Converting Radar Detectors to 10-GHz Rigs

The guts of old radar detectors can form the basis for building your own bargain-basement rig for 10 GHz. Here's how to do it.

So you've slowed down and don't need that radar detector any more (and I'm the Queen of England), or maybe you found some used ones at a flea market and—having read my July column—snapped them up to convert to 10 GHz transceivers. OK, as promised, here's how to do it.

First, though, a word of caution: this is one project for which you'll probably need help from an "Elmer" who's well versed in microwave construction. The oscillator in the radar detector will need to be retuned from 11.5 GHz down to 10.25 GHz. A spectrum analyzer or a microwave frequency counter is very helpful here. I have retuned Gunn oscillators with a wavemeter, but they're tricky to use, so I don't recommend this unless you've had previous experience using wavemeters.

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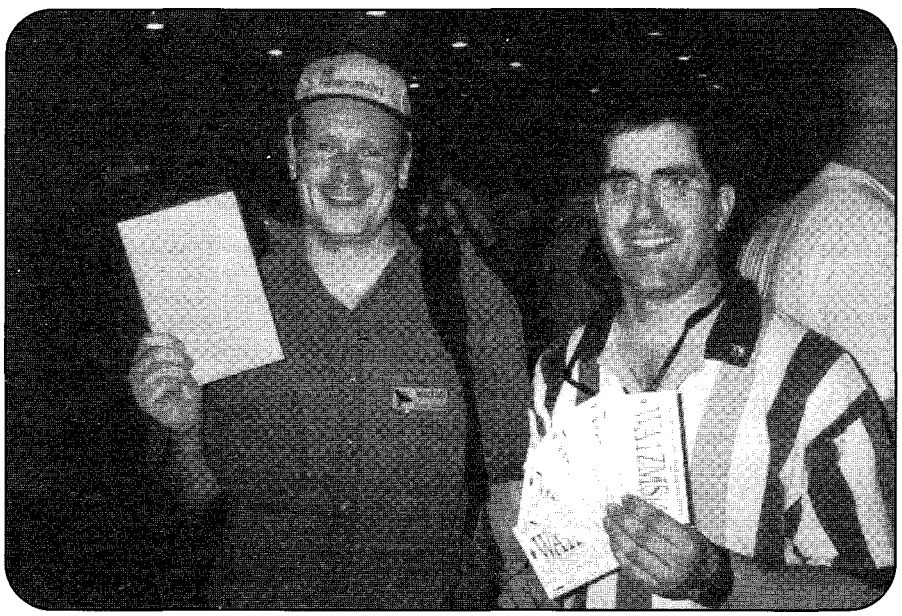

Brian Justin, WA1ZMS, and Doug Sharp, K2AD, are all smiles at the Dayton Hamvention after getting certification from WA5VJB for 47-GHz VUCC Award #1.

Using AM to Make FM

A Gunn diode is controlled more by the *current* flowing *through* the diode than by the *voltage across* the diode. The PSU power supply modulator shown in Figure 1 uses a 33- to 39-ohm 2-watt resistor (R1) to drop 12 volts down to 8 volts or so. This part of the circuit is just about as simple as it gets.

The rest of the circuit in Figure 1 is the modulator. When you change the voltage slightly on a Gunn diode, its frequency changes as well. So by building an AM modulator and putting about 1% AM modulation on the Gunn diode, the voltage changes produced by the AM generate a wideband FM signal!

The microphone preamp in Figure 1 is simple, but all you need for wideband FM. I didn't include any kind of modulation limiter or compression amp since (as I'll talk about later) with Gunnplexers, you hear yourself talking. This is much like a telephone, in which audio from the mike comes out the earpiece. This is a great feedback circuit. If the audio is weak, you naturally speak up. If it's loud and distorted, you can easily tell and back off the mic. The transistor (Q1) is a simple 2N2222, but just about any general purpose NPN transistor can be used. The microphone is any general purpose dynamic mic. I used one off an old cassette recorder.

