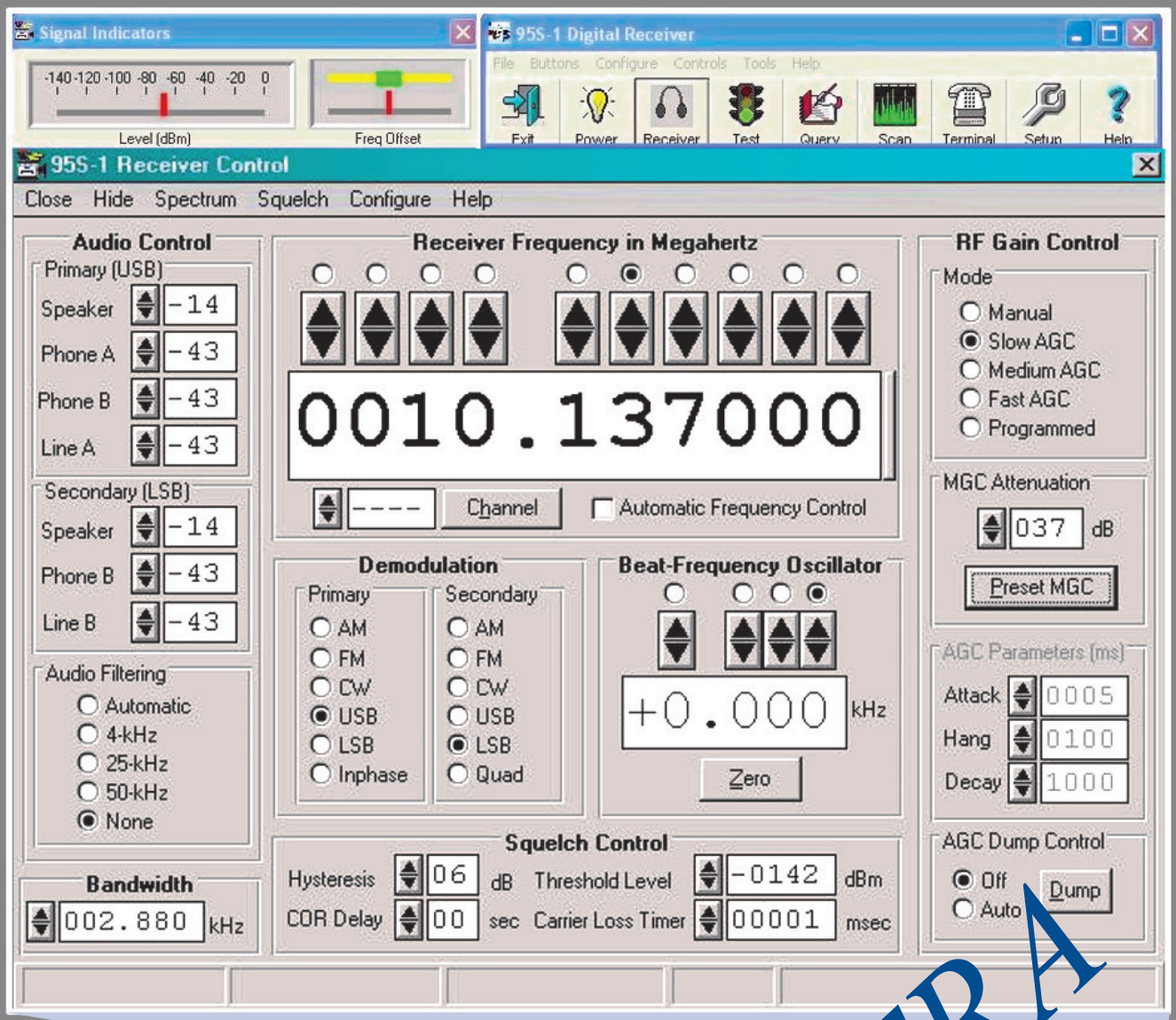
The Signal

OFFICIAL MAGAZINE OF THE COLLINS COLLECTORS ASSOCIATION * Q1 2014 Issue *

Not Your Grandfather's Oldsmobile



Arthur would Smile

The Rockwell Collins 95S-1

EXTRA

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Collins Collectors Association

FROM THE STAFF

by Bill Carns, N7OTQ & Don Jackson, W5QN

From the Desk of N7OTQ

This will seem a bit like that old introduction to the Outer Limits TV program from the '60s that said that "We are now taking control of your Television Set . . We will control the Vertical, and the Horizontal . . "

The editorial staff of the *Signal Magazine* now takes back control of the contents of your magazine. We will control the "vertical" (that would be the length) and we will control the "horizontal" (that would be the content) . . . . and maybe, just maybe, life will return to some version of normal around here.

While we thoroughly enjoyed the journey through the 80 years of Collins history, and we major enjoyed learning and meeting all the new folks from Collins during the research, it is nice to be back running the ship. That last year was rather like being stuck in a Mercury Space Capsule and being launched. It was exciting and breathtaking, but for sure, we were just along for the ride. Thank goodness, we are hearing that the "launch" was a success.

For those of you that joined the CCA during the wild ride, the magazine is going to return to its previous Q4 2012 size (around 24-28 pages – less inserts), but it will – for sure – retain the experience gained and the quality improvements - so you hopefully will not feel disappointed. 52 pages – or even close – would break the piggy bank – not to mention the staff here. I want to thank the CCA Board of Directors for letting the *Good Times Roll*. Now we get back to balancing the budget.

The president has talked in this issue about our Birthday. I will only add that this theme will be carried along during this year. The 2014 issues will continue to be a little "special" I hope so that you all feel like you are getting your Birthday present. As we go on, you are in for some nice surprises. Reading the CCA Business Section, you will see the first one announced in this issue.. It is only fitting on our Birthday to get nice presents.

We are pleased to say that you did not notice that we were forced to change printers between Q2 and Q3 of 2013 right in the middle of the Anniversary Issues. While seamless on your end, it meant dealing with a new layout format here. I mention this because it is impacting our ability to offer the bound *Limited Edition 2013 80th Anniversary Reprint of the Signal Magazines*. We will be going ahead with this, as many people have requested it, and it will make a wonderful keepsake and collector's item to have on your shelf. It does mean however, that I have to re-layout two of the issues, and that has caused the delay. Stay tuned and we will announce in the next issue when the subscription period will open and what the cost will be. It will be offered only through the website. I have been getting quotes from printers and we just have to finish the layout and preparation work.

Finally, let us hear from you. This is your magazine and we love to hear what you want to see, and share in your feedback. That is it for now……. As always,

Best 73, de Bill, N7OTQ/K0CXX email: wcarns@austin.rr.com

From the Desk of W5QN

And, from your Technical Editor, here comes my typical *Call for Papers*. The *Signal* would like to encourage people who are doing that "winter project" restoration or repair job to take some before and after pictures—document the work, and consider sharing your experience and your results with our readers. Whether it is a technical article that might fit in the Service Line series of articles, or a standalone project article, or even a feature article on some aspect of Collins, its history, or its equipment, we sure would like to talk with you about it. Drop me an email, or send in a rough draft and let's talk. This *Signal Magazine* has a great tradition to live up to. It was started by Art Collins and then published by the Collins Radio Company for many years. We are privileged to be able to continue the tradition. It can only continue to happen if our membership (that is you) contribute when you have something to share. Do not be worried about time pressure. We schedule and work on content out several issues so that no one gets put in a bind.

I also am ever on the hunt for nice shacks that show off your Collins. If you would like to have your shack be in the magazine, that starts with you also. Do not be shy.

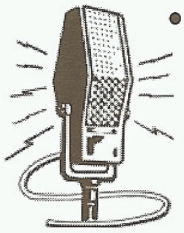
73s - Don, W5QN email: w5qn@verizon.net

The Signal Magazine

OFFICIAL JOURNAL OF THE COLLINS COLLECTORSASSOCIATION

Issue Number Seventy Three - 1st Quarter 2014

Join Us on the Air!



- Sunday 14.263 mHz at 2000Z
- Tuesday 3805 kHz at 8pm CST
- Thursday 3805 kHz at 8pm CST
- Friday (West Coast) 3895 kHz at 10pm CST
- Sunday 10m AM 29.050 mHz at Noon CST
- 1st Wednesday AM 3880 kHz at 8pm CST

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

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Editor & Publisher Bill Carns, N7OTQ
Ass't Editor, Don Jackson, W5QN

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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.

- 2014 -

20 Years of CCA Service to the Collins Community

2013 was not just a good year for the CCA, it was a great year. We celebrated the 80 year anniversary of Collins Radio by producing 4 issues of the *Signal Magazine* that covered the four eras of Collins history. Along the way, we met a lot of new Collins Gang friends and we increased our CCA ranks by over 200 members. We also held five events around the country where our membership could gather in person and get some personal time together.

While last year was Collins' birthday, this year is ours. Our plans for this year are just as exciting. In 2014, we will have six events around the country (Orlando – a new site - is already behind us), the *Signal* will continue in "Birthday Dress" mode for the rest of the year, and we have some real surprises for our membership as the year goes on.

We are privileged to have three new very qualified members on our Board of Directors - Dennis Kidder, W6DQ, Paul Kluwe, W8ZO and James Green, WA3DJU. They each bring unique talents to the board and to our activities and you will be hearing more about them in this issue and also – in person – as the year goes on. My welcome goes out to them.

I also want to thank the two retiring Board of Directors members, Karl Bowman, W4CHX and Jim Stitzinger, WA3CEX. Both of them put huge amounts of effort and time into working for you. We are pleased that both have expressed their desire to come back at some point in the future and serve with us again, should you be so inclined. In particular, Jim Stitzinger has stepped up and volunteered to continue to bring his S-Line Van and his HF-80/TSC-60 Shelter to various events. Many of you probably do not know how much time this takes and that Jim funds this himself.

As a result, we will be seeing the S-Line Van again at Dayton this year. It will be setup outside our dinner location on Friday. He is also planning on taking it on to the ARRL 100th celebration in Hartford, CT in July. For more details on these events, you can go to our Events Calendar on the website at collinsradio.org.

To say that I am excited about this coming year is an understatement. I think you all will enjoy it and we are looking forward to welcoming many new members again this year since the rate of growth shows no sign of slowing down. This is not surprising when you think about the quality of the equipment that we collect, the history of the company and its people that we get to share, and the truly fun group of people that constitute our membership.

Thank you all for what you bring to us as we try to support our membership and tell the story of Collins Radio and Rockwell Collins.

It is a privilege to work with you all and I hope to see as many of you as possible at the upcoming events this year.

Best 73s, Bill Carns, N7OTQ

A Quick Look in This Issue

Issue No. 73
First Quarter 2014 Signal Magazine

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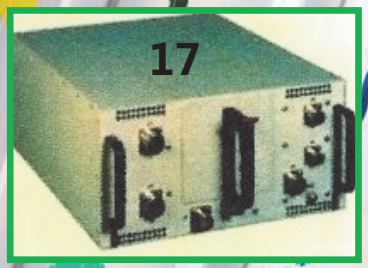
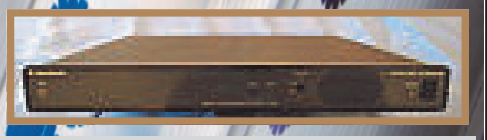




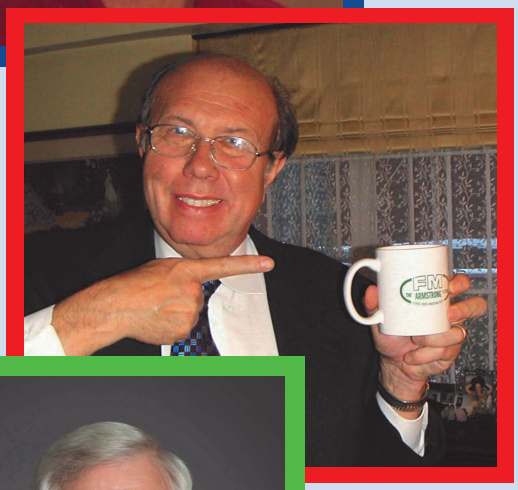
ON THE COVER: Graphical User Interface for the **Rockwell Collins 95S-1 Receiver** Introduced in 1997

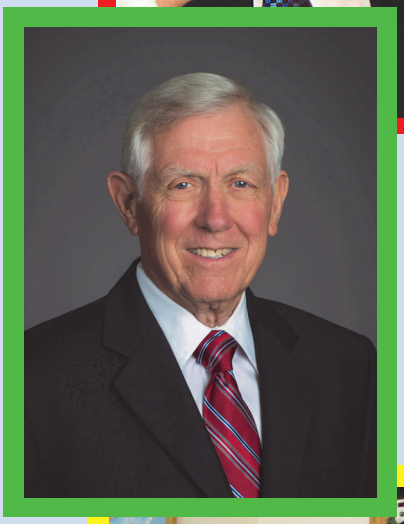
BIRTHDAY

FEATURES

Regulars

OUR CONTRIBUTORS





Bill Carns, N7OTQ/K0CXX
"In the Beginning - The 51F" *page 6*

Bill first became a ham in 1954 as a teenager in California. He has been dreaming about Collins radios ever since. When the career calmed down and the family was gone, he got back into ham radio again and started hunting for his dream—a KWS-1 …. and it has been downhill ever since. He is passionate about the quality, the work ethic and the people of Collins Radio and Rockwell Collins and works to use this passion to try and impact the future scientists and engineers of America. Imagine the love affair that blossomed when he found the most rare receiver ever made by Collins.

Ted Hartson, WA8ULG
"Pizza Anyone", *page 17*

Ted is writing for the *Signal Magazine* for the first time. He is a retired engineer turned entrepreneur. Although not recommended, he quit school at age 15 and went to work in a radio shop. By age 17 he had a commercial FCC Phone & Radar License. He went to work in the engineering field rising to engineering management and then on to starting his own companies. He holds several patents in the area of video TV signal processing, has run an experimental UHF TV station in the process, and grown one of his startups into an entity sold to the Disney complex in the late 2000s. His big claim to technical fame is a spectrum packing digital technology innovation that could be likened to a QAM/NTSC combo. He was first licensed as a ham in 1967 and started his Collins journey in 1968 with a 51J-3. He now regularly operates a Rockwell Collins 820D-2 "Rock" on 160 & 75 Meters AM.

Loney Duncan, W0GZV
"VLF/LF Receivers at Collins" *page 20*

Loney joined Collins Radio in 1957. He served in Engineering Development & Line Management before becoming Division Director of HF Equip. & High Power Transmitters. After moving to Dallas in 1969, he was promoted to VP, Electronic Technologies & Processes reporting to R. Cattoi, Sr. VP of Engineering. He is an avid Collins preservationist and recently authored a article on the TACAMO program at Collins—The longest running program in the company. This article is a "must read" and Loney's perspective as an operational manager during the peak of the program provides incredible insight into this awesome engineering effort. Here he shares the receiver side of the coin with us.

Don Jackson, W5QN
"HF Receiver Conversion Schemes" *page 22*

Don gets to play in his favorite sand box this issue. Having made receiver design his specialty as he spent his career in the Electrical Engineering field, he is well qualified to explore and explain the evolution of receiver design at Collins. In this issue, he also summarizes some of the salient specifications and performance parameters of the 95S-1 in his sidebar article on page 19. Unable to leave behind his curiosity and technical capabilities—even though he is technically retired from engineering, Don can be found most days at his bench exploring some facet of a piece of Collins that will give us new perspective on our equipment.

