2.4 GHz Spectrum Analyzer Adapter

Overview

This is a updated and slightly more robust version of a 2.4 GHz downconverter which we first talked about in Issue #6. This particular downcoverter will be designed mostly for extending the range of a spectrum analyzer or a frequency counter. The high dynamic range will also allow this converter to be useful in certain electronic warfare applications.

The RF input will be able to handle slightly more input power, up to 100 mW (+20 dBm), and will not be bandpass filtered. An optional external bandpass filter can be used to narrow the frequency range of the mixer. The 2.278 GHz local oscillator will be supplied from a stock California Amplifier MMDS downconverter circuit board. The downconverter's die–cast aluminum case and the antenna input N connector will also be used.

The theory of operation is simple. Direct RF energy in the range of 2.4 GHz to 2.5 GHz is applied to the RF port on a Mini–Circuits MBA–25MH mixer. The California Amplifier's 2.278 GHz local oscillator signal, slightly underpowered at +5 dBm, will then be applied to the mixer's LO port. The mixer's IF output will be in the VHF frequency range, at around 172 MHz for a 2.45 GHz input. The IF signal will then be low–pass filtered and sent to a Motorola MWA120 wideband amplifier. The MWA120 was chosen for its natural tendency to roll off frequencies above 400 MHz, and also for its fairly low–noise and high third–order intercept capabilites. Standard Mini–Circuits MAR–x series MMICs can be used for post–mixer IF amplification, or even no IF amplification can be used, if so desired.

Proper RF and microwave construction techniques will be required to keep the circuit from oscillating or generating a large amount of output spurious signals. Proper 50 ohm termination on all the mixer's ports will also be required for maximum performance.

Frequency Conversions

RF Input (MHz)	IF Output (MHz)	Notes
2300	22	13 cm Ham Band
2325	47	
2350	72	
2375	97	
2400	122	Part 15 / Ham Band
2425	147	Part 15 / Ham Band
2450	172	Part 15 / Ham Band / Microwave Ovens
2475	197	Part 15 / Ham Band
2500	222	MMDS
2525	247	MMDS
2550	272	MMDS
2575	297	MMDS
2600	322	Pedophiles / MMDS
2650	372	MMDS
2700	422	MMDS

