VI. Metal Fabrication

A. A Short Discussion of Various Metals

1. Steel is not used for a large amount of fabrication work in electronics. Basically, it is too heavy for many of the products that we fabricate. It also rusts, but rust can be prevented by a number of different techniques -- painting, plating, and hot dip galvanizing are three of the methods used.

2. Copper and brass are used where it is necessary to solder electronic components to the chassis for shielding or other electrical purposes. It is rare to find copper or brass used for any other purpose.

3. Other more exotic metals find limited use in electronic fabrication.

B. Aluminum

1. By far and away, aluminum is the metal of choice for electronic fabrication. It is lightweight, easily machined, relatively unaffected by corrosion, and inexpensive. Aluminum comes in hundreds of versions and strengths. Here are a few comments on the various alloys of aluminum:

Basic Aluminum Alloys

1xxx series---Aluminum of 99 percent or higher purity has many applications, especially in electrical and chemical fields. These compositions are characterized by excellent corrosion resistance, high thermal and electrical conductivity, low mechanical properties and excellent workability. Moderate increases in strength may be obtained by strain-hardening. Iron and silicon are the major impurities.

2xxx series---Copper is the principal alloying element in this group. These alloys require solution heat-treatment to obtain optimum properties; in the heat-treated condition mechanical properties are similar to, and sometimes exceed, those of mild steel. In some instances, artificial aging is employed to further increase the mechanical properties. This treatment materially increases yield strength, with attendant loss in elongation; its effect on tensile (ultimate) strength is not so great. The alloys in the 2xxx series do not have as good corrosion resistance as most other aluminum alloys, and under certain conditions they may be subject to intergranular corrosion. Therefore, these alloys in the form of sheet are usually clad with a high-purity alloy or a magnesium-silicon alloy of the 6xxx series, which provides galvanic protection to the core material and thus greatly increases resistance to corrosion. Alloy 2024 is perhaps the best known and most widely used aircraft alloy.

3xxx series---Manganese is the major alloying element of alloys in this group, which are generally non-heat-treatable. Because only a limited percentage of manganese, up to about 1.5 percent, can be effectively added to aluminum, it is used as a major element in only a few instances. One of these, however, is the popular 3003, which is widely used as a general purpose alloy for moderate-strength applications requiring good workability.

4xxx series---The major alloying element of this group is silicon, which can be added in sufficient quantities to cause substantial lowering of the melting point without producing brittleness in the resulting alloys. For these reasons, aluminum-silicon alloys are used in welding wire and brazing alloys where a lower melting point than that of the parent metal is required. Most alloys in this series are non-heat-treatable, but when used in welding heat-treatable alloys, they will pick up some of the alloying constituents of the latter and so respond to heat treatment to a limited extent. The alloys containing appreciable amounts of silicon become dark gray when anodic oxide finishes are applied and are in great demand for architectural applications.

5xxx series---Magnesium is one of the most effective and widely used alloying elements for aluminum. When it is used as the major alloying element or with manganese, the result is a moderate to high strength non-heat-treatable alloy. Magnesium is considered more effective than manganese as a hardener--about 0.8 percent magnesium being equal to 1.25 percent manganese--and it can be added in considerably higher quantities. Alloys in this series possess good welding characteristics and good resistance to corrosion in marine atmosphere. However, certain limitations should be placed on the amount of cold work and on the safe operating temperatures permissible for the higher magnesium content alloys (over about 3.5 percent for operating temperatures above about 150 degrees F) to avoid susceptibility to stress corrosion.

6xxx series---Alloys in this group contain silicon and magnesium in approximate proportions to form magnesium silicide, thus making them heat-treatable. The major alloy in this series in 6061, one of the most versatile of the heat-treatable alloys. Though not as strong as most of the 2xxx or 7xxx alloys, the magnesium-silicon (or magnesium-silicide) alloys possess good formability and corrosion resistance with medium strength. Alloys in this heat-treatable group may be formed in the T4 temper (solution heart-treated but not artificially aged) and then reach full T6 properties by artificial aging.

7xxx series---Zinc is the major alloying element in this group, and when coupled with a smaller percentage of magnesium results in heat-treatable alloys of very high strength. Usually other elements such as copper and chromium are also added in small quantities. The outstanding member of this group is 7075, which is among the highest strength alloys available and is used in airframe structures and for highly stressed parts.

(Data courtesy of Lusk Metals. www.luskmetals.com/reference.html)

2. Here are the chemical makeups of several popular aluminum alloys. Pay particular attention to 5052 alloy.

Alloy	Si	Fe	Cu	Mn	Mg	Cr	Zi	Ti	Aluminum
1100	.095 Si + Fe		0.05-0.20	0.05	. .	. .	0.10	. .	99.00
2011	0.40	0.7	5.0-6.0	. .	. .	. .	0.30	. .	Remainder
2024	0.50	0.50	3.8-4.9	0.30-0.9	1.2-1.8	0.10	0.25	0.15	Remainder
3003	0.6	0.7	0.05-0.20	1.0-1.5	. .	. .	0.10	. .	Remainder
5005	0.30	0.7	0.20	0.20	0.50-1.1	0.10	0.25	. .	Remainder
5052	***0.25***	***0.40***	***0.10***	***0.10***	***2.2-2.8***	***0.15-0.35***	***0.10***	***. .***	***Remainder***
5083	0.40	0.40	0.10	0.40-1.0	4.0-4.9	0.05-0.25	0.25	0.15	Remainder
5086	0.40	0.50	0.10	0.20-0.7	3.5-4.5	0.05-0.25	0.25	0.15	Remainder
6061	0.40-0.8	0.7	0.15-0.40	0.15	0.8-1.2	0.04-0.35	0.25	0.15	Remainder
6063	0.20-0.6	0.35	0.10	0.10	0.45-0.9	0.10	0.10	0.10	Remainder
7075	0.40	0.50	1.2-2.0	0.30	2.1-2.9	0.18-0.28	5.1-6.1	0.20	Remainder

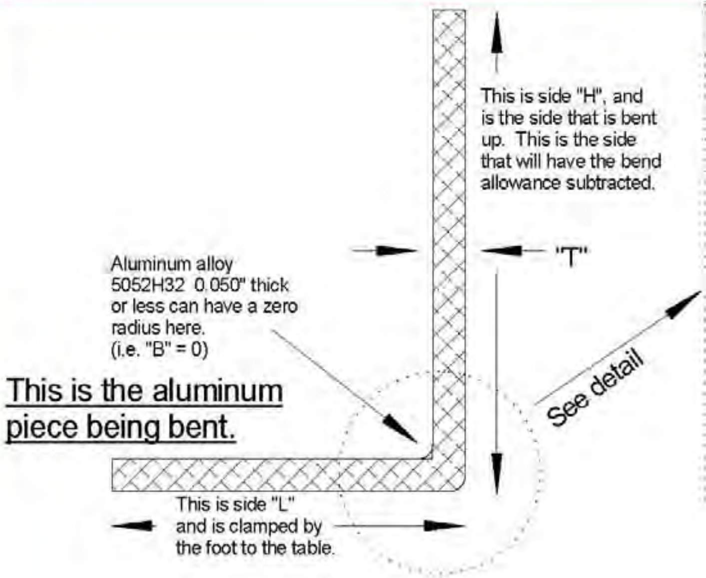
3. The aluminum alloy of choice for this class is 5052-H32 which is 0.050" (50 mils) thick. Here are some comments on this alloy:

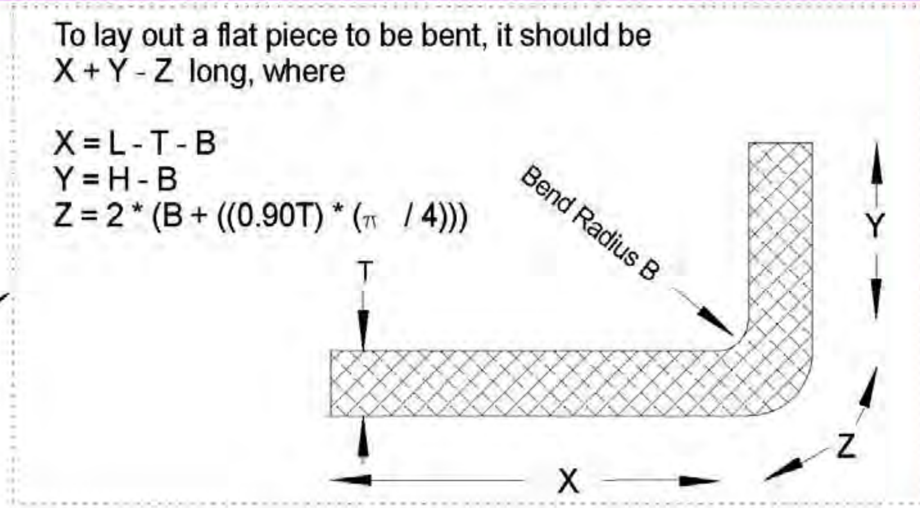
5052-H32 (QQ-A-250/8d)
Main alloy is magnesium. Forms well with reasonable inside bend radii. Corrosion resistance and weldability is very good. Better salt water corrosion resistance than 1100. Used for electronic chassis, tanks, pressure vessels and any number of parts requiring considerable strength and formability at reasonable cost. Anodizing may be slightly yellowish.

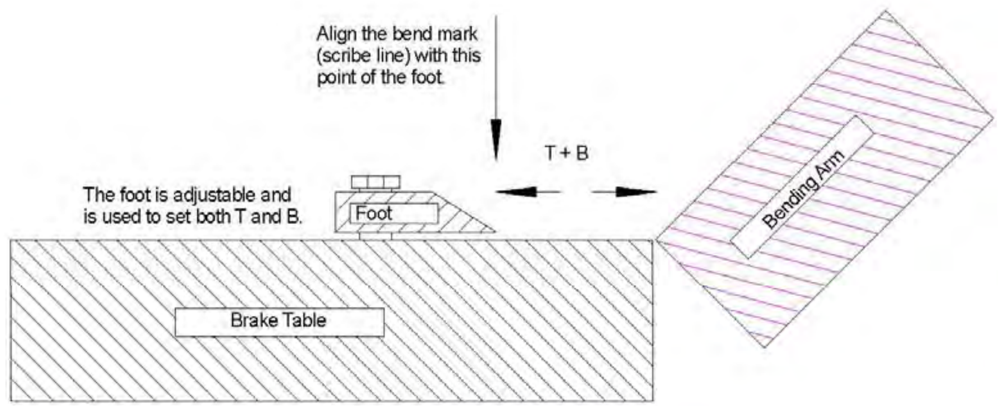
4. Note well that the comment is that this alloy "forms well with reasonable inside bend radii". This is the engineerspeak for "it makes nice tight bends". As a matter of fact, the aircraft bend specification for 5052-H32 is that it will take a zero radius (i.e. no curvature in the bend) for metal up to 0.2" (200 mils) thick. Our process in making aluminum chassis out of 50 mil aluminum will take advantage of this specification for zero-radius bends.

C. Bend Allowance

1. When any metal, including aluminum, is bent, there is a squeezing and stretching phenomenon going on that will "grow" the aluminum longer than the original flat piece that was cut to be bent. We will have to take this growth into account when we make the bends for the power supply chassis. As a matter of fact, as the next two pages show, 50 mil aluminum will grow 0.037" (37 mils) past what you would expect without the growth. Also do not forget that you gain an additional amount of growth because of the thickness of the metal. On a right angle bend, therefore, we will have to allow (50+37) for a growth of 87 mils in our chassis layout.

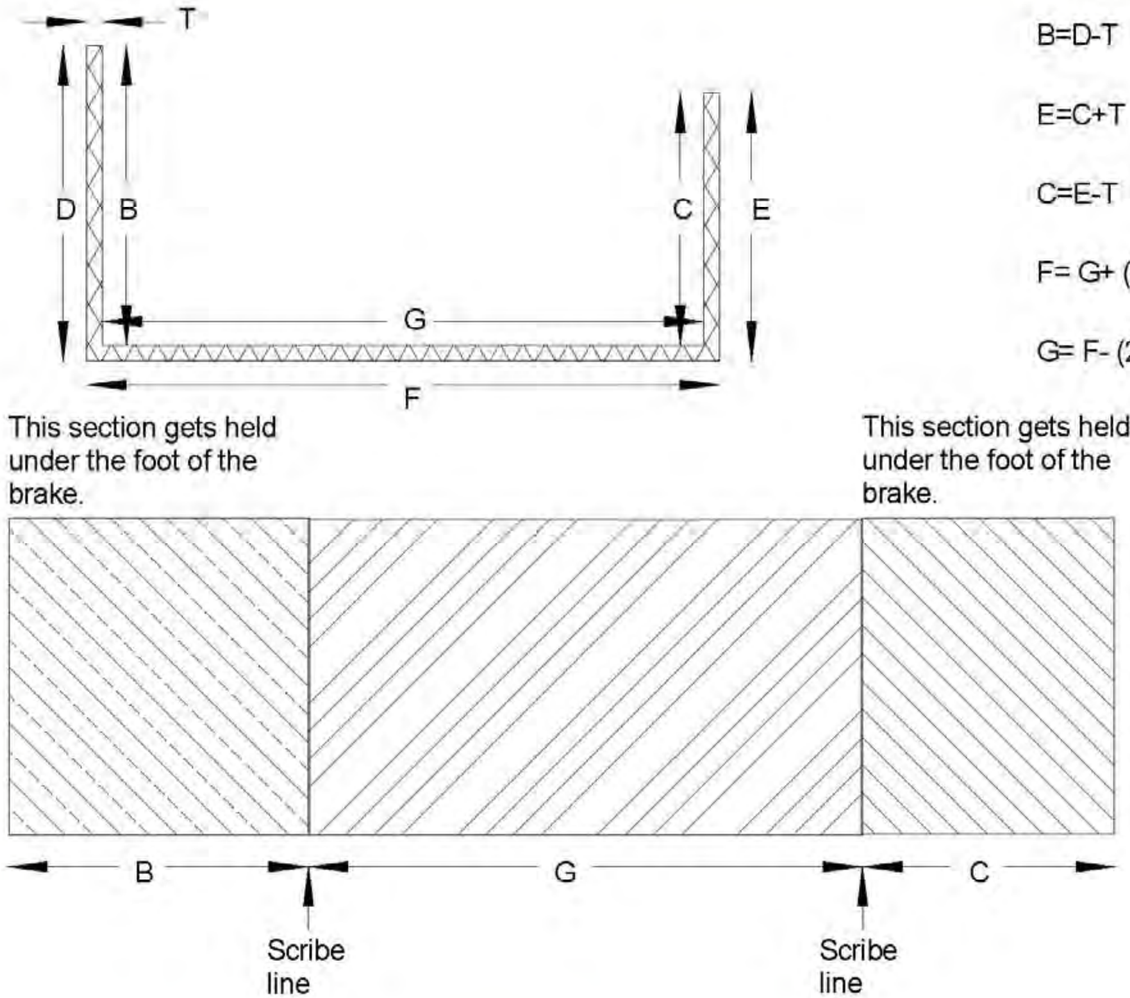






NOTES:
1. All dims in inches.
2. The equation for Z contains a $\pi / 4$ term. This is for a right angle bend. The general form of the term is $\pi / (360 / \theta)$ where θ is the angle of the bend in degrees from horizontal flat plate.