Receiver/IF

The receive mixer diode in the Gunn oscillator, which is designed for wideband (200-kHz bandwidth) FM, downconverts the received signal. The most common IF frequency for 10-GHz signals is 30.0 MHz. Just connect the receive mixer diode to a wideband FM radio through a 39-pFd capacitor, as shown in

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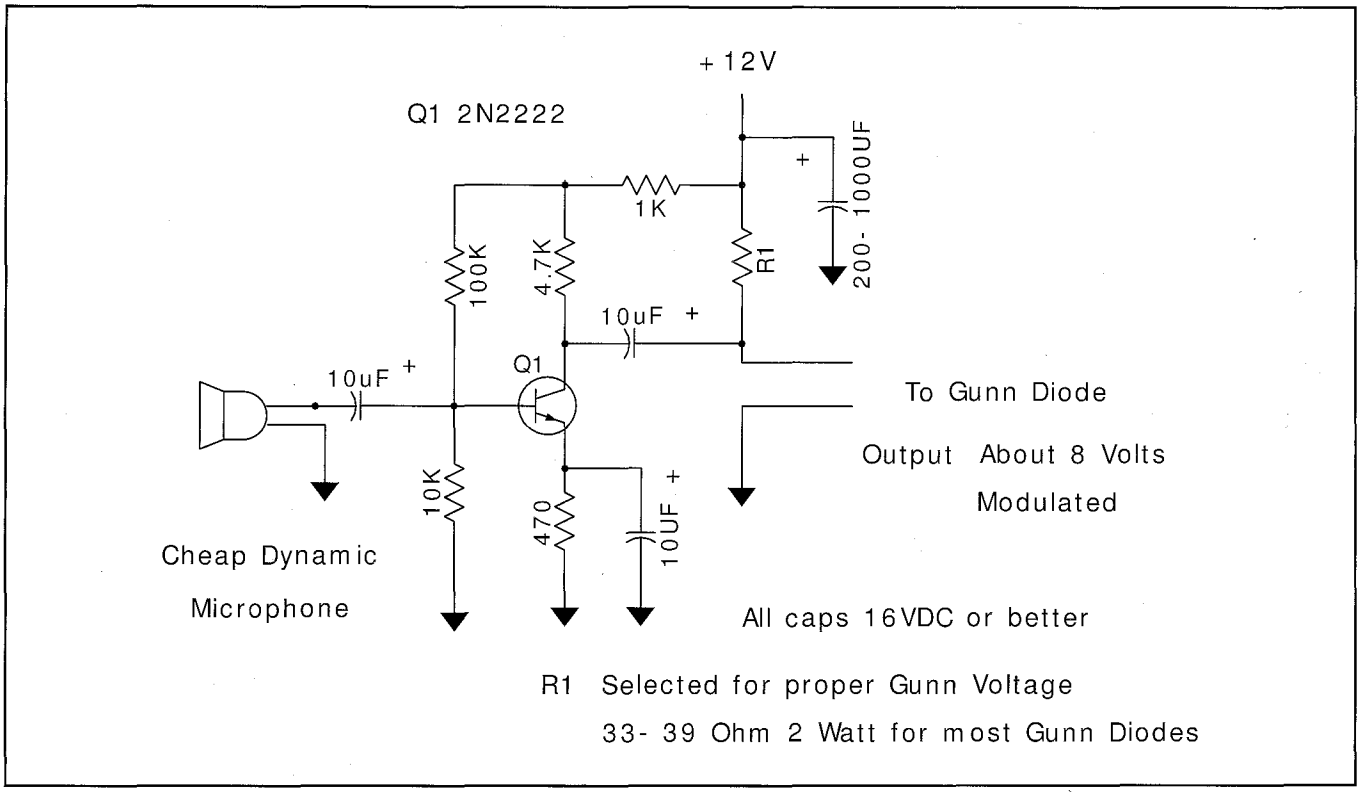


Figure 1. The PSU Power Supply Modulator, a basic power supply and modulator unit for putting the Gunn diode of a radar detector on 10-GHz wideband FM. See text for details.

