GARS

Glenn Amateur Radio Society

KJ6HCG

Prez Says — ***The GARS Repeater*** — August 2024

Salutations from the lair of KF6OBI! – As I take a break from the roller coaster ride I am on, I thought I would update the GARS membership about what is going on in my life. So this maybe a short newsletter.

As most of know my wife, Marlene, is in the ICU at Sutter Medical Health Center. She has Septic Double Pneumonia and is in a fight for her life. She has been in the hospital now for 6 days and it looks like she will be in the ICU for another 3 to 5 days. As I write this I have been informed that she did not have the best of nights, not like she did Thursday night when I stayed with her. The medical staff are keeping watch over her and keeping all her numbers stable, and going in the right direction. She struggles to become stronger but her breathing at times is very hard. This has a big effect on her lungs and heart.

The family is wrapped around her and a family member is always close by. I want to thank all of you for your fervent Prayers and blessings. We are seeing answers to those prayers each and every hour as we watch miracles unfold before us. Our faith continues to hold strong in the healing power of prayer, and our Lord God!

The camp out and maintenance trip to the Saint John site on 26-28 of July went very well. Thanks to Tyler, N6UTV, for his fine culinary skills and some fantastic food. We were able to complete most of the planned work at the site and have began plans for our next trip. I want to thank Jeramie, W6LND; Ryan, AG6VA; and Tyler, N6UTV for their hard work and support on this mission. The Kawasaki Mules that Tyler brought along made a vast improvement in traveling up to and from the repeater site. The mules relieved our personal vehicles of the harshness of the journey.

While at the site the Rigrunner was factory reset and upon returning to the valley it was accessible thru the Internet. There were not any changes made to the programming. When checked today the unit was not accessible again. So I will work with Stream IT to find out what the communications link problem is, and get it fixed.

The GMRS repeater was retrieved on the 24th of July from Sutter Buttes Communication where Bill, N6VPI, did his magic making sure that the repeaters were to functioning to specification. The GMRS repeater was placed into service again at the Saint John site for testing. We also replaced the GMRS feed line. The rest of the new feed line material has arrived and will be assembled and ready for the next maintenance trip. We also moved all coax from the floor flange and passed them through the coax weather boot on the upper east side of the shelter.

Parts and materials have also been received so we can now move forward with the testing of the GARS generator EMI/RFI testing.

NOTICE: The GARS Monday night net has been experiencing some difficulties with various repeaters systems. So pay special attention to your email and text messages for any notices of which repeater the net will be held on, any given Monday.

Up and coming events are: –See notices are on the GARS Website <https://www.garshamradio.org/>;

This months membership meeting will be on the second Friday, the 9th of August, at the Lutheran Fellowship Hall, 565 Main Street, Artois CA, at 7:00pm. Late arrivals and guests are always welcome. Also remember that one does not have to be a member of the club to participate in our membership meetings and activities. Be safe in all you do and may you all have many blessings in the days and months ahead!

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Effective radiated power

Effective radiated power (**ERP**), synonymous with equivalent radiated power, is an IEEE standardized definition of directional radio frequency (RF) power transmitted from a theoretical half-wave dipole antenna. It is differentiated from effective (or equivalent) isotropic radiated power (EIRP) mainly by use of relative antenna gain instead of absolute gain in the calculation. In the case of ERP, antenna gain is calculated as compared to the maximum directivity of a half-wave dipole antenna, whereas EIRP is calculated using antenna gain referenced to an ideal isotropic radiator, otherwise known as "absolute" gain. The term "antenna gain" is assumed to be absolute (referenced to isotropic) unless specifically stated to be relative. The gain is then multiplied by the power actually accepted by the antenna to result in the actual ERP value (or EIRP). Power losses which occur prior to the antenna, e.g., in the transmission line or from inefficiency in the generator itself are therefore not included in the calculation of ERP or EIRP

Antenna gain and directivity

Antenna gain is closely related to directivity and often incorrectly used interchangeably. However, gain is always less than directivity by a factor called radiation efficiency, η. Whereas directivity is entirely a function of wavelength and the geometry and type of antenna, gain takes into account the losses that always occur in the real world. Specifically, accelerating charge (time varying current) causes electromagnetic radiation per Maxwell's equations. Therefore, antennas use a current distribution on radiating elements to generate electromagnetic energy that propagates away from the antenna. This coupling is never 100% efficient (by Laws of Thermodynamics), and therefore antenna gain will always be less than directivity by this efficiency factor.