Bending Brake, Bending Radius, and Bend Allowance	Scale: NTS	Drawn by: OWJ	Approved by: Jim Weir	RST Engineering 13993 Downwind Court Grass Valley CA 95945 530.272.2203 tech@rst-engr.com	Drawing # 6622-0620
	Date: 28 Aug 01	Rev: C			Sheet 1 of 1



$D=B+T$

$B=D-T$

$E=C+T$

$C=E-T$

$F= G+ (2*(T*1.7))$

$G= F- (2*(T*1.7))$

Note – the "2" in these equations is because there are 2 bends. If the second bend does not exist, reduce this "2" allowance to 1 allowance.

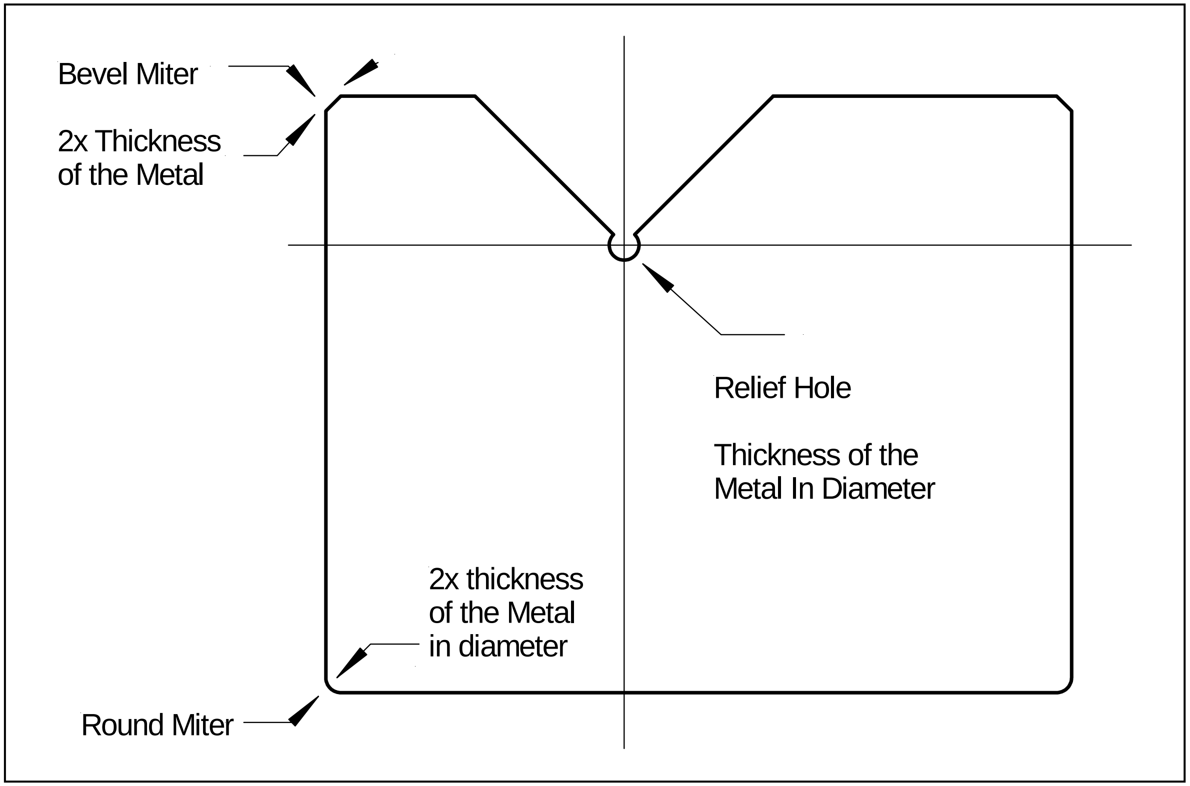
Metal Bending Allowances	Scale: NTS	Drawn by: OWJ	Approved by:	**RST Engineering**	Drawing # 6622-0621
	Date: 28 Aug 01	Rev: C	*Jim Weir*	13993 Downwind Court Grass Valley CA 95945 530.272.2203 tech@rst-engr.com	sheet 1 of 1

C. Mitering and Relief Holes

1. In general, sharp corners and tight box bends are things that we will need to address from a safety and stress relief point of view.

2. Mitering, or the "rounding off" of corners may be done in two general ways. One way is to take a little tiny bit (roughly twice the thickness of the metal wide) 45° cut across the corner ("bevel miter") and the other way is to round the corner with a file or rotary tool. Corners mitered in this manner have much less of a chance of causing damage to skin or finished surfaces than a plain sharp corner.

3. When a piece of metal comes to a sharp inside corner (like a V-notch for a box corner) it sets up stress lines into the metal from that corner. The sharper the corner, the more stress lines are set up. If, however, we have a small hole at that corner, the stress lines are greatly reduced. In general, a hole about the thickness of the metal will reduce the stress lines due to the corner to nearly zero .



D. Finishing

The finishing procedure for aluminum is a two-step process. First, we need to coat the bare aluminum with some sort of protective layer (paint or anodize) and we also need to put some sort of legend or lettering on the panel.

1. Priming and Painting

a. Aluminum does not readily take paint because of the growth of an impervious oxide layer on the surface of the aluminum. In general, it is necessary to PRIME the aluminum surface before proceeding to paint..

b. The very BEST primer for aluminum is zinc chromate. Unfortunately, zinc chromate is somewhat toxic to humans and animals and is generally relegated to commercial uses. It is widely used in the aviation industry and can be purchased without restriction from any aviation parts supply store. There are several dozen aviation mail order stores in the country that will ship small quantities of zinc chromate spray cans. (Note -- ground shipping is no problem; air shipping incurs a significant hazmat fee.)

c. Whichever version of primer you use, be sure to do a warm water and soap rinse of the chassis and rough the surface up just a bit using a green "tuffy" type nylon pot scrubber. Do *NOT* use steel wool on the aluminum surface; you will be years picking the little tiny steel fibers out of the aluminum. Dry the aluminum thoroughly (a toaster oven works well) before painting.

d. Primer should go on thin enough so that you can just barely see the surface of the aluminum below the primer. Do NOT put it on thick.

e. A second, and nearly as good a primer is the "rattle can" automotive primer found in any good home improvement store. For light duty such as that found by a lab bench power supply, spray cans of primer will do quite nicely.

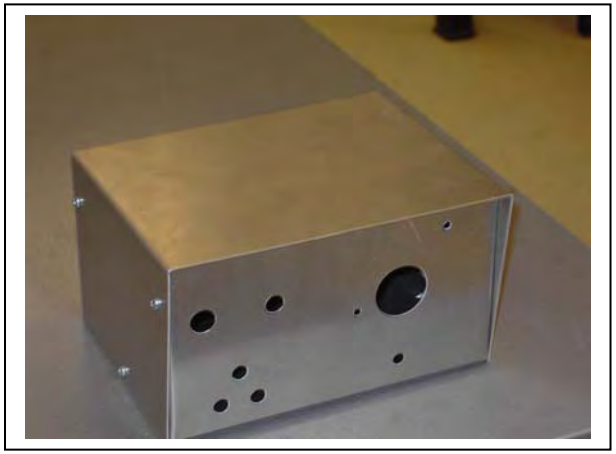
f. When it comes to the final finish, a good spray can of professional quality enamel is hard to beat. Keep the following in mind:

1. The piece to be painted should be at a warm room temperature … not freezing or baking.
2. There should be no hand contact with the aluminum after priming. Use vinyl gloves or use a wire pickup loop through a hole in the chassis for moving the chassis.
3. A few thin coats are better than one thick coat. Let the coats dry thoroughly between application (the legend on the can should give an approximate time between coats).
4. Choosing a color is an art. I personally prefer a light beige for the chassis and either a dark brown or black for the cover. Use satin rather than gloss or flat -- satin hides a multitude of toolmark sins.

2. Anodizing

a. It used to be that anodizing could only be done by the plating shop down in the industrial park. Then somebody posted that they tried doing it at home and it worked…sort of. Then a few more of us started experimenting and we've gotten quite good at it.

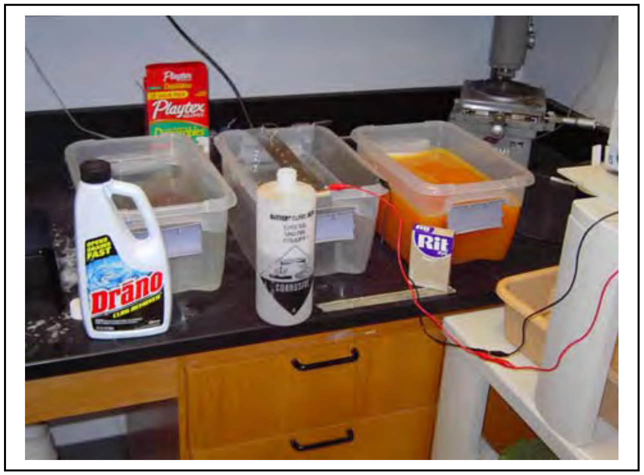
b. **CAUTION. YOU ARE WORKING WITH STRONG CHEMICALS THAT CAN BURN SKIN, CAUSE BLINDNESS, AND IN GENERAL NOT BE PARTICULARLY GOOD FOR YOUR HEALTH.** On the other hand, millions of people work with drain cleaner, battery acid, and fabric dye every day and don't hurt themselves. Just take precautions.



c. What we start out with is the raw aluminum chassis. Do not put ANY other metal into the anodizing baths. In particular, don't forget to take out the steel chassis screws before beginning the process.

d. Here is the process for anodizing and color coating:

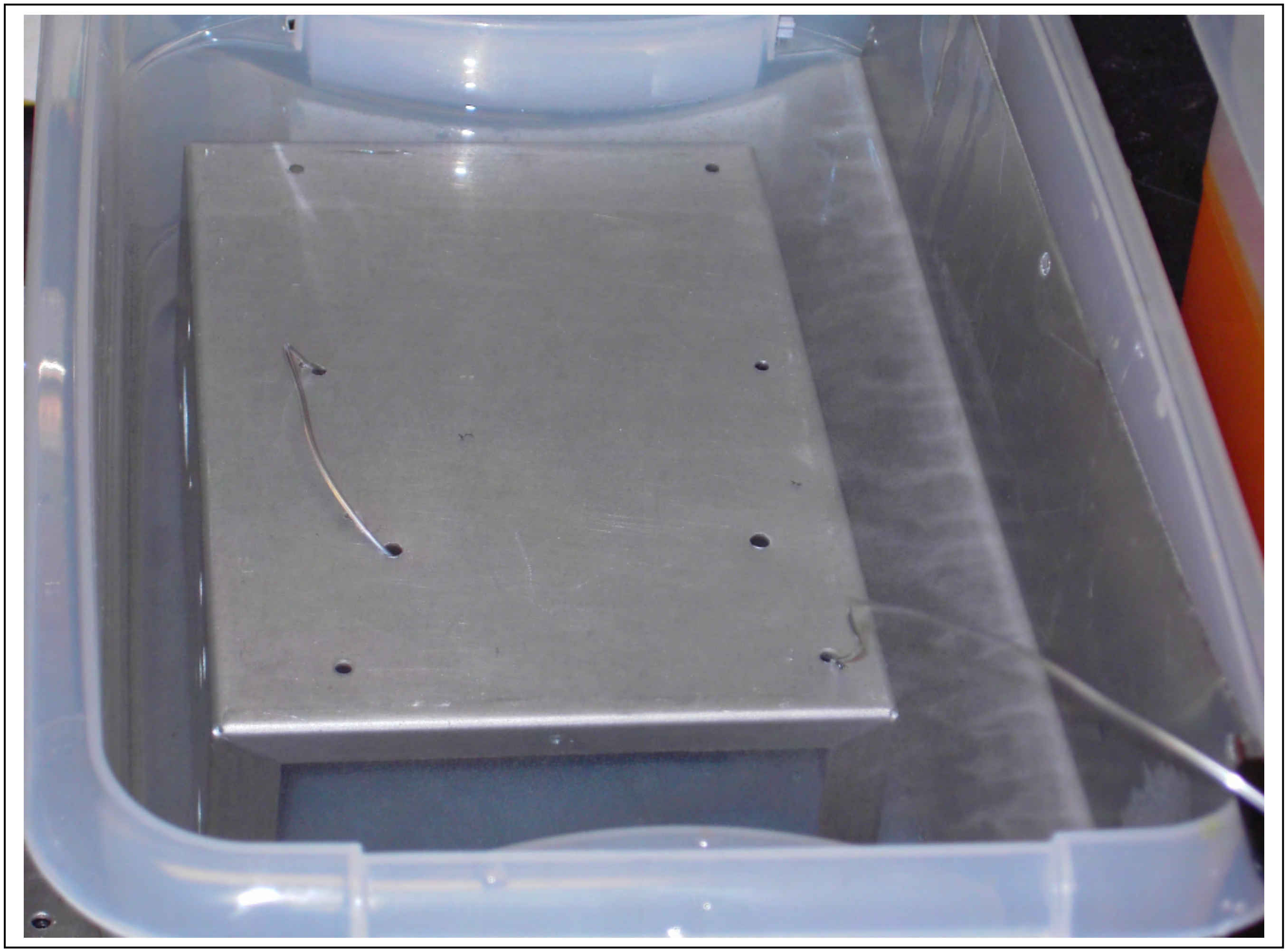
1. The chassis is thoroughly washed with warm soapy water and a green "tuffy" pot scrubbing pad. Any tool marks, nicks, and the like should be polished out with 400 grit sandpaper before washing. Thoroughly rinse the chassis with clear water.



2. The etch bath is drain cleaner ("Drano") mixed somewhere between 4:1 and 8:1 with water (pour Drano into water, not the other way around). I prefer the milder solution but it takes a little longer. The chassis is completely immersed in the drain solution for half an hour to an hour. You may see some slight bubbling, but if the bubbling becomes heavy or apparent, you have too strong or too warm a solution. Rinse well after the etch bath with warm water.

