THE SIGNAL

Collins Collectors Association

Issue Number Fifty Six

Fourth Quarter 2009
Special Holiday Issue

OFFICIAL JOURNAL OF THE COLLINS COLLECTORS ASSOCIATION

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- 1st Wednesday AM 3880 kHz at 8pm CST

Sunday for Technical, Buy, Sell & Swap
Tues., Thurs., Fri., & Sunday for Ragchew

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The History of S-Line Development

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Part II

The Rest of the Story by Bill Carns, N7OTQ/K0CXX

Beautiful - Yes? But, before you start looking for one, you need to read on.

In part one of this article, we saw the environment and conditions that led up to the definition and introduction of the basic S-Line through 1960. The 62S-1 had still not been introduced even though it was part of the initial S-Line program definition. In part two, we see the maturation of the S-Line through the 60s and look a bit at the Collins amateur development up to and through the KWM-380.

So, where did the 51S-1 fit in? My understanding, from talking with Gene Senti years ago, before he passed away, was that it was an after thought that came along in the late 50s. Chuck Carney (W0GDJ SK), the Amateur Radio Marketing Head came to Gene one day and commented that the 51J-4 was getting pretty old and that he thought they could do better. They concluded that they could, and should, do an S-Line version of the 51J-4…. and the 51S-1 idea was out there. Gene went to work on the "Birdie Chart" and the conversion scheme and assigned Ed Andrade to work as Project Lead on the new receiver. Jerry Vonderheide

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From the Editor's Desk

by Bill Carns, N7OTQ and Co-Editor Joe Nyberg, WILJN

Another quarter has flown by here and it is time to get going. It amazes me how this building project that I am doing can suck up a quarter in a heart beat.

I want to thank all of you for the compliments on the last ***Signal*** and the S-Line Perspective article. It is hard to believe that it has been almost 2 ½ years since the Editor's position came my way. This issue will be the 10th one in my tenure and I am sure enjoying it. Contained herein you will find the conclusion of the S-Line piece – with some surprises maybe - as well as another great contribution to *The Service Line* by Don Jackson. We appreciate Don's efforts in supporting the technical threads on the CCA reflector and particularly I want to thank him for the effort he puts into doing his articles. All of us are learning a lot. It is a great "refresher" for me, having lost much of my theoretical smarts with age and, from those of you that are getting exposed for the first time, the reaction seems to be very positive.

The CCA Board of Directors would like to wish all of you a very safe and Happy Holiday Season. We try and make each holiday issue a kind of special present to our members. Hope you enjoy it and the days ahead.

The CCA continues to evolve. Please read *From the President* in this issue for additional details in this area. We have lost a very successful CCA President to his own successful future. Paul Kluwe, after hanging in there for a couple of extra quarters, has found it necessary to resign from his CCA position due to a fantastic opportunity of his own making. Paul has ventured into "Spin-Off" land and become deeply involved with one of the GM bankruptcy spin-offs. He also has been chosen as the CEO of same and this has required a physical move from Michigan to Tennessee for himself and his family and a career move for his Physician wife. We all owe him a debt of gratitude and the CCA BoD wants to thank him, and I personally want to thank him big time, for his service and what he has contributed to the CCA. Big shoes to step into for anyone! By the way, Paul continues to support the CCA behind the scenes and this, also, is much appreciated.

That being said, as acting President, I will try and carry on in Paul's way of doing things and work to make the CCA the best that it can be. By the time that you read this, the board should have held elections for President. My hat has been cast in the ring - so we shall see.

Looking forward, it is your support, for the Signal and for the CCA activities and needs, which make our progress possible. I personally am looking forward to continued improvements in both the CCA and the ***Signal Magazine***, and continuing on a path of excellence – physically and ethically. Please continue to help as you can with writings for the magazine and support for our activities and nets. We are always looking for good articles

– Hint Hint !

Speaking of help, this quarter has seen a nice membership increase and that means that there is new blood out there to donate. The CCA is always looking for increased participation at the activity, and up to the board, level. If you are interested in helping – and we hope so – please contact any board member, or me personally, and we would love to talk with you. You are our future leaders.

This quarter also saw the realization of the 2009 Caribbean CCA Cruise and this is reported in this issue. Our thanks go out to board member Butch Schartau for his efforts in organizing this activity. His preliminary report to me verbally indicated that it was a great success but he also reported some disappointment in that the structured off boat activities really minimized the groups ability to get much radio operating time - as we all noticed. They are committed to getting this sorted out next time.

Again, we hope that you all have a wonderful holiday season and that your enjoyment of our great Collins collecting hobby grows. I am still working on getting a permanent 20 meter net manager, and have a promising lead. In the mean time, we will continue to do the best we can there (I am trying to get back in there a bit as my building project is coming to an end) and you guys keep the frequency warm.

Very Best 73s for now and I will see you all on the air very soon.

Bill, N7OTQ
wcarns@austin.rr.com

Bud Whitney, K7RMT, Enjoys the Well Deserved Friendship of Almost 100 Guests At His 90th Birthday Party


Bud cuts the KWM-2 cake with his ham friends

On the 24th of October of this year, Bud Whitney, K7RMT, better known as the Budster, turned 90 years young. What a party!

In all my years I have never seen the like, and I have been to a lot of parties. There were almost 100 people there from across the country and the local area. One can only hope, if and when I get there, that there are a tenth as many people that come to mine.

At first, the party was scheduled to be at a local neighbor's home. From there it finally settled at their church because of the crowd. After the party at the church, part of the crowd returned to Bud and Jan's home to share some Champagne, which Bud insisted on having with friends, and of course was not going to happen at the church.


Marion Anema organizer with Bud

One of the highlights of the party was one of the cakes which was a really great facsimile of a KWM-2. That couldn't have been more appropriate. Bud has repaired almost as many KWM-2s as he has 516F-2s and he has done over 500 power supplies. We carefully ate the PA deck first and worked forward towards the panel. That remains in their freezer as a memento. There was also a wonderful pot luck buffet dinner and then off to the house.


Bud about to work on 90 candles

Enjoy the pictures.


Champa at last !

We all sure enjoyed the party. I am looking forward to the next one in 10 years. **Best of heath to you and Jan, Bud!**


Bud with Son Stanley (foreground)

THE SIGNAL

Collins Collectors Association

The Service Line

Receiver Sensitivity Concepts and Measurement

by Don Jackson, W5QN

I. Introduction

The subject of sensitivity often enters the discussion when comparing receivers or amplifiers. Sometimes there is confusion over various sensitivity-related terms as well as methods of measurement. In this discussion we will attempt to clarify some of this confusion as well as provide a comparison of different methods used to quantify sensitivity.