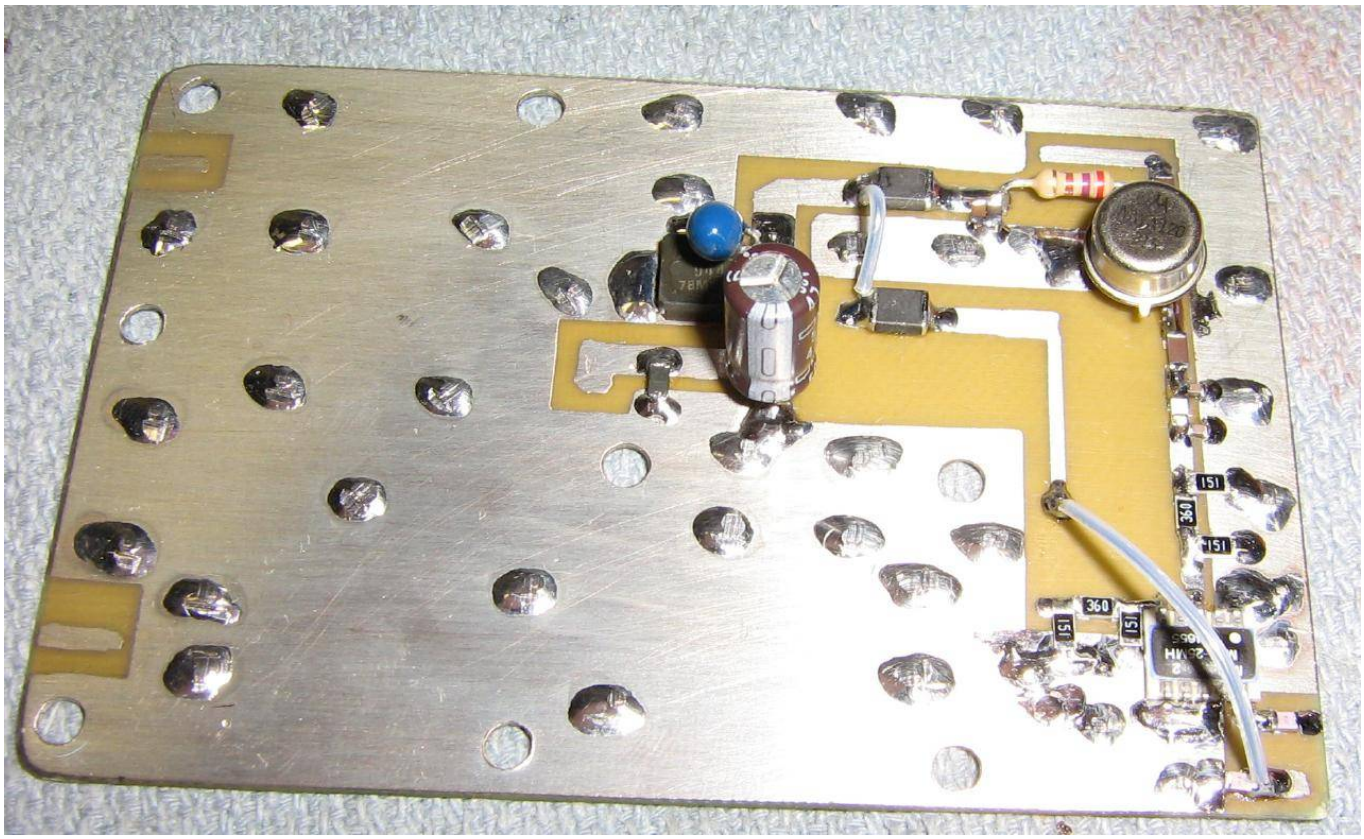
Local Oscillator : 2.278 GHz

The optional IF low-pass filter rolls off gain above 250 MHz.

Construction Notes & Pictures

Parts overview for the ammo box we'll mount the converter in.

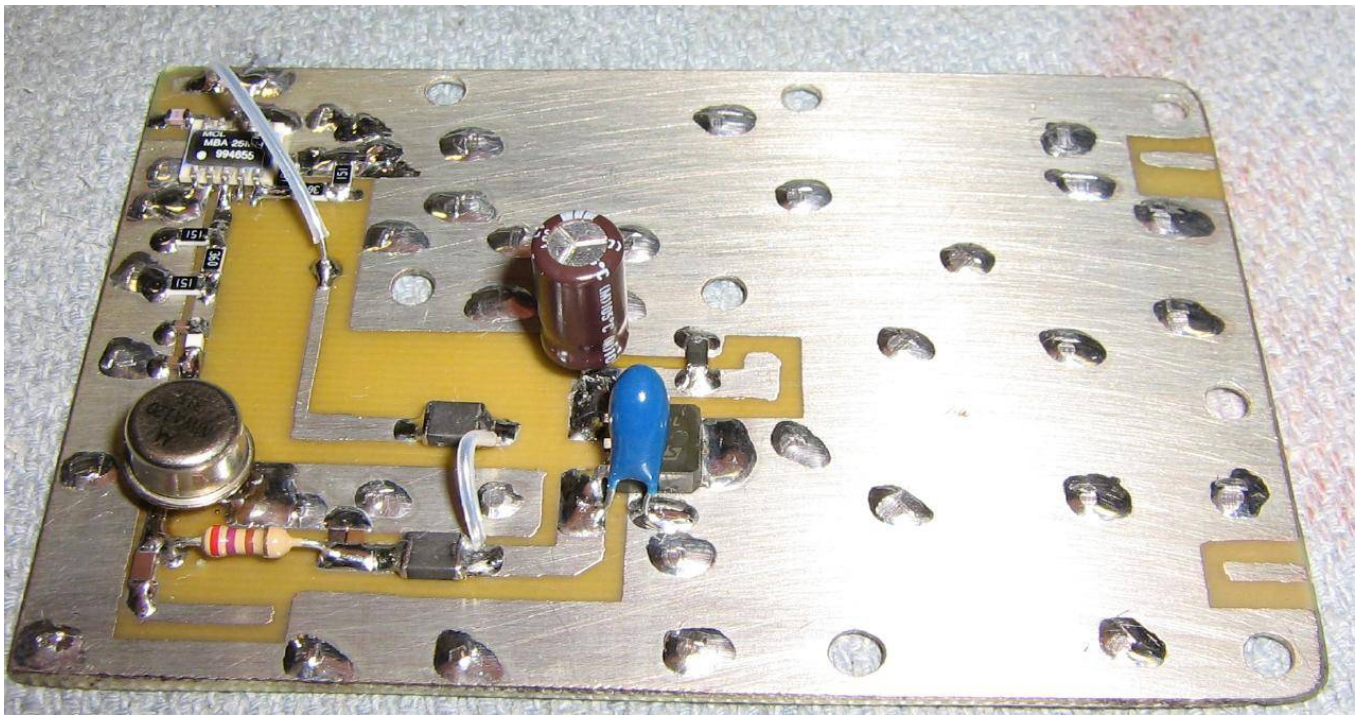
To the left is a filtered IEC AC line socket, a panel–mount fuse holder, a SPDT switch with a rubber boot cover, and a green neon power indicator lamp. In the middle are the panel–mount BNC and N RF connectors which will be used to connect up to the converter. On the right is a surplus +15 VDC "wall wart" power supply secured to a small piece of right–angle aluminum. Solder the 120 VAC input to the wall wart directly to the prongs and cover them with heatshrink tubing.



