Dual Band 10 GHz / 24 GHz Transverter Design Considerations

By

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When I began constructing a 24 GHz transverter, my first step was to decide how to package the system. I had a 10 GHz transverter system in a chassis that used considerably more space than it actually needed, and one day had the idea to assemble the new 24 GHz system in the same chassis, providing only one "box" to house both units. This was appealing in that it would eliminate additional space requirments while roving and could be incorporated into the existing antenna system by use of a dual band feedhorn[1]. While this particular article deals with 10 and 24 GHz, the same concept can be used for any dual band transverter combination.

Dual Band Requirements

My first step was to identify the system requirements for two transverters to function in one housing. They are:

- The system must operate from a single 12 Vdc source
- The system must operate from a single 144 MHz IF source
- Each individual transverter must operate independently from the other.
- All oscillators must remain on at all times when the main power is on to promote stabilization when the required transverter is pressed into service.
- The design must not produce interfering conditions between transverters

With this in mind, I set out to incorporate the 24 GHz transverter into the 10 GHz transverter housing.

Physical Layout

To maintain anonymity between the transverters, I chose to place the 10 GHz components on the left side of the chassis and 24 GHz on the right side. This worked great in that it allowed a free space down the center to run interconnecting RF, DC voltage, and control lines and branch them off as needed at the appropriate place.

The RF stages should be located at the rear of the chassis where antenna connections will be. Likewise, the Source should be located near the front of the chassis since they normally require only DC voltage.

10 GHz Section

My 10 GHz transverter was a basic system. It utilized a 10.224 GHz source to a mixer with a 144 MHz IF. The mixer output connected to a 10 GHz bandpass filter with an SMA relay at the output for TR switching between a series of preamps[2] for receive and a 2 stage N1BWT 10 GHz amplifier[3] on transmit. The only issue to address here was the 24 Vdc requirement for the source. Kent Britain had located some modules that had a 9 to 30 Vdc input and produced a +22 Vdc output at 1.25 amps. This was perfect and incorporated into the design. The only other issue to address was IF switching and control. This was easily accomplished by utilizing a Down East Microwave PINK IF switching unit.

24 GHz Section

The 24 GHz transverter required more space because of the 144 MHz IF requirement. The source was a surplus Digital Microwave Corp (DMC) 21.887 GHz unit I located at Dayton. In order to get to 144 MHz, a 2.305 GHz IF stage would be required. A Down East Microwave 2304 MHz transverter board would work great since it uses a 144 MHz IF. The 24 GHz system then began with a 144 MHz IF through a DEM PINK IF switch board to the 2304 DEM xvtr feeding the mixer. The 21.887 GHz source fed the other mixer input. A 24 GHz filter was also acquired at Dayton with the source, so it is utilized at the output of the mixer, producing a clean 24.192 GHz RF signal.

Gain stages are a problem at 24 GHz. Available components on the surplus market are hard to find, and commercial components are usually to expensive for amateur purposes. I was fortunate to acquire two amplifier blocks with the source and filter. The problem with having only two is that I needed both on transmit and receive to provide sufficient gain for the system. I had an SMA transfer relay I was planning to use on 5.7 GHz. A quick check indicated it had very minimal loss at 24 GHz, so I utilized it to switch the two block amplifier line as preamplifiers on receive and power amplifiers on transmit. The system had a 4.5 dB noise figure on receive and produced about 100 mW output. In order to avoid "hot switching" the amplifier stage, I used a sequencer to control the transfer relay. The last thing I wanted to do was blow up my precious, hard to find 24 GHz amplifiers!

The only remaining issue for the 24 GHz system was the DC voltage requirement for the DMC components of 8.2 Vdc. I used a separate LM317 regulator stage to bias each component.

Control Circuit

- Relays
  All of the relays I used operated from 28 Vdc. A voltage doubler circuit was used to operate the relays from 12 Vdc. These are available from DEM if you prefer to buy them.

- DC voltage switching
  13.8 Vdc enters the rear of the unit through the Main Power switch. When this is in the OFF position, no component is on. When the switch is in the ON position, voltage is applied to the 10 GHz source, 24 GHz source, and the local oscillator for the 2304 xvtr. This allows all oscillators to warm and stabilize regardless of which band is being utilized or even if they are both turned off.

  From the Main Power Switch, a line connects to the 24 GHz Power Switch on the front panel. When it is in the OFF position, 13.8 Vdc is connected to the 10 GHz Power Switch. This gives priority to 24 GHz. Anytime 24 GHz in turned on, 10 GHz is turned off regardless of the 10 GHz Power Switch position. This was to prevent interference from the 10 GHz system into the 24 GHz system. Remember, the 10 GHz source is still running, only the amplifier and control circuits are disabled. When the 24 GHz Power Switch is turned off, DC voltage is made available to the 10 GHz system. In addition, the 24 GHz Power Switch provides control of the 144 MHz RF line going directly to the radio. With 24 GHz off, a relay is in the normally closed position routing the 10 GHz IF signal to and from the radio. When 24 GHz is turned on, it activates the relay to route the 24 GHz IF signal to the radio. There is only one PTT line required at the rear of the unit from the 144 MHz radio.