In engineering terms, sensitivity is intended to characterize the lowest signal input to a device that meets a particular signal-to-noise ratio criterion. There are several common criteria used, such as Minimum Discernible Signal (MDS), S=N, 0dB S/N, 3dB (S+N)/N, 10dB (S+N)/N, Tangential Sensitivity, and others. Some of this confusion can be immediately simplified since S=N, 0dB S/N and 3dB (S+N)/N are simply different ways of stating the same thing. And, by some definitions (ARRL and Rob Sherwood for example), MDS is also the same thing. However, MDS in some disciplines is subjective because it may be defined as the signal power that is discernible on a video display or audibly discernible by the human ear. In these cases the ability of human beings to distinguish signals in noise is sometimes impressive, resulting in perception of signals at powers levels well below the noise level. Tangential Sensitivity is a concept used to describe the level of a pulsed carrier in the presence of noise when observed on a visual display. Therefore, Tangential Sensitivity is not pertinent to this discussion.

Sometimes sensitivity is specified based on output taken from the detection circuitry of a receiver. This can be misleading because the detector may be non-linear, and/or may introduce various S/N improvement processes. In this discussion we assume the output measurements are taken prior to any detection circuitry, or, if the detector is included, it is linear in nature. By linear, we mean that the gain of the detector is constant over the amplitude range used in the measurement process. A product detector is sufficiently linear since it is basically a mixer (multiplier) circuit.

II. Noise Concepts

A fundamental concept that must be addressed in any sensitivity discussion is noise. Noise consists of random voltage or current fluctuations, usually caused by temperature (thermal noise) and the properties of electronic components such as semiconductors and tubes. There certainly can be other undesirable noise components in a receiver that can degrade sensitivity, but a properly designed and operating receiver should result in a noise level defined only by the temperature of the source connected to its RF input, the receiver noise bandwidth, and the noise added by its own electronic components. Perhaps the most important things to understand about all thermal noise is that it is broadband in nature, and its total power is directly proportional to temperature and the bandwidth of the measurement system. The maximum thermal noise power that can be delivered by a resistor is:

(1) Resistor Noise Power (maximum) = kTB (Watts)

"k" is Boltzmann's Constant (1.38×10^{-23} Joules/ºK), T is the temperature of the resistor in degrees Kelvin, and B is the bandwidth in Hertz of the device used to measure the power. In some literature, kTB is also referred to as the "noise floor". This maximum power value is only achievable in a conjugate impedance-matched condition where the load resistor is equal to the resistor under analysis. Note that

Service Line (Cont'd)

the value of the resistor is not part of this equation. The resistor only comes into play if you wish to calculate the noise voltage across the resistor. The kTB function can be easily derived using the open circuit RMS noise voltage of a resistor, SQRT(4kTBR), and the basic relationship for power, $P= E^2/R$. Throughout this discussion, matched source and receiver input impedances are assumed. Because the random phase/amplitude characteristic of noise allows noise powers to be added, power (as opposed to voltage) is used throughout this discussion. We will refer to Figure 1 as our basic block diagram representation of the receiver model and noise sources.

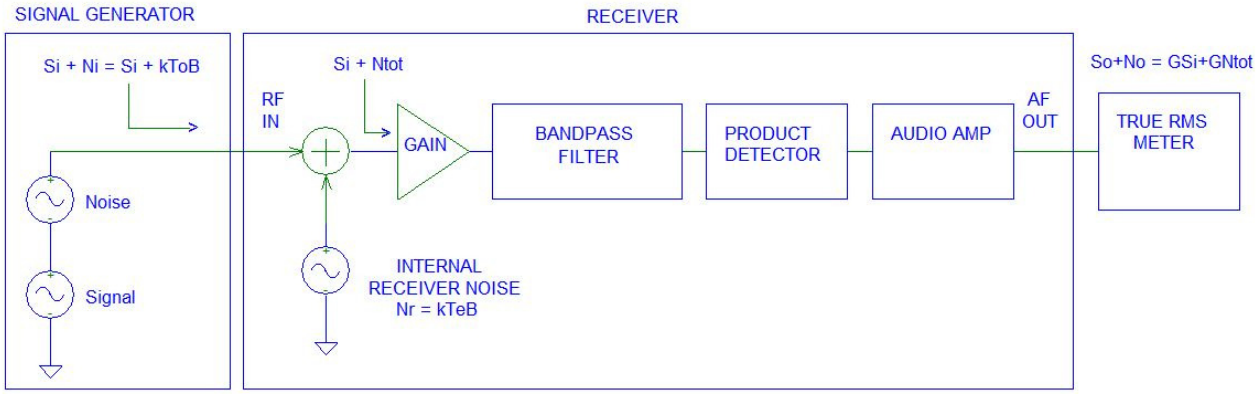

Figure 1 – Block Diagram

So, what does this mean to us? Well, kToB (Ni in Figure 1) is the noise power produced in the signal generator, the lowest possible noise power that can occur at the input to our receiver, given the receiver noise bandwidth B, and ambient temperature To = 290ºKelvin (17ºC). Therefore, it also sets the maximum sensitivity of an ideal receiver when the sensitivity criterion is that the signal power be equal to the noise power. It is this level against which we compare our actual receiver or amplifier. Since the output power measurement includes the receiver, we must take the receiver bandwidth, or more properly its "noise bandwidth", into account. Normally, the receiver IF 3dB bandwidth is satisfactory to use as "B" in the power equation. Another factor when considering the correct noise bandwidth is the shape of the actual filter response. Ideally, the filter would have a perfectly rectangular frequency response shape, but an extremely sloppy filter characteristic might require adjustment of "B" from the actual 3dB points of the filter. In the case of Collins receivers with the excellent characteristics of the mechanical filters, the 3dB bandwidth is a satisfactory estimate.

Let's plug some values into equation (1) and see what we get. Assume our external source resistor is at standard room temperature, 290ºK, and that we have selected a 1Hz bandpass filter in our receiver. (This is obviously unrealistic, but it yields a useful number.) The power generated by the source resistor (this could be an actual terminating resistor, or a signal generator with its RF output power disabled) would then be:

$$Ni = kTB = 1.38\text{x}10^{-23}\ \text{J/ºK x 290ºK x 1Hz} = 4\text{x}10^{-21}\ \text{Watts}$$

Converting Watts to milliWatts, it becomes $4\text{x}10^{-18}$ mW. Converting to dBm [$10\log(4\text{x}10^{-18})$], the noise power is approximately -174dBm. We can also think of this as a "spectral noise density" of -174dBm/Hz which is easily scaled to yield the maximum power in any bandwidth we desire.

