Power Supply Box
Field Power for an LX200 Telescope

By Danny Cobb

To free my telescope from it's power connection to my vehicle when observing at remote sites, I made a power supply box to furnish 18VDC for the LX200 telescope, as well as 12VDC and 120VAC for accessories. The box provides all the power I need without having to cobble together anything in the field.

Having few skills with electronics, I decided to use off the shelf components mounted inside a homemade case. The major components are a 33 amp-hour gel cell battery from Sears, a 140 watt inverter from Wal-Mart and a Meade 12VDC to 18VDC converter. The battery sits in the bottom of the case, which has a triple 12V outlet and a duplex 120V outlet on the front. The 18V outlet, switches, charging terminals and voltmeter are mounted on the top. The box is also ventilated, with a small computer fan pushing air out an opening on the opposite side. The fan is perhaps unnecessary with a sealed battery.

The 12V outlets and the 18V outlet each have panel mounted fuses on the top panel. The inverter itself is fused, so I did not add a separate fuse for it. The 12V power and 120V power supplies also have indicator lamps. I used resistors to dim the lamps to an unobtrusive level. Since the 18V outlet used is female and the connection to the telescope is also female, a double male cord must be used. The cord is easy to make and an in-line fuse is not required because the supply is fused.

I made most of the electrical connections using the terminal strips and spade tongue connectors on the wires. That arrangement saves having to solder many connections and allows for easier maintenance if required.

The case can be opened for battery replacement or maintenance, but it is not designed for frequent access to the internals. Some of the aluminum angle trim must first be removed to open the box. The two long trim strips on the top are the sole means of holding the control panel in place. The whole front can also be removed by unscrewing it from the rest of the case. The bottom, sides and back are permanently assembled.

The overall outside dimensions of the box are 16-1/2" tall x 10-1/2" wide x 6-1/4" deep. These dimensions allow for a little extra room for the battery, in case a slightly larger replacement battery must be used in the future.

Below are detailed instructions for making the power box. If you don't want to figure out all the dimensions, construction details and wiring arrangements on your own, the instructions will save you time. If you like to tinker and modify things, you may only want to use my instructions as a starting point.

PARTS LIST

Home Improvement Store
1 ea 1/4" hardwood plywood, 2' x 2' sheet
1 ea 1/2" hardwood plywood, 2' x 2' sheet

1 ea 3/4" hardwood plywood (I only used one small piece of 3/4" plywood for the bottom. If you don't want to buy a piece of 3/4" plywood for it, either use 1/2" or laminate 1/2" and 1/4"pieces. Or use a piece of solid lumber if you have one on hand.)
6 ft 1/2" x 3/4" aluminum angle
6 ft 3/4" x 3/4" aluminum angle
2 ea Belwith solid brass handles, chrome finish, 4"center to center (drawer pulls)
2 ea 1-1/2" trap adapter, black ABS (NIBCO p/n 22810; for fan and vent openings; in the plumbing section)
1 ea Duplex 120V outlet
1 ea Outlet cover plate
2 ea 1/4-20 x 1-1/2" round head machine screws (charging posts)
2 ea 1/4-20 x 1" round head machine screws (to connect wires to the battery terminals)
2 ea 1/4-20 wing nuts
1 pk 1/4-20 nuts
1 pk 1/4" washers
1 pk 1/4" lockwashers
4 ea Rubber feet
1 lot Paint
1 lot Assorted wood screws

Wal-Mart
1 ea 140 watt inverter
1 ea Cigarette plug double outlet (this will be cut apart later)

Radio Shack
2 ea Screw-cap panel-mount fuse holder (270-364E)
1 ea Panel-mount voltmeter, 0-15 VDC (270-1754)
1 pk Midget screw-base lamps, 12V, 75mA (272-1143)
1 pk Subminiature lamp holders (272-340)
1 pk Coaxial DC power plugs, 5.5mm OD, 2.5mm ID (274-1573A)
1 ea Coaxial DC power jack, 5.5mm OD, 2.5mm ID (274-1576A)
5 ea Rocker switch, SPST (275-694)
1 ea Rocker switch, DPDT (275-695)
1 ea 12VDC microfan, 1-9/16", 5.3 cfm (273-240)
1 pk 330 ohm resistors (271-1113)
1 ea 3-outlet dash-mount DC accy outlet (270-1544A)
1 pk 2-amp fast-acting fuses (270-1007)
1 pk 5-amp fast acting fuses (270-1011)
2 ea 8-position dual row barrier strip (274-670)
6 ea "round" connectors for battery and charging posts
1 lot Lots of spade tongue connectors (3 dozen or more)
1 lot Wire

Miscellaneous
1 ea 3-prong plug with about a foot of cord
1 ea Small piece of mesh to cover the vent
1 lot Rigid foam scraps
1 lot Labels for the control panel
1 lot Wood glue

TOOLS

These are the tools I used. You can use more or less depending on what you have available and your preferences.

