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THE MONITOR

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Happy New Year to all ECARS Members

From Ike Meredith K1VBD, ECARS President

This past year was an exciting one for the net. We saw band conditions finally start to improve, and now we can all hear each other. I have noticed that the net is much busier now, at all hours. ECARS is fortunate to have had many fine people step in and take the net control position to handle the increase in traffic. It's great to get on frequency at 2:00 PM and still hear the net operating.

We now have a web page, thanks to Phil K2HQ, where ECARS members can find all kinds of great information about radios, antennas, solar conditions, membership information, and even a rouge's gallery were we can check out photographs of many ECARS members.

Bill K1WS, our net manger and the net controllers have been conducting a very successful membership drive. We have had over twenty new members sign up in the last few months and we are getting more each week. Great job Bill.

Now as we go into 1999, I think that ECARS is in very

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Why Use an Antenna Impedance Matching Network

By K2HQ Phil Morrissey

Before we get into the transmatch proper, let's review that part of basic AC theory which states: <b>" when the internal impedance of the generator is equal to that of the load, maximum power will be transferred from the generator to the load ".

Your final amplifier (tube or transistor) is an AC generator which, in order to transfer maximum power into a load, must see a load impedance equal to the internal impedance (in our case internal impedance is 50 ohms, therefore the load impedance must be 50 ohms). The network in the output circuit of older 'tube type' transmitters

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ECARS Election Results

President	Ike Meredith, K1VBD	67 votes
Vice President	Vince Bardsley,	47 votes
Vice President	J.R. Fellows, W5UVG	20 votes
Secretary/ Treasurer	A. Ann Hoffman, KA2ACF	68 votes
Director	Peter Lairos, K2RSK	45 votes
Director	Jim Benedict, WB2PHK	21 votes

Congratulations to ECARS' new president, Ike, new vice president, Vince, and our new director, Peter.

Linear Amplifier Power Output – The Real Story

By Robert J. Traister, WB4KTC

If you want to get a lively discussion going among ham radio operators, simply mention linear amplifiers. The subject of amplifiers for amateur radio purposes is fascinating, as are the many tales of the ultra-high power someone was able to extract from his/her linear. "By Golly! It's all I can do to hold my amp down to legal power." "Heck, I looked at the wattmeter and I was putting 3 kilowatts into the dummy load!" .... and many more stories like them are abundant on the airwaves.

However, most of these stories, although sincere, are the result of inadequate knowledge about power output and also to wattmeters that are, to put it kindly, rather liberal in their readings. By and large, though, the main culprit in these exaggerated power figures is the term, "PEP" or "peak-envelope power." And, it has been demonstrated repeatedly that many hams (and radio engineers as well) have a misconception as to what this term really means. Without going into a long, technical discussion, let's examine "peak-envelope-power."

We all know what peak means and we all know the definition of power, so let's take the middle word,

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Transmatch from page one

is actually a limited range transmatch, built within the transmitter for the purpose of matching the final amplifier to the load. This is the reason the older transmitters can deal with varying impedance; the same is not true for the transistor type units.

Here's how the transmatch works: let's use the popular "T" circuit for our transmatch. This circuit consists of two air variable capacitors in series, with a variable coil connected between the junction of the two capacitors and ground. The antenna feed line is connected to the free end of one of the capacitors and the transmitter is connected to the free end of the other capacitor. Manipulation of the transmatch is simple: First, set both capacitors halfway open. Then, with the receiver operating, adjust the variable inductor for the strongest received signal...this puts you in the ball park. Then, applying low power, alternately juggle the two capacitors back and forth, until you see maximum power output and minimum SWR the same time, both being measured between the rig and input to the transmatch. It is important that you use the minimum amount of inductance necessary, thus assuring maximum efficiency.

Of course, since the coil is shared by both input and output capacitors, there will be some interaction and both capacitors must be juggled alternately for optimum tuning. This is all much simpler than it sounds and takes less time to accomplish than I have taken to tell about it. When you have become accustomed to your transmatch this all happens in a few seconds. Also, you should log the transmatch settings for favorite frequencies. Tuning is fast thereafter.

A good tuner will reduce radiated interference. An antenna tuner properly adjusted will provide 20 or more dB attenuation at 2nd harmonics and above. This amounts to a reduction of harmonic output power of more that 100 to 1. An important consideration when running Tri-Band beams and other multiband antennas. This is something not accomplished with a standard low pass filter, which normally starts attenuating at around 45 MHz. Thus your tuner will reduce the interference to other services.

An antenna tuner allows you to tune over a much wider range of frequencies and still maintain an excellent power transfer to a given antenna.

The final amplifier in any transmitter or linear is subject to greater loads as the SWR increases and this extra load results in added heat loss and shorter life for the equipment as well as poor performance. Many of the new solid state amplifiers have limiting circuits that reduce the power output if the SWR exceeds a predetermined value. Some units will be damaged if the SWR is too high. The antenna tuner reduces the load on the amplifier.

Perhaps of equal importance and often overlooked is the attenuation of unwanted signals into your receiver, thus improving reception. The antenna tuner becomes a tuned RF circuit to the input of your receiver.

This article should have answered your questions about an antenna tuner, or at least refreshed your memory. Of course if your antenna tuner is built into your rig and you do not use an amplifier, all tuning is done for you.

