Replacing the IFR 1100, 1500 and A7550 Power Supplies

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Revision A

ASSUMPTIONS:
This is not a basic servicing techniques paper. It is assumed that the reader has a working knowledge of electrical safety, DC and AC voltage measurements, RF signal generators; RF level measurements, RF units (micro-Volts, milli-Watts, Watts, 50 Ohm impedance measurements, dB, dBms, etc.) and PCB repair techniques. The writer will not be responsible for your soldering mistakes, PCB damage, putting polarized capacitors in backwards, making mistakes in wiring or assembling components incorrectly. I have checked all of the drawings, captions and pictures to the best of my ability but no guarantees of zero errors can be assumed.

COMMENTS:
My day to day monitor is an IFR 1200S that over the years has been apart and put back together several times but still continues to provide good service. I have repaired Cushman CE5 & CE6, IFR 1500 and Motorola service monitors but my experience is mostly with the IFR 1200 families.

I was a Heathkit repair technician at the Pomona CA store back in the mid-1970s when I was going to college and Heathkits were a big deal. I have many fond memories of building Heathkit TVs, audio, ham radio gear and test equipment.

The most common failure in the IFR instruments is the power supply. I have found that once the power supply is running correctly that most of the other modules can be counted on to be operational or at least semi-operational. Replacing suspect electrolytic capacitors and a recalibration will usually make a “ham radio” quality test instrument.

IFR 1100, 1500 & A7550 HISTORY:
IFR 1100 series are somewhat rare but utilize a similar power supply as the 1500 and A7550. I have not tested this power supply with an IFR 1100 but based on the service manual and voltage / current ratings the design should work perfectly.

IFR 1500 series of service monitors were a short lived replacement for the IFR 1200. They are suitable for all measurements of a ham radio repeater or bench testing of AM / FM radios from 100 KHz to 1 GHz. The dual mixer RF synthesizer technique employs mostly simple discrete thru-hole components.

These components are still generally available or can be substituted using more modern and usually smaller parts.

IFR A7550 spectrum analyzers use a similar power supply. The IFR A7550 has a direct entry keyboard and menu structure that is relatively simple to understand. I was most familiar with the HP series of spectrum analyzers and had to reorient my thinking when using the IFR analyzer. The operational differences are significant but the displayed results are the same. Some models of the A7550 include a tracking generator function that is useful for tuning cavity duplexers and may also be used for antenna response analysis.

SERVICING PROBLEMS:

Unfortunately, time is passing and these units are getting old. Some of the passive components were not designed for an unlimited operational life. Thirty five years is stretching it for electrolytic and paper capacitors. There are a lot of carbon composition resistors in the designs and while these are usually low in value (<10K Ohm) they too can change over time and go out of tolerance range.

Power supply issues seem to be the biggest problems with older test equipment. These new design modular power supplies utilize modern ICs and are minimum size and maximum efficiency. They are much more reliable than the original older discrete switchers.

As far as I know, no one is supporting the IFR instruments for flat fee repairs. If you have an IFR 1500 or A7550 and the power supply fails then you are on your own to get it working again. To repair them commercially is generally not cost effective and this results in another E-Bay advertisement of an “IFR XXXX AS-IS” for sale. Hopefully, you can find an inexpensive as-is unit, follow the following outline and get the power supply functioning.

This paper will provide some of the lessons learned on trying (note trying!) to get about eight IFR units back on the air. It was my intent to supplement my retirement income by repairing / refurbishing these units but the labor hours involved are not worth the effort. Commercially I can easily understand why I no one has a flat fee for repairing / calibrating them.

DECISIONS ON REPAIR / PARTS / SCRAP:

When presented with an older DOA (Dead on Arrival) UUT (Unit Under Test) the first thing I do is open up the outside covers to expose the chassis. Then carefully look at all the accessible PCBs, modules and sub-assemblies. Connect the power supply to a dummy load (see Figure 1 later in this article) and verify that the output voltages under load appear correct. Then make a decision if the product is worth the estimated time and materials to restore it. As the old saying goes, it is easier to get into something than out of something. Once you start putting your money / time into a project it is very hard to abandon it.

Smelling the chassis is a good starting technique. Your nose can be a good source of locating burned components, blown electrolytics and vaporized tantalums.

If you have several similar units consider specifying one of them as a “parts unit”. This is the unit that you will strip internal modules, steal test cables and provide comparisons when reassembling other units. A designated parts unit can be very useful if you are restoring a number of similar items and if it is still reasonably complete at the end (most unlikely) then repair it last.

POWER SUPPLY:
Considering the switch mode power supply technology available at that time they were probably a pretty good design. Now however, these power supplies are almost always guaranteed to be DOA or soon will be. This is the most common cause of selling an IFR unit onto another home.

IFR ORIGINAL POWER SUPPLY TESTING:

DUMMY LOAD:

It is necessary to make an IFR dummy load for testing the power supply. An over voltage condition or missing voltage may damage components in the logic and RF sections. My dummy load is just a heavy piece of aluminum with some power resistors and mounted on heat sink compound. I have a good selection of Dale 25 and 50 Watt 1% resistors but other types may also be used. It is necessary to have a significant load on the 12.6 V source in order to get the other voltages in regulation. Switching power supplies typically must have a load on one or more of the power outputs to operate correctly.

You will need a 12 pin (3 x 4 grid) 0.062" Molex female connector housing and 0.062" male pins for the power supply test harness. Use at least 20 gauge hook up wire to keep the wire resistance losses to a minimum. Only have one wire per pin connection to keep the series resistance low.

