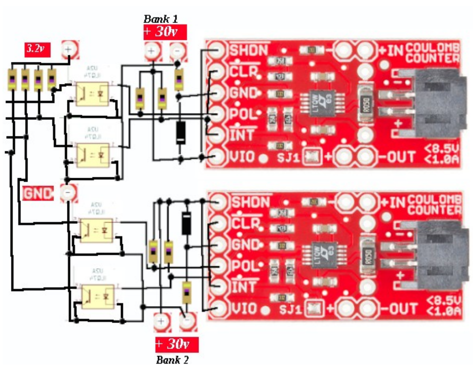


/shdn connects to VIO which is either +25.6 discharge or +30v charge

/clr connects to /int and sends pulses to the computer every .0353 A

pol is low for discharge and high for charge

A 5v zener goes between VIO and GND and a 470 ohm resister goes between the GND of the coulomb counter and the real GND of the system. An ILQ2 (quad optic isolater) safely level shifts the signals from 0 – 30v to 0-3v for the computer.

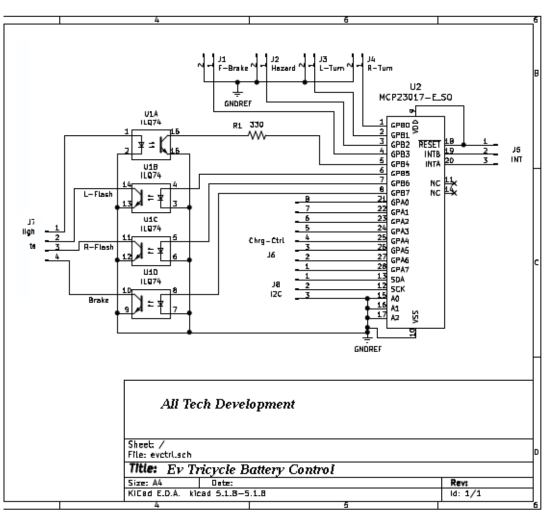


This simple circuit board handles 2 Banks of Batteries for both charge and discharge. Connections are pol 1, pol 2, int1, int 2, GND, and 3.2V on the computer side.

Another computer circuit has drive En 1 , drive En 2, Chrg En 1, and Chrge En 2. Such that complete control is handled on 8 wires.

We could use 4 SPST relays rated for 10A contacts or use IRF540 ‘s run from ilq2 chip to accomplish simple switching.

The Mosfet can drive 19A at over 90v so it can handle our control requirements.

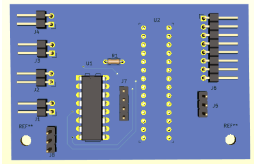


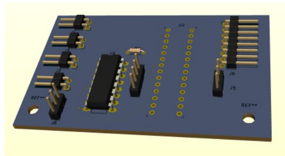
We could also do both charge monitoring and battery control with just 1 mcp23017 chip and use only 2 wires. It does so using a I2C interface of 2 wires to control up to 16 inputs or outputs or any combination there of.

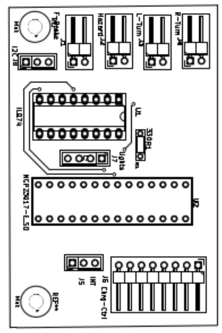
```
As seen at the left, a simple control board placed at
the front controller provides sampling of the
    1. left turn
    2. right turn
    3. hazard
    4. front brake switch
    5. rear brake sample , and sends
    6. Left-Turn
    7. Right-Turn
    8. Brake states
```

to the front control circuits. It also reads pol and int states from/to battery packs, and issues the charge and drive control for two battery packs. Int-A, Int-B, Scl, Sda, GND, and plus 5v does all the communication with the front control board.

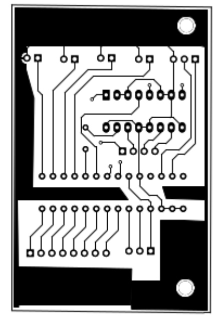
Below is the board views.