In the Beginning -
There was the 51F

by Bill Carns, N7OTQ

This journey started for me over a year ago. I am not quite sure of the date. But, I remember it well. Preparing for the upcoming 2013 anniversary year editions of the *Signal Magazine*, work had already commenced on the research to support the Q1 issue. This issue was to focus on the first 8 or 9 years of the history of the Collins Radio Company. This was worrying me because the focus of the collection (and my knowledge) here at K0CXX had always been on the years from 1945 through the logo change in the mid-1960s. The prewar years were far from my specialty.

In the course of putting together a viable picture of that period, I had been assembling what I hoped was a pretty accurate listing of the products developed during that period. Since some prior anecdotal inputs indicated that there had been some 57 new products introduced by the small company in that time period, this was a daunting research task - to say the least. One of my best sources was the advertising and literature that I could assemble or get copies of - either physically, on-line, or through the Rockwell Collins Museum archives.

Figure 1

Hiding in my collection of 1930s ad copies, was a 1939, and then another 1940, ad for a Model 51F receiver. There were several pictures, and it was a "charmer". Taken individually, these two ads were informative of just the top level features. As I would discover later, taken together - and studied in detail - they told a very interesting story. Based on what I thought I knew at the time (and this continues to be the case), this receiver appeared to be the first receiver introduced by Collins as a standard product – not the first receiver built mind you - but the first one introduced. Information already on hand at that time provided just brief glimpses of receivers (models like the 50A, 50B and 51A) that had been built by Collins as "One-Offs" for customer systems and shipped with a transmitter sale. These previous receivers all had common characteristics. While they were built on the standard aluminum bent channel chassis of the period and capped with steel end inserts, they were also built using National off-the-shelf components and appear very similar in design to the National AGS of the time. The one schematic that we have for the 51A indicates a single conversion superhet limited general coverage design. The period involved was 1933 and 1934 for these early examples. Later in the research, the smallest reference to a proposed 51B "Customer Solution" receiver would appear in a letter that Art wrote to his customer in November of 1934.

What happened to the models 51C through 51E has yet to be revealed. Perhaps someday it will be, but back to the 51F saga.

I was smitten, I must admit. Having already done a lot of the prewar research, it was clear that almost no one (maybe nobody) had ever seen or even really heard of the 51F. My first reaction – Yup! - - I wanted one…. Then reality set in. The ads did not continue in the following months that led up to the war. There was no further indication that production had been ongoing. No one had ever seen one. Well, reality set in and I realized that the chances that one would ever surface (and particularly that I would get it) was less than slim, and probably in the "none" category. I shook off the brief love affair, and pressed on with my research for the Q1 issue.

About a month passed. One day, I was going through a stack of paperwork that had been given to me by a friend of a silent key who had an interest in Collins. The material was pretty typical, until I got to an old style grey manual…… A 51F manual….. a brand new – never been wrinkled - 51F manual that still had the original loose schematic D size blueprint drawing folded in the stapled drawing pocket at the back of the manual. It had never been unfolded.

Dang…how unlikely is that…First I find out about it, get smitten, but write it off, and then the manual comes waltzing into my life bold as brass. Love blossomed again and I spent hours reading the manual and looking at the partially unfolded drawing schematic – very carefully. This was Collins' first receiver model to be introduced and I had the manual – a new manual. But, reality again set in, the need to press on with the research loomed, and the manual went gently into my "Old Grey Manual" drawer for future enjoyment.

But, that manual had given up a secret. In the late '30s at Collins, engineers were still drawing their own schematics and then the drawing was traced by a professional draftsman. That schematic drawing (drawn by F. M. D.) thus revealed the name of the designer and project lead on the receiver. It was non-other than Frank M. Davis, one of Art Collins' first engineering hires (June of 1934). By 1939, when the 51F was being designed, Frank had already become the Chief Engineer reporting to Arthur Collins and, by the start of WW II, he was a solid member of the Brain Trust upper management group that governed Collins during the war. During most of the war he was Director of Research. He was also a member of the Board of Directors following the incorporation of Collins in 1944. In early 1946, following a business trip, Frank fell ill and he was diagnosed with a serious heart problem. He died soon thereafter. Frank's son, Brian, has written a fine biogra-

phy of this important engineer and manager in Collin's history and this bio will appear this year in the Signal Magazine.

The manual now safely stowed away, life went on at K0CXX. The production of the *Signal* made the time fly, and soon not only Q1 was gone, but the Q2 issue had gone to the printer and I was busy getting lined up for Q3. The phone rang one night and it was an acquaintance asking me if I knew anything about an old rack mount receiver that had the Model Number 51F embossed on the front panel. He had found it at a small swap meet, and did not know much about it. He had bought it not knowing exactly what it was, and because he thought it was old and cool looking. He was under the impression that it was incomplete and needed an external power supply.

Then, I guess, I shot myself in the foot. I told him how rare it was, and that – no – it did not need an external power supply. It was all there. I have never been a good bargainer, or a liar.

To my great surprise and good fortune, he did not care to keep it, thought it should go to a home where it would be "conserved", and thought I should have it and write about it….but now he did know it was rare and important.

The bottom line, we struck what I think was a fair deal. Some money and a couple of trade pieces changed hands and that baby is sitting here right beside me as I write. …. The "Love Affair" has a happy ending.

The following are some detail photos that were taken during the minor amount of disassembly that was required to remove a dent in the chassis that occurred when the pull handle was hit diagonally from the left. This hit pushed the panel in and depressed the chassis about ¼ inch. After removing the front knobs and panel (which was almost completely straightened with the exception of a minor imprint of the handle itself). A special "dent removal" tool was fabricated that allowed me to put a flat surface up inside the chassis from the back and transfer the axis of movement down out of the chassis – just clearing all of the parts in the crystal injection oscillator – and then run it to the back of the chassis and out and up where I could nudge it from the correct axis and direction. That tool worked like a charm, and the dent is history.

While the panel was off, I took the opportunity to clean well with just a damp Q-Tip, or 60 or so, and then get some pictures to document the upper construction and the lower wired area.

While it was opened up, it immediately became apparent that I was looking at the first run of the chassis itself, in spite of the fact that the receiver I have is the fourth or maybe fifth variant.

The first ad appeared in August of 1939 and actually showed two very early versions of the receiver.

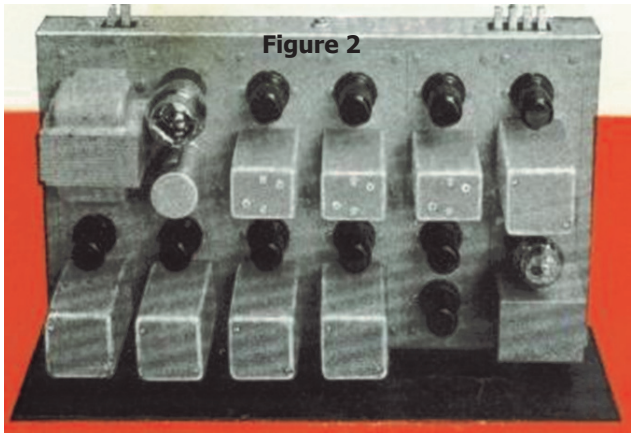


Figure 2

The first version, or maybe it was the first two versions, had at least the volume and squelch knobs below the chassis. We know that work was being done as early as June of 1939 and this first photo, clipped from the first ad in August 1939, shows a configuration where the knobs for Volume and Squelch are mounted on the chassis. Due to the fact that there are also two holes on the unit just discovered below the final upper two holes for the two RF can tuning adjustments, it is possible that at the time that the V & S knobs were mounted down on the chassis, the RF1 and RF2 capacitors were also mounted on the chassis. (No V & S Brackets are seen above the chassis on the right

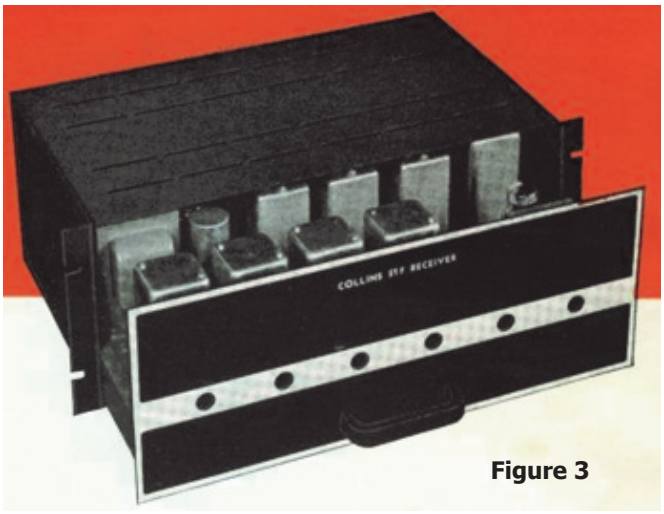


Figure 3

By the time that the August 1939 ad was released to QST (Best guess in July), the tuning and Volume and Squelch knobs had moved up and onto the brackets where they would stay.

The February 1940 ad below shows a configuration where all of the controls are up on the brackets and now the Volume and Squelch knobs have appeared. The electrolytics in the main power supply have also been combined and put in a custom single container box.

Both of these views in the ad abstract below apparently show the same receiver. [5)]

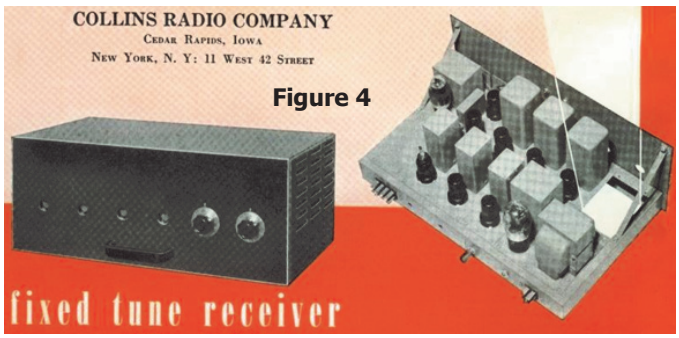


Figure 4

The first and only revision of the manual shows drawings dated from June of 1939 (module level) to November of 1939 (full schematic level) - so development continued from before June of 1939 through at least the end of 1939 and may have continued into very early 1940. The war was looming by this time.

The only apparent surviving receiver is #7306-14 (Suspected to be receiver serial No. 14). This receiver has nicer panel trim, knobs apparently manufactured by Collins (very nice) and the tuning ports for RF1, RF2, Mixer and Oscillator now have a sliding cover (See Figure 1, Page 6). No. 14, though, has a chassis that carries the vestigial four holes for the original (below chassis) positioning for the RF tuning (the two on the left) and the squelch and volume controls (the two holes on the right), so it is assumed that the chassis involved was made in the first run of chassis that were made in about June of 1939.

The 51F (Cont'd)

Production apparently started after the first of the year (1940) for the unit (#14) that survives. It is likely that at least several prototypes of earlier receiver versions were made. None have ever been seen.

The photo below also clearly shows the dent in the chassis that occurred when the handle was hit by something. Figure 1 on Page 6 shows the straighten panel and chassis back together. Some detail photos of the insides taken at various stages are shown opposing.

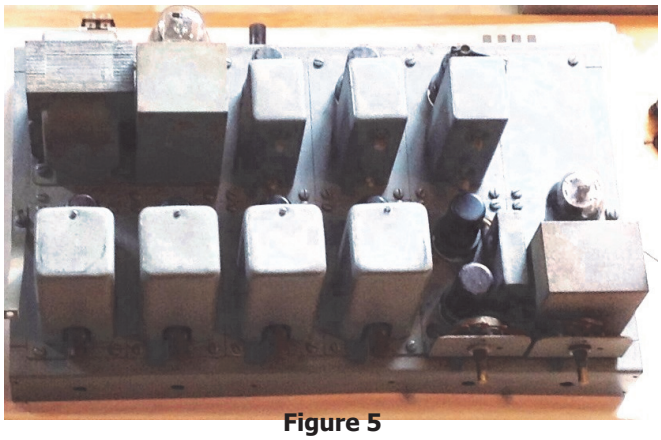


Figure 5

One of the charming facets of the little receiver is the fact that almost all of the individual modules are hand marked in pencil by either the Assembler or the Quality Inspector. I suspect it was the inspector because they are signed "OK". Two of them are also initialed. The figure below shows the injection oscillator signed in beautiful script handwriting . . .

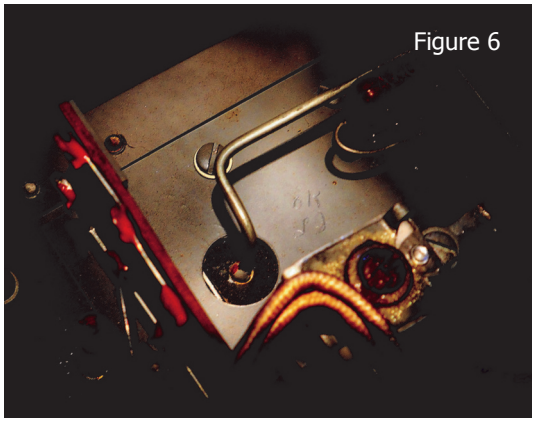


Figure 6

OK EJ

Now you have seen the photos, and the 1939/40 ads, and you know it is a charmer - just as I do. Advertised as a modular customizable configuration receiver, it covers a single channel between 1.5 to 20 mc, and could be ordered with one or two RF Amp units (317A-1 and 317B-1) that had a 2:1 tuning range "meeting the customers desires". You could also order a variable or crystal controlled injection oscillator (317D-1 or 317E-1) module configuration. The configuration selection included an optional BFO module (317J or M) for CW reception and, if required, a squelch stage, the 317L. Standard (always required) required modules finished it out. These include the 317K Power Supply, 317C Converter (First mixer), 2 each 317F IF Stages, the (called Second) Detector (BFO injection), and a 317H Audio Output module that could be internally strapped for 8 ohms or 500 ohms output.

Sensitivity was quoted as being better than 2 microvolts for 50 mV of output and better than 6 db Signal to Noise Ratio.

The implication of the 2:1 tuning range of the RF modules is that there were 4 options available, 1.5 to 3, 2.5 to 5, 5 to 10 and 10 to 20 mc. The manual does not contain a RF components parts call out in the detail level needed to exactly pin down the tuning ranges of the options. The modules that have a frequency coverage option are wired in and they do not have plug-in coils so this is definitely a factory optional "build" concept.

Tuning is done through the four access holes that are visible on the front panel using a provided tuning tool. The holes are covered with a sliding cover behind the panel that has a small knob that travels in the slot that can be seen between the second and third hole. The phenolic tuning shafts can be seen projecting from the base of the RF cans in Figure 5.

My unit (Serial No. 7603-14 [1)] and labeled 51F-1 in the serial number area) grid-dips from 2.7 to 6.4 mc at the extremes of its range, so it is the second option more than likely. One would think that the model number on the plate should be 51F-2. It has the 317E-1 crystal controlled injection oscillator set for operation at 3105 kHz. It also has the squelch module installed. It does not have the 317J/M BFO Oscillator module. As ordered, it was a 3 to 6 mc, AM (Squelch Option) receiver intended for aviation ground service on the, then, only air traffic control frequency.