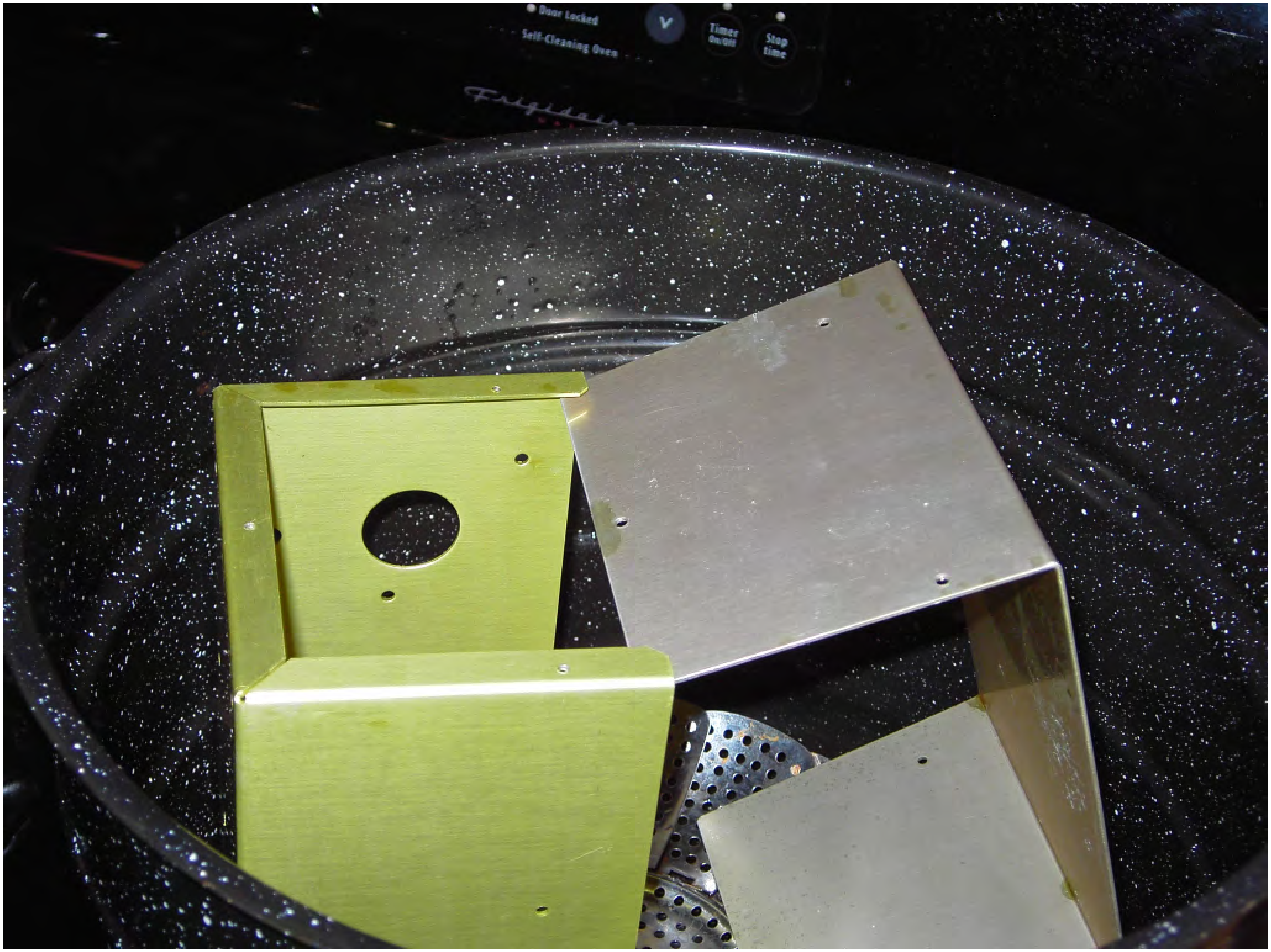
3. The anodize bath is battery acid mixed in the same proportions as the etch bath (first water, then acid). A "cathode" (negative plate) is immersed in the solution along

with the chassis to which has been attached an aluminum wire. (DO NOT USE STEEL OR COPPER WIRE or allow the cathode to touch the chassis.) A power supply is attached to the cathode (-) and chassis (+). The current of the power supply is adjusted so that you have approximately one ampere of current for each square foot of surface area on BOTH sides of the chassis. The cathode will become quite full and "boiling" with bubbles, but the chassis should have relatively few bubbles on the surface. If you are using thin aluminum wire, be prepared to change it several times during the anodizing process. The anodizing process itself should take between half an hour to an hour, depending on how thick you want the anodize layer. Note in this photo the aluminum contact wire serpentining through holes on the bottom and lots of bubbles coming from the cathode plate in the right side of the tray.

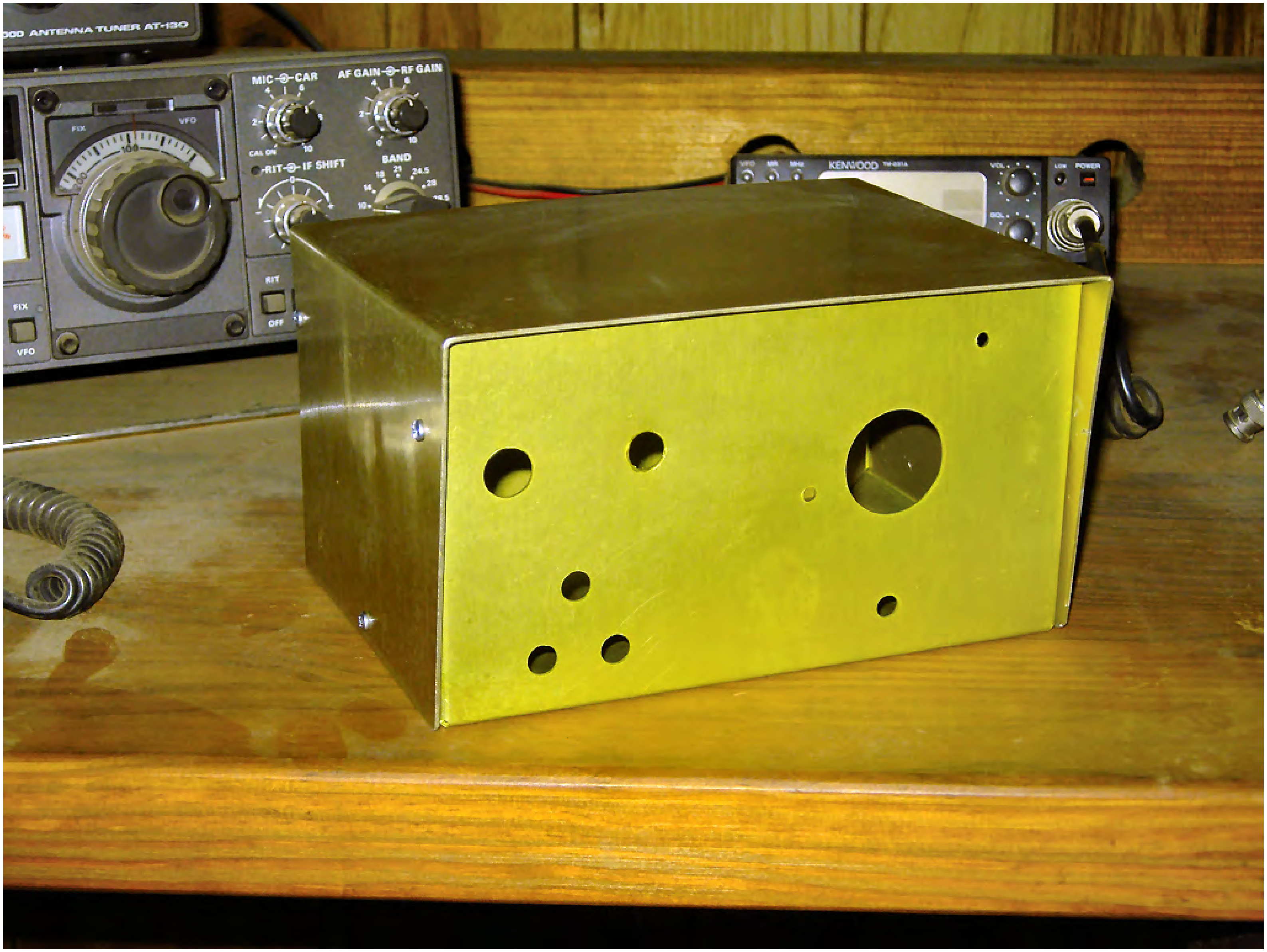


4. After the anodize bath, and rather quickly, rinse well with warm water and immerse the chassis in the fabric dye bath. For light colors, two packages of dye per gallon works well; it may take double or triple of the dye plus some heating of the solution for darker colors. Again, depending on the depth of the color, it will take between half an hour to an hour in the dye bath.

5. After the dye bath, to completely harden the surface (it actually turns the surface into aluminim hydrate), steam the chassis and other parts that you have anodized for an hour in a vegetable steamer.



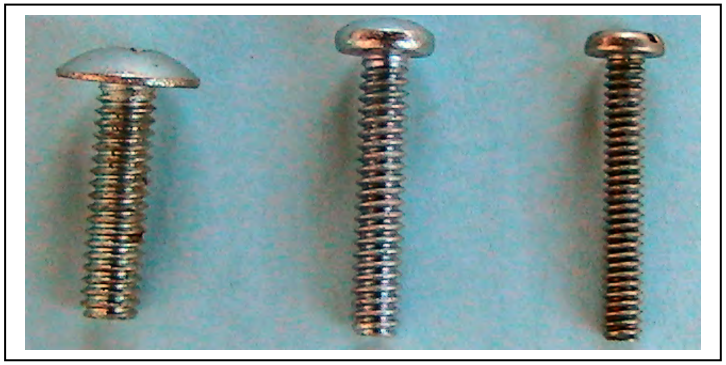
6. Here is the finished product:



3. Lettering & Legend

1. (tbd)

E. Hardware & Fasteners

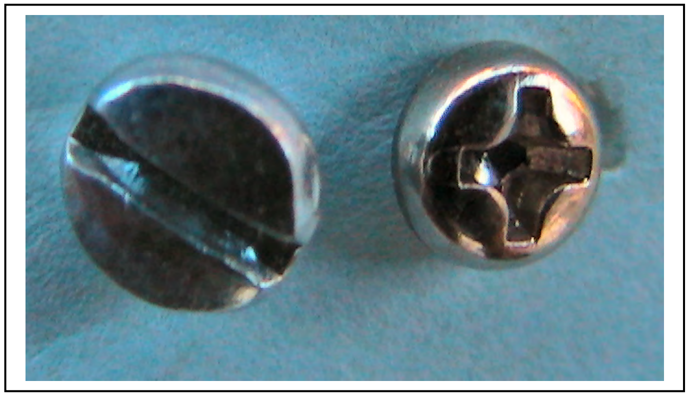


1. When joining two pieces of metal together, there are a wide range of fasteners used. Here are the most common in the electronics industry.

2. By far and away, the most common are machine screws. Machine screws come in sizes from tiny (holding a wristwatch together) to huge (holding a spacecraft together). Rarely in electronics do we go outside the range (right to left) of #4, #6, or #8.

   Note that a machine screw has a constant and uniform thread from top to bottom.

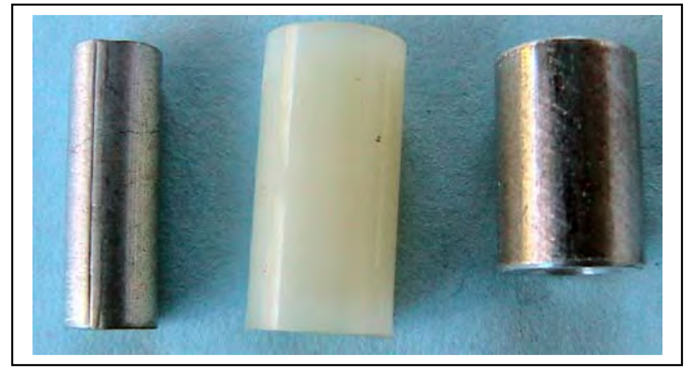
3. To fasten that screw down we need a little more hardware. Here we see (left to right) a flatwasher, an internal tooth lockwasher, and a machine nut. The flatwasher is only necessary if you are absolutely sure that the metal surface that you are fastening down on is flat, otherwise the lockwasher is useless.



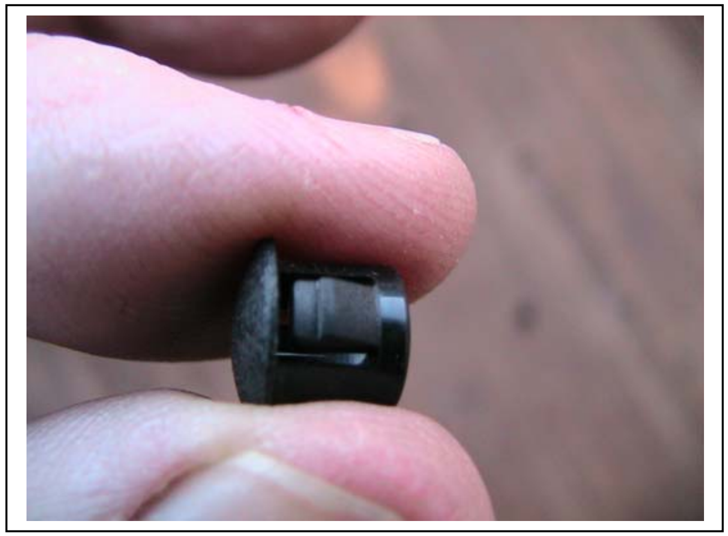
4. The screws can have several types of heads on them. Some of the most common (left to right) are the flathead, the pan or binder head, and the brazier head. Note that the pan and brazier only need a through-hole for mounting, but the flathead needs a countersink in the hole also so that it will lie flush with the top of the metal.

5. The screws can also have several styles of drive. On the left is the slot type of drive and on the right is the so-called crosspoint commonly called a phillips head.

6. Where components will be mounted at some distance above the chassis, we can use spacers to put some clearance between the component and the chassis. From left to right we have the relatively inexpensive rolled aluminum spacer, a nylon insulating spacer, and a solid aluminum spacer (least to most expensive).



7. Where we want to feed wires through a hole in the chassis we can use a rigid plastic or flexible vinyl (shown here) grommet. A grommet simply puts an insulating layer between the sharp edge of a chassis and the relatively soft insulation of a wire.