Assemble the converter PC board as shown above.

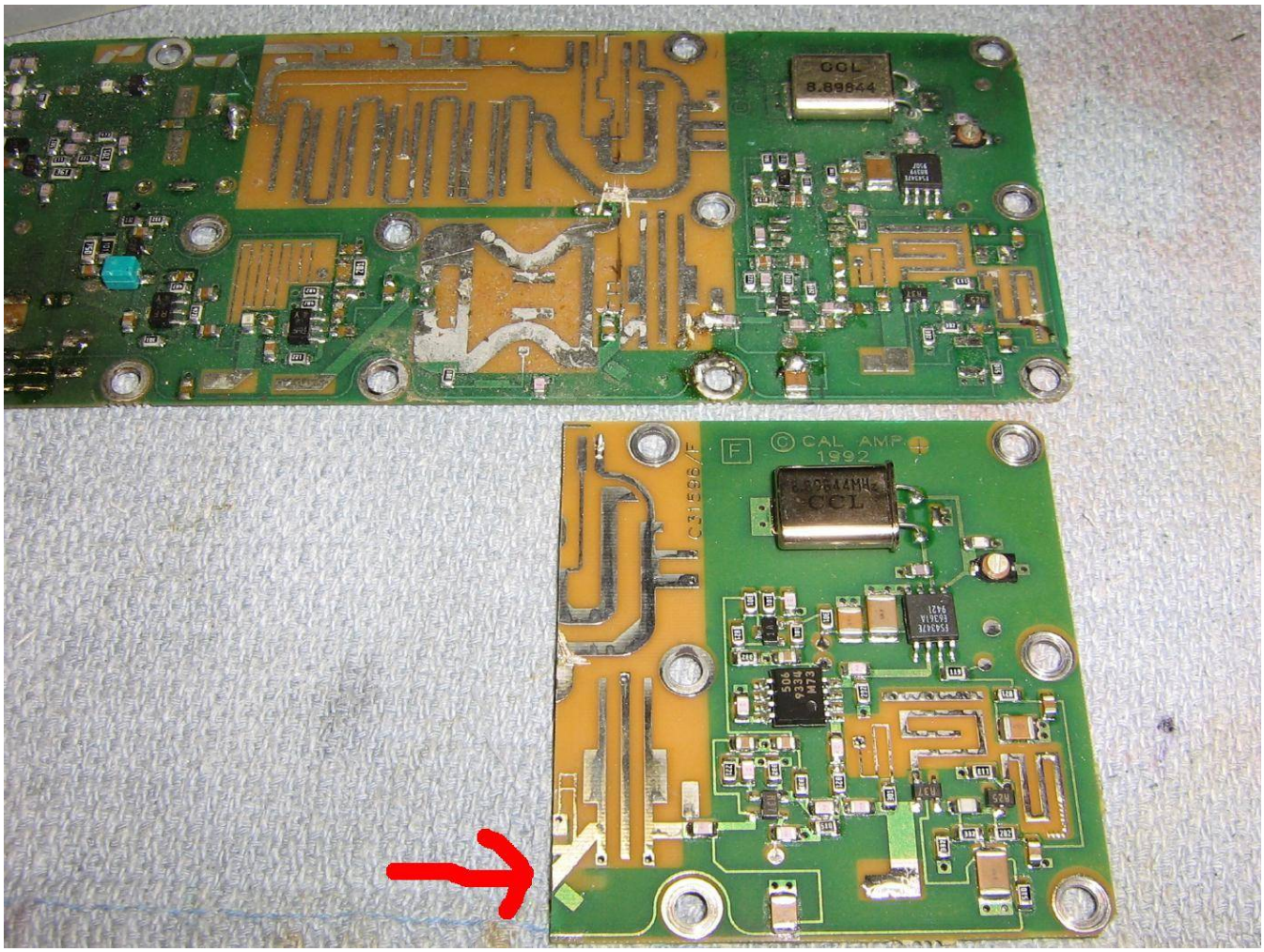
The mixer's local oscillator input is on the lower–right. The RF input is via the attenuator pad going off to the left. The IF output goes up into the MWA120 amplifier. A 78M12 regulates the incoming wall wart voltage.

