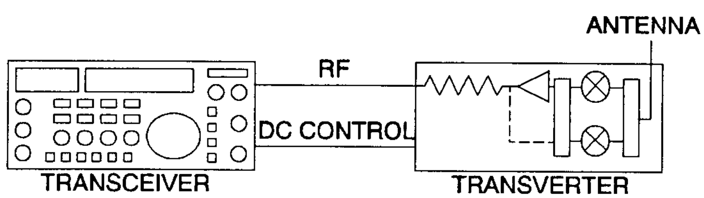
Transceiver/Transverter Interfacing

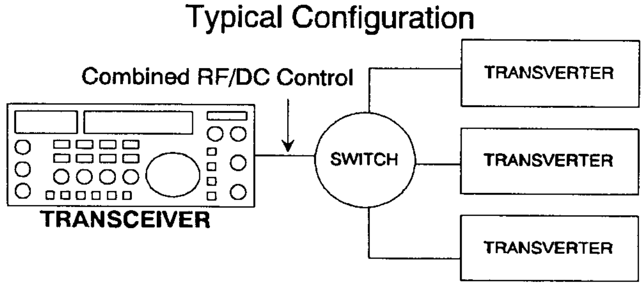
Dave Meier N4MW
3205 Covington Pike
Memphis, TN 38128
(901) 382-4919

Many of us use a transceiver in combination with one or more transverters to provide high performance operation on the microwave amateur bands. As intermediate frequency receivers and transmitters, transceivers provide digital frequency synthesis and display, reasonable receiver performance, many operating conveniences and plenty of transmit drive power. With a variety of commercial, kit and home brew transverters in common use, reliable and efficient interfacing is an issue receiving little coverage both as part of transverter construction related articles and in articles specifically addressing interface techniques. This article will discuss some methods used and will present general details of a perhaps novel technique developed and used in my own station. A comparison chart is provided to place the various discussed approaches in perspective. Interface design criteria are:

1. Maintain positive protection of the transceiver output to prevent transmitting into other than a proper termination.
2. Maintain positive protection of the transverter receive input from inadvertent application of transceiver output power.
3. Provide level matching between transceiver output and transverter intermediate frequency input.
4. Avoid excess receive gain just to overcome drive attenuation.
5. Allow selection between multiple transverters using a single switch.



Typical Configuration



Convenient Multi Band Configuration

The major concerns in interfacing transceivers and transverters are safety, efficiency and operating convenience. Safety means assurance that no damage will occur to either transceiver of transverter due to operator errors or other likely mishaps. Efficiency translates into properly matching differences in received and transmitted levels. Operating convenience deals with ease of changing bands and minimization of adjustments. Ideally, a transceiver/transverter interface excels in all three. In practice, some operating convenience is often sacrificed to assures safety. Efficiency can be built into the interface so as to be of little operational concern.

A modern transceiver represents an investment deserving protection through use of safe interfacing design. Avoid manual cable swapping when changing bands because errors can be destructive. Ideally, a single switch quickly and accurately transfers all connections needed to change bands. A not so new technique for using a single switch to transfer both intermediate frequency RF signals and DC control (PTT) is discussed below. The other big safety issue is assurance that the transceiver can never be energized into the transverter so as to zap any components, which might occur if the transverter is left in the receive state. Also, the transceiver should always transmit into a good termination.

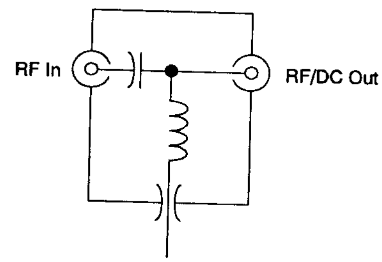
A reliable interface promotes efficiency. Common practice for reducing IF transmit drive is to use resistive attenuation. This requires either switching the attenuation in and out for transmit and receive or using excess IF gain to overcome the attenuation. For example, a 1 milliwatt input transverter driven with 10 watts could require 40 dB of excess receive gain. PIN switches or relays might bypass some or all attenuation. Beware! Some techniques might allow transceiver output to reach the transverter receive output port if the DC control connection fails even momentarily.

It is desirable to change bands without much switching, cable changing, level adjustment or other error-prone reconfiguration. Ideally, a single multiposition switch selects transverters. A single switch could be used to route IF signals and provides DC control by superimposing a voltage on the coaxial cable to various transverters (more on that later). This concept of superimposing RF and DC on a single cable allows use of a single coaxial switch and is easy to implement. Alternatives are either separate RF and DC control switches or one multipole switch and separate IF and DC control cables.