Ike from page one

good shape, due to the increase in both propagation and membership. But remember, it is your net and without net controllers and participants there is no net. I want to thank all of you who check in and help out with relays for instance, for without you, we have no purpose.

Lastly I would like to thank everyone for electing me as your president. I hope to do a good job for ECARS, but I can't do it alone. I'd like to hear from all of you, pro and con, good and bad. If there's a problem or a compliment, please let me know. If you have suggestions, I'd like to hear them. I will be on the air as much as I can and will be glad to QSY with any of you and listen to your suggestions. If you want to write to me, my address is: Ike Meredith RFD 1, Box 241A, Center Harbor, NH. My email address is smeredith@lr.net.

I hope 99 will be a great year for everyone. See you on 55 73 Ike

ECARS Get-Together

ECARS is having a get together in Ocean City, Maryland at the world famous Carosel on the weekend of April 16-18th. The cost for a double occupancy ocean front room is $69 plus tax. The Saturday night buffet will be $23 per person.

Please make your reservation by calling 410-524-1000 ext. 751 or 1-800-641-0011 ext. 7151

Please note that all reservations must be confirmed with the Carosel by February 14th.

G5RV Multi-Band Antenna

By Phil Morrissey K2HQ

There have been a lot of questions about the G5RV antenna on the ECARS Nets of late; many of these questions have been aimed at me. It is very hard to answer these questions on the air. Hence this article. I think that after you read this, all of your questions about the G5RV will be answered. I have included lengths for the Double, Standard and Half G5RV's. In the last twenty years I have used all three types, and found the antenna to work well on all bands with the use of a tuner.

THE G5RV ANTENNA, with its special feeder arrangement, is a multiband center-fed antenna capable of very efficient operation on all HF bands from 3.5 to 28 MHz, specifically designed with dimensions which allow it to be installed in gardens which accommodate a reasonably-straight run of about 102 ft (31.1m) for the "flat-top". However, because the most useful radiation from a horizontal or inverted-V resonant antenna takes place from the center two-thirds of its total length, up to one-sixth of this total length at each end of the antenna may be dropped

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"envelope " and explain what it is. Regarding an SSB signal, the envelope references the waveform of the human voice that is impressed on a carrier (AM) prior to suppressing that carrier and one sideband in order to arrive at single-sideband. This is a complex sinusoidal wave that goes from a **peak** negative to a **peak** positive value, and then to a **peak** negative value again, as do all sine waves. This envelope waveform represents the power of the human speech, but this power is not a continuous single value. Rather, it goes from high to low and low to high constantly, and the values of those lows and highs also change with the speech characteristics. The average power of the waveform depends upon the exact nature of the human voice, the speech pattern and several other factors. However, as a rule of thumb, average power of the human voice is considered to be about one-half of the peak power. Therefore, if the peak power in the speech waveform is 1000 watts, the average power "may" be around 500 watts. It could be a little more or a little less, depending upon the exact nature of the human voice making that speech pattern.

With this in mind, we can also state that the peak power of a human speech waveform that registers 500 watts of average power on a meter is approximately two times this 500 watt value or 1000 watts. Again, it might be a little more or a little less, but 2:1 is a good ratio for most human voices. In this example, the average power indicated on an accurate wattmeter is 500 watts and the peak-envelope power is 1000 watts. This discussion assumes that no speech processing is being used, since processing increases the **average** power contained in the voice input to the microphone, and most meters can read this increase in average power. In other words, the 2:1 ratio no longer applies when using a speech processor. The ratio is closer to (but never equal to) one-to-one.

Now, let's explore what is, perhaps, the biggest misunderstanding in amateur radio. Assume that we have an amplifier that runs 3000 volts on the plate and has an efficiency of 60 per cent. If we supply drive to this amplifier and tune it so that it draws 500 milliamperes of current, keydown, then the input power is 1500 watts (3000 X 0.5) and the output power (keydown) is 900 watts (assuming 60% efficiency, 1500 X 0.6). With this in mind, what will the PEP output power be when we speak into the microphone?

Many, many amateurs will say that the PEP output is 1800 watts, twice the keydown power indicated by the ammeter (and multiplying by the efficiency factor). This is totally and absolutely **incorrect**! The maximum PEP output from an amplifier tuned in such a manner is 900 watts. Keydown power and PEP are exactly the same value, given this example.

"Hey! I always heard that PEP was twice the meter reading!"

That statement is true **ONLY** when the meter is read while speaking normally into the microphone (and without speech compression). Given the tuning procedure above, when speaking into the mike, the ammeter should read a peak of approximately 250 milliamperes. This would represent an average output of 450 watts. However, the PEP output is closer to 900 watts even though the meter is not fast enough to measure those peaks.

