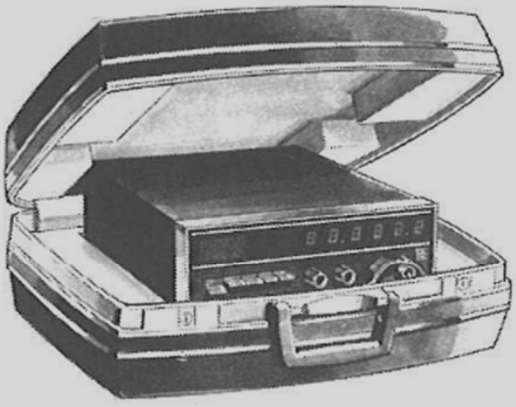
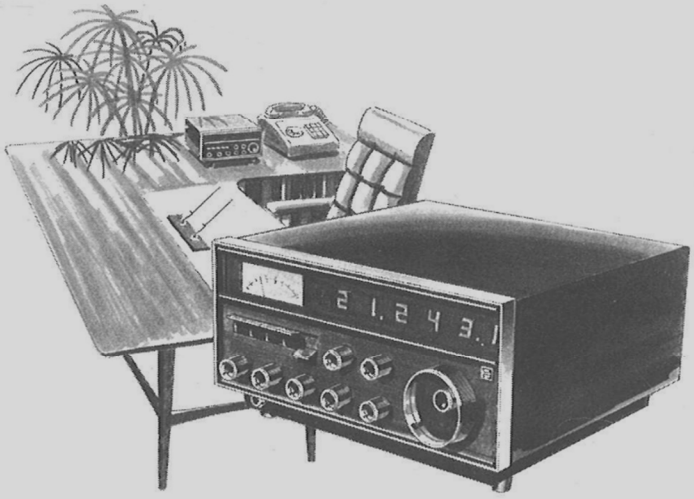
The Signal

OFFICIAL MAGAZINE OF THE COLLINS COLLECTORS ASSOCIATION * Q2 2015 Issue *

651S-1 ~ The New Breed





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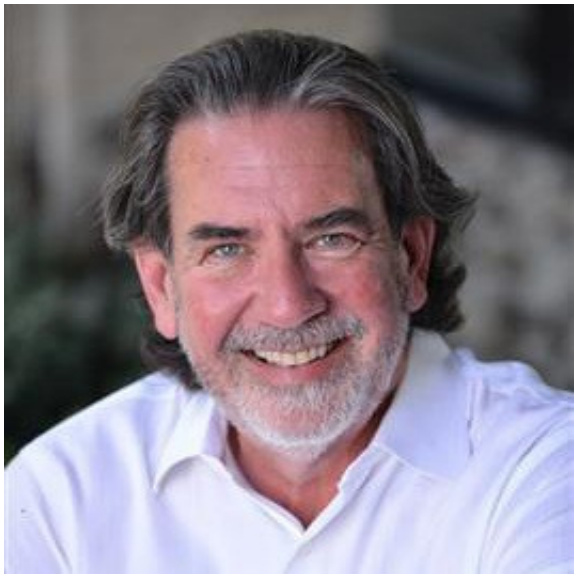

From the President's Desk…

The second quarter has been busy time for the CCA! With the release of our new CCA "Collins Collections" virtual Museum (http://collections.collinsradio.org), our linked Facebook page (search for *Collins Collectors Association* on Facebook), the Dayton Hamvention and Dallas Ham Com events (see the reports on both of these events in this issue), we have been really busy the last few months!

These events have given me a chance to see many old CCA friends and make quite a few new ones. What I have seen is a continued interest in all things Collins and - even more encouraging – we have been approached by many who are taking their first steps into getting on the air with a Collins station. I remarked to Bill Carns, our past President and *Signal* Editor, that we should warn the newbies that starting down the Collins road may lead to an obsessive desire to own one of each – a slippery slope that many of us have given up avoiding!

For 2016 we are considering a Northeast gathering in the fall. This idea was hatched in the booth at Dayton as several of us were sitting around talking. I am excited about this as I have always wanted to see the fall colors up there. This would be on the scale of the past Cedar Rapids trips, or the cruises we have had – in other words, something that is talked about for years to come. Stay tuned for more news on this over the next few months as we work out the details.

We have also started a new section of our website (http://www.collinsradio.org) called RX for your Collins. Bill and I have been talking about this concept for some time and he took the time to pull together the links and format the material to get this kicked off. We already have the largest collection of Collins manuals on the web. In addition, since digitizing an older manual usually ruins it, we are working on new techniques to digitize rarer manuals and keep them intact.

Bill has also been working with Jeff Hilliard, AK6OK (http://bigschematic.com/) to identify critical signal paths on some of his large schematics. Take a look – these things are amazingly easy to read, especially as the eyes age! Go to http://collinsradio.org/rx and you will find a huge amount of material as we build the most comprehensive source on the web for the repair and maintenance of your Collins rigs. We are trying to get the best answers together in one place, sorted by the rig model number. I encourage you to look there first for an answer to your question rather than just throw a question out on the reflector on a subject that has been answered many times over. Also, if you know of an article or resource that should be added please shoot either Bill or I an email and we will get it added.

Finally, now is the time to start talking about board elections. We have two board positions that will open in the fall. We need some members to step up and express an interest in being nominated, followed by an election in early October. Please see the section on upcoming elections in the CCA report in this issue. We are using a new streamlined election process that is more informative and faster for both you and for us. If you have never stepped up to serve a term – I encourage you to get more involved and then consider it. This is a fun group to work with, and new fresh ideas are always welcome! If you want to join the fun shoot me an email – skerr@trackersoft.com and let's talk.

73 de KE1RR
Scott Kerr,
President, Collins Collectors Association
Dallas Texas
(214) 991-2850

ELECTION NOTICE

The Signal Magazine

OFFICIAL JOURNAL OF THE COLLINS COLLECTORS ASSOCIATION

Issue Number Seventy Eight - 2nd Quarter 2015

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- 1st Wednesday AM 3880 kHz at 8pm CST

Sunday for Technical, Buy, Sell & Swap
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The *Signal Magazine*

Published quarterly by the
Collins Collectors Association

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See our New Features & Members Area.

You can renew your membership or join the CCA on our website using the "JOIN US" link.

- Second Quarter - 2015 Looking "UP"

Hee Hee…. I couldn't resist. Last quarter, as we entered 2015, this little introductory column addressed our coming year and all we had to look forward to.

Now, here we are – almost half way through the year - and already many of these things have come to pass. For one, we have made good progress on many fronts (website and magazine) in getting you more maintenance and restoration material.

Over the past several years, you know that we here at *The Signal* have first launched heavily into the preservation and presentation of the history of Collins Radio and then back into the more balanced approach of giving you more maintenance and restoration (equipment) oriented information.

This *Signal* issue delves into an area that has been little explored and takes us "up" instead of forward – a bit of a play on words. We step "up" and even backwards a bit as we visit with one of the more significant technical contributions from the engineering side of Collins. Following that, in a coming issue, we will then visit with some of the related history.

For those of you that delve into the architecture of – particularly – our receivers, you know of the history of the progression from TRF (not at Collins) through Single Conversion to Double Conversion (with the Collins Radio notable variation using the PTO/VIF preselector technique). Due to lack of exposure, many readers and members are not familiar with some of the later contributions by Collins Radio in the field of receiver architecture.

In this issue, we will start to explore Collins' developments in the area of Up Conversion. Don Jackson, our Technical Editor, will give us some insight into this history (and some of the benefits) of conversion schemes. Then Randy Best will give us a real good look at one of Rockwell Collins' first receivers to use this new technology.

In the next issue – more surprises as we again hear from the then Director of Engineering at Collins who was the manager at the time of these significant developments.

Enjoy!

A Quick Look in This Issue

Issue No. 78
Second Quarter 2015 Signal Magazine

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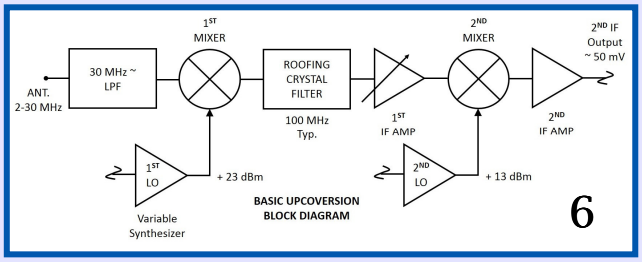
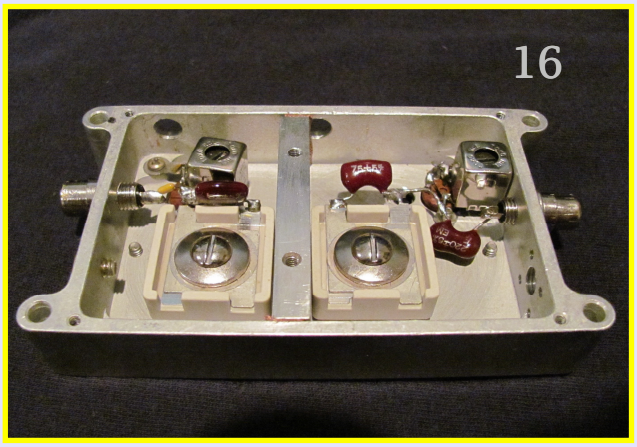




ON THE COVER - The Collins Radio 651S-1 General Coverage Receiver ~ First of its breed at Collins

FEATURES

REGULARS

FROM THE STAFF

by Bill Carns, N7OTQ & Don Jackson, W5QN

From the Desk of N7OTQ & W5QN

For some time now the staff of the *Signal Magazine* and the CCA management have been struggling with a growing issue.