There are many design solutions with varying degrees of safety, efficiency and convenience. Most control designs use both DC control and RF signals. Some designs depend on the DC control signal to protect the transverter circuitry. If separate RF and DC control cables are employed, there is a distinct possibility that someday RF will be applied without the associated DC control signal, possibly damaging the transverter. Combining the RF and DC control signals on a single coaxial cable enhances the safety but still depends upon the transverter to protect itself by responding to the DC control signal.

OK, how can we do better? Just design the interface such that the attenuation required to match the transverter input level is inserted in the transverter's power-off state. Loss of transverter DC power or DC control signal from the transceiver will result only in a good termination for the transceiver with no damage to the transverter. It is unnecessary to use excess gain to overcome attenuator loss because the transverter receive mixer output can be safely connected through the relay or PIN switch to the IF transceiver's with assurance that any faults will result in restoration of the terminating attenuator to the transceiver output.

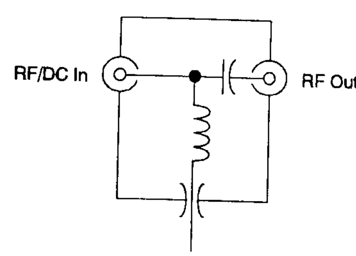
A convenient and safe T/R control method is to apply a DC control voltage to the IF tranceiver's coaxial output center conductor in the *receive* condition. This can be accomplished by a DC "inserter" consisting of a DC blocking capacitor and an inductor/capacitor forming a low pass filter. Apply a PTT derived DC signal to the DC bias Tee ("inserter") during receive. Although available commercially, a DC inserter can be constructed at low cost. But wait! Do you use an ICOM, YAESU or other transceiver with provisions for a mast-mounted preamplifier? If so, forget the DC inserter and just leave the preamp button on. This serendipitously provides the desired DC control voltage (13.8 volt nominal) at the transceiver RF connector during receive.



DC Inserter

Switching the IF transceiver between transverters also switches the DC control voltage, placing all unselected transverter's input circuitry in the protected (transmit) condition. A secondary PTT derived DC control voltage switches all other transverter circuitry between receive and transmit. It is a good idea to include a standby switch in each transverter to place unselected transverters and any external preamplifier or amplifier control circuitry to the idle (receive) state. Transceiver PTT controls transmit-receive DC switching of everything but the transverter input circuitry. This requires both RF and PTT transfer switches to change bands, but provides transverter input circuitry protection. I will describe how to eliminate the PTT transfer switch a little later.

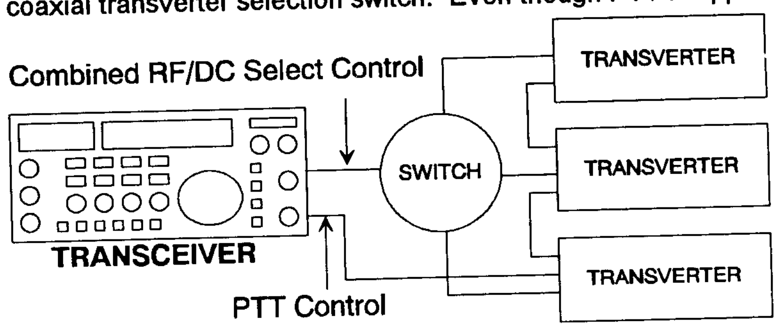
A DC "extractor" circuit can be easily made to utilize the DC voltage superimposed on the coaxial cable from the transverter. An inductor capacitor low pass network can be built in a small box or as part of a switching PC board. In fact, the DC inserter previously described can be used, although the series blocking capacitor may not be needed if the transverter input is capacitively coupled. Component values are not critical so long as the series resonant frequency of the inductor capacitor low



DC Extractor

pass filter is greatly below the IF frequency and the inductor is sufficiently large to present a high impedance path to the IF signal.

The circuit design I use contains a small PC mounted relay to switch the IF signals between the transceiver and transverter. Another small relay controls transmit and receive changeover using the transceiver PTT output. To avoid having to switch the PTT between transverters, I added another relay to select the active transverter. The select relay is energized from the DC voltage superimposed upon the transceiver's coaxial output during receive. The voltage is applied to the select relay through a diode. During receive the select relay closes, allowing PTT operation through a set of relay contacts. A capacitor across the select relay is charged during receive. Upon switching to transmit, the input relay changes state and the select relay remains closed while the capacitor discharges (about 50 milliseconds), long enough for the PTT control relay to change state and apply voltage to the select relay through another diode, effectively latching the select relay. Removal of PTT voltage returns everything to the receive state, recharging the capacitor for another PTT cycle. Summarizing the purpose of the select relay, it allows selection of a specific transverter upon application of PTT to all transverters simultaneously. The selected transverter is the one that is currently receiving as determined by the position of a multi-position coaxial transverter selection switch. Even though PTT is applied to all transverters at once, only the actively receiving transverter will switch to transmit mode. PTT can be routed between transverters in a daisy-chain or hub and spoke manner.