The bottom line to all this is that at room temperature, the best we can do (with a completely noiseless

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receiver) with an IF bandwidth of 1Hz is achieve an S=N sensitivity of -174dBm. Using a more realistic bandwidth of 2000 Hz, the result with a noiseless receiver would be:

$$\text{Max. Sensitivity (@ S=N)} = Ni = 1.38\text{x}10^{-23}\ \text{J/ºK} \cdot 290\text{ºK} \cdot 2000\text{Hz} = 8\text{x}10^{-18}\ \text{Watts}$$

This converts to $8\text{x}10^{-15}$ mw or -141dBm. At this point you may recognize that if we deal only in logarithmic units, the equation simplifies to:

(2) Max. Sensitivity (@ S=N) = Ni (dBm) = -174dBm + 10log(B)

Now we have a simple equation for the sensitivity (or "noise floor") of an ideal receiver at room temperature. Note that this equation is independent of receiver gain.

Of course, our real receiver adds its own internal noise, Nr, to the noise of the input source resistance. The receiver designer would like Nr to be dependent only on noise generated by resistances in the receiver and the noise created by the receiver input RF amplifier circuit. However, unless care is taken with the design, other noise contributions can occur. These include noise generated by insufficiently isolated digital circuitry, local oscillator noise, spurious responses, first mixer image noise, insufficient RF amplifier gain, or poor choice of IF filter location in the receiver gain chain. These are all considerations that must be addressed when designing a receiver if the expected sensitivity is to be achieved.

Next, we need to select a useful "figure of merit" for evaluating the sensitivity of our receiver.

III. (S+N)/N, Noise Figure, and Noise Temperature

Specifying sensitivity based on a certain (S+N)/N criterion is a strong legacy metric, but is not a particularly handy method for comparing the noise performance of receivers. Knowledge of an input sensitivity number, whether in dBm or microVolts is of little value unless bandwidth, the specific (S+N)/N criterion and modulation and detection method are known. Even with that knowledge, considerable calculations are required to achieve a satisfactory "figure of merit" that indicates how good (or bad) the receiver sensitivity really is.

Two more figures of merit for the sensitivity of a receiver or amplifier are "Noise Figure" and "Noise Temperature". These share the advantage of being independent of the noise bandwidth of the receiver or amplifier.

In current terminology, "Noise Factor" is defined as the ratio of the S/N at the input of a device to the S/N at the output of the device. The more common term, "Noise Figure", is simply the Noise Factor in decibel form. Noise Factor is written as:

$$\text{Noise Factor} = (Si/Ni)/(So/No) \quad \text{(numeric ratio)}$$

Si/Ni can be thought of as the ideal S/N if the device under test contributed no noise. So/No is the actual S/N that results when the device noise, Nr, is taken into account. For calculation convenience, it is useful to develop the concept of "input referred" signal and noise levels. "Input referred" means that we relate a quantity at the output of a device to its input. Since we have required that the system be linear, the input and output are related by overall gain, G. This results in an equivalent input that produces the measured output. Referring to Figure 1, we define the following relationships, where G is the numeric gain of the receiver, and Ntot is the total "input referenced" noise related to No:

$$So = GSi \quad \text{and} \quad No = GNtot$$

Service Line (Cont'd)

The quantity Ntot is the sum (Ni + Nr) in Figure 1. Substituting these relationships into the equation for Noise Factor yields the following simplified result (We leave this mathematical manipulation as an exercise for the reader!):

$$\text{Noise Factor} = Ntot/Ni$$

Notice that the quantities G and Si have cancelled out of the equation. As well, actual knowledge of specific So and No power is not required.

The more common metric, Noise Figure, is simply the Noise Factor expressed in decibels:

$$\text{Noise Figure (dB)} = 10\log(\text{Noise Factor}) = 10\log G(Ntot/Ni)$$

or

$$\text{Noise Figure (dB)} = 10\log(Ntot) - 10\log(Ni)$$

Since we already have Ni (dBm) from equation (2), we can substitute:

$$\text{Noise Figure (dB)} = 10\log(Ntot) - (-174\text{dBm} + 10\log(B))$$

If we can obtain Ntot in dBm, we can write the equation:

(3) $$\text{Noise Figure (dB)} = Ntot\ (\text{dBm}) + 174\text{dBm} - 10\log(B)$$

All we need now is to measure Ntot for an easy calculation of receiver Noise Figure.

"Noise Temperature" is another common figure of merit. Its basic premise is that the receiver (or amplifier) internal noise may be represented by a single resistance at the input to the device. The temperature of this resistance is such that the noise power it generates is equal to the sum of all internal receiver noise sources. The temperature of this resistance is generally referred to as the effective noise temperature of the device, Te. Note that kTeB is identical to Nr in Figure 1. So, the Noise Figure and Noise Temperature concepts are similar, but Noise Figure is a ratio based on noise at 290ºK, whereas Noise Temperature refers the actual noise power created by the device under test. Noise Temperature has an advantage when dealing with devices exhibiting very low noise levels. This is typical for very low noise amplifiers (LNA) used in satellite and space communications. In a space environment, the effective antenna source temperature may be only tens of degrees above absolute zero, and an LNA must have comparably low noise temperatures to take advantage of this cold, low noise environment. There is a one-to-one correspondence with Noise Factor and Noise Temperature, so if one is known the other can be calculated. The conversion equations are:

$$\text{Noise Factor} = Te/290^{o} + 1$$

$$\text{Noise Figure} = 10\log(Te/290 + 1)$$

$$\text{Noise Temperature (Te)} = 290(\text{Noise Factor} - 1)$$

Some insight into the usefulness of Noise Temperature for very low noise devices can be obtained with an example. Consider LNA #1, with a Noise Temperature of 20ºK, and LNA #2 with a Noise Temperature of 40ºK. It is obvious from the Noise Temperatures that #2 generates twice as much internal noise (3dB) as #1. However, if we compare the equivalent Noise Figures of these two LNAs, .29dB and .56dB respectively, the comparison of their noise performance is not at all obvious.

Cont'd Next Page

Service Line (Cont'd)

For our purposes where we are operating in a terrestrial temperature environment, we prefer Noise Figure as our measurement metric.

IV. Noise Figure Measurement Method (Signal Generator Method)

In order to measure Ntot, we need a well-calibrated signal generator or a source with a known output power and a set of good step attenuators. In addition, we need an output power meter or true RMS voltmeter. Our Noise Figure calculation will only be as accurate as the amplitude accuracy of our signal generator. Actual ambient temperature also has an affect, but normally only a small one. Determining Ntot is quite straightforward. Follow these steps:

1. Arrange the equipment as shown in Figure 1.

2. Reduce the Signal Generator RF output level to its minimum, or disable its RF output if it has that function. The idea is to provide a matched termination for the input of the receiver with the source impedance of the generator, normally 50Ω. (The signal generator output level must be well below the noise level to be measured, so be aware of any signal leakage that might occur at the output. If signal leakage is a problem, you might temporarily tune the signal generator to a different frequency.)