8. Now we come to what I consider one of the greatest inventions of all time. This little plug goes by several names. The formal name is "hole plug" but in the real world it is more likely to be called a "botch button" or a "butch plug". Its sole function in life is to conceal the fact that you drilled or punched a hole where it should not have gone and you don't want to have to remake the chassis. When asked what it is for, you simply smile and say that you were making provisions for additional peripherals to be attached to your product at some future point in time. No need to spill the beans that you botched up the drawing.

   Speaking of botching up the drawing, I want you all to be aware that all of us, newcomers to old timers, all of us work to a single MIL-SPEC when making prototypes. That specification is MIL-TDD-41 (Make It Like The Damned Drawing For Once).

F. Paper Dolls

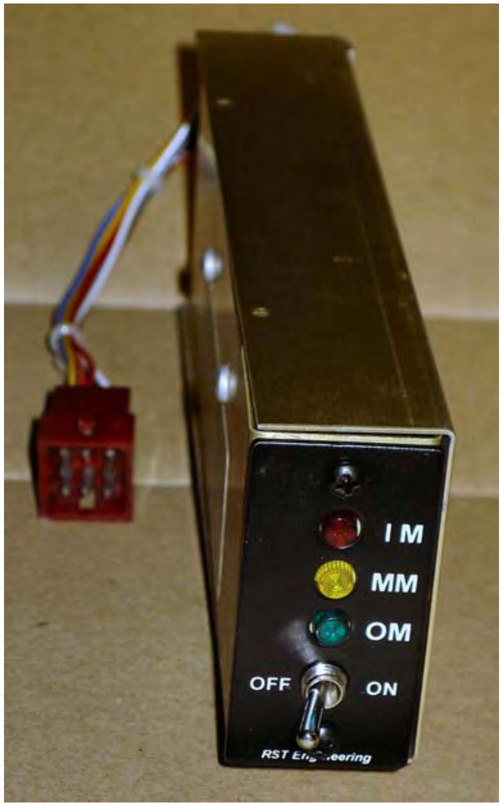
1. Before beginning the prototype construction of any project and committing the design to bent up metal, a cardboard cutout of the design, with all the parts simulated in cardboard, is a good way to "proof" the design.

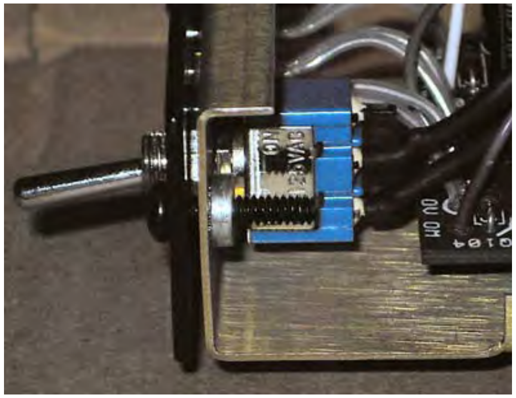
2. "Cardboard" as used in this sense means any stiff paper. The most common "stiff paper" found around the average shop or office is a manila file folder. These file folders come in letter size for small projects and legal size for slightly larger projects, and they are cheap.

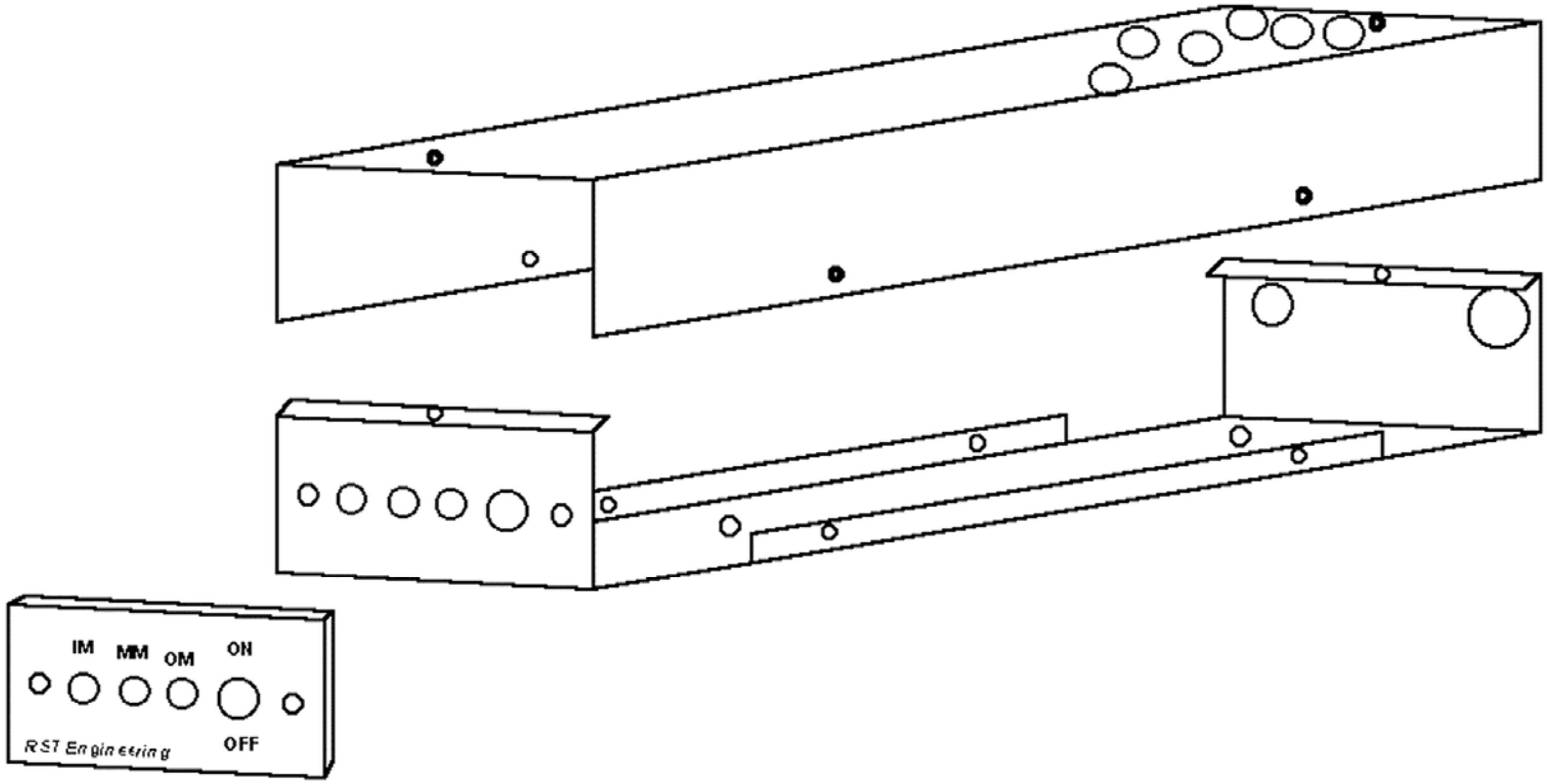
3. The next pages contain a 3-d drawing and a full size print of a paper doll for a small navigation receiver. This navigation receiver is made up of a chassis bottom, chassis cover, faceplate, pc board, and small mechanical components. It is VITALLY IMPORTANT to make paper dolls of all the parts so that (for example) the front panel switch doesn't hit the PC board when the unit is assembled.

4. It is certainly possible rather than making paper dolls for ALL the components to use the components themselves if the structure will support the components. For example, we made a paper doll for the PC board in this receiver, but we used an actual switch to see if there was clearance. (There was NOT enough clearance in the original design; we had to move the PC board back a couple of hundred mils to clear the switch terminals.)

5. Here are photographs of an assembled receiver. Notice how close the switch terminals (blue switch) are to the (black) PC board.