The jumper wire is the +12 VDC line for the stock local oscillator section in the California Amplifier downconveter.



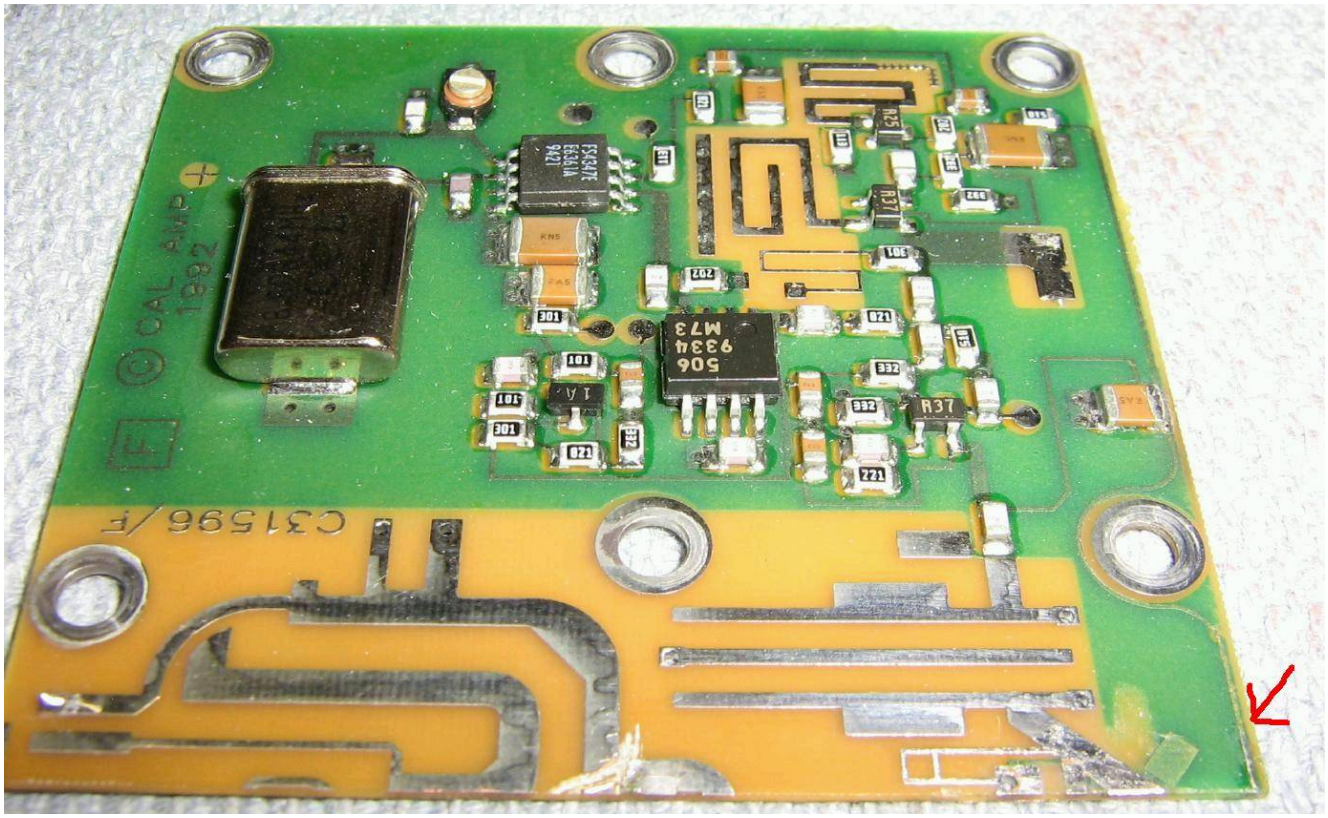
Alternate view.

