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VHF And Above Operation

C. L. Houghton WB6IGP
San Diego Microwave Group
6345 Badger Lake Ave.
San Diego CA 92119

Mixers and Other Small Case Devices

This month I will cover mixers: prepackaged, home-brewed, and a few others. Applications for mixers are numerous. I will show how a surplus mixer can be used at 10 GHz in my home-brewed station. Most of the mixers to be covered will be the small commercially available hermetically-sealed types associated with Mini-Circuits Labs. Be aware that these are not the only types available as they do not need to be hermetically-sealed to work at high frequencies.

There is some confusion associated with this type of device in that not all devices in similar packages are mixers. They can be power splitters, mixers, phase splitters, attenuators and even amplifiers. These devices have become quite common in the surplus market, making their use very popular in most amateur design projects. Take a look in any *ARRL Handbook* for the last 10 years and you will find articles peppered with SRA-1s or similar type mixers. The beauty of these devices is that if you have to go out and purchase them, they are available right off the shelf and the cost is not prohibitive: under the \$20 mark.

First, let's cover mixers of the SRA-1 type. This type is made for operation up to 500 MHz and is one of the most popular mixers produced to date. It has been used and observed in so many different types of projects over the last 10 years that I think it is a household word synonymous with mixer.

The SRA-1 and its cousins are produced by Mini-Circuits Labs and are constructed using the double-balanced configuration shown in Figure 1. Case styles may vary, as well as the frequency and level (dBm) han-

dling capabilities of similar type devices available from them. Be warned: Mixers are not the only devices that can occupy similar case styles. I have observed people purchasing surplus PC boards with devices looking like mixers on them, only to find out later that they were not mixers at all. A quick scan of a catalog will identify the device you have. I find that attenuators, phase splitters and mixers comprise the most common devices found in surplus. I have not yet observed amplifiers in these case styles. Mini-Circuits Labs does provide several series of amplifiers fully packaged and some of them look very similar in case style to our mixer cases, but I have never seen one in surplus.

If you can remember all the part numbers in the catalogs you have no problem identifying surplus parts. However, we are not computers and we don't carry data books with us so just try to recall some of the more memorable devices when out scrounging. What I try to do is generalize my memory bank to common types and use the catalogs for others. There are just too many part numbers and variations to try and remember. Don't memorize the more specialized components, just form some mental note on the most popular devices to look for in surplus. That limits most mixers to the GRA, SRA, SBL, TAK, TSM, TFM and SAM type mixers. The following prefix on these mixers is not important at this time if the highest frequency of use is 500 MHz. Most mixers will work to these limits. Sure, some go much lower but the odds are that the device you will find is good to 500 MHz. The SRA-2000 and the SBL-11 are good examples of mixers that go up to 2 GHz and seem to populate surplus boards.

Re-Pack Mixers

Re-packs, as I call them, are nothing more than commercial mixers in a



Photo A. OZ1UM with his microwave setup in Denmark for 10, 24, and 47 GHz operation.

small pin configuration housing placed in a container that connects the pins to coaxial connectors. Most of the re-pack mixers use some of the previously described mixer products as their main component. Some of these mixers with coaxial connectors are denoted with the prefix of ZLW, ZAD, ZEM, and ZFM identifiers. They are constructed with easy-to-use coaxial connectors for bench tests and lots of other applications requiring sturdy packages and quick connect/disconnect coaxial connectors. They can be furnished with almost any type of coaxial connector. These mixers are usually much harder to locate in surplus than the pin-packaged ones previously described, and when they are available they have a higher price.

As I stated before, power splitters or power dividers are packaged in similar case styles and can be confused quite easily. The differences in some of them lie in the labeling of the component parts, such as PSC, or PSCQ or PSCJ. If the part you find has a "P" in the part identifier, you can be assured it is some form of phase splitter or combiner. There are variations such as the PDC identifier, which is a directional coupler. Again, packaged directional couplers use ZFDC, still retaining the "DC" notation directional coupler. It's just like the "PSC" or "SC" part denoting the splitter coupler above. With most Mini-Circuits components you can make a basic determination on the function by word similarity of their code identifier.