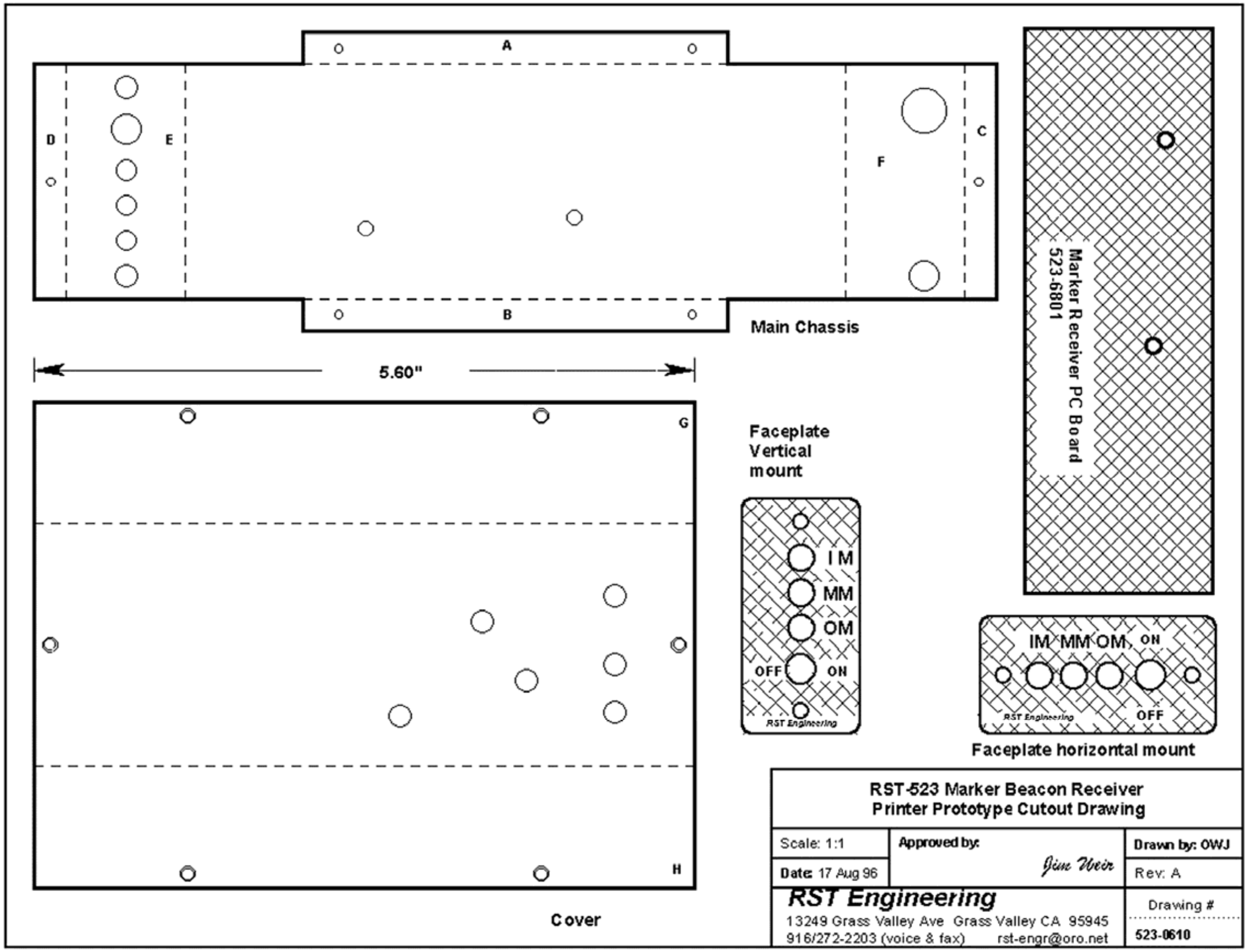




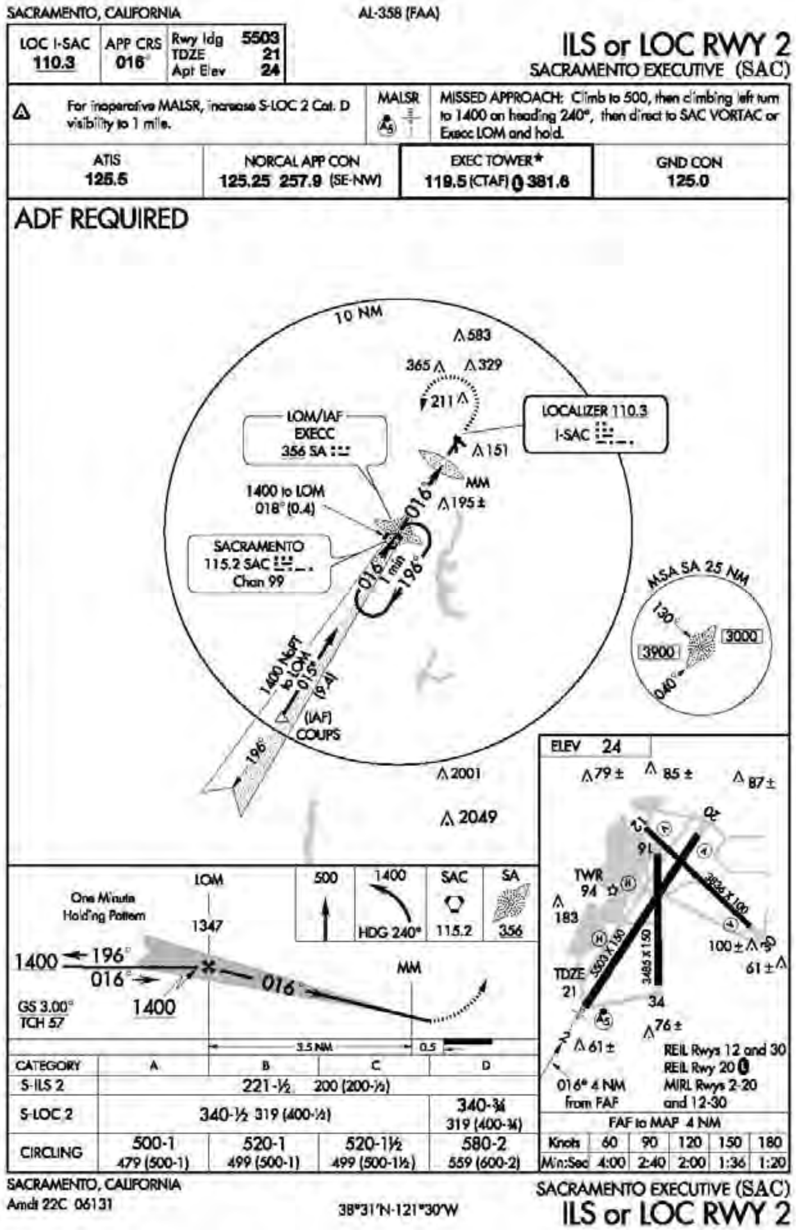


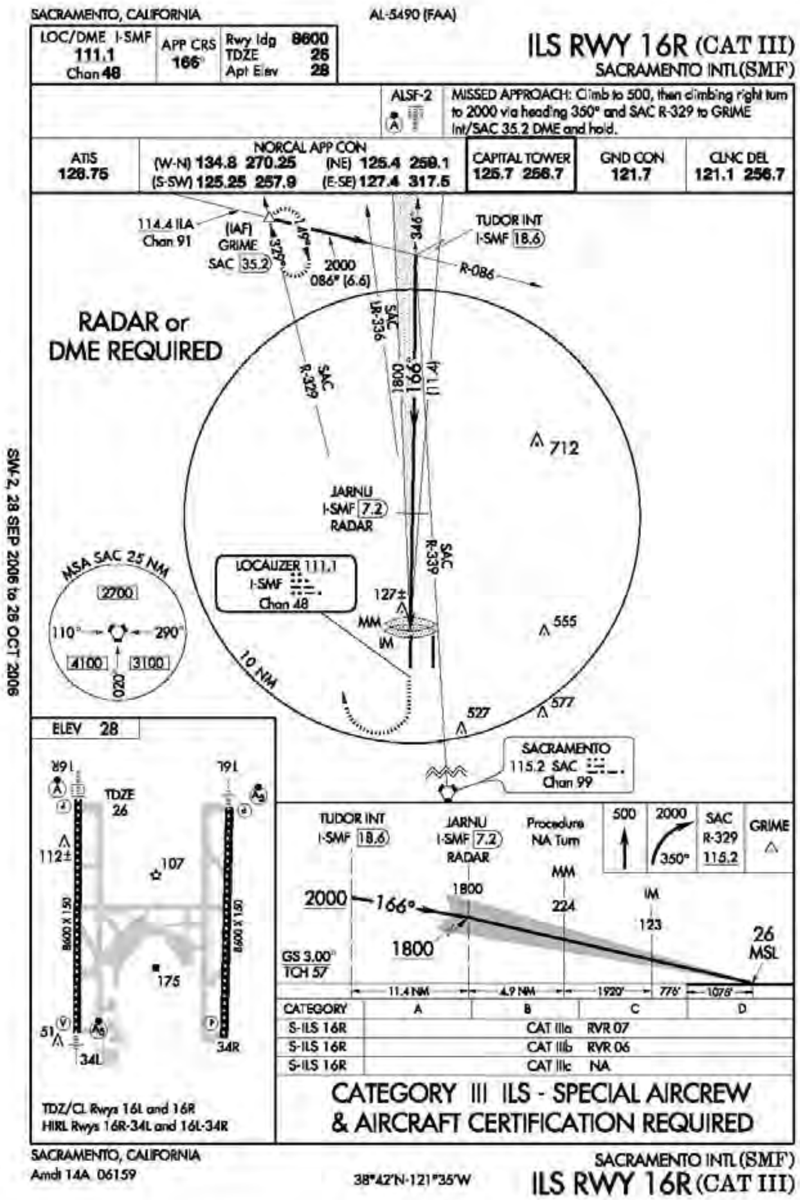
RST-523 3-d Conceptual Views

Scale: NTS	Approved by:	Drawn by: OWJ
Date: 15 Aug 96	Jim Weir	Rev: A
RST Engineering 13249 Grass Valley Ave Grass Valley CA 95945 916/272-2203 (voice & fax) rst-engr@oro.net		Drawing # 523-0600



6. Note on the drawing 523-0610 that there is a single dimension of 5.60" for the length of the top cover. This is given so that if you have been given a drawing that is not an original copy of the drawing that you can check to see if there has been some sort of printing distortion (bigger or smaller) and that if you use the drawing as-is that there will be size differences between the real part and your paper doll.


SACRAMENTO, CALIFORNIA
AL-358 (FAA)
LOC I-SAC 110.3
APP CRS 016°
Rwy ldg 5503
TDZE 21
Apt Elev 24
ILS or LOC RWY 2
SACRAMENTO EXECUTIVE (SAC)
For inoperative MALSR, increase S-LOC 2 Cat. D visibility to 1 mile.
MALSR
MISSED APPROACH: Climb to 500, then climbing left turn to 1400 on heading 240°, then direct to SAC VORTAC or Execc LOM and hold.
ATIS 125.5
NORCAL APP CON 125.25 257.9 (SE-NW)
EXEC TOWER★ 119.5 (CTAF) 381.6
GND CON 125.0
ADF REQUIRED
10 NM
LOM/IAF EXECC 356 SA
LOCALIZER 110.3 I-SAC
1400 to LOM 018° (0.4)
SACRAMENTO 115.2 SAC Chan 99
MSA SA 25 NM
1400 NoPT to LOM 015° (6.4)
(IAF) COUPS
ELEV 24
One Minute Holding Pattern
LOM
MM
HDG 240°
115.2
356
GS 3.00°
TCH 57
CATEGORY A B C D
S-ILS 2 221-½ 200 (200-½)
S-LOC 2 340-½ 319 (400-½) 340-¾ 319 (400-¾)
CIRCLING 500-1 479 (500-1) 520-1 499 (500-1) 520-1½ 499 (500-1½) 580-2 559 (600-2)
REIL Rwys 12 and 30
REIL Rwy 20
MIRL Rwys 2-20 and 12-30
016° 4 NM from FAF
FAF to MAP 4 NM
Knots 60 90 120 150 180
Min:Sec 4:00 2:40 2:00 1:36 1:20
SACRAMENTO, CALIFORNIA
Amdt 22C 06131
38°31'N-121°30'W
SACRAMENTO EXECUTIVE (SAC)
ILS or LOC RWY 2
SW-2, 28 SEP 2006 to 26 OCT 2006


SACRAMENTO, CALIFORNIA
AL-5490 (FAA)
LOC/DME I-SMF 111.1 Chan 48
APP CRS 166°
Rwy ldg 8600
TDZE 26
Apt Elev 28
ILS RWY 16R (CAT III)
SACRAMENTO INTL (SMF)
ALSF-2
MISSED APPROACH: Climb to 500, then climbing right turn to 2000 via heading 350° and SAC R-329 to GRIME Int/SAC 35.2 DME and hold.
ATIS 126.75
NORCAL APP CON (W-N) 134.8 270.25 (NE) 125.4 259.1 (S-SW) 125.25 257.9 (E-SE) 127.4 317.5
CAPITAL TOWER 125.7 256.7
GND CON 121.7
CLNC DEL 121.1 256.7
RADAR or DME REQUIRED
TUDOR INT I-SMF 18.6
(IAF) GRIME SAC 35.2
JARNU I-SMF 7.2 RADAR
LOCALIZER 111.1 I-SMF Chan 48
MSA SAC 25 NM
SACRAMENTO 115.2 SAC Chan 99
ELEV 28
TDZE 26
GS 3.00°
TCH 57
CATEGORY A B C D
S-ILS 16R CAT IIIa RVR 07
S-ILS 16R CAT IIIb RVR 06
S-ILS 16R CAT IIIc NA
CATEGORY III ILS - SPECIAL AIRCREW & AIRCRAFT CERTIFICATION REQUIRED
TDZ/CL Rwys 16L and 16R
HIRL Rwys 16R-34L and 16L-34R
SACRAMENTO, CALIFORNIA
Amdt 14A 06159
38°42'N-121°35'W
SACRAMENTO INTL (SMF)
ILS RWY 16R (CAT III)
SW-2, 28 SEP 2006 to 26 OCT 2006

G. Power Supply Chassis Design & Fabrication

1. In the design of any product, one of the primary things to take into account is how the product is going to be used. In the particular instance of the power supply, the end product is intended to be used as a laboratory utility bench power supply, not intended for rough-and-tumble use outside, nor for high-precision work inside.

2. For lab instruments, we generally try and:

    a. Put large heavy components on the bottom for mechanical stability

    b. Put some sort of shield over expensive delicate components.

    c. Since 90% of the world is right-handed, put the most used controls as far to the RIGHT as possible and indicators or lesser used controls on the LEFT side of the chassis front.

    d. Almost-never-used controls and parts on the rear of the chassis.

3. Let's see if we can achieve these design goals with our power supply:

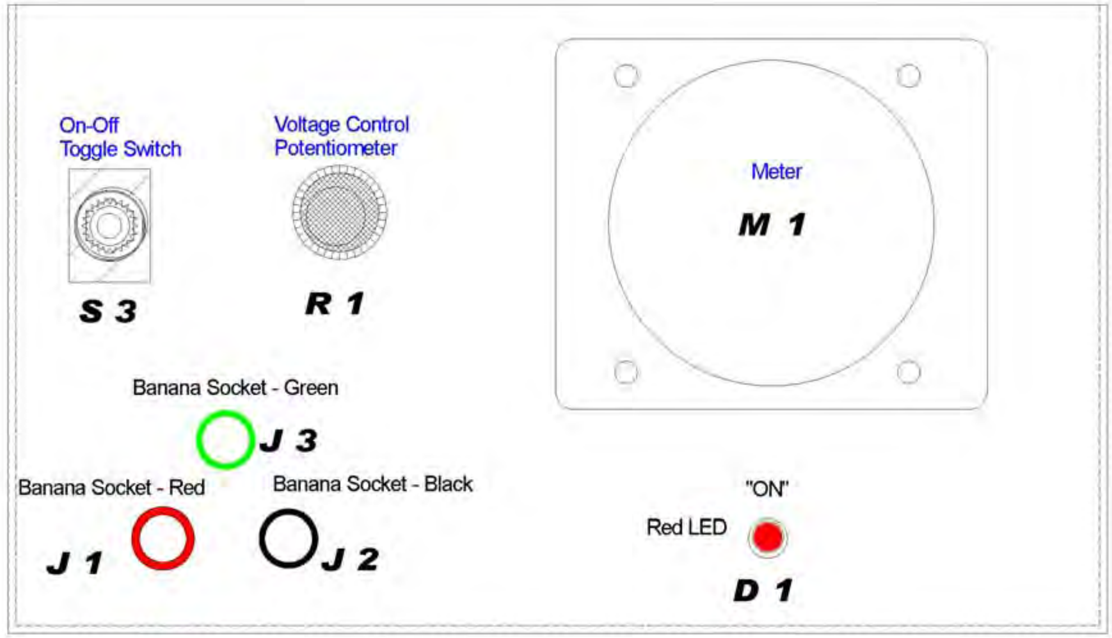
    a. The transformer is the heaviest component in the power supply and the PC board with all its components is second heaviest. Mount them both on the chassis bottom.

    b. Make a U-shaped chassis with lips for mounting screws and an "eyebrow" cover so that if the power supply gets tipped over, the eyebrow will keep the expensive delicate meter from being trashed.

    c. Put the on-off switch to the far left, the voltage control near the middle and the voltage-current meter switch on the far right. Mount the meter on the far right in the "corner" of the eyebrow to achieve maximum protection.

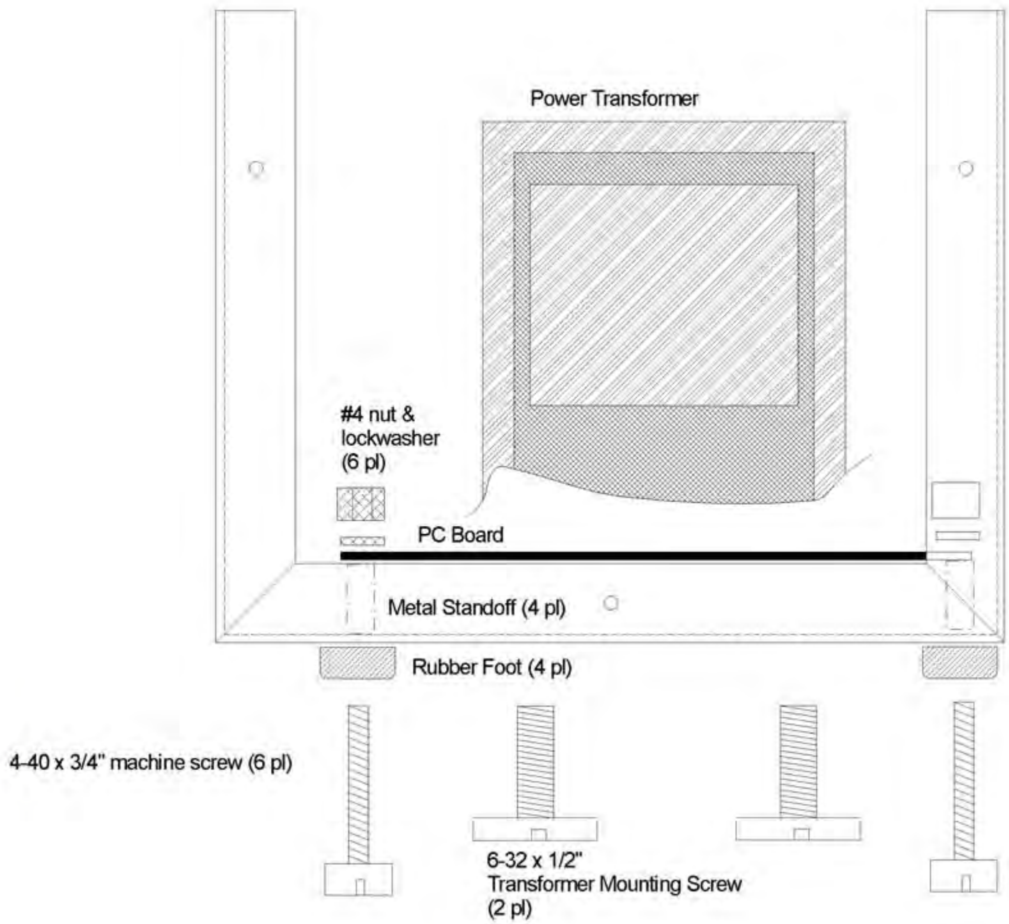
    d. Mount the power cord and fuse on the back of the chassis.

4. The drawings on the following pages are illustrations of how such a supply might be fabricated. Please feel free to choose another form factor (mechanical design) for your supply if you wish.