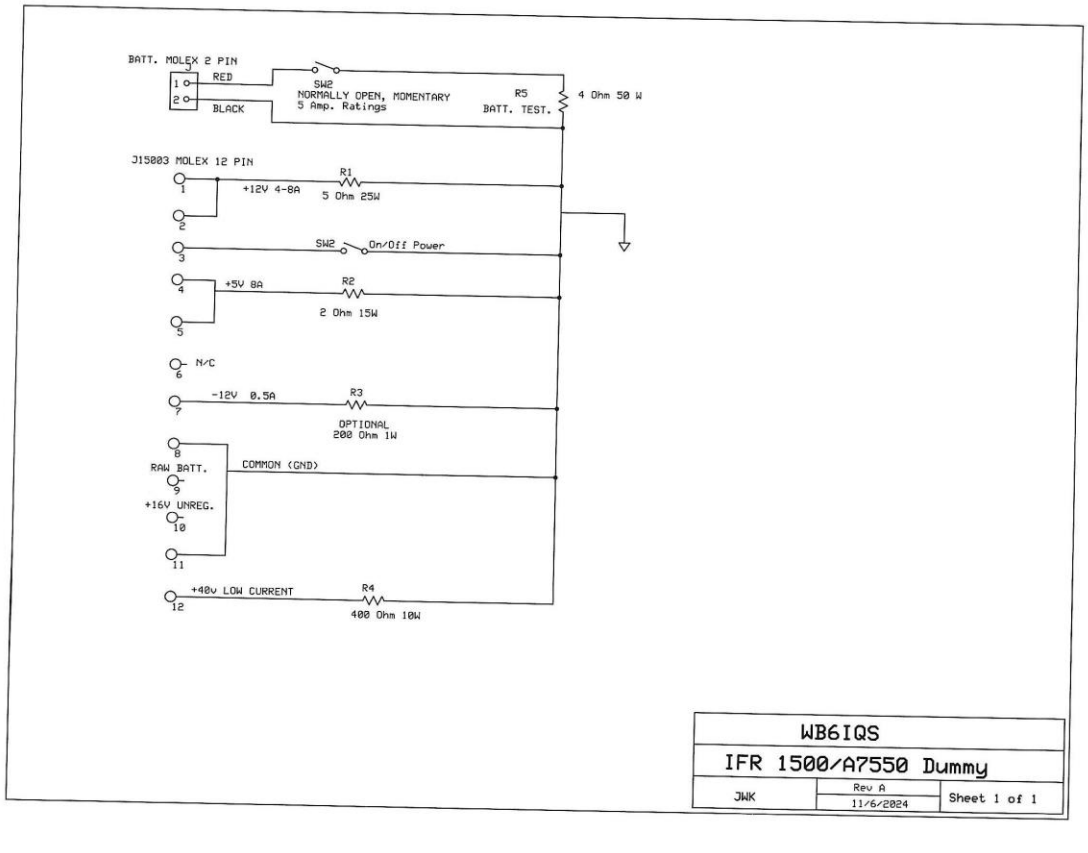
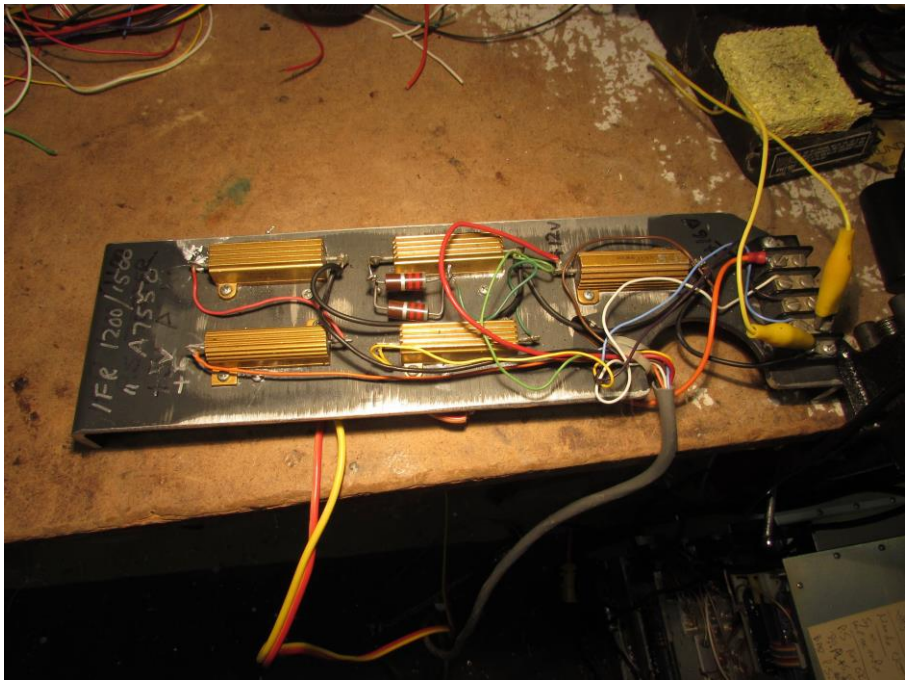
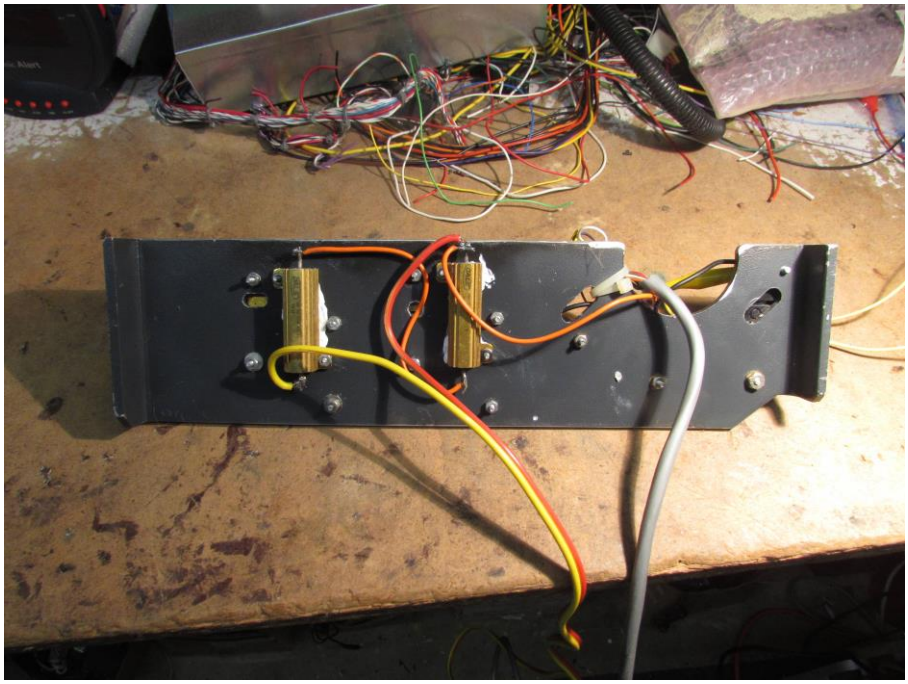
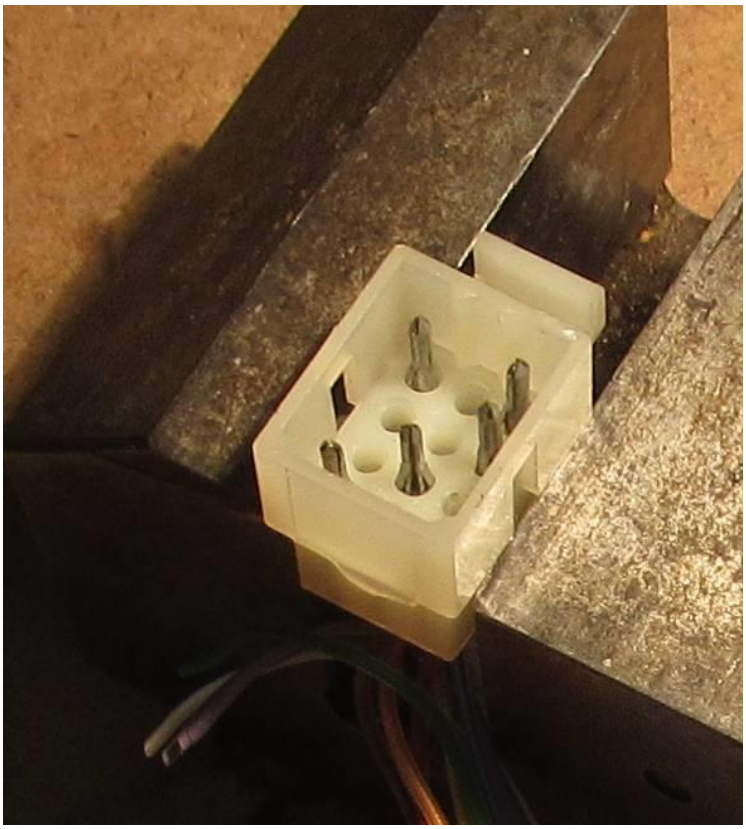


Figure 1


IFR 1200/1500
A7550





POWER SUPPLY FIRST PROTOTYPE CONSTRUCTION:

Original DOA power supply with cover removed.

Note that the components are stacked very tightly.

