Antenna Switch for 2.4 GHz Applications

Overview

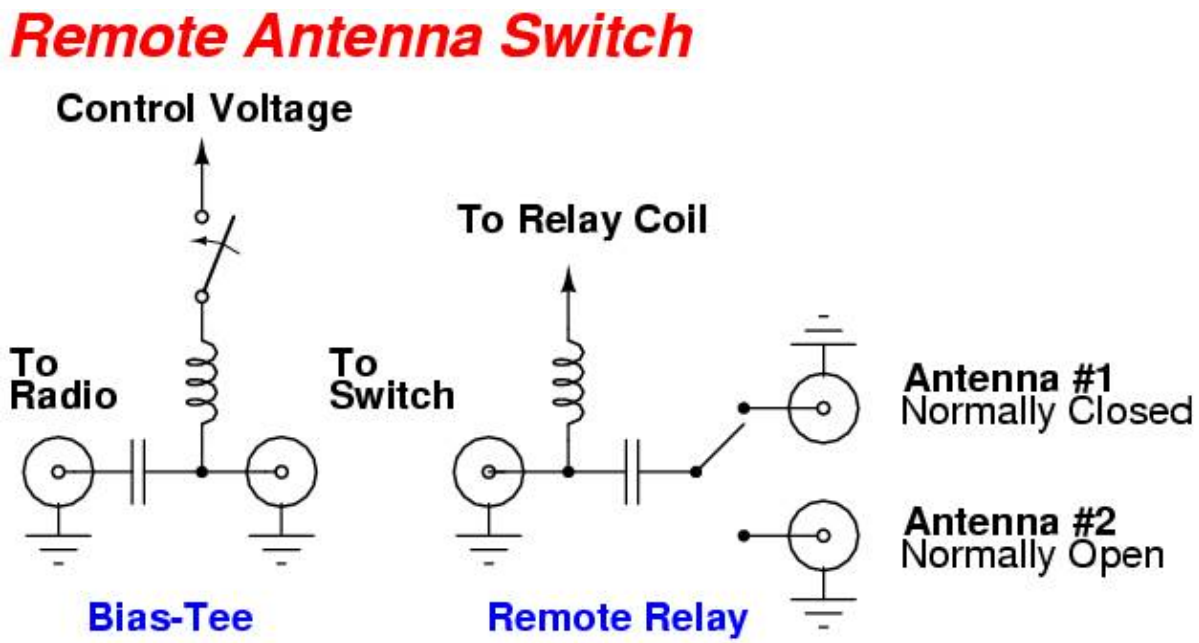
Probably every amateur radio experimenter in the history of the planet has experienced the same problem – you have too many antennas and not enough feed lines. The common solution to this problem is to use a remote–mounted, automotive relay to switch between two or more antennas at the end of a single coaxial feed line run. Automotive relays work quite well up into the VHF range, and they can even switch several hundred watts of RF power. At UHF and microwave frequencies, the preferred method of antenna switching is to use special RF relays, which are usually very expensive, hard–to–find, and sometimes operate at strange high voltages.

Thankfully, a new and cheap solution to this problem had come around. Omron Electronics now sells a series of low–cost, surface–mount RF signal relays that can easily switch low–levels of RF power up to at least 3 GHz. The Omron G6Z–series of RF signal relays offer fairly high isolation (30 dB min.) and low insertaion loss (0.5 dB typical). They will also handle up to 10 watts of RF power if you wish to transmit through them. The can be ordered to operate at the standard 5 and 12 volts and need less than 100 milliamps to operate. They also offer versions with a 75 ohm impedance for video switching operations. All this with only a price tag of around $6 each!

For this project, we'll be using the Omron G6Z–1FE–A relay, which is available from Mouser Electronics. The idea is for this circuit to remotely switch between two antennas operating in the 2.4 GHz band. The basic idea is to switch between an omni–directional and directional Yagi antenna to monitor any signals in the local area.

