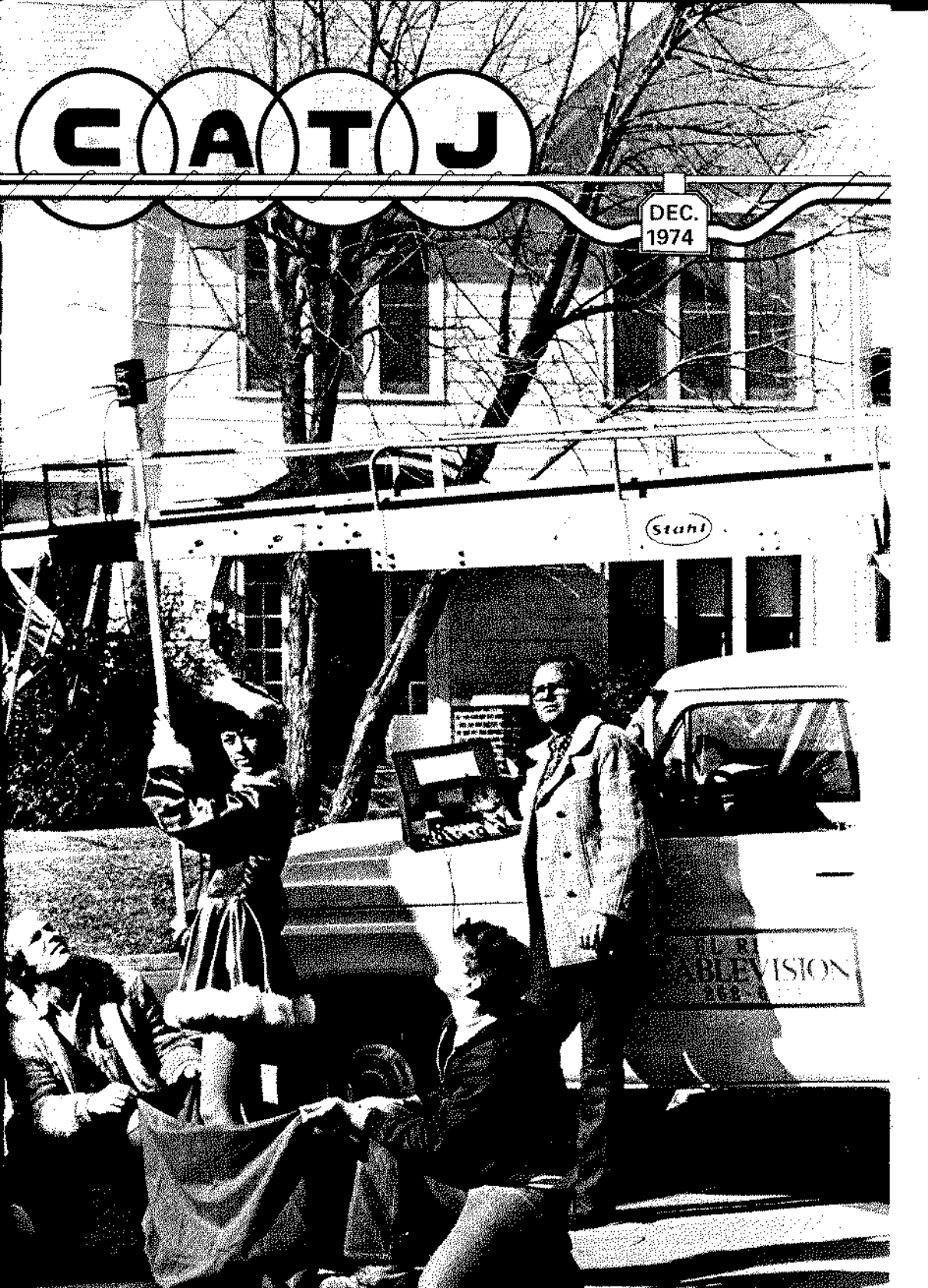


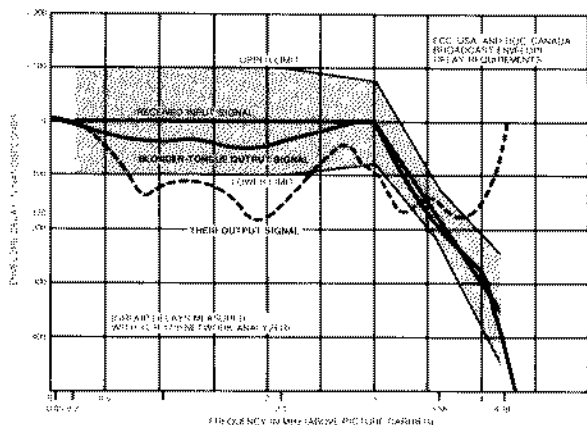
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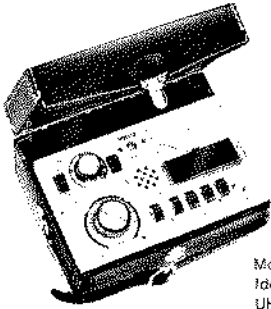
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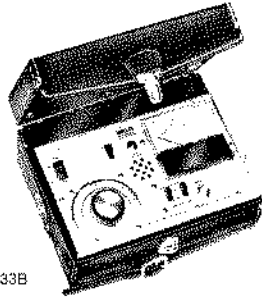
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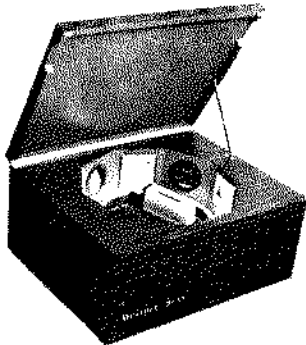
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NUMBER 8

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OUR COVER

Look what Santa brought! CATJ's Heather Pennington, decked out as befitting the season, gives the El Reno, Oklahoma Cablevision folks a thrill as she uses the Mid-State RD-1 to check for cable radiation.

CATA -TORIAL

KYLE D. MOORE, President of CATA, INC.



GOOD BYE EXPOS?

For several years now the fall season has been "dominated" by something the NCTA PR staff playfully dubs "EXPOS", which I assume is short for exposition. This year there were four: one each in Florida, Philadelphia, Cleveland, and Kansas City. Apparently only the Philadelphia EXPO drew anything like a crowd, if you believe the people who attended them. The "official NCTA count" for the Florida meet was "over four-hundred", while those manufacturers in attendance said fewer than one-hundred CATV people (i.e. operators or operating personnel) were on hand. The NCTA count for the Cleveland meeting was also "approximately four-hundred", while the manufacturers on hand were so disappointed they took down their booths a day early and left for home. The Cleveland count of real CATV people was probably closer to fifty. In Kansas City the banquet on November 21st had only one-hundred-sixty meals served, and that included all of the suppliers with thirty booths, wives, and people who wandered in off of the street from the Kansas City locale.

The EXPO concept was conceived during a period in our industry when money was in abundant supply and every product you had to have tomorrow was back ordered six weeks to six months. The NCTA muscled in on regional meetings where several states had banded together to have their own meetings in years past. When a regional meeting became an "EXPO", NCTA took over the collection of funds, booth space rental, and the program became heavily NCTA dominated.