The large black things in series with the voltage lines are surface−mount ferrite beads. The input filter capacitor to the 78M12 is 47 µF and the output capacitor is a 10 µF tantalum.



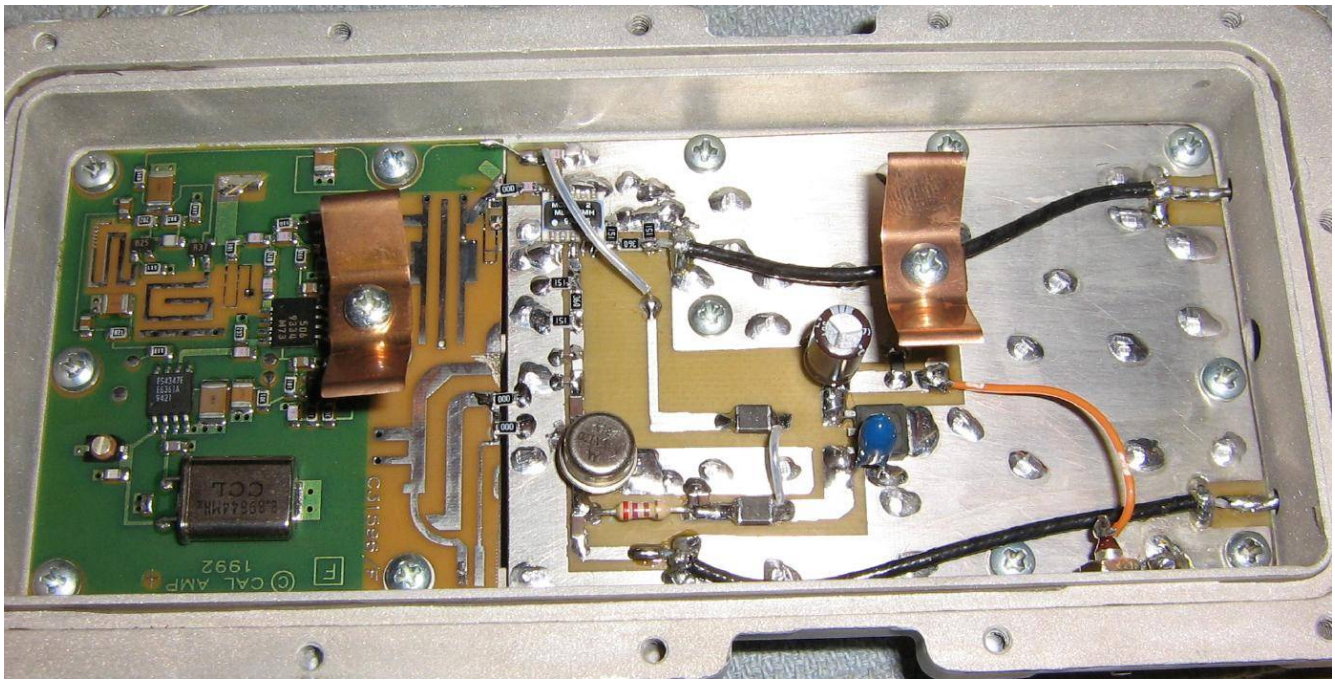
Modified California Amplifier downconveter.