This can be depressing. Possibly I am giving up part of my gray matter for ransom by this description, but that's how I try to group the miniature parts in my mind. The trick is to remember in generalities how the scheme works and make some rules for your use. It's necessary when looking at surplus PC boards as you never seem to have the proper catalog along when you find something interesting.

There are exceptions to any rule but in this case they seem to be unusual components and there aren't enough of them to worry about. For detailed information, contact: Mini-Circuits Labs, P. O. Box 350166, Brooklyn NY 11235-0003; (718) 934-4500.

Be aware that there are also filters,

RF solid-state switches, and even RF transformers available. If new demands are present and the market wants them I suspect almost anything that can be produced will be put into a similar package for ease of use. Please note that this is not the only company that manufactures this device but it is the most popular from both an advertising and a surplus availability basis. See Figure 2 for some of the more popular case styles. These units all look alike and even have the same pin counting method, so just consult a catalog for your device on pinout connections. In most cases a blue insulating bead lets you know which pin is pin #1.

Open-Frame Mixers

The market is also saturated with open-frame mixers constructed on small PC boards in the open. They are used in cable TV converters and even in amateur radio transceivers. These are configured the same but are constructed using discreet components instead of the prepackaged types. I am not sure that this is cost effective, but in any case the circuitry is quite the same. The basic diode mixer is connected in a quad double-balanced mixer configuration. This ring of four diodes has input and output toroid transformers connected in such a way as to form three ports.

The primaries of these two transformers are the actual input and output for the mixer, while the center tap of one secondary serves as the third port, the IF port. The other secondary center tap is grounded in normal operation. The input is the "L" or local oscillator and the output is the "RF" port. Keep in mind that the RF and IF ports are bidirectional. They can be used for receiving and transmitting.

See Table 1 for port identification. As shown in Table 1, RF and IF terminals are bidirectional—that is, receive or transmit. Only the LO (local oscillator) terminal is singular in that the LO is maintained for either receive or transmit states. The specific type of mixer you use does not make much difference as long as it will work at the frequency of interest. Most mixers are good to 500 MHz and some to just over 2,000 MHz, then stripline or spe-