Well, times have changed. Associate Members of NCTA (i.e. manufacturers and suppliers) are dangerously close to financial chaos. Sales have gone to pot and every penny spent must be balanced by suitable returns. The fault lies with the general state of the economy, and the terrible financial state of the money market vis-a-vis risk capital for new CATV system ventures. Manufacturers simply cannot afford to spend upwards of \$2500 to rent booth space, transport people and materials, man hospitality suites and the like for a show that produces fifty real live CATV peo-

ple. And, when a high percentage of those people are operations types from large systems, with no purchasing authority, the number of live potential customers dwindles to an insignificant number.

Now the high cost of "seeing live customers" is only one aspect of the 74 EXPO fiasco. An equally dangerous source of embarrassment to the industry is the EXPO format of trooping out (by NCTA cue) various FCC and political people to address the assembled throngs. When the throngs are small, the FCC and political people must indeed wonder what kind of industry we are, and whether we merit the kind of attention we have been getting. In the end, this does our image no good.

I would like to propose that the EXPO program be grounded. As long as the NCTA "national" show oscillates north and south in the mid-section of the country each Spring, and the Western Regional Show brings the West Coast operators together in December, we fail to see the need for anything approaching the magnitude of an EXPO at any location except perhaps one on the East Coast in early Fall.

It may sound radical, but if the western and eastern shows limited booth space to twenty or thirty foot maximums, the industry would profit by having more displays and more suppliers would have the opportunity to meet operators.

An equally radical proposal, proposed recently by a supplier, suggests that if the NCTA really wanted to show some concern for the Associates, it would cut in half the posted booth rental space charges for the upcoming New Orleans national show. The NCTA, by reliable reports, has approximately \$900,000 salted away in a "rainy day fund". It would go down only slightly, if at all, if the NCTA made this gesture of mutual assistance to the industry's suppliers at a time when this industry needs to find ways to strengthen the faltering role played by our supply Associates. It is reported that NCTA plans to make not less than \$250,000 clear profit on the 1975 New Orleans show. We think that if they chose instead just to "break even", and put the money back into the suppliers' pockets, the industry would be much healthier for the gesture.

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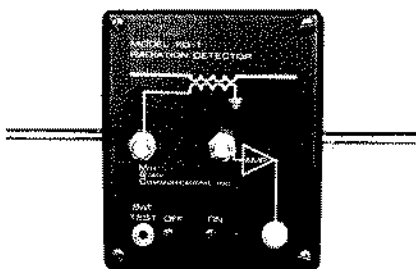
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CABLE CAPTIONS

While attending the NCTA Board of Directors meeting in December CATJ managed a day at the Cable Bureau studying the final reports from several of the C-TAC panels. C-TAC, you will recall, is that body of able cable people which has been spending the better part of nearly two years trying to figure out where our industry is going, and preparing recommendations for the FCC on how we ought to get from where we are to where they think we are headed. **This is some task.**

The final reports of several of the C-TAC panels will be presented in something less than colorful detail in the February issue of CATJ. Here are some **highlights** you should know before hand: (1) One C-TAC panel has decided that the way we should standardize channel assignments in CATV is to **call for FCC action** to mandate that all channels be assigned on the 6N + 1.25 MHz plan (with a few special twists, including requiring all off-the-air stations to maintain **precise zero-beat frequency control**); (2) another C-TAC panel **urges the FCC** to set up several classes of technical licenses for CATV personnel, **with tests to be administered by the FCC**; and (3) another C-TAC panel **urges the Commission** to redefine cable systems away from the "each political entity is a separate system" concept, in favor of "each head end served area is a complete system" concept.

While nosing around the Commission, we managed a peek at the newly drafted Sub-Part "K" which the Cable Bureau plans to deliver to the full Commission for a rule making in March or April. Among **other** things, it suggests that the traditional Commission definition of what constitutes a system should be redefined to state that rather than defining systems by political entities, systems should be defined by head end service areas. **Chalk one up for C-TAC!**

We also uncovered a plot to do away with the dbmv scale in CATV. There is a plan afoot (plan heck . . . it is in the form of a full-blown draft of a notice of proposed rule making!) to **make CATV conform** to all of the other communication services the Commission administers by **doing away with the db** as a basic unit of measurement and replacing it with the **picowatt**. A picowatt is a millionth of a watt, and the Cable Bureau technical people are all caught up in the grand scheme to make us start measuring received levels in **fractions of a watt**. They would still allow us the luxury of making **relative comparisons** using the db increment, but absolute measurements would be expressed in all to be Part 76 data in picowatts. Just for kicks, drag out your own conversion scales and a calculator and figure out what -20, -10, 0, +10 and +20 dbmv would be in picowatts. We did this and found 0 dbmv was approximately 1.333 picowatts. Which meter manufacturer will be the first to offer scales calibrated in both dbmv and picowatts? When we jumped up and down on the desk of a Cable Bureau engineer over this one he said, **"Well, the suggestion came from one of your C-TAC panels."**

Hats off to the **Anixter-Pruzan Company** for getting together with the A.B. Chance Company (Chance makes line hardware) and attacking the spiraling cost of building cable systems. Anixter-Pruzan has just announced a new light and intermediate duty suspension clamp. Rather than a buck-plus for the standard **super heavy duty suspension clamp** that is far too strong for normal CATV uses, the Anixter-Pruzan Model T203-D223 sells for 57 cents each, and can save you real money per pole. The Anixter-Pruzan people say that if the new economy version takes off well, that the Chance people are considering other specialized hardware items for CATV, strong enough for CATV use, but priced below the usual telephone grade hardware. **Well done fellows!**

The United States cable position on copyright (well, **at least the NCTA position**) is catching a lot of flack from Canadian operators, as well as European CATV entrepreneurs. The Canadians have just completed work on their own "national copyright position paper" in which they maintain **cable has no business paying copyright**. The advanced Canadian CATV art regards our own (NCTA) position as **out of touch with reality**. In Europe, the feeling is almost as intense and operators there get very uptight when they talk about what it is we are trying to do here. In Belgium, where virtually the whole country is operated by the Federal Government CATV System, the Belgium government is considered the world's largest "copyright pirate". The Belgium state-run CATV systems "steal freely" French, German, and other nearby (Dutch, etc.) signals for their subscribers. Maybe that is our solution here. **the increasing pressures from the Federal Government might best be averted by simply handing the industry over to the FCC now, and then let them worry about copyright!**

Finally, there is the funny story of the month . . . it seems a high ranking individual representing a Texas CATV supplier rushed to Cleveland to set up his booth at the NCTA North-Central Expo. When he arrived, he ran into the local watering hole where he found other suppliers nursing a cool one. "Here I am gang, let's get busy and get our booths set up", he greeted his fellow suppliers. "Can't do that . . ." was the response. "And why not?", he asked. The counterpart snickered, "Because we have already torn down our displays and packed up to go home." Which they had done one day early, because the turn out was so bad. Better luck next time JS!

TWO MUST READ documents prepared in the course of documenting CATV's case against paying any copyright, before NCTA Board meeting held November 19-20th in Washington, are available on request. From **Jim Y. Davidson, Number One Lou Ellen, Little Rock, Arkansas 72202** is a booklet entitled **Community Antenna—The injustice of a Distorted Image**. From **Ad Hoc Committee of Concerned Cable Television Operators for a Fair Copyright Law, P.O. Box 389, Painted Post, New York 14870**, is a very thorough **Memorandum Report** prepared by Washington Attorney Frederick W. Ford. Both are available for the asking to any concerned CATV system operator or employee.