GEL CELL BATTERY BACKUP:

Long ago I decided that the IFR's 1200 and 1500 12.6V gel cell batteries were heavy and useless plus a constant worry for acid leakage. In all my engineering work and ham radio activities I pulled the 6 gel-cell batteries out and used the IFRs exclusively on AC power. If you absolutely have to have a portable unit, then ignore the following changes. If you are like the 95% of service techs that only use AC power in normal repairs then this provides a much more modern power supply that is easily built and more reliable.

FIRST PROTOTYPE POWER SUPPLY (NOT RELIABLE!)

Replacing the original IFR switch mode power supply is relatively easy due to the Molex 12 pin power supply connector located side of the unit. The first attempt was to delete the defective IFR power supply and completely replace all the power supply voltages.

REPLACING THE IFR POWER SUPPLY

The IFR 1500 and A7550 family requires the following voltages / currents:
+12 VDC unregulated 0.2 Amps. to operate the power on/off main relay.
+5.2 VDC regulated, 4.0 Amps.
+12.6 VDC regulated 4.2 Amps.
+40 VDC semi-regulated @ 10 milli-Amps.
-12 VDC semi-regulated @ 0.5 Amps.

+12.6 VDC SOURCES:

The +12.6 VDC open frame switcher is available from EBAY. Purchased from XcTrading3, model AC 85 – 265V 12V 8 Amps. Switching Power Supply Module. $12.14 each. It operates on an AC switched source via a Normally Open (NO) relay contact.

NOTE: Other power supplies may also be suitable.

An AC continuous +12.6V relay power supply and an isolated regulated -12V source runs on the AC switched line voltage.

The +5 VDC and +40 VDC were originally purchased from EBAY, EnVistia Mall. The 5.2 VDC supply is a “Buck” type, LM2596S DC Converter Step Down Module that is adjustable and supplies a maximum of 3 Amperes. The +40 VDC supply is a “Boost” type, EnVistia Mall Boost Power Converter Module, P/N XL6009 US, that converts +12.6 VDC up to a maximum of +53 VDC. They are approximately $4.50 each.

NOTE: I believed that I could use the step down 5 Volt power supply and it would be OK for the required power. However, the current supplied was insufficient and caused the power module to occasionally “sag” below the minimum 5 V requirement. This caused the IFR A7550 to show a malfunction. A more robust 5 Volt source was required.

WARNING: The relay power supply is suitable only for 120 VAC primary power. The other AC supplies will operate from 120 – 240 VAC. If your power source is 240 VAC use a different “wall wart” power supply. The original IFR 1100, 1500 and A7550 also had an option for a high stability heated crystal oven. If you have this option (Pin 10, Blue Wire) then a continuous +12V / +16V power source will be needed.

-12V SOURCE:
The -12V source is a standard isolated switching power supply that is wired the reverse of normal connections. With the + (Positive) source connected to ground (Common) then the – (Negative) 12V output is available as a power source. An AC power supply is required so that the output connections were totally isolated above any common reference.

These power supplies were found from a well stocked “goodie box” of random “wall wart” power supplies. I have a large supply that I have saved over the years. Crack open the cases to retrieve the PCB assemblies (see Figure 2).

If power supplies are not available then a trip to the Goodwill or DAV stores may provide a ready source for conversions.

WARNING:
I initially had a problem that I thought that my +40V modules were DOA (Dead on Arrival) but I found out that that they must be adjusted from a full CCW (Counter Clock Wise) minimum setting to start the supply’s normal operation. NOTE: If full CCW rotation does not kick on the supply try turning the adjustment pot fully clock wise (CW) and then adjusting it CCW. Different designs from China have reversed this rotation.

+40 VDC BOOST SOURCE:
Most any voltage above 35 VDC can be used. The original +40 VDC voltage is further regulated downstream for powering the phase locked loop reference voltage. The power supply is “Boost” type switching power supply. The standard +12.6V source supplies +40V.

The boost source is capable of much higher current than is required. Add a 1.2K Ohm 2 Watt resistor in series to limit the current should a problem occur in the IFRs.

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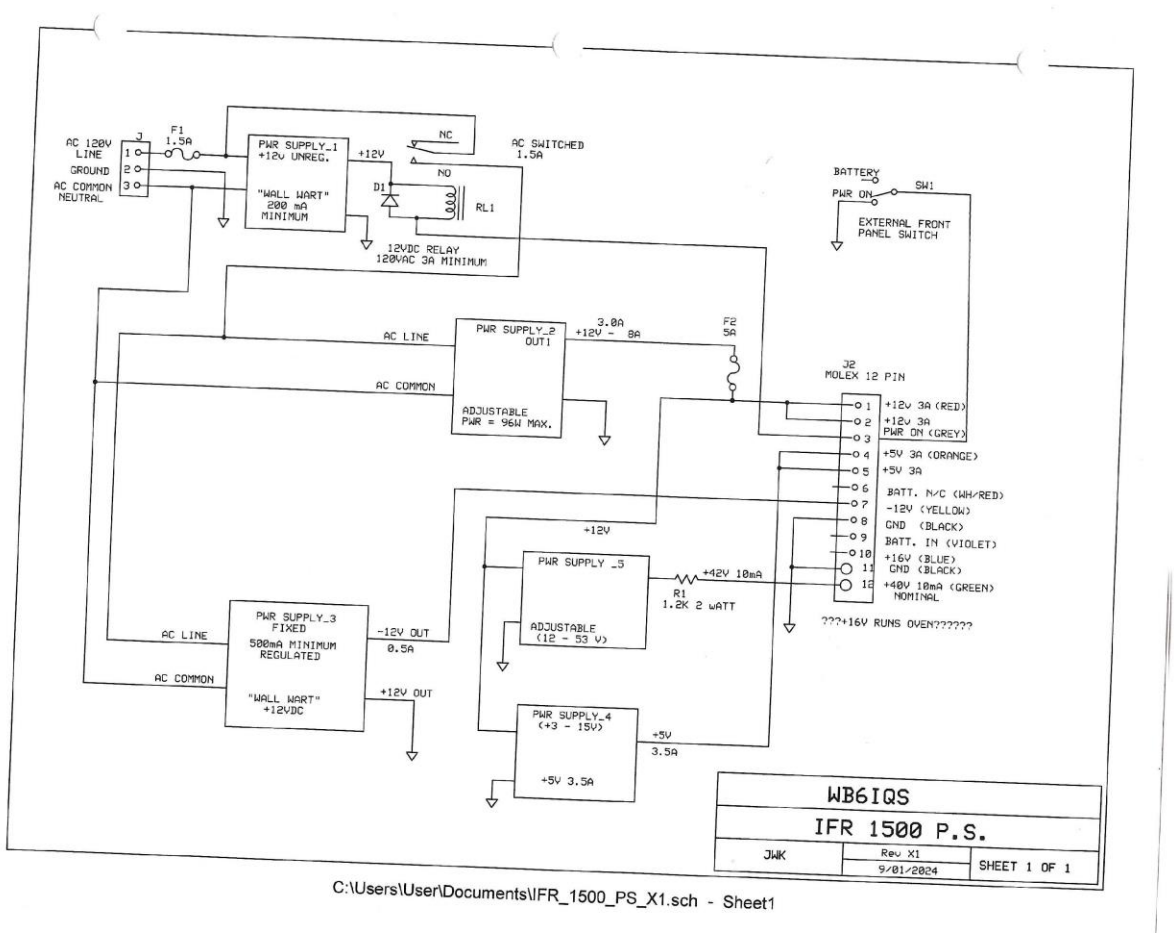
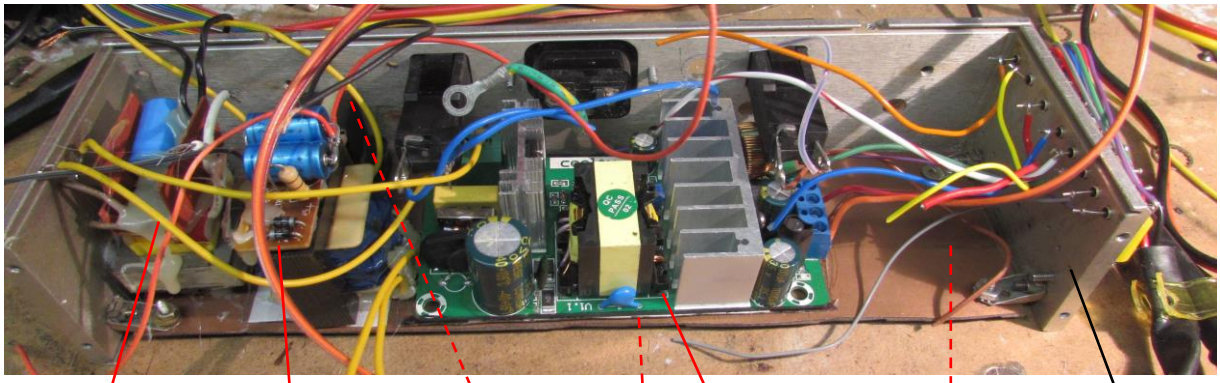