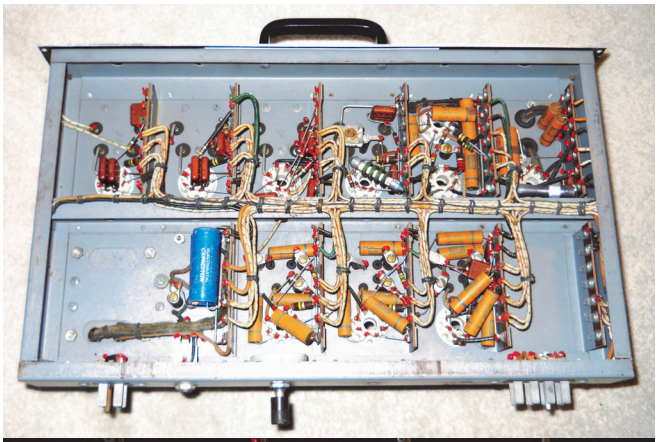
Figure 7

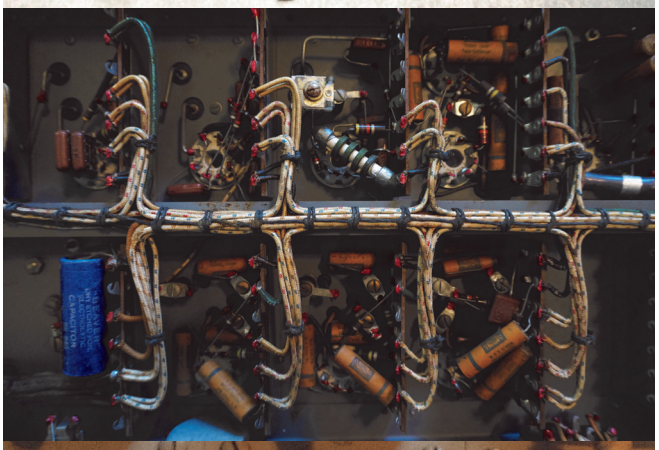
As originally advertised, the 51F was touted by Collins as having applications in aircraft ground installations, as well as other commercial services.

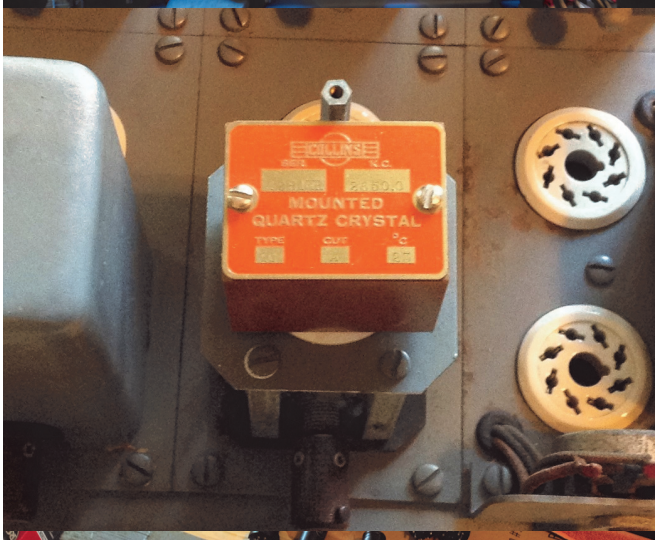
Now, the saga gets even more interesting. On arrival, a detailed inspection showed that the under-chassis wiring is completely intact and unmolested. The unit has never been repaired, as can be seen from the photo in figure 3. All of the tubes appear to be the original RCA Radiotron brand and of the correct date codes for 1939. They all test good. The connector blades (early style pin locator Jones Connectors) all have a uniform deep patina and no signs of repeated wiping. The front panel screw holes for cabinet security have no scratches or any signs of use. The knobs (anodized machined aluminum, show almost no signs of wear although there is some on the volume control serrations. The mating female connectors that should be attached to the rear of the case are missing. It looks very much like this unit was never used to any significant degree. Other than some very mild surface corrosion under the paint, and on one painted module plate, there are no signs of damage.

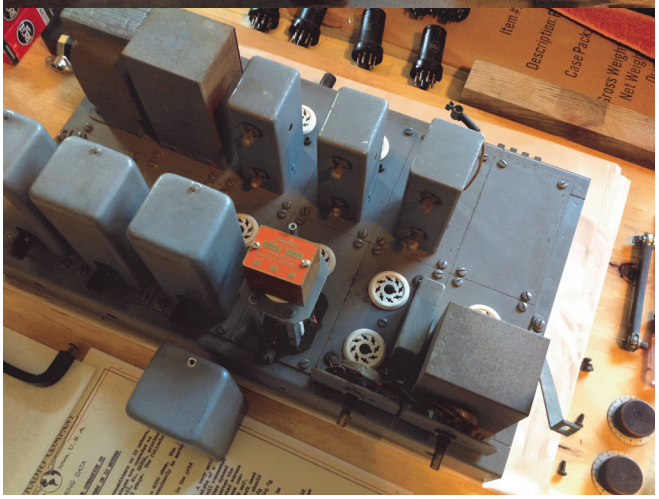
So, from learning of the 51F's role and existence - to finding a new manual - to finding a what appears to be fairly new 51F-1 - took about 8 months and an incredible stroke (or two) of luck. Sometimes, love affairs are just meant to be.

The receiver is now headed for the Rockwell Collins Museum (when I finish looking at it) because it is historically very important and should be preserved. After discussion with Lawrence Robinson, RC Museum Curator, we have made the decision to not repair or significantly restore it. An attempt is being made to non-invasively stop the rust on the one steel chassis plate and slow the filigree corrosion on the RF/IF cans under the paint. The unit did, at one time, see some high humid-









ity for a long enough period for these processes to have started.
I had originally planned on using it in an operating position fixed on a 75 meter AM net frequency and paired with a beautiful NIB (new in crate actually) 32RA fixed frequency transmitter that came to roost here a few months ago. That may still happen - if the caps will reform and the 51F receiver will work. I am proceeding very cautiously with this plan because I do not want to damage anything[2]. If the 51F does not work, it will be left unmolested and serve as a very rare example of this first receiver and its original workmanship from the 1939 Collins factory on First Avenue NE. [3] The 32RA operating position will then get an early 51J, or R-388, since it is a post war 32RA. That will be another story, I am sure. . . . . de Bill, N7OTQ, K0CXX

Notes:

1) Art Collins was known to add a few digits to his serial numbers in the early days of Collins Radio in order to make the output of his fledgling company look bigger. This appears to have been the case until start of World War II.

2) Interesting is the fact that nowhere in the manual does it show what the power consumption of the receiver is. There is a comment that the use of a power switch, fusing and AC interconnect is left to the customer at time of install. Careful analysis of the circuits and bias yielded the fact that the power consumption at 115 Vac is a little less than 60 watts (about ½ amp), so a 1 amp fuse is planned.

3) This building complex went on to serve Collins until the 50s when it was sold. It has now been demolished and redeveloped.

4) Tube Lineup

First RF	317A	1853
Second RF	317B	6SK7
Converter	317C	6SA7
First IF	317F	6SK7
Second IF	317F	6SK7
Second Detector	317G	6R7
CW Osc (BFO)	317J or M	6SJ7
HF Osc.	317D	6SJ7
Audio Sq.	317L	6SF5 (2 ea)
Audio Output	317H	6K6G
Power Supply	317K	80

5) Development 51F Model Evolution

I. Knobs down on Chassis – Top view (only) in August ad. This configuration is from estimated April - May when drawings started. Electrolytic capacitors in power supply are smaller and round.

II. Knobs for V&S moved up to behind 5th and 6th "Tuning Ports". Clearly no cover on tuning ports. This variant is the main frontal photo (with bright trim stripe) in the August adv so this was the configuration in say June July '39.

III. Feb ad shows the knobs moved up and the chassis view is consistent showing the brackets, and the electrolytic in the PS is the large square type found in 7603-14. The knobs are an earlier type (Dakaware with numbered flat aluminum flange) and there is no cover on the tuning ports (now 4 to the left). The ad appears to show a mockup or very early panel because there is no main Collins Radio Model 51F Receiver logo across the top as shown in the first ad (second variant). You can conclude therefore that the knob variant was in development right at the end of the year (about 2 months lead on the ad photos) and that the knurled and flanged knobs, the dial locks, and the sliding cover were added after that in early 1940.

IV. The fourth variant is represented by the receiver found, Serial # 7603-14 and added a sliding cover over the four remaining tuning ports and the two knurled and flanged knobs and locks. As shown by Figure 5, there are blank unused chassis holes below the current position of the volume and squelch knobs that are covered by the panel.

6) Interestingly, there are also two unused chassis holes in the front under (and aligned with) the two RF stage tuning ports. Apparently, the original conception of the tuning and control configuration was that the RF tuning would be done with variables that were mounted below the chassis and the above chassis coils might have been plug-ins like the 7000 series. This was the "5th" possible configuration (actually the very early first) that was also planned when the first batch of chassis were made.

7) It seems fair to conclude that the original batch of chassis were made very early in development and would not have totaled more than 20 or 25 given the previously observed methods of prototyping and the build of early manufacturing runs. This could suggest that the "-14" in the serial number 7603-14 is the actual serial number.

8) Given impending war in Europe and the previously documented war preparation mentality at Collins Radio in 1940 and early 1941, a second batch of 51F chassis production may have never happened. This implies that

Your CCA Continues to Change - 20 Years Later

The CCA in 2014 – A Report

Now that 2013 is behind us, it is time to again look forward. Before we do though, it is good to take a look at what we are trying to achieve. The CCA has always been a great operation and one that has tried to focus on providing what our membership wanted in the way of support (website, events, communication media – newsletter & then magazine, etc.). Several years ago, things started to change. It was a simple change – but important. We started asking: How can we make our group better – make our products (the website and magazine) better, and give our members "more for their money" ? You have seen the results. The website was overhauled and expanded – and this continues. The magazine started to change, and has grown to what you see today. And, the events have grown in number (5 now) and scope and we now have more opportunities to see each other personally and get together and share equipment and stories.

All this was done while at the same time, expanding our contacts with the "Collins Gang" – e.g. the guys and efforts in Cedar Rapids related to both the Rockwell Collins Museum, the support groups there (the Museum Club and now the Arthur A. Collins Legacy Association video archiving work) and the preservation, archiving and communication work going on there in Iowa. At the same time, we have become more involved with the corporation itself with their cooperation with the *Signal Magazine* on the running of current Rockwell Collins ads - and then the nice letter from CEO, Kelly Ortberg.

The consistent motivation and perspective behind all of this work was to "become the best we could be" and to make our efforts of a quality that Arthur and Collins Radio could be proud of … After all, we were publishing the magazine that Art started at Collins and that was, for years, the presentation to their customers of "the best they could be". We had a lot to live up to.

In short – we became driven by the concept that, if we were going to be associated with, and support, the best products in the industry, we needed to hold ourselves up to that same standard.

Now, with that as background, some interesting things started to happen. Building good networks of resources, supporters, suppliers and customers has always had an amazing impact on results – if you will only let it happen. Synergy is a wonderful thing, and bouncing ideas off others and sharing concepts and objectives with others always results in good ideas and enthusiasm coming to the foreground.

As we did the research for the website, and as we opened doors to talk about the history, and as we became involved with other events, the inevitable happen. New ideas – new excitement and new possibilities came onto our plate.

Two years ago, the CCA had worked with members of the Antique Wireless Association (AWA) that were also CCA members to establish a theme of "Collins Radio" at the 2012 AWA world convention. Every year, the AWA has a theme for their conference. As a result the CCA was invited to participate. We did that – setting up a booth at the show - working with John Dilks, K2TQN (AC09-12371), and QST Editor, to help bring his entire Collins desk and S-Line to the show (won best in show by the way), and we gave two papers at their forums.

The event was a resounding success by any measure. At the most obvious level, everyone had a great time and the AWA folks learned a lot about the CCA and visa versa. We got some new members, and so did they. We will be going back each year now.

But, more importantly, the management of the CCA got to meet – and be very impressed with – the management of the AWA. We also found that we had much in common, not only as far as our goals and activities were concerned, but at a higher level regarding our guiding precepts and thoughts about why all this preservation work is important. More on that later.

To make a long story short, out of that meeting, and subsequent discussion with two of their managers, came a new and lasting relationship between the CCA and the AWA.

Scan to see more about the CCA

This relationship has now taken up a heartbeat of its own. So, here is your first present for our 2014 20th birthday.

Announcement

The CCA and the AWA are very happy to announce that they have just signed a Letter of Intent (LOI) defining a consortium that will cooperate on achieving our mutual objectives in several areas.

We will cooperate in the areas of:

- Supporting the preservation and archiving of Collins Radio and Rockwell Collins related historical material, equipment and anecdotal history.
- Facilitating the tax deductible donations and preservation of both CCA and AWA member's estate components or financial contributions.
- Supporting common objectives of other similar organizations that foster Collins Radio historical preservation and archiving.
- Fostering the sharing of display materials between the AWA Museum facilities, and other museum facilities that display Collins artifacts and stories. This includes potential loan of materials for occasional CCA temporary exhibit requirements.
- Working to leverage the efforts of the CCA and the AWA to have a positive impact on the national STEM program in the future.

This consortium has been established and will be known as the *Collins Radio Heritage Group* (The CRHG). The CRHG will have a website in the near future and will make available both a summary of their objectives and their activities. In addition, details of the CRHGs support of an exciting Collins related Video Project will be made public, and there will be an opportunity for the public to support this important project financially. All of the funds raised will be donated directly to the video project through the AWA 501(c)3 and will be tax deductible. Web url: collinsradioheritagegrp.org.

We are very much looking forward to the coming years and working within this cooperative agreement environment. The current video project, and the defining of our relationship, is just the beginning. There will be more projects and more events in the future. In short – this is just the "Tip-of-the-Iceberg". The CCA now has two fundamental objectives, and they are very closely related. The first, of course, is to support our membership and their Collins collecting and operation needs. But, also we will be using this work to have a positive impact on future generations – not only of collectors, but future generation of children as they choose their career paths. There is strength in numbers and common objectives. There is strength in the synergy that you can find in such relationships when you listen and look, and we intend to use that for our common good and the benefit of the hobby.

Happy Birthday!

Plans for 2014

As we have stated elsewhere here, the *Signal Magazine* will return to its normal size and scope. The quality will remain the same. There will be a reprinting of the four 2013 80th issues of the *Signal Magazine*, but the subscription period will be later in the year due to workload here. We have made the plans and gotten the quotes and samples, but because we changed printers mid-2013 to solve a problem that came up, we have two different layout formats in use in 2013. So, two of the magazines will have to be laid out again. This will take some time.

The events schedule has been published for 2014 and, again, we will have six events around the country. In fact, Orlando – a new location – is behind us and the report is in this issue. By the time you get this, the Dayton Hamvention pages will be expanded and opened for bookings. Please make your plans early. This Dayton – always our main event – we will have some very special happenings. There will be more information on the CRHG announcement and also several good talks. This one is only going to happen once folks so do not miss it. For Dayton, and all of our other events this year, always check the EVENTS CALENDAR on the website and watch the site for more exciting announcements.