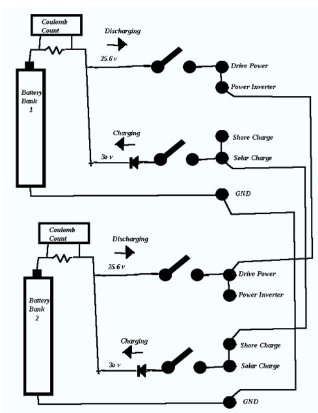


EV Battery Control
W = 1.85 " x L = 2.82 "



Down at the Battery Banks

We have 8 control wires that come from the front controller, plus a common ground. Battery bank 2 cell row 1 provides us with 3.2v for LTC4150 coulomb boards (0.5” x 1.25”) and the 10 resistors and 2 zeners take care of the biasing for checking charge / discharge. 4 IRF540n Mosfets connect the 2 Battery Banks for driving the tricycle or connecting the solar charge and or inverter charger to the battery banks.

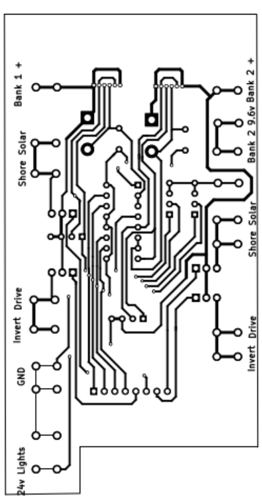


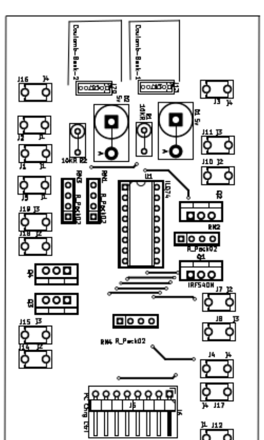
The concept is shown at the left. The Mosfets will replace the switches such that the computer can control which bank gets charged and which bank gets discharged. The coulomb counters monitor each bank separately.

When the computer is in drive mode the select drive bank provides motor power. When in Inverter mode the computer allows the selected bank to generate 120v ac from the batteries.

When in Shore charge mode charging comes from the battery charger. And when in Solar charge mode charging is from solar power.

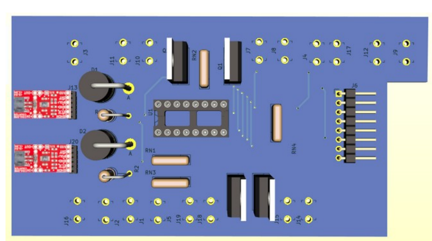
At this point let us address the switching and monitoring circuit. In the back battery compartment we have the switchover board.

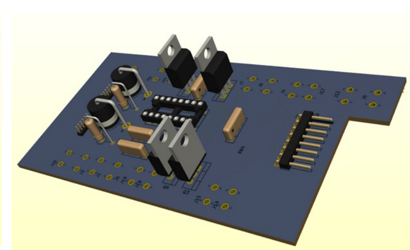




width = 2.39"
length = 4.53"