3. Select SSB mode or any mode that uses the receiver product detector. Alternatively, an IF output can be used if available. The only requirement is that the input/output chain be linear, meaning the gain of the receiver must remain constant over the amplitude range of the measurement process. It is assumed that the output meter being used has a bandwidth greater than the receiver bandwidth selected.

4. Select a receiver IF filter for the measurement. Although any filter can be used, we suggest using the one that has the most ideally shaped (rectangular) frequency response, and a known 3dB bandwidth.

5. Place the AGC or AVC in the "off" mode. This is to ensure that the AGC will not activate during the measurement process, which might change the overall gain or compromise the linearity of the receiver. Typically the AGC should not be a factor, even if it is on, but if the internal gain is set too high, you might have a problem. To be safe, turn the AGC off.

6. Turn the RF gain to maximum and peak the preselector, if the receiver has one. Increase the AF gain control to a setting that produces a convenient level on the true RMS meter. Keep the level low enough to ensure the receiver is operating in a linear region, but high enough to be well above the output meter internal noise level. The meter will be reading noise only at this point. Note this level as a reference.

7. Activate the RF output of the Signal Generator and increase its output amplitude until the RMS meter increases by 3dB. (If your meter is a power meter, a 3dB increase means the power increases by a factor of two. If you are using a true RMS voltmeter, the reading should increase by a factor of 1.414.) At this point you will have achieved the S=N sensitivity criterion, which is the same as (S+N)/N=3dB. Note the Signal Generator output. Its amplitude (dBm) is the receiver noise floor and the Ntot power level we need to complete our Noise Figure calculation. (If your signal generator is calibrated in open-circuit EMF voltage, be sure to take this into account when converting to dBm input power.)

8. Calculate the receiver Noise Figure using equation (3).

For example, let's assume that we have determined from Step 8 that our receiver Ntot power is -132dBm, and we performed the measurement with the bandwidth set to 2000Hz. The receiver Noise Figure is then:

Noise Figure (dB) = -132dBm + 174dBm – 10log(2000) = 9dB

What if you are given (S+N)/N data (in uVolts) for a receiver, but the measurement criterion was not 3dB, but some other amount? You can still use equation (3) to calculate the receiver Noise Figure, but a rigorous solution takes considerably more effort. First you must ask what the system bandwidth was for the measurement. Next you must convert the uVolt signal input, S, to Watts, usually in a 50Ω system. Next is to convert the measurement criterion from dB to a numeric value, R, and solve the (S+N)/N = R equation for N. "N" is the value of Ntot in Watts. Convert this Ntot to dBm and plug it into equation (3). Clearly, this process is annoyingly complex.

Let's take the sensitivity specification for the 75S-3B as an example. The data sheet shows a specification of .5uV at 10dB (S+N)/N, in SSB mode. SSB mode means the receiver has the 2kHz filter and product detector selected. (Note that an AM modulated specification would add more complexity to the required calculations, even if the AM detector had excellent linearity.) The calculations in the above paragraph yield an equivalent Noise Figure of 18.4dB. This is a surprisingly high number considering measurements on my own 75S-3B indicate a Noise Figure between 4dB and 5dB on all bands. Although my Fluke 6062A signal generator amplitude hasn't been calibrated recently, a number of checks indicate its accuracy is within a couple of dB at worst in the HF band. Bob Jefferis KF6BC, and David Hallam KW4DH, measured Noise Figure on their S-Line receivers using the method described above. Their results agree reasonably well with my measurements, so I believe my signal generator is fairly accurate.

Note that if your only goal is to determine whether your Collins receiver is meeting its published spec, you may follow the test method at the beginning of this section and perform Steps 1 through 6 as stated. However, in Step 7, increase the Signal Generator output level until the RMS meter reading increases by 10dB. This means the total output power will have increased by a factor of 10, or the voltage by a factor of 3.16. At this point you will have achieved the (S+N)/N= 10dB measurement criterion. Read the Signal Generator output in microvolts, which should be equal to, or less than, the published specification. It is assumed that your Signal Generator output meter is calibrated for a 50Ω output termination.

V. Alternative Measurement Techniques

The technique described in Section III is fine for amateur purposes. However, it is a bit cumbersome because it requires a signal generator to be tuned to the frequency of interest. In addition, uncertainty of the calculation gets larger as the Noise Figure of the receiver or amplifier under test drops. A method that improves these shortcomings is the Y-Factor method. This method involves measuring the output of a device with two different known noise sources connected sequentially to the device input. The device noise output is then measured as the two noise sources are switched to the device input. The resulting ratio in dB (Y-Factor) can then be used to directly calculate Noise Figure or Noise Temperature of the device under test. This approach eliminates the need for a signal generator since the noise sources are extremely broadband in nature, the input noise spectral density remains quite constant over frequency. A second advantage of the Y-Factor method is that the accuracy of measuring very low noise devices can be greatly improved by immersing one of the input noise sources in a very cold environment, such as liquid Nitrogen at 77ºK. The choice of the two input noise source temperatures affects the accuracy of the Noise Figure calculation, and should be selected based on knowledge of the approximate Noise Figure of the device under test.

Another method that is sometimes used to measure Noise Figure (especially in amplifier measurements) is the "gain method". However, this method requires knowledge of the gain of the device under

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test, which is not easily determined in the case of a receiver. In addition to a calibrated RF signal generator, a calibrated output meter would also be required. The "signal generator method" described in this article requires only a relative output measurement.

VI. Conclusions

From the noise performance perspective, weak signal reception capability of a receiver is dependent only on its noise bandwidth and Noise Figure (or Noise Temperature if that method of measurement is used). Although these quantities are generally measured at IF prior to detection circuitry, they may be measured at the output of a receiver product detector. This is acceptable because a product detector linearly translates noise and signal from IF audio frequency, and the relation between noise and signal is not changed. This is not true of other typical analog detectors.

Don Making a Noise measurement on his 75S-3B

Use of Noise Figure (or Noise Temperature) is highly recommended for comparing receiver or amplifier sensitivities because it gives an immediate idea of the device's performance compared with the theoretical optimum. Additionally, Noise Figure is independent of the system bandwidth, meaning it stays the same regardless of the IF filter selected during the measurement process. By contrast, if someone says their receiver has a sensitivity of 1uV, that number by itself has little meaning. The next questions should be "What was the bandwidth of your measurement, and at what (S+N)/N did you make the measurement?" In addition, knowledge of the modulation and detection methods would be required. Even after getting satisfactory answers to these questions, a number of calculations would be necessary to convert the "1uV" number into the more meaningful Noise Figure.