N4MW Multi Band Configuration & Interconnections

Suggested circuitry, circuit board layout and component placement are shown in the drawing. I designed a small circuit board to contain the required components and simplify interconnections. The DC extractor is built into the board. The board layout is simple enough to be easily hand drawn and etched or a prototyping board available from Radio Shack can be substituted. Components are surface mounted for ease of access, although conventional drilled holes could also be used. I use lengths of ribbon cable to connect between the board and most other components. A simple way to affix the board inside the transverter chassis is to use a layer of double-stick foam tape. Relays used are available from Radio Shack also.

Future improvements might include conversion to solid state design instead of relays and improving the transverter/LNA/PA/antenna side of the interface. It should also be possible to design the input attenuator into the control circuit board.

Transceiver/Transverter Interfacing Technique Comparison

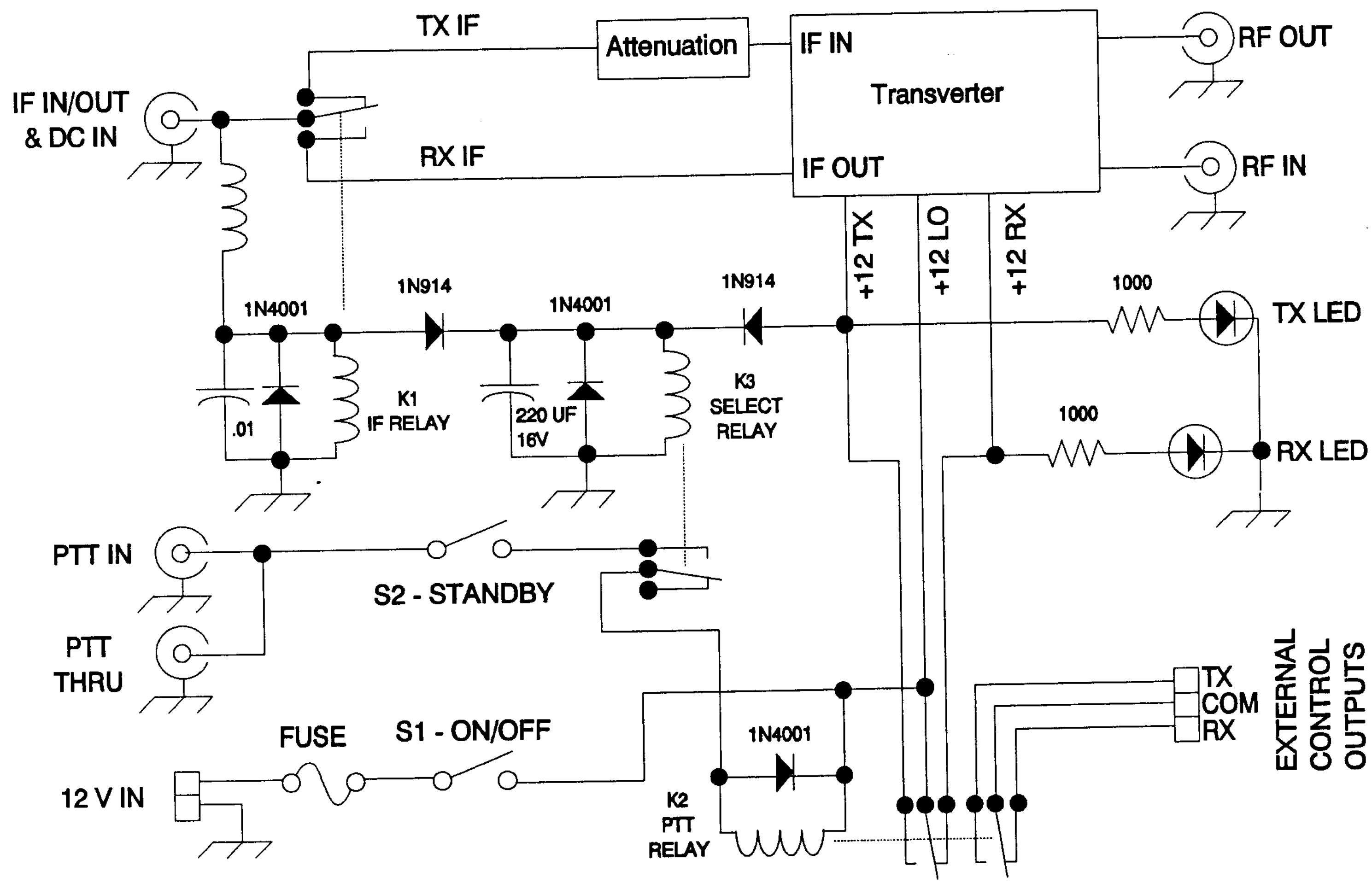
Technique	Method of Implementation	Pros	Cons	Bandswitching
Old Standard	Separate transmit drive and receive intermediate frequency connections (no coaxial switching)	Expedient and safe, minimum of circuitry	Somewhat obsolete, requires separate transmitter/receiver or modification of tranceiver to separate transmit and receive	Requires two coaxial switches plus PTT switching
T/R Relay	Relay switches transceiver between transverter IF out port and drive attenuator	Simple	Zaps receive mixer if PTT connection fails	Requires coaxial and PTT switching
Typical	Permanently attenuate IF drive to transverter and provide excess receive (IF) gain to overcome it	Easily implemented (Downeast PIN kit)	Moderately complex (uses active devices) and inefficient (uses excess gain just to overcome drive attenuation)	Requires coaxial and PTT switching
Safety	DC control of input switching using superimposed DC on coaxial connection (ICOM mast mounted preamp style)	Safe to transverter IF output port and transceiver output stage, inexpensive	For transceivers without provision for mast mount preamps, slightly more complex than the typical approach	Requires coaxial and PTT switching
N4MW Approach	Same as for Safety, adding transverter autoselection	Added convenience for multiband operation	Requires additional relay plus associated components and provision for PTT chaining	Requires only coaxial switching, PTT connections daisy-chained