Reports from all C-TAC panels except subjective evaluation of picture quality were due into Commission by early November. These preliminary reports will be modified slightly by the C-TAC Steering Committee, and a date of late January is planned for final format of all panel reports. The subjective evaluation of picture quality panel (Panel 2) hopes to complete its work by late summer, 1975. Purpose of the subjective analysis is to develop a chart (perhaps wall chart) of various types of picture degradation, which will allow systems to make certain "measurements" by **comparing** their system pictures with those shown on the chart. Archer S. Taylor, Chairman of Panel 2, has been working with RCA to develop special video tapes for subjective analysis, and the National Science Foundation has promised to fund the program.

UNDERSTANDING PLANT AMPLIFIER POWER SUPPLIES

THE SERIES REGULATOR

All power supplies can be broken down into four basic parts: (1) the rectifier, (2) the filter, (3) the regulator, and (4) the reference voltage. Some power supplies also include an option, the current limiter, which we shall discuss in depth later.

Rectifier

The AC input voltage is first fed to a silicon diode which is used to rectify (or convert) the sine-wave AC to a pulsating DC. The most basic form of rectifier is shown in Figure 2, a half-wave rectifier. Half-wave rectifiers are quite widely utilized in CATV amplifiers for two reasons: (1) they do not require a bulky (or expensive) transformer, and (2) they allow you to design a circuit with just a B+ and ground power system. However, they do have some drawbacks, the largest of which is that current is drawn through the power supply during only 50% ($1/2$) of the AC sine-wave cycle. This means that only $1/2$ of the power available is utilized.

Three basic approaches have evolved for satisfying the limitations of the half-wave rectifier:

by:

S.K. Richey
Richey Development Company
Oklahoma City, Oklahoma

(1) Use a bridge rectifier (see Figure 3) to develop full-wave rectification. If you use a bridge rectifier *without a transformer*, the negative side of the rectified AC cycle must be run *throughout* the amplifier, where you could otherwise connect to ground through bias resistors you must connect to the B- line from the power supply. See Figure 4.

(2) Use a bridge rectifier with a transformer (see Figure 5). This avoids the B- line complications and now bias connections can go directly to the ground plane on the amplifier circuit.

(3) Or, there is an alternative method that can be used to obtain full-wave rectification, rectifying both sides of the AC sine-wave (see Figure 6) with individual (a pair) of half-wave rectifiers. Both the B+ and B- sides must be individually regulated, and separate B+ and B- lines must be run to the amplifier stages.

All techniques are utilized in CATV equipment; each has its advantages

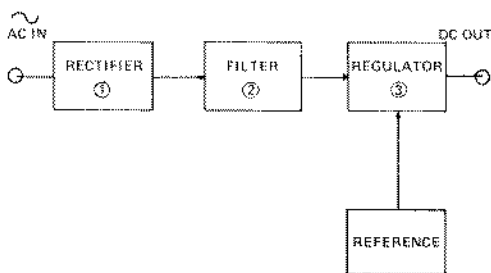


FIGURE 1



FIGURE 2

and disadvantages, and each is utilized by the design engineer where the individual circuit needs call for different requirements.

Filter

The basic job of the filter capacitor is to *charge up* during the maximum voltage swing (see Figure 7) and to *discharge* during the minimum voltage swing. This procedure results in a *leveling* of the DC output voltage, which usually has less than 5% ripple at this point in the circuit.

Regulator

The regulator transistor is the heart of the series regulator (see Figure 8). Here is how the regulator transistor works. Voltage from the basic supply (i.e. the rectifier and the filter) is fed into the collector of the regulator transistor and any current that is drawn by the load (i.e. the CATV amplifier) will be drawn from the collector. However, *the voltage of the regulator transistor emitter is a representation of the voltage applied to the base.* For example, if we apply 30 volts on the collector, and 5.7 volts to the base, we will see a voltage of 5.0 volts on the emitter (there is a 0.7 volt drop between the base and the emitter). If the 5.7 volts

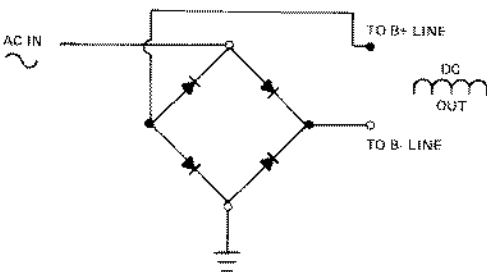


FIGURE 3

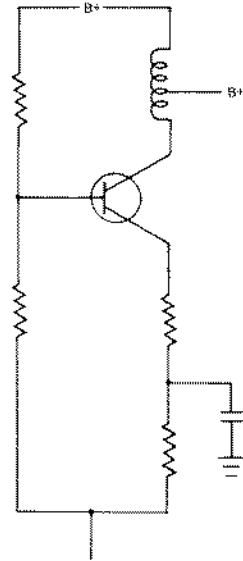


FIGURE 4

are stable at the base, the collector voltage could drop to 9.0 volts or rise to 40.0 volts, and the output would remain stable at 5.0 volts.

Reference Voltage

The reference voltage fed into the base is developed by "dropping resistors" R1 and R2 and by a zener diode (see Figure 9). The function of the zener diode at the base is to maintain the reference voltage to exactly the rated zener voltage level. It accomplishes this by increasing or decreasing the amount of current drawn through resistors R1 and R2 (Figure 9).

It is worth noting with a series regulator that voltage at the emitter will

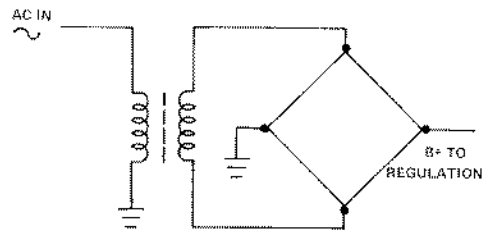


FIGURE 5

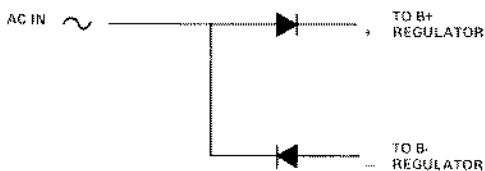


FIGURE 6

have basically the same amount of hum (i.e. unwanted distortion products on the power supply line) as the transistor base voltage, although the collector of the transistor may have considerably greater hum present. This is because resistors R1 and R2, along with capacitor C2, provide very clean (no ripple) DC to the base.

Current Limiting

If the output of the series regulator is shorted, or a large load is suddenly placed across the power supply output, the series regulator transistor can be destroyed. To avoid this unwanted fuse-action, a circuit such as shown in Figure 10 is often employed.

As long as there is a load of 1 amp the voltage at the output of the 1 ohm resistor is higher than the voltage drop across diodes D1, D2, and D3. However, if the load increases to 2 amps the output voltage would drop to 13 volts and thus appear negative to diodes D1, D2, D3. At this point these diodes would begin to conduct, drawing additional current through resistors R1, R2. This lowers the base voltage and the emitter voltage, and effectively reduces the current output capability to under 2 amps, thereby protecting the series regulator transistor.

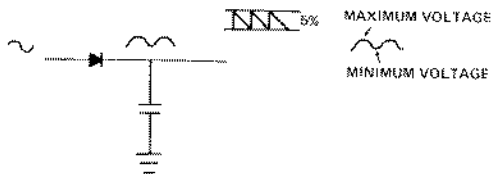


FIGURE 7

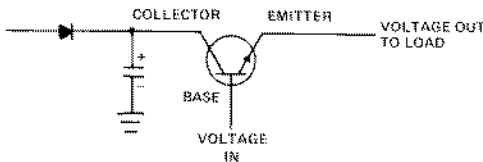


FIGURE 8

Switching Regulator

Switching regulators are becoming more and more popular, due to their high operating efficiency and low heat problems. A basic switching regulator is outlined in Figure 11.