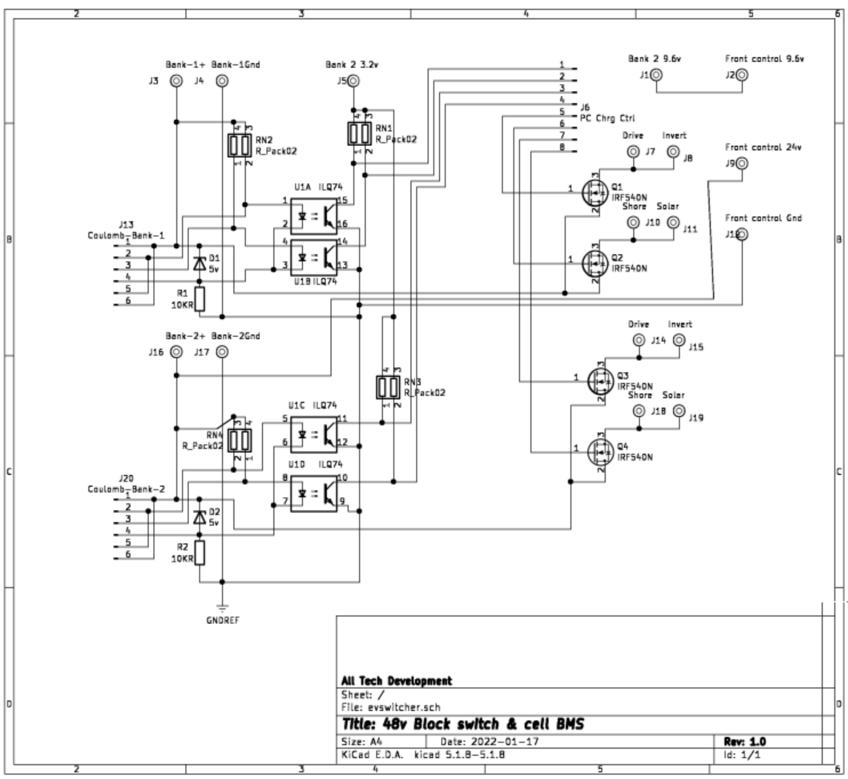
We have two board views. On the left is the back side of the PCB with the front topside view beside it. Below is the actual layouts.





The board has two micro coulomb modules shown red that track the charge to and from the battery banks. Along the top edge we wire +25.6v to bank 1 battery pack, next is solar and shore inputs, then we have drive and Inverter outputs, next to that are 3 Ground tags and finally +24v for front console light system. An 8 pin header goes up to the front console. Working left to right along the bottom edge we have +25.6v to bank 2 battery Pack, then we have 9.6v tap on bank 2 which goes to the front console for main power. Then we have 3.2v tap on bank 2 , next is solar and shore inputs, next is drive and inverter outputs. So battery bank 1 has +25.6v and ground. Battery bank 2 has +25.6v, +9.6v, +3.2v, and ground. The two solar inputs connect together and go to the solar panels. The two shore inputs connect together and go to the shore charge circuit. The two drive outputs connect together and go to the drive circuit. The two Inverter outputs go to the Inverter. The computer up front gets +24v, +9.6v, 8 pin cable, and ground.

So why do I only do taps on bank 2? Well the computer needs to draw power for lites, horn, signals, and itself and if it sends command to turn off the supply it is running from everything stops including itself. So I use the 3.2v, 9.6v taps for the computer and run those from bank 2 only. The computer including all lights, horn, signals, brakes use less than 2A per hour. So on a .8 hr trip, bank1 depletes by 10A, bank 2 depletes by 2A. If there is no sun and we shop for 2 hrs bank 1 may deplete 1A between stops and bank 2 depletes 0.2A. On the return trip we further deplete bank 1 another 10A and bank 2 another 2A. Back at home bank 1 has 9A left and bank 2 has 25.8A. We can use shore power to recharge both banks at 4A and be ready to go again in 6 hrs.



On the left side of the schematic we have two ltc4150 coulomb counters connected directly to their independent battery banks. An ilq2 quad optic-coupler with it's associated biasing resisters convert 30v levels to 3v levels for the computer. At the right is the computer connection which has the top 4 lines to do charge/discharge reading , and the bottom 4 lines enabling run/charge on two banks.