Someone once told me that he had tuned an amplifier in this manner and, when speaking into the mike, saw the meter go to 500 milliamperes, therefore it must be putting out 1800 watts PEP, twice the indicated power while speaking into the mike. I asked him to demonstrate this to me. As it turned out, he didn't speak into the microphone, at least not exactly. Instead, he held the mike close to his mouth and uttered a sustained "Ahhhhhhhhhhhhhh." This does not produce a normal human speech pattern and is equivalent to a keydown condition. During this "Ahhhhh", the ammeter was reading the equivalent of keydown power. When he spoke in a normal voice, the meter read peaks of about 250 milliamperes, which is exactly what it should have been for 900 watts PEP or 450 watts average. If it had read more than approximately 250 milliamperes under normal voice conditions, then the signal from this amplifier would have been "flattopping" and distortion would result. Then too, most meters were never designed to accurately read rapidly fluctuating values. Some are faster than others and will read a higher percentage of the peak value than will the slower types that may not even be able to follow a peak to 50 percent of its actual value.

Regardless of what you have heard over and over and over again and what is claimed by many linear manufacturers, only a few commercial linears will actually produce a full 1500 watts output. There is only one current amateur amplifier using a pair of 3-500Z tubes that I have tested that will go a full 1500 watts output and that is the Ameritron, AL-82, which runs in excess of 3000 volts on the plates under load. Even then, it requires about 135 watts of drive to achieve this, even though the specs say 100 watts will do the job. My Amp Supply LK-500ZA with the Hypersil transformer is claimed by the manufacturer to produce in excess of 1500 watts output with 100 watts drive. In fact, it will do only about 1100 to 1200 watts output with brand new finals..... and that's all it ***should*** do. This amp runs about 2400 volts on the plates under load (as do many 3-500Z amps) . Maximum current rating for the 3-500Z is 400 milliamperes for each tube. Multiplying 2400 by 800 milliamperes yields an INPUT power of 1920 watts. Multiply by a 60% efficiency factor and you arrive at 1152 watts of output. That's exactly what it should be doing. I know that some amp manufacturers claim an efficiency of 75%, but that's a bunch of hokum. Maybe on 80 meters some will approach 70%, but most will exhibit efficiencies of 60-65% and a bit less on the higher frequencies. These figures assume grounded-grid amplifiers, operating in Class B and take into account the series feed-through power from the exciter that is added to the total output power from the amplifier. Grid-driven linear amplifiers, operating in class AB1 or AB2 will exhibit a little less efficiency.

Put simply, the PEP output of an amplifier is the same as or less than the sustained keydown power of that

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Linear from page

amplifier, when tuned for maximum output. It cannot be more. This is evidenced in the power amplifier sections of modern solid-state rigs as well. For example, my Yaesu FT-1000MP is rated at 100 watts output, CW and PEP. With power at full output, closing the key on my rig yields a reading of exactly 100 watts on the built-in power meter. Some amateurs might interpret this to equate to 200 watts PEP output on sideband. No Way! The SSB output is ALSO 100 watts PEP or approximately 50 watts average power, which is about what the meter reads on voice peaks, while I am speaking in a normal tone of voice. Now, when I use speech processing, this serves to increase the **average** power in my voice envelope. However, it does not and CANNOT increase the maximum peak power output, and any linear amplifier attached to my transceiver operates under the same rules of performance.

With all of these facts in mind, the following guidelines may be of some help to the intended purchaser of a new linear amplifier.

First of all, make certain that the total plate dissipation of the tubes it contains is nearly equal to the output power that you wish to obtain. While it is possible to eke 1500 watts out of a pair of 3-500z tubes (total plate dissipation 1000 watts) providing that the plate voltage is high enough, it is difficult to do and probably impossible above 20 meters. If you want maximum legal power, you had better opt for an amp with a 3CX1500A7 (1500 watts), 3CX1200A7 (1200 watts) or a pair of 3CX800s (1600 watts). On the other hand, if you only desire to output 500 watts or so, then buy and amp containing a tube or tubes that total nearly 500 watts of plate dissipation. Running a 1500-watt amplifier at 500 watts output will result in very low efficiency, higher heat, and wasted input power. Most tube-type amplifiers are most efficient when operated at or near maximum output.

Make equally certain that the power supply is rated to deliver the power that you want. If you expect to output 1500 watts on 10-meters, where efficiency may drop to around 50%, your power supply had better be rated at TWICE the intended output power. Many, many amplifiers intended for ham purposes are skimpy in the power supply area. It does you no good to have an amp tubed for 1500 watts of continuous output if its power supply is only good for 800 watts or so.

Additionally, don't trust any inexpensive wattmeter. I have yet to see one that comes properly calibrated from the factory or one that will stay calibrated across even a fairly narrow power range. If the SWR is other than 1:1, the power readings are even more inaccurate. Furthermore, the so-called "Peak" reading capabilities of these meters tend to be alarmingly inaccurate. Even the venerable Bird 43 meters will exhibit inaccuracies when reading power levels that fall within the lower half of their meter ranges.

I would be remiss, if I did not mention solid-state amplifiers. The same rules of performance apply; however efficiency will be much lower, because these typically operate as Class AB or even Class A amplifiers, exhibiting excellent linearity but very poor efficiency. For typical performance from 160 to 10 meters, expect no more than 45% efficiency. This means that, for 1000 watts output, the power drain will be 2222 watts or more. For an output of 500 watts, more than 1000 watts of power supply input will be required. You may luck out and get 50% efficiency, but 45% is about average. There are a number of manufacturers of solid-state amplifiers that originally intended their products for Citizen Band activity (illegal, by the way) who discovered that their amps would also work (some better than others) on the ham bands. These manufacturers are notorious for overstating amplifier output. When purchasing one of these amps, reference the power dissipation rating of the transistors. Peak output power will be a little less that the total power dissipation rating of the final transistors, even though most of these manufacturers will typically claim twice the actual power output that can be produced.