In summary though, you can find us this year at Orlando, Dayton, Dallas, Rochester, Hartford CT and again in California. We'll leave it to you to see the website and get all the details. Jim Stitzinger is, again, going to be bringing the restored beautiful S-Line Van to several of our events, so if you have missed it in the past, now is your chance to sit in the chair where Art sat, and operate a piece of history.

Watch the website also for updates on the bound collector's edition of 2013 Anniversary Issues of the *Signal Magazine* as well as future announcements relating to events and our new CRHG relationship. We will also be putting announcements out on the CCA reflector.

Meet Your New CCA Board Members

Paul Kluwe, W8ZO

is past President of the CCA and Member of the CCA Board. For those that do not know him, he is a strong leader and contributor to our group.

He is a well informed Collins and Rockwell Collins collector and is quite passionate about preserving the history of Collins. His collection tends to focus on the pristine and the later Rockwell Collins gear and is worth a look. Welcome back Paul!

Jim Green, WA3DJU, is a very welcome returning member of the CCA Board and has served as Treasurer for many years in the past. Jim brings a steady hand to the till and the tiller and it's a pleasure to see him again in this capacity.

Jim is planning on being at Dayton again this year so come by and see him if you get the opportunity. He and his wife Millie are often volunteer greeters at our Dinner. Welcome Back Jim.

Dennis Kidder, W6DQ, has previously served as President, Vice President and Director of one of the most well-known clubs in the world, Professionally he has worked as a hardware designer, software developer and system engineer. He spent the majority of his time at Hughes Aircraft Company (eventually Raytheon) where he worked on programs that did everything from flying satellites to building airports.

CCA Events News

2014 – ORLANDO - Next Up, Dayton !

Orlando HamCation 2014 was a smashing success for the new CCA presence. The booth space was right in the incoming traffic area and very visible. In a way, the weather even cooperated - Lemonade from Lemons - so to speak. It rained almost the entire weekend. This may have lowered the total attendance a bit, but it moved everyone inside most of the time, so attendance at the booth was great. The new Orlando team of Jay Tindall, WW4E and Dick Blumenstein, K0CAT had everything under control. The added display material brought by Glen Thibodeaux, KF5FNP (A complete stuffed CC1-CC3 *S-Line Fly Away* setup and a PRC-72), and the wonderful display signage he made, were the frosting on the cake. My thanks also to Jim Stone and Hanford Wright for their help. The dinner was great even with a little mix up on the room. The bottom line is that a lot of Florida, and "parts south", CCA members got some eyeball time, we got some new members, I saw some very good friends from Arizona days, and we will be back next year for sure. See the expanded write up and photos on the website Report for more information.

A Guide to the Evolution of HF General Coverage Receivers at Collins Radio

The story of the evolution of receivers at the Collins Radio Company is an interesting walk both through the progress of technology, and also a look at how, and where, Collins Radio did business over that time period.

What is presented here will by no means be complete. To try and be all inclusive would be both too long, and almost impossible to get right. Even with that caveat, I am sure that there will be cases where someone will say that a sin of omission has occurred, or that this or that should been selected in place of one chosen here. For sure, there will be entire marketplaces that are omitted since, after all, there were eventually amateur radio, microwave, commercial, military, avionics, space and even a humble broadcast band receiver.

Since our audience is almost exclusively mainly interested in the area of HF and Amateur Radio, the focus here will be in that area that is overtly aimed at (or could be applied to) Amateur Radio use or collection. At the same time, this sampling will attempt to demonstrate the evolution of technology and manufacturing during the period represented. Again however, we will see Art Collins' almost premonition/vision of the importance and future roll of the computer come to life.

To start, one must be aware of the fact that Collins Radio did not set out to be a receiver manufacturer. This fact.. this mindset … was driven mostly by Arthur Collins' search for significant communications technology and progress in areas where he could make significant contributions. Additionally, early on, there were many more fairly mature for their time receiver companies already in business at the time the Arthur entered the scene. National, RME, Millen ……. Just to name a few.

For easily the first four or five years that Collins Radio was in business, they considered themselves soundly as a transmitter (and to some degree early on a transmitter parts) manufacturer. In fact, one of the first names chosen (there were several) by young Arthur when he first started in business was just "Collins Radio Transmitters". Renamed the Collins Radio Company by the time it incorporated in 1933, it still approached its future with the "Transmitter" mindset.

Never the less, receivers did enter the picture very early in the history of the company. One of the things that we do know – driven by a passion for getting business that smacked of recovery from a depression – is that Art would do almost anything to get a sale, or go after business. This passion led him in a number of documented cases, and there are probably more, where he provided a receiver "solution" to a customer who came to Collins looking for a communication system.

50A Receiver

During 1933 and 1934, there are three documented receivers, the 50A, 50B and the 51A that show up in early documentation. In these three cases, it is believed that just one receiver was built for one customer who also purchased a transmitter.

50B Receiver

The 50A and 50B pictured here are representative of the companies design philosophy at the time. All three of the receivers mentioned above are built with standard off the shelf National - with perhaps a little Millen thrown in - components. They are however constructed on, and with, typical Collins chassis and hardware components of the period, and may involve some further circuit development. We do not know for sure. They do have an appearance of being very similar to the National AGS of the period.

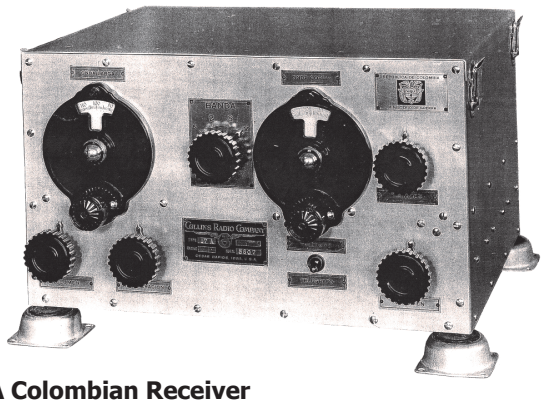
The third photo shows the complete system provided for the *Standard Fruit Company* and contained the 50B, a Collins 150C in an enclosed cabinet system with a door. This was the first totally rack mounted system believed sold by Collins.

50B Receiver In 150C System

Also in this same early period, we have documentation indications that Collins changed their receiver numbering from the 50 series to the now familiar 51 series. There was a (low volume) 51A and then we have one letter indication there was a 51B.

The first "volume" production receiver built by Collins Radio was most certainly the Colombian Army Air Force contract 17A. Again, this piece of business was developed as a system solution for the customer in order to capture this, what amounted to, huge piece of business for its day. In 1935, the fledgling Collins Radio Company received their first really large order for a suite of equipment that included airborne receivers, transmitters (and support components) as well as ground station equipment. The airborne equipment was destined for a number of different types of aircraft with some model variations by aircraft.

There isn't a detailed accounting of these various models remaining, but we do know that the order was for $57,677 and that the dominant receiver design involved was the 17A pictured below. While the entire order is known to have been enough to provide communication for 50 aircraft, the exact volume of the 17A build is not known. There are at least 8 pictured in one photo that survives.



17A Colombian Receiver

Regarding the 17A receiver, little is known about the circuitry of this receiver other than it was a 4 band HF receiver with main and band spread dials and was intended for both AM and CW reception. Since the contract covered both fighter (Curtis Hawk) and bomber type aircraft, it is not known what type this one receiver was intended for.

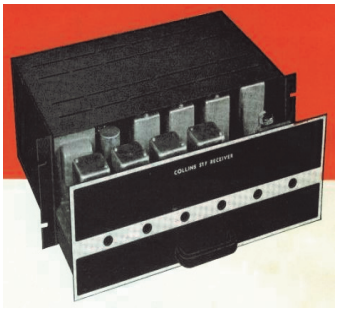
Following this Colombian contract activity, little remains of the records of individual receiver activity until we see the 51F receiver emerge in 1939. We should point out that, in April of 1939, Collins did announce the 18M/TCH Transportable Transmitter Receiver and in this context, the first actual production receiver was the 18M receiver that was completely independent inside the 18M.

In August of 1939, Collins Radio announced the 51F rack mounted single channel Phone or CW receiver and this would go on to have – what appears to be – just one build of receivers before the WW II efforts started to shut down commercial product development and focus at Collins.

The following "Guide" to the evolution of general coverage HF receivers is thus presented in this context. More information on the 51F can be seen in the article in this issue, and more technical information relating to feature evolution can be found in Don Jackson's nice Service Line article herein. Please see our website for a more complete pictorial guide to receivers @ http://www.collinsradio.org/receivers

Receiver Guide—HF General Coverage & Derivatives

General Coverage HF receivers of significance in the development of the receiver products at Collins Radio: Period covered is from 1939 though 2005. This spans from single channel fixed tuned single conversion superhet though the Software Defined Receiver (the 95S-1) from 1995, and the more current KGR-70 VLF/LF Receiver that is baseband A/D converted right off the antenna and then all "more classical" functions are accomplished in the processor…. Arthur would, indeed, smile. See the articles in this issue on the 95S-1 and the KGR-70 for more information on this amazing evolution of receivers over a 65 year period…..and it goes on - Not Your Grandfather's Oldsmobile.



51F Receiver

Single Channel
1.5—20.0 Mhz Phone/CW
Rack or Cabinet Mount Opt.
Introduced: August 1939
Used "New" RCA Metal Tubes

The first production volume announced standard product receiver was unique in many ways. It used a modular custom order factory construction method that came and went with this model. It could be ordered with one or two RF stages, crystal or variable injection oscillator, optional CW BFO and an optional Squelch module. It also sported a new style that was short lived as well. Less than 20 produced. Rare. It "reappeared" redesigned in January of 1946 as the post-war 51N-1. (Weight 22 lbs.)

51H-3/ARR-15 (R-105) Airborne Receiver

Autotune 10 Channel + Analog
1.5 - 18.5 MHz AM Phone/CW
Shock Mount Airborne
Introduced: 1944
26.5 - 28 Vdc 1.4A w/ Internal DY-34 Dynamotor supply 220 V.
Wt. 39 lbs. - Uses 70E-2 PTO

This receiver was developed early in WW II as a mate to the very successful ATC/ART-13 transmitter done initially for the Navy. The R-105 used the same channeling scheme as the ART-13 and could be channeled from the same control head providing pilot controlled "transceiver" operation on 10 channels—a first at that time. It did not see service in WW II but served through the Korean War & beyond.

51J & 51J-X Series

General Coverage - 30 Bands
0.5 - 30.5 MHz AM/CW
Rack or optional cabinet mount
Introduced: 1945
115 Vac Standard Power Req'd
Wt. 80 lbs. - Uses 70E-7A thru 70E15 PTO

Anticipating the end of the war, development was started in 1944 for this first post-war general coverage receiver. The Project Lead was Roy Olsen. Following Roy's departure in 1946, Lou Cuillard continued development, leading to the 51J-X and the 75A-X family of receivers. They all shared a unique combination of electrical/mechanical features using the new linear PTO, crystal controlled 1st injection oscillator and mechanical slug rack and geared tuning to achieve revolutionary electrical stability and frequency readout accuracy and reset ability. This line of receivers set a new standard and was remarkably successful.

R-390

General Coverage - 32 Bands
0.5 - 32.0 MHz AM/CW
Rack or optional cabinet mount
Introduced: 1950
115/240 Vac 60 Hz, 115 Vdc or 28 Vdc depending on options
Wt. 85 lbs., 33 tubes w/ 3TF7

The R-390 was developed by Lou Couillard at Collins Radio on a Navy contract during 1950 and production commenced in 1951. It was developed as an improved version of the 51J series which culminated in the 51J-3 in this timeframe. It was much more expensive than the 51J series and first contract cost to the government was $2500 per unit. The R-390 was developed to be much more rugged than the 51J series and also it was completely modular. Any functional module could be quickly removed and replaced at a field depot without the involvement of highly trained maintenance staff.

R-390A

General Coverage - 32 Bands
0.5 - 32.0 MHz AM/SSB/CW
Rack or optional cabinet mount
Introduced: 1956
Same power opt. as R-390
Wt. 85 lbs., 26 tubes

Development commenced in 1954 on a cost reduced and improved version of the R-390 which became the R-390A. It featured mechanical filters for pass band definition and was intended to bring the R-390 into the Single Sideband era.. It was wildly successful with over 50,000 produced by Collins and associated subcontractors. Like the R-390, it features triple conversion or double—depending of frequency, and uses just 26 tubes. Discontinued in 1970 with some exceptions.

- The Rockwell Collins 451S-1 Receiver -
A spinoff of the Casper project, this receiver was produced in very limited - almost prototype - volume and is rarely seen. Only 10 were produced. This one is from the collection of J. Stitzinger with thanks


263.00
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ENT
CLR

51S-1 (S-Line) General Coverage

0.5 - 30 MHz AM/SSB/CW
Introduced: 1959 - 1982 w/ over 12,000 produced
Wt. 28 lb. Shock, rack, or cabinet mounting optional
IF pass band Transformer or Mechanical Filter

651S-1 (651S-1B Shown)

General Coverage - 30 Bands
0.25 - 30.0 MHz AM/SSB/CW
Rack or optional cabinet mount. Wt. 30# - Synthesized
Introduced: 1970
115/240/28 Volt Optional

This receiver was a derivative of the 671U-4/718U-X Commercial comm product line at the Collins Division of Rockwell International. The receiver employed a significant change in receiver architecture at Collins—using initial up-conversion to 99 MHz, the use of roofing filters and then down conversion to the first IF. It was the voice of the future and shared many boards in common with its parent products.

Early versions used NIXIE tube display technology, while the later units employed LED displays. Production ran from 1970 though 1977. It was also the first table top receiver to be frequency synthesized and capable of digital control through a serial port.

HF-80 Rcvr Family

HF-80 851S-1 Variable Gen. Coverage 0.25-30 MHz
All Mode 38 lb.

HF-8050A One Synthized Channel 0.25-30 MHz
All Mode

HF-8054A 4 Ch. ISB
0.25-30 MHz
All Mode 1981-1989

Developed by Paul Zeigelbein (851S-1/2) and Sil Dawson (8050A & 8054A), this family of receivers led the industry in cost-performance and was a very successful high performance, lower cost family of receivers that was developed in conjunction with the entire HF-80 lineup of exciters, transceivers, receivers, controllers and amplifiers.

The entire story of the development project and program history is available in the Q4 issue of the *Signal Magazine* from 2013. It is a fascinating story of change in an organization. The products all featured a new design paradigm employing off the shelf components where possible and "just enough" performance to win in the market place. It was hugely successful and the products still serve today in many applications—some 25 years later. Mating exciters are the HF-8010A and the HF-8014B—the single channel and 4 ISB channel versions respectively. Amplifiers range from 1 KW (HF-8020) tube and solid state (HF-8023) workhorses to the more eclectic 3 KW (HF-8021) and 10 KW (HF-8022) monster amps. The transceiver is the HF-8070)

451S-1 Receiver –Limited Production (10)- circa 1980

0.2 to 30.0 MHz AM/SSB/CW—Derivative of Casper Project
Same construction as KWM-380
Frequency Synthesized 10 kHz steps w/ Mechanical Filters
Wt. 28 lbs, Project Lead : Jerry Vonderheid

851S-1A Prototype—Updated Display & Control

Developed during 1980s as follow on to 851S-1
General Coverage - Frequency Symthesized
0.25 - 30.0 MHz AM/SSB/CW

851S-2 Prototype

General Coverage - Very similar to 851S-1 production version
0.25 - 30.0 MHz AM/SSB/CW
Wt. 38 lbs.

