Repair and Servicing of the IFR 1000A/S Series

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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:
Many of these notes are directly applicable to the IFR 1100A & 1100S monitors but I do not have any direct experience with these models nor have I worked on them in the past. My day to day monitor is an IFR 1200S that over the years has been apart and put back together many times but still continues to provide good service. I have repaired Cushman CE5 & CE6, IFR 1500s and Motorola service monitors but my experience is mostly with the IFR 1200 and 1000 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.

IFR 1000 HISTORY:
The IFR 1000A and IFR 1000S series of service monitors are a good compact synthesized RF test set that when working represent good value for the money invested. They are suitable for almost all measurements of a ham radio repeater or bench testing of AM / FM radios from 100 KHz to 1 GHz. The 1000S spectrum analyzers and baseline 1000A/S RF generator outputs are generally cleaner than later models that included microprocessor controls and noisy data busses. 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.

Unfortunately, time is passing and we are all getting old. Some of the passive components were not designed for an unlimited operational life. I have several low serial number IFR 1000As that were made in 1978. 35+ years is stretching it for electrolytic and tantalum capacitors.   There are some carbon composition resistors in the design and while these are usually low in value (<10K Ohm) they too can change over time and go out of tolerance range.

As far as I know, no one is supporting the IFR 1000 family of service monitors for flat fee repairs. If you have an IFR 1000 and it 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 ….. as-is” for sale. Hopefully, you can find an inexpensive as-is unit, follow the following outline and get a fully functioning repaired unit into your life.

This paper will provide some of the lessons learned on trying (note trying!) to get all my 7 IFR 1000A and 1000S 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 almost not worth the effort. Commercially I can easily understand why I no one is repairing / calibrating them anymore.

DECISIONS ON REPAIR / PARTS / SCRAP:
When presented with an older DOA (Dead On Arrival) UUT (Unit Under Test) piece of equipment, the first thing I do is open up the outside and inside covers to expose the chassis. Then I carefully look at all the accessible PCBs, modules and sub-assemblies. Disconnect the power supply (if possible) and verify that the output voltages under zero load appear correct.   I then have to 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.

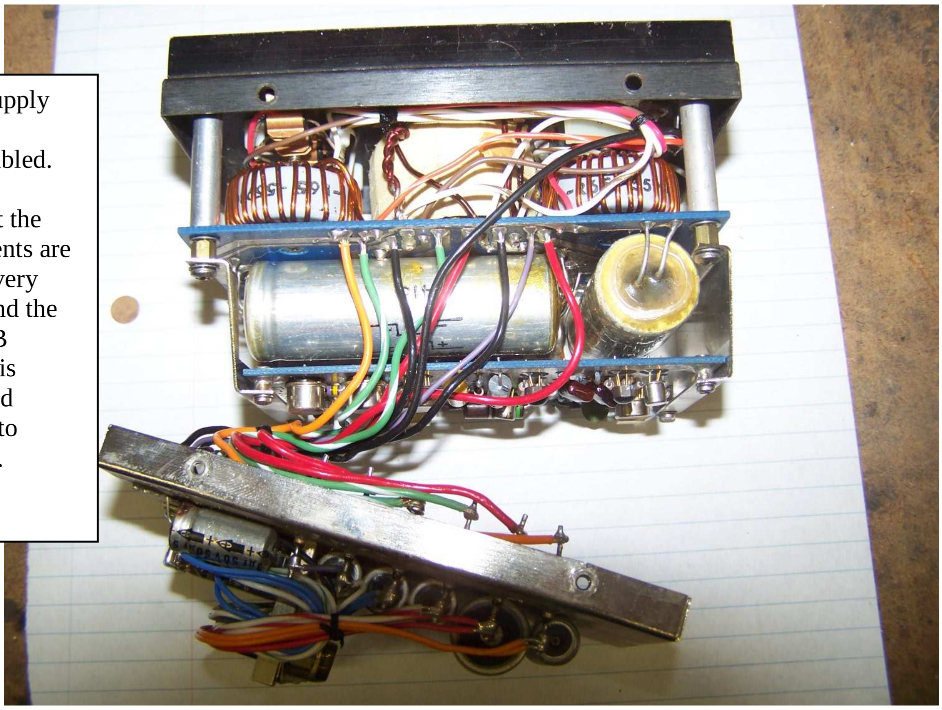
Smelling the chassis is a good starting technique. Your nose can be a good source of locating burned components, blown electrolytics and vaporized tantalums.