+5V SOURCE:
The initial power supply was a “Buck” type switching power supply. I used the standard +12.6V source to power the supply. It was rated at +5V 3.0A (15 Watts) and ran the main TTL logic and display electronics. However, the 3 Amps. rating was insufficient. An AC operated +5 Volt supply rated at 6 Amps. was substituted and it has never sagged under start up loads.



A plastic cover was first glued to the copper PCB chassis as an insulating barrier. Use the “Goop” to glue it down and then place a weight on the board. Let it cure overnight.

Initially low temperature hot glue was used to mount the power supplies and to keep them isolated from the copper ground plane. Everything worked OK but it got quite hot after 4 hours of operation and the hot glue become soft.

Future builds used a combination of high temperature hot glue with a 100 Watt glue gun. “Goop” glue was used to mount the modules. Be careful when using high temperature hot glue as it will severely burn your skin.

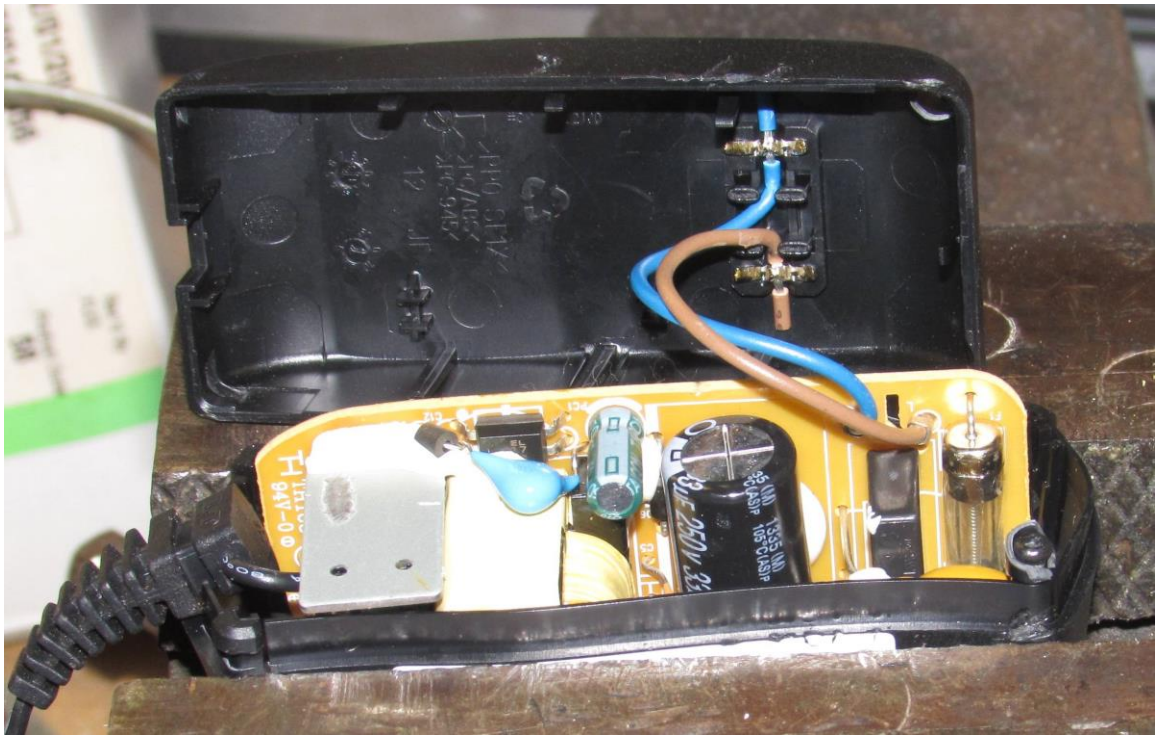


Figure 2, Power Supply Removal

Open the plastic housing to get a 12 Volt regulated switching power supply and 12 Volt relay power supply. First use a medium to large vise to squeeze the case along the case halves. Then using a small hammer and flat bladed screwdriver split the case and remove the power supply.

A small isolated switching regulated power supply is used for the -12 VDC source.

A similar unregulated 12 Volt “Wall Wart” is used for the relay power supply. The output rating is not critical as long as it can supply sufficient current to close the AC power relay.

Be careful when mounting it that no metal touches the copper ground plane chassis. Line potential is present of many of the heat sinks and circuitry.

SECOND PROTOTYPE:
Using a finger brake and hand shears I fabricated a replacement metal chassis. Pop-rivets held the sides and PCB chassis in place. A single AC power fuse and computer type AC power connector completed the sheet metal housing. Similar construction techniques as before were used. You will need high temperature hot glue and a 100 Watt glue gun. Clear “Goop” glue is also used to mount the PCB assemblies.

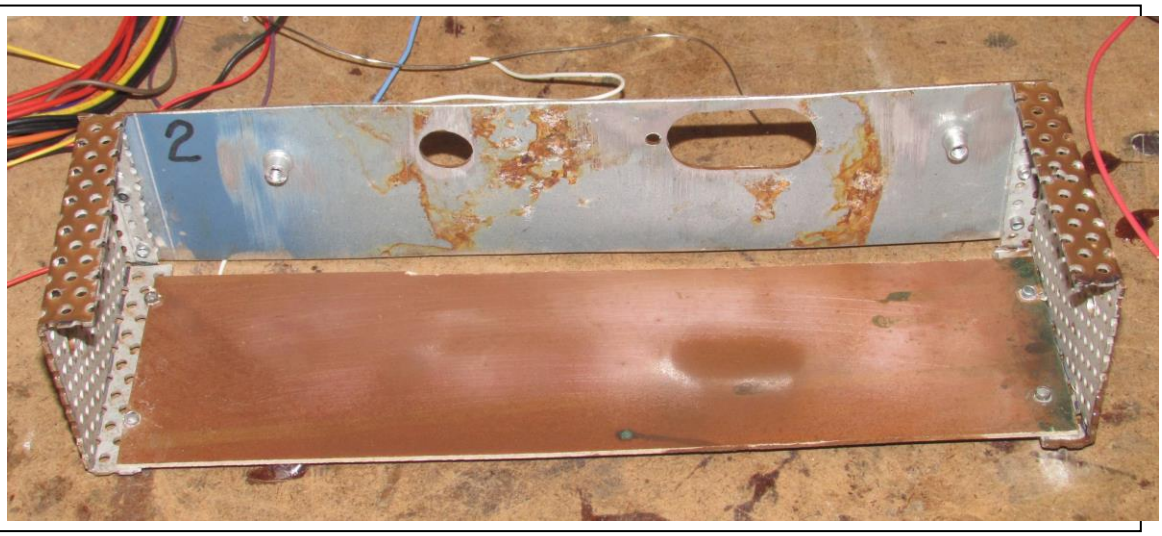
Carefully measured 8/32 Pem-nuts were mounted in the chassis to match the original mounting holds on the rear panel.