Dipole vs. isotropic radiators

Because ERP is calculated as antenna gain (in a given direction) as compared to the maximum directivity of a half-wave dipole antenna, it creates a mathematically virtual effective dipole antenna oriented in the direction of the receiver. In other words, a notional receiver in a given direction from the transmitter would receive the same power if the source were replaced with an ideal dipole oriented with maximum directivity and matched polarization towards the receiver and with an antenna input power equal to the ERP. The receiver would not be able to determine a difference. Maximum directivity of an ideal half-wave dipole is a constant, i.e., 0 dBd = 2.15 dBi. Therefore, ERP is always 2.15 dB less than EIRP. The ideal dipole antenna could be further replaced by an isotropic radiator (a purely mathematical device which cannot exist in the real world), and the receiver cannot know the difference so long as the input power is increased by 2.15 dB.

Unfortunately, the distinction between dBd and dBi is often left unstated and the reader is sometimes forced to infer which was used. For example, a Yagi-Uda antenna is constructed from several dipoles arranged at precise intervals to create better energy focusing (directivity) than a simple dipole. Since it is constructed from dipoles, often its antenna gain is expressed in dBd, but listed only as dB. Obviously this ambiguity is undesirable with respect to engineering specifications. A Yagi-Uda antenna's maximum directivity is 8.77 dBd = 10.92 dBi. Its gain necessarily must be less than this by the factor η, which must be negative in units of dB. Neither ERP nor EIRP can be calculated without knowledge of the power accepted by the antenna, i.e., it is not correct to use units of dBd or dBi with ERP and EIRP. Let us assume a 100 Watt (20 dBW) transmitter with losses of 6 dB prior to the antenna. ERP < 22.77dBW and EIRP < 24.92dBW, both less than ideal by η in dB. Assuming that the receiver is in the first side-lobe of the transmitting antenna, and each value is further reduced by 7.2 dB, which is the decrease in directivity from the main to side-lobe of a Yagi-Uda. Therefore, anywhere along the side-lobe direction from this transmitter, a blind receiver could not tell the difference if a Yagi-Uda was replaced with either an ideal dipole (oriented towards the receiver) or an isotropic radiator with antenna input power increased by 1.57 dB.

Polarization

Polarization has not been taken into account so far, but properly it must be. When considering the dipole radiator previously we assumed that it was perfectly aligned with the receiver. Now assume, however, that the receiving antenna is circularly polarized, and there will be a minimum 3 dB polarization loss regardless of antenna orientation. If the receiver is also a dipole, it is possible to align it orthogonally to the transmitter such that theoretically zero energy is received. However, this polarization loss is not accounted for in the calculation of ERP or EIRP. Rather, the receiving system designer must account for this loss as appropriate. For example, a cellular telephone tower has a fixed linear polarization, but the mobile handset must function well at any arbitrary orientation. Therefore, a handset design might provide dual polarization receive on the handset so that captured energy is maximized regardless of orientation, or the designer might use a circularly polarized antenna and account for the extra 3 dB of loss with amplification.

FM example

An antenna tower consisting of a high-gain collinear antenna array.

For example, an FM radio station which advertises that it has 100,000 watts of power actually has 100,000 watts ERP, and *not* an actual 100,000-watt transmitter. The transmitter power output (TPO) of such a station typically may be 10,000 to 20,000 watts, with a gain factor of 5 to 10 (5× to 10×, or 7 to 10 dB). In most antenna designs, gain is realized primarily by concentrating power toward the horizontal plane and suppressing it at upward and downward angles, through the use of phased arrays of antenna elements. The distribution of power versus elevation angle is known as the vertical pattern. When an antenna is also directional horizontally, gain and ERP will vary with azimuth (compass direction). Rather than the average power over all directions, it is the apparent power in the direction of the antenna's main lobe that is quoted as a station's ERP (this statement is just another way of stating the definition of ERP). This is particularly applicable to the huge ERPs reported for shortwave broadcasting stations, which use very narrow beam widths to get their signals across continents and oceans.