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 if the UUT cables are suspect, comparisons when reassembling other units, etc. A designated parts unit can be very useful if you are restoring a number of similar items and if it is still physically 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.   The main filter capacitors are exotic dual lead (4 wires per axial capacitor) types that are no longer readily available and the PCB design is such that you cannot directly replace an original dual lead capacitor with a single lead axial type.

Power supply shown disassembled.

Note that the components are stacked very tightly and the blue PCB material is brittle and difficult to unsolder.



NOTE: 2 positive terminals and two negative terminals on each capacitor.

Replacing the switch mode power supply is relatively easy due to the DB-15 power supply connector located under the power supply at the rear of the unit. The DB-15 female connector plugs directly into the external power supply and controls power on, battery charging and regulated output voltages.

Long ago I decided that the IFR's 12.6V gel cell batteries were a waste of weight and a constant source of acid leakage and corrosion fumes. In all my work related IFRs I pulled the 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 99% of service techs that use AC power in our normal repairs then this provides a much more modern switch mode power supply that is easily sourced and more reliable.

REPLACING THE IFR POWER SUPPLY
The IFR 1000A/S family requires the following voltages / currents:
5 VDC regulated, 3.0 Amps.
12.6 VDC semi-regulated (max. 13.6 VDC), 3.76 Amps average, 4.2 Amps peak.
-39 VDC un-regulated @ 100 mA.

+5 and +12.5 VDC SOURCES:
I have found a +5 and +12.6 VDC open frame switch mode power supply using the Powdec PTH6501, 90 – 264 VAC, 65 Watt at $16.99 each. They are a standard 3" X 5" X 1.34" size off the shelf supply used in many products.

An alternate similar power supply is the Sico SNP9063. They are rated for 85 – 270 VAC operation and have similar physical size and DC power outputs.

Other power supplies would also be suitable. They fit into the same space as the original gel-cell battery and are much lighter when carrying around.

The connectors are different on the above power supplies so my schematic is generic showing the power supplies as a block, rather than detailed pin locations.

WARNING: These power supplies are suitable for 120 – 240 VAC primary power but the original IFR 15 VDC unregulated power supply are still being used for the 10 MHz reference crystal heater. If you need to operate the IFR on anything other than 120 VAC power be sure to strap the primary power transformer for the correct primary voltage. These power supplies do not require any re-wiring for the different primary voltages.

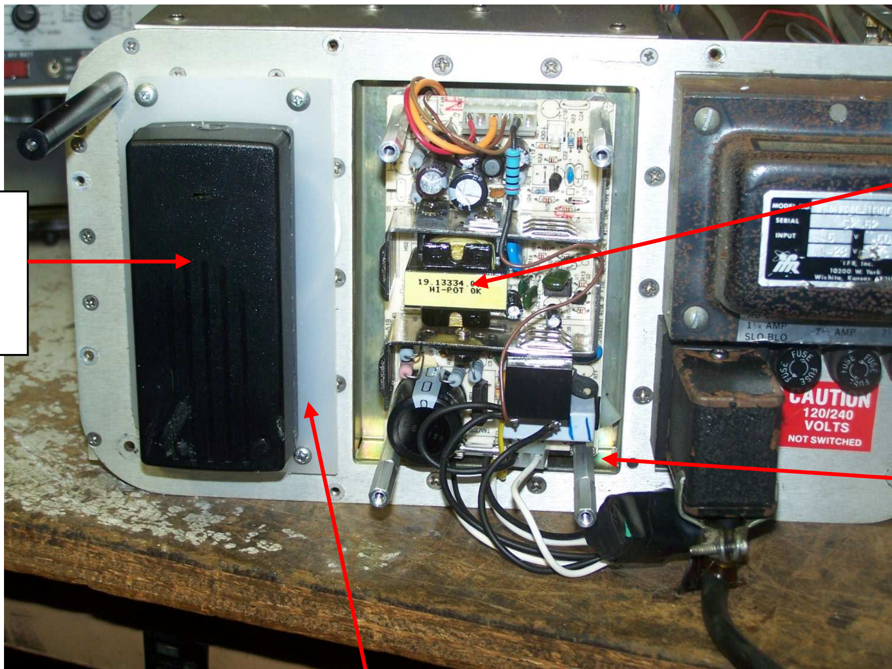
The +5 / +12.6 VDC power supply will be covered over by the original battery cover using aluminum standoffs and drilling extra holes in the corners of the plastic battery cover.

