al considerations such as rates, services, and fees, the *jurisdictional* consideration may have been taken too lightly. But even more unsettling is this characterization offered by West Peoria's Supervisor, Daniel R. McAvoy: "It is ridiculous when one party wants to buy a service and the other presumably wants to sell it and they have to go to court to accomplish it."

Fix AFC Problems

A SOLID STATE DOWN CONVERTER FOR COMMANDER I

This is one of those "projects" you have always wanted to do, but it took a system operator coming to us with a problem and a plea for a "low-cost solution" to get us off the dime and onto the bench.

Having come into the CATV world in the mid 1960's, I cut my teeth on Channel Commander One headends. Anyone who has ever had the Com-1 experience knows that this basic signal processor by Jerrold took us out of the dark ages of straight-through (on channel) signal processing by offering the option of heterodyne processing.

In these troubled CATV times, it is somewhat comforting to recall through ten-year-old filters that *this was a dynamic era.* Equipment changed (for the better) almost before your eyes; what was good and current yesterday was outmoded and headed for the museum today. Transistorized equipment made the scene, plants got longer and longer, and Jerrold brought out the Commander One.

by:
Steve K. Richey
Richey Development Company
Oklahoma City, Oklahoma 73107

The Commander was introduced at a time when a whole new myriad of problems were being offered to CATV: *technical problems* with *technical solutions.* There were new stations and with them came adjacent channel interference. Then there was color smear, as more and more stations went to more and more color. Off-air distances increased, and as we went further into the fringes we discovered we need more AGC range. And then channel conversion hit us square in the headend as we moved into markets with one or more local stations. Finally, with heterodyne processing, we discovered the phrase "beats."

The Commander One had the headend world by the tail in this era, and after a few false starts with early units, the world suddenly looked better; better that is, than it had looked before with demods and re-mods, and on channel processing.

So it was the rare headend that did not have at least one Commander One. But today, a scant ten years after the introduction of this most popular and successful headend unit, where do you find them? Usually in small systems where updating costs too much, or larger systems in backrooms gathering dust in a pile next to other relics of an era gone by; relics such as the Super 60, the AV-7, and the ATM-50.

Our message, naturally, is that this is not really necessary. Not if you address the major problems of the Commander One, and set about to *solve* them one by one. What is so terribly wrong with the Commander One?

Priority Objections

(1) AFC drift
(2) Tuner overload (strong signals zap it)
(3) Tubes (aging and replacing is a pain)
(4) Output oscillator drifts as tubes age
(5) Dirty contacts (on turret tuner)

There may well be other problems, but they seldom give the operator as many fits as the five just listed. If you will notice, *the tuner is the problem*, as a sub-module, not the Com-1. Anyone who has used (or is using) a Com-1 knows of the daily (usually morning) trips to the headend to flip the AFC switch off, turn the fine tuning 1/32nd of a turn, and then flip the AFC back on. Shortly after the Com-1 hit the industry, word was out about a prototype crystal-controlled down converter for the Com-1. Thus shortly after the Com-1 was introduced, everyone (including Jerrold) *knew the tuner was the major shortfall* for the design.

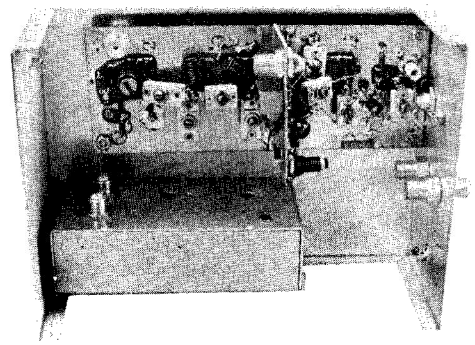
Other than the tuner (which we will address ourselves to), the major complaint is that the unit is tube design. Frankly, within reasonable redesign-cost parameters, there is little that can be done about that; *with one exception.* The output oscillator (part of the drift problem) *can be replaced* with a solid-state Fetron TS6AK5 (made by Teledyne Semiconductor). This will cure *that* portion of the drift problem. Additionally, if real care is used in aligning the Com-1 I.F. and the match between modules is truly optimized, *it is possible* to go through tube change-outs with little degradation in performance (and thus avoid realignment).

DESIGN YOUR HEARTS OUT

Normally construction features in CATJ take on reasonably detailed step-by-step instructions, or they rely heavily on some design criteria which even modestly experienced personnel can cope with.