Figure 2a. A typical amateur mobile setup using this equipment is shown in Figure 2b. The box labeled FR-10 is a wideband FM receiver. Suitable radios are available from many sources, and units such as the ICOM 7000, R1, and IC-706 have been used with good results. But if you really what to do this on the cheap, the most inexpensive 30-MHz receiver is the Ramsey FR10. Conversion is quite simple, especially if you make the changes as you build the kit.

FR10 Conversion

If you're using the FR-10, there are a few minor modifications you'll need to make. The first mod (see Figure 3a) is replacing filter FL2 with a .01-µFd capacitor. This makes the FR10 a wideband receiver. The .01-µFd cap goes from Pin 3 to Pin 5 of IC U2. Next, you can improve the audio by adding a 3300- or 3900-ohm resistor across the FM detector quadrature coil on U2. This replaces the FR10's R14 and is connected between Pins 4 and 8 on the IC.

The next mod is in the audio stage (Figure 3b). The FR10 is designed to drive a speaker and the audio output is far too hot for headphones. (With Gunnplexer systems, you need headphones to prevent feedback since you're operating full duplex and mic audio also comes through the speaker.) Omitting C36 (it was optional anyway!) and adding a 330-ohm resistor in series with the headphone jack works well.

Finally, Figure 3c shows my *tuning ranges* mod. Replacing C12 with a 15-pFd capacitor and adding a 15-pFd capacitor across L3 will tighten up the tuning range (12-pFd caps should also work).

Alignment is quick: just put the tuning control in the middle of its range and listen to a 30.0-MHz signal while adjusting L3. Be sure to mark where 30.0 MHz is on your tuning range. It is very important to keep the IF centered on 30.0 MHz for proper operation on 10-GHz FM.

Operation

Now you're ready to get on the air. Have your Elmer tune the Gunn oscillator to either 10,250 or 10,280 MHz, the 10-GHz FM calling frequencies. A Gunnplexer is a bit of a strange animal. Your transmitter is also the receive local oscillator (note the 30-MHz difference in frequencies), and therefore the receive local oscillator is also the transmitter.

"When you change the voltage slightly on a Gunn diode, its frequency changes as well. So by building an AM modulator and putting about 1% AM modulation on the Gunn diode, the voltage changes produced by the AM generate a wideband FM signal!"

About the best analogy I have been able to think of is to imagine a crystal-controlled 2-meter rig which uses a 600-kHz IF. Now, a 146.34-MHz transmit crystal will also serve as the 146.94-MHz receive crystal. This rig would work well though repeaters, but you could never work simplex with it.

Well, this is how the Gunnplexer operates. You tune 10,250 MHz and your buddy tunes 10,280 MHz. Your transmitter is on his receive frequency and his transmitter is on your receive frequency (see Figure 4). Now that's true duplex operation! It makes your QSOs just like a telephone call. Both sides can talk at the