As pointed out by Keith, K0KE in the Collins Reflector thread that inspired this article, HF operation does not require a very low receiver Noise Figure because atmospheric noise from the antenna usually dominates noise generated internally by the receiver. Even the relatively poor Noise Figure of 18.4dB indicated by the 75S-3B ".5uV" SSB mode specification would likely be adequate for HF reception. Careful attention to Noise Figure is usually only considered critical as the operating frequency increases above 30MHz or so. Nevertheless, if you are like me, you want to know exactly how your receiver is performing, and determination of its Noise Figure is the most informative measurement that achieves that goal.

A special thanks to Bob Jefferis for his edits and comments.

Cheers, Don,W5QN
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Editor's Note: Collins used a conservative standard that they referred to as the "Hard Microvolt" when making all receiver input sensitivity measurements. A 6 db pad was placed between the generator and the receiver under test and the test level referred to the input of the pad. This standard was formalized and put into practice for S-Line test by Dave Hallock and Russ Hanson. This, and design margin, explains much of the observed difference between the "specified" and measured sensitivity numbers.

Product Review—Weighted 4:1 Knob For 75A-4 and KWS-1

From 73cnc.com

We seldom do Product Evaluations. From time to time when something special comes along, after making sure that the product and people involved are top notch, this may happen again.

One day when prowling eBay for Collins parts, I stumbled upon an offering from Fred Freeman in Ohio for a weighted spinner knob for the 75A-4 or KWS-1. I emailed him and talked with him on the phone to see how he made these and what his plans were to continue offering them, and possibly other knobs as well.

In the course of the conversation, I decided to ask him for a sample to evaluate because I was just impressed with the precision and beauty of the 75A-4 knob. When it came, I was not disappointed. The knob was everything it appeared to be and it didn't take long to get it installed on one of my favorite A-4s. Beautiful. The tuning feel is dramatically different, especially when you are scanning across the band.

Fred, N8BX, has a CAD/CAM and CNC machining operation that produces these knobs and he plans to continue offering them and installing a website where you can buy them direct. In addition, he is planning on doing an S-Line knob that will be of equal quality.

Fred is also an active member of the CCA and has both 75A-4/KWS-1 gear (his favorite) and S-Line equipment as well as a R-390A.

Right now, if you would like to discuss buying one of these with Fred, you can contact him at N8BX@73cnc.com or phone at (419)-688-1505, or write him: P.O. Box 249, Caledonia Ohio, 43314-0249.

The price of the knob is $220 plus shipping.

Beauty Does Not Happen by Accident

The End Result

Bottom View

Sample of Things to Come, S-Line Prototype

Perspective S-Line Part II (Cont'd)

and Gerry Nelson also helped with the engineering.

The 51S-1 was introduced in late 1959 and early 1960 at a pretty high price level for hams, but the $1828 was consistent with, albeit a bit higher than, the price of its predecessor, the 51J-4.

Following the introduction of the 51S-1, and particularly after the military started buying it, there were many complaints about the intermod capability of the radio, particularly with respect to the bottom two bands. In the mid 1960s, and coincident with the general Collins Radio logo change from the winged to the round emblem, Collins developed the 55G-1 preselector designed to cover these two bands and improve the front-end sensitivity and selectivity. This preselector consists of a small power supply and a single stage of gain using a MRF102 JFET amplifier to improve the parent receiver system intermod capability. Jerry Vonderheide was the inventor and the Project Lead on the 55G-1.

There were no "stock" winged emblem 55G-1s manufactured. As the product went to production, Collins was going through an awkward period where they were supposed to be changing the logo, but they were trying to use up all of the old inventory……..And, there was some internal resistance to the logo change.

The 55G-1

Figure 1. Winged Emblem 55G-1 Preselector in Service at K0CXX

The 55G-1 engineering prototype was winged emblem but the Rev 0 55G-1 manual was round emblem with a picture of the winged emblem prototype. When the 55G-1 went into pilot and final production, all standard units built were round emblem. There is one exception to this. Collins still had some winged 51S-1s in inventory, and they could have also been running some production of the 51S-1 with old panel and logo inventory to use up winged inventory. In either case, if a customer knew they were getting a winged 51S-1, and were also buying a 55G-1, they could special order a matching 55G-1 that was winged. Production would simply pull a round production 55G-1 and change the logo to the old winged one. Accompanying my winged emblem 51S-1 and 55G-1 when I got them was the customer request letter, the corresponding Collins letter acknowledging the special request and the bill-of-sale for the pair. These winged 55G-1s were sequentially serialized in with the round production units. How many of these were originally made is unknown, but there are only about 5 known winged 55G-1s.

So, here we are in about 1961 and the S-Line is pretty much fleshed out. But, where is the 62S-1 Transverter. One can only imagine, considering all of the other priorities and their lack of experience with 2 & 6 meter SSB, that this transverter wound up down on the priority list. With all of their VHF experience in avionics, Collins certainly was not stymied by this product from an engineering standpoint. It would not be until 1963 that the 62S-1 would hit the distributor shelves and, by that time, FM was starting to immerge as the modulation of choice above 30 mHz. The intro

Perspective S-Line Part II (Cont'd)

price was also pretty up there at more than a grand. The unit sold poorly and thus is pretty rare today.

Back to 1961 and the 75S-3: After interning at Collins Radio during his college years, Dennis Day returned for permanent employment in May of 1960. Gene assigned him as the Project lead for the 75S-3 receiver – the follow on to the 75S-1/2. Joe Jekerle was the Lab Technician assigned to work with him. There would also be a 75S-3A extended frequency version, but that would come later. Dennis relates that the objectives for the S-3 were similar to the original 75S-1, but with some improved performance in the audio output level, variable BFO and notch filter, e.g. CW selectivity areas. Cost was still an issue but interestingly the 75S-3, when introduced in 1961 at $680 retail, was more expensive than the current asking price of the 75S-1. Most knowledgeable users of the full S-Line receiver offering say that the 75S-3/3A is the best of all the S-Line receivers from the S-1 to their end in the late 70s. The S-3 had most of the performance advantages of the 75S-3B, but did not suffer from the selectivity degradation caused by stray coupling in the resulting 75S-3B/C plug-in filter/socket arrangement. Also, there is just something intangible stemming from the combination of noise performance, skirt isolation and AGC characteristics that just makes the 75S-3 "brighter".

Figure 2. Early Winged Emblem 75S-3C circa 1964 In Service at K0CXX

While Dennis was working on finishing up the 75S-3, Jerry Vonderheide was assigned the update of the 32S-1 and, in 1962, the much improved 32S-3/3A (with its updated CW scheme, a better balanced modulator and the carrier spotting capability) was introduced with just a slight increase in price to $750 retail (32S-3).