HF-2050—Production

General Coverage - Synthesized, 1st DSP RCVR to production
0.1- 30.0 MHz AM/SSB/CW w/ 99 Stored Preset Frequencies
Feature VLSI circuitry and just four circuit cards
Rack or optional cabinet mount
Mil Std 461 Qualified (No Deviations) - 1150 units produced
Produced 1985 through 1988 - Project Lead: Dave Church
Major customer was Canadian Government

The Rockwell Collins 95S-1 - 55 Years of Evolution

By Ted Hartson, WA8ULG, - AC08-12187

April 1974 - Update

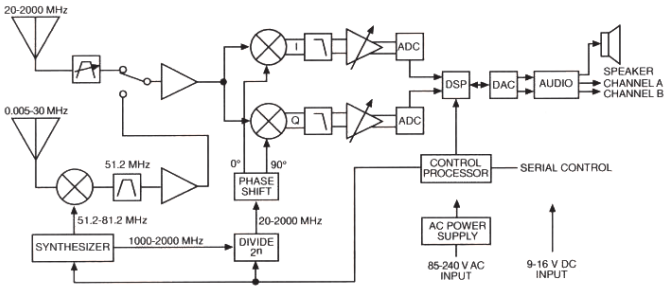
As Rockwell International sought to bring new products to the flagging Collins brand, they considered opening a chain of Pizza Parlors. Imagine, if you will, a Rotund Roman with a spear yelling Collins Collins. This was not a viable undertaking, yet they had all these pizza boxes left over - so someone came up with a neat radio that fit the boxes, and as they say, the rest is history. Until a more definitive story on the birth of the 95S-1A comes up, this is my story and I am stickin' to it. (Please note that this article is appearing in April.)

A look at what the 95S-1 is about

Under the hood of the Rockwell Collins 95S-1A is a very impressive Software Defined Radio (SDR) which predates the amateur community's fascination with SoftRock, FlexRadio Systems ® (and $15 dongles) by a decade or more. Introduced in 1997, and built through the early 2000s, this receiver had a host of new features which simply were not achievable in an earlier time while tuning 5 kHz to 2 GHz. Yet it all fits in a 1RU enclosure. If you are familiar with wide band "snoop receivers", those from the past were not much on performance - other than a huge tuning range. That is not the case with the 95S-1. It tunes SSB (U/L), AM, FM (wide/narrow) and CW with the attributes one would expect of a modern HF communications receiver. It utilizes a Digital Signal Processor (DSP) for filter bandwidth, and there are an immodest 74 filters available down to 100 Hz - with skirts down 60dB at 149Hz. That is a skirt drop off of 60 db in 9 Hz folks. That being said, this write up is directed more toward - ***there is a Collins 95S —*** rather than ***what it is.*** The performance is therefore reduced to a word or two - - darned neat.

Simplified Drawing:

The 95S differs from other previously mentioned SDR boxes in that the I and Q processing happens in the radio, and control and display



alone come from the host computer; This through a serial (RS 232) port used to manage the radio itself. Audio comes from an internal speaker or many other available outputs. The support computer can be rather minimal. I am using an older Dell Laptop with Windows XP Pro. This is because the "heavy lifting" of I-Q processing is, as mentioned, done internally. The specifications state the LO radiation is -110 dBm. In an SDR where the LO is on the receive frequency, that is a downright respectable specification; wonder how they do that? The RF chain takes advantage of as many as four RF gain blocks depending on the band tuned. The gain block is your friend, as typically a block might have 10 dB gain and 20 dB reverse isolation. This means four gain blocks will tame down the LO radiation by 80 dB - neat huh. More esoteric stuff inside, but Radio Physics 101 class for today is dismissed.

My reaction to the original brochure ?

My first reaction was how clunky… looks like a WW1 modem, but Ahhhhhh! . . . this is not your Father's Oldsmobile.

Then - What Am I getting into?

You can always spot an engineer with too much time on his hands. Life is incomplete without the regular perusing of my favorite auction site . . . eBay. Suddenly there it is - - a circuit board and, on closer examination in another auction, a matching case for a Rockwell Collins 95S-1. Well 50 years of hamming has made me a bottom feeder; but a little suspicious of incomplete radios. Yet, I was fascinated. I remembered seeing one of these at Dayton 10 years ago---an all seeing, all dancing, and expensive box directed toward - *Three Letter Agencies* - was my take. So maybe I will chase it for a couple hundred bucks, and it is worth a flyer. This calls for more research; not a lot of detail found at first except a write up on a Chinese site….a Chinese site yet?

Inside the pizza box

Well curiosity turned to lust and ***I gotta have it*** set in - and logic was out the window. I won the case auction first for a mere $450 . . . and then the board for just a pittance at $875. I paid up and time dragged as my new discovery found its way across the country. In a few days, here they are from the very pleasant and helpful seller. . Now what?

Well after some missteps and false starts, we got it to boogie. Now the hard part, the steep learning curve of a mnemonic driven radio with a crude GUI. Well, at least it was not well north of a Kilo-buck down the rat hole . . . it runs. Now, let's see what it can do. . . . What a cool box!! . . . Indeed, it's like, well . . . Pizza Supreme. There are a couple of these in the CCA Community and I chatted up those players to see what was known. A variant on this radio is the 95V-1 which is intended to fit within a VME (this is an older Motorola computer processor standard) cage; a standardized buss system and computer interface. Some additional research also disclosed an interesting experimental satellite application for the 95V:

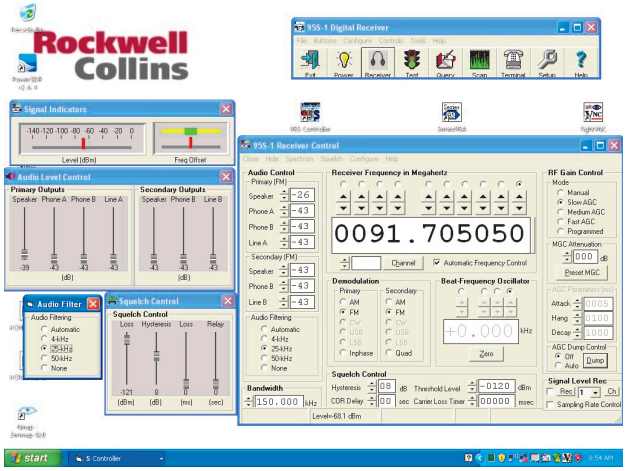
http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=2234&context=smallsat

It is also noteworthy that the development work for this application, a flying radio lab, turned the receiver into a transceiver by invoking the properties of its I-Q based architecture. Maybe this reads on the future of this nifty rig for amateur radio applications.

In for a Penny, In for a Pound

Buoyed by my recent success, I grabbed another 'kit' a few weeks later. It also came right up. I hope to see more of these and find some boards at Dayton for $10 . . . The Bottom Feeder's dream! A cautionary note---if you happen to get one of these that is broken, I'll bet it stays broken. Without a lot of experience and access to some custom parts, this system goes beyond "ham shack" repair capabilities. So far I have been lucky. I got lucky and located some updated software of the so called -004 series that turns the earlier clunky GUI into something lovely with lots of add-ons and functionality.

A screen shot of the 95S-1 in use – Later GUI



The add-ons to the left are selected from a library available under ***Controls*** so you can select what is interesting for the signal you are looking at. This display is derived from what is thought to be the latest software produced for this receiver (Rev 091-1393-004). The receiver has two detectors, so two selectable detected outputs are available for the signal tuned. One of the boxes of the GUI (shown at ***Demodulation***) allows the selection of the I and Q outputs - which are then available through a kind of hinkey 1/8" stereo jack.

Half a Loaf

In some references there is made mention of what is called a mezzanine board (probably third party), where data is passed internally from the main 95S board to an add-in board for subsequent processing. A lot of things are not documented. For example, the radio can time stamp, and GPS stamp, reception but with attributes that are brought into a mezzanine board. Probably somewhere a little box lies around that opens up this mystery world. I was going to call NSA, but it seems they have their hands full just now. Perhaps as more of these come into the ham community, more utility will drift over the transom which will benefit us all. For your light reading enjoyment, a 200 page instruction manual with component level schematics is also available.

WA8ULG an Expert?

Hardly, just in my Freshman Year with the 95S-1. It is a fascinating item and worthy of the name Collins. Keep your eyes peeled for pieces and software and maybe we will all get a little smarter.

End note

So welcome *Mr. SDR* to the family. In my shack here, I also have an early 51J (s/n 221) which is a long way in time, and technology, from our latest addition. Between these bookends are A line, S line, 51J4, an 820D-2 and a couple 651S-1s . . . and, yes, the odd Kachina (or two) - and of course a Flex.. I have spent a lifetime (almost) in and around radio and love to see the evolution of the art. This receiver is a notable addition and, in this case . . . Thanks Art. Nice Vision

Ted Hartson, WA8ULG - Parks, AZ awombat@earthlink.net

Did You Know?

It is clearly recognized today that brand management, and a company's "image" is something to be cleverly conceived and carefully controlled. It is pretty obvious that, in the early days of Collins Radio, such control was not paramount and that the brand image – the winged emblem – kind of "snuck up" on them. There were no less than seven "winged" emblems in the period between the company's incorporation in 1933 and the adoption of the "classical" winged emblem as we recognize it today on our '40s through '60s equipment.

When it came time to incorporate the company in late 1933, Art Collins needed a logo for his new stationary that would be used in the new company's business. He did not have one. The local stationary store that was to supply the letterhead paper for Collins was asked to design one. The result was the very early elongated "truly winged" emblem. It is now sometimes referred to as the Early Globe Emblem.

It did not last long. By the presentation of one of the first ads to actually carry a logo (in February of 1934), the wings on the Globe Emblem had gotten shorter and the globe rendering less cryptic.

Then it changed again in the 1935 Letterhead.

... and again in the 1934 February QST 30DXB Advertisement

This evolution of the early logo continued in a rather uncontrolled manner until it was decided within the Collins ranks that they needed a new more modern logo. During this same time period (Oct. 1935), the original very elongated globe emblem even showed back up in one ad.

Now, on January 4, 1930, Arthur Collins had married Margaret (Peg) Van Dyke of Cedar Rapids. In the process, he acquired a Brother-in-Law – Jack Van Dyke. Jack was already a recognized artist at that time.

Sometime between 1935 and early 1936, Art asked his Brother-in-Law Jack to design a new more modern logo for the growing Collins Radio Company. The result was an intriguing logo that ran concurrently with the old logo but only for 3 months in 1937 in Communication Magazine Collins ads. It was a very art deco-like rendering of what evolved to be the now "Winged Emblem". At the same time, Collins continued to run their old and now again elongated Globe Emblem in QST.

In April of 1937 the first use (above) of the famous – but still evolving Winged Emblem appeared in QST. It had only three bars and was not very stylized.

Finally in October, 1944 . . . . .

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Understanding the 95S-1 DSP Receiver

Preface: As with most any receiver, the casual observer could spend a great deal of time wondering about its design. The curiosity of a receiver designer can stir even more interest. Here are some comments, questions, and a few insights given to me by Bob Sternowski, one of the original design engineers of the 95S-1. The 95S-1 was designed by Rockwell-Collins in the 1995-1996 time frame. Although there has been the suggestion that the model "95S-1" derived from the 1995 design date, Bob said he did not believe this was the reason for the model name. The 95S-1 covers a wide frequency range (0.1-2000 MHz) and, with its DSP capability to potentially vary bandwidth and demodulation tasks, it is interesting that the 95S-1 had a short production lifespan. Bob told me the reason for this was internal to Rockwell-Collins. The 95S-1 was "killed off' because it was viewed as a threat to other Rockwell product lines.

As with several other receiver conversion architectures, in the 95S-1, analog mixing techniques convert signals in the HF band to an IF of 51.2 MHz. At this point, "direct conversion" mixes the signal to a "zero IF". For signals in the VHF/UHF bands, there is no analog conversion at all. All signals are mixed directly to zero IF. Of course, zero frequency implies DC, and, in fact, this is one of the problems with a "direct conversion" receiver design. The issue is that local oscillator (LO) signal leakage to the mixer RF input port can combine with the local oscillator signal at the mixer LO input port to produce a "DC offset" at the mixer output port. If the mixer output port is DC connected to the following amplifier stages (as appears to be the case in the 95S-1) it is possible that the DC offset could saturate the amplifiers or reduce their useful dynamic range. DC offset can also be produced by 2nd order amplitude distortion when an in-band interfering signal is present. (the explanation of this is beyond the scope of this article) There are techniques for reducing these problems, but it is not clear how the Rockwell-Collins engineers addressed them.

Local oscillator radiation is another problem that presents a difficult engineering problem in the design of the direct conversion receiver. In the VHF/UHF band, the local oscillator is at the same frequency as the RF input signal, so no amount of RF filtering at the receiver input can reduce the LO level radiated by the receiving antenna. LO radiation is often an important issue for government customers. Solving this problem requires a great deal of attention to mixer LO-RF isolation, the application of reverse isolation of all amplifiers in the RF chain, and meticulous shielding of the LO circuitry from the RF portion of the receiver.

I-Q Processing: The RF input signal is fed to a pair of mixers. The LO for these mixers is split into two paths, one in quadrature (90º) with the other, using some clever circuitry. This scheme creates an "I" output from one mixer that is "In-phase", and a "Q" output from the other mixer that is in "quadrature". One advantage of having I and Q components is that they define all amplitude and phase characteristics of the signal. The I and Q signals are then digitized by separate A/D converters, and the results processed by the digital signal processing (DSP) circuitry. With I and Q signals available, the DSP can produce an "image reject mixer" configuration for the receiver. In the direct conversion receiver, this would have the affect of rejecting the undesired sideband. The circuitry used to create the 90º split in the LO is interesting. The design engineers used 6 identical "cross-connected" transformers in the implementation. These transformers are commonly used to construct directional couplers, but the designers used them as splitters, baluns and phase shifters. This is a clever effort to improve component commonality.

Comments: The schematic diagram indicates that the LO quadrature phase split can be bypassed, and a standard "zero degree" split substituted. I'm not sure why this feature is included, but would like to know.

A question I had while looking at the 95S-1 specifications concerned the Image Rejection specification, which is stated as ">100 dB".

Although this number is reasonable for the HF frequency range of the receiver which uses the "up-conversion" 1st IF, it may be misleading if applied to the VHF/UHF frequency range. Since the only "image" created in the VHF/UHF frequency range is the "unwanted sideband" of the "image reject mixer", I think the 100 dB number may not be correct. Although there are modern automatic quadrature error correction techniques that have been developed over the past 10 years or so that improve image rejection, I doubt that the digital hardware or algorithms were available to engineers in 1995. However, I could be wrong. Normally a good image reject mixer might only provide 40dB image rejection, and even this is very difficult when the LO covers a range of 20-2000MHz. With modern adaptive correction techniques, this perhaps could be improved to 100dB, but this is current state of the art. Maybe one day further light can be shed on this subject. If the Rockwell-Collins engineers were achieving this in 1995, my hat is off to them!