As many of you know - but some of the newcomers may not - going back to 2007, the CCA *Signal* was more of a newsletter than it was a magazine. While we were always proud of what was done then, we always – and will continue to – want to do better. Particularly, we wanted to make the *Signal Magazine* into a publication that both honored, and was true to, its predecessor and namesake, the Collins Radio Company Signal that was published by Collins from the 1930s on through the '60s.

Starting in 2007, we began to dramatically change both the format, the quality and the content of the magazine. It grew from the usual 4 pages (a single printed sheet folded) to what we now have. Along with that growth came better paper and printing and, we are happy to say, the magazine evolved into one that gets rave reviews and more than seems to please our "customers" – that is you.

During the 80th anniversary year of Collins Radio (2013), the CCA board made a decision to invest in the opportunity and honor the company by expanding the magazine to an ultimate 52 pages of historical content. Everyone was more than pleased with the result. Particularly, we were very happy with your response and the resulting growing membership.

In 2014, we started getting the budget back in range - as there was no way we could continue to print that size and quality of a magazine without breaking the piggy bank – even though the bank was quite healthy. The magazine, by original plan started to come down in page count, but the quality remained. In addition, there was no way that we could continue to generate 40 to 50 pages of content with the volunteer staff that we have – even though it is quite large for such an organization. But there was a challenge…. 2014 was OUR CCA 20th anniversary and we wanted to tell that story and still accomplish our goals regarding the budget. The magazine did not get a whole lot smaller.

Now comes the difficult part that we are, and have been, struggling with during this same two year timeframe. The printing world and the game of publishing is changing. It is moving with great speed towards e-Publishing. Even complete libraries are going through huge changes as people both expect (not me), and use, e-Books in place of hard copy that you can hold in your hands. Gone in a library lately? . . . They look more like computer rooms.

One of the results of all the electronic and on-line publishing activity, is that the physical book and magazine printing market is shrinking dramatically. Printers are being forced to change their business models or they are disappearing completely.

This has had a dramatic effect on us. Our printing costs have been rising steadily, and as we have tried to get the magazine back to a manageable (and still completely adequate) size, the cost of printing a smaller magazine has risen in front of us.

Let me be real clear. We have no intention of going to electronic publishing for our main *Signal Magazine*. Our members want a quality book to hold in their hands and keep, and they (you) will get it. We did go to e-Publishing with our CCA Associate Member's newsletter, the CCA Columns, but that will not happen with the *Signal* – rest assured.

And, bless our US government, the cost of postage has risen dramatically in the last several years. You would be shocked to know that it is now costing us more in postage and printing costs for the international members than we get in international revenue. THAT has to be dealt with.

In general we have tried to limit our CCA membership dues increase over the years. In fact, we have only had one increase in the 20 plus years that we have been in existence. That's pretty good. The current $32 for domestic and $40 for international is a pretty good bargain when you consider all of the benefits on the website, the magazine and the events.

Bottom line, we particularly want the new members that just have seen 40 and 50 page magazines, and are now watching as it returns to its normal size, to rest assured that this was the plan all along and that we still plan on giving you full value.

We have no current plans for a dues increase for the US mailing although this may be looming. The Canadian mailing may have to go up a bit and the foreign dues will definitely have to increase. There are some countries where just the postage is over $5.00 a copy. Making the magazine lighter (less pages) will help with that. We will keep you all informed as we proceed.

Thanks you for your understanding and also rest assured that before there is a significant domestic dues increase, all avenues will be explored and discussed with you here in the magazine, and on line.

This is your CCA, and we want you to be thoroughly satisfied and have input into what happens as we continue to grow. We have every intention of remaining one of the finest - if not *the* finest – collectors support organization in the world. Collins deserves no less and you do too.

de Bill, N7OTQ email: wcarns@austin.rr.com

& Don, W5QN email:w5qn@verizon.net

Some Background on Receiver Conversion Architecture at Collins radio

Recently, we have been exploring the world of Collins Radio receivers more than we normally would. While all of us have our favorite (ours is the 75A-4), there is certainly more than one contender. This is both an open topic and one that is much discussed. It is also very subjective because every receiver and every conversion scheme has its strong and weaker points.

Most people never really realize that the Collins Radio Company was, for a very long time, one that was most known for its transmitters. Certainly, when Arthur first started the company, it seems pretty evident that he envisioned it as such. Even the first names of the fledgling start-up shouted "We build Transmitters." Only during World War II, with the advent of the TCS sets and the ARR-15 did Collins go seriously into receiver production. Yes, of course, the 51F was introduced right before the war, but very few were made and this was more of a specialty receiver – being a single channel market focused aircraft ground control radio.

A more intense focus here on receivers was prompted originally by the research effort that was required when the 2013 Collins Radio 80th anniversary *Signal Magazine* issues were produced. This then led to more natural activity on our part - as we learned more about the history and the early receiver efforts at Collins. What helped bring it all into focus was when our then board of director Jim Stitzinger prepared a wonderful presentation on Collins Radio receiver development for use at CCA events during 2013. Jim's presentation dealt with Collins receivers - post World War II and beyond - and echoed the content of his collection and knowledge base.

The magazine research efforts and the presentation work came together when we wanted to use Jim's presentation work for the dinner talk at Orlando 2014. Based upon the results of some of the recent research, and this editor's good fortune with some acquisitions like the 51F-1 and some early literature, we set about (with Jim's help) adding the perspective of the period from 1933 on through the war.

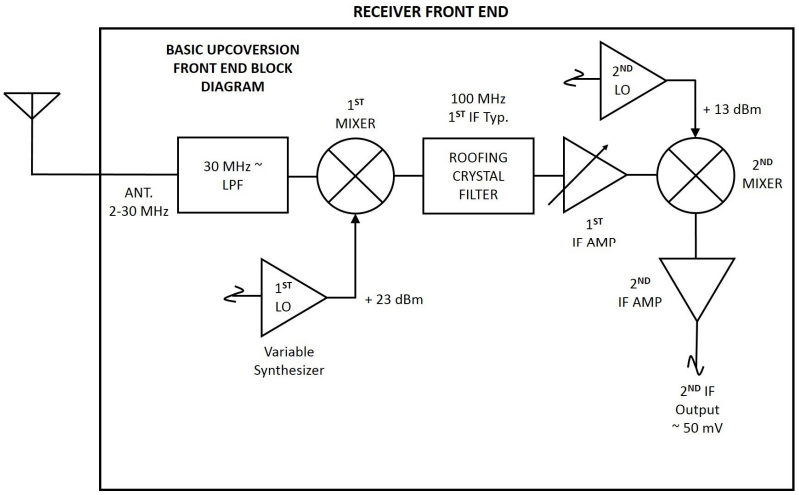
When we finished, and Jim had helped integrated these two somewhat separate bodies of work into one, we had not only learned a great deal about the prewar years but also added some more knowledge and perspective about the period after the war where we all have more experience. During that same period, we also had the good fortune to work with Loney Duncan on the VLF TACAMO program articles including his writing on VLF receivers.

When this all came together, the accomplishments of a transmitter company in the field of receiver design and production were stunning. Collins was not only a leader in transmitter development and production, but they were truly a "communication solution" company with significant contributions to the state-of-the-art in receiver design – not to mention propagation and antenna design.

We are all familiar with their contributions in the area of PTO stability and the use of this technology to provide a linear (higher frequency & very stable) "second injection" oscillator in the flipped double conversion method pioneered by Collins.

What had not registered, was all of the firsts and significant other receiver developments that were contributed over the years by Collins. While not limited to use in just receivers, Collins was an early pioneer in the use of frequency synthesis way back before digital logic made this scheme a lot more straight forward. Their use of Comb Generators and frequency selection techniques to make these early "synthesizers" makes for a fascinating story just in itself.

Beyond that though, they pioneered the first digital readout (albeit mechanical R-390 development in the early 50s), ISB demodulation (51S-1 development 1960), and then true digital frequency synthesis using optically scanned analog tuning and up-conversion with "roofing" filters. This last development represented the wave of the future and was used initially at Collins in the commercial 671U-4/718U-x series of commercial avionics HF receiver/exciters. They then promptly employed it all in the new 651S-1 HF receiver that we all are familiar with.



Just the digital control and optical analog to digital conversion patents involved here provided a huge revenue stream for Collins well into the 80s.

Then in 1985, Collins introduced the HF-2050 receiver which was one of the first, and probably the first very successful, DSP IF processed receiver that was introduced. It is still a very competitive receiver given today's higher technology DSP full processing standards and resulting performance. These were followed by some of the first single board processor compatible receivers at Collins, the S-1 and the S-2, and then one of the first industry Semi-SDR Zero IF receivers, the 95S-1, which was introduced by Rockwell Collins in 1995. From early stability and channel control, to frequency synthesis (basic to digital true synthesis), on to up-conversion and analog to digital control, computer control, DSP and then SDR, Collins stayed at the leading edge of receiver development for over 50 years. – Not too bad for a transmitter company.

Not mentioned here is a less tangible contribution, but one worthy of serious mention. Feeling the need for a more cost competitive line of general coverage HF receivers to complement their HF-80 communication systems development work, Collins designed a broad line of multi-channel digitally tuned and analog tuned variants (the 451S-1, HF-8050A and 8054A and then the 851S-1 & S-2). What was very notable about this entire series of developments, was that they employed (lower cost) standard product design methodology using off the shelf industry standard active circuits. Yet, they went on to become some of the most respected and sought after equipment in the market place - and remain so today. That is real cost effective successful design.

This issue of the *Signal* explores just one area of this remarkable receiver side of the story. It will be followed by a second issue that talks about the development environment and happenings at Collins Radio during this same period. We will again hear from VP of Engineering at the time, Loney Duncan.