The red arrow points to the downconveter's local oscillator output, after a stripline bandpass filter. The 2.278 GHz signal is at around +5 dBm (3.1 mW). This is a little low and conversion loss will suffer. The mixer is designed to see at least +10 dBm (or even +7 dBm) on its LO port.



Close up view.

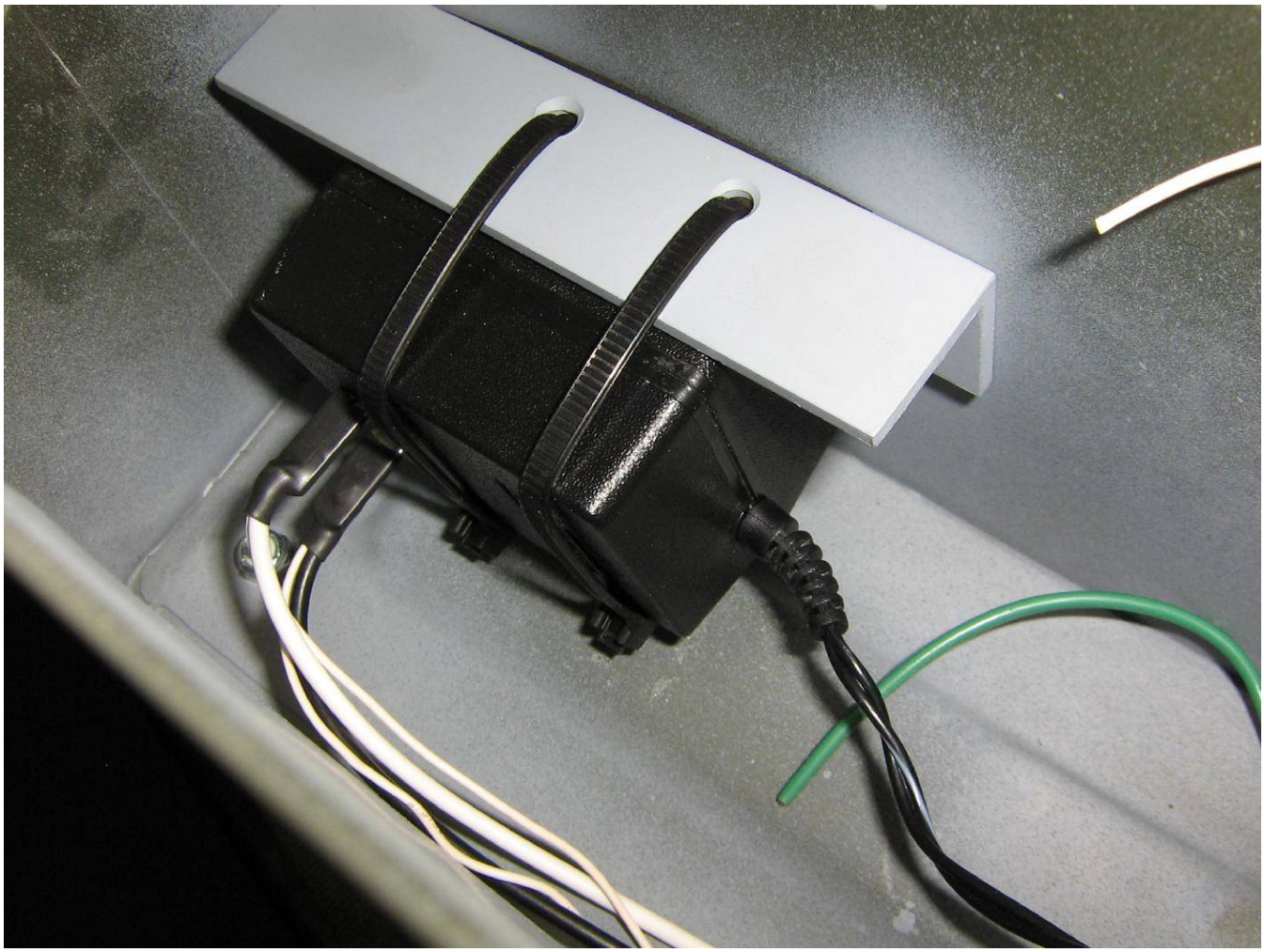
You'll have to scrape a little bit of solder mask off the output stripline from the bandpass filter, as shown on the lower−right. Also note the thin stripline trace off to the far−right of the PC board. This is the +12 VDC line for powering the 2.278 GHz oscillator circuit.