Assembly Drawing

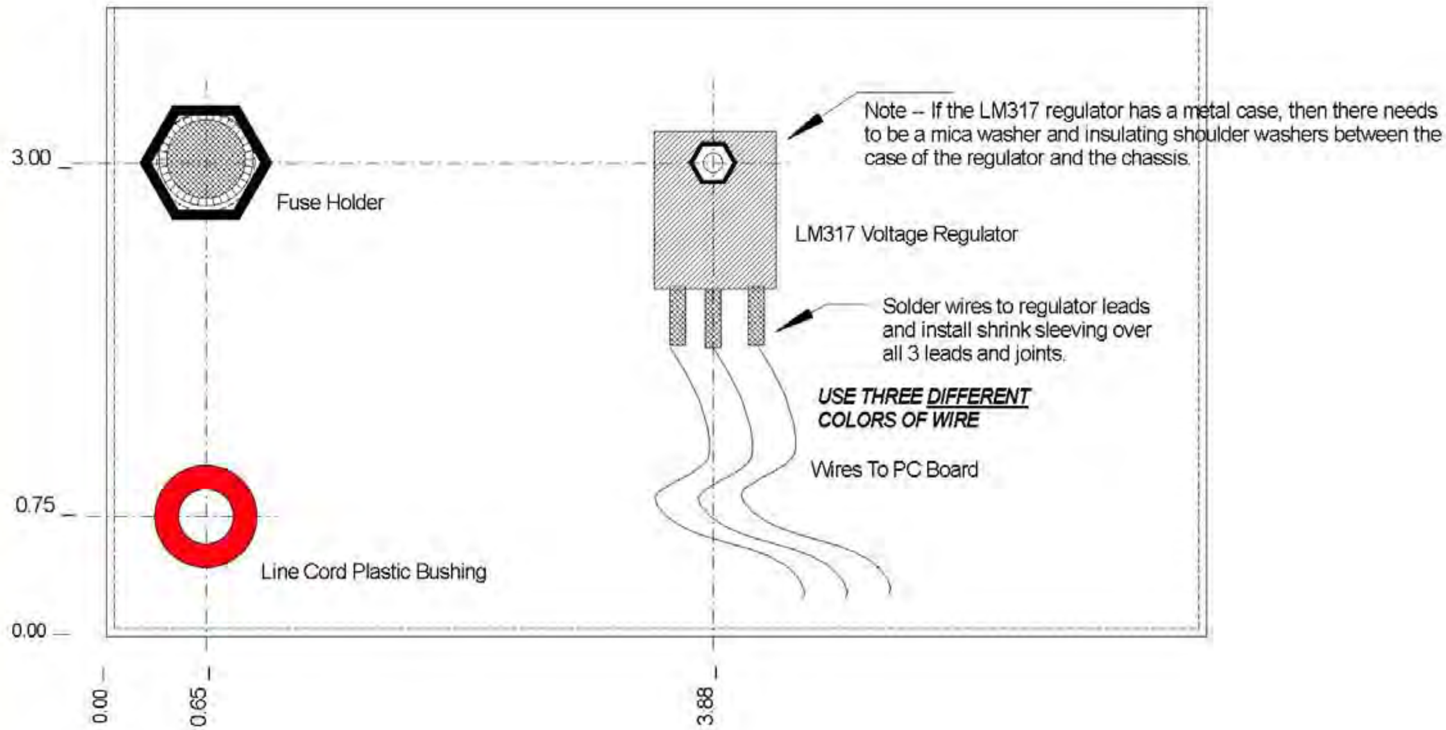
Power Supply Main Chassis	Scale: 1:1	Drawn by: OWJ	Approved by:	**RST Engineering**	Drawing # 6622-4200
	Date: 26 Oct '17	Rev: F	*Jim Weir*	13249 Grass Valley Ave Grass Valley CA 95945 530.272.2203 tech@rst-engr.com	Sheet 1 of 4



Assembly Drawing

Right Side View

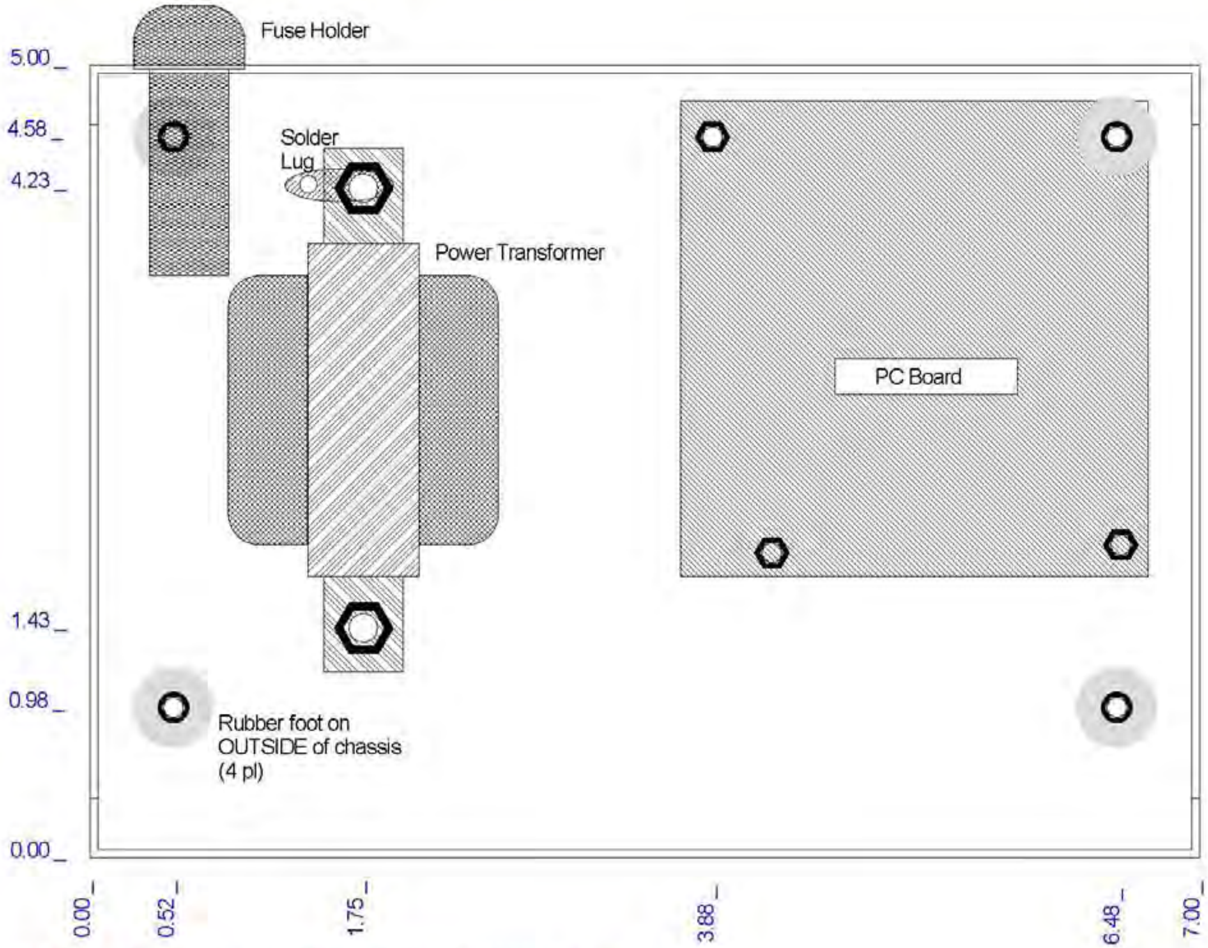
Power Supply Main Chassis	Scale: 1:1	Drawn by: OWJ	Approved by:	RST Engineering	Drawing # 6622-4200
	Date: 20 Nov 01	Rev: B	Jim Weir	13249 Grass Valley Ave Grass Valley CA 95945 916.272.2203 tech@rst-engr.com	Sheet 2 of 4



Assembly Drawing

Back Seen Through Front

Power Supply Main Chassis	Scale: 1:1	Drawn by: OWJ	Approved by:	**RST Engineering**	Drawing # 6622-4200
	Date: 30 Aug 04	Rev: D	Jim Weir	13249 Grass Valley Ave Grass Valley CA 95945 530.272.2203 tech@rst-engr.com	Sheet 3 of 4



Note: Use shrink sleeving on both white and black power cord wires to the **MAXIMUM** extent possible. Do not expose **ANY** metal objects to which white or black wires are connected.

Assembly Drawing Bottom View

Power Supply Main Chassis	Scale: 1:1	Drawn by: OWJ	Approved by:	***RST Engineering***	Drawing # 6622-4200
	Date: 11 Oct '18	Rev: E	Jim Weir	13249 Grass Valley Ave Grass Valley CA 95945 530.272.2203 tech@rst-engr.com	Sheet 4 of 4

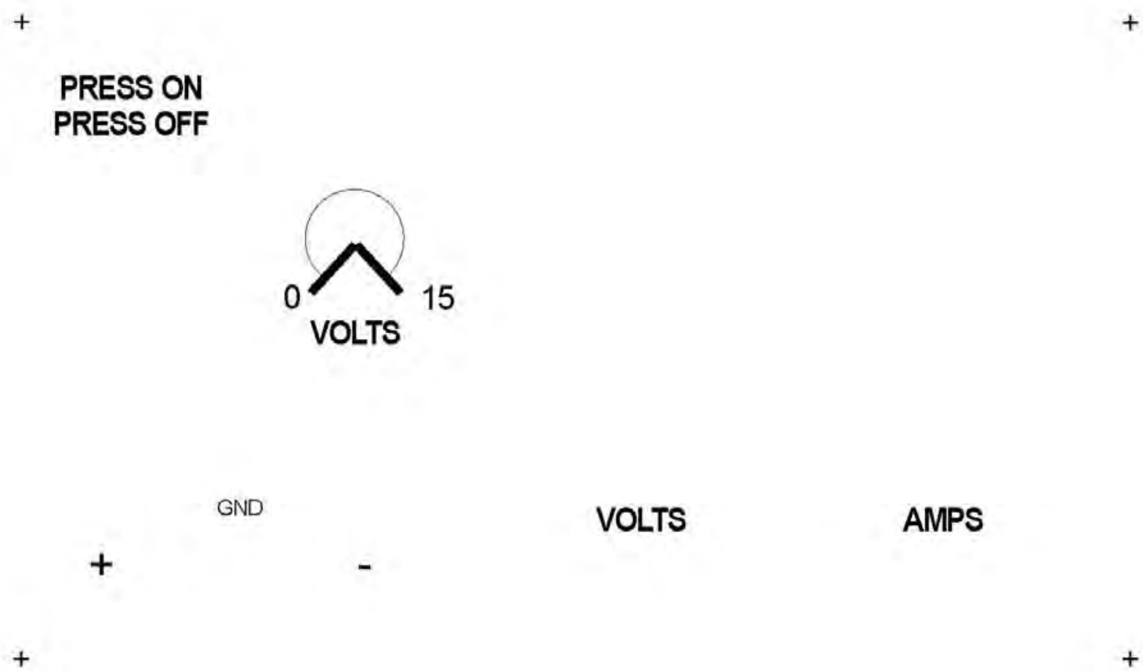
Lab Regulated Power Supply
0-15 volts DC @ 1.5 amperes

Fuse
Type 3AG
0.25 amp
Slo-Blo

CIE-14 Fall '07
27 August 2007 jw

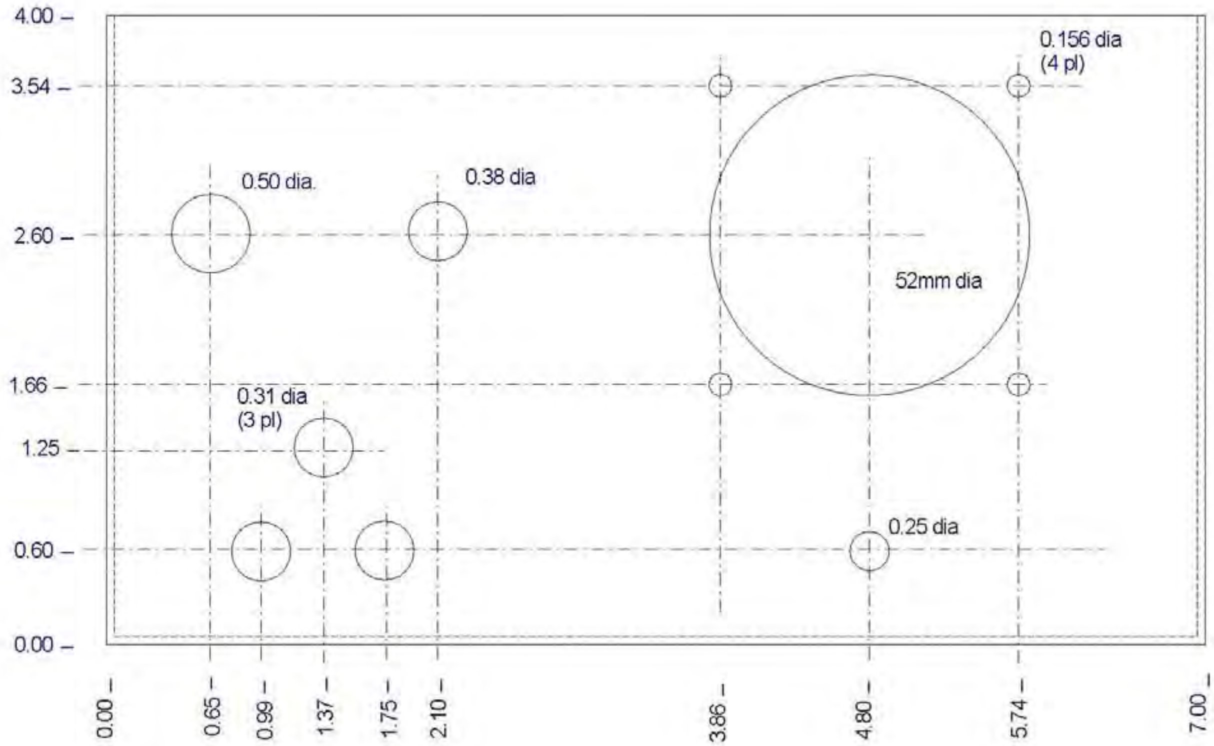
110 VAC
60 Hz
15 w
1 ph

Power Supply Rear Panel Screen	Scale: 1:1	Drawn by: OWJ	Approved by:	**RST Engineering** 13249 Grass Valley Ave Grass Valley CA 95945 916.272.2203 tech@rst-engr.com	Drawing # 6622-1200 Sheet 1 of 1
	Date: 27 Aug 07	Rev: B	Jim Weir		