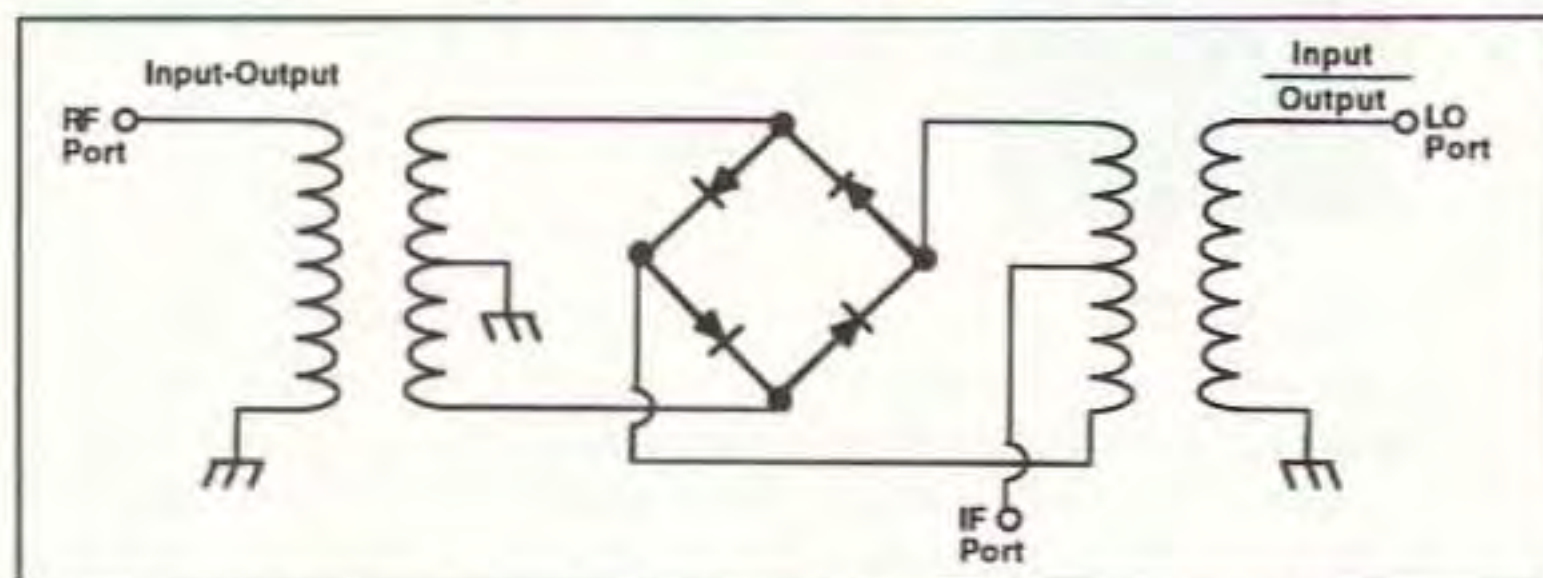


Figure 1. Basic double-balanced mixer (DBM) wound on two toroid cores, usually ferrite.

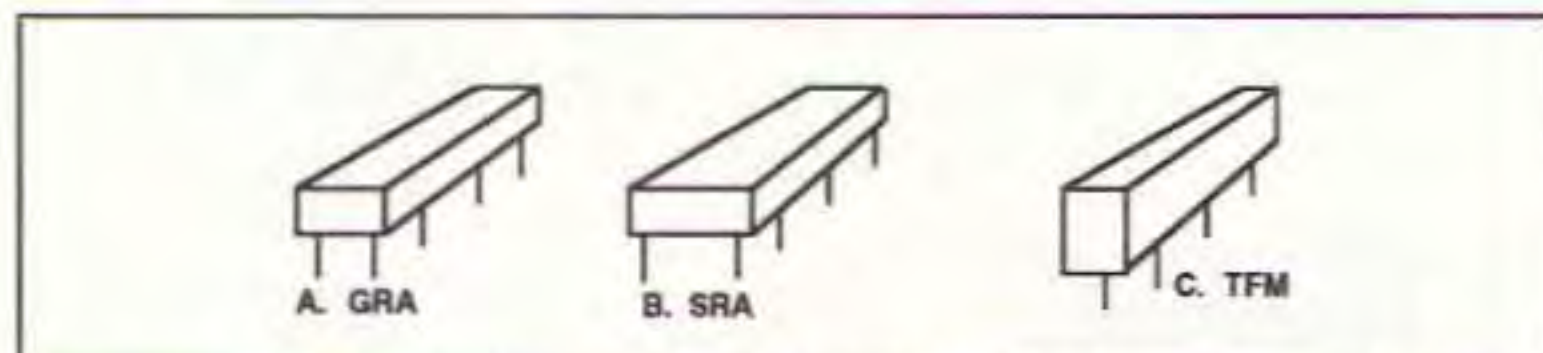


Figure 2. Typical case styles. Style "B," the larger unit, is popular with the SBL and SRA mixer types. Style "C" is typical for TFM types.

cial construction type mixers take over.

10 GHz Mixers/Applications

The easiest mixer for microwave use is the 3 dB hybrid mixer. See Figure 3. This is the mixer that is used on my 10 GHz system. It can be easily reproduced in larger scale for other lower microwave frequencies and is very forgiving of construction errors. The local oscillator injection is on 10.223 MHz and uses an IF frequency of 145 MHz (a 2 meter SSB HT) for receive and transmit.

On the mixer RF port, coaxial relays are used to switch preamp direction to change from receive to transmit. In this way only one low-noise amplifier is needed for normal receive and then it serves as a gain block in the transmit direction to boost the output from the mixer to a higher level. In my application, I use the amplifier to

drive a 10 watt TWT (traveling wave tube) to full output power. A TWT requires about +2 dBm drive power and has about 40 dB gain. For reference: 0 dBm = 1 mW, +20 dBm = 100 Mw, +30 dBm = 1W and +40 dBm = 10 watts.

To construct a converter for any frequency, all you need is a mixer and local oscillator source, and an i-f amplifier. The frills for transceiver and filtering can be added later as the converter progresses. All stages in the mythical converter can be individual circuit blocks made up of surplus or salvaged components (gain blocks/mixer blocks) and hooking them together in a coaxial connection. It's really quite easy. If you don't believe this, look inside any high quality spectrum analyzer or microwave test set as this is basically the approach they take.