Before buying that big linear, remember that going from 100 watts to 1000 watts output results in an increase in signal strength on the receive end of less than two S-units. If your 100 watt signal is being received at S-7, then going to 1000 watts will result in that signal now being received at a little less than S-9. The best and most efficient "linear amplifier" of all is a good directional antenna. Going from a dipole to a good beam can easily net you the same (or better) signal increase as that described above and you're still running only 100 watts of power. As important is the fact that a beam is a two-way amplifier. It amplifies received signals as well as those that are transmitted. A big linear amplifier will increase your transmit power but it won't do a thing for receive sensitivity. A beam antenna with a 6 db gain quadruples your power output (in comparison with an isotropic antenna with a gain of zero). This same beam also increases your receive sensitivity by one S-unit (6 db gain = 1 S-unit), plus a lot more (effectively) by discriminating against signals coming in from the sides and back of the beam. There's a lot to be said for having your "power in the antenna."

Finally, obey the spirit as well as the letter of the FCC regulation, which states that the MINIMUM amount of power necessary to establish a contact is to be used. If you're S-9 at 100 watts, it is not only wasteful and inefficient to run 1500 watts but illegal as well. Regardless of the legalities, why use excess electricity and create more QRM when it is totally unnecessary.

The next time someone tells you about getting incredible output from an amplifier that is obviously incapable of such performance just smile, nod, and move on. However, you and I know that a quart jar cannot hold a "Full Gallon." If it holds a quart, it's doing the best that it can.

(Since the author retains the copyright to this story, it can not be used for other purposes after this one-time use by ECARS). editor

WA4UJJ ECARS Director Silent Key

Phillip E. Kern, October 30, l939--November 29, l998

While walking in Florida, Phil and his wife Doris were struck by a vehicle. Phillip died quickly, never regaining consciousness. His wife Doris, survived the accident and is recovering.

Phillip resided in Lisbon Falls, Maine, before moving with his wife to Fernandina Beach, Florida this October. He served in the US Navy and retired at the rank of Chief Warrant Officer (CWO-4) after serving more than 22 years. He also was retired from the L. L. Bean Co. and Bath Ironworks of Bath, Maine.

Funeral services were held at Fernandina Beach, Florida. Full military honors were bestowed by the honor guard from the Jacksonville Naval Air Station. A memorial service was held at Colonial Beach Baptist Church, on Sunday, December13th, for Phil whom I'd met more than twenty years ago when our families lived apartments away at U. S. Fleet Activities, Sasebo, Japan? At the memorial service, his former teacher, Sara Lee, aptly offered the following response by saying, “Let us all rejoice and be thankful that Phillip passed our way”.

Earlier she observed, “I taught Phillip in the sixth grade and he could really be exasperating. Not a discipline problem, but it was a chore to get him to do his work. He never sat there idle. He made up games and played against himself. In those days-‘back in the dark ages’, we had no programs for the gifted and talented and knew very little about children who fell into this category. We never once thought about him being bored and having no real challenges. Phillip remained my friend and when he came home he would always come to see me. For making such a poor beginning, he certainly grew up to be a fine young man. My life has been made much richer by having taught him and for having him as my friend.”

His brother, Jeff Kern gave insight in his comments by saying, “When I was born, Phillip was already 19 years old and away from home serving in the Navy. But that never stopped him from being interested in all that I was doing, and in showing kindness and encouragement to me at every turn. In one of the last letters I received from my brother he said, ‘Do the best you can, and pray.’ That's the Phillip Kern challenge to all of us”.

His close friend James Drummond recounted their early days, adding the following, “Our Grandma Barnes was always looking after others, putting them before herself and showing kindness and generosity, which must have rubbed off on Phil, forever becoming a part of him. Phil, David and I, known as The Three Musketeers, eventually joined the Navy. David and I were on the same ship, and after one cruise, pulled into Keywest, Florida and there was Phil on the pier, on a bike, like the old days; true to character and friendship. Through the years Phil advanced very fast in rank. He made us all proud”.

The memorial service was very moving, beginning with the Navy Hymn and ending with Anchors Away. Dr. Bill Jenkins, Pastor, spoke eloquently throughout, and with particular relevance as follows, “Let me share with you some words from June (his Mom) as we talked the other day about Phillip." “My son never let a friendship lie in the past. A friend for life was the only kind of friend he knew. Phillip served his country for more than 22 years in the Navy and did so with pride and devotion. He was a Ham Radio Operator and widened his circle of friendships to include folks all over the world. My son was especially proud of Doris and completely devoted to her." Dr. Jenkins added, “Each of you who knew Phillip will carry their own particular memories on their hearts.”