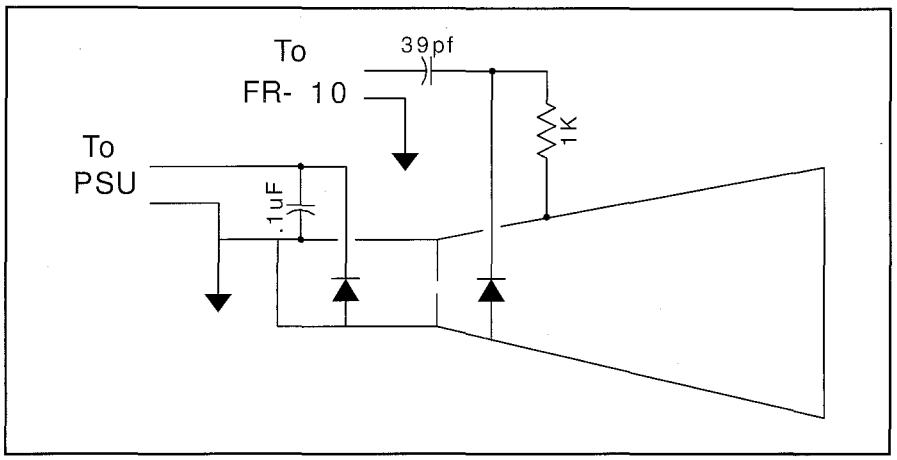


Figure 2a. Connections to the Gunn oscillator from the PSU power supply modulator and from the IF radio, labeled here as FR-10. Be sure to add the 39-pFd capacitor between the receive mixer diode and the radio, and to include the 1K resistor and .1 μFd capacitor as shown.

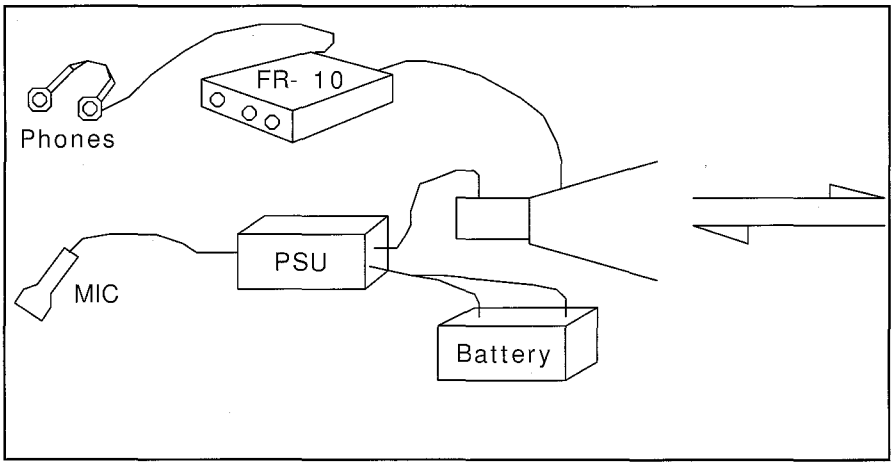


Figure 2b. Block diagram of a typical setup for portable 10-GHz operation using the equipment described here. The AM modulator in the PSU directly feeds the transmit diode in the Gunn oscillator, with voltage changes from the AM modulation causing the Gunn to transmit a wideband FM signal. The receiver, marked FR-10, needs to have a wide (200 kHz) bandwidth and be able to tune to the common Gunnplexer IF frequency of 30.0 MHz. Headphones are essential since operation is full duplex and using a speaker will cause audio feedback.

same time, you don't need a push to talk mic, and you hear your own voice coming out of your receiver. This makes for really neat QSOs.

Don't Look for DX

Basically, these units are line-of-sight, meaning that if you can't see the other guy with a good telescope, you're not going to work him. With just the horn antennas, range is about a mile. With a big horn on my rig and a commercial Gunnplexer/1-foot dish at the other end, my best DX with one of these units has been 55 miles. Still, not bad for a retired radar detector!

Plus, there are several ways of improving on the performance of this basic unit. First, you can develop a limited tuning range by varying the voltage to the Gunn. Typically, the Gunn oscillator in a radar detector can be moved about 100 MHz this way. This works out to about 25 MHz tuning per volt, so tune very carefully. It's a great place to use 10-turn pots (potentiometers) for their precision control.

"A Gunnplexer is a bit of a strange animal. Your transmitter is also the receive local oscillator...and therefore the receive local oscillator is also the transmitter."