Bibliography

Chennault, Charlie (WA5YOU), A Versatile Transverter Interface, Proceedings of Microwave Update '91, p. 247

Britain, Kent (WA5VJB), Protective UHF Converters, (Publication data not known)

McIntire, Greg (AA5C), Microwave Station Integration, Proceedings of Microwave Update '89, p.148.



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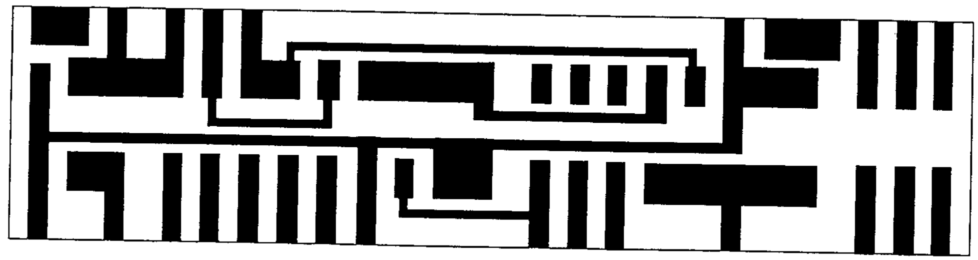
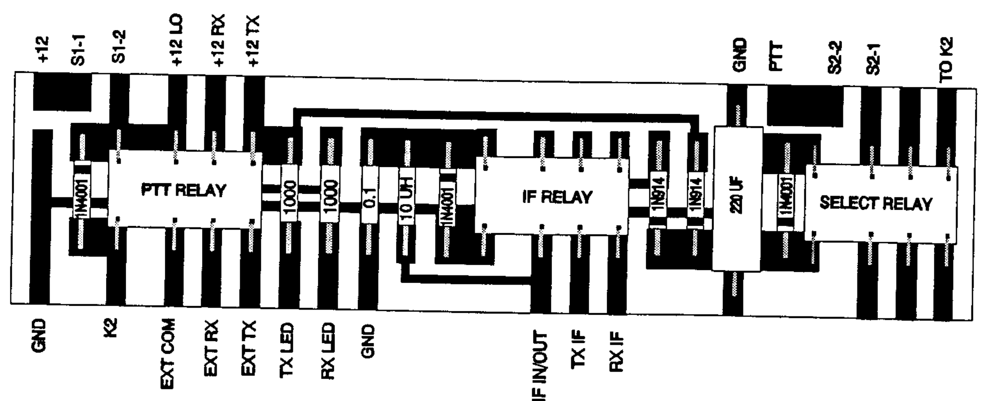


CIRCUIT BOARD LAYOUT



CIRCUIT BOARD COMPONENT PLACEMENT