The power source which feeds the regulator is the same as we have previously discussed. The output to the electronic switch/pass transistor is where the change takes place. Instead of regulating the output of the transistor to a constant voltage, the output of the transistor is turned on and off to produce a square wave at the output. The square wave output (i.e. pulsed output) is then passed through a low pass filter which basically converts the output back to a DC voltage. At this point, the output is sampled and compared in voltage to a fixed reference (zener diode). If the output voltage is lower than the reference voltage, the Schmitt trigger is turned on, which activates the electronic switch. The output is constantly being compared to the reference voltage, and if the output begins to rise above the reference voltage, the trigger shuts off and so does the electronic switch.

This sequence happens again and again, many hundreds (thousands) of times per second, and the result is a

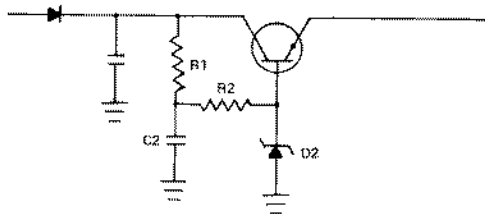


FIGURE 9

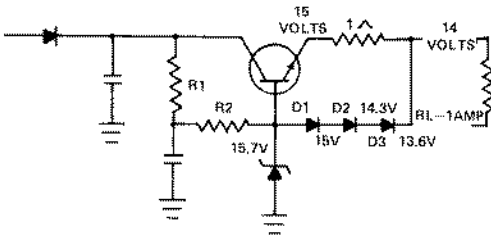


FIGURE 10

regulated output with little heat generated by the power supply.

There are many other ways of accomplishing the same thing. In the supply described, both the frequency and the duty cycle of the square wave are varied with the load and input voltage. There are other designs which only vary the duty cycle while the frequency remains constant.

Synopsis

CATV power supplies are basically voltage suppliers to the power requirements of the solid state active devices in our amplifiers. In the process, the power supplies generate heat (unwanted) and are subjected to sudden variations in their input voltages (rare), and their current loads (quite

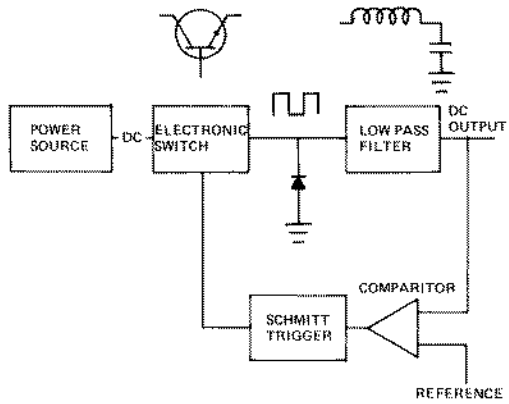


FIGURE 11

common). Heat must either be disposed of (heat destroys parts directly and cause operating parameters to change drastically); input voltage changes must be tamed before component parts are destroyed. And sudden increases in current loads must be caught before the supplies are operating beyond their own current output capabilities and burn up.

Understanding how the supply functions is a leg-up on the correction of faults and preventing supplies from breaking down at an inappropriate time.

THE OFFICERS OF CATA

& THE STAFF OF CATJ WISH YOU

A Joyous Holiday Season

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WHY FILTER?

There are more filter designs around than you can shake a stick at; each has its own particular advantages. Some filters even take on the duties of signal traps.

The filter most of us are familiar with is the *bandpass* (or *pass band*) unit. Such a device allows one particular bandwidth of frequencies to pass through it, but it rejects all other frequencies. We commonly employ bandpass units at the input or output of signal processing units.

A tuneable (or fixed) signal trap, such as the Blonder Tongue MWT series or the Jerrold TLB/THB *could be considered* band reject filters. That is one of the nice things about RF range filters and/or traps; you can just about select the filter you need, almost regardless of the problem you are experiencing.

Basically, you filter out unwanted RF energy at frequencies other than the desired signal frequency to prevent the undesired RF carriers from interfering with reception of the desired carrier. Ideally, you would do this at the source of the undesired carrier; but if that source is a TV or FM broadcast station, probably the best filter device is a case of dynamite strategically placed at the base of the offending station's transmitting tower! So you tackle the filtering *at your receiving location*, and hope that in the process of filtering out the signal(s) you do not want, you will be able to maintain a useable signal on the signal(s) you do want.

Most CATV filtering is done at the input to the head end or the output of the signal processing phase of the head end. Let's explore why.

INPUT FILTERING

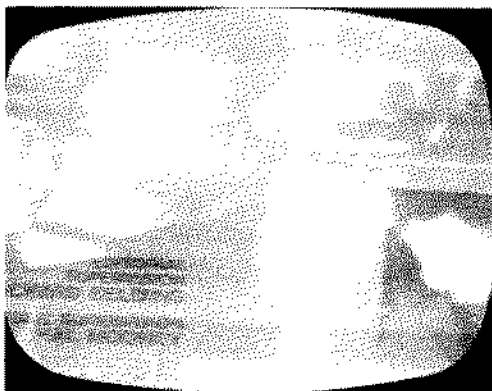
One of the most common problems we experience is *overload* of a signal pre-

amplifier. There are basically two types of signal pre-amplifiers on the market today; those that employ bi-polar type transistors for amplification and those that employ field effect transistors for amplification. There are advantages to both, overall, and disadvantages to both. However, the FET type of device will *usually handle larger* input signal levels before it cross-modulates (i.e. folds up) and for this reason FET pre-amplifiers generally perform better in areas of high ambient signals.

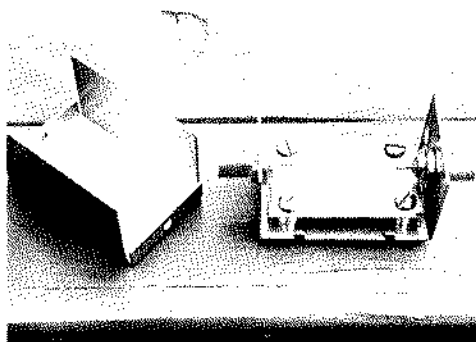
Another solution to the problem is found in the Jerrold approach to pre-amplifiers; a relatively broadly-tuned bandpass filter is placed in front of the transistor amplifying device(s) and this filter rejects signals some distance outside of its passband.

Any transistor amplifying device *has an overload point*; that is, a point where the *input* (signal) voltage(s) multiplied by the *gain* of the unit (usually expressed in db's of gain) equals an *output voltage* which is *greater* than the rated output power level of the output transistor. When this critical power is exceeded, the *output stage* of the pre-amplifier *overloads* (cross modulates) and the unit becomes useless for CATV signal pre-amplification. An example of what this may look like appears here as Photo 1.

To keep on pre-amplifying *without cross modulation degradation* in the presence of strong local signals, we must design our system so that the strong local signals do not overload the pre-amplifier unit. There is only one way to do this: the undesired (strong, local) signals must be attenuated *below the point* where they can create cross modulation.