- Metering
  I chose to use a meter on the front panel to monitor power out on 24 GHz. One of the 24 GHz amplifiers had an output pin for relative power. I used a standard cheap meter picked up at Dayton for a dollar with a dropping resistor to calibrate the meter in milliwatts. I chose to get fancy, so I removed the meter face, scanned the image into my computer, modified the scale and identification, and printed a new face.

Front Panel

I use plexiglass as the front panel on all of my transverters. Plexiglass is inexpensive, can be cut to the exact size you want, is available at any glass shop, and is easy to work with.

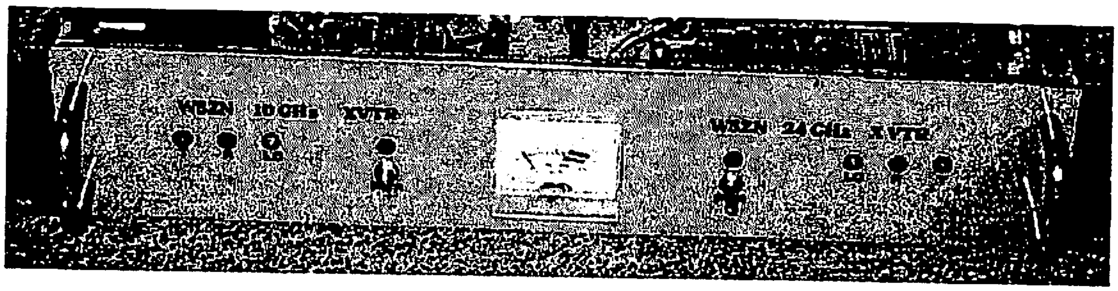
The front panel has the 24 GHz RF output meter in the center with the 10 GHz and 24 GHz Power Switches on either side. Each side also has LED's to indicate 13.8 Vdc power, LO voltage, and whether the unit is in transmit or receive.

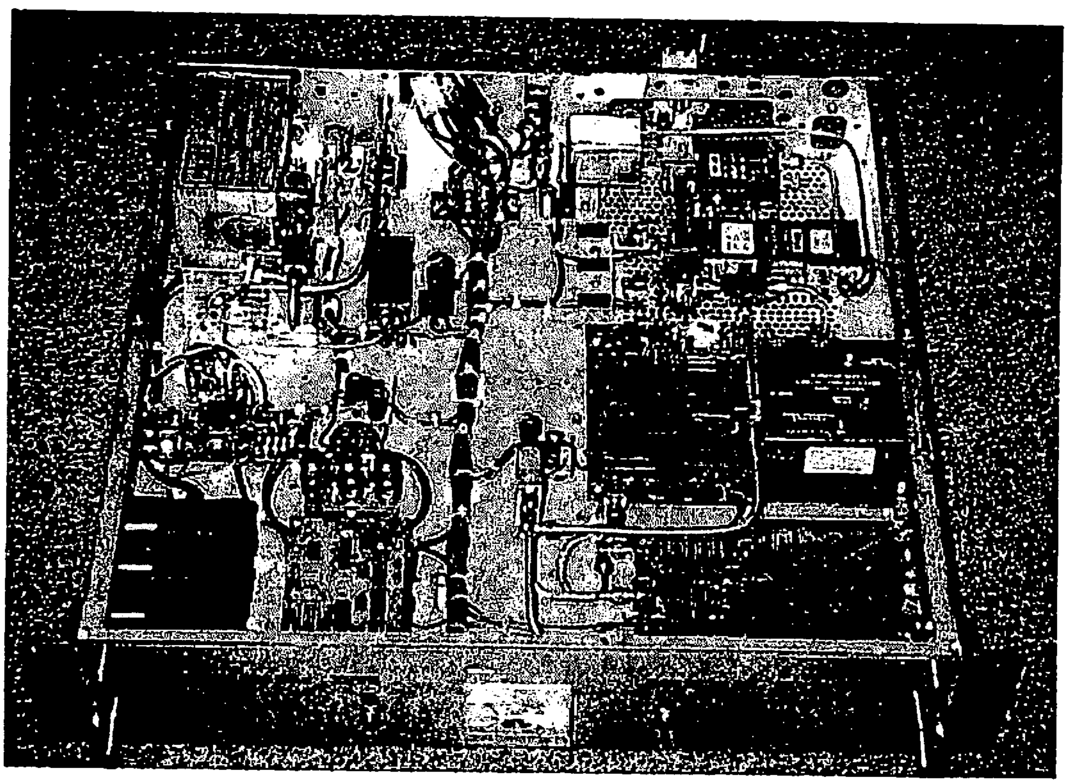
Conclusion

A block diagram of the dual band transverter is shown in Figure 1.