To use the RF switch remotely, we'll need to also build a device called a "bias–tee" which will inject the relay's control voltage into the common coaxial cable feeding the switch. The bias–tee can inject this DC voltage into a coaxial cable system without effecting any RF signals or altering the line's impedance. The use of a bias–tee to control the switch is optional, as you can just run an external control line, if you choose.

Block Diagram

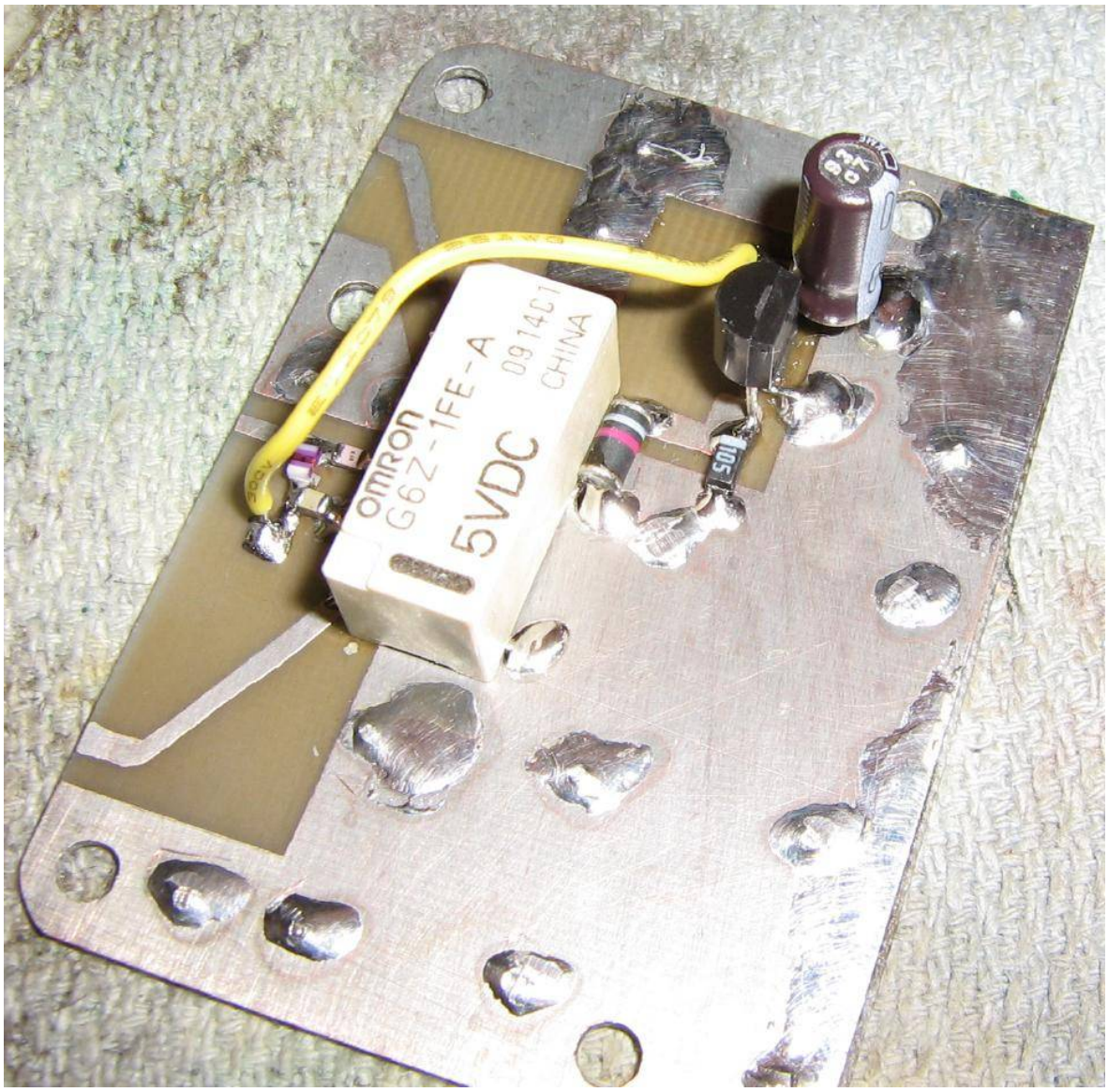


Construction Notes & Pictures

PC board construction for the remote relay switch. Good RF construction skills will be required if operating at UHF or microwave frequencies. This board was designed to be mounted in an old California Amplifier MMDS downconverter case.