IFR POWER CABLE:
The power supply uses a common 12 pin 0.062” Molex male (3 x 4) connector as a power source. It consists of Molex P/N 03-06-1122 male housing and female connectors P/N 02-06-1101 (tin plated). IFRs originally had gold plated connectors. None were available at any sort of reasonable price on EBAY.

Pem-Nut for mounting to rear panel.

Bare chassis as manufactured on home equipment.

Pem-Nut for mounting to rear panel.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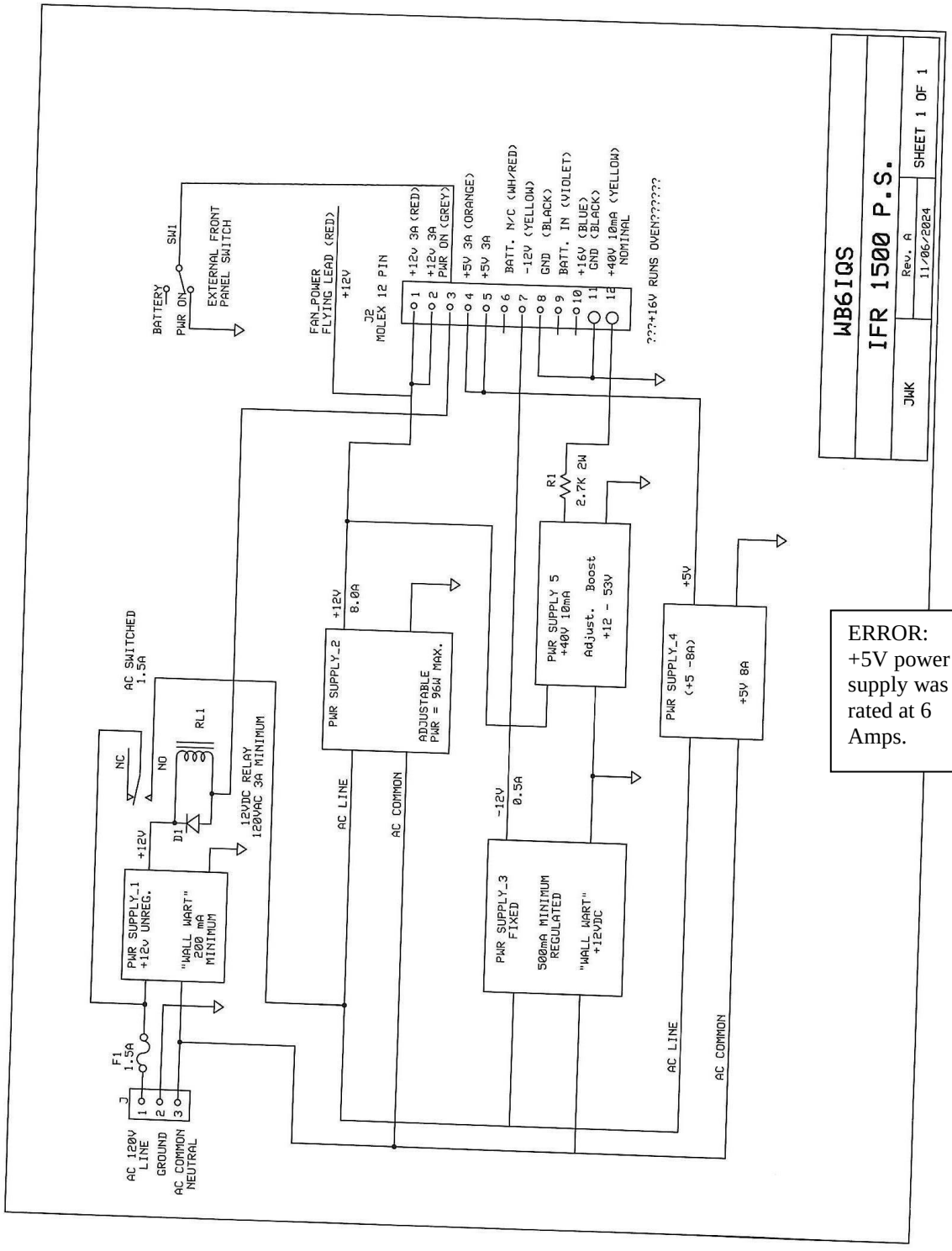
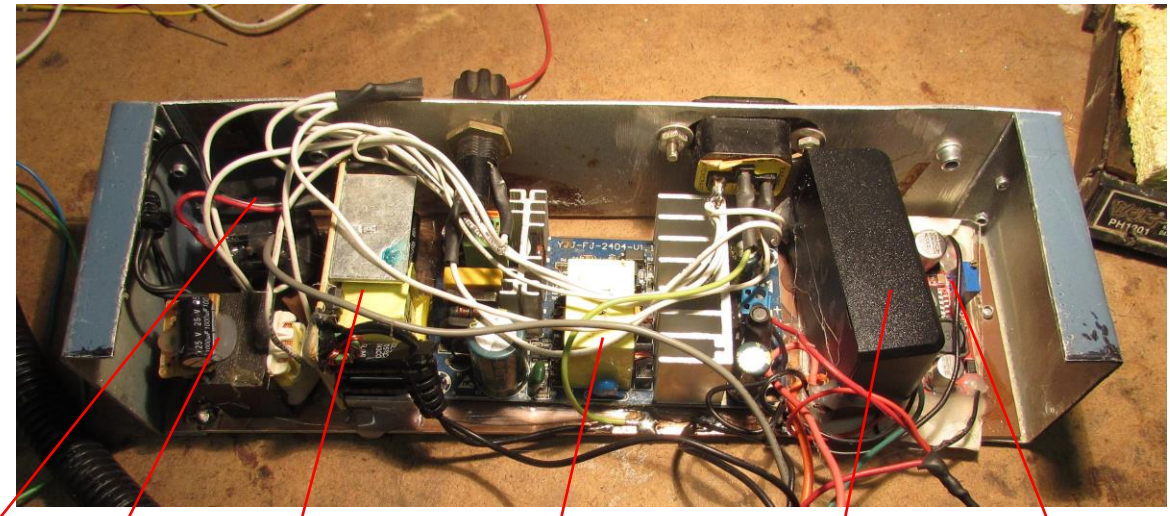


ERROR: +5V power supply was rated at 6 Amps.

Redesigned heavier duty power supply using larger capacity +5 V 6 Amps. power supply.