Next, there are two ways to upgrade the antenna. I prefer to glue on a few pieces of sheet metal and make the horn a bit bigger, but this really depends on how your Gunn system is constructed. The second method is to mount the Gunn system at the focus of a small dish. I find that 12- to 18-inch diameter dishes usually work best. Larger dishes become very difficult to point out in the field.

Building a Doppler Radar

Keep looking for those old superhet detectors. Soon I'll show you how to make one into your own small private Doppler radar. Maybe we'll even talk about one of my favorite sports, making these old radar detectors into 10.495-GHz CW rigs and calling CQ on the Interstates. The truckers will hear you!

Microwave Activity

In Photo A, we have Brian Justin, WA1ZMS, and Doug Sharp, K2AD, holding their QSL cards for 47-GHz VUCC (VHF/UHF Century Club) Award #1. Brian and Doug completed the feat last April and May by working each other five grids on 47 GHz. Both stations used 100-milliwatt Gunn oscillators with a two-foot dish on one end and a one-foot dish on the other. Both antennas had rifle scopes mounted on the dishes to aid in pointing. The beams were between .5 and 1 degree wide.

As Brian explains it, he stayed in FM07 on Apple Orchard Mountain, outside Lynchburg, Virginia, operating as W2SZ/4 (both Brian and Doug are members of the Rensselaer Polytechnic Institute Amateur Radio Club, and are active W2SZ contest operators), while Doug, operating as WA1ZMS/4, traveled through FM07, 06,96,08, and FM97. The FM06-FM96 QSO established a new North American 47-GHz record of 71 miles. For additional information, see Brian's report on the record-breaking effort on page 75 of last month's issue. Future plans include station improvements and an assault on the current world record of 114 miles between HB9MIN and DK4GD, in Europe.

As a VUCC Awards Manager, I had the personal honor of verifying Brian's QSL cards. Seems they had first tried to

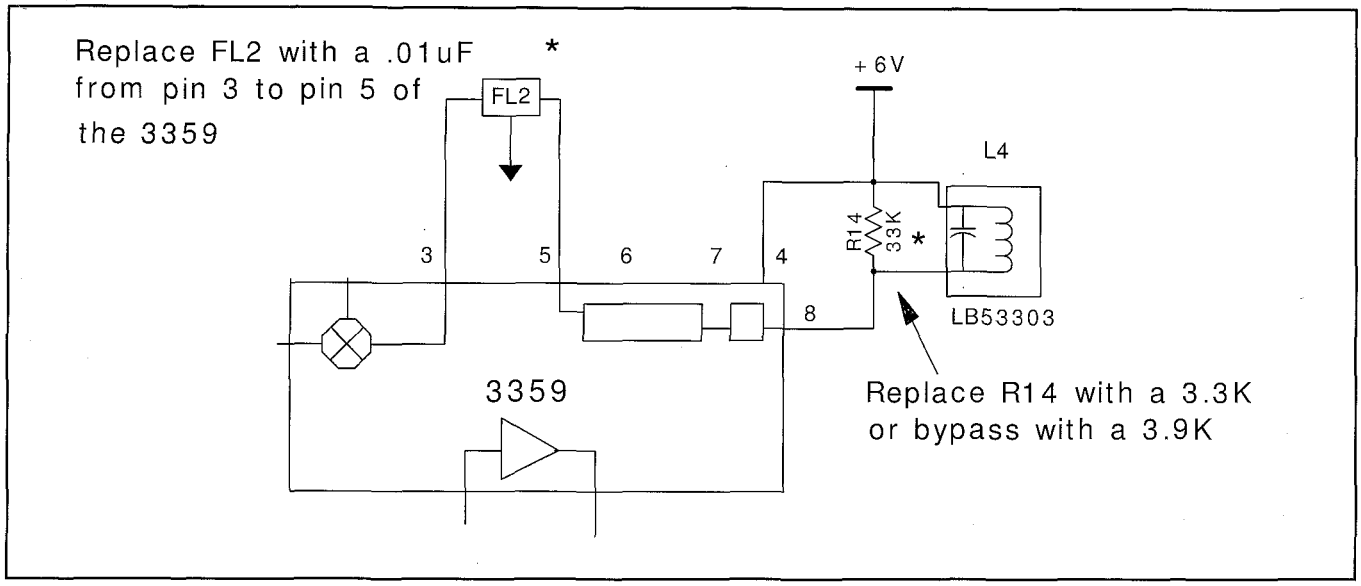
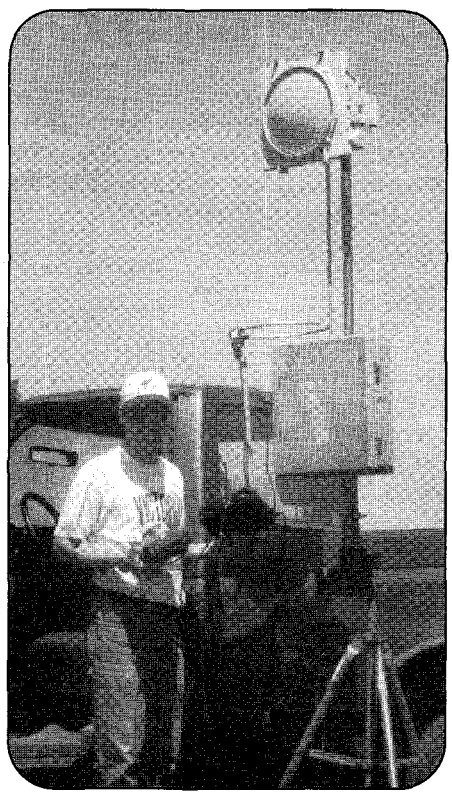