----------CCA----------

RF Conversion Scheme ~ Strategies ~ An Overview

by Don Jackson, W5QN

Introduction

This article is a follow-up to an earlier one on Collins receiver conversion plans that appeared in the 1st Quarter 2014 issue of The Signal. I recommend a review of that article for a more detailed description of some of the terms in this article. In this article, we will consider the various design considerations that led to the choice of a conversion plan in Collins' (or any) receivers.

Types of Conversion Plans

All receivers we will discuss are of the superheterodyne type, which have at least one mixing stage. Collins utilized single, double, and triple conversion plans in their receivers. Some receivers have more than one conversion plan in the receiver, with different plans implemented for different RF input ranges. For example, the 51J4 uses triple conversion for the .5-1.5 MHz range, single conversion for the 1.5-3.5 MHz range, and double conversion for the 3.5-30.5 MHz range.

In the design of a receiver, the first step is usually to establish the electrical and mechanical specifications desired. The next step is to create a block diagram that will support the electrical specifications. The frequency plan is a major part of the block diagram step.

Conversion Plan Considerations

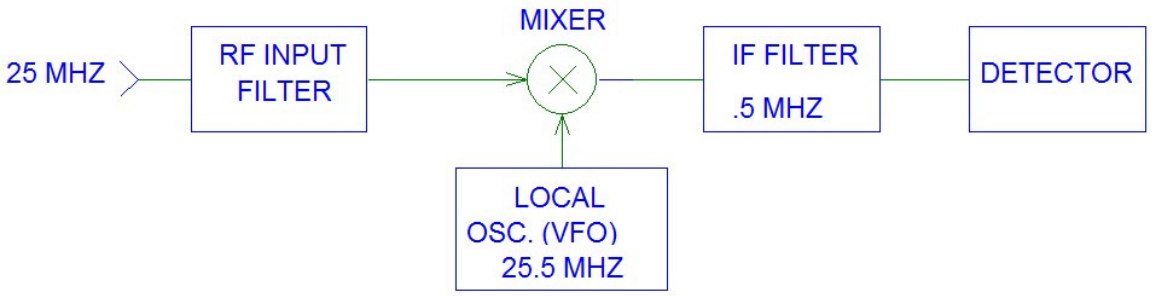
Commonality of key components: There are often key components that offer optimum performance, and are expensive to design and/or duplicate. It is advantageous to utilize these components in "multi-duty" whenever possible. The mechanical IF filters and PTOs are obvious cases in the Collins receivers.

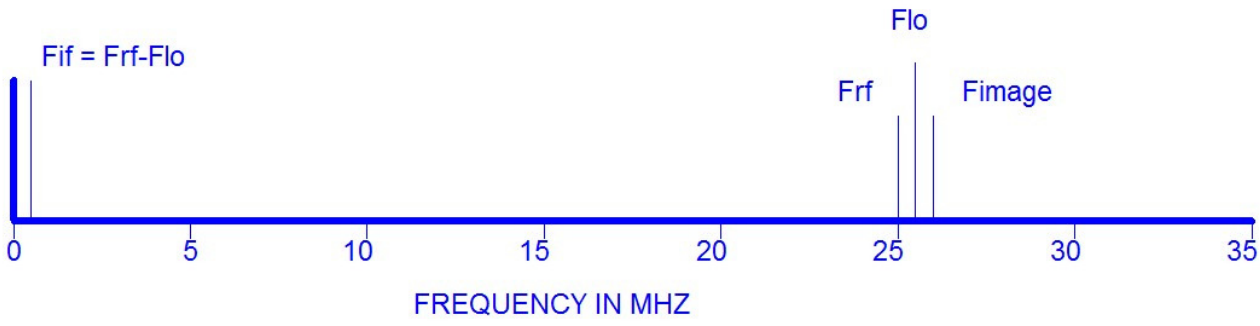
Spurious rejection requirements: This covers myriad mechanisms that might cause undesired "birdies" in the receiver. Some of the major categories are RF harmonic rejection, IF rejection, N* f_{RF} ± N*f_{LO}, and internal mixing products due to multiple local oscillators and digital clocks. Fortunately, these mechanisms are somewhat below the level of the desired RF input signal because they all involve some type of harmonic content, which is produced at lower amplitude than the fundamental RF input signal. Unfortunately, there is another spurious input that is produced at the same level as the desired RF input signal, and this is known as the "image". It is of paramount importance that the receiver is designed to reject the image frequency. For example, if the desired input frequency is f_{RF}, the IF is f_{IF}, and the local oscillator is at f_{LO}, the relationship of the between these might be: $f_{RF} = f_{LO} - f_{IF}$

If this were the case, the image frequency would be $f_{Image} = f_{LO} + f_{IF}$

Single Conversion

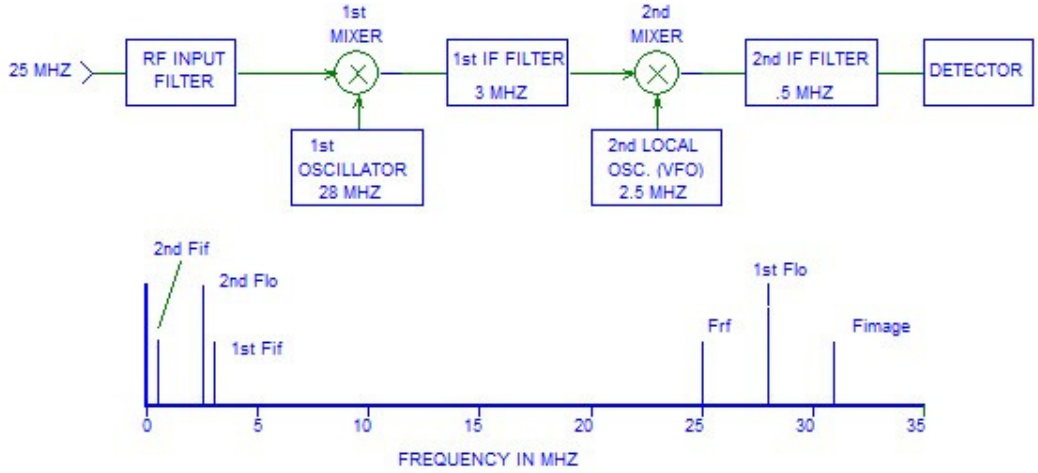
Single conversion was used in Collins' earliest receiver, the 51F. In general, single conversion can be effective at low RF input frequencies. However, the local oscillator in a single conversion design must follow the RF input frequency, since f_{LO} must be spaced f_{IF} from f_{RF}. This creates stability problems for the local oscillator as the required RF input frequency gets higher. The 51H receiver attempted to improve the stability problem by using a highly stable PTO and its harmonics for the local oscillator. This was better, but still not an ideal solution. Due to the stability problem, the single conversion design quickly fell out of favor.





Double Conversion

The double conversion plan was probably the most common solution to the local oscillator stability problem. In this plan, a high stability crystal oscillator was used to convert the RF signal down to a low 1st IF, such as 2.955-3.155 MHz in the S-Line. A high stability PTO was then used in a second mixing stage to convert the signal to the 455 kHz 2nd IF where the mechanical filter was implemented. This design provided commonality for the PTO and mechanical filter regardless of the RF input frequency. As well, excellent frequency stability was maintained, at least for analog applications.



Triple Conversion

Some early Collins receivers, notably the 51J-4, R-390 and R-390A used triple conversion in their low frequency coverage bands. In these cases, triple conversion was required to create commonality for the PTO and mechanical filter.

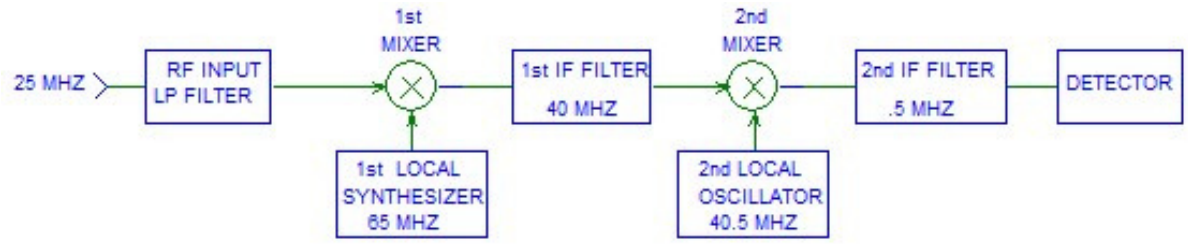
Up-Conversion

In the late 1960s, two technological breakthroughs occurred that changed the way HF receivers were designed. These were the design of the phase-locked frequency synthesizer, and the VHF crystal filter. The synthesizer technology made possible stable local oscillators in the VHF/UHF range. The VHF crystal filter meant that the 1st IF frequency of a receiver could be 40 MHz or higher.

Why was up-conversion a big deal for HF receiver designers? The primary reason was the image rejection problem. In order to achieve good image rejection in earlier receivers, the receiver had to have a somewhat narrow band preselector filter that tracked the selected RF input frequency. Witness the design complexity involved in the S-Line slug rack, and the mechanical nightmare of the R-390. But, with the up-conversion plan, image rejection could be achieved over the entire HF band with a single 30 MHz low pass filter. This was a huge cost and space savings.

Another advantage of up-conversion is simplified rejection of other $N*f_{RF} \pm N* f_{LO}$ spurious responses. If the frequency of the 1st IF is high enough, many of the most troublesome spurious responses of this type could be attenuated by the input low pass filter.

The first general purpose commercial HF Collins receiver to implement the up-conversion plan was the 651S-1, which had a 1st IF (and filter) at 109.35 MHz, and a synthesized local oscillator that tuned from 79.35-109.1 MHz. This meant the image frequency band was from 188.7-218.45 MHz, well above the cutoff frequency of the low pass filter.