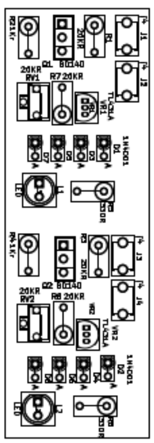
```
The states are:
      0 0 0 0 … all off
      1 0 0 0 …. bank 1 run
      0 1 0 0 …. bank 1 charge
      0 0 1 0 …. bank 2 run
      0 0 0 1 … bank 2 charge
      1 0 0 1 …. bank 1 run bank 2 charge
      1 0 1 0 …. bank 1 & 2 run
      0 1 0 1 …. bank 1 & 2 charge
```

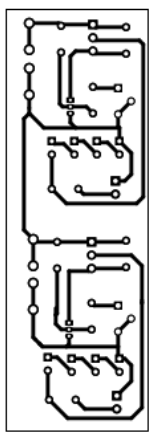
The BMS

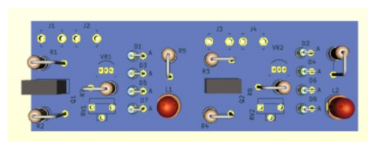
There are 8 cell rows in series per bank and each row contains 5 parallel cells. So for each bank we build two blocks of 4 rows x 5 columns (20 cells). From the bank 2 perspective here is how it wires. Items in bold only pertain to bank 2.

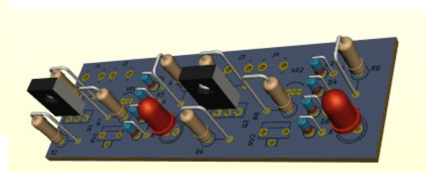
- Cell row 1 (-) is the ground and it goes to BMS board 1A, and the switcher board GND and also to front controller and rear charge inverter and motor drive.
- Cell row 1 (+) goes to cell row 2 (-) , **switcher board +3.2v**, BMS board 1B.
- Cell row 2 (+) goes to cell row 3 (-), BMS 1C and BMS 2A.
- Cell row 3 (+) goes to cell row 4 (-), +**9.6v**, BMS 2B.
- Cell row 4 (+) goes to cell row 5 (-) on second block, BMS 2C and BMS 3A.
- Cell row 5 (+) goes to cell row 6 (-), BMS 3B.
- Cell row 6 (+) goes to cell row 7(-), BMS 3C and BMS 4A,
- cell row 7 (+) goes to cell row 8 (-), BMS 4B,
- cell row 8 (+) goes to +24v of the switcher board, +24v of Inverter, +24v of Drive control, BMS 4C

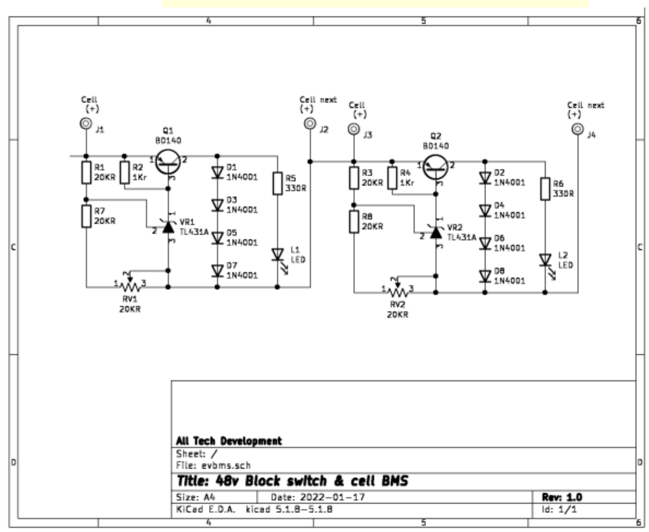
The other bank wires the same as the first bank replacing BMS #A,B,C with designations 5 through 8.











W = 1.08 "
L = 3.17 "

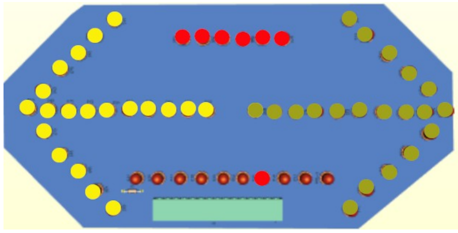
Basically the BMS boards each handle 2 rows. Batteries are 1.26” x 2.78” so each row is 1.39” wide x 3.03” high x 7.55” long. Due to storage in the battery compartment the boards have be mounted on the 3.03” x 7.55” surface of block 1, 2, 3, and 4. We also need to mount a 2.39” x 4.53” switcher board too.

