MICROWAVELENGTHS

A Glossary of Microwave Terms

We tend to use a lot of terms in ham radio, so I felt it was time to review some of them. Many of these terms apply to communications in general, so the brief definitions given here are focused on the meaning to microwavers. Unfortunately, this list cannot be exhaustive so I have chosen some of the more important terms. The *QST* issue in which Microwavelengths discusses the term is also given for further reading.

Amplifier—A device that increases power. Linear amplifiers are usually used to increase the power of signals that are modulated. Microwave power amplifiers tend to be expensive, so loss between a transmit amplifier and the antenna is like throwing away money. [May 2003] Also see LNA.

Antenna—The device that transfers electromagnetic waves between free space and a transmission line. See Horn, Dish and Feed. [July 2002]

Aperture—The effective size of the antenna as it captures or radiates the electromagnetic wave. This can be expressed as a diameter or an area, usually in meters or square meters respectively. For well-fed dishes, this is some large fraction of the actual dimensions. [July 2002]

Aperture efficiency—The ratio between the effective dimensions and the actual dimensions of the dish or horn. A very well-fed amateur dish can achieve 65%. The best professional systems can reach 80%. [July 2002]

Bandwidth—The range of frequencies that a modulated signal occupies or that a receiver is detecting or presenting in audio. Large bandwidths can carry more information, but also bring along more receiver noise that degrades performance of a communication system. [November 2002]

Beamwidth—The angular width in space of a transmitted signal (equal to the width of sensitivity to a received signal). This is a property of an antenna, expressed as an angle, and is most often meant to describe the angle between points that are 3 dB lower than the center. [July 2002]

Cable loss—Transmission line loses power to heat at some number of decibels per unit length. This loss increases with frequency. It is best to check with manufacturers for details, or better yet, measure a sample.

Connectors—Coaxial connections for microwave frequencies are very specialized. Generally smaller connectors are suitable for higher frequencies, but only a few types such as the N and SMA work really well. [November 2004]

Decibel—Abbreviated *dB*, this is a logarithmic expression of a ratio of power. To convert power ratio to decibels, where R is the ratio, dB = 10 * log(R). To convert from decibels, where dB is the value, $R = 10^{(dB/10)}$. Decibels can be used in a variety of ways to express power ratios—such as the input/output ratio of an amplifier (its gain) or the signal-to-noise ratio of a system. [March 2004]

dBm—This is an absolute (logarithmic) measure of power as related to 1 milliwatt. For instance, 0 dBm is 1 mW, whereas 30 dBm is 1 W (30 dB is a ratio of 1000, and 1000 times 1 mW is 1 W). Similarly, –30 dBm is 1 microwatt.

Dish—A type of antenna consisting of a parabolic reflector and a feed. Some parabolic reflectors are non-central sections of parabolas, and are called "offset dishes" because their feeds appear to be offset from a normal position. An offset fed dish has no shadow from the feed, and the spillover points toward quiet sky, so the performance can be better than a conventional dish. Because these are mass produced for satellite TV, they are relatively inexpensive and available. [July 2002]

EHF—Extremely High Frequency, which is a range from 30 GHz to 300 GHz. In the US this includes the 47-47.2, 76-81, 122.25-123, 134-141 and 241-250 GHz ham bands. There are two oxygen (60 and 118 GHz) and water vapor (22 and 183 GHz) absorption frequencies along with a general tendency of greater absorption at higher frequencies that affect propagation. [July and September 2003]

Feed—A type of antenna that is used in conjunction with a reflector to make a large or high gain antenna. Often this is a small horn designed to feed a dish, but it could be any of several types of small antennas including dipoles and slots. [July 2002]

Gain—The ratio between an input and an output of a device or the ratio between a standard and a measured value. Usually this is expressed in dB. The gain for an antenna is the ratio between the signal from a hypothetical isotropic radiator (equal power radiated in all directions) and the power received from the direction of maximum signal.

Gunn—A type of diode with negative resistance which when placed in a resonant circuit and biased will oscillate at microwave frequencies. Gunns are employed from 10 GHz through 47 GHz at power levels up to 100 milliwatts. Without locking, however, they are not stable enough for narrow bandwidth com-

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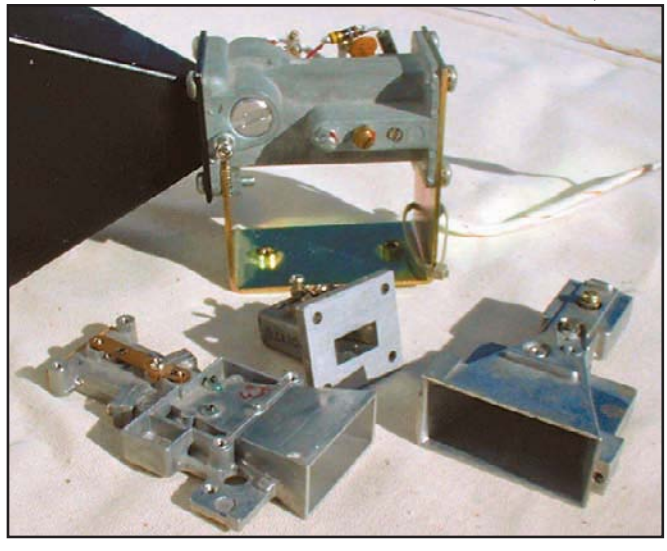

A selection of surplus Gunnplexers from radar detectors and door openers.

