

Gunnplexers

The Gunnplexer radio system is a combination of a microwave oscillator (based on the Gunn diode), a mixer, an audio amplifier, microphone and a wideband FM receiver. There are some variations on the theme, but every Gunnplexer style radio has at least these components. In Gunnplexers that operate at 10 GHz and higher, the entire microwave system is built into waveguide, and usually a horn type waveguide antenna is connected to complete the system. Figure 1 and the accompanying photo show a typical physical layout, although specific configurations may vary.

John B. Gunn originally investigated this microwave diode source in the early 1960s. When an applied voltage is increased, current continues to rise to a point called the threshold voltage. As the applied voltage is increased past this point, the current begins to fall and continues to do so until the breakdown voltage is reached. The portion of the curve where the voltage and current move in opposite directions is called the negative resistance region. If the device is made to operate in a resonant circuit and dc biased into this region, it will produce RF. Typical power levels are 5 or 10 mW, but there are 100-mW devices available. The best operating voltage is about three times the threshold voltage. Gunns can be designed and made to oscillate up to about 100 GHz.

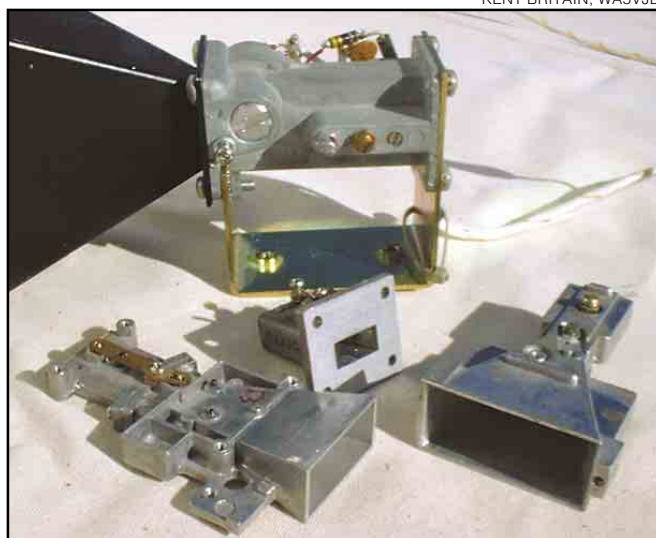
As in any free-running oscillator, me-

chanical stability, constant load, clean power, and stable temperature are needed. In practical terms, a free-running 10-GHz Gunn in a well-designed cavity, at stable temperature and load can keep frequency stable to a few kilohertz over several minutes. Because of phase noise and typical frequency instability, practical free-running Gunnplexers are used in fairly wide bandwidth communications systems. Amateur Gunnplexers operate at a nominal 75 kHz of deviation, resulting in about 200 kHz of bandwidth for good quality audio.

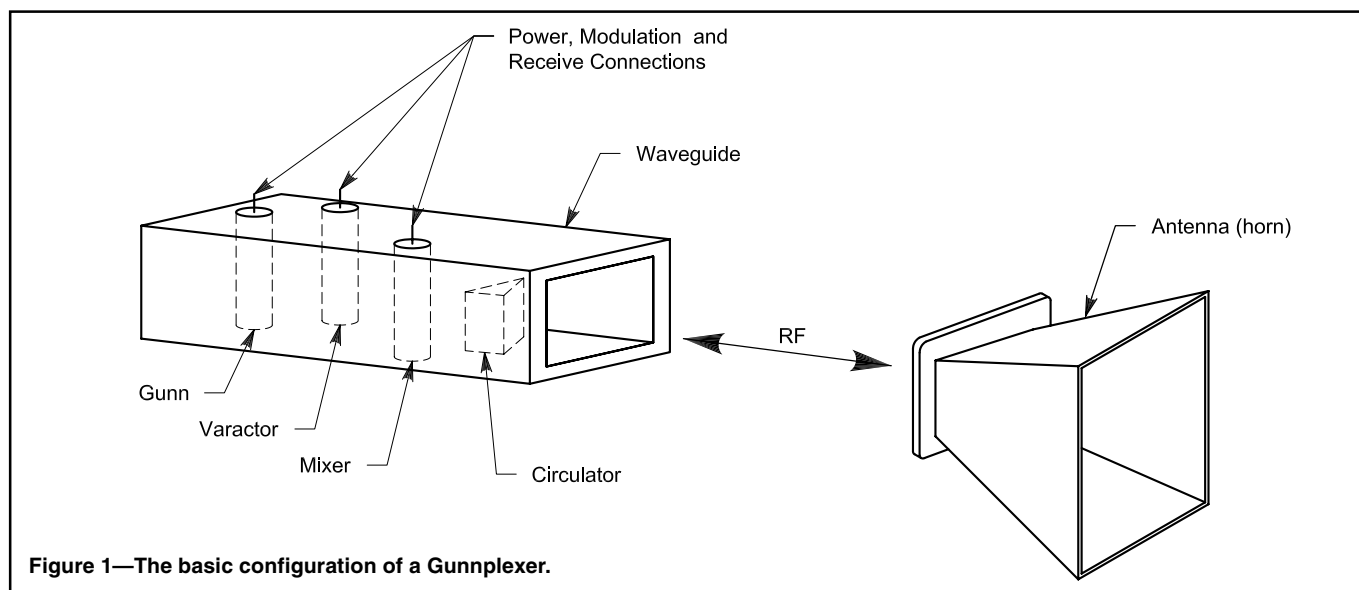
Q: How is the Gunn oscillator modulated?