Even though the up-conversion plan using a VHF IF was a big improvement to receiver size, cost, and spurious rejection, it doesn't solve all the spurious problems. The major remaining spurious problem is that of sub-harmonics of the desired RF input frequency, and to a lesser extent, sub-harmonics of the IF. A simple HF low pass filter in the up-conversion design offers no attenuation to sub-harmonics of the desired RF signal, whereas older receivers with tracking input preselector filters did provide some rejection to these signals. The solution to this problem in up-conversion designs is usually to add "sub-octave" band pass filters into the RF chain in series with the low pass filter, and this is the approach implemented in the 651S-1 receiver. The appropriate band pass filter for the selected RF input frequency is automatically switched into the RF chain with electronically controlled diode switches. These filters are also useful in that they reduce the overall spectral power input to the 1st mixer, reducing the possibility of overload to the stage.

Direct Conversion

With the advent of digital signal processing (DSP), much of the filtering, demodulation and other functions could be done in the digital domain, further decreasing the size of a receiver. As well, this is a very flexible approach since many key receiver functions can be changed in software rather than hardware. The HF portion of the 95S-1 is a typical double conversion design, using up-conversion to 51.2 MHz for the 1st IF. However, the second conversion uses a fixed 51.2 MHz local oscillator, meaning the 2nd IF is at zero frequency. This is what is meant by a "direct conversion" design. The second conversion stage uses "image reject mixer" technology that rejects the unwanted sideband.

The Collins 651S-1 Receiver
Observations and Restoration Notes

by Randy Best, W7CPA

This article focuses on my restoration experience with notes that might be useful to the Collins collector community. The technology used was top shelf for 1970 with a high MTBF. One can download the Principles of Operation from the Archives for a detailed time machine tour of discrete digital design and high performance RF stages using early JFETS and discrete transistors.

The CCA website "Archive" has all the manuals available for download. The CCA "Historical Archives" has the best Collins product brief to peruse complete features and specifications.

When compared to modern off-shore, pre-DSP top-of-the-line receivers, I wonder where they found their designs – or was it the other way around. There isn't room in this article to show even a summary level block diagram of the triple conversion design. It is complex and you should look at the manual for this kind of overview.

Figure 1 – An Excellent 651S-1 Top Hat for the R-390A

I first heard details of the Collins 651S-1 whilst rag chewing here locally with Ted, WA8ULG, on AM. Ted mentioned he had paired this receiver with his Collins 820 D2 broadcast transmitter. He spoke highly of its performance and interesting odd-duck properties. It's devoid of typical ham radio features like noise limiters/blankers, notch filters and pass band tuning.

Visually, it resembles a 1970s Heathkit home audio device - real 70's modern. They sold for $10-30k so there were no QST ads. I then discovered that Bill Carns didn't have one in his extensive collection. So, of course, I had to find one.

Know Your Options

The receiver had many options. Do your research before buying boards for a given chassis dash number.

VLF - an option to extend the frequency range down to 12 kHz, perhaps to monitor submarine fleet encrypted RTTY signals. This was a small board attached to the shielded RF module.

Remote Control – a RS-232C/MIL-STD-188C computer interface was available to support the Collins 514S-1 Remote Control Unit or other computer-based systems. The U.S. Air Force used these on tactical weather systems.

Filters – 200 Hz, 500 Hz, 1.0 kHz, 3 kHz and 8 Khz were optionally available. The basic filter components supplied in most cases were 16 kHz, 6 Khz and 2.7 kHz.

ISB - an independent sideband unit was optionally available to support old school, encrypted full duplex voice operations.

RTTY - a teletypewriter control unit (TCU) provides remote RTTY control with a Collins 514S-1 unit.

FM - narrow-band FM was available with squelch.

SCAN - a frequency scan option also offered.

The fundamental RF path summary is as follows:

Antenna
Low Pass Filter
Switch Band Pass Filters
109.35 MHz First Mixer with Variable Injection
Crystal Filters
10.35 MHz Mixer with Fixed 99 MHz Injection
10.35 MHz IF Amplifier
Crystal filters 500 Hz, 3 kHz, 1.1 kHz
450 kHz Mixer with 9.9 MHz Injection
FET Filter Input Gates
Mechanical Filters (6 kHZ, 200 Hz, 2.7 kHz)
FET Filter Gates and Preamp
450 kHz IF Amplifier

Operational Experience Observations

Compared to the modern Flex 5000A, the 651S-1 performs extremely well for SSB, CW and AM modes. I can copy CW at 0.2 uV on 14.300. Sensitivity is excellent. I plan to get it online with my R-390A for my antique SSB and AM nets. In addition, the receiver is extremely stable. The temperature compensated 9.9 MHz reference OSC is superb.

My filter boards support, 16 kHz, 6 kHz, 3 kHz (AM), 2.7 kHz (SSB), 1.1 kHz RTYY and 500 Hz CW band widths. Filters are installed on the two sandwiched IF Filter boards. The plug-in board is shown on the schematic within the dotted line sections. The filters are switched inline using JFETS and an internal 3.9 Vdc enable voltage. More on this card below.

The receiver has one annoying behavior. If you tune too fast, the synthesizer can't keep up and you can hear something that resembles a gerbil in pain. The design attempts to mute this to limit these dying gerbil noises. The later 851S-1 model fixed this problem.

The meter is calibrated in DB referenced to 1uV and also provides audio level in dBm assuming a 600 ohm load on the back panel terminal block.

The audio quality is excellent with the small rack mount oval speaker.

There is no connector for muting, other than a pin on the expensive circular connector on the rear. I rigged up an easier access "closure-to -ground" to mute control by running a wire from the small board on the bottom rear to the unused ISB BNC. The circular connector mute pin connects to this little board and you can solder directly to the pin without disassembly.

Some thoughts if you plan to acquire a 651S-1

The only high failure components in the receiver are the original 7 segment displays. The geezer Vacuum Florescent Display (VFD) tubes are older vacuum tube technology with all that that entails. The models with plug-in LED displays are better but still early LED technology. See Figure 2 for VFD and LED examples.

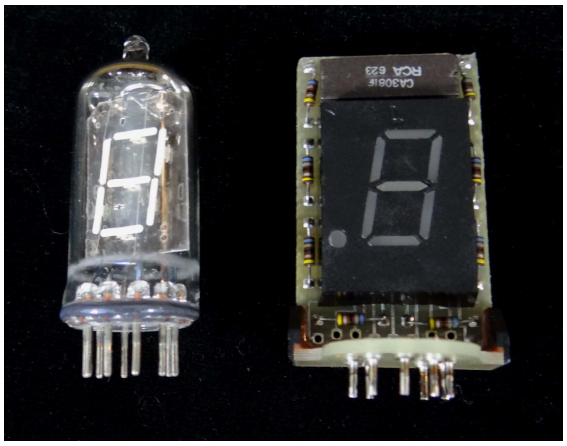


Figure 2 - VFD and LED Module

There are many different versions of the 651S-1 design and there are plug-in board incompatibilities. Be careful buying spare cards. See the Principle of Operation tables for your chassis dash number. Also see the Information Bulletin I-72 for a list of the boards and the subassembly compatibility information. Be advised this is pretty complex stuff.

Also, keep in mind the information in Table 1 (this article) when making a purchase decision. The 1970 seven segment LED modules had no standards in both pin-outs and physical dimensions – quite "unobtanium" today. Modern LED modules could be adapted with a new PC board design affixed to 9 pin tube bases.

Table 1 - Display Configuration Serial Numbers

Serial Numbers	Display Configuration
Up to 5000	VFD Display Tube
Up to 5000 - SB#10 Installed	Plug-in LED Modules
5001 and Beyond	LED Board Replaced 9 Pin Tube Modules

Restoration

I purchased a reasonably good unit and a parts unit. The poor condition desktop cover is another project by itself in the future. It is very thin aluminum with special feet. Of the 11 plug-in LED modules, only one had all segments working! I verified that the failure was the Packard Corporation LEDs and not the TTL driver chips as some had suggested.

I made the decision to back out Service Bulletin #10 and return to the original VFD tubes. I found 12 NOS on eBay to select from for best luminescence. This is huge task to get at the bottom of the display tube sockets to replace the 6 SB#10 jumpers with 82 ohm resistors per the original design. SB#10 disassembly instructions are not complete and it's easy to break the mini-coax solder connections on the tuning unit since they are soft pure silver. **Move carefully and secure the tuning unit during disassembly.**

The comma and period were little bulbs in fixtures that were long gone after SB#10 was applied. They were butted against a round hole and a comma-like hole in the metal front panel assembly. I used blue LEDs in tubular rubber grommets to replace the bulbs - see Figure 3. The enable voltage is 25 Vdc. Choose your serial resistor to match the LED current requirements. I had to add yellow filter material to achieve the same blue-green color of the VFDs. I used silicon adhesive to keep the grommet in place. This was not pretty but easily removed and no holes were drilled in the process.