Relay

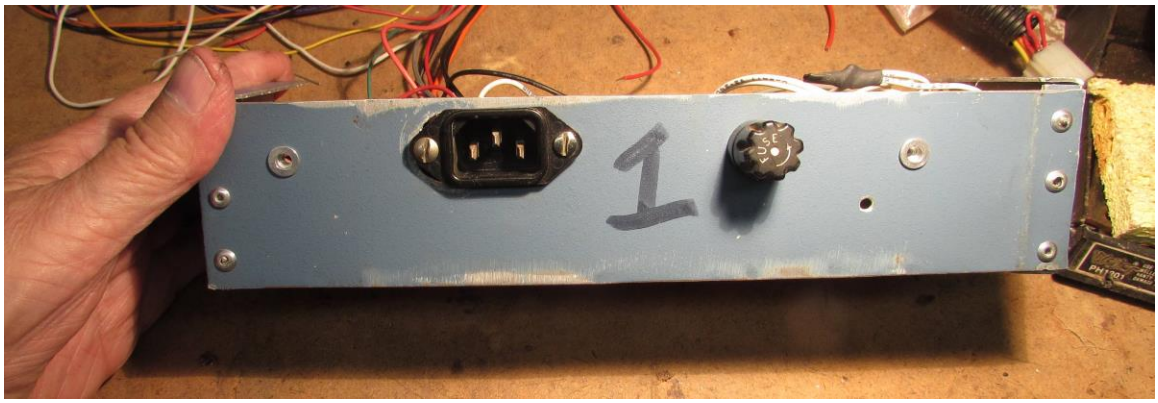
Relay Power Supply.

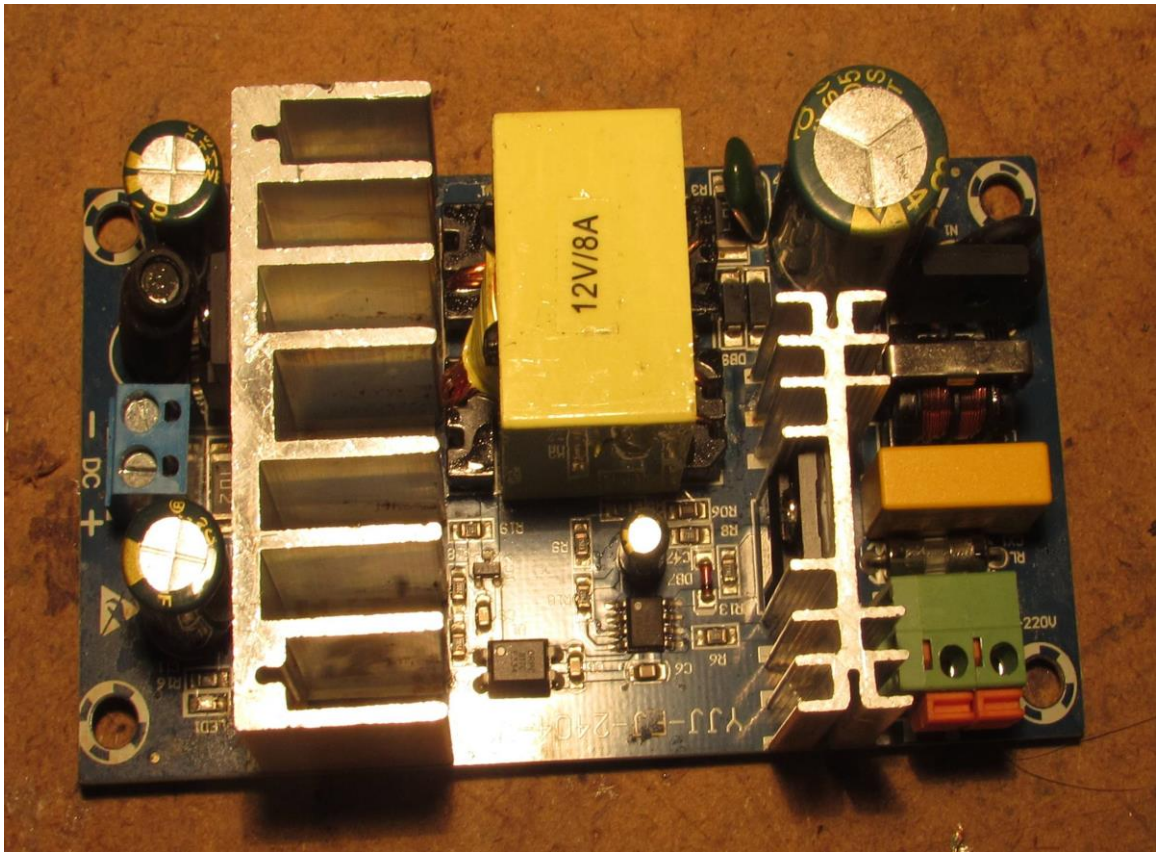
-12 V Power Supply. Isolated above chassis ground.

+12V 8 Amps. Power Supply.

+5 V 6 Amps. Power Supply.

+40 V Boost Power Supply.