The inductors in the bias–tee circuit should be chosen to have an impedance of around 200 to 400 ohms at the *lowest* operating freqency and also a self–resonant frequency *above* the highest operating frequency. They should also be able to handle the relay's current draw without saturating (40 mA continuous).

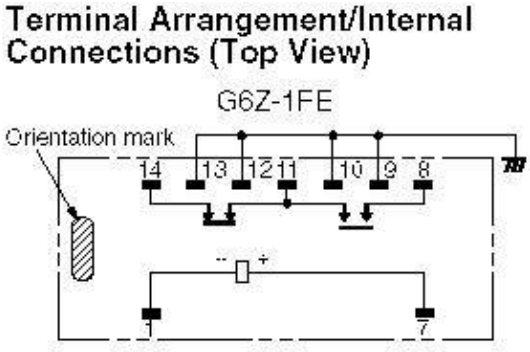
The DC–blocking capacitors should have low impedance over the operating range and should also be able to handle the DC voltage.

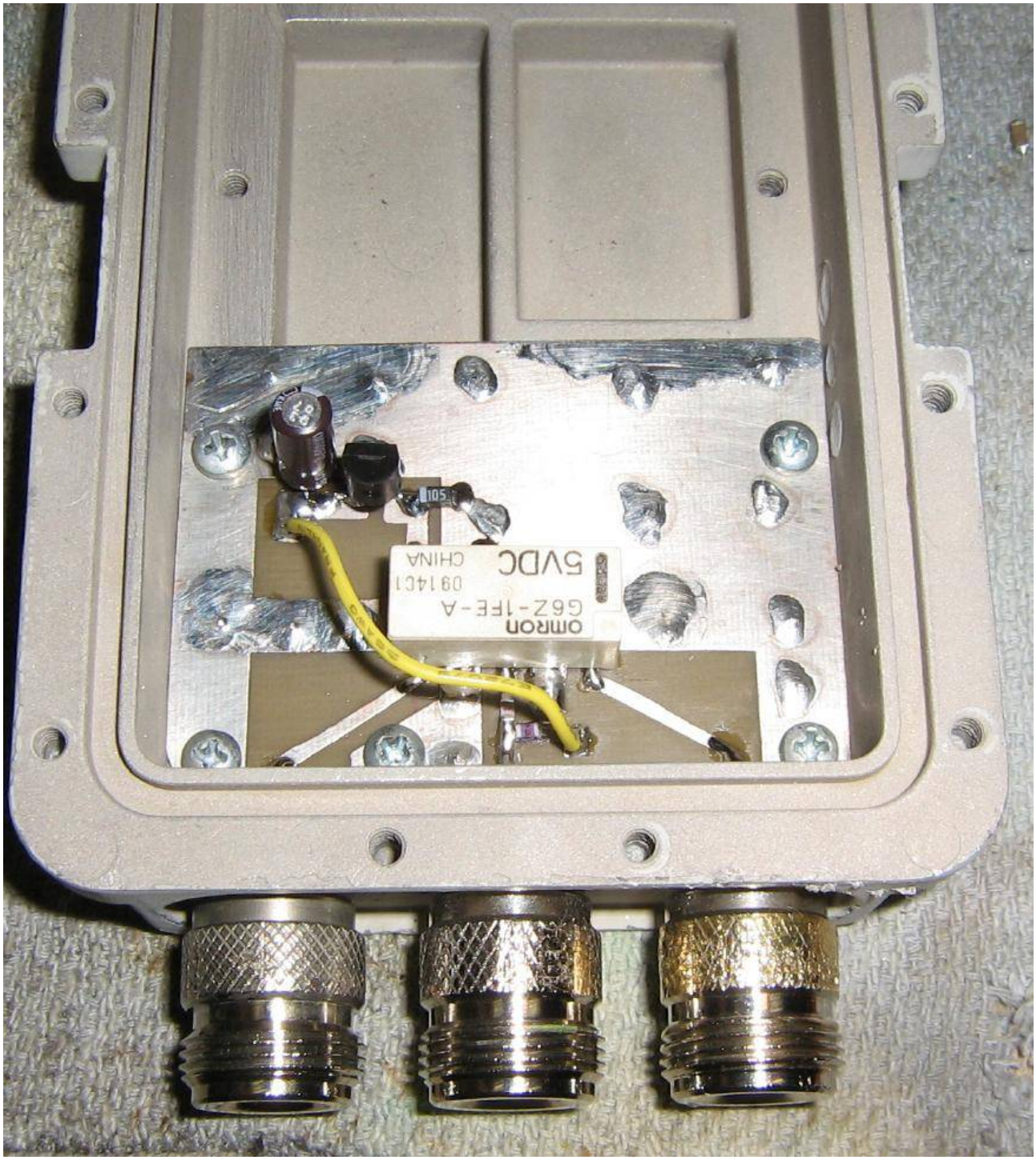


Construct the circuit as shown. The ground pins on the relay need to be connected directly to the circuit board's ground plane with low–inductance vias.

Pin–out diagram for the Omron G6Z–1FE–A relay. Pin–11 in the **RF Common**, Pin–14 is **Normally Closed**, and Pin–8 is **Normally Open**.

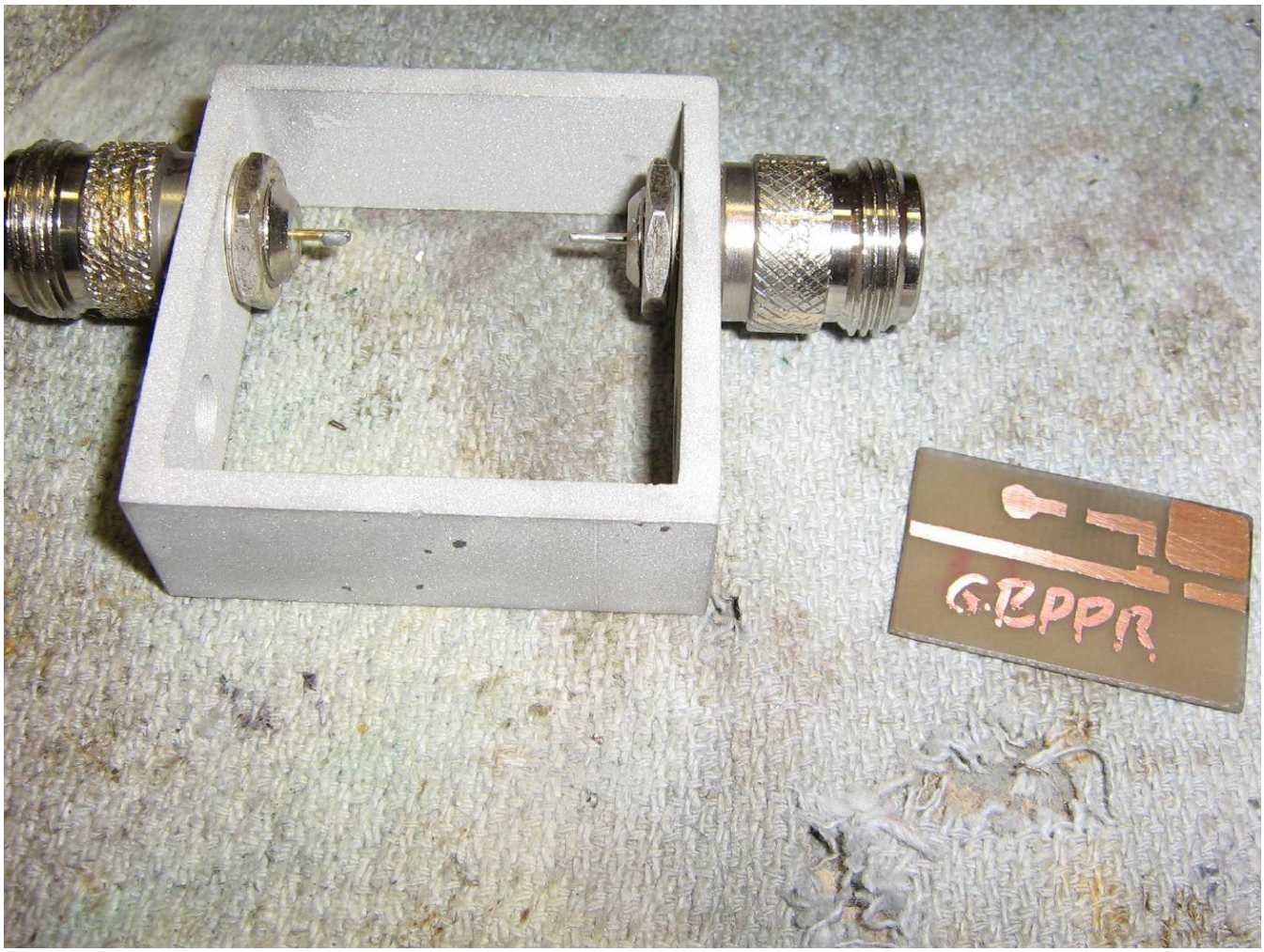
Pins–1, –9, –10, –12, –13 are **Ground**, and Pin–7 is the relay's coil **Positive**.