Figure 3a. Converting the Ramsey FR-10 receiver for wideband use involves a few simple modifications (mods). Replacing FL2 with a .01-μFd capacitor makes the receiver widebanded, and replacing R14 as instructed helps improve the audio.



Greg McIntyre, AA5C, poses with his 24-GHz mobile station. If the antenna on top of the mast looks like you've seen it somewhere before, STOP *and think about it. Then see the text for details.*

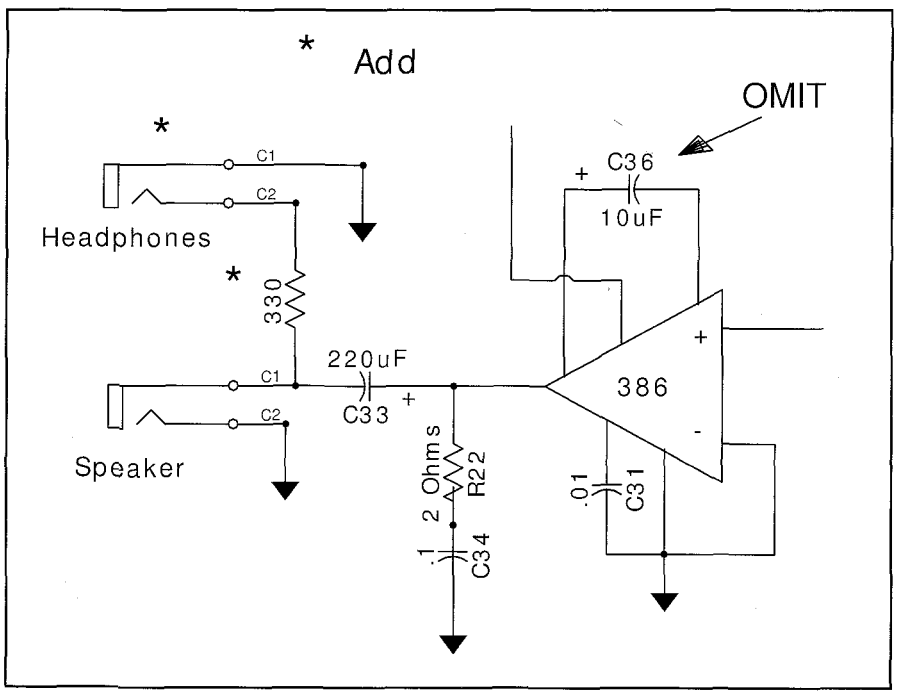


Figure 3b. The two mods shown here—omitting C36 and adding a 330-ohm resistor between the speaker and headphone jacks as shown—should bring down the audio level of the output for comfortable headphone listening. This is necessary due to full-duplex operation.