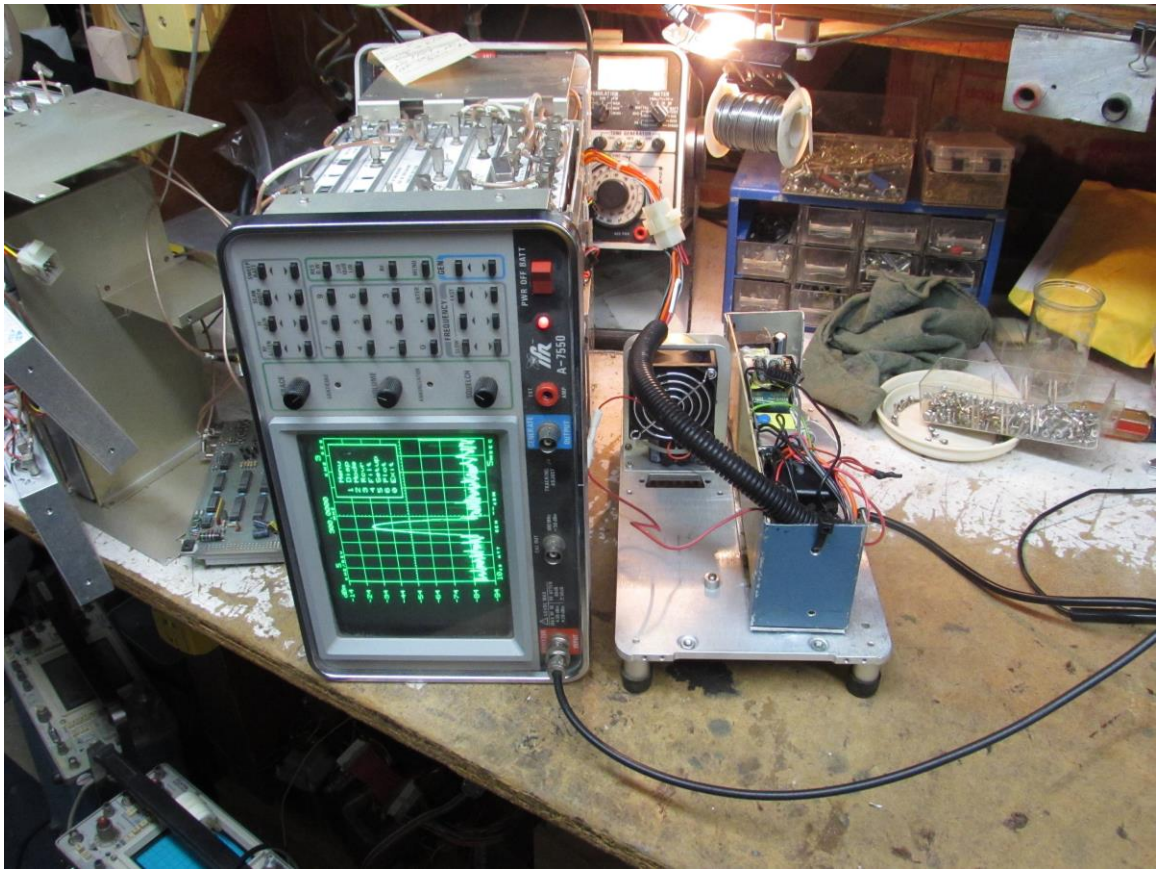

12V/8A
DC
220V

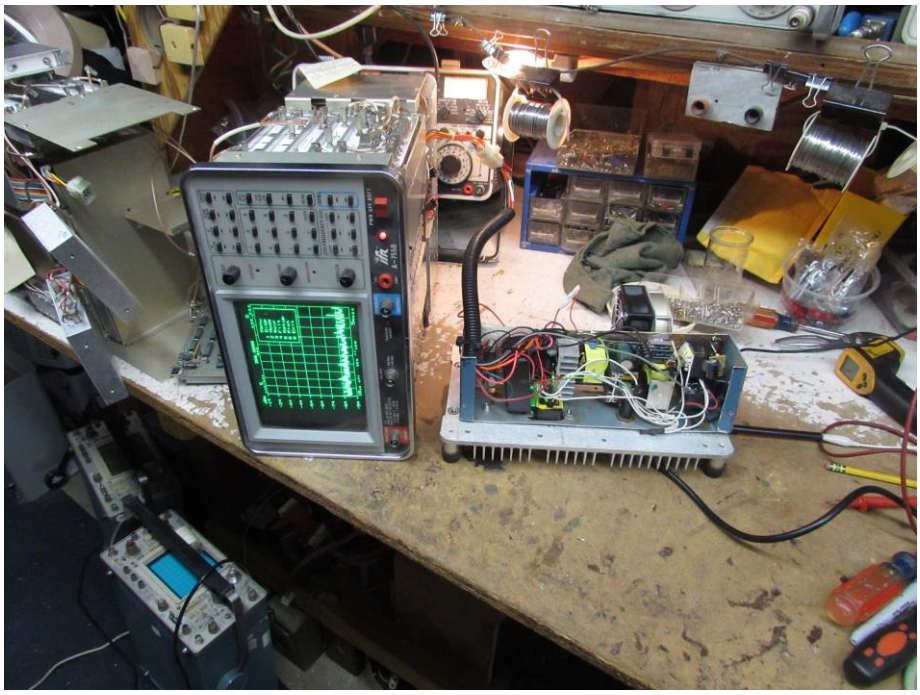

AC/L
AC/N
MW
MEAN WELL
(型號)(電源供應器)
IRM-30-5
-Vo
+Vo
INPUT(輸入):100-240VAC 0.75A 50/60Hz
277VAC 0.375A 50/60Hz
(277VAC for North America only)
OUTPUT(輸出): 5V 6A
LPS
MEAN WELL ENTERPRISES CO., LTD.
No.28, Wuquan 3rd Rd., Wugu Dist., New Taipei City 24891, Taiwan
Manual: www.meanwell.com/manual.html
S2052 (中國製造)MADE IN CHINA-MW02

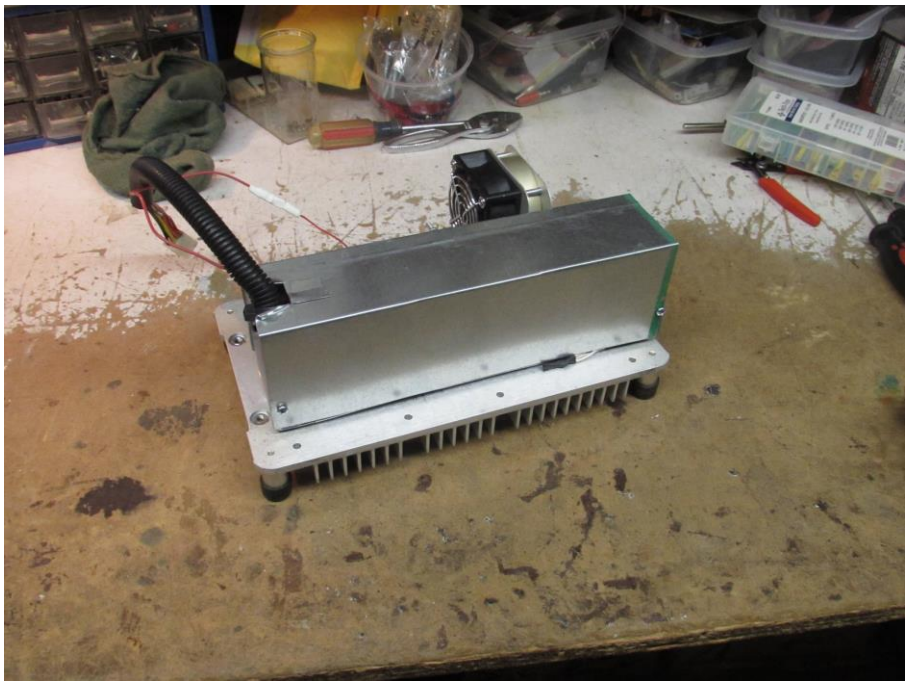
This glue is also known as “Goop” and is commonly available at auto parts stores, Wal-Mart and Lowes. Goop is normally used to repair the soles of running shoes where the sole is separating from the upper part of the shoe. Two part non-conductive epoxy may also be used to secure the boards to the chassis.

OPERATIONAL TESTING:

The following are pictures of the replacement power supply during testing. A laser guided thermometer showed no more than a 10 degree C rise in temperature after 5 hours of continuous operation. The connector cable was made too long and should only be about 6". Even with the extra cable it was possible to fit the harness into the chassis.







REPAIR PROCEDURES:
GENERAL COMMENTS ABOUT OLDER TEST EQUIPMENT:

CAPACITORS:
Electrolytic capacitors have a limited lifetime. Normal failure mode starts at about 25 years. If the IFR has been stored in a hot vehicle for most of it's' life, then the life of the capacitors will also be further reduced.

After opening up the chassis and removing all the assessable covers, replace ALL of the electrolytics that are easily accessible. Especially any bulk power supply decoupling capacitors within the modules. Some of the modules include screw on covers and are difficult to remove. If you do not change out the electrolytics then you run the probability of changing them out later. The normal failure mode for any older piece of equipment used in the field is what commonly called the desperation factor. Whenever you are desperate that the piece of equipment absolutely needs to work and you have no backup equipment; then that is when the weak components will decide to fail. This is a technician's subset of "Murphy's Law".

I have a well stocked goodie box but you may not, then you will have to purchase the capacitors from a list (Excel sorting makes this much easier) document the PCB assembly, rough X-Y position, value, voltage, radial / axial orientation and any special notations such as LOW ESR, high temperature (105 degrees C) etc. Modern electrolytics can generally be substituted across the board for any older electrolytics (even low ESRs) as long as the voltage and ratings are comparable. The only caution is for the temperature ratings. Many commercial quality generic components only have a rating of 85º C. Power supplies often require higher temperature 105º C components.