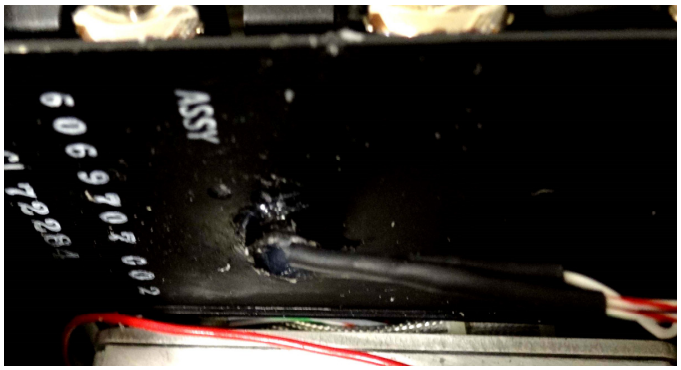
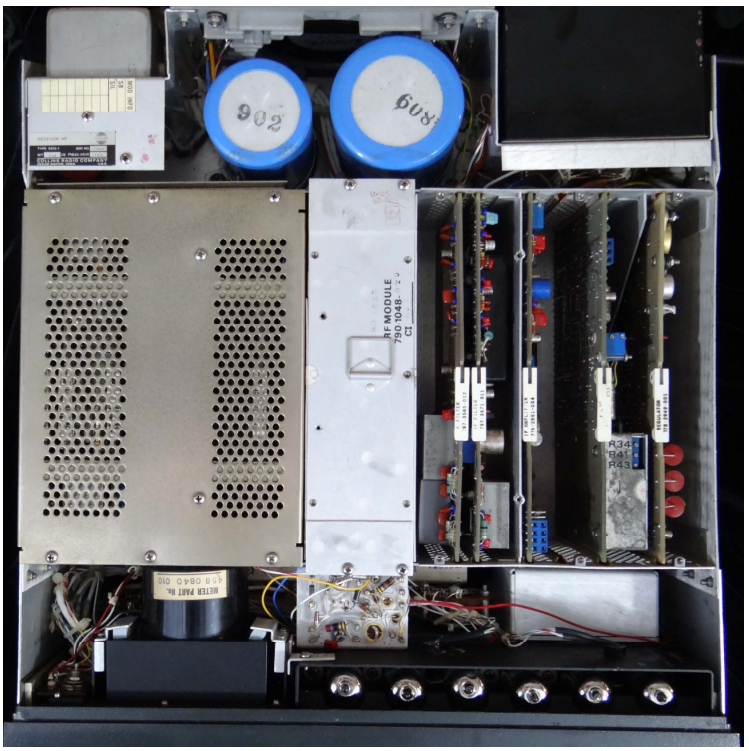


Figure 3 - Comma-Period LED

Mechanical Layout

The chassis is beautifully designed to support plug-in cards with high MTBF in a rugged environment. The cards have unique, heavy duty gold connector jacks and mini-coax plugs so there is no such thing as a common card extender and subsequently there is no way to plug a card into the wrong slot. This is a good thing in the field, but adds some challenges to trouble shooting if you do have access to all of the unique extender cards. One can tack small braided wires to the board to debug signals if you do not have these extenders.

Figure 4 (below) shows the card rack with one cover off



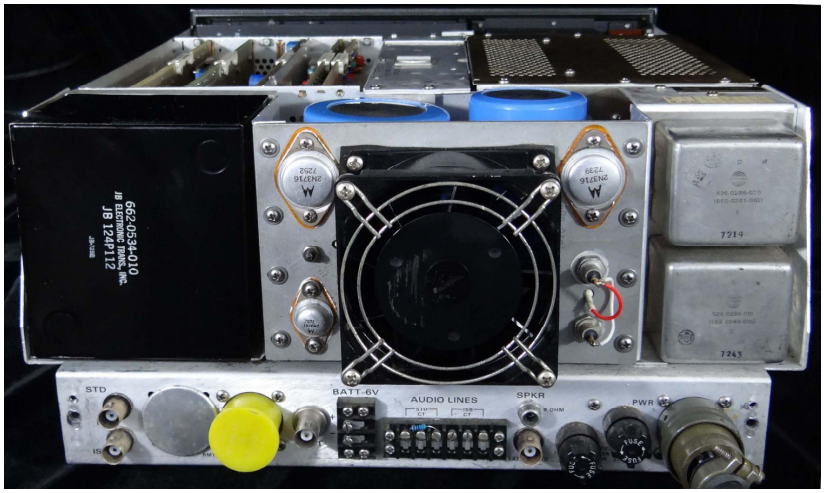


Figure 5 – Back

All connections are available on the back of the unit. The chassis bottom shown in Figure 6 features high quality connectors, Teflon wires and mini-coax jumpers.

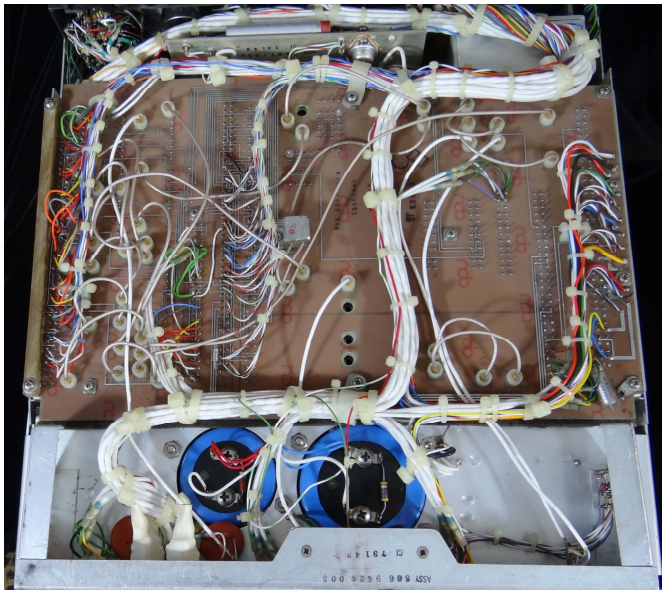


Figure 6 - Chassis Bottom View

The RF board in Figure 7 is fully shielded. The cavity is where the VLF option is installed. I am trying to find one of these. So far they are proving to be very rare.

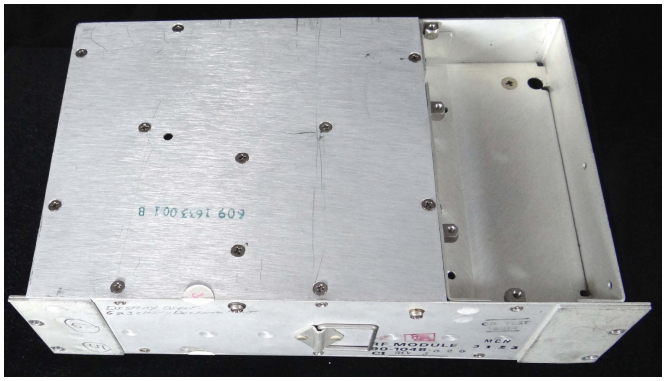


Figure 7 - RF Module sans VLF Option

When I initially put the receiver on the air, I was hearing SSB signals about 20-30 Hz off frequency. The following calibration solved the problem perfectly.

The SYNTH reference card shown in Figure 8 has the precision 9.9 Mhz oscillator you might want to put "on the beak". If you have a good scope probe and a precision counter, there is a much easier way to adjust than described in the manual.

With the board plugged in normally, unscrew the nylon or stainless screw that seals the access hole above the precision trim pot. If the nylon screw breaks, pick it out and replace it with a stainless cap screw and O-ring washer. Place the scope probe on the input pin of the X10 module next to the oscillator can. Power on and warm the unit up. Now tweak the trimmer for 9.9000000 MHz and replace cover screw – easy. This is most amazing precision trimmer I have ever trimmed – a real pleasure.

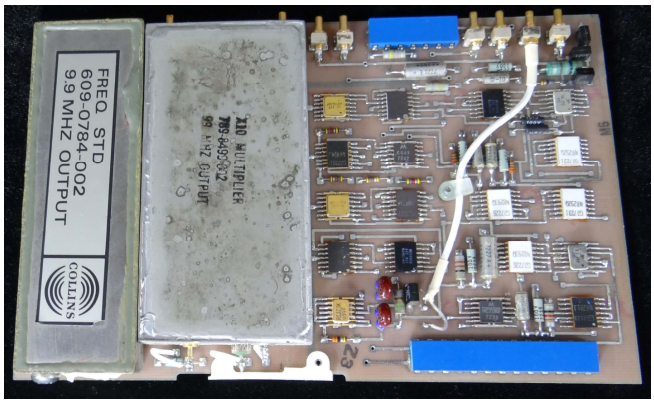


Figure 8 (above) - SYNTH Reference Board

You might also recalibrate the variable BFO to zero beat when ON and the knob pointer is straight up as long as perfection is what we seek.

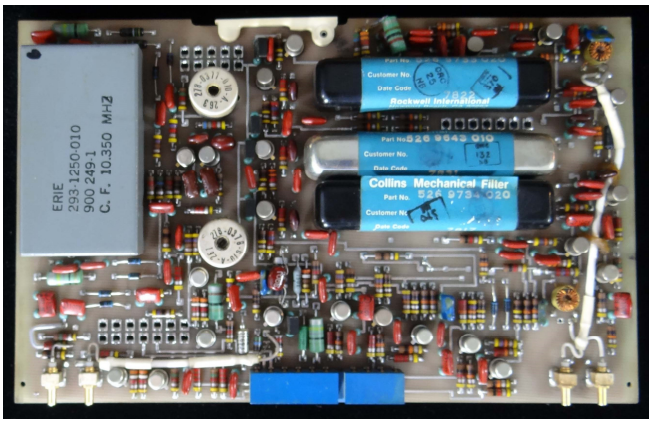


Figure 9 - IF Mechanical Filter Board

The 6 kHz, 2.7 kHz USB and 2.7 kHz LSB mechanical filters are located on the main IF Filter Board shown in Figure 9. Optional filters are located on the board that plugs into the back of this card – the filter sandwich.

If you have what appears to be a dead mechanical filter it might not be the culprit. The mechanical filters are selected for the signal path using JFET switches. I successfully used a bench debug process to repair what appeared to be a dead USB filter – the second JFET (JAN 2N4416A) was the culprit. The 1st JFET is also a possible culprit. If you change the SSB first JFET, note the factory select gain resistors R69 and R83 to match SSB levels. They range from 1.2k to 3.3k.