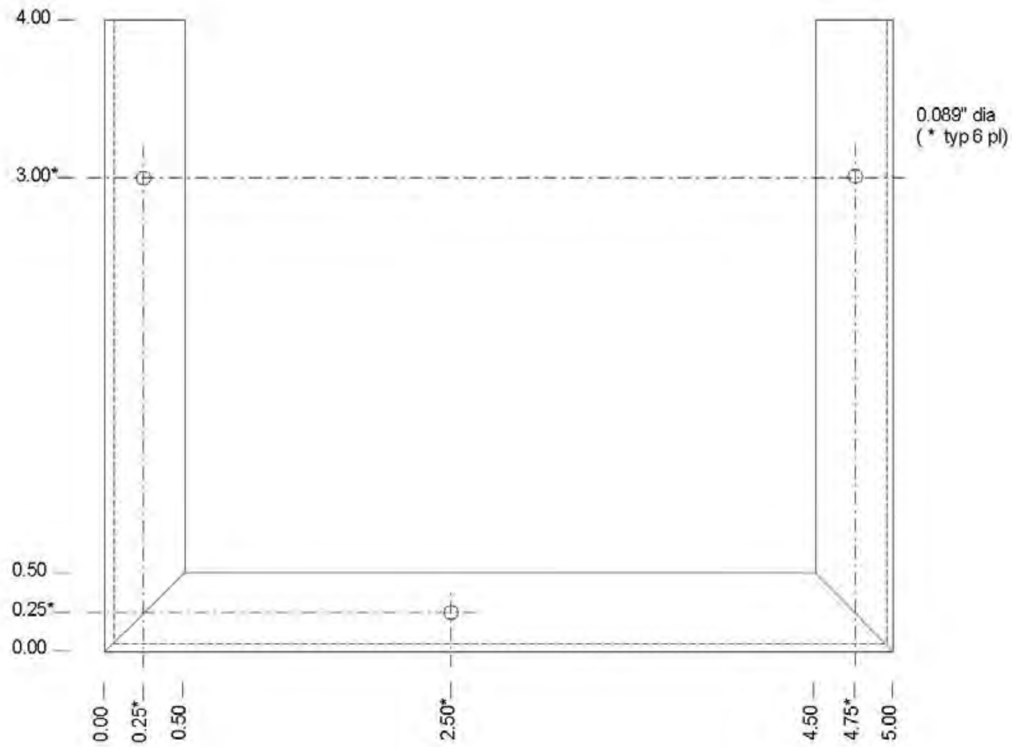
FRONT PANEL SCREEN

Power Supply Main Chassis	Scale: 1:1	Drawn by: OWJ	Approved by:	**RST Engineering** 13249 Grass Valley Ave Grass Valley CA 95945 530.272.2203 tech@rst-engr.com	Drawing # 6622-1201 Sheet 1 of 1
	Date: 27 Aug 07	Rev: A	*Jim Weir*		



Front View

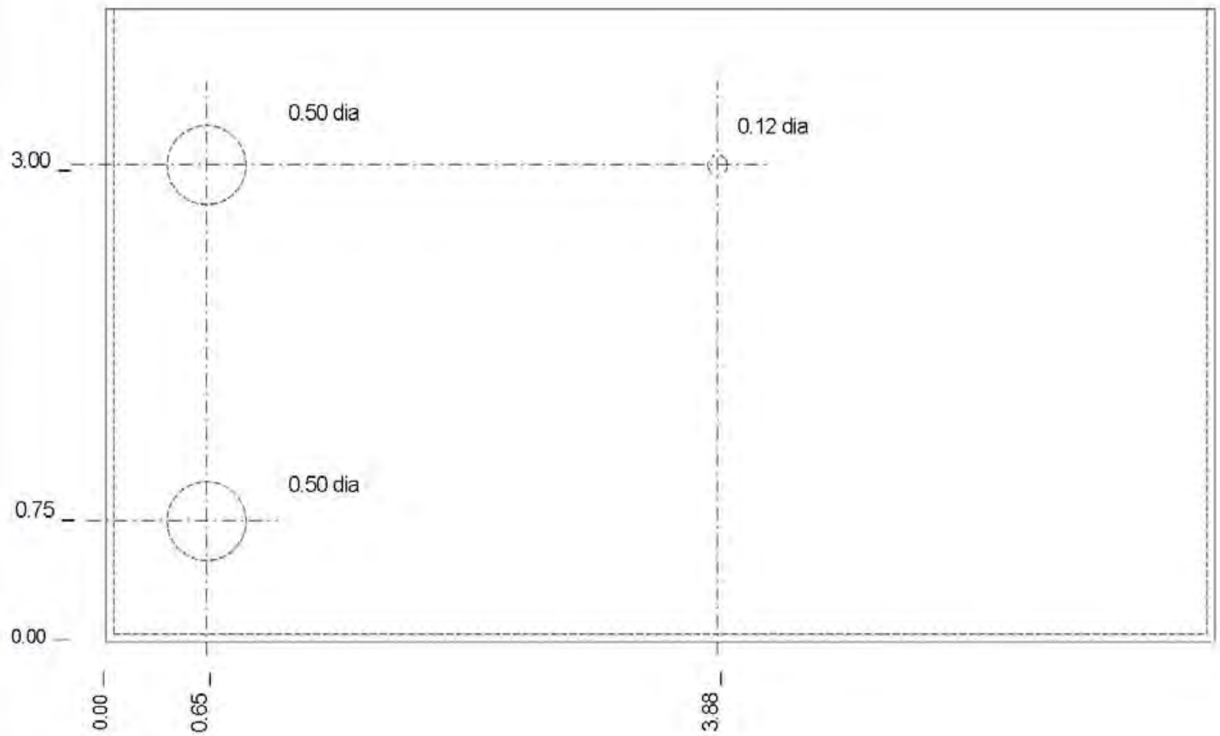
Power Supply Main Chassis	Scale: 1:1	Drawn by: OWJ	Approved by:	RST Engineering	Drawing # 6622-2200
	Date: 26 Oct 17	Rev: K	Jim Weir	13249 Grass Valley Ave Grass Valley CA 95945 530.272.2203 tech@rst-engr.com	Sheet 1 of 6



NOTE: Hole dimensions marked with an asterisk (*) will be drilled using the cover as a template.

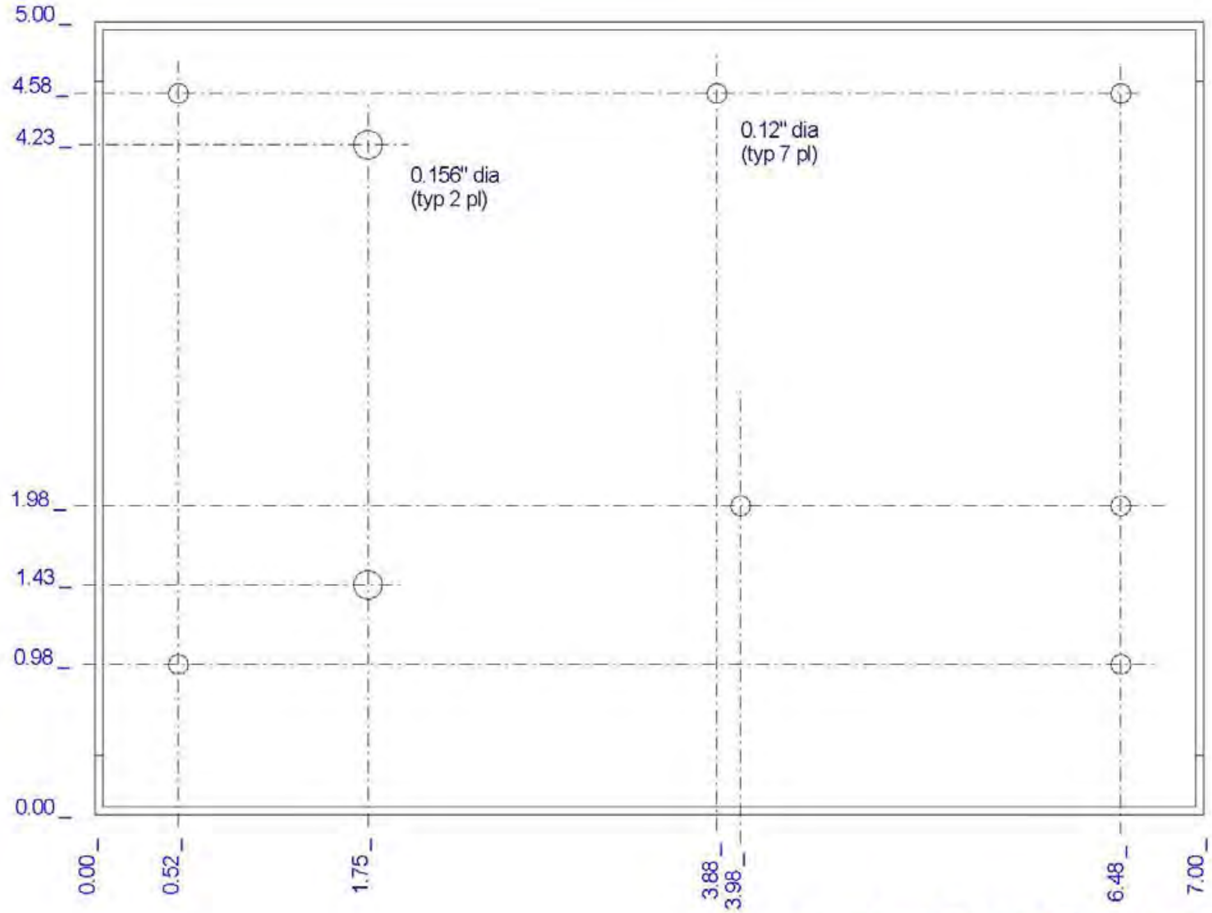
Right Side View

Power Supply Main Chassis	Scale: 1:1	Drawn by: OWJ	Approved by:	**RST Engineering**	Drawing #
	Date: 08 Oct 08	Rev: C	Jim Weir	13249 Grass Valley Ave Grass Valley CA 95945 916.272.2203 tech@rst-engr.com	6622-2200 Sheet 2 of 6



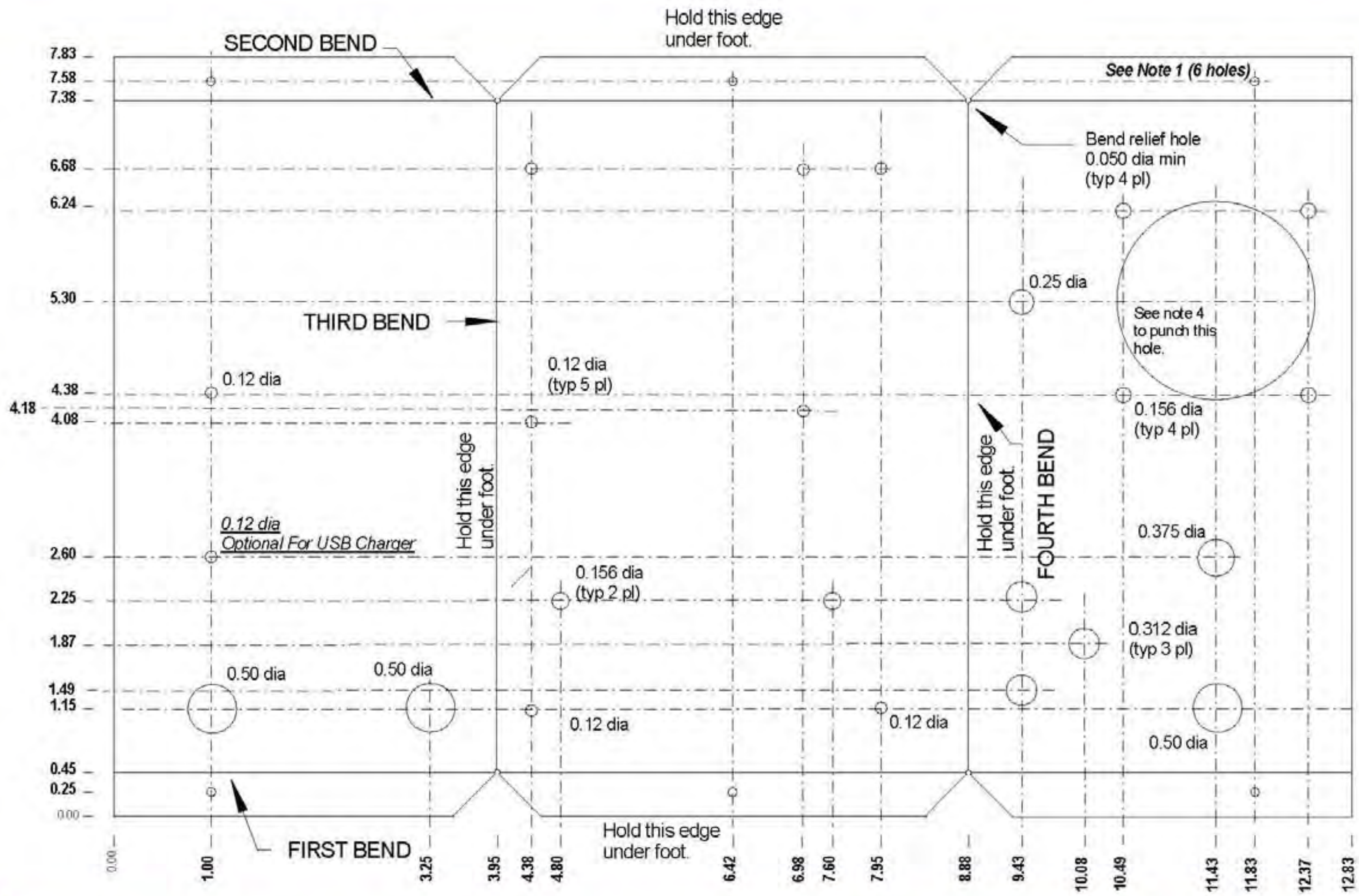
Power Supply Main Chassis
Back Seen Through Front

Power Supply Main Chassis	Scale: 1:1	Drawn by: OWJ	Approved by:	**RST Engineering**	Drawing #
	Date: 08 Oct 08	Rev: D	Jim Weir	13249 Grass Valley Ave Grass Valley CA 95945 530.272.2203 tech@rst-engr.com	6622-2200 Sheet 3 of 6