We need to frequency modulate the signal with a deviation of about 75 kHz for voice communications. There are two ways to do this. One is called "push" modulation and the other "pull." The push technique modulates the bias voltage that powers the Gunn. The push sensitivity of 10 GHz Gunns runs 10 MHz/V or greater. This means that to get 75 kHz of deviation you need only 7.5 mV of modulation! Although "push" also amplitude modu-

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A selection of surplus Gunnplexers from radar detectors and door openers.



lates the oscillator, the resulting distortion is unnoticeable. When modifying some surplus Gunn systems such as door openers, push modulation is the way to go.

"Pulling" an oscillator refers to changing the reactance or loading of the cavity. This change is accomplished by placing a varactor diode inside the waveguide, near the Gunn diode. Varactors are chosen that have parameters appropriate to the kinds of tuning range and modulation range desired.

In either type of modulation, the system is fine-tuned for a QSO by adjusting the dc voltage with a multi-turn potentiometer.

Q: What kind of antenna do I need to make contacts? How about contesting?

The modulated signal travels out the end of the waveguide into the antenna and is radiated. Wideband operators use vertical polarization, where the narrow dimension of the waveguide would be vertical, as in [Figure 1](#). When making your first contacts on 10 and 24 GHz it is probably easiest and most rewarding to operate a Gunnplexer with a horn type antenna. After you have mastered the basics of making contacts and want to try for some DX or to make a high score in a contest, you might want to add a dish. W5VSI took third place nationwide in QSO count in the 1999 ARRL 10-GHz and Up Cumulative Contest using a 19-inch dish and a 10-mW Gunnplexer. It is common to use a 2-meter radio as a liaison to help set up, choose frequencies, etc. Your local club or group can advise you.

Q: What does the mixer do in a Gunnplexer?

The receiver for a Gunnplexer is based on a mixer diode. It is possible to use the Gunn itself as a mixer diode, and this is done in some of the very inexpensive door openers, but for useful communications over reasonable distances, a separate mixer diode is needed. A high sensitivity Schottky barrier type is best. It is placed in the waveguide so that it intercepts energy being transmitted and also energy being received. The mixer diode mixes the outgoing and incoming signals and produces the difference signals. These signals are fed into a wideband FM receiver, usually tuned to 30 MHz.

Q: How does a circulator work in a Gunnplexer?

In higher quality Gunnplexers, a *circulator* is employed to separate the transmitted and received signals. The internal workings of a circulator include a piece of ferrite and a magnet that steer the RF signals around the ferrite. A circulator is

Resources

- VE3SMA from Ontario, Canada has put together a valuable Web page for Gunnplexer information at www.kwarc.org/10ghz/10GHZ-4.htm.
 - A Web page describing a data (Ethernet type) experiment with Gunnplexers by KE5FX can be found at www.guerrilla.net/reference/10ghz_link/10ghz_link.html.
 - A very thorough application note on putting a Gunnplexer on ATV is available at PC Electronics. Go to their Web page at www.hamtv.com and request document [10 GHz TXapp.pdf](#).
 - *The Gunnplexer Cookbook*, Bob Richardson, W4UCH, The Ham Radio Publishing Group, Greenville, NH. (This book is out of print, so check your library or used book supplier.)
- Gunnplexers, antennas, complete systems, technical notes and related parts*
- Advanced Receiver Research, Box 1242, Burlington, CT 06013; tel 860-485-0310; www.advancedreceiver.com/.
 - SHF Microwave Parts Company, 7102 W 500 S, La Porte, IN 46350; www.shfmicro.com/.

constructed inside the Gunnplexer waveguide so that a small amount of the transmit energy is "leaked" to the mixer, just enough to make the mixer operate correctly. The circulator further steers as much of the received RF to the mixer diode as possible. This arrangement increases the effectiveness of the receive mixer diode and improves overall performance.

Q: How are Gunnplexers operated?

The mixer will produce frequencies that are the difference between the transmitted and received frequency. Therefore, for two Gunnplexer stations to communicate, their oscillators are adjusted to transmit on frequencies that are different by an agreed amount. The typical offset is 30 MHz, and two common RF frequencies used are 10,250 and 10,280 MHz. When the two systems are pointed at one another, both stations will be receiving a signal at approximately 30 MHz at the mixer output. The receiver is usually a conventional FM radio, modified to operate at 30 MHz or a radio constructed for this purpose. One interesting benefit of Gunnplexer operation is that the radios are full duplex—that is, both operators can speak and listen at the same time.

Q: How do I get Gunnplexers and parts?

There are door openers, police radar detectors and police radars that have been modified with the addition of suitable dc, audio and receivers to operate successfully as Gunnplexer radios on 10 GHz. In the photo that shows the collection of Gunnplexer components, the larger unit in the back is a door opener—the others are radar detectors. It is usually possible to retune the Gunn cavity to move it from the typical door-opener frequency of about 10,500 MHz or a typical radar detector



24 GHz (left) and 10 GHz (right) high-quality communications Gunnplexers.

frequency of about 11,500 MHz down to 10,250 or 10,280 for amateur use. Of the most common door-opener units, the ones with two or three electrical connections will have a mixer and varactor, respectively. They are much easier to use than the ones with a single connection.

For new, and generally higher quality and pre-tuned Gunnplexers, there are a few sources of the Gunn assemblies including higher power units, modulators, receivers, power conditioners, horns and various schemes for automatic frequency control. One of the suppliers, Advanced Receiver Research, can deliver a completely operational system. They are regular advertisers in *QST*.

In the next column we'll lift the lid on a microwave *transverter* and begin a series of issues on the components and functions of the type of radio that amateurs use to set DX records, talk way beyond the horizon, scatter signals off of rain, and generally have a blast!

I wish to thank Kent Britain, WA5VJB for his assistance in reviewing the column this month. Kent has been, and continues to be a big promoter of Amateur Radio microwave construction and operation.

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