This is the exception to that rule. A solid-state front end for the Channel Commander One series headend signal processors may well be beyond the capability of the average bench tech. However, we have a different purpose in mind in presenting this piece. There are unknown numbers of Channel Commander One units still operating in the CATV industry. When **CATJ** ran a survey of reader interest, in last year's August issue, readers voted our (frankly) manual-oriented "Alignment Procedures For Channel Commander One" near the top of the list. This told us that practical features dealing with commonly utilized CATV equipment have real interest and serve a useful purpose.

Now most anyone with real bench savvy can duplicate Steve Richey's instructions given here and come up with a state-of-the-art solid-state front end for a Commander One. But if you have never constructed something from scratch, other than a step-by-step Heathkit, we advise you to leave this one alone. Rather, profit from what it teaches you about design problems, and, run down some guy in the next town who has the necessary savvy to put this one together for you. It will be well worth the effort, because now for the first time you can forget about "morning visits" to the CATV headend to re-lock the Commander One AFC!



Curing The Tuner Problem

The design criteria for curing the tuner and its associated problems was this: the replacement module, a solid-state crystal-controlled down converter, must interface directly with the Com-1 mainframe. That is, unhook the Com-1 turret tuner RF/I.F. Connections, plug the cables back into the new solid-state replacement, and slip the replacement into its main frame.

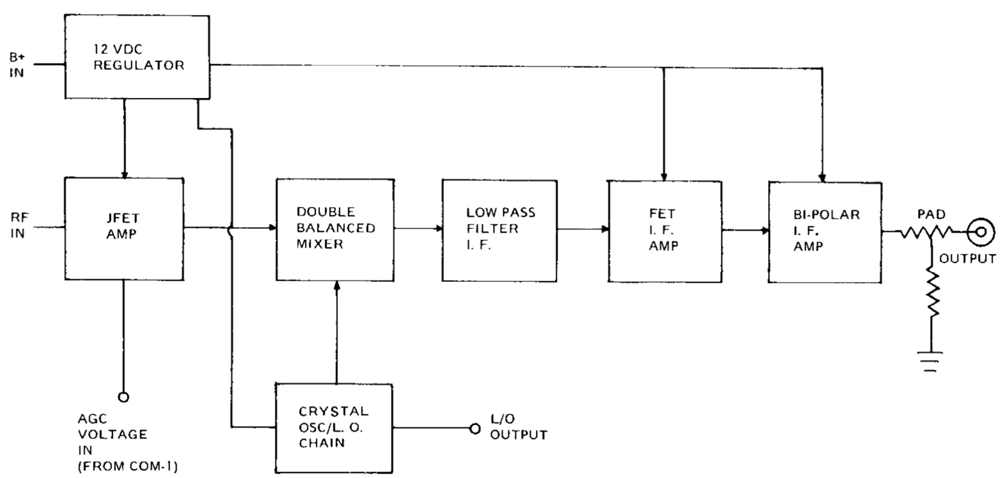
The block diagram of the replacement tuner is shown in Diagram 1. The final operational specs are as follows:

Gain .... 28-30 dB
AGC Range .... 35 dB
AGC Voltage .... —1 to —4 Vdc
In Channel Response .... +/— 0.25 dB
Output Match .... 27 dB
Input Match (*) .... 15 dB
Noise Figure (*) .... 3.0 dB
Upper Adjacent Sound Reject... 10 dB
I.F. Bandwidth ...... 46.5 / 41.25 MHz
*—at Maximum Gain

Design Tricks

Diagram 2 shows the complete RF portion of the down converter, less the local oscillator. The local oscillator for low-band and high-band channels is shown in Diagram 3.