Table saw (mine is an inexpensive Black and Decker)
Router (mine mounts to my table saw from underneath to effect a router table)
Hand drill
Dremel tool with miniature sanding drums
Miter saw with abrasive disc
Countersink drill bits to match the wood screws used to assemble the case
Forstner drill bits to drill the holes for the 12V outlets on the front and the holes in the control panel.
Misc: hand saw, small drill bits, soldering iron, solder, screwdrivers, sandpaper, file, etc.

BUILDING THE CASE

Cut the pieces
Bottom, 3/4" plywood, 5-1/2" x 9-1/2"
Sides, 1/2" plywood, 5-1/2" x 16"
Back, 1/2" plywood, width = 9-1/2" plus twice the thickness of the 1/2" plywood, height = 16" plus the thickness of the 1/2" plywood (plywood, like most lumber, is slightly undersized)
Strips on either side of the control panel (where the handles attach), length = 5-1/2" plus the thickness of the 1/2" and 1/4" plywood, width = 1-1/4" (these 2 pieces are subsequently referred to as "strips")
Front, 1/4" plywood, same dimensions as the back
Control panel, 1/4" plywood, 5-3/4" x 8-1/4"

Both top corners of the front and back pieces are notched to fit around the strips; the strips overhang the side pieces (1/4" on the front, 1/2" on the back.) Cut the notches 1-1/4" wide and a depth matching the thickness of the 3/8" plywood.

Set up your router to cut to a depth matching the thickness of the 1/4" plywood. Route a rabbett 1/4" wide into the top edge of the back (the back edge of the control panel sits in this rabbett.) Route rabbetts 1/8" wide into the strips (the sides of the control panel sit in these rabbetts.)

I used the "trap adapters" (plumbing fittings) to provide a more finished look to the openings for the vent and the fan. Obviously, plain holes will work if you do not want to use the trap adapters. The trap adapters have male threads on one end of the fitting. Cut off the threaded portion with a hand saw, so you are left with a short tube with a flange on one end. Glue mesh over the fitting for the vent. The micro fan is a perfect fit to the inside diameter of the fitting; secure it to the other fitting with a couple of screws.

Left: Fan mounted on the right side of the box. Right: Vent mounted on the left side of the box.

Drill holes for the fan and vent in the side pieces. You can drill the holes after the case is assembled, but it may be easier beforehand depending on your tools. The trap adapters require 1-7/8" diameter holes. Not having, or wanting to purchase, a pricey 1-7/8" Forstner bit, I roughed out the holes with a jig saw and used a miniature sanding drum in a Dremel to carefully sand to the line. The vent hole on the left side is centered 13-7/8" up from the bottom and 1-3/4" towards the front from the back edge. The hole for the fan in horizontally centered in the right side, 10" up from the bottom. (Since the front and back are not the same thickness, horizontally centered on the finished case means shifted towards the back 1/8" when

measuring on the side piece itself.) Drill pilot holes for the screws that will attach the trap adapters. Three pan head screws hold the fittings in place. Drill pilot holes for mounting the two terminal strips. These are on the right side above the hole for the fan. If you do not drill these pilot holes now, you won't be able to get a drill in position once the case is assembled.

Glue and screw the bottom, sides and back together. When positioning the screws, keep in mind (1) the aluminum trim pieces need to cover the screw heads and (2) the screws for the aluminum trim must avoid the wood screws. Screw heads must be sunk flush. Install a 3/4" thick spacer block (2-1/4" x 5-1/2") for mounting the 12V outlets on the left side. Mount the block flush towards the front, with the bottom edge 8" up from the bottom of the box (measured on the outside, from the bottom edge of the bottom piece.) Install a small block of wood on the back piece to secure the battery against upward movement.

Glue and screw the strips onto the tops of the side pieces. Clamp the strips and control panel in place when attaching the strips to ensure a perfect fit with the control panel. Mark and drill the holes for mounting the handles. Position these holes accurately to allow enough room for the screw heads and lock washers to clear the sides of the case.

Drill the screw holes for attaching the front and screw it in place. Double-check the location of the 12V outlets. The bottom outlet is centered 2-1/4" from the side, 9-1/2" up from the bottom. Remove the front and drill the three 1" holes on 1-1/4" centers. I recall the holes required slight enlargement for a perfect fit. Cut the opening for the 120V outlet centered 2-3/4" from the side, 11" up from the bottom. I also glued a little strip of wood (1/4" x 3/4" x 8") near the top of the front panel to support the front edge of the control panel since the box front panel does not have a rabbett.