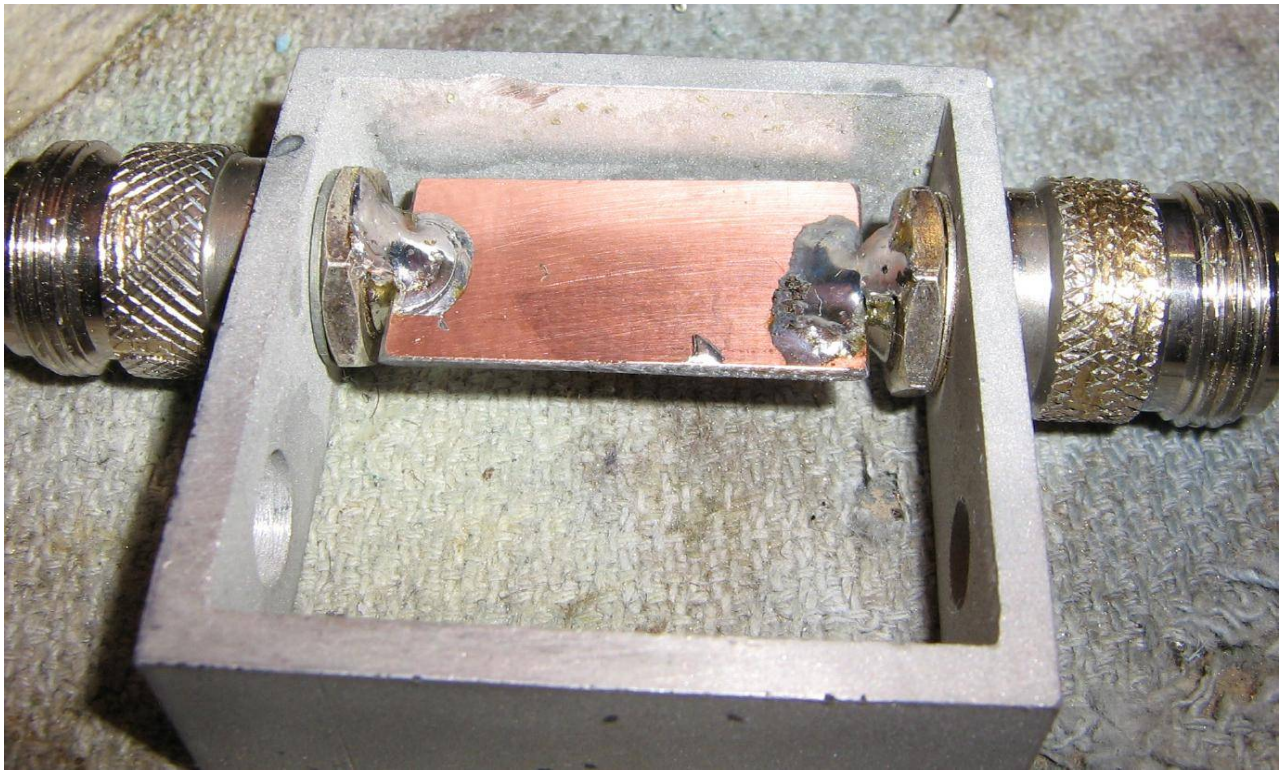
Alternate view showing the circuit board mounted in the case.