get another VUCC Manager to look at the cards, but realized there was a problem when he didn't think we had a ham band up there! They ran me down at Dayton and the rest is history.

For those who may be considering building narrowband 47-GHz equipment, the calling/center frequency is 47088.100 MHz

Moving Down to 24 GHz!

In Photo B, we have AA5C's 24-GHz SSB station. Does anything look familiar about his antenna? Hint: they usually come in sets of three, one red, one yellow, and one green! His station is built around a commercial GEM system, which, some years ago, was a popular 23.5-GHz wideband data link unit. For an antenna, the designers needed a weatherproof housing with a 12-inch parabolic reflector. The engineers found one already in production that was manufactured in large quantities and was rela-

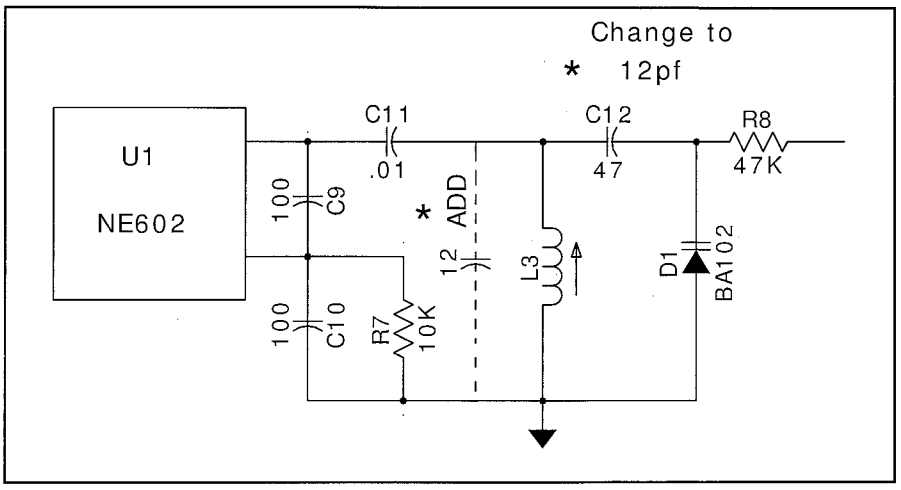
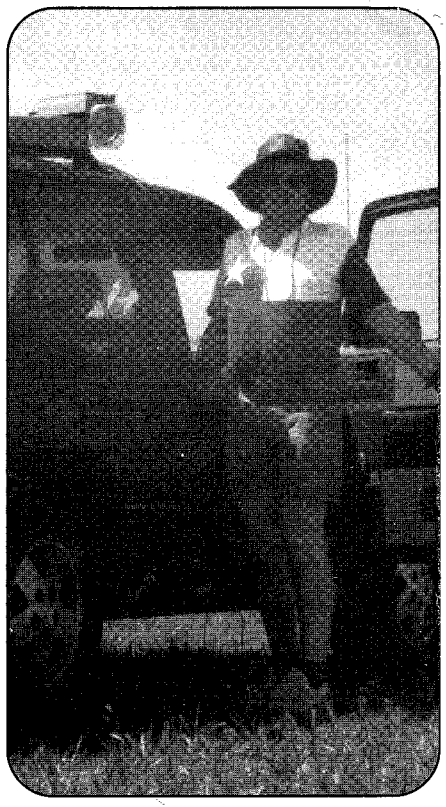


Figure 3c. The final mod to the FR-10 for use with a Gunn oscillator on 10 GHz entails tightening up the tuning range by changing C12 to a 12-pFd capacitor, and adding another 12-pFd cap in parallel with L3.

tively inexpensive. They figured, "Why reinvent the wheel?" and put their antennas in the housing from traffic lights!