The same is true in my 10 GHz station. The mixer used was surplus and

a bare-bones 3 dB hybrid type. It was enclosed in a box fashioned out of 1/2"-wide brass strips. Again, SMA coaxial connectors were soldered to the appropriate ports on the PC board for the RF, LO, and IF connections. See Figure 4 for a description of this type of mixer construction. This surplus mixer was intended for use at 12 GHz with an IF of 1.4 GHz. We had to modify the IF port to make it usable at 145 MHz. This was accomplished by cutting dead the 1.4 GHz RFC (stripline) and replacing it with small wire-wound RF chokes resonant at 145 MHz.

Recently, during the ARRL 1992 10 GHz contest, I took this same mixer, using it in my 10 GHz system. Operation on the last weekend was mobile 10 GHz SSB with my partner N6IZW. Both of us operated 10 GHz mobile in motion along the coast road from San Diego towards Los Angeles. We used

the waveguide slot omni antennas described in this column some time ago. This omnidirectional antenna made mobile operation possible. The omni performed well, giving about 10 dB nominal gain.

How was operation? Well, we both logged about 27 SSB contacts from Kerry N6IZW's truck. The

rigs we used were placed in boxes in the bed of the truck and they had to be modified for mobile operation. We had been using toggle switches to transfer relay-controlled circuit functions from receive to transmit.

The circuit was modified by constructing an RF actuated relay circuit that would do the required switching in the 10 GHz converter when we pushed the PTT on our 2 meter HTs in the cab of the truck. In this configuration, the 2 meter HTs act as a rec/xmit IF of our 10 GHz system. When we operated the PTT on the 2 meter HT, RF was detected in the truck bed detect circuit and it in turn operated a myriad of coaxial relays in the rear of the truck. This re-configured our equipment from receive and went to transmit, activating the TWT amplifier last. Quite a hunk of junk going on, but it performed flawlessly for the entire day's operation on both Kerry's and my system.

With the switching in good operation and planing operation using omnidirectional antennas several things had to be proved. As far as I know, mobile operation in motion has not been done before, at least with omnidirectional antennas. In actual use the antennas worked out quite well, as shown by the 27-some contacts we made. Of course, we took advantage of the terrain along the coast highway, making most paths over the water. However, many contacts were made over land paths and communication