In 1963, the 75S-3A finally immerged at $750. By this time, work was already under way to again improve, add filter options

Cont'd Next Page

Did You Know?

Thanks once more to some additional work by Rod Blocksome of Collins Radio, we have the following updated information. There will be a more detailed article by Rod in the near future.

The S-Line production ran continuously for 24 years. That has to be some sort of record for an Amateur Radio product line.

During that time period, records, and some well researched estimates, put the total production quantity at 162,402 units - not including the DL-1. This included 27,684 KWM-2/2A units.

Interestingly, this total production quantity is very close to the number of hams in the US in that time frame, meaning that if the equipment survival rate was 100%, there would be one piece of Collins gear for each of us to enjoy……..

During this sustained production of the S-Line family, production lines were located in 7 different locations which, as previously reported in this ***Did You Know?*** column, included factories in Cedar Rapids, Anamosa, Richardson, El Paso, Salt Lake City, Toronto and Tokyo, Japan.

What a run!

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Perspective S-Line Part II (Cont'd)

and cost reduce the 75S-3/3A. Dennis was at it again, and out came the 75S-3B in 1964. Customers were asking for more selectivity options and they got it. The first 75S-3B/Cs were basically very similar in schematic form to the S-3/SA, but with the plug-in filters added. Over time, this design would evolve adding T-9, better IF noise performance and better mechanical filter and under-chassis RF shielding. When you are working on a 75S-B/C, you better know which manual you need, and have the right one, or it gets real confusing.

Other than collateral engineering, 1963 was pretty much the end of the active S-Line development. Solid state was coming but transistor performance did not allow the engineers to really improve, or even equal, tube performance. Art Collins was getting way too embroiled in the new computer business, among other things, and amateur development kind of stalled out at Collins. This is not to say that the engineers were not coming up with some really great stuff.

Now, as Paul Harvey used to say, "The rest of the story"

Development of the Amateur Radio Products in the late 50s through the 60s was not limited to the models introduced. I became curious about the obvious gap in introductions between 1964 and 1979 when the KWM-380 was introduced. Some discussion with Dennis Day revealed that they were certainly not sitting on their hands. Beside the continuing evolution of the 75S3B/C that occurred in the several years after the initial introduction, there was the obvious collateral line engineering of the running S-Line production well into the late 70s.

In addition there were a couple of early aborted attempts to "update" the S-Line. Around the end of the 30L-1 development, a Green Room project was set up to develop a new "Cadillac" (That is what it became known as in the engineering group) version of the KWM-2. By model number it came to be called the KWM-5000 and was a dual PTO, 200 watt, version of the KWM-2 with a built in

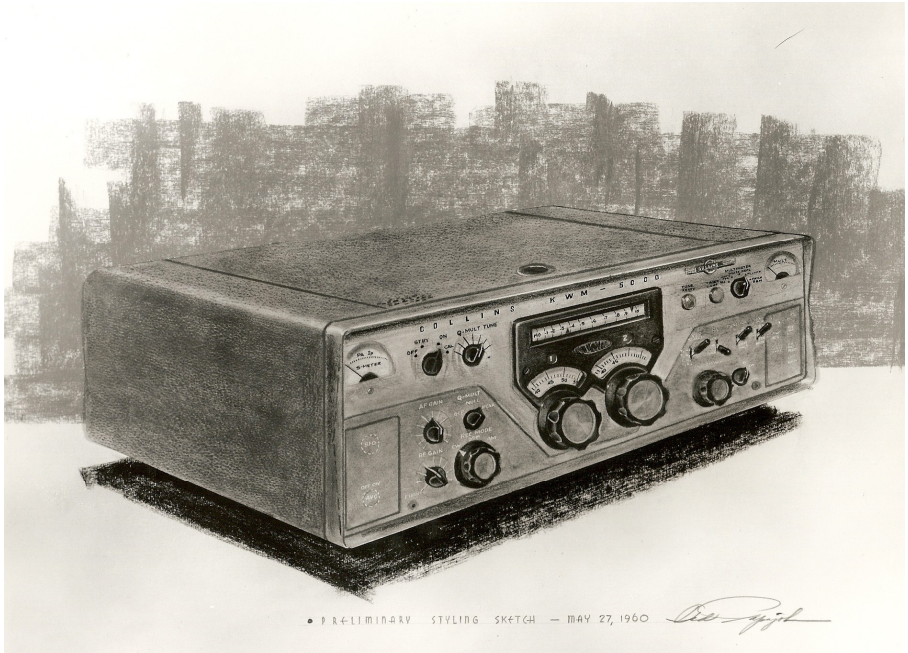

Figure 3. Artist Rendering of the KWM-5000 "Cadillac"

power supply. It was big. The Project Lead was Dennis Day and Joe Vanous (PE) and Ron Brockhauf (ME) did the bulk of the design work. Arnie Spielbauer was again the Design Draftsman. The engineering effort was still in the original Engineering Building 120 at the time and there is an early rendering of the proposed KWM-5000 by Ted Papajohn dated May 27, 1960. Since a ***Signal*** article has previously appeared on this unit (Q4 2006 #44), enough said on that subject, but the unit was killed in 1961 by Art before the engineering move to Bldgs 105, 106 and 107. The prototype unit still exists, having been saved from destruction by Dennis, and you can see it in the Rockwell Collins Cedar Rapids Museum.

At about the same time that the KWM-5000 work was going on, development was started on a new autotune version of the 30S-1 that would become the 30S-2/3. Two units were built - One 30S-2 and one 30S-3. It was basically an autotune 30S-1 and looked very similar but with different front panel controls. Chuck Carney, Amateur

Perspective S-Line Part II (Cont'd)

Radio Marketing Manager, wound up with the 30S-3 prototype and wrote a historical paper on these two units which was also published in past ***Signal*** issue #16 in Q4 1999. This unit has since been passed on to his son and then sold to a collector in Japan. The 30S-2 is being donated to the Collins Museum. The 30S-2/3 was canceled shortly after the engineering group moved into new quarters in Bldgs 105, 106 and 107.

Figure 4. Artist Rendering of TMT-1 The Engineering Development of a Transistorized Mobile Transceiver
(Photo courtesy of Dennis Day)

Figure 5. Brass Board Miniature Transistorized PTO believed to be developed for the TMT-1 …Donated by Dennis Day

Thus, all new and not introduced models of the S-line were off the plate by 1962. Remember that development of the 75S-3A (minor) and then the 75S-3B/C were also occurring in this time frame leading to the 75S-3B/Cs intro in 1664. Talking with Dennis, and looking at the development time of the KWM-380, there is a new model and development gap from 1964 until 1977 when work started on the KWM-380/HF-380/HF-280 amateur and commercial family.