Cross Mod from overloaded channel 8 pre-amp (local 9) shows as 9 video over 8 video



Simple filters described here are constructed in mini-boxes on G-10 PC board as a base mounted on 1/4" metal stand offs

If we installed a pad at the input to the pre-amplifier, we would accomplish our goal. However, a pad has no respect for frequency. It will not only attenuate the undesired strong local signals, it will also attenuate the desired weaker signal. So in most situations a pad is not the answer.

On the other hand, a frequency selective pad would do the job nicely. A signal trap or band-reject filter is exactly that — a frequency selective pad. Placed in the line ahead of the pre-amplifier (or signal processor) it will selectively attenuate the undesired frequency(ies) and allow the desired signal to pass through with (design) tolerable attenuation. If the unit functions as it has been designed, the non-desired carriers will be attenuated below the point where they can create cross modulation in the pre-amplifier and the pre-amplifier will be able to do the job intended.

Most CATV pre-amplifiers are placed on the tower at the antenna, to take advantage of the best signal to noise ratio at the receiving system point where the signal is strongest (i.e. before downlead losses). Because this is outdoors, it is not a particularly good point to install a signal trap or a highly selective bandpass filter. Commonly employed traps and bandpass filters in CATV service are largely tuned inductors (on air or plastic forms) which are in turn quite sensitive to changes in ambient temperature and humidity. In effect, as air temperature and humidity levels change, the tuned traps and/or bandpass filters "drift" up and down in frequency. There is no known trick to

solve this problem with commonly available CATV devices, except of course moving the pre-amplifier down inside the head end where hopefully the temperature remains more consistent.

CATV pre-amplifiers can suffer from front end signal overload (by nearby transmitters) when the undesired signals are close to the operating frequency of the pre-amplifier (i.e. receiving channel 2, local channel 3) or when the transmitter frequency is quite some distance (in frequency) removed from the receiving frequency (i.e. receiving channel 2, local FM station on 92.5 MHz). Of course the further away in frequency the offending undesired carrier signal(s), the easier it becomes to handle it by trapping or filtering.

OUTPUT FILTERING

Signal processing devices tend to have outputs which are not totally linear. That is, a channel 2 unit will generate some undesired signals in the processing procedure and often these undesired carriers end up at the output of the processor along with the desired channel 2 carrier. If this happens, these undesired carriers also find their way into the CATV system combiner network, and the undesired carriers create "beats" (herringbone patterns — 1) on other channels on the system.

As CATV system head ends become more complex with the addition of mid-band processed signals, one or more local modulators, and numerous channels of FM signal carriage, The demands for purity on processed channels become

greater and greater. It almost takes a mini-computer to calculate all of the possible "beats" in a modern head end. It is far more simple and probably more effective to *bandpass filter* all head end output channels right at the processing unit or modulator. The key is to keep signals *other* than the desired signals from coming out of the head end processing units and mixing in the combiner system with desired channels, thereby causing undesired beats.

SIMPLE FILTERS

The purpose of this article is to acquaint you with a few simple-to-build filters, one or more of which may help you clean up some of your channels. Most CATV filters are considerably more exotic than those we will discuss here. There is no known way of achieving high selectivity at VHF with simple filters. Most CATV bandpass filters, for example, achieve their high rejection of adjacent channels by employing multiple filter stages and two or more trapping stages. The most complicated part of these exotic filters is the alignment procedures and the ability to couple from one stage into the next stage without distorting the desired pass band of the filter.

We are going to avoid those problems in this "learning report" by sticking to the more simple filter forms. If interest in filters warrants a more detailed examination of more exotic designs, this will be covered in subsequent issues of CATJ.

STOP BAND / BAND REJECT

For our purposes here we will call the first filter circuit to be described a stop band filter which rejects a band of undesired frequencies. See Diagram 1.

This filter will function, with the values given, as a tuneable band reject device over the range 50 to 250 MHz. By following the values given for the low frequency end you will have a filter which is optimized for rejection of the FM broadcast band (88-108 MHz), while allowing frequencies from approximately dc (0 MHz) to 80 MHz and 125 to 300 MHz to pass through without annoying amounts of attenuation.

The unit is constructed in a small LMB chassis box, outfitted with F61A fittings

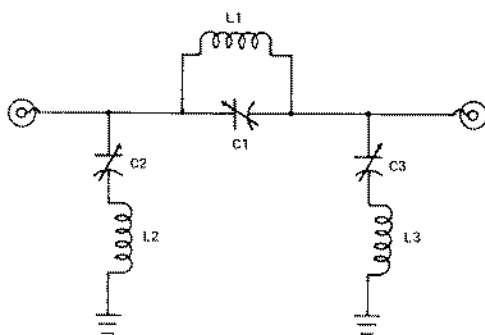


DIAGRAM 1

Diagram 1 Components — Low Frequency

L14T, #24, 3/16" air form
L2, 312T, #24, 3/16" air form
C1463 trimmer, 9-180 pF
C2, 3402 trimmer, 0.9-12 pF

Diagram 1 Components — High Frequency

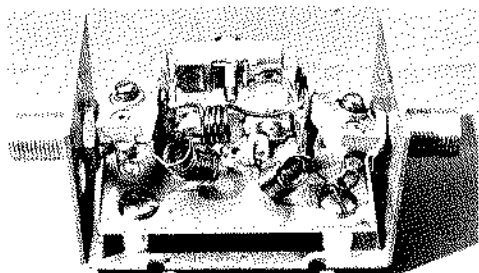
L14T, #24, 3/16" air form
L2, 36T, #24, 3/16" air form
C1422 trimmer, 4-40 pF
C2, 3402 trimmer, 0.9-12 pF

on either end (input and output). The box may be hung at the input of any unit which you wish to keep 88-108 MHz signals out, although if you place it outside ahead of a signal pre-amplifier, some attempt should be made to weatherproof the container (use Dow Corning Silastic 732 RTV adhesive/sealant on all edges and holes where moisture might get inside).

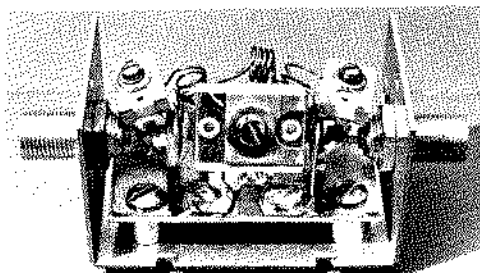
There are only six active components. C1 and L1 broadly determine the center of the band reject frequency range. C1 for the lower frequency range version is an Elmenco/Arco 463 trimmer (9 to 180 pF). C1 also passes the spectrum from 0 to 300 MHz, less the portion "carved out" by the reject filter. C2 and L2, plus C2 and L3 act as shunt traps to ground. The tuneable capacitors (Elmenco/Arco 402 trimmers; 9 to 12 pF) plus the inductors (L2 and L3) make up tuned circuits that resonate within the band reject range, carrying (shunting) energy in that frequency range to ground.

Note that L1 and C1 are mounted across two floating tie point terminals; the bottom of each is attached to an F61A connector. C2 and C3 are connected to the same tie point terminals and the adjustable end of each "floats" in air. L2 and L3 attach to these floating ends, and then go to ground. L2 and L3 should be mounted so they are at right angles to L1

(1) See May 1974 CATJ, RFI, Page 19.



High band pass, low band reject version



Low band pass, high band reject version

to prevent stray coil to coil coupling from upsetting the balance of the device.