The better plan is purchasing an assortment of electrolytic capacitors available on EBAY. Look for radial vs. axial mounting and approximate voltage ratings. An assortment package will usually be more readily available and cheaper than a long list of specific voltages and ratings.

Electrolytic capacitors are not typically used for any critical time constant applications. A higher voltage can be substituted for a lower voltage of the same rating (example 35 V substitutes for a 25 V original). The older electrolytic capacitors often had a +80/-20% tolerance. Today this is typically +/- 20%. You may substitute a higher value electrolytic (i.e. example 33 UF for a 25 UF) as long as you do not exceed about 50% higher. Good design experience must be used in certain special applications so be careful.

I have not seen any paper capacitors in my IFRs. That is good because old paper capacitors are a major cause of trouble. Mica capacitors, glass, Mylar and ceramics generally are good forever. They may occasionally fail due to over

voltages or random chance but for repair purposes you can assume that they will have an unlimited lifetime.

Tantalum capacitors are like electrolytics, except that they normally have an unlimited lifetime. However, when they fail they fail spectacularly and usually end up shorted with large amounts of smoke, smell and black soot emitted from the capacitor. In general, leave the tantalums in place on initial inspection and then wait for the first power up “smoke test”. Replace them as necessary after searching for other troubles. Be sure to re-check all the primary voltages from the power supply once the unit is up and operating. An under-voltage condition due to excessive current drain may initially not show up as a functional problem. A low voltage may later cause erratic operation or random failures.

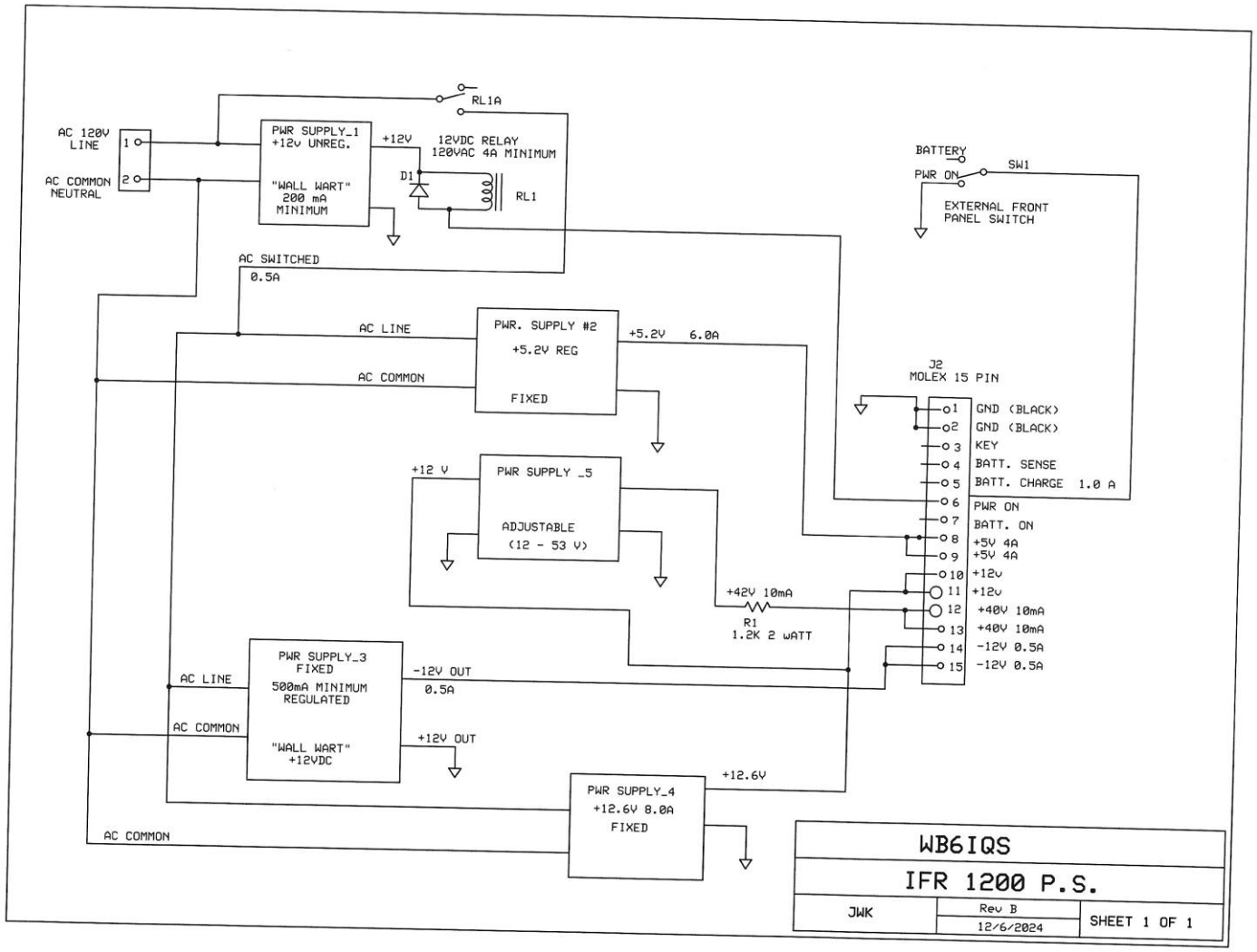
IFR 1200 SERVICE MONITOR:
I have several working IFR 1200s. Using this replacement technique you can build a replacement power supply for the IFR 1200. It uses the same voltages and has similar current requirements. Pull out the gel-cell battery pack and make / find a similar sized metal box. Then using the hot glue and Goop make a replacement power supply. I have not had to do this (so far!) but the same construction technique will work OK.

NOTES:
The 15 sliding contact housing is also a Molex connector with the sliding contacts commonly available from EBAY.

The existing +16 VDC unregulated power supply source may be required if you have a temperature controlled crystal reference.

The original power supply is very hard to repair. Trouble shooting requires an adapter cable to mate up to the IFR 1500 dummy load (See above text) or a new replacement dummy load.

A suggested schematic follows:


AC 120V LINE
AC COMMON NEUTRAL
1
2
PWR SUPPLY_1
+12v UNREG.
"WALL WART"
200 mA
MINIMUM
+12V
D1
12VDC RELAY
120VAC 4A MINIMUM
RL1A
RL1
AC SWITCHED
0.5A
BATTERY
PWR ON
SW1
EXTERNAL FRONT
PANEL SWITCH
AC LINE
AC COMMON
PWR. SUPPLY #2
+5.2V REG
FIXED
+5.2V 6.0A
J2
MOLEX 15 PIN
1 GND (BLACK)
2 GND (BLACK)
3 KEY
4 BATT. SENSE
5 BATT. CHARGE 1.0 A
6 PWR ON
7 BATT. ON
8 +5V 4A
9 +5V 4A
10 +12v
11 +12v
12 +40V 10mA
13 +40V 10mA
14 -12V 0.5A
15 -12V 0.5A
+12 V
PWR SUPPLY _5
ADJUSTABLE
(12 - 53 V)
+42V 10mA
R1
1.2K 2 WATT
PWR SUPPLY_3
FIXED
500mA MINIMUM
REGULATED
"WALL WART"
+12VDC
AC LINE
AC COMMON
-12V OUT
0.5A
+12V OUT
PWR SUPPLY_4
+12.6V 8.0A
FIXED
+12.6V
AC COMMON
WB6IQS
IFR 1200 P.S.
JWK
Rev B
12/6/2024
SHEET 1 OF 1