95S-1 Specification

Frequency range ..... 0.005 to 2000 MHz

Frequency resolution ..... 1 Hz

Tuning time ..... 13 ms typ. w/ AGC off

Frequency setability .... +0.1 PPM, using electronic adjustment of the internal standard

Frequency accuracy ..... +1 PPM, 0 to 50 deg C

Synthesizer noise ..... Characterized as follows:

Frequency Separation	Noise Power @fo=100 MHz	Noise Power @fo=1000 MHz
10 Hz	-55 dBc/Hz	-40 dBc/Hz
100 Hz	-90 dBc/Hz	-75 dBc/Hz
1 kHz	-105 dBc/Hz	-94 dBc/Hz
10 kHz	-110 dBc/Hz	-94 dBc/Hz
100 kHz	-135 dBc/Hz	-120 dBc/Hz
>1 MHz	-145 dBc/Hz	-140 dBc/Hz

Noise figure
0 to 30 MHz antenna ..... 14 dB (typ)
20 to 2000 MHz antenna .... 12 dB (typ)

External standard in ..... 1, 5, and 10 MHz

External standard level ..... 0 dBm (typical)

BFO ..... 1-Hz step, range of +/-4 kHz

Serial control

Interface RS-232/RS-422/RS-485

Data rate ..... 75 to 38,400 bits/sec.

Format .... 8 data bits or 7 data bits w/ 1 par. bit

Inter. preselector .. 20 - 2000 MHz (Dual conversion used for f= < 20 MHz)

Demodulation modes .. CW, SSB, ISB, AM, FM, I/Q

Carrier operated relay .... Included Standard

AM sensitivity ..... 30% amplitude mod. (400 Hz w/ bandwidth of 6.4 kHz f/ 10 dB (s+n)/n)
0.1 to 30 MHz ..... 3 uV
>30 MHz..... 2 uV

FM sensitivity .... SINAD of 12 dB with BW of 12.8 kHz
2 to 30 MHz ..... 1.1 uV
>30 MHz..... 0.5 uV

SSB/ISB/CW sensitivity ..... SINAD of 10 dB with bandwidth of 3.2 (1.6 CW) kHz and the input signal - tuned 400 Hz from the dial frequency
0.005 MHz..... 13uV (typical)
>0.1 MHz..... 0.4 uV

Second order input intercept
<30 MHz ..... +80 dBm (typical)
>30 MHz..... +60 dBm (typical)

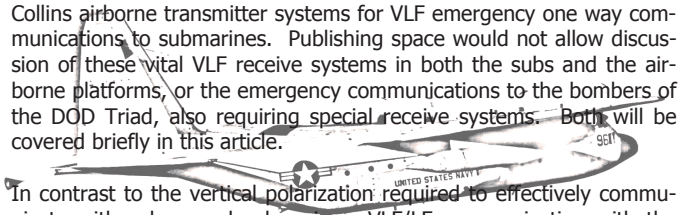
Third order input intercept
<30 MHz..... +25 dBm (typical)
30 to 500 MHz ..... +7 dBm (typical)
>500 MHz ..... 0 dBm (typical)

Image rejection ..... >100 dB

VLF Receivers at Collins Radio - - The other Side of the TACAMO Coin - -

by Loney Duncan, WOGZV - AC13-12852

The TACAMO article in the last issue of the *Signal* mainly covered the Collins airborne transmitter systems for VLF emergency one way communications to submarines. Publishing space would not allow discussion of these vital VLF receive systems in both the subs and the airborne platforms, or the emergency communications to the bombers of the DOD Triad, also requiring special receive systems. Both will be covered briefly in this article.



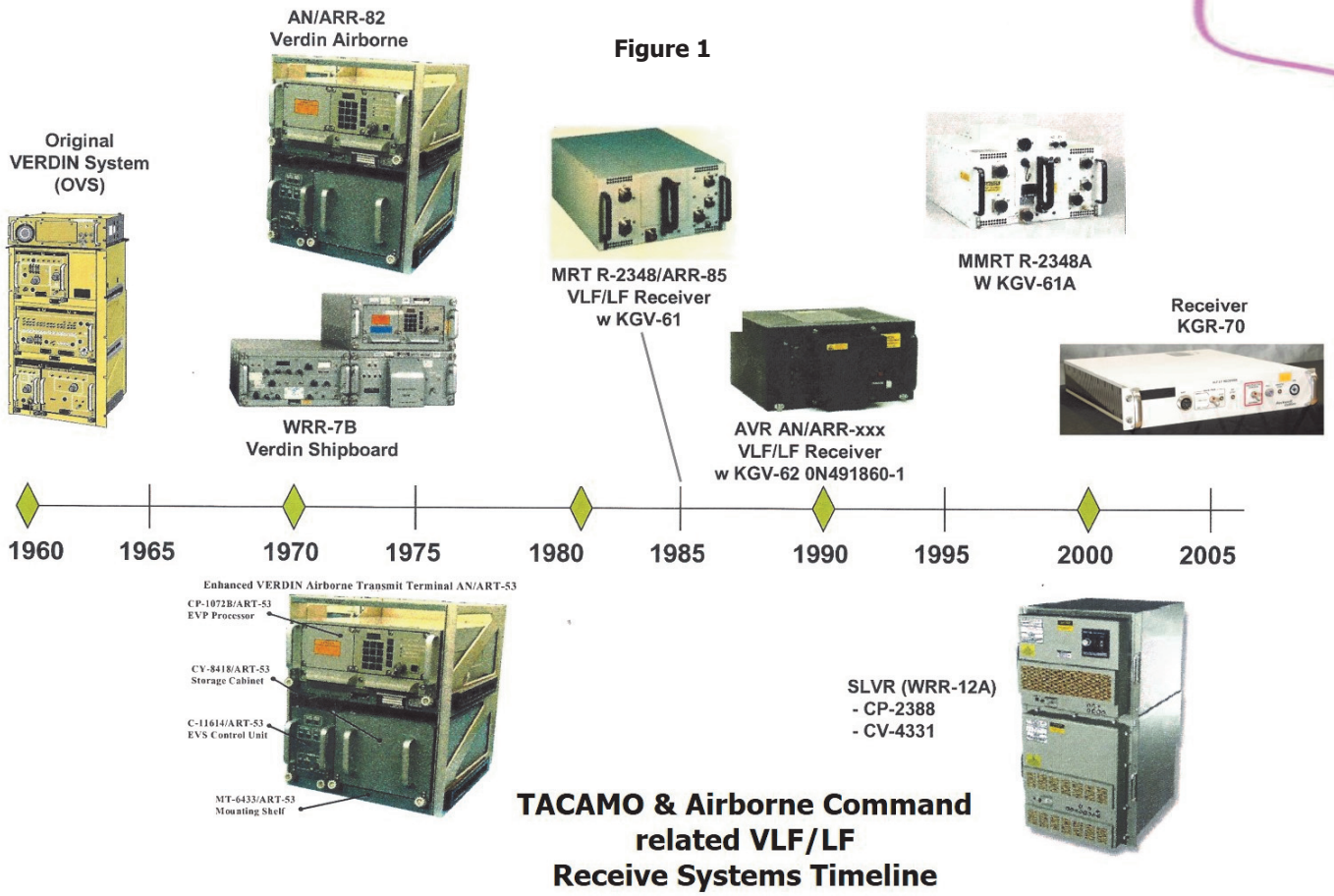
In contrast to the vertical polarization required to effectively communicate with submerged submarines, VLF/LF communication with the Strategic Air Command (SAC) bombers can be accomplished with the horizontal polarization of the TACAMO "straight and level" flying trailing wire antennas. No orbiting maneuver is necessary. The receive antennas on these bombers are compact loop types, and the receive systems are very similar in function to those on the submarines. Originally, emergency comm to the bombers came from the Air Force Airborne Command Post EC-135s, but as stated in the TACAMO article, it now comes from the Navy E-6B integrated airborne platform that provides the total emergency comm to the DOD Triad.

These VLF/LF receive systems, whether on subs, the TACAMO E-6B, SAC's B-52s, or the Advanced Airborne Command Post E-4B, all contain special processing features to insure a secure and anti-jam received signal. First of all, the signal is encrypted at the transmit end, and processed with encryption key-sets at the receive end. Further, the signal is a spread spectrum type to combat jamming. This, in turn requires the high MSK [1)] 800 and 1600 b/s keying rates of the TACAMO transmitters, and special signal processing of this spread spectrum signal in the receive systems. It should be noted that, after recovery processing, the resulting emergency message is delivered at a relatively low digital rate. The high keying rates have secured it and made it highly immune to jamming, an absolutely crucial requirement in the decision process to deliver nuclear warheads.

Collins involvement in the development of these receive systems, as illustrated in Figure 1, roughly parallels the TACAMO period, and continues today with a just received development contract for the next generation VLF/LF airborne receive system. When you consider the original **VERDIN** (**VER**y low frequency **D**igital **I**nformation **N**etwork) system on the left, and the latest KGR-70 system on the right, you see - of course - the profound effect that a half century of semiconductor technology explosion had on the evolution of these systems. A few of these systems will be briefly discussed.

The original VERDIN airborne receive system on the left was developed with discrete components, including mag core memory and very simple computer processing. Its Collins R-1590 receiver was a double conversion superhet (with impulse noise hard limiting) that received a single RF signal, used a single demodulator, and was tuned by a thumb wheel assembly. The system employed a cesium frequency/

Figure 1



time standard. Most of the hardware was for processing and controlling the demodulated digital signal from the VLF receiver.

Airborne versions of the VERDIN receive and transmit terminals that were used on TACAMO IV are shown as the ARR-82 and ART-53 units respectively. These were considered "enhanced" VERDIN units with updated semiconductor technologies developed by the early 1970s. A "floating" limiter circuit was employed in the receiver which considerably improved performance in the presence of impulse noise. The R-2141 receiver (production R-1590), the encryption key-set, and the rubidium frequency/time standard were separate from the illustrated terminals. Power supplies for these terminals were airborne 400 Hz types.

The WRR-7B VERDIN Shipboard (submarine) system was similar to the enhanced airborne system, but used the Collins R-1738 receiver (left unit in the WRR-7B graphic). It up-converted the 14-30 kHz VLF range to 340 kHz for the first IF, and down-converted to 7.5 kHz for the second. The airborne R-2141 had a similar frequency plan, though not identical.

In the mid-80s, the Air Force desired an upgraded receive system for its B-52 and B-1 SAC bombers to receive VLF emergency messages from its Airborne Command Post EC-135s. Rockwell Collins won a highly competitive contract for the MRT (Miniature Receive Terminal) system. As developed, MRT had three input RF channels (same frequencies) for 3-axis loop antennas, and digitized the receiver IF output for software demodulation and subsequent processing. It could scan up to five VLF/LF signals. Further, it could dual mode process an MSK spread spectrum signal (800 or 1600 b/s), and an FSK 50 b/s signal. MRT housed the KGV-61 encryption unit and integrated the RF receiver, in contrast to the VERDIN receive terminals of previous years where these were separate. Obviously, high level semiconductor integration played a major role in this miniaturization.

A decade later, this receive system was upgraded by both hardware and software for enhanced signal processing and the inclusion of the improved KGV-61A encryption unit, to become the MMRT (Modified Miniature Receive Terminal). MMRT replaced the VERDIN airborne receive system on the TACAMO E-6B, and was installed on the Advanced Airborne Command Post E-4B. Both are operational today.

By far, the greatest technical advancement in these receive systems came with the KGR-70 system. The total 14-60 kHz VLF/LF range was digitized at the antenna to baseband with a fast, high dynamic range A/D converter. My corporate staff boss, Bob Cattoi, at the time chief engineer of Rockwell, for years visualized "putting a computer on the antenna" for receivers. Now, at least at VLF/LF, this was accomplished. This resulted in five concurrent RF receive channels (not scanned as with MRT), each digitally demodulated with automatic mode recognition for 50, 800 and 1600 b/s, thus resulting in fifteen demodulated outputs. In comparison, the VERDIN systems had one demodulation, and MRT/MMRT had two.

The NSA mandated encryption key-set was integrated into the KGR-70 and this new design resulted in a substantial reduction in weight, volume, and power compared to the previous receive systems.

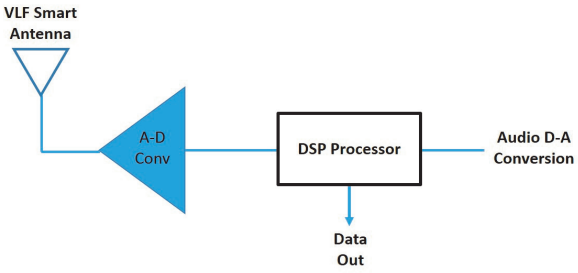
The new, next generation receive system will build on the KGR-70 architecture, use improved semiconductor components, and improved signal processing. The front end A/D converter, for example, will have a significantly higher clock speed thus providing additional RF bandwidth and dynamic range.

Collins and Rockwell Collins have been involved in these VLF/LF receive systems for more than 50 years, considering the present development contract. Because of the digital nature of these systems, a much more radical technical evolution occurred over this long period than with the TACAMO transmitter systems of the previous article. This rapid evolution was largely driven by the stunning semiconductor evolution during that same period.

Figure 2

The KGR-70 Receive System

The Receiver Architecture of the Future is



I have a friend who spent several years as a navigator aboard one of the Polaris subs of the 1960s. Jim told me that at all times they were at T-minus 15 minutes of launching a missile with nuclear warheads. But when they received a TACAMO emergency message, they were at T-minus 2 minutes, and never knew whether it was a practice drill or not until they were told to stand down - - a chilling reminder of the importance of these receive systems with their secure and jam resistant attributes to accurately receive that command message.

Note 1 – MSK (Minimum Shift Keying) was developed by Collins Radio in the early 50s to enhance the performance of "Shift Keying" system used in several communications markets including microwave.

The Service Line

Collins Receiver Performance Over the Years

by Don Jackson, W5QN - AC03-11523

A Little Radio History

When radio receivers were in their infancy, there was only one type, which was known as the Tuned Radio Frequency (TRF) design. This design was very simple, consisting of several RF amplifier stages, all tuned to the desired receive frequency with L/C tuned circuits. Following the amplifiers was a detector stage and an audio amplifier. This design was adequate for receiving AM broadcast signals, but as the desired receive frequency increased, it became difficult to achieve the required gain to drive the detector without instability (oscillation) occurring. In addition, achieving adequate selectivity became very difficult at higher frequencies. Even if a single tuning stage could be constructed with this selectivity, having several stages "tune" together was very problematic.