Godspeed, Phil. Among my memories from Japan include seeing you struggle with code before I gave you the 5 words per minute test for your first ham license. Then finding later that you had passed the 20 words per minute requirement for the highest level Amateur License that one can earn. I've still got a way to go! Then there was your idea that we should do breakfast on the grill for all those in our building. You wanted to awaken the parents to action on weekends. Sure did feed a lot of children then, didn't we? The parents apparently did not share your conviction, at least until they had awakened. That every day, every minute, every breath and reaching out to others, truly is a gift from God. I hope to join you one day in the very best antenna location known to man!

Proud to be counted as a friend, Roy,W1CRD

Phil W4UJJ Remembered

As most of you know, Phil W4UJJ pasted away at the end of November. I never had the pleasure of meeting Phil in person, but he was my best friend on the air. Phil got me involved in ECARS and was always there to help. There were many times when we wouldn’t realize that Phil was at his radio until someone had a question. Then, as usual, Phil was there, ready to help.

Phil was hit by a car while walking with his wife near his new home in Florida. He had just moved into his new house a few days before. I don't know any of the details of the accident, but I can't express the sadness that I felt when I heard the news. Phil was in good health and had just had the opportunity to move to the area where he wanted to live. All was going well until then. Unfortunately and he was taken from his wife and family in that senseless accident. I am deeply saddened.

I extend my condolences to his family and say, "Phil, you were a good man and I am really going to miss you"

Ike, K1VBD

G5RV from page

vertically, semi-vertically, or bent at some convenient angle to the main body of the antenna without significant loss of effective radiation efficiency. For installation in a very limited space, the dimensions of both the "flat-top" and the matching section can be divided by a factor of two, to make the half-size G5RV, which is a very efficient antenna from 7 to 28 MHz. The full-size G5RV will also function on 1.8 MHz band if the station end of the feeder (ether balanced or coaxial-type) is fed by a suitable antenna tuner using a good earth connection or a counterpoise wire. Similarly, the half-size version may be used thus on the 3.5 and 1.8 MHz bands.

In contradiction to multiband antennas in general, the full size G5RV antenna was not designed as a half-wave dipole on the lowest frequency of operation, but as a 1/2 wave center-fed long-wire antenna on 14 MHz. In this case, the 34 ft (10.36m) open-wire matching section functions as a 1:1 impedance transformer, enabling the 75 ohm twinlead or 50/80 ohm coaxial cable feeder to "see" a close impedance match on that band with a low VSWR on the feeder. However, on all the other HF bands the function of this section is to act as a " make-up" section to accommodate that part of the standing-wave (current and voltage components) which, on certain operating frequencies cannot be completely accommodated on the "flat-top" (or inverted-V) radiation portion. The design center frequency for the full-size version is 14,150 KHz. In practice, since the whole system will be brought to resonance by the use of an antenna tuner, the antenna is cut to 102 ft (31.1m).

As it does not make use of traps or ferrite beads, the "dipole" portion becomes progressively longer in electrical length with increasing frequency. This effect confers certain advantages over a trap or ferrite-bead loaded dipole because, with increasing electrical length, the major lobes of the vertical component of the polar diagram tend to be lowered as the operating frequency is increased. Thus, from 14 MHz up, most of the energy radiated in the vertical plane is at angles suitable for working DX. Furthermore, the polar diagram changes with increasing frequency from a typical half-wave dipole pattern at 3.5 MHz and a 2 1/2 wave in-phase pattern at 7 and 10 MHz to that of a "long-wire" antenna at 14, 18, 21, 24 and 28 MHz. Figure 1.

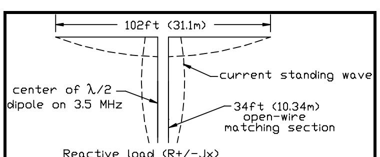

Fig. 1

The impedance match for 75-ohm twinlead or 80-ohm coaxial cable at the base of the matching section is very good at 14 Mhz. Even the use of 50-ohm coax cable results in only about 1.8:1 VSWR on this band, but the use of a suitable antenna tuner is necessary on all the other HF bands. On those bands, the antenna plus the matching-section will present a reactive load to the feeder. Thus the use of the correct type of antenna tuner (unbalanced input to balanced output if twin-wire feeder is used, or unbalanced to unbalanced if coaxial feeder is used) is essential in order to ensure the maximum transfer of power to the antenna, if using typical transceiver having a 50-ohm coaxial (unbalanced) output. This is necessary to satisfy the stringent load conditions demanded by such modern equipment, which employs an ALC system to "sense" the VSWR condition presented to the solid-state transmitter output stage. The equipment must be protected from the damage caused by a reactive load having a VSWR of more than about 2:1. Figure 2

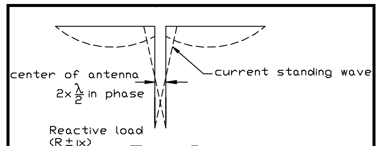

Fig. 2

The above reasoning does not apply to the use of the full-size G5RV antenna on 1.8 MHz, or to the use of the half-size version on 3.5 and 1.8 MHz. In these cases the station end of the feeder conductors should be "strapped" and the system tuned to resonance by a suitable series-connected inductance and capacitance circuit connected to a good earth or counterpoise wire. Alternately, an "unbalanced-to-unbalanced" type of antenna tuner such as a "T" or "L" matching circuit can be used. Under these conditions the "flat-top" (or inverted-V) portion of the antenna plus the matching section and feeder function as a "Marconi" or "T" antenna, with most of the effective radiation taking place from the vertical, or near vertical, portion of the system; the "flat-top" acting as a top-capacitance loading element. However, with the system fed as described above, very effective radiation on these two bands is obtainable even when the "flat-top" is as low as 25 ft (7.6m) above ground.