Input RF is coupled through impedance matching network L1, C1 and into the source of the J-310 FET RF stage. Normally FET's of this family operate with the gate grounded, where maximum gain and non-neutralized stability are required. However, to provide protection against large input signal levels (overload) to the tuner, the gate *in this application* is brought above ground and a negative (AGC) voltage provided. This AGC voltage



BLOCK DIAGRAM - COM 1 SOLID STAT DOWN CONVERTER

DIAGRAM 1

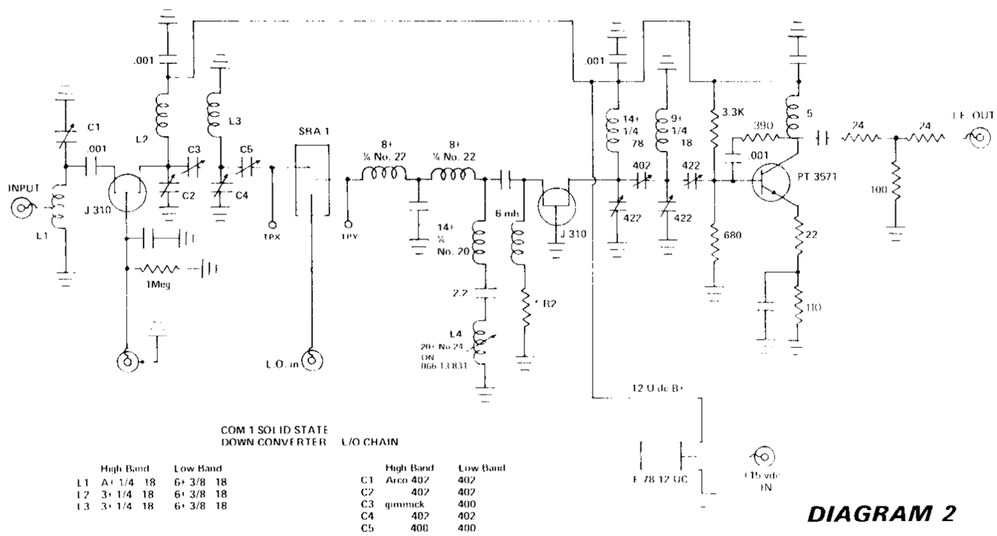


DIAGRAM 2

will bias the J-310 FET to the point where overall circuit gain is reduced by as much as 40 dB. By keeping the front end from *overloading*, we have achieved one of our design criteria.

The output of the input RF stage is coupled through a bandpass filtering circuit composed of L2, L3, C2, C3, C4, and C5. The bandpassed signal is then fed into an SRA-1 double balanced mixer.

The double balanced mixer has been selected for three reasons:

(1) Excellent *dynamic* range (i.e. good signal-handling capabilities);
(2) High *rejection* of the input RF signal (i.e. frequency) at the output port;
(3) High *rejection* of the local oscillator (injection frequency) at the output port.

Additionally, modern double balanced mixers have quite respectable "noise figures," even when standing alone *without* an RF stage before them. This is *another way of saying* that a double balanced mixer has low(er) conversion loss. And this contributes to the overall Com-1 noise-figure equation, meaning simply that higher signal plus noise-to-noise ratios are possible with *given* RF input levels than can be expected with the factory (tube-type) RF stage plus mixer. In a few words, the picture quality improves for lower input levels, and long(er) cascades become possible before signal to noise becomes a problem.

The local oscillator is a separate submodule inside of the container of the replacement down converter. The L/O signal is coupled into the SRA-1 double balanced mixer through an F-61 connector. The output of the SRA-1, now an I.F. signal, is run through a low-pass type of filter and a series (resonant) trap which is tuned to 47.25 MHz (lower adjacent channel sound frequency after conversion).

Following the low-pass filter, the I.F. signal is fed into an I.F. amplifier stage, another J-310 FET. Now in the "old days," designers usually felt that if they wanted a low noise figure, the only real "design trick" was to build up sufficient gain in the RF amplifier stage to overcome the conversion loss in the mixer, and to make the usually low noise figure of the RF (first active) stage the commanding noise figure for the processor. However, this usually meant that I.F. amplifier stages tended to be high gain, and often little