Layout the control panel and drill the holes. I drew my layout with drawing software, printed it actual size, and used it as a template to center punch the holes. I recommend using Forstner drill bits to avoid splintering the plywood. Hole sizes for the components I used: switches, 5/8"; miniature lamps, 3/8"; 18V outlet, 7/16"; fuse holders, 1/2", charging posts, 1/4". The voltmeter requires one 1" hole and two small holes.

Paint it all, inside and out. I brushed on several coats of enamel, sanding between coats. Stained and sealed is an option too.

MOUNTING THE COMPONENTS AND WIRING

Mount the 12Voutlets. Since positioning is critical, I stuck the outlet piece in the front piece (friction holds it in place), attached the front to the case, then marked the locations for the two screws. Install the trap adapters (vent piece on the left, fan on the right.) I put 1/8" thick spacers (gaskets) on the trap adapters to keep them from protruding too far to the outside. Install the terminal strips and the inverter. The inverter will probably need to be offset to one side to allow room for the 120V plug, which connects it to the 120V outlet. Mount the 120V outlet on the front of the case. I used an old cord from a deceased appliance to connect the 120V outlet to the inverter.

Mount the switches, lamps, fuse holders, etc. in the control panel. The voltmeter has two long threaded

posts on the backside. I screwed some small plastic drywall anchors over these posts to secure the voltmeter in place. I clipped a short piece, including the female connector, from the cord supplied with the 1812 to use as the internal connector for the 1812. Solder on the wiring that goes from one control panel component to another. Solder the wires onto the control panel components that go to the terminal strips. Allow enough length so the control panel can be lifted up for future maintenance.

Install the wiring. The inverter and 1812 converter just plug into the two internal 12V outlets. Tape these plugs together so they won't come apart. Stick the 1812 converter to the front with mounting tape. Install the handles using lock washers. Put the battery in place and connect the wires to it using the 1/4-20 x 1" screws, washers, and lock washers. Wedge the battery in place with the rigid foam scraps as required to prevent it from shifting.

Once all the connections are made, install the front panel with screws only. Then press the control panel in place.

Cut the aluminum trim pieces to fit. I framed the top and bottom with 1/2" x 3/4" angle, then cut the vertical pieces (3/4" x 3/4" angle) to fit. I used an abrasive blade in my miter saw to make the cuts, which required a little cleanup with a file. The top and bottom pieces are each fastened with two small pan head screws, the vertical pieces each use four screws. Make sure the screws do not align with any of the screws holding the case together. The trim pieces are all that holds the control panel in place. Install the rubber feet.

Construct a double female cord for supplying the LX200. I used the cord provided with the 1812 converter, cut to about 6' long, with a male plug soldered to the cut end.

I had my engraved labels for the control panel switches made at a trophy shop.

WIRING SCHEME

The following connections are made on the control panel itself:

1. Connect the pair of contacts on one side of the Charge Switch to the charging posts (one contact to the negative post, the other to the positive post.
2. Make a short cord with the female coaxial jack on one end. Connect the other ends to (a) the 18V jack and (b) the fuse holder for the 18V supply. Connect the free contacts on the jack and fuse holder to each other.
3. Connect one side of the 12V switch to the 12V fuse.

<u>The upper terminal strip (positions are numbered 1-8 left to right)</u>

On the top row:

1. Place a 330-ohm resistor across positions 1 and 2.
2. Place a 330-ohm resistor across positions 3 and 4.
3. Place the 15k ohm resistor furnished with the voltmeter across positions 5 and 6.
4. Position 7 connects to the 18V switch.
5. Position 8 connects to the lower terminal strip at position 5 on the bottom.

On the bottom row:

1. Position 1 connects to the 120V lamp
2. Position 2 connects to (a) the 120V switch and (b) the + wire on the 12V outlet for the inverter. Label this plug "inverter" so it's not confused with the plug for the 1812 converter.
3. Position 3 connects to (a) the 12V fuse and (b) the + wire on the triple 12V outlets
4. Position 4 connects to the 12V lamp
5. Position 5 connects to the + side of the voltmeter
6. Position 6 connects to the voltmeter switch
7. Position 7 connects to the + wire on the 12V outlet for the 1812 converter. Label this plug "1812."
8. Position 8 connects to the - wire on the 12V outlet for the 1812 converter

The lower terminal strip (positions are numbered 1-8 left to right)