Another popular early receiver type was the regenerative detector, invented by Edwin Armstrong in 1914. With this approach, feedback in a tuned RF amplifier was adjusted to a point just below oscillation. This adjustment was touchy, but produced a great deal of gain in a single amplifier stage. It also resulted in a fairly narrow RF bandwidth for such a simple circuit. It was quite effective considering its simplicity, but it became a "transmitter" if it broke into oscillation, was not very stable, and had poor linearity. A modification to this design was an even more sensitive circuit, the super-regenerative detector. In this concept, the amplifier actually was designed to oscillate in a pulsed fashion. Of course, this created a low power pulsed transmitter by design, so was not popular for military or commercial applications.

The Superheterodyne Receiver

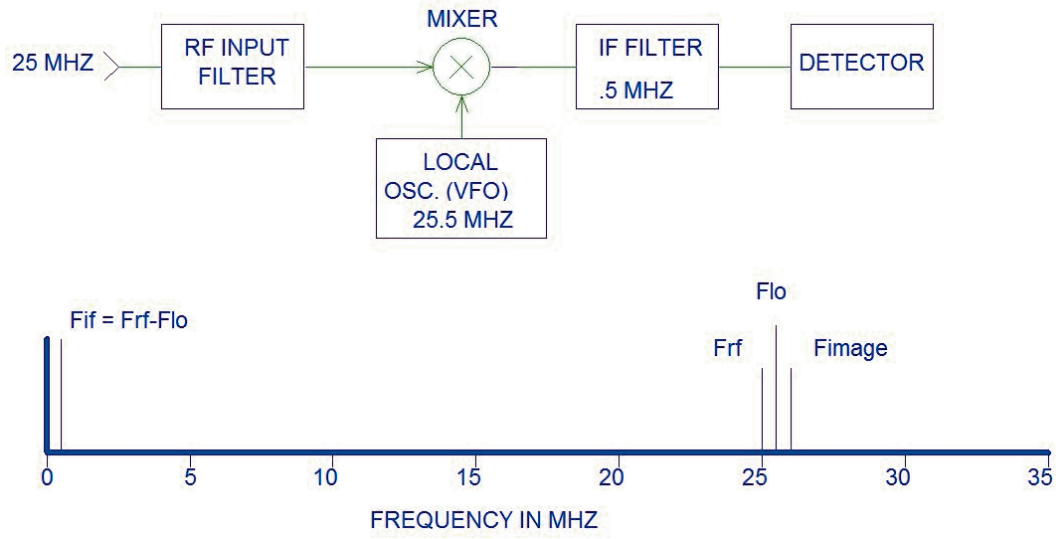
The superheterodyne (usually abbreviated to "superhet") receiver concept is the solution to most of the early receiver problems. The superhet design was also invented by Edwin Armstrong in 1918, and revolutionized receiver design. However, there is usually no "free lunch" in the engineering world, and the superhet design creates some challenges that must be considered. There are a huge number of possibilities for the "frequency conversion plan" used in superhet design, but we will follow along the trail of the Collins engineers starting with their earliest receivers, A-Line, S-Line, KWM-380, and the 95S-1. All are superhet receivers and have certain things in common:

at least one mixer
at least one local oscillator (f_{LO})
at least one intermediate frequency (f_{IF})

The mixer function is the most important concept to grasp in order to understand how a superhet receiver works. In its ideal form, a mixer is simply a device that multiplies two input signals (f_{RF} and f_{LO}) together. Considering the simplest case, where f_{RF} and f_{LO} are sinusoids, the mixer output consists of two sinusoids: f_{RF}-f_{LO}, and f_{RF}+f_{LO}, which we will call f_{IFhi} and f_{IFlo}. In the case of a complex f_{RF} input and a sinusoidal f_{LO}, the two IF output signals are essentially copies of the RF signal, translated to new frequencies. The only other difference between f_{IFhi} and f_{IFlo} is that they are "spectrally inverted" with respect to each other. Which of the two mixer outputs is "inverted" depends on whether f_{LO} is larger or smaller than $f_{RF.}$ Note that if f_{LO} is greater than f_{RF} , f_{IFlo} is a negative value. However, the sign is irrelevant to the problem, as a "plus" or "minus" sign simply indicates a phase inversion.

So, let's look at an example of a "single conversion" (one mixer) superhet receiver and examine the advantages and disadvantages. Assume we wish to receive an f_{RF} signal at 25 MHz, and we have a detector that functions well at .5MHz. If we apply a 25.5MHz f_{LO} to the mixer LO input, and f_{RF} to the mixer RF input, the output of the mixer will consist of f_{IFlo} at .5MHz, and f_{IFhi} at 50.5MHz. Clearly, we want to use f_{IFlo}, and remove f_{IFhi} from the input to the detector with a lowpass filter. A block diagram and spectral diagram are shown in Figure 1.

Figure 1 – Single Conversion Superhet



The resulting receiver has the following advantages:

- The desired RF frequency can be varied by simply adjusting the LO frequency.
- Selectivity is provided by a filter at the relatively low IF frequency.
- The IF filter does not have to be tuned as the RF frequency is varied.
- Most of the receiver gain can be implemented at the low IF frequency.

Continued on p 45

These are huge advantages for a receiver design. So, why isn't the single conversion superhet a "free lunch"? Here are a couple of disadvantages:

The design requires a very stable LO, which is difficult for an analog variable 25.5MHz design.
Undesired RF input frequencies may produce output at the .5MHz IF frequency.

Clearly, designing a stable variable frequency oscillator (VFO) operating at 25.5MHz is much more difficult than it would be at a lower frequency. And, the problem just gets worse as the RF input frequency rises. Until the invention of the frequency synthesizer, which allowed multiple selected LO frequencies to be locked to a single stable reference frequency, this was a difficult problem to solve.

Receiver Responses to Undesired Input Frequencies

Undesired, or "spurious responses" as they are usually known, are the bane of the superhet, and considerable design attention is required to keep these responses at a low level. With a TRF tuned to 25MHz, the receiver detector theoretically will only see a 25MHz signal. However, since there are inherent non-linearities created by the amplifiers, input signals at the sub-harmonics of 25MHz (i.e. 12.5MHz, 8.333MHz, etc.) will also create an output at the detector. Unfortunately, the problem becomes far greater with a superhet design, and you now have at least one additional signal (the local oscillator) to contend with. Mixing of the LO (and its harmonics) with an RF input signal (and its harmonics) create a wide variety of input frequencies that produce an output at the detector. Let's consider our single conversion receiver of Figure 1. Assume a 25.25MHz signal at the input of this receiver. The 2nd harmonic of this signal is 50.5MHz. When this harmonic mixes with the 2nd harmonic of the LO (51.0MHz), the result is a .5MHz signal at the detector. Unfortunately, this is exactly at the center of our .5MHz IF band. The example given here is known as a "2RF X 2LO" spurious response, but there are many others to consider. And, as you can imagine, adding even more LO sources to the receiver escalates the "spurious response" problem.

The good news is that the class of spurious responses described above is considerably attenuated from the level of the desired signal because the strength of harmonics are much lower than the fundamentals. However, there is one "undesired" input that is of primary consideration, and is known as the "image" frequency, f_{IMAGE}. Consider the output of the mixer with a 26MHz RF signal present at the antenna. In this case, f_{RF}-f_{LO} would be -.5MHz. (Again, the "minus" sign may be disregarded.) This "image" response is passed through the receiver with the same gain as that of the desired 25MHz input signal. Therefore, it is imperative that the "image" be attenuated by input filtering or other means. Unfortunately, in our example, the 26MHz image is only 1MHz away from the 25MHz desired signal. A bandpass filter centered at 25MHz would solve the problem, but designing such a filter that would attenuate 26MHz by at least 50dB, and be automatically tunable with f_{RF}, would present an extremely difficult production engineering problem. The image frequency is given by the equation:

$$f_{IMAGE} = f_{RF} \pm 2 * f_{IF}$$

If $f_{RF} > f_{LO}$, the "minus" sign is used. For $f_{RF} < f_{LO}$, use the "plus" sign.

Double Conversion Superhet

So, how can we get around these two problems inherent in the single conversion design? Enter the double conversion superhet design. With double conversion, we typically have a first conversion that uses a stable crystal controlled LO, and a second conversion stage using a stable VFO that is used to tune to the exact desired RF input frequency.

Let's tackle the same receiver scenario as before, with an f_{RF} of 25MHz, and f_{IF} of .5MHz. In this case, let's choose a "first IF" (f_{IF1}) of 3MHz. Given this choice for f_{IF1} , the "first LO" (f_{LO1}) is chosen to be 28MHz. For stability, f_{LO1} will be fixed and crystal controlled. The "second LO" (f_{LO2}) is chosen to be 2.5MHz, providing conversion of f_{IF1} (3MHz) down to f_{IF2} (.5MHz). The block diagram and spectral diagram might appear similar to that in Figure 2 below.
How does this help us? First, our analog tuning function can now be provided by a VFO at 2.5MHz, which is much easier to realize than a VFO at 24.5MHz, as required by the single conversion design. This is not to say that even a low frequency VFO is an easy design task. It was not until around 1945, when Collins developed the "Permeability Tuned Oscillator" (PTO), that a suitably stable variable oscillator with excellent tuning linearity became available.

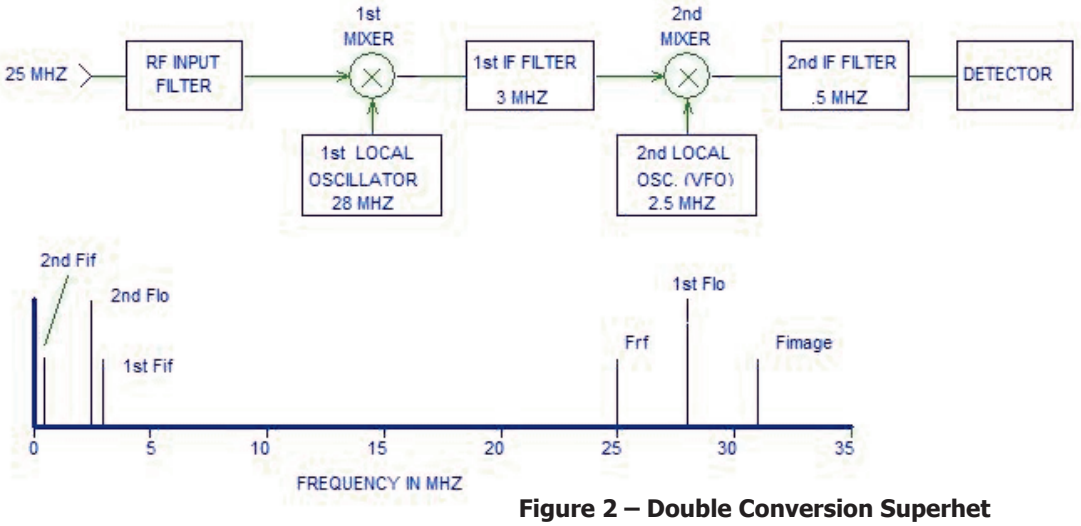


Figure 2 – Double Conversion Superhet

Secondly, our first conversion image frequency is now centered at 19MHz. The spacing between f_{RF} and f_{IMAGE} becomes 6MHz. Building a tunable RF input bandpass filter to provide 50dB image rejection becomes feasible with the double conversion superhet design. Note that although every mixing stage has an associated "image" frequency that must be considered, the image in the first conversion stage is nearly always of primary consideration.

Note that the bandwidth of the 1st IF Filter must be at least as wide as the tuning range for each "band" selected by a 1st LO crystal. In other words, if each selectable band covers .2 MHz, as in the S-Line, the 1st IF Filter must be at least .2 MHz wide, and the 2nd LO must tune over a .2 MHz range.

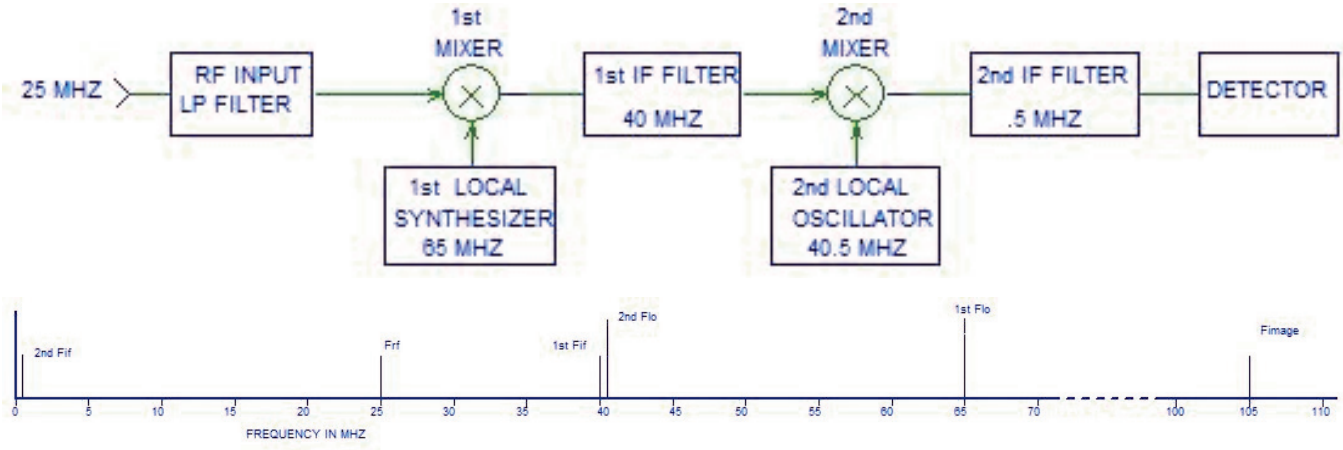


Figure 3 – Up-Converting Double Conversion Superhet

The primary disadvantage of the double conversion scheme is that the "spurious response" problem becomes more complex due to the addition of a second local oscillator. Very careful attention must be paid to the choice of IF and LO frequencies to eliminate the spurious responses to the extent possible.

Modern HF Receiver Design

The introduction of frequency synthesizers allowed another approach to the design of HF receivers. For the first time, the design engineer had a stable, tunable VHF local oscillator available. With such a device, the receiver designer could conceivably go back to the single conversion superhet. However, the image rejection problem was still an issue. Fortunately, effective solid state VHF amplifiers had become available, as well as relatively narrowband VHF crystal, SAW (Surface Acoustic Wave) and ceramic filters. These developments allowed the implementation of what is often called an "up-conversion" superhet design.

In this design concept, the RF input signal in the HF band is converted to a first IF in the VHF range, where it is filtered by a fixed bandpass filter. A second conversion mixes f_{IF1} down to f_{IF2}. But, why is this any better than the single conversion implementation? The answer becomes apparent when you calculate the image frequency for this scheme. Let's once again assume an f_{RF} of 25MHz, and f_{IF2} of .5MHz. As an example, choose f_{IF1} to be 40MHz. This means f_{LO1} is 65MHz. Using our formula for calculating f_{IMAGE}:

$$f_{IMAGE} = f_{RF} \pm 2 * f_{IF} = 25MHz + 2*40MHz = 105MHz$$

In fact, notice that for f_{RF} between 1MHz and 30MHz, f_{IMAGE} is from 81MHz to 110MHz. What this means is that the required image rejection over the entire HF tuning range can be achieved with a simple 30MHz lowpass filter at the receiver front end. Tunable bandpass preselector filters are not required. This approach not only provides much improved image rejection using a simple input lowpass filter, it also provides "IF rejection" (an RF signal appearing at the antenna that happens to be at f_{IF1}) and attenuation of f_{LO1} radiated at the antenna port. The KWM-380, 651S-1, HF-2050, and 95S-1 all use this basic up-conversion concept. Figure 3 shows an example of the "up-conversion" frequency plan with an RF input signal of 25MHz.