Shortly after the 30S-2/3 project was cancelled, Dennis became involved with the development of the TMT-1. TMT stood for Transistorized Mobile Transceiver and it was conceived as the eventual follow-on to the KWM-2. The year was 1962 and they built, or attempted to build, two units. They were different and the second even reverted to a 12 Vdc instant-on mobile radio band dual tetrode - the Amperex 8300 PA tube - in order to get adequate power output through 10 meters. In the long run, they concluded that transistors were not capable of making a state-of-the-art (no pun intended - but certainly appropriate !) producible transceiver and the project was abandoned, not to be resumed until work commenced on the

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Perspective S-Line Part II (Cont'd)

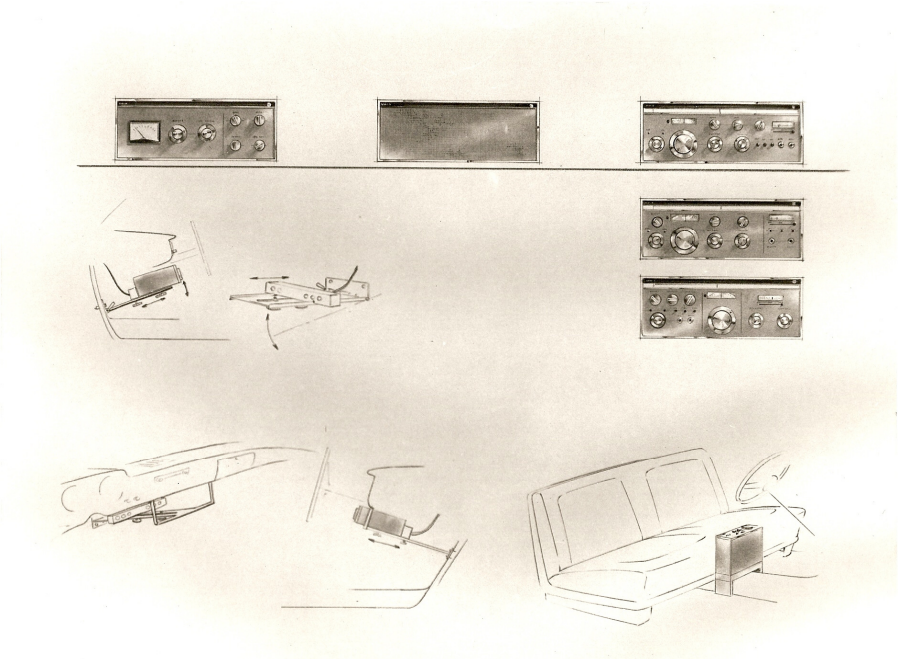

Figure 6. Family Portrait of the TMT-1 Family Including A Proposed Amplifier Which Was Never Worked On
(Rendering photo courtesy of Dennis Day)

KWM-380 in 1977.

There was actually a preceding attempt to make a small all transistorized transceiver which was done by Ed Andrade on the side in 1961 – That was really pushing it. This unit, nicknamed the "Critter" was smaller than a KWM-1 but never was even an official project and did not result in any producible product either. Ed did use his unit in his car for some period of time so it, indeed, worked. Later, a second Collins employee who had left the company, but was a friend of Ed's, updated the design somewhat and built a second unit similar to the critter. I saw this transceiver at an acquaintance's home and watched as he added a winged emblem. This transceiver is now in the hands of a collector who thinks it is a Collins winged emblem factory engineered unit. Buyer beware.

Dennis related to me that, in the period between 1963-5 and 1977 when KWM-380 work began, and more so after Rockwell entered the picture in 1971, his engineering group became totally consumed with military related development contracts which include the radios for the Lockheed SR-71 Blackbird program, the B-58 radios, AWACS related work and related URG-2 and ISB programs. The ISB was a predecessor to the HF-80 which employed ARINC boxes similar to URG-2/TSC-60 shelter equipment. He commented that it was a busy time, but that not much got done on ham radio until 1977.

The KWM-380 was introduced October 19, 1979 at the ARRL Midwest Division ARRL Convention and Collins Radio amateur group development came to an end.

So, you are probably asking, what about the KWM-3? There is an interesting sidebar story about this follow-on "transceiver". Management of the Collins amateur radio line was clearly centered in Cedar Rapids. Sometime in the late 60s, following the introduction of the URG-2 group of military offerings by Rockwell Collins, the engineers in Dallas apparently wanted to participate in the amateur radio game. The unit shown on page 1 of this issue is part of a proposal that they did to management for a KWM-3. The unit shown was a photo of a mockup that was, in fact, just a control head for the complete system. This system proposed was made up of URG-2 ARINC boxes bundled as a system called the KWM-3. The resulting retail price of the system, while not exactly known, would have been up in the $50,000 range. Can you imagine how many of those they would have sold?? Pretty nice to think about though!

Now you know the "Rest of the Story".

de Bill Carns, N7OTQ/K0CXX
wcarns@austin.rr.com

Authors Note:

This series of articles would not have been possible without the help of both Dennis Day and Dave Hallock who spent much time on the phone with me documenting the past at Collins Radio. More will appear about these two worthies in the near future.

CCA Caribbean Cruise a Big Success

by Butch Schartau, K0BS

Holland America's MS Eurodam

On the 24th of October of this year, 20 of our CCA members, and some brave XYLs, set sail from Ft. Lauderdale, Florida for a seven day adventure in CCA camaraderie, W0CXX/MM operation and trips ashore throughout the central Caribbean Sea. Ports of Call included Grand Turk, Turks and Caicos, San Juan, Puerto, St. Thomas, U.S.V.I., Half Moon Cay and the Bahamas.

The luxurious Holland America Line *MS Eurodam* was our QTH for the week. This huge cruise liner has accommodations for 2100 passengers, 11 decks with abundant shops, restaurants and bars and is served by a crew of 900. The ship is 900 feet long, with a maximum speed of 24 knots and is powered by 6 Diesel generators. The state of the art navigation and safety systems are impressive.

W0CXX/ MM ON THE AIR w/ WB5WUX, George operating the KWM-2 & K4IUD, Barry, doing logging duty (Notice the empty wine glass and the smile)

Our first task (See below left) was to put W0CXX/MM on the air including putting up an antenna. This consisted of a telescoping fiberglass pole with a trailing wire off the railing of the balcony. A similar antenna was used very successfully on the last CCA Cruise. Just when operation was starting up, there came a knock on the cabin door. It was the ships security officer wanting to know what we were doing. We tried to explain that we were ham radio operators and had approval to operate. Well, he didn't buy this and insisted we report to the ship's Operation Officer. Again we explained our intention and that we had prior approval to operate. He said he would have to check this out and would get back to us. So, in the meantime, there was no operation. After several hours we got a phone call indicating everything was OK and we could operate. By this time it was time for the evening social activities to start, so only a few contacts were made. The next morning, we were ready to start operating in earnest, only to find out the passengers in the cabin below us were very irate and about to call security because the trailing antenna wire was obstructing their view! Clearly we didn't need a second run in with the Security Officer, so the trailing wire was reeled in and we regrouped to come up with a different antenna. The best we could do was put up a 20 meter inverted V off the end of the pole running back to the balcony railing. To our surprise we were able to operate both 20 and 40 meters with this antenna.