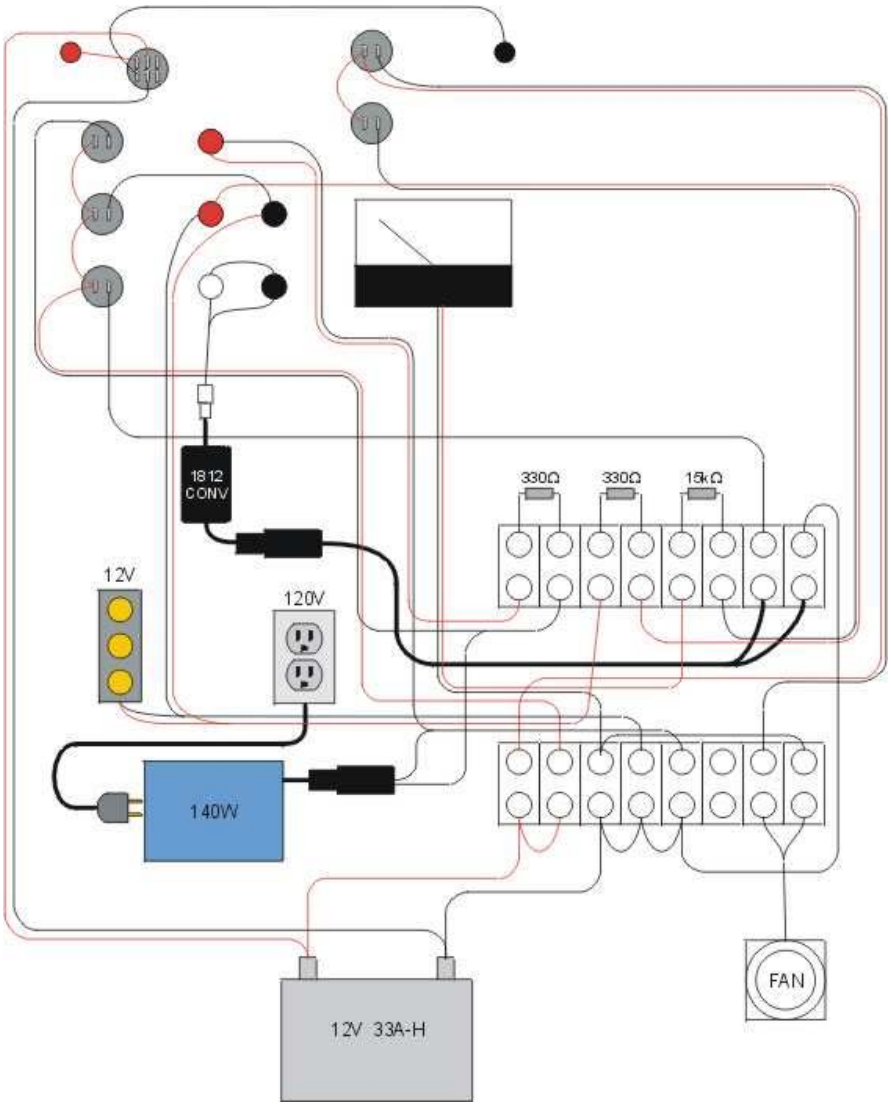
On the bottom row:

1. Install jumpers to connect positions 1 and 2, positions 3 and 4, and positions 4 and 5.
2. Connect the battery + wire to position 1 and the battery - wire to position 3. Do not connect the ends at the battery at this time.
3. Position 5 connects to the upper terminal strip at position 8 on the top as mentioned above.
4. The fan connects to positions 7 (positive) and 8 (negative.)
5. Position 6 is not used.

On the top row:

1. Position 1 connects to (a) the meter switch and (b) the fan switch
2. Position 2 connects to (a) the 12V switch and (b) the 120V switch
3. Position 3 connects to (a) the - side of the voltmeter and (b) the top of position 8 on this terminal strip.
4. Position 4 connects to (a) the - wire for the triple 12V outlets and (b) the 12V lamp
5. Position 5 connects to (a) the - wire on the 12V outlet for the inverter and (b) the 120V lamp
6. Position 6 is not used
7. Position 7 connects to the fan switch
8. Position 8 was already connected to position 3

Make sure you connect the coaxial plugs and cigarette plugs with the proper polarity! If the fan rotates in the wrong direction, just reverse the leads.



IN HINDSIGHT

I would add a battery bypass arrangement to the charging posts so that if the battery died, I could connect another battery to box via the charging posts and power everything without the dead internal battery sucking up the current.

Another person who copied my box used little circuit breakers instead of fuses.

I've never blown the fuse for the inverter, but replacement requires opening the box. I might add a panel mount fuse for it as well and put a high amp rating fuse in the inverter itself that will never blow.

You could add an indicator lamp for the 18V output.

I might use a 300W inverter rather than a 140W.