-39 VDC SOURCE:

I was unable to find any OEM type power supplies that had all three voltages in the same package. I ended up using a HP printer power supply with an isolated +35 VDC source and then reversing the output to become a -35 VDC source. There are many smaller sized HP printer power supplies available at swap meets, E-Bay and from well stocked junk boxes. Most any voltage above 30 VDC can be used up to 500 MHz but I looked around for units that had 35 VDC or greater. The original -39 VDC voltage is further regulated downstream for powering the phase locked loop reference voltage.

Some newer technology power supplies use +35 VDC to power CAT5E cable accessories. These power supplies have an injector adapter that then can be used for downstream remote TV cameras, telephone audio amplifiers, CATV pre-amplifiers and data devices. I cracked open several CAT5E power supplies and rewired them for an AC source (black / white primary wires) and DC output (orange / green) for the -35 VDC output. I used green for the -35 VDC power source and orange as the ground.

-35 VDC Power Supply. Case glued to plastic cover panel.



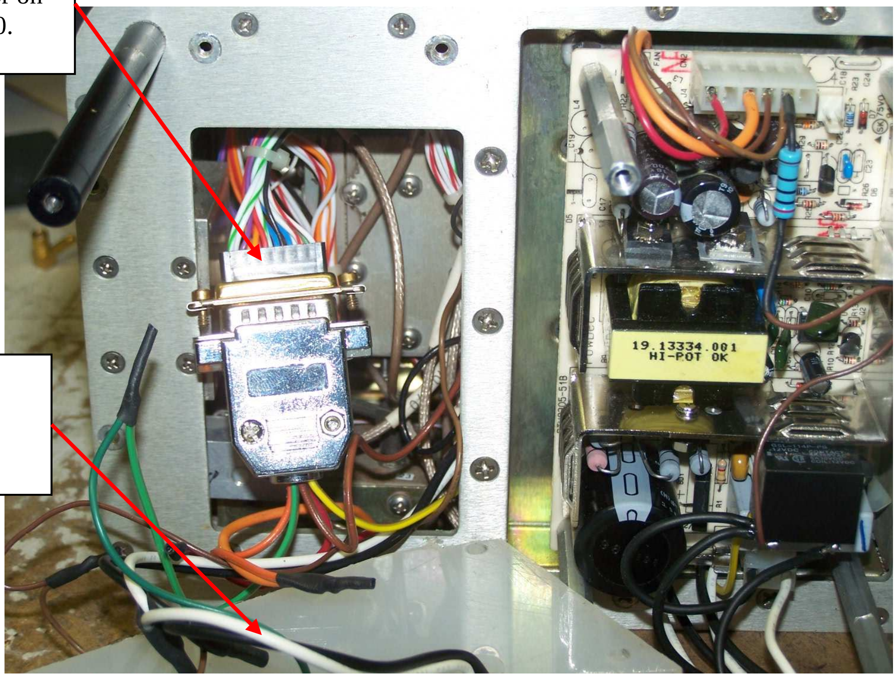
Switch mode power supply in place of original gel-cell battery.