A small piece ($1/4'' \times 1/8''$) of G-10 circuit board was cut to make up the base plate for the filter; it in turn is mounted on $1/4''$ spacers above the bottom of the LMB box to align the F-61A connector pins with the two point tie terminals.

The low frequency version shown will cover band-reject of any frequency-range in the 54-150 MHz region. It is optimized to reject approximately 20 MHz in width, or 88 to 108, at 100 MHz. By tuning C1, C2 and C3 you can locate your band reject pass band virtually any place you wish between 54 and 150 MHz with the *low frequency* components shown. Tuning C1 locates the "center" of the reject pass band while tuning C2 and C3 locate or adjust the *width* of the reject pass band. Around 60 MHz center it is "optimum flat" over approximately 16 MHz; at 100 MHz center it is optimum flat over 20 MHz and at 140 MHz center it is optimum flat over approximately 25 MHz.

Alignment should be done with a sweep and marker display, although *it can be done with a signal source* (such as antenna signals) *and an FSM*. If you do not have a sweep and marker display system available, tune in on the FSM a signal in the *middle* of the band reject range. Note how strong a level it has. Insert the band reject filter in the line *ahead* of the FSM. *Tune C1 for maximum attenuation* of the middle-of-band-reject region carrier. Now tune the FSM for a carrier approximately 10 MHz *higher* than the center frequency. Adjust C2 for *maximum attenuation* of the upper frequency carrier. Repeat one more time with a carrier approximately 10 MHz *lower* than the center frequency, adjusting C3 for

maximum attenuation. If you do this with carriers not more than 16 MHz apart (high to low) down around channels 2-4, not more than 20 MHz apart in the FM band (88-108 MHz) and not more than 25 MHz apart in the 110-150 MHz region, you should have a flat band reject level within ± 1 db that is from 20 to 25 db deep (in rejection).

The higher frequency version functions in exactly the same way, except because of the components chosen it will have a wider reject bandwidth than the lower frequency version. The components chosen will reject 150 to 250 MHz with 170 to 225 being at the bottom of the reject pass band with a 195 MHz center (see Diagram 4) down 20-25 db. The actual amount of rejection in the "bottom of the reject trough" depends to a large measure on the care with which you position components and how carefully you adjust things like turn spacings on L2 and 3. See box material here.

You can series (cascade) two or more of the simple band reject filter devices. The rejection numbers do not double however; in fact you add about 3-6 db of additional rejection "within the trough"

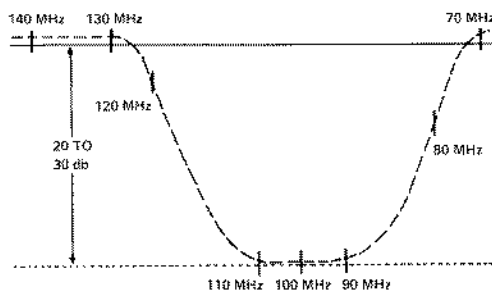


DIAGRAM 2

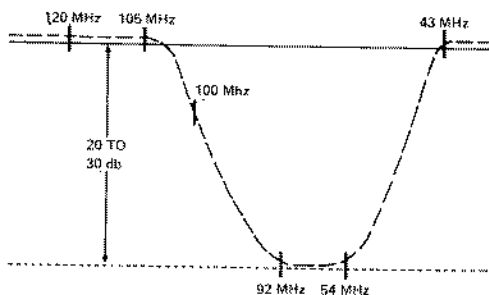


DIAGRAM 3

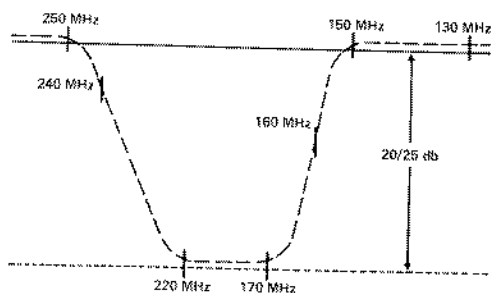


DIAGRAM 5

each time you add a section. However, you can series one that is tuned to 54-70 and another that is tuned to reject 88-108 and come up with a *quasi-bandpass filter* for channel 5. In effect you would be keeping channels 2, 3 and 4, plus parts of 6 and the FM band out of any channel 5 pre-amplifier you might place after the series band reject units. See Diagram.

There are two reasons why you might want to use this simple approach to filtering in lieu of using conventional bandpass filters. The first is low thru losses on the desired frequencies. Thru loss at 54-82 MHz when the band reject filter is tuned to reject 88-108, for example, is under 0.1 db. Thus the thru loss on a weak channel 2, 3 or 4 would be so low as to not to be a matter of concern to the man after the last db of on-channel system performance. Even a first rate bandpass filter has thru losses in excess of 1.0 db on low band.

The second is stability. True, the coils (inductor) and capacitors are apt to be

affected by changes in ambient temperature and humidity. But unlike a trap which is zeroed in on one *precise offending carrier frequency*, the band reject filter is pretty *wide* in its reject frequency range. And it can drift around a long-long way before it ceases to trap out undesired signals.

The big *disadvantage* to the band reject filter shown here is *lack of selectivity*. For example, as one of the diagrams indicate, while it has a flat rejection of 20 db plus over the 88-108 MHz range, it is still attenuating 5 db at 80 MHz and it does not recover to the nominal 0.1 db thru loss until we get down to 75 MHz.

MODIFIED STOP-BAND

A high-low band separator can be considered a form of band reject filter. Both low and high band signals are delivered to the input, but *only low band* signals appear at one output port and *only high band* signals appear at the other output port. In a sense, the low band port band rejects the high band signals, and the high band port band rejects the low band signals.

High-low separators are very useful devices, working both as separators and as combiners. Taken as a pair of circuits (low band and high band) they can be taken apart and used separately to place low thru loss filtering ahead of a unit that you want to see only low band (or high band) signals.

Diagram 6 shows a pretty standard commercial approach to building a high/low separator. The capacitors are fixed and the inductances are optimized with the related inductors for the service they perform.

Such a unit has a low band separate and high band separate function as indicated

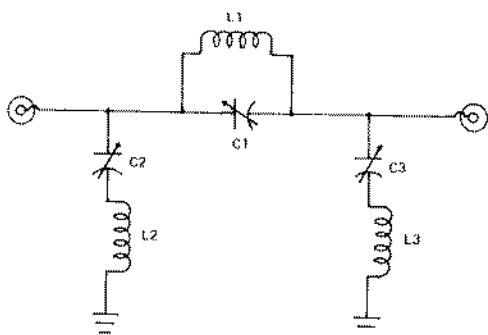
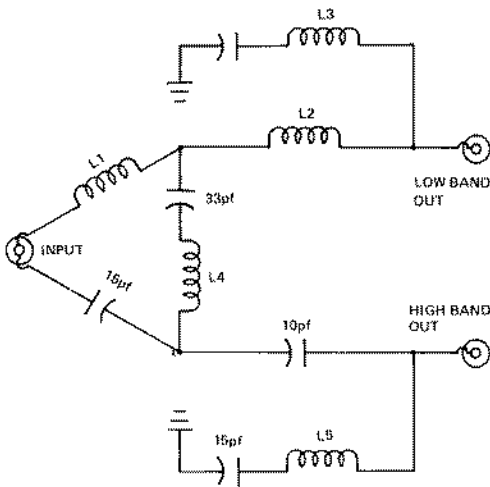


DIAGRAM 4

Diagram 5 Components

- L14T, #24, 3/16" air form
- L2, 36T, #24, 3/16" air form
- C1422 trimmer, 4-40 pF
- C2, 3402 trimmer, 0.9-12 pF



- L1 - 9 \times #24, 1/8 AIRFORM
- L2 - 9 \times #24, 1/8 AIRFORM
- L3 - 8 \times #24, 1/8 AIRFORM
- L4 - 4 \times #24, 1/8 AIRFORM
- L5 - 9 \times #24, 1/8 AIRFORM

DIAGRAM 6

in Diagram 7. Across ports, low band is down 30 db or greater at the high band port and high band is down 30 db or more at the low band port.