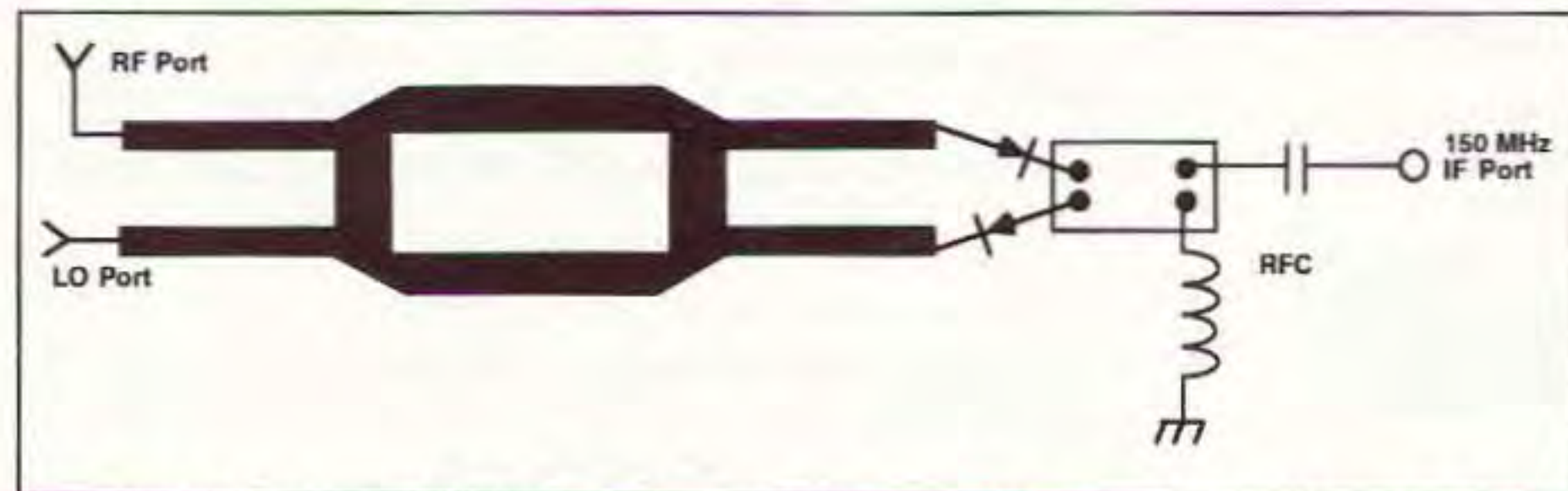


Figure 3. 10 GHz surplus hybrid (3 dBm) mixer, not to scale. The actual size is 3/4" square. All elements are constructed with 1/4-wavelength stripline. The IF port has a 1/4-wavelength stub acting as a short to 10 GHz and passing low frequency 2 meter IF.