The three N connectors are a little too cramped for most N connector shells, so you may have to fiddle with them a bit when connecting the cables or use different style connectors.

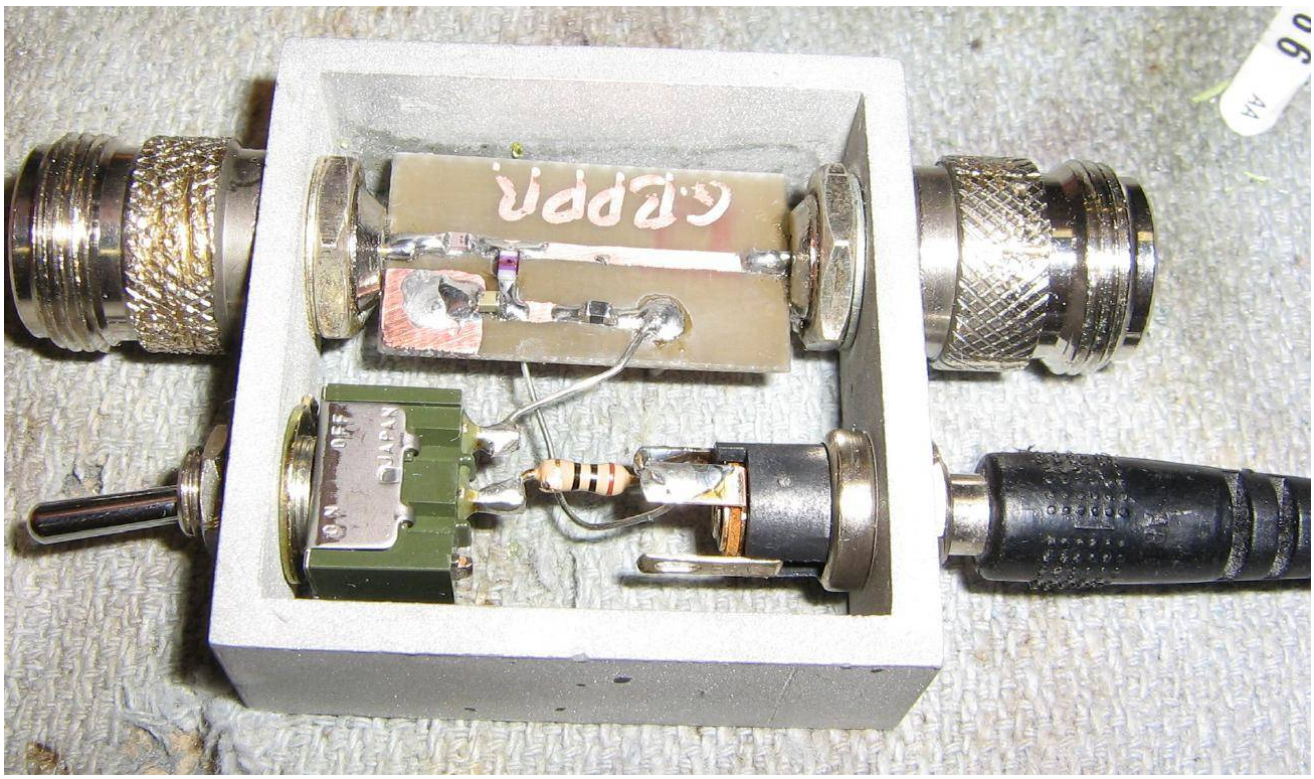


Beginning construction on the bias−tee.