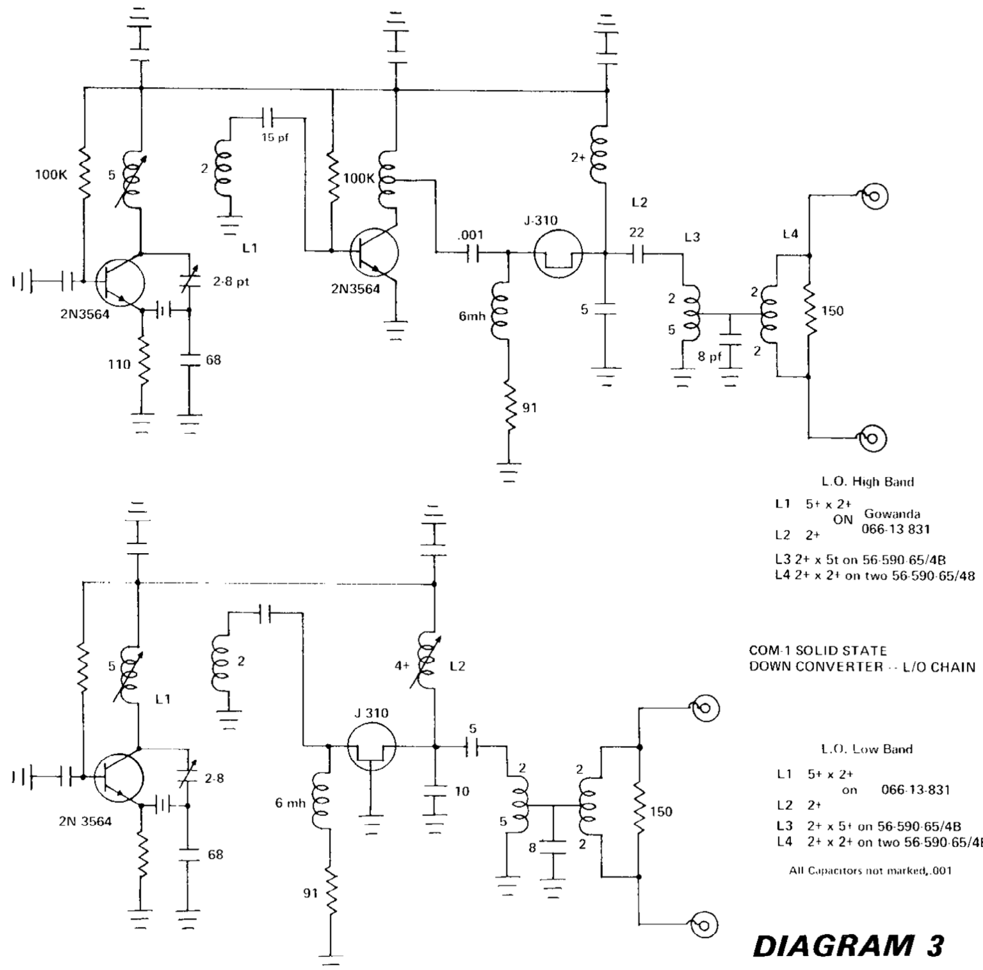
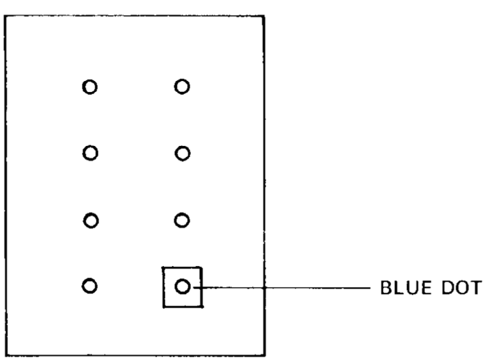


DIAGRAM 3

concern was exhibited for their own noise figure. Modern trends lean toward low noise *all of the way through,* especially since FET (and bi-polar) technology now makes low noise and high gain possible, for about the same price per device as high gain alone. One of the features of the design shown here is that the worst case (single "stage") noise figure (under *maximum* wide-open-gain conditions) is the 6.5 dB noise figure of the double balanced mixer; and when you precede and supersede the 6.5 dB mixer "noise figure" with 3.0 dB noise-figure devices, with suitable gain parameters, you end up with a unit noise figure not over 3.0 dB all of the way through (at maximum gain with the front-end J-310 so biased as to run wide open).



SRA-1 DOUBLE BALANCED MIXER

The output of the J310 I.F. amplifier is further bandpassed, and then amplified one more time by a broadly tuned bi-polar amplifier stage. This stage is *primarily for output match*, which we further ensure by inserting a 6 dB pad directly on the output. By achieving a high degree of match integrity, we end one of the major realignment bug-a-boos normally associated with *any* down converter.

Our approach to the power supply was to design one fairly stiff "brute-force" type of supply which could be utilized to power *several* down converters for several Com-1 channels in use, simultaneously. The supply (see Diagram 4) provides 15 volts DC to each converter. At the converter this is further regulated to 12 volts DC, by a Fairchild 3 terminal regulator.