S0 2 banks have 8 BMS boards 1.08” x 3.17” and one switcher board 2.39” x 4.53”. BMS is using 2.16” x 12.67” and the total space used = 4.55” x 12.67” out of the 7.55” x 12.67” Packs surface.

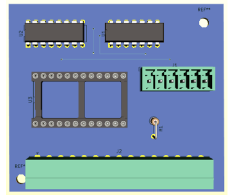
How the circuit works is you set the charge cut off for the cell on the associated trimer. During charge, the cell is charged until cutoff. At cutoff the led lights and the no further charging is done on the cell. Eventually all cells are fully charged and all leds are lit.

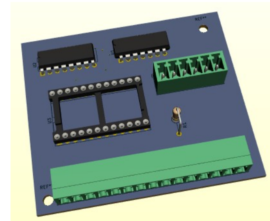
PCB images

EV-Trike Front signals x 6.5”



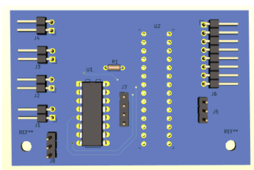
EV-Trike Cylon Board

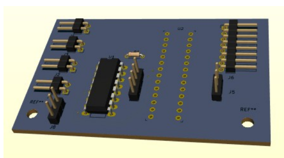




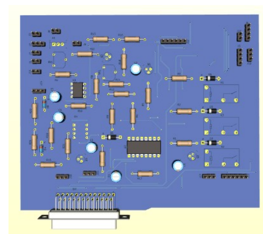
The front signal displays left and right turns and has the cylon eye. The cylon board makes the eye move back and forth while the tricycle is on.

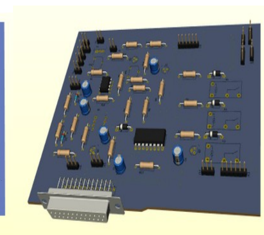
EV-Trike Evcontrol





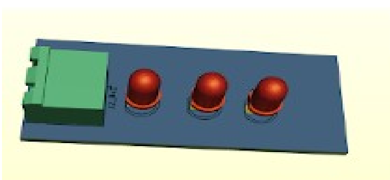
EV-Trike Main Control

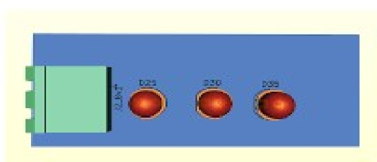




The Evcontrol board reads the left turn, right turn, brake and Hazard switches, reads the state of batteries, and sends control signals to the charge and drive control system. The main board handles lights, horn, braking, and communication with the computer

EV-Trike Marker Lights   0.5” x 1.5” 4.5v 20ma √

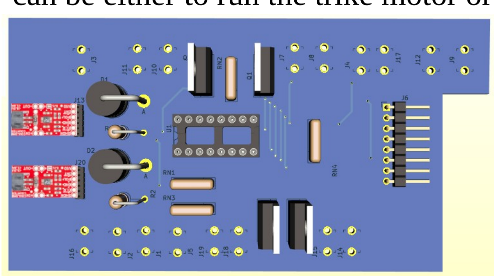


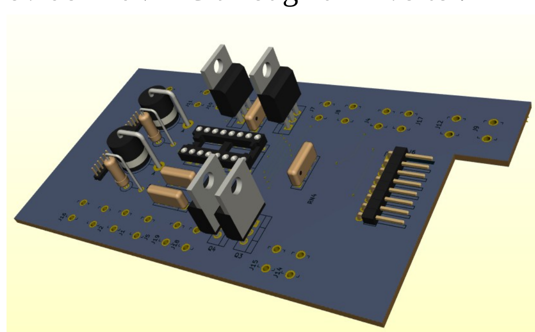


The marker lights go on the side of the rear basket to mark the width of the unit.