Bottom Seen Through Top View

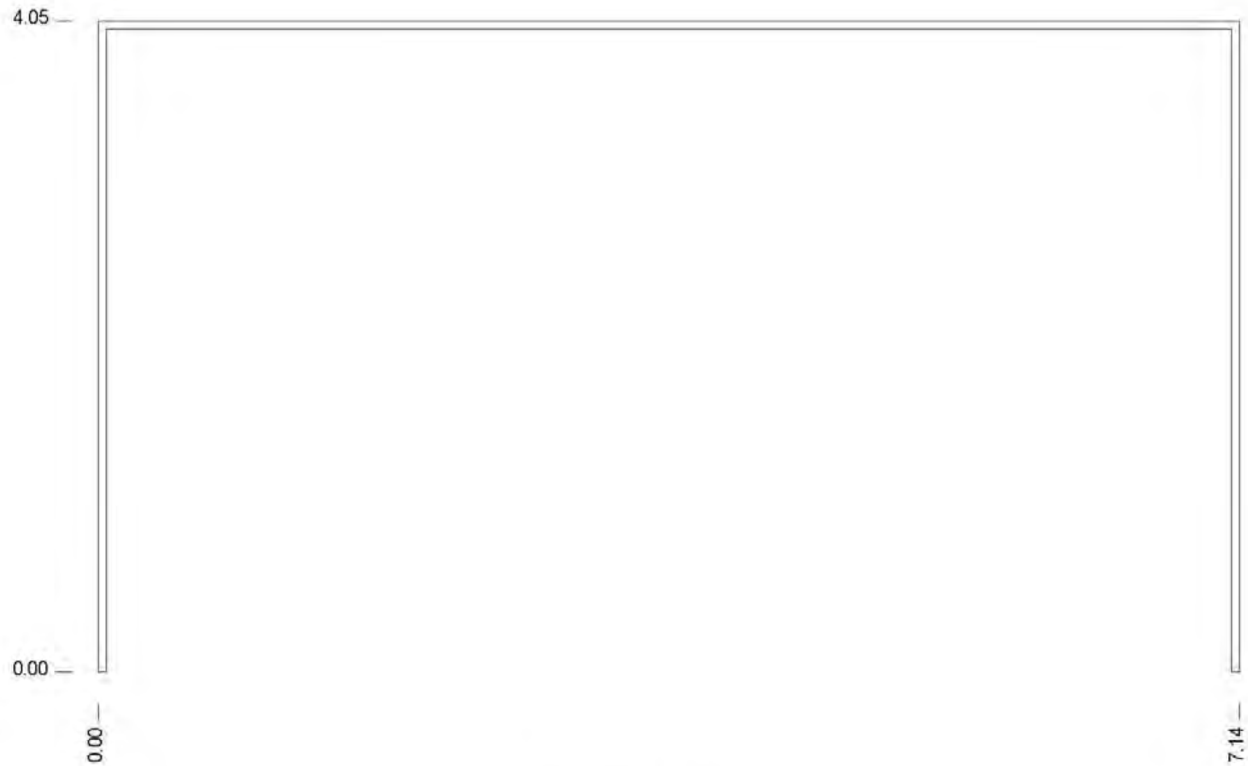
Power Supply Main Chassis	Scale: 1:1	Drawn by: OWJ	Approved by:	**RST Engineering**	Drawing # 6622-2200
	Date: 3 Nov '16	Rev: E	*Jim Weir*	13993 Downwind Court Grass Valley CA 95945 530.272.2203 jim@rstengineering.com	Sheet 4 of 6



NOTES:

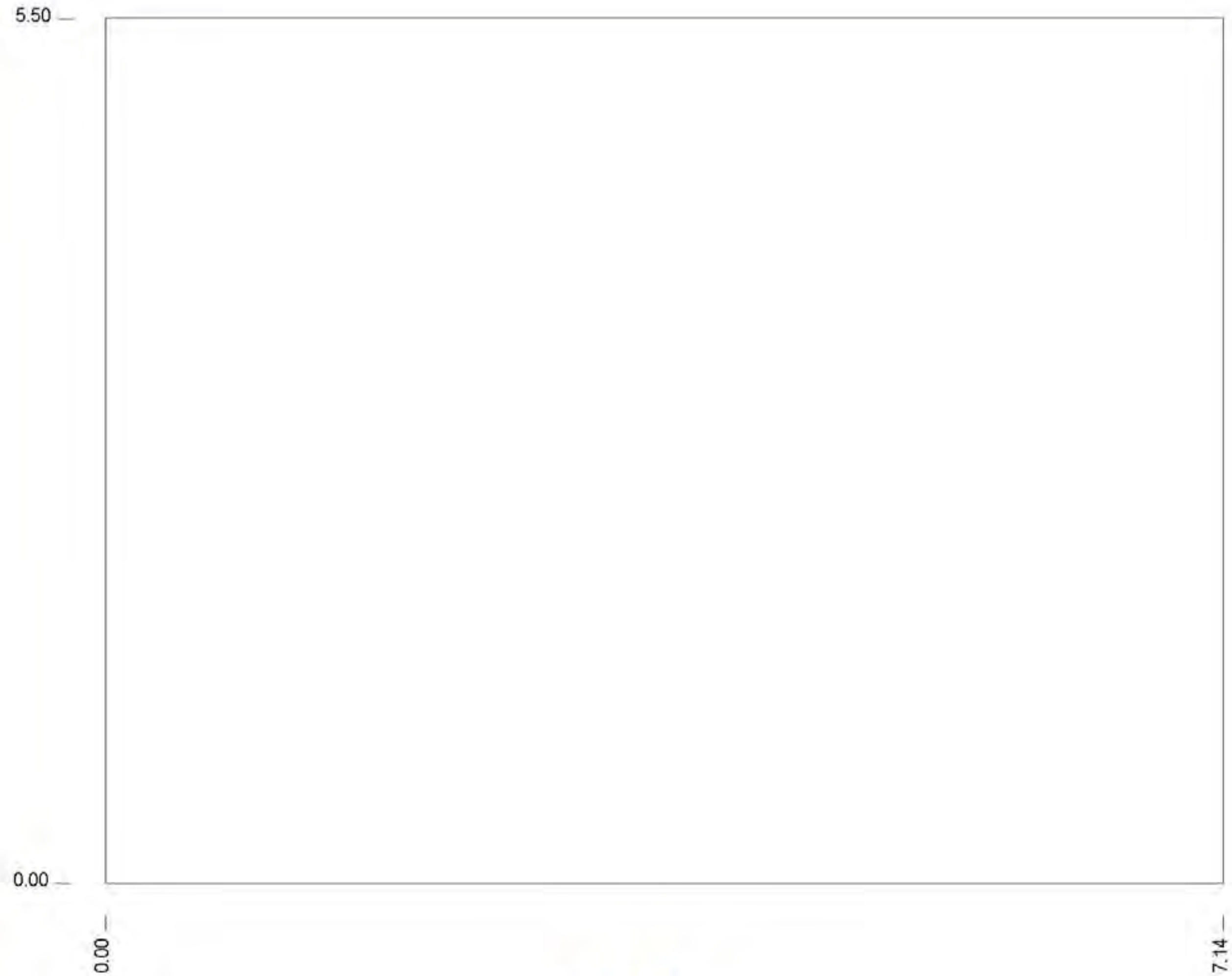
1. Before drilling the 6 cover mounting holes 0.089 diameter, fabricate the cover and then mark these holes using the cover as the template.
2. Material 5052H32 0.050 thick.
3. Drill/punch all holes FIRST, then cut the notches SECOND, then bend THIRD. Note order of bends. All bends are UP (away from sheet).
4. Punch the center of this hole with the 0.625" turret punch, then use the special 52mm chassis punch to complete the large meter hole.

BEND DRAWING BASIC CHASSIS	Scale 2:3 approx	Drawn by: OWJ	Approved by:	RST Engineering	Drawing # 6622-2200
	Date: 3 Nov '16	Rev: F	Jim Weir	13993 Downwind Court Grass Valley CA 95945 530.272.2203 jim@rstengineering.com	sheet 5 of 6



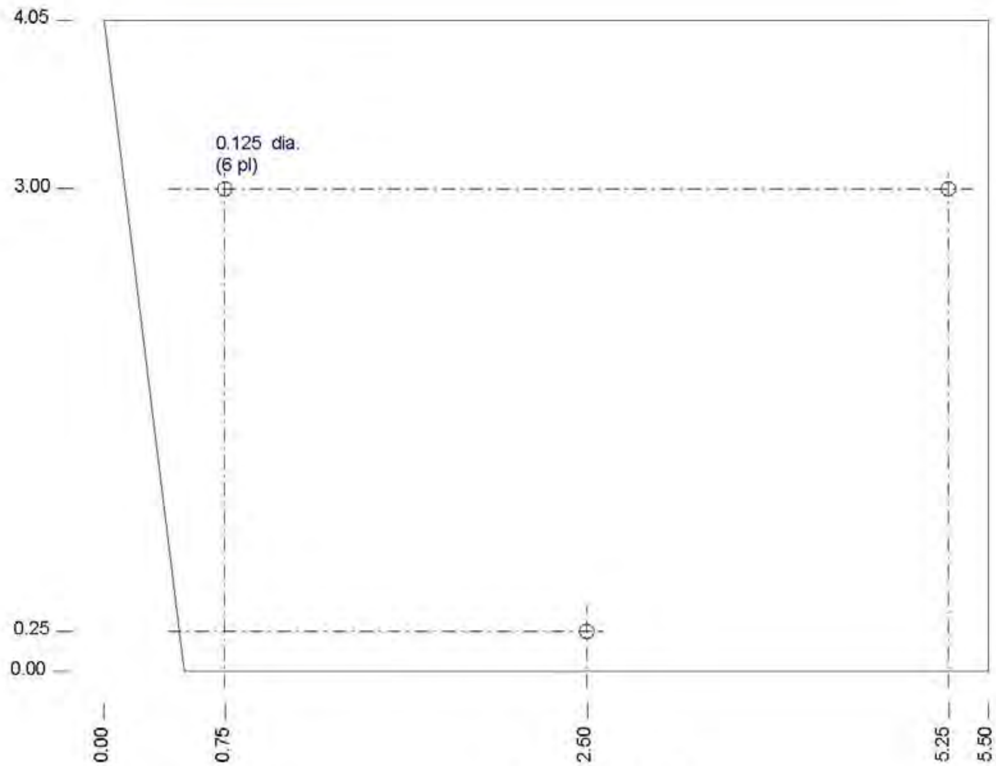
Front View

Power Supply Cover	Scale: 1:1	Drawn by: OWJ	Approved by:	**RST Engineering** 13249 Grass Valley Ave Grass Valley CA 95945	Drawing # 6622-2201
	Date: 08 Oct 08	Rev: D	*Jim Weir*	530.272.2203 tech@rst-engr.com	Sheet 1 of 4



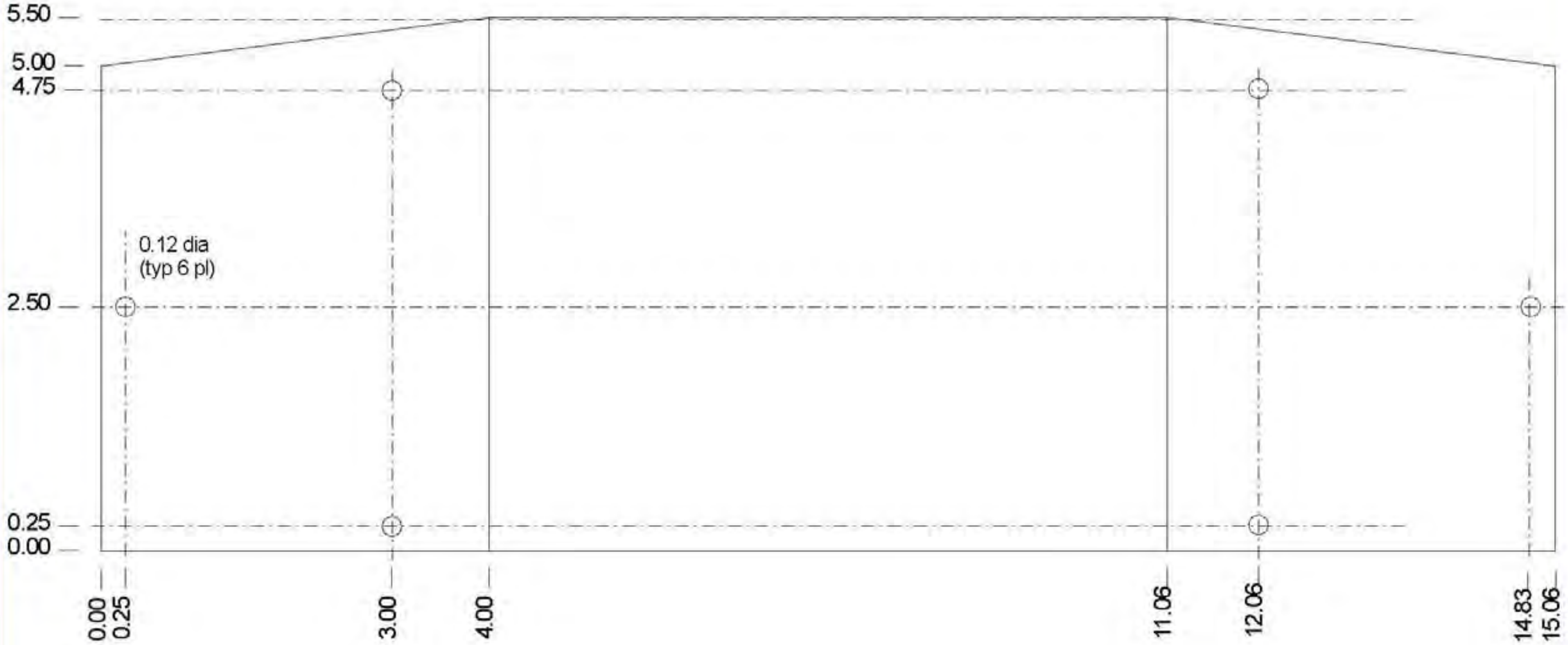
Top View

Power Supply Cover	Scale: 1:1	Drawn by: OWJ	Approved by:	**RST Engineering**	Drawing #
	Date: 08 Oct 08	Rev: D	Jim Weir	13249 Grass Valley Ave Grass Valley CA 95945 530.272.2203 tech@rst-engr.com	6622-2201 Sheet 2 of 4



Right Side

Power Supply Cover	Scale: 1:1	Drawn by: OWJ	Approved by:	RST Engineering	Drawing # 6622-2201
	Date: 08 Oct 08	Rev: D	Jim Weir	13249 Grass Valley Ave Grass Valley CA 95945 530.272.2203 tech@rst-engr.com	Sheet 3 of 4



BEND DRAWING - COVER	Scale: 2:3 approx	Drawn by: OWJ	Approved by: Jim Weir	**RST Engineering** 13249 Grass Valley Ave Grass Valley CA 95945 530.272.2203 tech@rst-engr.com	Drawing # 6622-2201 sheet 4 of 4
	Date: 08 Oct 08	Rev: C			

G. Chassis Fabrication

1. Fabricate a paper doll model of the MECH-14 power supply using the bend drawing layout 6622-2200s5 and 6622-2201s4 drawings in this section.

2. Replicate the bend drawings for the chassis and the cover in either Autosketch or Autocad, your choice.

3. Fabricate the power supply chassis from aluminum. You may wish to have a "class collaboration" to make a template for the whole class that all students can use in lieu of everybody making individual measurements on the chassis.

4. Finish the power supply chassis using either paint or anodize and letter the chassis using either iron-on (for anodize) or mechanical tape for paint.