I started by removing the IF Filter Board and then removed the optional filter (s) board from its back. Place the board on the bench and ready the following voltages from bench supplies: +15 Vdc, -15 Vdc and 3.9 Vdc. Connect +15 Vdc to pin #15, -15 Vdc to pin #1 and ground to pin #2 and 22. Connect a 450 kHz signal (100uV at least) to the 450 input bus. There is a pin on one of the connectors on the back of the board that is handy to inject 450 kHz. The 3.9 Vdc enable voltage connects to pin #3 (LSB), pin #5 (USB) or pin #6 (AM 6 kHz). Monitor the IF output on coax jack p2.

A 2N2907 receives the enable voltage. This turns on the 1st JFET to pass 450 kHz input to the mechanical filter, then a final JFET switch/preamp stage before P2 output. Figure 10 illustrates the preamp gain provided by the 2nd JFET. The top trace is input. The bottom trace is the filter output destined for the IF Amplifier board.

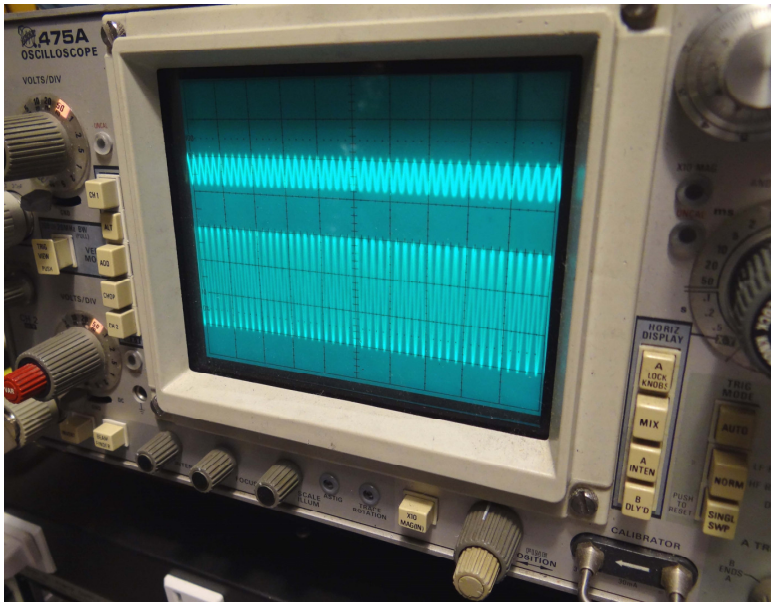


Figure 10 - IF Filter Preamp Gain (above)

You should be able to move the enable signal to pins 3, 5 and 6 and see the output for each. If not, the filter might be dead. In my case Q18 (output JFET JAN 2N4416A) was the culprit and not the expensive mechanical filter.

The board position reference is also printed on a placard available on a chassis side panel.

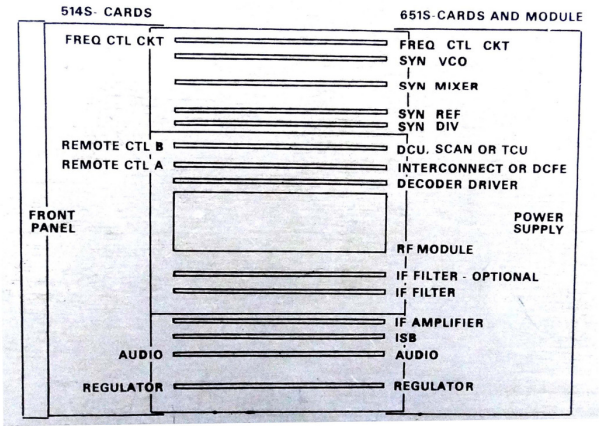


Figure 11 - Board Positions (above)

Figure 12 (below) shows the 651S-1 ready to install in the rack mount from the back side.

Conclusion

I believe that the expression "moving the frontiers of science forward another 5/8s of an inch" seems quite appropriate for the 651S-1 in 1970. There are no switches or mechanical relays in the signal path. It is all realized in silicon. Additionally, VHF first stage roofing filters might be a first or at least bleeding edge technology for the day.

Figure 12 – Front View Prior to Rack Mount

Your CCA - 2015 - The Second Quarter Report

Dayton 2015 Hamvention Report

Dayton was full of changes this year. We have had the same hotel and banquet facility for our annual CCA Dayton gathering as long as I can remember. Last year we decided we had had enough and knew that we needed a change. The old Ramada was worn out and poorly managed, and was not going to be updated. Since none of us lives anywhere near Dayton, we made a deal with the Fairfield Hotel and the Barnsider Restaurant sight unseen. We did our research on the web though. As I made the drive to Dayton I knew this could turn out well - or be VERY ugly! Fortunately, it turned out really well.

The Barnsider Banquet facility was nice but came with a challenge - since the group seating area is on two levels. When Jim Stitzinger and I first saw it we were concerned, but with some creative arrangement of the screen and speaker's position, it worked out well. Everyone raved about the food -- a very welcome change after the Ramada!

Jim at the mic during the dinner talk at the Barnsider

After dinner, Jim and Rod Blocksome gave a talk about the removal of the VOA transmitter from Delano along with pictures of the group effort. The door prizes were distributed (see the list of donors on the website) and then the grand raffle prize – a KWM2 generously donated by Jim Stitzinger – was won by Chuck Rippel (K8HU). I know that everyone missed Bill Carns, K0CXX, who was unable to attend.

Saturday was the usual crazy day with a line at the booth that never seemed to end. Some have been concerned that the Collins enthusiasm will die off as older members age, but we are continuing to see new and younger members buying their first Collins station and anxious to get it on the air. All day we were asked – what to buy – how to hook it up – how to get it repaired.

There were plenty of Collins rigs spotted out in the flea market – both A and S-line gear - but I did not hear of any rare finds. At 5pm on Saturday Floyd and his crew tore down the booth and we all headed for Marion's Pizza – a tradition that has lasted almost 20 years. The pizza was great, but I must say I have never seen pizza with sauerkraut as a topping before!!

Chuck Rippel, K8HU
Proud KWM-2 Winner

CCA Report (Cont'd)

According to the Dayton Hamvention officers, attendance was up this year and I will say that the Hamvention staff has made some changes to make the experience of setting up and tearing down much easier. We had a constant crowd at the booth and special thanks to Tony (W9JXN), Rick (K8PJQ), Chuck (K8HU), Jerry (N4JL) and Floyd (W8R0) for their help in manning the booth and answering the thousands of questions. We also added a number of new members to the fold as attendees saw the *Signal Magazines* on display and realized that there is a large organization that shares the excitement that we all have about all things Collins.

Finally, The hotel was reasonably priced, had just been updated, and the staff was extremely helpful. Breakfast was served each morning starting at 4:30 am and was a real upgrade from the old venue. In the evening the warm chocolate chip cookies were a great way to cap off the day. I never heard a negative word on the hotel and many encouraged me to make a deal with them for next year.

If you have never made the trip to Dayton, then I highly recommend you start making plans to join us next year. A good friend - and CCA member – David (N5DBK) made the trip for the first time this year and remarked that there is just nothing in Ham Radio that can compare with Dayton! I have to agree!

Dallas (Irving) Ham Com 2015 Report

For the 5th year now, the CCA has had a presence at Ham Com with both a booth and small banquet.

This year, the Ham Com venue moved to a newer and larger facility, the Irving Convention Center. The Plano Amateur Radio Club decided they had outgrown the Plano facility and did a great job of trying to make the change as seamless as possible. While the facility itself is a real upgrade, the lack of parking, the $5 charge for parking, and the absence of any outdoor flea market or tailgating seemed to dampen the spirits of the attendees. Crowds seemed down this year and only time will tell if this ends up being a positive change for Ham Com and the CCA. We had a great time at the booth seeing old Collins friends, and I even got to finally meet Pete Zilliox (K5PZ), our retired membership chairman of many years. I had talked and emailed with Pete for years, but never got to meet him. Both Pete and Jim Stitzinger made the trip from California this year.

Dinner at the *On the Border* was great!

Friday night was our usual small group gathering at the *On the Border* restaurant in Plano which included a Fajita Buffet. Unlike the large dinner gathering at Dayton, the Ham Com dinner is about 20 or so attendees and it gives us a chance to have a more personal visit as a group during Happy Hour and dinner. It's a great atmosphere and there are usually a higher than average number of Ex-Collins Radio employees due to the proximity to Richardson. This year the talk was given by Jim (WA3CEX) and Bill (N7OTQ/K0CXX). We were all glad that Bill was feeling better and had made the trip! The talk was on the history of receivers made by Collins over the years, and included pictures of each receiver model from both Jim and Bill's collections.

We all came away with a greater knowledge of the many 'firsts' that Collins had made with receivers (not surprising). We were even more impressed with the completeness of both their collections! Thanks to both of you for sharing.

Following the show on Saturday, both Pete and Bill got an opportunity to go out and visit with JB Jenkins, W5EU, south of the Dallas & Ft. Worth complex in Midlothian, TX.

JB is a retired Collins Radio employee and friend of the Art Collins family. He is also a well-known Collins Radio historian and preservationist. He is currently replicating the transmitter that was used by young Arthur during his contacts with the MacMillan expedition. Bill commented on how good it was to see JB's recovery progressing well and also to see his very interesting collection. We are all looking forward to JB's coming article in Electric Radio on Arthur Collins' early transmitters.

Bill & Pete enjoy the visit in JBs "Candy Store"

This was a fun weekend and many thanks to all that pitched in and helped . . . but I really hope that the leaders of Ham Com can address some of the issues that kept the usual crowds away.