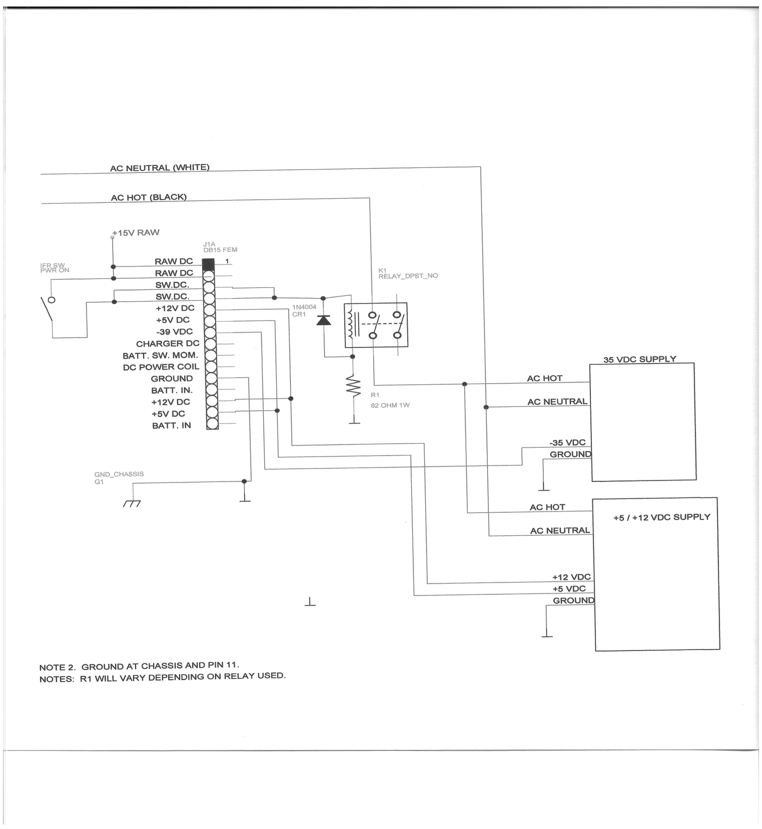
Standoffs mounted into tapped holes in case.

Plastic cover drilled to match original power supply holes.

Original DB15 power connector on IFR 1000.

Wiring to -35 VDC power supply.

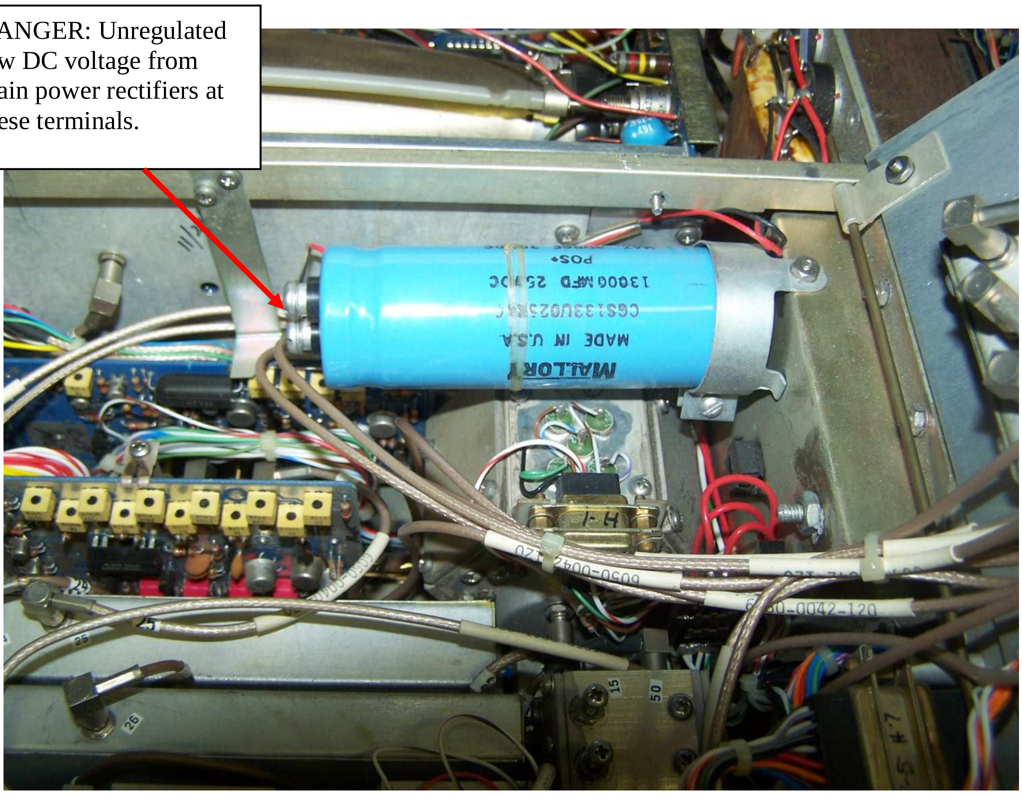




The main computer grade filter capacitor that is mounted in the center top of the IFR 1000 is a worry because the +15V RAW DC unregulated screw terminals are nearly touching the top door modules when the top is closed.   Originally there was some sort of shrink wrap cover over the terminal leads but in all of my units they have long since disappeared. These IFR units are built like a Swiss watch and if anything is even slightly out of position it may short out to other assemblies as the doors are closed and tightened down.