This photo was taken during a 24-gig outing on which AA5C (Greg McIntyre) worked Dave Robinson, G4FRE/WW2R, in various parts of Texas. You can see Dave and his 24-GHz mobile setup in Photo C.

"[The Gunnplexer] makes your QSOs just like a telephone call. Both sides can talk at the same time, you don't need a push to talk mic, and you hear your own voice coming out of your receiver. This makes for really neat QSOs."



Dave Robinson, G4FRE/WW2R, was on the other end of AA5C's 24-GHz QSOs on the day these photos were taken.

And Way on up There...

Finally, for those of you who think 24 and 47 GHz are absurdly high frequencies, we have word from Europe of the first amateur QSO on *411 GHz*, between DB6NT and DL1IN.

Both stations used crystal-controlled local oscillators and downconverted to 144 MHz. Two Russian beam-lead Schottky diodes were very useful in their designs. DB6NT used a more "conventional" local oscillator, mixer, and Cassegrain antenna, but DL1IN went the quasi-optic route, where energy is focused onto the mixer with mirrors and a large plastic lens. Their first test covered a distance of 50 meters (about 162 feet), but both stations have a lot of room for improvements and I'm sure this record will be greatly extended.

Until next time, 73.

—WA5VJB

Resources

The Ramsey FR-10 receiver described in the text is available from many ham radio dealers or directly from Ramsey Electronics, Inc., 793 Canning Parkway, Victor, NY 14564; Phone: (716) 924-4560; Fax: (716) 924-4555; Web site: <http://www.ramseyelectronics.com>.

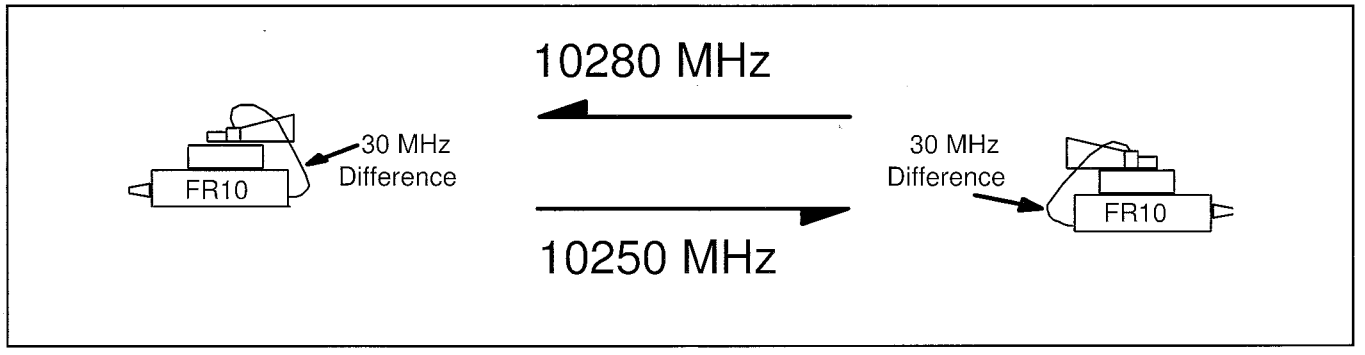


Figure 4. If you're wiring up a pair of Gunn oscillators to talk to each other, make sure one of them is tuned to 10,250 MHz and the other is on 10,280 MHz. This is the most common arrangement when using a 30-MHz IF, and it allows both the receiver and the transmitter to share circuitry for full duplex communications using channels 30 MHz apart.