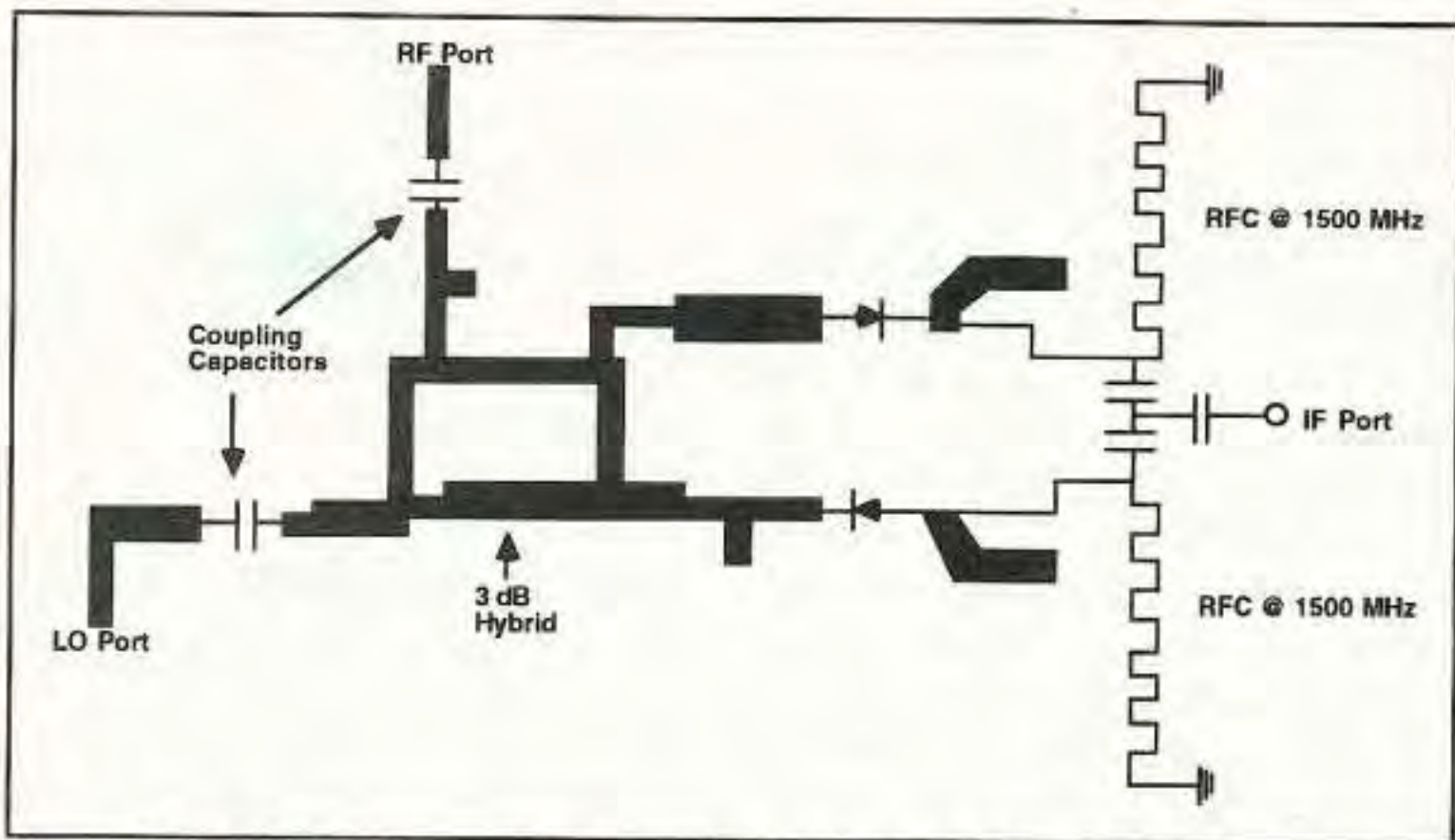


Figure 4. 12 GHz commercial mixer with 1500 MHz IF to modify the IF port for 150 MHz/2 meter IF. Cut out 1.56 GHz RFCs and replace with 2 meter RFC. RFC (choke) must be a miniature device the size of a 1/4-watt resistor as the PC board is 3/4" wide by 2" long.

was just great. When the Doppler shift became too great due to our motion and signals were strong, we shifted to FM narrowband operation with our HTs (a flick of the mode switch). FM worked quite well. As a matter of fact, in a few cases communications on 10 GHz was so good it was a vast improvement over simplex 2 meter communications.

We made no attempt to aim antennas, other than trying to locate a parking space or drive until signals peaked up to higher levels. On one stop temptation was rampant as the best signal strength was obtained when parking in front of a bakery. Normally, traveling from San Diego to Los Angeles is

done on freeways and little is noticed of the small coastal communities. But, since time was not important, we took the coast road and it proved to be an additional pleasure for a Sunday outing.

So much for our operation. The point I wanted to make is that our rigs worked well and they were constructed out of surplus components. You don't have to pay dearly for an expensive commercial unit, just watch the surplus sales and swap meets. What you want may be disguised as part of a much larger PC board. In our case, we had to cut the mixer out of a much larger PC board and attach connectors to it. It worked well. Keep your

eyes open and you too can possibly find some rare goodies in surplus.

International Microwave Operation, Denmark

I received another bit of information from Steen Gruby OZ9GI in Denmark. Steen sent the logs of operation from their group's (the North Zealand and Procom's Amateur Radio Club) activity. They operated on not only 10 GHz but 24 GHz and 47 GHz as well. Quite an accomplishment. In 1990 the best they did on 24 GHz was 227 km, set by OZ1UM and DB6NT, just 52 km off the world record for 24 GHz distance. This year they planned to work 47 GHz and from their notes never believed that they would equal or better their previous distances set on 10 GHz or even 24 GHz. However, DB6NT, DF9LN and DF2CA succeeded in carrying out a two-way SSB/CW QSO with OZ1UM. That equates to a contact on 47 GHz of 90 km, and a European record.

The equipment at DB6NT was a transceiver with 5 mW output and a noise figure of 15 dB. They used a 30

cm parabolic dish with a Cassegrain feed system. OZ1UM's transceiver had 100 microwatts and a similar noise figure, 15 dB. See Photo A. The antenna was a 25 cm Procom dish with an open waveguide feeding system, referred to as a "shepherd's crook." They all appear quite active and look like they are mounting a very serious effort towards breaking the world distance record of 104 km on 47 GHz. I have to add that they must have had a good source for components especially for 24 GHz and 47 GHz materials. Members of our microwave group here in San Diego are looking for materials for these frequencies as they are quite hard to obtain. You have to watch out for lots of those components that start with the "M" word ("microwave") that makes components expensive at swap meets and other gatherings.

Well, watch out for that "M" word. I hope you enjoy it as much as I do. As always, I will be glad to answer any questions concerning this or other related topics. Please enclose an SASE for a prompt reply.

73

TABLE 1. PORT IDENTIFICATION FOR DBMS.

Type	SRA	SRA	SRA	SBL	GRA
LO	1-3	2-4	5-11-12	1-3	A11
RF	8	8	8	8	1
IF	1	3-4	1	1	6
Ground	3-4	1	3	3-4	4
	2-5-6-7	2-5-6-7	2-5-6-7	2-5-6-7	2-3-5