The local oscillator chain provides the necessary L/O drive to the mixer (SRA-1). See Diagram 3 for the local oscillator section. The L/O drive is brought out to the SRA-1 and to a separate port for looping into the Com-1 output "up converter." A table here gives the local oscillator (crystal) freqencies for each channel in the VHF spectrum.

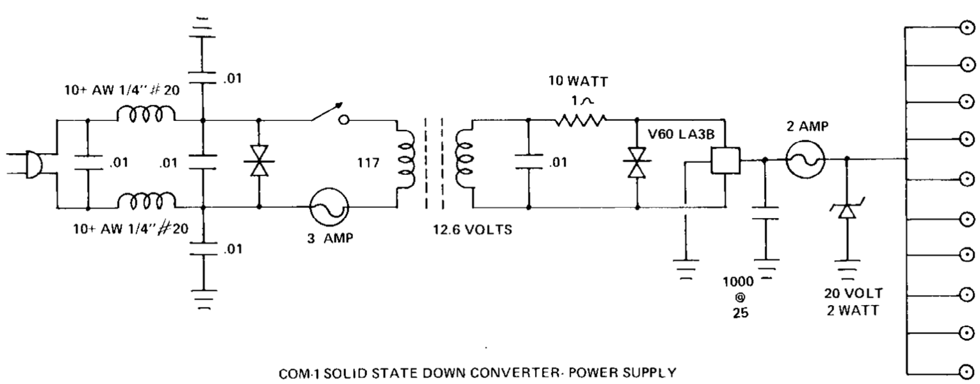
Solid-State Oscillator Frequencies

L/O Freq	Channel	Crystal
101 MHz	2	101 MHz
107 MHz	3	107 MHz
113 MHz	4	113 MHz
123 MHz	5	123 MHz
129 MHz	6	129 MHz
221 MHz	7	110.5 MHz
227 MHz	8	113.5 MHz
233 MHz	9	116.5 MHz
239 MHz	10	119.5 MHz
245 MHz	11	122.5 MHz
251 MHz	12	125.5 MHz
257 MHz	13	128.5 MHz

Alignment

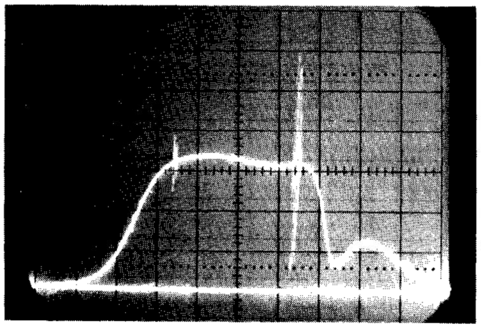
To align the unit, first solder a 330 ohm resistor to test point "X" (input to SRA-1 double balanced mixer); connecting the opposite end of the 330 ohm resistor to the center terminal of an F-61 connector (with shell connected/soldered to chassis).

Insert your sweep into the input of the J310 RF amplifier and connect the detector to test point "X" (through the 330 ohm resistor). Align the unit with C1, C2, C4, and C5 for best (i.e. flatest) response (at maximum gain) across the VHF input channel. When this is completed, move the detector to the output of the down converter and connect the sweep to test point "Y" (see Diagram 2), through a 330 ohm (isolation) resistor. This is the output (I.F.) section of the down converter, and it is to be aligned for response in the 41.25 to 46.5 MHz region (see scope-screen display of response of one unit). At this time, set L4 for maximum rejection of 47.25 MHz; remove the test-point connections.



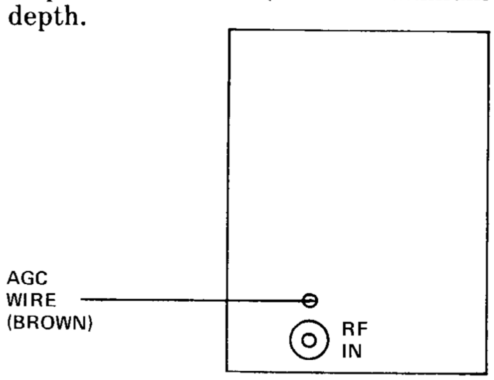
COM-1 SOLID STATE DOWN CONVERTER- POWER SUPPLY

DIAGRAM 4



The alignment or tuneup of the local oscillator is quick and easy. With power to the L/O, connect the output of the L/O chain to the marker-input on your scope/sweep system. Adjust L1 until you have a birdy (pip) on your display. Disconnect the L/O from the marker-in and place the detector on the output of the L/O. Now simply tune L1 for maximum scope display (i.e. greatest amplitude or signal from the L/O) on a DC coupled scope (alternately, an AC VTVM). Then back off 1/4 turn on L1, and tune L2 for maximum output. This completes the L/O tuning.