While there are many possible arrangements for dual band transverters, this is one which has work very well in rover operations as well as home station use. It provides the operator with easy control of the system from the front panel with just two switches for selecting the band to operate on. The remaining control is automatic via operation of the 2 meter IF radio.

References:
1. A number of articles have been published on dual band feedhorns. An separate article on a 10/24 GHz dual band feedhorn appears in this proceeding.
2. I recommend a LUACOM preamp by W5LUA as the first stage. Available from Down East Microwave.
3. Available from Down East Microwave





W5ZN 10 GHz / 24 GHz Dual Band Transverter

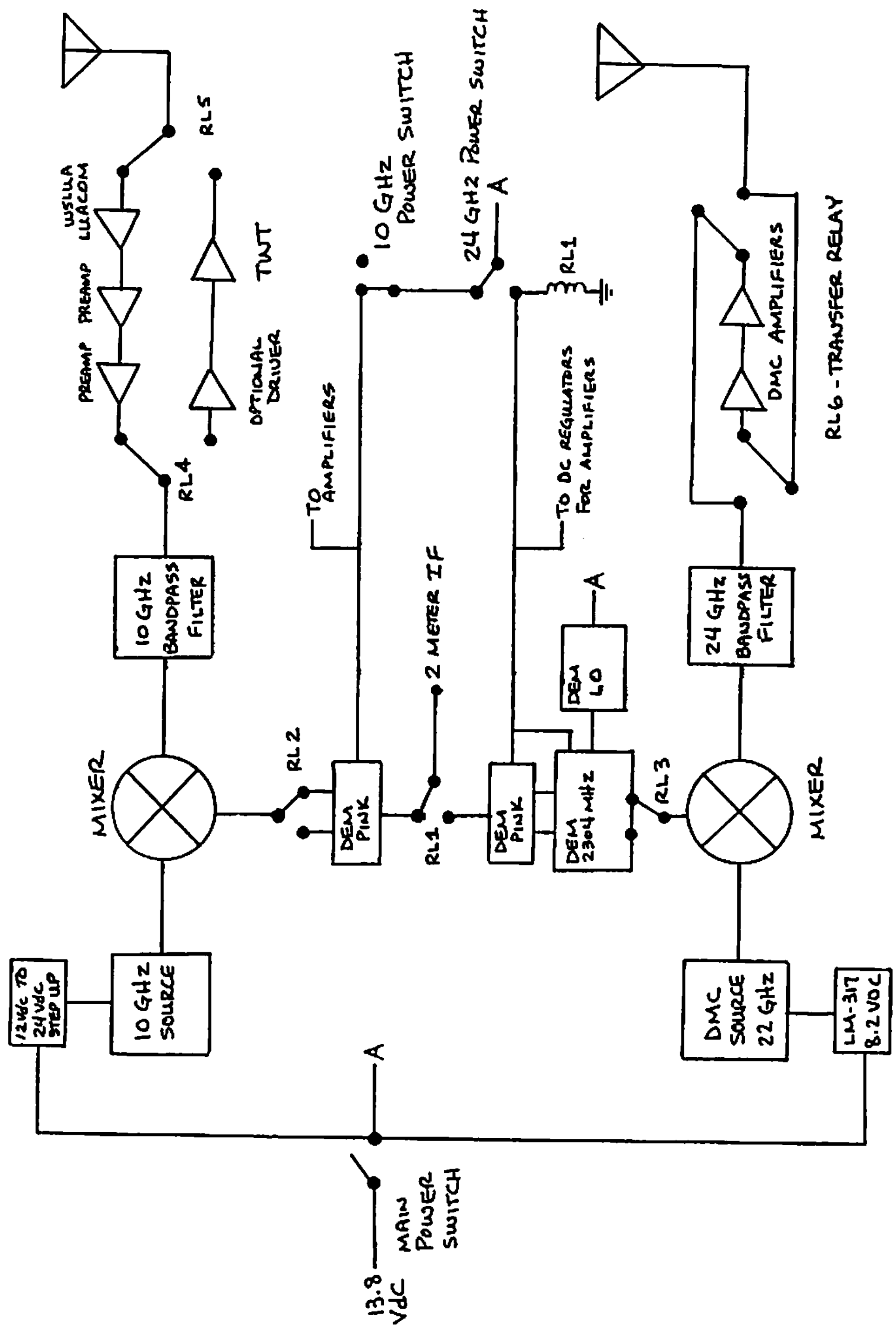


Figure 1