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munications (SSB or CW) and are therefore rarely used for modern DX microwave work. [March 2002]

Horn—A simple antenna made of metal opened at one end. It can be rectangular, square or circular in cross section and constant or expanding diameter towards the opening. Horns can support various polarizations and patterns and can be fed with probes and coaxial cable or waveguide. They make very good antennas or dish feeds. [July 2002]

Interface—For microwave transverters, the connections, level conversion and logic needed to interconnect a transceiver with a transverter. Typically, the transmit control and transmit power level are the most important interface features. [May 2002 and July 2004]

Local oscillator—The signal used inside a transverter to mix with the incoming or outgoing signal that converts the transceiver's frequencies to and from the microwave frequencies. The most difficult achievement in LO implementation is frequency stability and accuracy. Most successes begin with a quality crystal oscillator in the 100 MHz region. [May 2002]

LNA—Low Noise Amplifier usually used as the first stage after the antenna in a receive chain to establish the lowest receive noise prior to mixing or introduction of cable losses. [January and March 2004]

Microwave(s)—Generally the frequencies between 1 GHz and 300 GHz, but some extend the range down to 300 MHz and/or limit it to 30 GHz [January 2002]

Mixer—A device that mixes two signals and produces the sums and differences of the input frequencies and their harmonics. This is very helpful in the conversion necessary in a transverter. Often a multiple is used on EHF where generation of a fraction of the LO frequency is much easier. [May 2002]

MMIC—Monolithic Microwave Integrated Circuit, a single component that contains several RF functional elements constructing a useful unit, such as an amplifier.

Nf—Noise figure, a ratio, expressed in dB, between the power output by an amplifier with a room temperature load connected to its input and a perfect (noiseless) amplifier with the same gain and input load. A noise figure of 3 dB represents an amplifier that generates just as much internal noise as a room temperature matched input load generates. [March 2004]

NF—Noise factor, the linear version of noise figure, where 2 is the same as 3 dB. [May 2004]

Noise temperature—The temperature to which a matched black-body radiator (or resistor) would have to be heated to create the equivalent noise that an amplifier generates internally (as though it all were generated at its input). [May 2004]

Operating procedure—In microwaves, when the contact is expected to be difficult, usually the higher power station transmits first. The receiving station reports when the signal is heard and peaked, the process is reversed, and the QSO begins. This requires a liaison communications channel, often accomplished on 2 meters SSB. [March 2003]

Rain scatter—This ability to scatter RF from rain droplets is especially useful on ham bands from 5 GHz to 24 GHz. This allows amateurs to make contacts past the horizon and around obstructions. [January 2003]

Rose—A dial as is often seen on a compass for indicating direction, and is usually mounted on a tripod and set from sun direction or known station or beacon directions. [March 2003]

Sequencer—For TR switching, a device that turns equipment and relays on and off in a predetermined sequence with appropriate delays to prevent component damage. [January and March 2005]

SHF—Super High Frequency, those between 3 GHz and 30 GHz. This includes the 3456, 5760, 10,368 and 24,192 MHz ham bands.

Signal to noise ratio—The ratio of the signal to the noise, often expressed in decibels. When the signal power is equal to the noise power in the bandwidth, the ratio is zero dB. A positive number represents a signal stronger than the noise. [November 2002]

System margin—The performance of a complete communications system in one direction, usually expressed as the resulting signal to noise ratio. The equations $P_r=P_t+G_t-L_p-L_a+G_r$ and $P_n=B_r-174+N_F$ give the power of the received signal and the power of the noise. [November 2002]

Transverter—A device that connects between the transceiver (rig) and the antenna that converts the transceiver's operating frequency to a microwave band. LNAs and power amplifiers are added between the transverter and the antenna to improve system performance. [May 2002, July 2004]

TR relay—As with any communications system, the TR relay switches the antenna between transmit and receive circuits. At microwave frequencies conventional relays are very lossy so specialized coaxial or waveguide relays are used. [March 2005]

UHF—Ultra High Frequency, those between 300 MHz and 3000 MHz (3 GHz). This includes the 432, 902, 1296 and 2304 MHz ham bands.

Waveguide—A type of transmission system that encloses the signals in a single conductor, which can be circular, square or most often rectangular in cross section. Waveguide can have very low loss but because of size is most often used on 10 GHz and above. [July 2002]

Next Issue

After three and a half years writing this column I believe it is time for new perspectives. I was honored to have the editors of *QST* ask me to contribute in this way, and over these years I have grown in my own clarity and understanding. The next issue of Microwavelengths will be in the hands of Paul Wade, W1GHZ. Paul has been one of the major contributors to Amateur Radio microwaves for years, is very active on the bands, and is especially well known for his investigation and clear explanation of antennas. Please join me in welcoming him as conductor of this column. QST

Strays

WB5SYT

Congratulations! **The Edmond (OK) Amateur Radio Society was recognized for its significant contribution to public service at a recent ceremony. At the presentation, the National Weather Service recognized the city as a Storm Ready Community. From the left: Edmond Emergency Manager David Barnes; Rick Smith of the National Weather Service; ARRL Oklahoma Section Manager John Thomason, WB5SYT, and EARS President Andrew John, AD5FX.**