If you replace the original power supply with the above modifications then you will not need as much ripple regulation and can get away with a smaller value computer grade electrolytic capacitor.   The original capacitor is 4.5” tall and replacement capacitors of smaller value / same voltage ratings are commonly available that are less than 3” tall.   I strongly suggest that when replacing the electrolytics that you use a smaller value but same diameter capacitor for C18001.   See picture below.

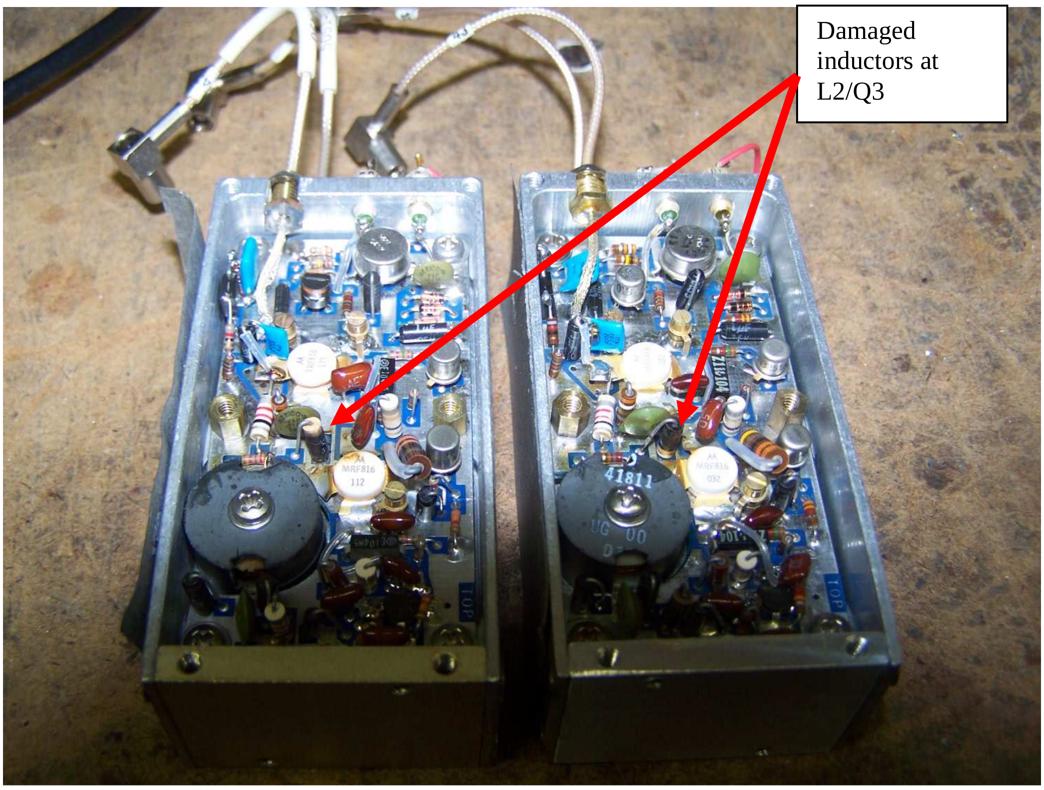
DANGER: Unregulated raw DC voltage from main power rectifiers at these terminals.



Hi Level Amplifiers:
The IFR 1000S and some 1000A monitors have a high level output option that includes a 55 dB gain amplifier block, 0 dBm sensing warning light and 3 position high level output toggle switch.   The basic unit puts out a maximum -33 dBm (5000 uV) signal that is more than adequate for repairing / calibrating a working radio however is not sufficient for adjusting cavities in the field, repairing dead receivers or radiating a test signal to a local antenna to verify audio performance over the air.