We can take this circuit apart and build a modified stop band filter that will stop either low band or high band, but allow the alternate to come through with 1 to 1.5 db thru loss.

Diagram 8 is such a unit for low band stop, high band pass. This unit can be constructed in the mini-box, as is shown here. L1 plus L2 form a broad series trap for the 50-100 MHz range. This could be modified to cover a lower range by increasing the number of turns of L1 and L2 accordingly. C1 tunes L1 + L2. C2 is a shunt to ground and it can be operated as C2 directly to ground, in which case it series tunes both L1 (+C2) and L2 (+C2) or it can be operated with alternate induc-

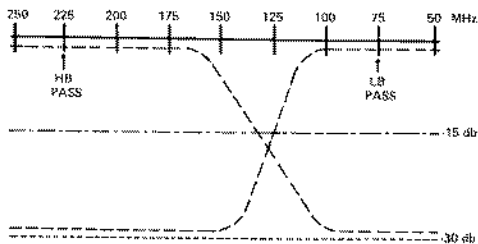


DIAGRAM 7

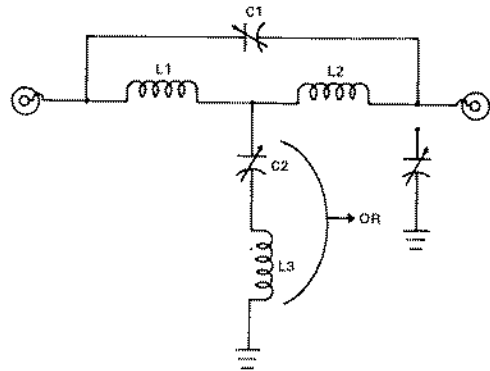


DIAGRAM 8

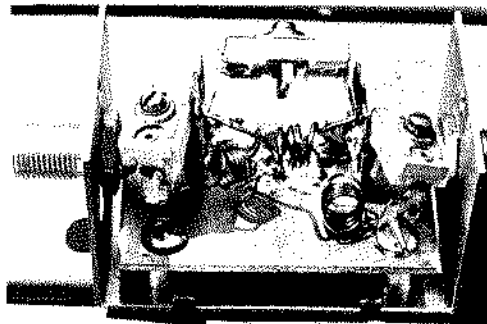
Diagram 8 Components

- L110T, #24, 3/16" air form
- L25T, #24, 3/16" air form
- L38T, #24, 3/16" air form
- C1, 2422 trimmer, 4-40 pF

tor L3 which forms an additional series shunt trap to ground.

Without L3 the reject band is 35 or more db down from the pass band and extends from 55 to 92 MHz. With L3 you can tune the reject bandwidth to any 15 MHz wide range between 55 and 100 MHz, such as 55 to 70 MHz. This is shown here in Diagrams 9 and 10. With this circuit the high band (as well as below 40 MHz) is passed with from 1 to 1.5 db thru loss.

By modifying the components utilized, we can extend the stop band range with stop or rejection of low band and passage of high band. Diagram 11 shows the circuit for low band stop or reject, high band pass. This circuit has additional shunt trapping in it to allow the designer to sharpen the roll off between pass and