The case is from an old VHF pre−amplifier. The bias−tee's circuit board is on the right.



Bottom ground connection of the PC board to the N connectors. Grind the base of the N connectors with a Dremel tool to "roughen" them up to allow them to more easily take solder.



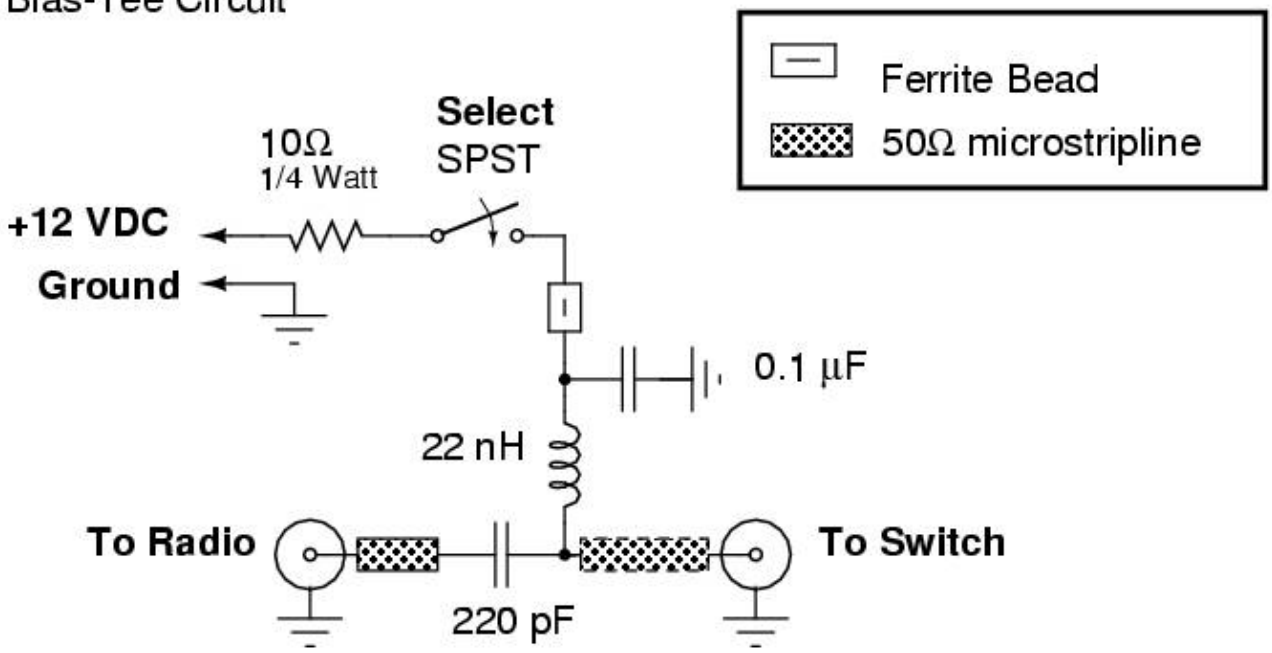
Overall view of the finished bias–tee. There is not much to it. The DC voltage comes in via a 12 volt wall–wart power supply and is controlled via a SPST select switch. A 10 ohm resistor acts as a current limit and fuse. The radio connects to the left–side N connector. The switch circuit and DC–inject signal connect to the right–side N connector.

Finished view of the switch and bias–tee cases.

Schematics

Antenna Select Relay for 2.4 GHz

Bias-Tee Circuit



Antenna Select Relay for 2.4 GHz

Relay Circuit