Now insert the L/O signal into the down-converter L/O input jack, with the sweep connected to the input of the RF side of the down converter. (Keep your sweep level down in the 0/+10 dBmV range.) Connect the detector to the output of the down converter and touch up alignment for best single-channel response, making sure the 47.25 MHz adjacent-channel sound trap is still notched for maximum depth.

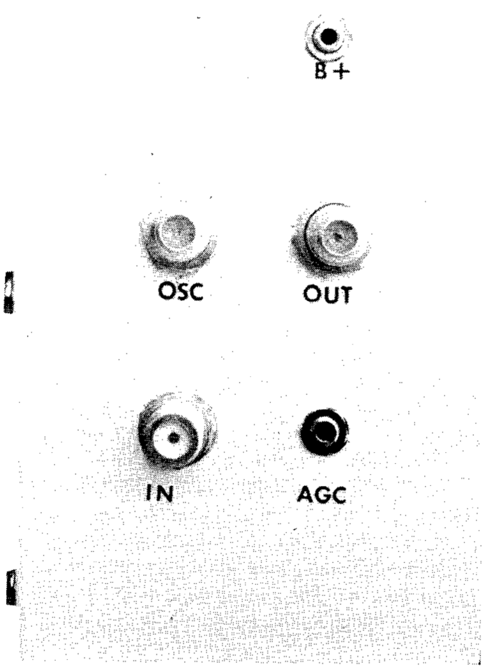


COM-1 Hookup

Interconnecting the solid-state down converter to the Com-1 unit is very simple. Just connect the antenna input to the down converter and run a jumper from the output of the solid-state down converter to the I.F. input on the Com-1.

Run a wire from the AGC connection on the tube tuner to the AGC input on the down converter. (Note: When *no voltage* is applied to the AGC input, it should be shorted to ground. This can be done by using a normally closed miniature phone jack.) See illustration.

The L/O output (from the new local L/O input on the Com-1 up converter, if you are using "on-channel" conversion/operation. If you are converting to a different output channel, terminate the L/O output on the new L/O chain with a terminating resistor, on



the F connector on the solid-state converter.

One item of additional note: you can *delay the AGC* additionally by inserting a 1N914 diode in series with the AGC lead. This should be done on channels with very low input levels; do it on a try-and-see basis.

This completes the solid-state down converter for the Com-1. It should provide you with *hands-off* operation and forever end your daily trips to the headend in the morning to touch up the wandering nature of the tube-type Com-1 front end!

III Is Better Than II

DESIGN CONSIDERATIONS FOR MODERN CATV HEADEND SIGNAL PROCESSING EQUIPMENT

This report describes signal processing requirements of a modern CATV headend, with design criteria for heterodyne processing equipment and modulator equipment.

Multiple Sources/Multiple Requirements

The signals to be reprocessed in a CATV headend may arrive from many sources and by various forms of transmission. Diagram 1 depicts some of the signal sources to be expected with a modern headend. Assuming all signals are cable carried in the 40-300 MHz VHF band the following forms of signal processing may be required:

(1) VHF to VHF processing (possibly requiring channel conversion on the output/cable end);
(2) UHF to VHF conversion (always requiring channel conversion);
(3) Video to VHF modulation (from multiple sources);
(4) Special CATV channels (possible channel conversion or channel dropping);
(5) Sub-band to VHF conversion.

Although the types and sources may vary widely, the headend equipment must deliver each signal at a VHF channel with consistent technical characteristics to guarantee proper operation of the distribution system.

Generally speaking, baseband video signals have consistent electrical characteristics (i.e. peak to peak levels, spectrum, etc.). However, RF (radio frequency) signals are much less pre-

by:

Graham S. Stubbs
Director of Engineering
Jerrold Electronics Corporation
Horsham, Pa. 19044