Theory of Operation

The general theory of operation has been explained above; the detailed theory of operation on each band from 3.5 to 28 MHz follows, aided by figures showing the current standing wave conditions on the "flat-top" and the matching (or make-up) section. The relevant theoretical horizontal plane polar diagrams for each band may be found in any specialized antenna handbooks. However, it must be borne in mind that: (a) the polar diagrams generally shown in two dimensional form are, in fact, three dimensional (i.e. solid) figures around the plane of the antenna; and (b) all theoretical polar diagrams are modified by reflection and absorption effects of near-by conducting objects such as wire fences, metal house guttering, overhead electric power and telephone wires, house electric wiring system, house plumbing systems, metal masts and guy wires, and large trees. Also the local earth conductivity will materially affect the actual polar radiation pattern produced by an antenna. Theoretical polar diagrams are based on he assumptions that an antenna is supported in "free space" above a perfectly conducting ground. Such conditions are obviously impossible in the case of typical amateur installations. What this means in practice is that the reader should not be surprised if any particular antenna in a typical amateur location produces contacts in directions where a null is indicated in the theoretical polar diagram and perhaps not such effective radiation in the directions of the major lobes as theory would indicate. Figure 3

G5RV from page 3

3.5 MHz

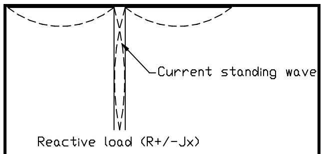

Fig. 3

On this band each half of the "flat-top" plus about 17 ft. (5.18m) of each leg on the matching-section forms a foreshortened or slightly folded up half-wave dipole. The remainder of the matching-section acts as an unwanted but unavoidable reactance between the electrical center of the dipole and the feeder to the antenna tuner. The polar diagram is effectively that of a half-wave antenna. See figure 1

7 MHz

The "flat-top" plus 16 ft (4.87m) of the matching section now functions as a partially-folded-up "two half-wave in phase" antenna producing a polar diagram with a somewhat sharper lobe pattern than a half-wave dipole due to its collinear characteristics. Again, the matching to a 75 ohm twinlead or 50/80 ohm coaxial feeder at the base of the matching section is degraded somewhat by the unwanted reactance of the lower half of the matching section but, despite this, by using a suitable antenna tuner the system loads well and radiates very effectively on this band. See figure 2

10 Mhz.

On this band the antenna functions as a two half-wave in-phase collinear array, producing a polar diagram virtually the same as on 7 MHz. A reactive load is presented to the feeder at the base of the matching section but, as for 7 MHz, the performance is very effective. See figure 3

14 Mhz

At this frequency the conditions are ideal. The "flat-top" forms a three-half-wave long center-fed antenna which produces a multi-lobe polar diagram with most of its radiated energy in the vertical plane at an angle of about 14 degrees, which is very effective for DX working. Since the radiation resistance at the center of a three-half-wave long-wire antenna supported at a height of half-wave above ground of average conductivity is about 90 ohm, and the 34 ft (10.36m) matching section now functions as a 1:1 impedance transformer, a feeder of anything between 75 and 80 ohm characteristic impedance will "see" a non-reactive (i.e. resistive) load of about this value at the base of the matching section, so that the VSWR on the feeder will be very nearly 1:1. Even the use of 50 ohm coaxial feeder will result in a VSWR of only about 1.8:1. It is assumed that 34 ft (10.36m) is a reasonable average antenna height in amateur installations. See figure 4

18 Mhz

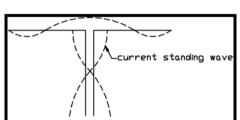

Fig. 4

The antenna functions as two full-wave antennas fed in phase; combining the broadside gain of a two-element collinear array with somewhat lower zenith angle radiation than a half-wave dipole due to its long-wire characteristic. See figure 5

21 Mhz

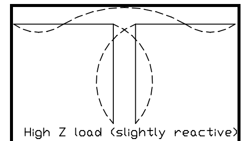

Fig. 5

On this band the antenna works as a "long-wire" of five half-waves, producing a multilobe polar diagram with very effective low zenith angle of radiation. Although a high resistive load is presented to the feeder at the base of the make-up section, the system loads very well when used in conjunction with a suitable antenna tuner and radiates very effectively for DX contacts. See figure 6

24 Mhz

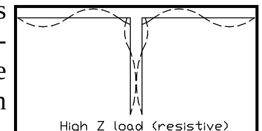

Fig. 6

The antenna again functions effectively as a five-half-wave "long-wire" but, because of the shift in the positions of the current anti-nodes on the flat-top and the matching section, as may be seen from figure 7, the matching or "make-up" section now presents a much lower resistive load condition to the feeder connected to its lower end than it does on 21 MHz.. Again, the polar diagram is multilobed with low zenith angle radiation.