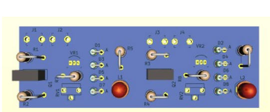
EV-Trike BMS (battery management system)

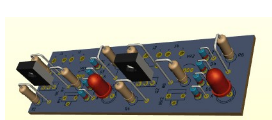
Charge / Run selector determines which battery pack is charged and which one runs the trike. Two coulomb counters report the state of each battery pack. Charging can be by Solar or Shore power. Running can be either to run the trike motor or provide 120V AC through an inverter.





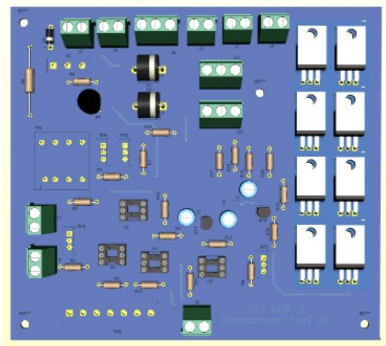
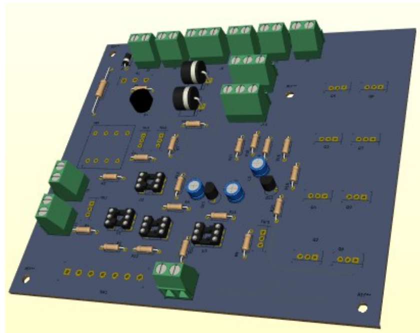
There are 8 BMS balancing circuits like below. 4 dual battery cell monitors go to each battery bank.





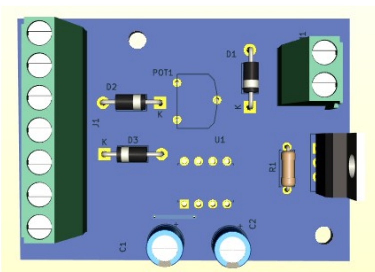
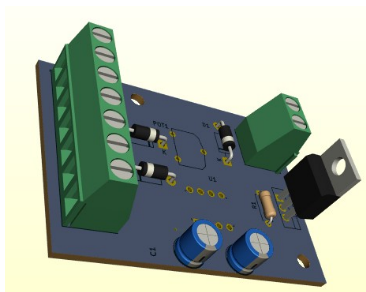
EV-Trike Charge / Inverter

This board is run by a selector switch to set the operating mode. Mode 0 is off, Mode 1 is shore Charge, Mode 2 is Inverter and Mode 3 is EV-Trike. The charge / run selector above chooses which battery bank is charged and which can be used for E-Trike or Inverter.

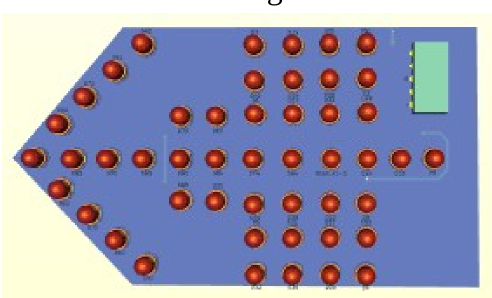
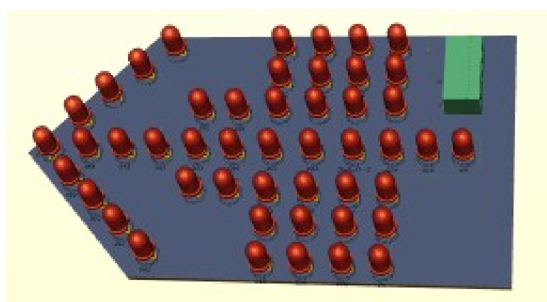
EV-Trike Drive board

This board reads the accelerator hand grip and using pulse width modulation controls the motor speed. IfTrike. The charge / run selector above chooses which battery bank is charged and which can be used for running the motor. When the brake is applied the motor is disengaged immediately.

Tail Lights

The two tail light boards each have turn signal, marker, and stop LEDs

The following do not have their own circuit boards they wire to existing boards

- Turn signal / horn switch
- PWM brake servo
- Solar panel array

This concludes the Solar Electric Tricycle