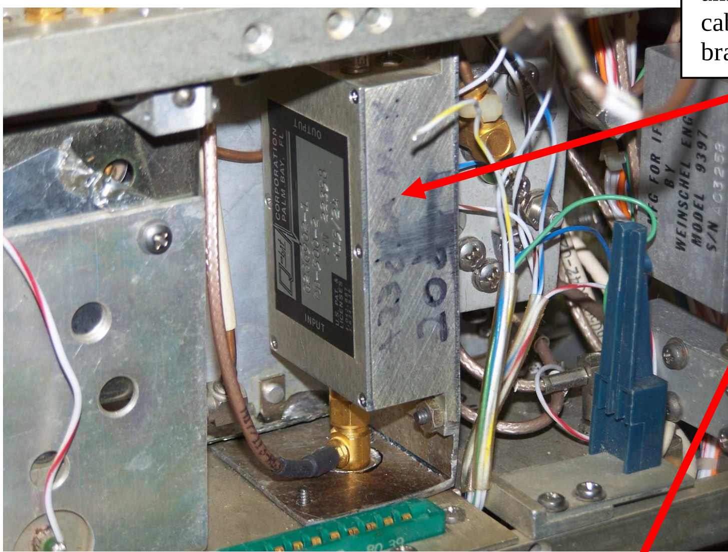
The basic 50 uV standard indicated signal can be switched to X100 (5000 uV) switch and then in the Hi-Level models go to a maximum output of about +20 dBm (100 milli-Watts).

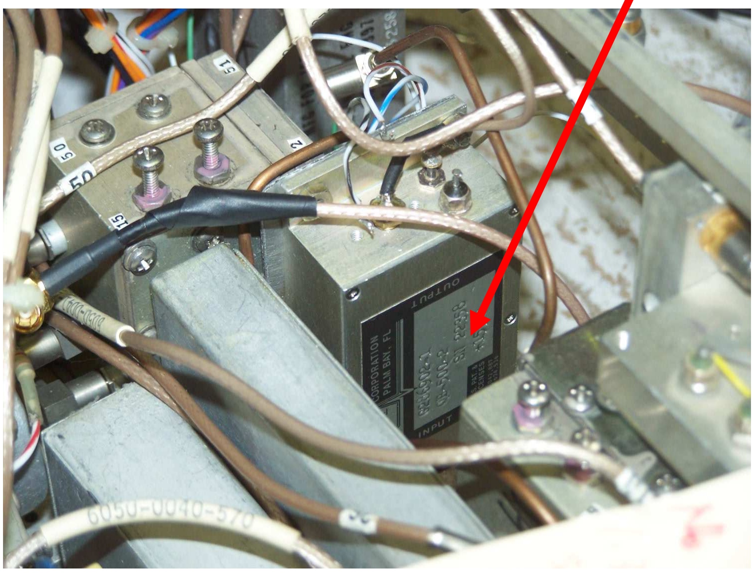
The Hi-Level amplifier again was probably a good design for the time but the original MRF911 and MRF816 RF devices have long gone obsolete. When last I checked the two MRF816 output transistors had an asking price of $113 each. Of the 3 IFR 1000S units 2 had burned up Hi-Level amplifiers.   The same stage had smoked in both units with blackened inductors, charred PCB and shorted semiconductors.



I had several 20 dB gain, Q-Bit 500-2 block amplifiers that operate from 2 to 500 MHz and have slightly reduced output above 500 MHz. I manufactured some aluminum brackets to take the place of the original aluminum shielded enclosure and reworked the original SMA RF connectors to be compatible SMB fittings. See photographs below. Mini-Circuits also make the ZFL-1000 series of amplifiers. When I was working in EMC testing, I used two SMA connected units in series a LN (low noise) and the other high-level amplifier as gain blocks. This provided a 50 dB gain up to 1 GHz. As their price was about $40 - $60 each I elected to use what I had on hand.