28 MHz

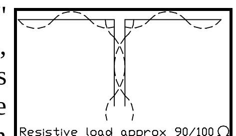

Fig. 7

On this band, the antenna functions as two "long-wire" antennas, each of three half-waves, fed in-phase. The polar diagram is similar to that of a three half-wave "long-wire" but with even more gain over a half-wave dipole due to the collinear effect obtained by feeding two three-half-wave antennas, in line and in close proximity, in-phase. See figure 8

Construction - The Antenna

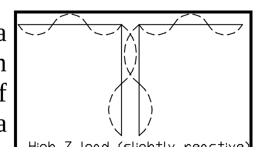

Fig. 8

The dimensions of the antenna and its matching section are shown in Figure 9. The "flat-top" should, if possible, be horizontal and run in a straight line, and should be erected as high as possible above ground. In describing the theory of operation, it has been assumed that it is generally possible to erect the antenna at an average height of about 34 ft (10.36m), which happens to be the optimum radiation efficiency on 1.8, 3.5 and 7 MHz for any horizontal type antenna, in practice few amateurs can install masts of the optimum height of half a wavelength at 3.5 or 7 MHz, and certainly not at 1.8 MHz.

If, due to limited space available, or to the shape of the garden, it is not possible to accommodate the 102 ft (31.1m) top in a straight line, up to about 10 ft (3m) of the antenna wire at each end may be allowed to hang vertically or at some convenient angle, or be bent in a horizontal plane, with little practical effect upon performance. This is because, for any resonant dipole antenna, most of the effective radiation takes place from the center two-thirds of its length where the current antinodes are situated. Near to each end of such an antenna, the amplitude of the current

Continued on next page

standing wave falls rapidly to zero at the outer extremities; consequently, the effective radiation from these parts of the antenna is minimal.

Bands	1.8-28 MHz	3.5-28 MHz	7.0-28 MHz
Flat top	204 feet	102 feet	51 feet

The antenna may also be used in the form of an inverted-V. However, it should be borne in mind that, for such a configuration to radiate at maximum efficiency, the included angle at the apex of the V should not be less than about 120 degrees. The use of 14 awg enameled copper wire is recommended for the flattop or V, although thinner gauges such as 16 or even 18 awg can be used.

Flat Top Lengths

The Matching Section

This should be, preferably, of open-wire feeder construction for minimum loss. Since this section always carries a standing-wave of current (and voltage) its actual impedance is unimportant. A typical, and very satisfactory, form of construction is shown in figure 10. The feeder spreaders may be made of any high-grade plastic strips or tubing; the clear plastic tubing sold for beer or wine siphoning is ideal.

If it is desired to use 300 ohm ribbon type feeder for this section, it is strongly recommended that the type with "windows" be used because of its much lower loss than that with solid insulation throughout its length, and its relative freedom from the "detuning" effect caused by rain or snow. If this type of feeder is used for the matching section, allowance must be made for its velocity factor (VF) in calculating the mechanical length required to resonate as a half-wave section electrically at 14.15 MHz. Since the VF of standard 300 ohm ribbon feeder is .82, the mechanical length should be 28 ft (8.5m). However, if 300-ohm ribbon with "windows" is used, its VF will be almost that of open-wire feeder, say .90, so its mechanical length should be 30.6 ft. (9.3m). This section should hang vertically from the center of the antenna for at least 20 ft (6.1m) or more if possible. It can then be bent and tied off to a suitable post with a length of nylon or Terylene cord so as to be supported at above head-height to the point where, supported by a second post, it's lower end is connected to the feeder.

Bands	1.8-28 MHz	3.5-28 MHz	7.0-28 MHz
Open wire	67.3 feet	34 feet	17 feet
Ladder line	62.4 feet	31.5 feet	21.2 feet
"TV" twin lead	56.9 feet	28.5 feet	14.4 feet

Matching Line

The Feeder

The antenna can be fed by any convenient type of feeder provided always that a suitable type of antenna tuner is used. In the original article describing the G5RV antenna, published in the, then, RSGB bulletin November 1966, it was suggested that if coaxial cable feeder was used, a balun might be employed to provide the necessary unbalanced-to-balanced transformation at the base of the matching section. This was because the antenna and its matching section constitute a balanced system, whereas a coaxial cable is an unbalanced type of feeder. However, later experiments and a better understanding of the theory of operation of the balun indicated that such a device was unsuitable because of the highly reactive load it would "see" at the base of the matching or "make-up" section on most HF bands.

It is now known that if a balun is connected to a reactive load presenting a VSWR of more than about 2:1, its internal losses increase, resulting in heating of the windings and saturation of its core (if used). In extreme cases, with relatively high power operation, the heat generated due to the power dissipated in the device can cause it to burn out. However, the main reason for not employing a balun in the case of the G5RV antenna is that, unlike an antenna tuner which employs a tuned circuit, the balun cannot compensate for the reactive load condition presented to it by the antenna on most of the HF bands, whereas a suitable type of antenna tuner can do this most effectively and efficiently.

Recent experiments by the author to determine the importance or otherwise of "unbalance" effects caused by the direct connection of a coaxial feeder to the base of the matching section had a rather surprising result. They proved that, in fact, the HF currents measured at the junction of the inner conductor or the coaxial cable with one side of the (balanced) matching section and at the junction of the outer coaxial conductor (the shield) with the other side of this section are virtually identical on all bands up to 28 MHz, where a slight but inconsequential difference in these currents has been observed. There is, therefore, no need to provide an unbalanced-to-balanced device at this junction when using coaxial feeder.