Install the new PC board, being sure it is both mechanically and electrical stable.

You can also install the RF connectors at this point and small pieces of coax to connect up to the connectors. For this particular project, a N connector will be used on the RF input and a BNC connector on the IF output.

Small zero−ohm jumpers connect the downconveter's local oscillator output to the new PC board. The two zero−ohm jumpers to the left of the MWA120 in the above photo are for mechanical stablity.



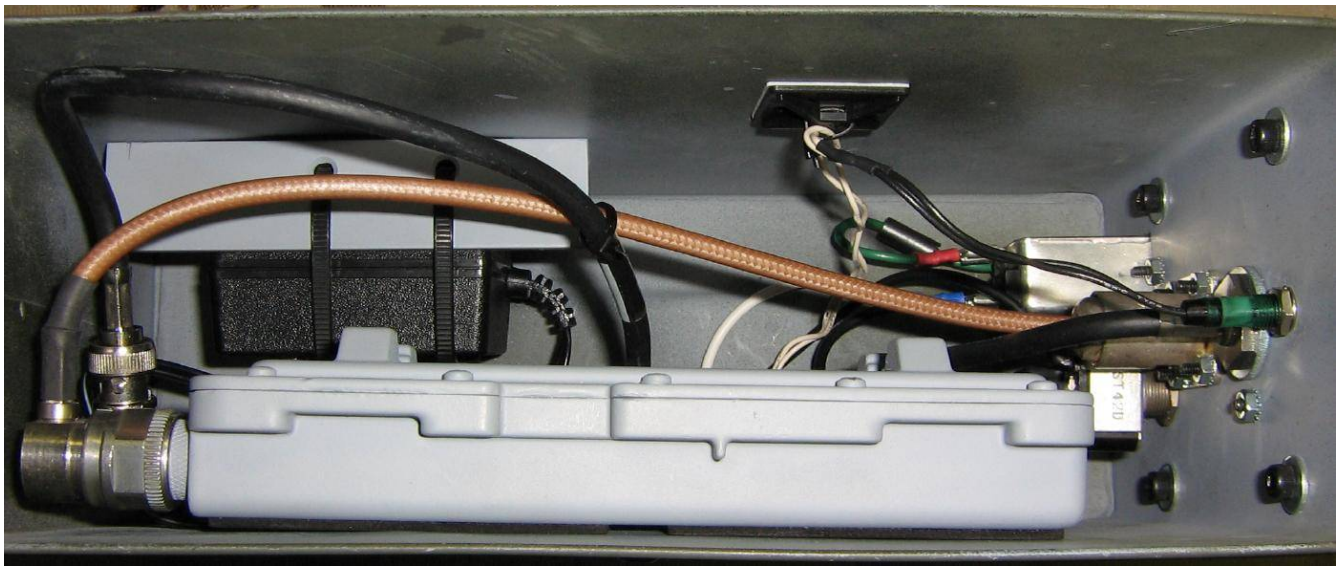
Mount for the +15 VDC wall wart power supply.

Secure the power supply itself with small pieces of art foam and zip ties.

The incoming AC power lines are soldered directly to the wall wart's prongs, with the extra set of wires to power a neon power indicator lamp.

Rear view of the front panel AC power input connections.

A small ferrite bead is slipped over the green ground wire on the lower–left. The ammo box should have a good Earth ground.



Installation of the MMDS downconverter case holding the new converter circuit board.

The MMDS downconverter case is secured to the side of the ammo box using a small 1/4"–20 inch bolt and some art foam.

Note the RF cable connections to the front panel.

Alternate internal overview.

Completed front panel overview.

There are dust caps installed on the input N connector and the output BNC connector.

Brass drawer handles protect the front panel and the RF connectors from any abuse.

The green neon lamp in the upper–center is a 120 VAC power indicator.