Collins Receiver Conversion Schemes

Collins engineers were well aware of the advantages of the double conversion superhet advantages, and every receiver from the 51J series through the 75S series used this basic conversion philosophy. With the double conversion approach, high performance general coverage of the HF band can be achieved by simply changing crystals in the first LO, while all circuitry beyond the first mixer remains the same. Below is a table showing the pertinent frequencies for a selection of Collins receivers.

It is clear that Collins used a variety of conversion plans to optimize receiver performance, spurious responses and tunable bandpass filter design. The 51J-4 uses single, double and triple conversion schemes, depending on the region of the HF band to be tuned. The modern receivers using digital synthesizers all use the up-conversion scheme, and these designs show a marked improvement in image rejection compared with their early vacuum tube counterparts.

Conclusions

The superhet concept is the basis for all Collins receivers, even the most modern design, such as the 95S-1. The specific conversion scheme chosen was dependent on receiver specification requirements and the technology available.

This discussion by no means is intended to suggest that the proper choice of superhet schemes solves all receiver design problems. It does not. However, the basic conversion scheme is usually the starting point for a receiver design, and this dictates basic requirements for each stage in the receiver. From that starting point, many other factors must be considered to meet a variety of issues. A wide variety of receiver "spurious responses" to signals at the receiver input port (in addition to the image) are created by mixing of harmonics of the local oscillators. Additionally, internally generated signals (local oscillator harmonics or digitally generated artifacts) can result in unwanted outputs if careful attention is not paid to shielding and grounding. Nevertheless, I hope this discussion provides an idea of the basic concepts involved in the choice of a frequency conversion plan for a superhet receiver.

Cheers,

Don W5QN w5qn@verizon.net

Corrections & Addition regarding the Q3 & Q4 2013 issues:

The Editorial Staff would like to apologize and offer the following corrections. For Q3 2013, the **On The Cover** caption at the bottom of page 5 mistakenly identified the launch as Apollo 8. It should have been "Gemini 8" .. For Q4 2013, in the TACAMO article: - First sentence in text above Figure 21 on page 17 should read "The E6B aircraft was reconfigured . . ." - and the Figure 21 caption should read "E6B" - Figure 20 caption should read "HPTS E6B in Flight with Drogues Coming Out . . . ." - Finally, Page 14, footnote 1) The LEBUS mechanism is a free running guide for the incoming wire that assures that placement of the wire on the reel is exact. Adapted from the drilling industry.

HF Collins Radio Receivers
A sampling of Conversion Scheme Characteristics

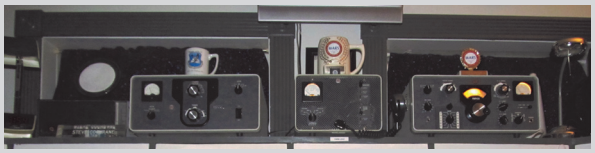
Collins Model	RF Input (MHz)	1st LO (MHz)	1st IF (MHz)	2nd LO (MHz)	2nd IF (MHz)	3rd LO (MHz)	3rd IF (MHz)	Image Rej. (dB)	Weight (lb)	Volume (cu.in.)	Date (approx)	Spectral Inversion	Dim (in)
51F	1.5-20.0	(RF +/- .456) ?	0.456					75(at 5MHz)	22	1330	1939	?	7X10X19
75A-1	3.2-21.8	5.7-23.3	2.5-1.5	2.0-3.0	0.500			50	57	3578	1946	NO	21.1X12.2X13.9
75A-1	26.0-30.0	31.5-33.5	5.5-3.5	6.0-4.0	0.500							NO	
51H-3/ARR-15	1.5-2.5	2.0-3.0 (PTO, High Side)	0.500					?	39	1775	1950	YES	7.9X10.4X21.6
51H-3/ARR-15	2.5-3.5	2.0-3.0 (PTO, Low Side)	0.500					?				NO	
51H-3/ARR-15	3.5-5.5	4.0-6.0 (PTO X2,High)	0.500					?				YES	
51H-3/ARR-15	5.5-8.5	6.0-9.0 (PTO X3, High)	0.500					?				YES	
51H-3/ARR-15	8.5-12.5	8.0-12.0 (PTO X4, Low)	0.500					?				NO	
51H-3/ARR-15	12.5-18.5	12.0-18.0 (PTO X6, Low)	0.500					?				NO	
R-390	.5-8.0	Sel.Xtal (7.0-12.6)	9.0-18.0	Sel.Xtal (12.0-18.6)	3.0-2.0	3.455-2.455	0.455	?	85	3192	1950	NO	10.5X19X16
R-390	8-32.0	Bypassed	Bypassed	Sel.Xtal (11-34)	3.0-2.0	3.455-2.455	0.455					NO	
75A-2/3	1.5-2.5	Bypass	1.5-2.5	1.955-2.955	0.455			50	50	3482	1950/1952	YES	21.1X12.5X13.2
75A-2/3	3.2-21.8	Sel.Xtal (5.7-23.3)	2.5-1.5	2.955-1.955	0.455							NO	
75A-2/3	26.0-30.0	Sel.Xtal (31.455,33.455)	5.455-3.455	5.910-3.910	0.455							NO	
R-390A	.5-8.0	17.0 Xtal	17.5-25.0	Sel.Xtal (20.5-27)	3.0-2.0	3.455-2.455	0.455	60	85	3192	1954	NO	10.5X19X16
R-390A	8-32.0	Bypassed	Bypassed	Sel.Xtal (11-34)	3.0-2.0	3.455-2.455	0.455					NO	
75A-4	1.5-2.5	Bypass	1.5-2.5	1.955-2.955	0.455			50	35	2804	1955	YES	10.5X17.25X15.5
75A-4	3.2-30	Sel.Xtal(5.7-31.5)	2.5-1.5	2.955-1.955	0.455							NO	
51J-4	.5-1.5	12.0 Xtal	11.5-10.5	8.0 Xtal	3.5-2.5	3.000-2.000	0.500	40	43	2993	1957	YES	10.5X19X15
51J-4	1.5-3.5	Bypassed	Bypassed	Bypassed	Bypassed	2.000-3.000	0.500					YES	
51J-4	3.5-30.5	Sel.Xtal (6-32)	2.5-1.5	Bypassed	Bypassed	3.000-2.000	0.500					NO	
75S-1/2/3/3B	3.4-30.0	Sel.Xtal (6.555-33.155)	3.155-2.955	2.69865-2.49865	0.455			50	20	1408	1958	YES	7.75X14.75X13.2
51S-1	.2-2.0	28.0 Xtal	28.2-30.0	Sel.Xtal (31-32)	3.0-2.0	3.500-2.500	0.500	50	28	1508	1959	NO	7.75X14.75X13.2
51S-1	2.0-7.0	Sel.Xtal (12.5-8.5)	14.5-15.5	17.500	3.0-2.0	3.500-2.500	0.500					NO	
51S-1	7.0-30.0	Bypassed	Bypassed	Sel.Xtal (10-32)	3.0-2.0	3.500-2.500	0.500					NO	
651S-1	.25-30.0	109.1-79.35 Synth.	109.35	99.000	10.350	9.900	0.450	80	30.2	1304	1970	NO	6.25X13.2X15.8
KWM380	.5-30.0	39.645-69.145 Synth.	39.145	39.600	0.455			60	48	1814	1979	NO	15.5X6.5X18
851S-1	.25-30.0	109.35-79.35 Synth.	109.35	118.800	9.450	9.900	0.450	90	15	2780	1982	NO	7X20.9X19
HF-2050	.014-2.0	12.0 Synth.	12.014-14.0	111.014-113.0	99.000	96.000	3.000	80	32	1796	1984	YES	5.25X19X18
HF-2050	2.0-30.0	Bypassed	Bypassed	99.5-129.00	99.000	96.000	3.000					YES	
95S-1	.005-30	51.2-81.2 Synth.	51.2	51.200	0.00			100	9	482	1997	YES	1.72X19X14.75
95S-1	20-2000	Bypassed	Bypassed	20-2000 Synth.	0.00							NO	
451S-1(non-prod)	.2-30.0	39.645-69.145 Synth.	39.145	39.600	0.455			60	28	1814	1980	NO	15.5X6.5X18

IN THE COLLINS SHACK

Steve Cochrane, W7JSC, has been a member of the CCA since 2006. We chose his shack for our feature this month because of its equipment and also the wonderful layout and presentation. We will forgive him his non-Collins as an attempt to adequately show the competition - so people can see the obvious quality difference with regard to his Collins gear.

Steve is now retired, having served 25 years in the Air Force (1990) and then another 19 years in the Department of Homeland Security/FEMA – retiring in 2009. HE has been a ham since 1978 and holds an Extra Class license obtained in 1987. Now that he is retired, he has set up shop in a motor home and will be traveling the U. S. sharing in the local swap environments - so be on the lookout for him.

Steve is also a member of a number of organizations that serve amateur radio. These include being a member of ARES (past Wyoming Section Manager and Section Emergency Coordinator), the Wyoming and Laramie County RACES (past State and Laramie County RACES Officer) and currently Steve is the Wyoming Air Force MARS Director (AFA8SI/AFF8WY), AF MARS Region 8 Emergency Communications Coordinator, and AF MARS Northwest Area Emergency Communications Coordinator (AFE8EC). He is also a member of the National Communication System (NCS) Shared HF Resources (SHARES) Program and is a life member of the ARRL and QCWA.



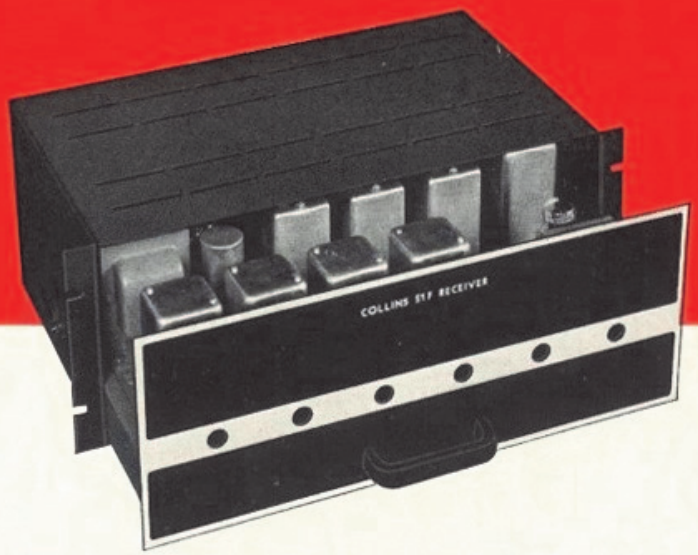
First licensed in 1962, **John Wilson, K0IP**, is certainly a fellow who has been around the block - and around the world - collecting experiences and Collins equipment along the way. John's first rig in the states was a Central Electronics 20A and a Hammarlund SP600. He stumbled into Collins equipment in 1970 when he acquired a somewhat imperfect KWM-1, which he operated from Thailand while in the USAF. If you run into John, ask him to tell you the story of the PTO slug in this KWM-1. His all-time favorite piece of Collins equipment is the HF-380, although it is a tough choice for him.

As you will see from this photo, John is an avid collector of a variety of boatanchors, but Collins is the major manufacturer. In his own words, stuff "sticks to me like a magnet". John's S-Line operating desk is a thing of pristine beauty. Attesting to the diversity of John's interests are his Model 28 RTTY unit, a 618T-3, and vintage military units such as a "like new" TCS-14, ART-13, and MRC-95. You can find photos and all sorts of Collins info on John's website, www.pocatelloarc.org.

John graduated from Central Technical Institute in 1968, and worked in the defense industry for one year. At that point he joined the USAF where he was on active duty for 6 years as a PMEL tech. After his USAF stint, John worked as a technical writer at Elektor Publishers in Holland for a couple of years prior to returning to the U.S. and signing on with the Union Pacific Railroad where he worked many positions in the Communications Department, mostly revolving around data equipment and later computer networking.

I'm not sure how he finds time for them, but his other hobbies include flying (although he hasn't used his pilot's license in many years) and scuba diving. John is lucky enough to have his wife, Pat, who supports (or at least tolerates) his radio hobby. John has a fascinating shack and we promise him a full spread next issue. This is just your introduction and teaser.

COLLINS 51F



FREQUENCY RANGE: 1.5 mc to 20 mc.

CIRCUIT: Superheterodyne with 456 kc i.f.

FREQUENCY CHANGE: Interchangeable r-f units each having 2 to 1 tuning range.

FREQUENCY CONTROL: Either self controlled or crystal controlled high frequency oscillator can be supplied.

SELECTIVITY: Total band width 5 kc at 6 db down and 18 kc at 60 db down.

SENSITIVITY: 2 microvolts, 30% modulated at 400 c.p.s. for 50 milliwatts output and 6 db signal to noise ratio.

AUDIO FREQUENCY RESPONSE: Uniform within 6 db between 150 and 2500 c.p.s.

AUTOMATIC GAIN CONTROL: Audio output variation less than 10 db with signal input 10 microvolts to .5 volts.

IMAGE REJECTION: 75 db at 5000 kc.

POWER OUTPUT: 500 milliwatts into 500 or 8 ohm resistive load.

CW OSCILLATOR: Either self controlled or crystal controlled oscillator may be supplied for cw reception. Both oscillators are designed for low drift with respect to variation in line voltage and temperature.

AUDIO SQUELCH CIRCUIT: Either electronic or relay controlled circuits can be provided to disable the audio channel in the absence of received signal.

HUM: 50 db below rated output at any gain control setting.

POWER REQUIREMENTS: 115 volts 50/60 cycles a.c. with self contained rectifier.

MECHANICAL CONSTRUCTION: Drawer type designed for standard 19" relay rack mounting with 7" panel. Quick accessibility by plug-in connections between receiver chassis and cabinet. Each stage is assembled on an individual chassis with its particular terminal strip, thereby permitting a variety of circuit arrangements without excessive re-design cost.

SPECIAL FEATURES: A.V.C. circuits available at terminals for use with diversity reception. Test jack in i-f cathode circuit for convenience of alignment. Remote control facilities supplied on special order.

Collins receivers are built with our usual care of construction and are of the same high quality that has made Collins equipment world famous.

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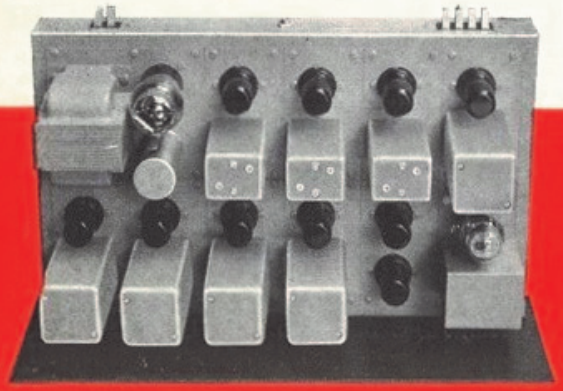

FIXED TUNE RECEIVER