However, the use of an unbalanced-to-unbalanced type of antenna tuner between the coaxial output of a modern transmitter (or transceiver) and the coaxial feeder is essential because of the reactive condition presented at the station end of this feeder which, on all but the 14 MHz band, will have a fairly high to high VSWR on it. This VSWR, however, will result in insignificant losses on a good-quality coaxial feeder of reasonable length; say, up to about 70 ft (21.3m). Because it will, inevitably, have standing waves on it, the actual characteristic impedance of the coaxial cable is unimportant, so that either 50 ohm or 80-ohm type can be used.

Another very convenient type of feeder that may be used is 75-ohm twinlead. However, because of the relatively high loss in this type of feeder at frequencies above about 7 MHz, especially when it has a high VSWR on it, it is recommended that not more than about 50 to 60 ft (15.2 to 18.3m) of this type feeder be used between the base of the matching section and the antenna tuner. Unfortunately the 75-ohm twinlead in the UK is the receiver type; the much less lossy transmitter type is available in the USA. By far the most efficient feeder is the "open wire" type. A suitable

Continued on next page

G5RV from page 8

length of such feeder can be constructed in exactly the same way as that described for the open-wire matching section. If this form of feeder is employed, almost any convenient length may be used from the center of the antenna right to the antenna tuner (balanced) output terminals. In this case, of course, the matching section becomes an integral part of the feeder. A particularly convenient length of open-wire feeder is 84 ft (25.6m), because such a length permits parallel tuning of the antenna tuner circuit on all bands from 3.5 to 28 MHz with conveniently located coil taps in the antenna tuner coils for each band, or, where the alternative form of antenna tuner employing a three-gang 500 pf/ section variable coupling capacitor is used the optimum loading condition can be achieved for each band. However, this is not a rigid feeder length requirement and almost any length that is mechanically convenient may be used. Since this type of feeder will always carry a standing wave, its characteristic impedance is unimportant, and sharp bends, if necessary, may be used without detriment to its efficiency. It is only when this type of feeder is correctly terminated by a resistive load equal to its characteristic impedance that such bends must be avoided.

Coaxial cable HF choke

Under certain conditions, either due to the inherent "unbalanced-to-balanced" effect caused by the direct connection of a coaxial feeder to the base of the (balanced) matching section, or to pick-up of energy radiated by the antenna, a current may flow on the outside of the coaxial outer conductor. This effect may be considerably reduced, or eliminated, by winding the coaxial cable feeder into a coil of 8 to 10 turns about 6 in. in diameter immediately below the point of connection of the coaxial cable to the base of the matching section. The turns may be taped together or secured by nylon cord.

It is important, of course, that the junction of the coaxial cable to the matching section be made thoroughly water-proof by any of the accepted methods; binding with several layers of plastic insulating tape or self-amalgamating tape and then applying two or three coats of polyurethane varnish, or totally enclosing the end of the coaxial cable and the connections to the base of the matching section in a sealant such as Silicon or epoxy resin.

ECARS Receives Praise

The following letter was sent to ECARS from the American Red Cross of Northeastern, New York.

October 1, 1998

It is hard to express in words the sincere thanks I would like to extend to you on behalf of the American Red Cross of Northeastern New York, for your valuable assistance to our communications team during the January 1998 North Country Ice Storm. When first summoned by the Red Cross, we had no idea of the magnitude and severity of the event. It was with the assistance and guidance of the ECARS crew that out primary operator. Peter Rea WZ2X, was able to begin to give us a more accurate picture of what was happening. What began as "routine Red Cross business" on January 8, evolved into the New York Sate Emergency Management Operations Net which lasted until January 23.

Recovery is still going on for some residents of the north country, however your interest and quick response to our communications needs helped ensure that the immediate concerns of area disaster victims were met in a timely manner.

Continued success to all of you. When we get our HF facilities at Red Cross up and running again, we'll be sure to stop by and say hello to our ECARS friends. Thank you again for all.

Sincerely,
April Stack K2ZCZ
Communications Officer

Dayton Hamvention - 1999

The KC2Q Bus & Plane Trip

Mike, KC2Q is organizing a bus and plane trip to Dayton. The trip includes local transportation, motel (3 nights), cont. breakfasts, admission to the Hamvention and banquet, taxes and gratuities. Bus from NJ on May 13, $295. Plane from Newark, May 13, 4:15 PM $420. Deduct $25 if not attending banquet.

Contact Mike DiPersio, KC2Q, PO Box 357, Bradley Beach, NJ 07720, Phone (732) 774-1095, email kc2qmik@juno.com.

For Sale

MFJ 1026 deluxe noise canceling antenna. Will pay shipping.

wa2she@klink,net
Daniel Sala, WA2SHE
ECARS #2675
326 Cohwy 155
Gloversville, NY 12078

Roll Call

Don’t forget to tune to 7.255 MHz at 10:00 AM on the second Saturday of the month for ECARS roll call. All members are encouraged to check in and show your support for ECARS.

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