United States regulatory usage

ERP for FM radio in the United States is always relative to a theoretical reference half-wave dipole antenna. (That is, when calculating ERP, the most direct approach is to work with antenna gain in dBd). To deal with antenna polarization, the Federal Communications Commission (FCC) lists ERP in both the horizontal and vertical measurements for FM and TV. Horizontal is the standard for both, but if the vertical ERP is larger it will be used instead.

The maximum ERP for US FM broadcasting is usually 100,000 watts (FM Zone II) or 50,000 watts (in the generally more densely populated Zones I and I-A), though exact restrictions vary depending on the class of license and the antenna height above average terrain (HAAT).[3] Some stations have been grandfathered in or, very infrequently, been given a waiver, and can exceed normal restrictions.

Microwave band issues

For most microwave systems, a completely non-directional isotropic antenna (one which radiates equally and perfectly well in every direction – a physical impossibility) is used as a reference antenna, and then one speaks of EIRP (effective *isotropic* radiated power) rather than ERP. This includes satellite transponders, radar, and other systems which use microwave dishes and reflectors rather than dipole-style antennas.

Lower-frequency issues

In the case of medium wave (AM) stations in the United States, power limits are set to the actual transmitter power output, and ERP is not used in normal calculations. Omnidirectional antennas used by a number of stations radiate the signal equally in all directions. Directional arrays are used to protect co- or adjacent channel stations, usually at night, but some run directionally 24 hours. While antenna efficiency and ground conductivity are taken into account when designing such an array, the FCC database shows the station's transmitter power output, not ERP.

Related terms

- **Effective monopole radiated power** (EMRP) may be used in Europe, particularly in relation to mediumwave broadcasting antennas. This is the same as ERP, except that a short vertical antenna (i.e. a short monopole) is used as the reference antenna instead of a half-wave dipole.
- Equivalent isotropically radiated power (EIRP)

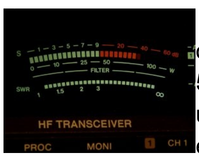
HAAT

The height above average terrain for VHF and higher frequencies is extremely important when considering ERP, as the signal coverage (broadcast range) produced by a given ERP dramatically increases with antenna height. Because of this, it is possible for a station of only a few hundred watts ERP to cover more area than a station of a few thousand watts ERP, if its signal travels above obstructions on the ground.

S-meter and signal strength

The S-meter is an instrument present on the majority of radio receivers that measures the strength of the signal that is being received, and uses a special unit: the *S-point*. S-points are often used for RST reports.

S-points go from S1 to S9 and each S-point is defined as a 6 dB change in signal strength. This means that each time the voltage is halved (–6 dB) the signal strength decreases by one point. S9 is already a very strong signal, but to describe larger signals, steps of 10 dB are used instead of 6 dB, noted "S9+20" meaning 20 dB above S9.



Today two reference values exist: for frequencies **below 30 MHz,** S9 is defined as a voltage of **50 µV** over 50 Ω at the receiver antenna connector; for frequencies **above 30 MHz,** S9 is defined as a voltage of **5 µV** over 50 Ω at the receiver antenna connector. This refers to an unmodulated carrier signal (N0N) that uses almost no bandwidth; in case of real signals using a given bandwidth, this definition may not be enough since a smaller receiver bandwidth allows a weaker minimum detectable signal, but S-points are still a good tool for comparing received signals.

S-points for frequencies below 30 MHz:

Signal strength	Relative intensity	Received voltage		Received power (Z_C = 50 Ω)	
S1	–48 dB	0.20 µV	–14 dBµV	790 aW	–121 dBm
S2	–42 dB	0.40 µV	–8 dBµV	3.2 fW	–115 dBm
S3	–36 dB	0.79 µV	–2 dBµV	13 fW	–109 dBm
S4	–30 dB	1.6 µV	4 dBµV	50 fW	–103 dBm
S5	–24 dB	3.2 µV	10 dBµV	200 fW	–97 dBm
S6	–18 dB	6.3 µV	16 dBµV	790 fW	–91 dBm
S7	–12 dB	13 µV	22 dBµV	3.2 pW	–85 dBm
S8	–6 dB	25 µV	28 dBµV	13 pW	–79 dBm
S9	0 dB	**50 µV**	34 dBµV	50 pW	–73 dBm
S9+10	10 dB	160 µV	44 dBµV	500 pW	–63 dBm
S9+20	20 dB	500 µV	54 dBµV	5.0 nW	–53 dBm
S9+30	30 dB	1.6 mV	64 dBµV	50 nW	–43 dBm
S9+40	40 dB	5.0 mV	74 dBµV	500 nW	–33 dBm
S9+50	50 dB	16 mV	84 dBµV	5.0 µW	–23 dBm
S9+60	60 dB	50 mV	94 dBµV	50 µW	–13 dBm