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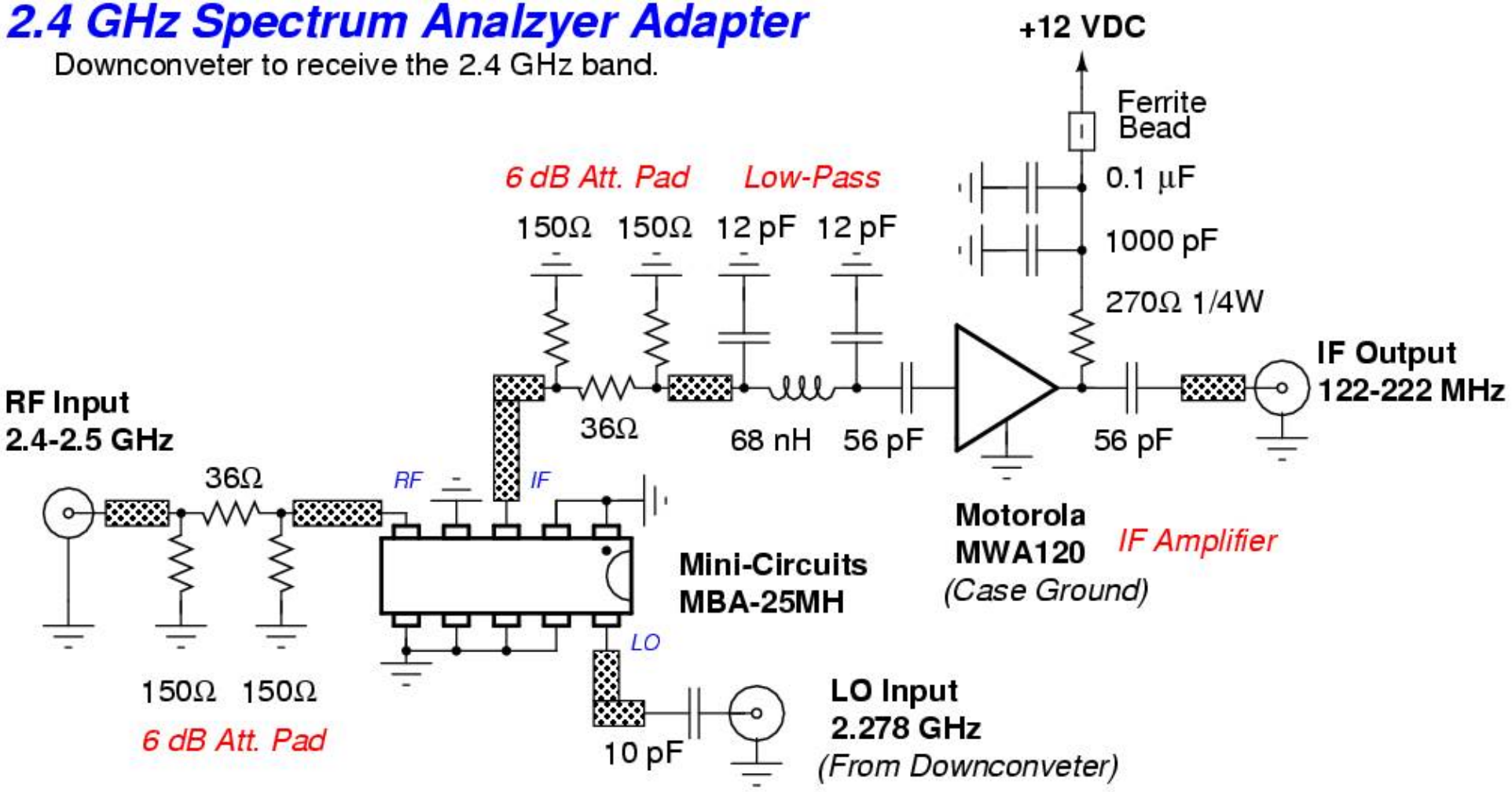
Downconveter to receive the 2.4 GHz band.



50Ω microstrip line

Ferrite bead is from an old SVGA video card.

Add bandpass filter on the input to decrease bandwidth.

The IF amplifier is optional.