Coming Events News

We are planning on being at the AWA Convention the week August 11 -15 for this partnership event. There will be an unveiling of the new Collins/VOA Model 821A-1 transmitter exhibit among other fun activities. There may also be some associated activities just for CCA members. The AWA now always holds a Collins Radio theme night dinner on one of the nights, so this will be there for sure. We would love to have our membership well represented and I know you would like the dinner and the 821A-1 tour.

In addition, we are still planning on being on the west coast in the fall for our annual gathering there. This will probably be held in late October or November. Watch the events calendar on the website for details of both these coming events to be posted soon.

We should also mention here, as Scott did in his letter in this issue, that we are just in the idea phase of a great happening in the Northeast region in the fall of 2016. This will be a "major" happening and be scheduled around the fall colors and include some side bus trips and a lot of Collins and fun. It is going to be the kind of event that you will want to bring your wife to. It's not too early to plan.

Collins Model 821 & VOA Preservation Project

Due to the weather and some construction delays, the progress on setting up the Model 821A-1 Collins Radio/Delano California VOA transmitter at the AWA Museum in New York is a little behind schedule. The museum staff has transferred the transmitter and the VOA audio and monitor board to the Phase Two area of the museum where it is awaiting temporary display "assembly". They anticipate that they will satisfy the New York GSA inspection criteria and that the display will be viewable along with the three other displays in Phase Two of their expansion. Funding for the process is still an open issue, and with unknowns regarding some for the safety considerations, funding is about half way home. During the upcoming AWA Convention in August (11th – 15th), visitors will be able to tour the area and see this huge piece of Collins engineering history and visit the VOA display.

If you are interested in more information about the funding of the project, and how you might be able to help, please contact one of the CCA board members or the *Signal Magazine* staff.

2015 CCA Election Notice

YA'LL COME ! . . . . to the CCA website – that is . . . and vote for your favorite candidate for the Board of Directors. That is our way of saying. . . . it's on! As of this notice, the **2015 CCA Election Process** has officially begun – and take note – it's a bit different this year. Due to the fact that we now have a CCA Members Only area of the CCA website, we can now hold our elections on line. This will speed up the process, make voting easy for every member, and save us the cost of mailing out the ballots and then manually collecting and counting them.

Scan to see more about the CCA

The process is open as of this issues mailing and is being simultaneously announced on the website at http://www.collinsradio.org and the CCA reflector.

There are two CCA Board of Directors positions opening, and nominations are now open for the following these slots. The positions held by Scott Kerr (KE1RR) and Jim Hollabough (W6TMU) – our Net Manager for the 20M net are not up for reelection.

The board position currently held by Dennis Kidder (W6DQ) is at the end of its first of two allowed contiguous terms. Dennis will be running for reelection.

In addition, the board position now held by Paul Kluwe (W8ZO) is up in November and nominations for this position are now open.

ELECTION NOTICE

The schedule is as follows: Nominations are now open and will close at midnight on August 31, 2015. The CCA website will carry an Election News page that should be up by the time you get this issue. This Election News page will be accessible from the Member Log-in Landing Zone. As soon as someone is nominated for either slot, their name and a biographical sketch will be posted on the Election News page. The Q3 issue of the *Signal* will also carry the names and sketches of the candidates that have been nominated and will mail mid-September so that you will receive it in time to read about the candidates. On October 1, 2015, a ballot page for voting will be accessible from the Landing Zone. This page will be secure and will only allow you to access the page and vote one time for each slot. On October 31, voting will close, results tabulated and new officers installed by the November deadline in our charter.

We hope that you will take the time to consider the open positions and the work being done – and to be done – and then participate in both the nomination and voting process as you see fit. We also sincerely hope that you will take the opportunity soon to log in and look at the Election News page so that you know that you have not forgotten your password. WE DO NOT want to have a big flurry of password help requests at the last minute. Be gentle with our IT and support folks and do it early and this will spread out the requests that are inevitable.

For those that absolutely do not have, or do not care to use, an online CCA voting process capability, you can review the candidates in the magazine Q3 issue and then mail in a simple letter that contains your name, your membership number and how you wish to vote for each open slot's candidate(s).

If only one candidate is nominated for either of the open slots, then no election will be held for that slot, and it will be struck from the ballot. If only two candidate run, then the results will be announced immediately in the website news page and printed in the Q3 issue of the magazine. There will then be no ballot page loaded to the website. de Scott & Bill

- - - - - - - - - - - - - - - - - - -CCA - - - - - - - - - - - - - - - - - - -

The Service Line

How to Test that Type FA Mechanical Filter

by Don Jackson, W5QN

There has been some recent interest in a test fixture suitable for checking out S-Line IF filters. Since I've been evaluating filters myself, I thought it might be useful to present the approach I took for my test fixture and the subsequent measurements. Let me point out that most mechanical aspects of the fixture are largely up to the builder but stability and shielding a definite must.

Electrical Design

From a design point of view, there are two requirements that must be met. The first is to transform the 50Ω impedance of your test equipment up to the 50kΩ (approximately) termination required by the Collins "FA" model mechanical filters. The second requirement is to resonate the internal inductance of the filter. The 1,000:1 impedance transformation ratio is too large for typical RF transformers, but is easily done with resonant lumped constant "L" impedance matching circuit. Resonating the filter is accomplished with a variable capacitor in shunt with a fixed capacitor. Figure 1 is a schematic of my test fixture.

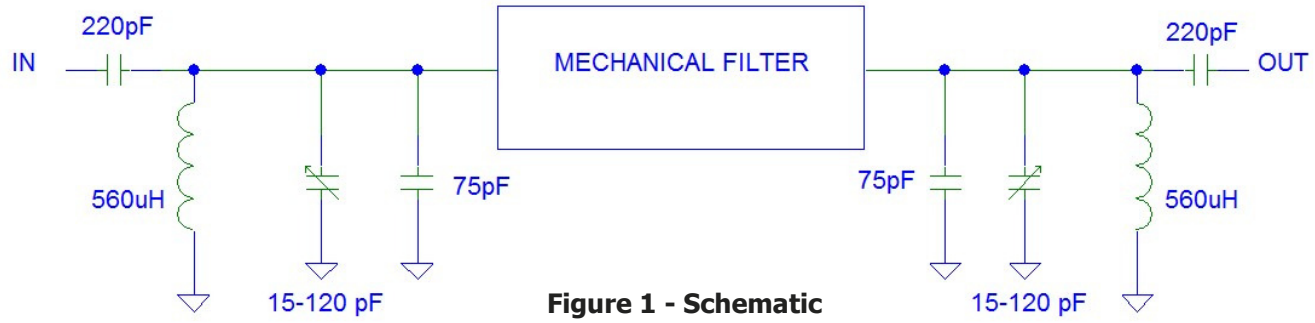


Figure 1 - Schematic

The filters have a shunt termination inductance of about 820uH. The variable capacitors (along with the 75pF fixed dipped mica capacitors) chosen to resonate this inductance are Sprague GME 50201, available from Mouser. This choice is convenient because the unit is panel-mount design, has a wide adjustment range, and provides sturdy internal solder lugs for wiring. The "L" section inductors are variable as well in order to adjust the impedance match to resonance at 455 kHz. They are Toko RWRS-T1024Z units that I just happened to have in my junk box. They are shielded, and have an adjustable slug that is used to resonate the matching network. These particular units have a Q of about 100, but are meant for PCB mounting, so they are not mechanically ideal. You can use another suitable variable inductor that works with your mechanical layout.

Since a resonant LC matching network is used, the impedance transformation has a finite bandwidth, and this has some impact on the measurement results. If you consider the two input/output matching networks alone, the total 3dB bandwidth is about 25kHz, and the 0.1dB bandwidth is about 4kHz. This is sufficient for measurement of the typical 2kHz SSB filter, but not ideal. The bandwidth can be broadened if the required impedance transformation ratio is decreased from 1000:1. For example, if a 9:1 transformer were used at the input and output of the fixture, the resonant matching network would only need to transform 450Ω to 50kΩ, a 111:1 ratio. This circuit results in a 3dB bandwidth of about 63kHz, and a 0.1dB bandwidth of 11kHz. Figure 2 is a schematic of such a circuit.

Figure 2 – Schematic Using Transformers

The bandwidth could be further broadened by using transformers with even higher transformation ratios. I used the circuit without the transformers since it wasn't mechanically convenient to fit the transformers into my housing, and the 0.1dB bandwidth

without the transformers was sufficient for my purposes. However, using transformers would be a more ideal solution. Mini-Circuits has a wide selection of suitable transformers.

Mechanical Considerations

A primary function of the housing is to isolate the input and output circuitry of the test fixture. To achieve accurate measurement of the ultimate attenuation ("floor") of the filter, it is imperative to minimize coupling between input and output components (witness the loss of skirt selectivity with the design changes from the S-Line 75S-3/3A to the plug-in filter 75S-3B/C). My housing is scrounged from my junk box, but looked like it would work. The main addition to the initial housing is a ¼ inch thick partition between the input and output. It is carefully sized to fit and mounted to the top and bottom of the housing with machine screws. Any remaining gaps are filled with small pieces of coax shield material to create an RFI gasket.

I used phono jacks as my input/output connectors because BNC connectors did not fit well in my housing. Although phono jacks perform fine electrically, I recommend using BNC connectors instead.

The sockets for the filter are actually vintage transistor sockets from my junk box. These are hard to come by new, but can be found on eBay. It is best if you can find sockets like mine that have built-in metal flanges for convenient mounting. Figures 3 through 5 are photos of my test fixture.