S-points for frequencies above 30 MHz:

Signal strength	Relative intensity	Received voltage		Received power (Z_C = 50 Ω)	
S1	–48 dB	20 nV	–34 dBµV	7.9 aW	–141 dBm
S2	–42 dB	40 nV	–28 dBµV	32 aW	–135 dBm
S3	–36 dB	79 nV	–22 dBµV	130 aW	–129 dBm
S4	–30 dB	160 nV	–16 dBµV	500 aW	–123 dBm
S5	–24 dB	320 nV	–10 dBµV	2.0 fW	–117 dBm
S6	–18 dB	630 nV	–4 dBµV	7.9 fW	–111 dBm
S7	–12 dB	1.3 µV	2 dBµV	32 fW	–105 dBm
S8	–6 dB	2.5 µV	8 dBµV	130 fW	–99 dBm
S9	0 dB	**5.0 µV**	14 dBµV	500 fW	–93 dBm
S9+10	10 dB	16 µV	24 dBµV	5.0 pW	–83 dBm
S9+20	20 dB	50 µV	34 dBµV	50 pW	–73 dBm
S9+30	30 dB	160 µV	44 dBµV	500 pW	–63 dBm
S9+40	40 dB	500 µV	54 dBµV	5.0 nW	–53 dBm
S9+50	50 dB	1.6 mV	64 dBµV	50 nW	–43 dBm
S9+60	60 dB	5.0 mV	74 dBµV	500 nW	–33 dBm

Older receivers were calibrated using the old standard that defined S9 as a voltage of 100 µV instead of 50 µV over 50 Ω at the receiver antenna connector.

Usually S-meters in amateur radio equipment are not calibrated and are not very precise. S-meter readings may also vary from one band to another and it's always interesting to check an S-meter with a precise generator and a step by step attenuator.

Bibliography and further reading

[1] Wolfgang Link, DL8FI. *Metodi di misura per radioamatori.* Franco Muzzio & C. editore, 1978, sezione 3.9.

GARS Officers: (Board of Directors)

President ………………… Michael A. Ellithorp, KF6OBI
Vice President …………. Bob Wirth, KC6UIS
Secretary ……………….. Jeramie Finch, W6LAD
Treasurer ……………….. Phil Zabell, KI6SMN
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Training …………………. Russel Doughty, KE6PMT
Publications ……………. Vacant
Webmaster / Social Media — Mike "Smitty" Smith, WB1G
Radio Officer …………… Phil Zabell, KI6SMN
Emcomm Officer ………. Vacant

Board Meeting, 2nd Wednesday of each month, meetings starting at 6:30 PM via Google Meets
General Membership Meeting, 2nd Friday of each month, meetings starting at 7:00 PM

GARS Meeting locations: Main site is the Lutheran Fellowship Hall, 565 Main Street, Artois CA, our alternate meeting site is the Willows Seventh-Day Adventist Church, 543 1st Avenue, Willows, CA.

GARS Net: Mondays, 8:00 PM Primary: 147.105 (N6YCK) (+)110.9 PL)

GEARS Club Net: Tuesday, 7:30 PM 146.850 MHz-PL 110.9

Sacramento Valley Traffic Net: Nightly 9:00 PM 146.850 MHz-PL 110.9

ARES Nets:
Butte Mondays 20:00 146.850 MHz-PL 110.9
Yuba Sutter Thursdays 19:00 146.085+MHz PL 127.3

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Editor ……………...…….. Michael A. Ellithorp, KF6OBI   Distribution—via email—monthly