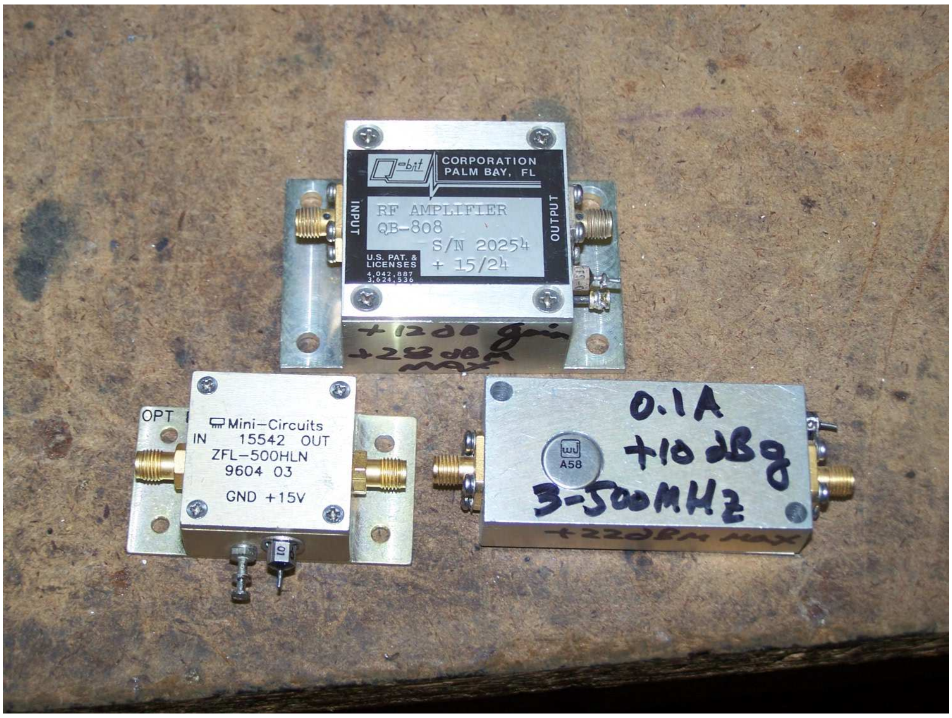
Replacement High Level amplifier using modified SMA cable adapters and mounting bracket.





While the output of the Q-Bit 500-2 the IFR's output only goes from -33 dBm (5000 uV) to -13 dBm (50,000 uV) this 20 dB gain block provides enough RF output to jam a signal into almost any dead front end and do signal tracing with a spectrum analyzer or sensitive wide band oscilloscope. It probably is not enough power to radiate a test signal to a repeater.

Alternate amplifiers are commonly available from surplus sources.



CAPACITORS:
Electrolytic capacitors had a limited lifetime. They may last 50 years but don't bet on it. Generally, you are pushing them beyond their normal failure mode curve at 25 years. If the IFR has been stored in a hot vehicle for most of its' life, then the life of the capacitors will also be reduced.

After opening up the chassis and removing all the assessable covers, replace ALL of the electrolytics that are easily accessible. Especially any large bulk capacitors on the chassis or used in the primary power supplies. Some of the modules will include screwed on covers and are difficult to remove. If you do not change out the electrolytics there 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 I call the desperation factor. Whenever you are desperate that the piece of equipment absolutely needs to work and you have no backup equipment, that is when the weak components will decide to fail. This is a technician's subset of the normal "Murphy's Law".

I have a well stocked goodie box but you may not, if you do not then you will have to purchase the capacitors from a list (Excel sorting makes this much easier) show 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 have a rating of 85º C. Power supplies often require higher temperature 105º C components.

Electrolytic capacitors are not typically used for any critical time constant applications. Any higher voltage can be substituted for any lower voltage of the same rating (example 50 V substitutes for a 25 V original). The older electrolytic capacitors often had a +80/-20% tolerance and today this is typically +/- 20%. You may substitute a higher value electrolytic (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 also a 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 kind of like electrolytics, except that they normally also 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. I generally let the tantalums go on my initial inspection and then wait for the first power up smoke test. Then I replace them as necessary after powering up the device and searching for other troubles. Be sure to check all the primary voltages from the power supply once the unit is up and initially operating. An over-voltage condition may not show up as a trouble or functional problem but will be a cause of failed components that otherwise would not have failed.