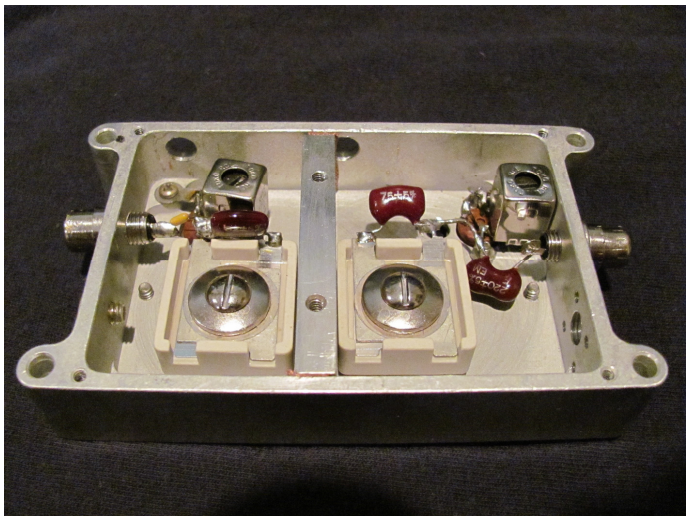


Figure 3 – Test Fixture Internal View #1

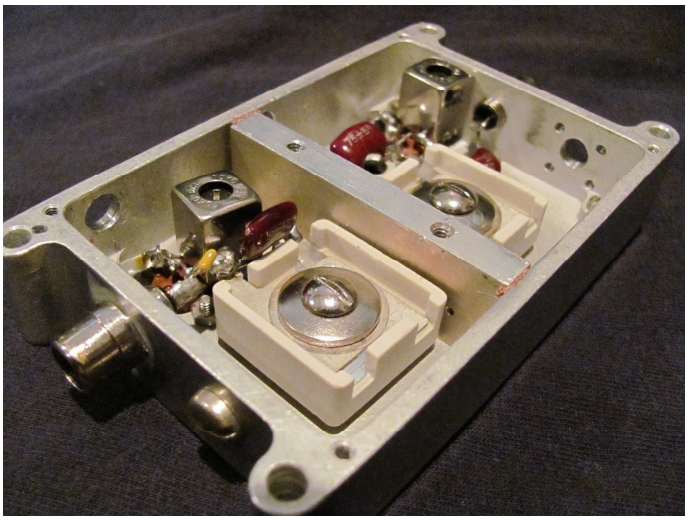


Figure 4 – Test Fixture Internal View #2

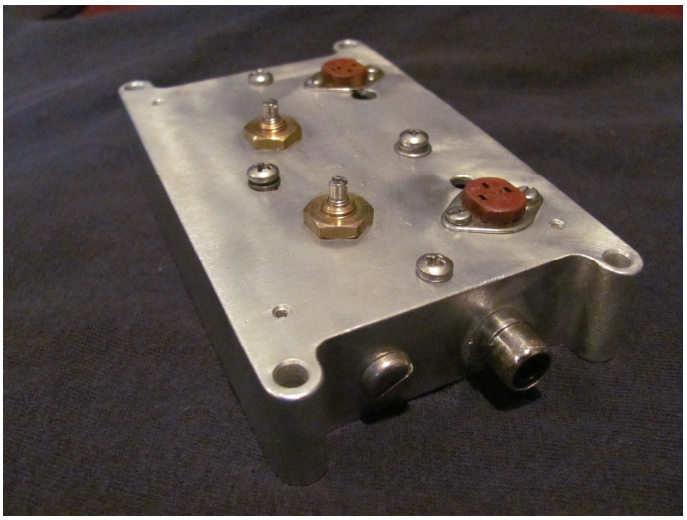


Figure 5 – Test Fixture Top View

Adjustment and Comments

Adjustment of the matching networks must be done prior to connection of the filter resonating capacitors. Connect the series matching capacitors and shunt variable inductors to the proper filter socket pins at the input and output per the schematic diagram. Jumper the "hot" input and output filter socket pins with a low value (less than 100Ω) resistor. Connect a 50Ω test generator (set to 455kHz) to the input connector of the test fixture, and a 50Ω load to the output. Monitor the output voltage with a low capacitance VTVM such as a HP410B. Adjust both variable inductors for maximum voltage output. The inductors will not need any further adjustment. Do not connect the resonating variable capacitors (or shunt fixed capacitor) to the circuit yet.

With the filter jumper in place, measure and record the insertion loss of the test fixture. Record this loss for future reference, as it must be accounted for in future filter insertion loss measurements.

Remove the filter jumper connection and connect all filter resonating capacitors. The variable resonating capacitors are peaked when a filter is installed, just as the variable capacitors are peaked in an actual 75S-3B receiver.

Test Results

Figure 6 shows the wideband frequency response of a 2.1kHz SSB filter (F455 FA 21) from my 75S-3B. The test was done using a Rigol DSA815-TG with its internal tracking generator.

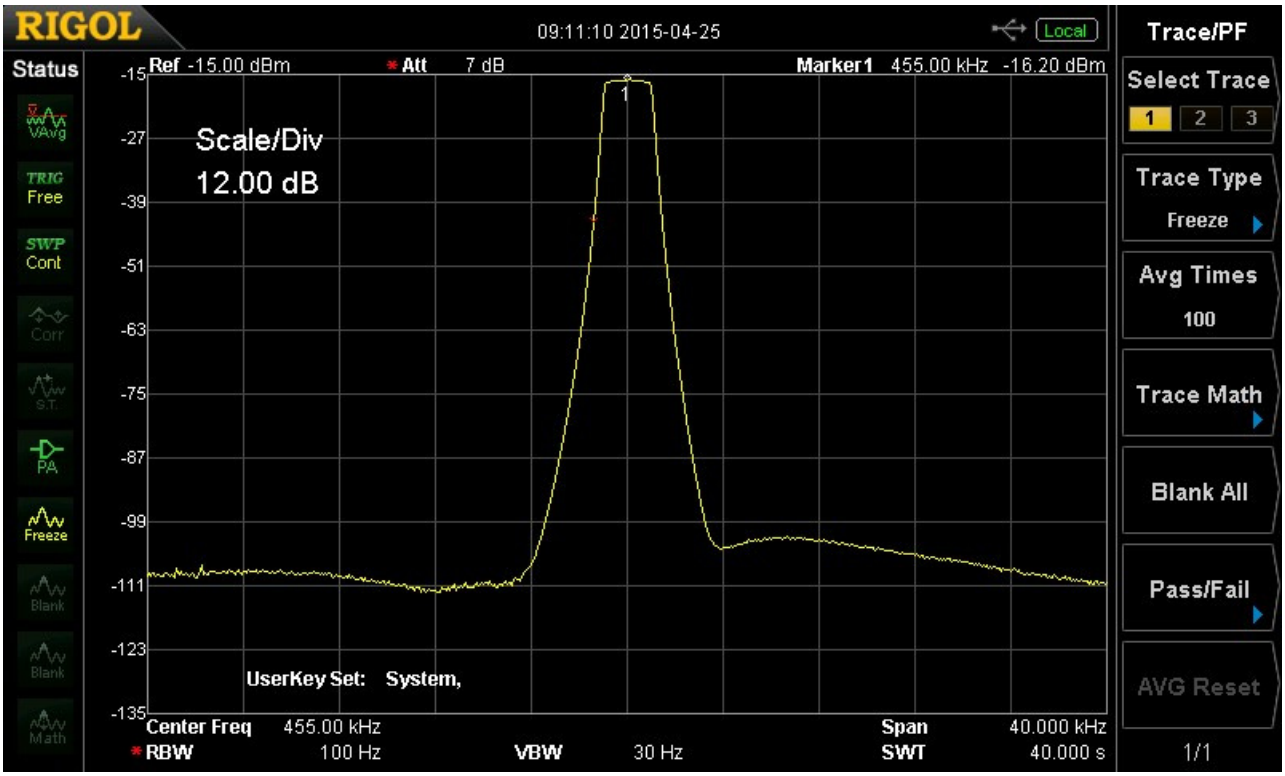


Figure 6 – Wideband Filter Response

It is important to note that in normal use, you will not be able to measure the test fixture insertion loss by simply removing the filter and jumpering across the filter pins because presence of the shunt filter resonating capacitors will invalidate the measurement.

Although I refer to the test fixture having an input and output, the fixture is symmetrical in design, so either connector may be used as the input.

Have fun! Let me know how your fixture performs if you build one.

Author's Information:

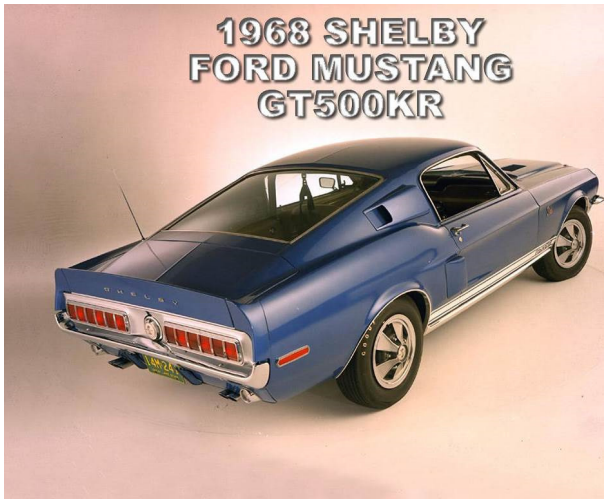
Don Jackson, W5QN, is the Technical Editor for the CCA *Signal Magazine* and brings strong credentials to his position. Now retired and living south of Dallas in Garland, Texas, Don had a long career in both receiver and transmitter design.

In truth, it would not be possible for us to produce the high level of technical quality that we strive for, were it not for his contributions and his critique and support of other contributors' writing and technical contributions.

As one of the assistant editors, he is one of the main coordinators and contributors to the In the Shack series that runs in almost every issue. Please feel free to contact him if you have a desire to see your name in lights.

Don is also one of our proof readers which is a thankless and difficult job behind the scenes.

He has written often for the magazine and we owe him our continuous gratitude for his responsiveness and for sharing his knowledge with all of us.



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