W0CXX/MM Antenna Viewed From the Balcony

Two private cocktail parties were given for our groups where we were able to visit with each other and also meet the QCWA participants. During the days we were at sea, there were several HAM Radio seminars presented. Our own K0DAS, Rod Blocksome, gave his outstanding presentation on ***The Search for Amelia Earhart's Airplane*** and his ***2008 DXpedition to Christmas Island (T32)***. K6DPZ, Hal Guretzky also gave a talk on ***Buying Boat Anchors***.

ARECIBO OBSERVATORY TOUR IN SAN JUAN: A special private tour of this famous Radio Telescope Observatory was set up for the group. There were two local Hams involved with the daily Arecibo operation that hosted our group tour. Hector Camacho, Observatory Director, provided the group with some behind the scenes views of operation of the Observatory that

Cont'd Next Page

CCA Caribbean Cruise a Big Success (Cont'd)

by Butch Schartau, K0BS

Cocktail Hour: Left to Right: VE1BMJ, Tom Gaum, N7ARY, George Carle, K7OSK, John Ellingson, K0DAS, Rod BLocksome, K4IUD, Barry Grove, WA4SOX, Bob Kershner, K0BS, Butch Schartau and WB5WUX, George Donavan.

Left to Right: WC0T, Leigh Patterson, WC0W, John Patterson, WB5WUX's XYL Ann Donovan, K4IUD's XYL Pat Grove, K0DAS's XYL Elizabeth Blocksome, K0BS's XLY Jane Schartau, K4IUD, Barry Grove, K0DAS, ROD Blocksome , and with their backs to the camera, K4JD, Nancy Morris AND K4XH, John Morris.

are not normally shown to the general public. It is the largest radio telescope in the world and represents a massive engineering effort. We were also allowed to operate from the Arecibo Amateur Club station while we were there.

Butch, K0BS Operating from the Arecibo Observatory Radio Club

The group had a wonderful relaxed - but busy – week however, with only two days at sea, and all the other on-shore activities, it was hard to find time to operate W0CXX/MM. We did, however, make some 200 contacts, both DX and state side.

QSL Information

So - if you worked W0CXX/MM, send your QSL to W0CXX (See qrz.com for the address) at the Collins Radio Club in Cedar Rapids, Iowa and we will QSL in return.

de, Butch, K0BS
k0bsbutch@gmail.com

Editors Note: I can see the problem with limited W0CXX operation. The KWM-2 should have been on the cocktail table.

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In the Shack of Mike Student, W7MS

Now that's an Operating Position

All articles are fun to write, but some are more fun than others. Mike Student, W7MS, is a very old friend of mine in many ways, yet I have never been to his home, met his wife and kids, or even seen his wonderful Collins collection. We met through ham radio and the CCA connection and have shared many hours talking on the Arizona AM frequencies.

Mike lives in Reno, Nevada with his wife Linda and their twins where he works in the telecommunication industry. In addition to focusing on his family, he enjoys, not only Collins collecting, but spending time doing photography and kayaking.

He has been a legal ham (I won't dwell here) for some 33 years-starting in 1976 as WN7DWB. His first rig was a Christmas present NC-300 and his-already broken in-ARC-5 transmitter. About 20 years ago he started, as he puts it, collecting seriously. His first piece of Collins gear was his KWM-2A which explains why he still sees this piece as his favorite, in a tie with his 300G-1 broadcast transmitter. His collection is now a very eclectic grouping of memorabilia, military equipment (notice the rare mint ARC-2, with rack yet) and amateur and broadcast gear that is exciting to see.

548U-5 PA

Rare ARC-2

Favorite 300G-1

Collins Collectors Association

From the President

In spite of the resignation of Paul Kluwe as El Presidente, this has been a great quarter.

Membership is up even with the necessary dues increase, the 2009 Caribbean Cruise in October was a great success and good progress is being made on increasing membership benefits for all of you.

I will repeat myself here in this column and say that we were all saddened to hear that it was necessary for Paul to reprioritize things and withdraw from serving the CCA as President.

We wish him good luck with his new venture and his new home. I am pleased to report that he is still active in the CCA, albeit in the background, and that he has recently purchased a 75S-2/32S-2/30S-1 station to stock his new QTH. I am sure that we will hear from him on the nets from time to time. ***Thank You*** Paul for your help now, and in the past.

Also, while I am in the thanks mode - Many thanks! – go to all of the board members, other volunteers and to the ***Signal Magazine*** contributors who have made this a wonderful year.

I am writing this column this month as your Vice President and Acting President. The election for officers will be held by the CCA Board of Directors during the following month. My hat has been tossed in the ring and, whether I serve you as Vice President or as the CCA President, I can assure you of continuity of effort, quality and integrity.

On another subject, the solution for our 20 meter net management issue has appeared (Thank You God) and it is with great pleasure that I announce that Jim Hollabaugh, K6TMU, of Visalia, California, has accepted the position of 20 Meter CCA Net Manager. Jim is a 50 year ham, experienced at net control and net management and is very enthusiastic about his new position. Many of you who have been so helpful in conducting this Sunday net during the absence of a net manager can expect a call - if you have not gotten it already. His active management of the 20 Meter Sunday Net will start in January.

That's it for now, Happy Holidays and have a great quarter.

Best 73s

Bill Carns, N7OTQ
wcarns@austin.rr.com

Renewal Time for Your CCA Membership Unless You are Paid Up Through 2010

If you have not done so already, **SAVE** the envelope that this ***Signal*** came in. It has your member number and your expiration date on it. If your membership expires in 2009, you will need to renew in the next 2 months in order to continue receiving member benefits.

Motivated by lower work load for our volunteer Membership Chairman, a better paper trail for our accountant, lower error rate, increasing postage rates, faster response time and going green, the CCA is going to a paperless renewal system.

You can easily renew your membership by going to the CCA website (membership) and paying with a Credit Card or PayPal

If this is not possible for you, please send your renewal information (name, call, member # and the years that you are renewing for, along with a check, to the return address on your ***Signal*** envelope. The renewal rate for mail is $35/yr

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Editor Bill Carns, N7OTQ
Co- Editor, Joe Nyberg, W1LJN

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