MINI-filter for high band pass, low band reject

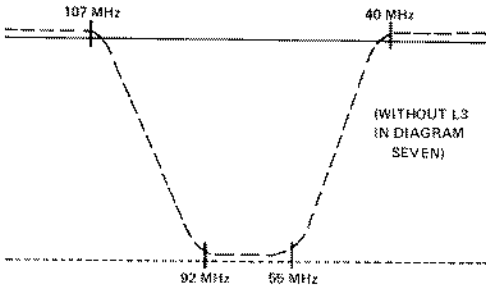


DIAGRAM 9

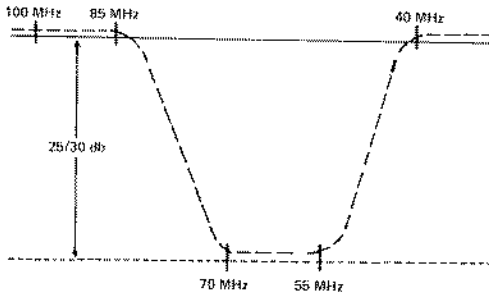


DIAGRAM 10

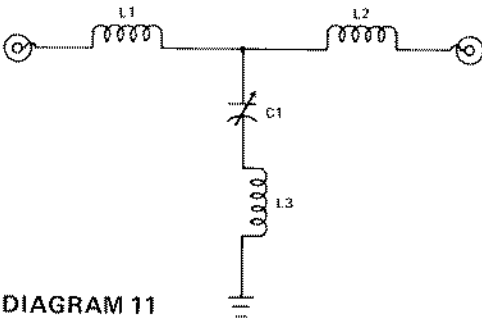


DIAGRAM 11

Diagram 11 Components

L1, 2, 35T, #24, 3/16" air form
C1422 trimmer, 4-40 pF

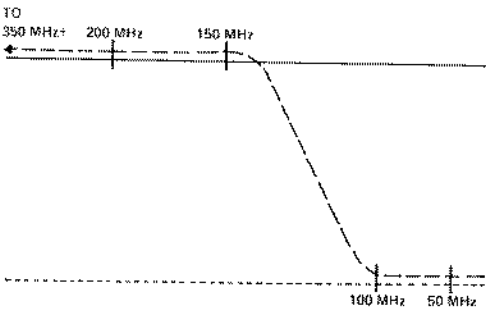


DIAGRAM 12

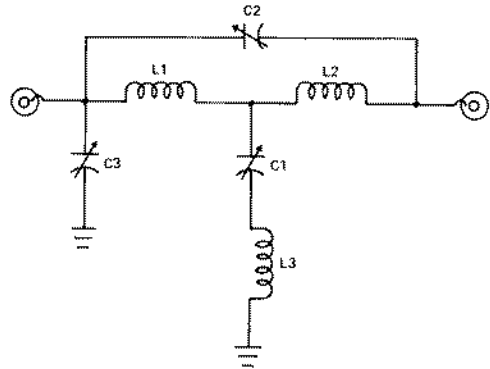


DIAGRAM 13

Diagram 13 Components

L1, 2, 35T, #24, 3/16" air form
C1, 2, 3422 trimmer, 4-40 pF

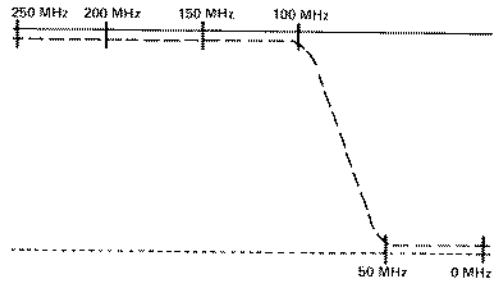


DIAGRAM 14

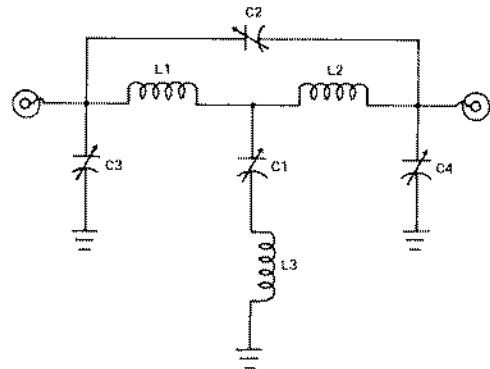


DIAGRAM 15

Diagram 15 Components

L1, 2, 35T, #24, 3/16" air form
C1, 2, 3, 4422 trimmer, 4-40 pF

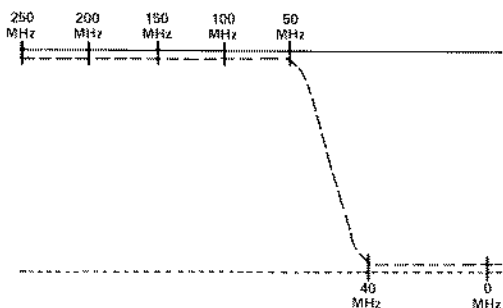


DIAGRAM 16

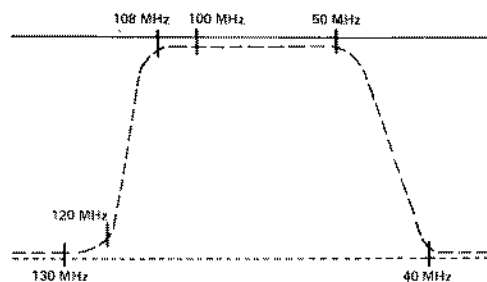


DIAGRAM 18

Now if we wish to extend the passband down to 100 MHz and decrease the stop band to 0-50 MHz (with some form of attenuation between 50 and 100) we can add the two capacitors shown in Diagram 13. This sharpens the "Q" of the reject circuit as shown in Diagram 14.

Finally, if we wish to have a filter that passes everything above say 50 MHz (tuneable from 48 to 62 MHz) with minimum attenuation, but attenuates ev-

erything below 40 MHz (tuneable 40-50 MHz) see Diagram 15. This is the same circuit as Diagram 13 with capacitor C4 added. Again the "Q" of the reject circuit is improved by adding C4 and the resulting passband is shown in Diagram 16. This would stop sub-low from getting into an amplifier set up to handle 50(54) to 350 (+) MHz.

The last filter design for this report allows low band to pass but rejects everything outside of the common low band range. The pass band is 50 to 108 MHz, while the stop band is at full attenuation from 40 MHz down to DC and 125 MHz up through 350 MHz (+).

Diagram 17 shows the schematic and Diagram 18 shows the pass and reject bands.

SYNOPSIS

A relative handful of small component parts and a little time will give you considerable new insight into the filtering processes. If you have access to a sweep system with markers, filter experimentation and alignment becomes about as interesting a project as you can undertake on your own.

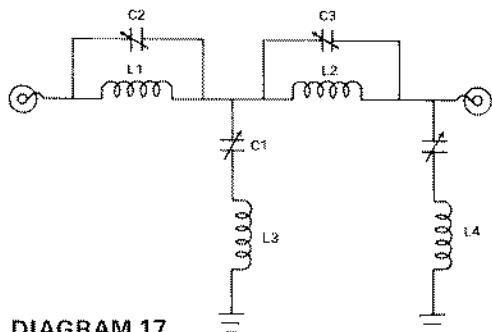


DIAGRAM 17

Diagram 17 Components

- L1, 213T, #24 3/16" air form
- L3, 45T, #24, 3/16" air form
- C1, 2, 3, 4422 trimmer, 4-40 pF

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CATJ COOK BOOK

FOR 1974/75

FCC MEASUREMENTS

In the November CATJ, guidelines for making annual measurements were discussed. The intent of the November portion of this two-part series was to lay the foundation for the tests themselves. Very little space will be devoted here this month to "who must make which tests, when". Rather you are referred to the November CATJ, pages 24 to 30, for a run down of this material.

76.605 (a) (4)

This is the visual signal level measurement required for all Class I (i.e. off-the-air signal) channels. This section states that *"The visual signal level, across a terminating impedance which correctly matches the internal impedance of the cable system as viewed from the subscriber terminals, shall be not less than the following value:*

75 ohms 1 millivolt".

One millivolt is the same as 1,000 microvolts, which is also the same as 0 dbmv.

Steps:

- (1) Disconnect the subscriber drop cable from the receiver (1) and connect to the RF input jack on your calibrated FSM/SLM;
- (2) If your FSM/SLM has both peak and average detection,

place in the *peak detection* mode;

- (3) Carefully peak the tuning of the FSM/SLM on the visual carrier of all channels carried on the system which originate at a television broadcast, translator source and record same. This includes channels delivered to you via microwave, having been picked up *off-the-air* at some distant point. Note the indicated level on your testing form (2) for each channel;
- (4) Note on your testing form the make, model, and serial number (if known) of the FSM/SLM device utilized for the measurements;

1) Measurements do not have to be taken "literally" at the end of a subscriber drop. Section 76.601 (c) states "The measurements may be taken at convenient monitoring points in the cable network, provided that data shall be included to relate the measured performance to the system performance as would be viewed from a nearby subscriber terminal." This means that if you have 6 db of cable loss in the drop at channel 13, and 2.5 db of cable loss at channel 2, that the measurement made at a "convenient monitoring point" must be numerically compensated to relate to the actual levels that would be found inside the home at the drop terminus.

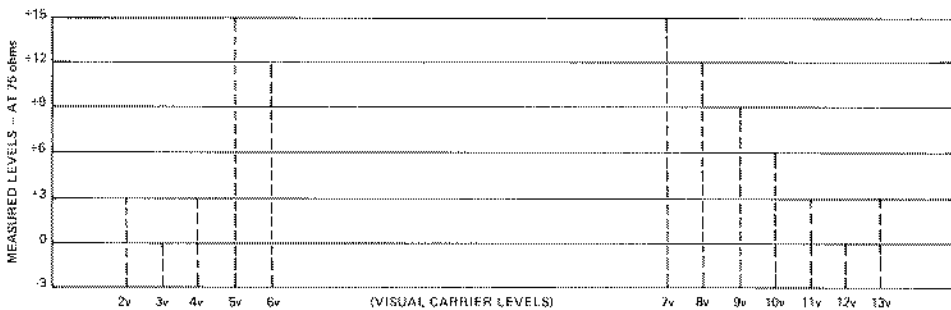


DIAGRAM 1

- (5) Note on your testing form the name and title (i.e. "system owner", "technician", etc.) of the *individual* making the tests, and the date and time of the tests, along with the street address (location) where the tests were made.

76.605 (a) (5)

This is the signal level *variation* measurement required for all Class I (broadcast television) channels. This section states "*The visual signal level on each (Class I) channel shall not vary more than 12 decibels within any 24 hour period, and shall be maintained within: (i) 3 decibels of the visual signal level of any visual carrier within 6 MHz nominal frequency separation, and (ii) 12 decibels of the visual signal level on any other channel, and (iii) a maximum level such that visual degradation due to overload in the subscriber's receiver does not occur.*"

See Diagram 1 here. This diagram shows one of the worst case (but passable) number-sets which you could measure, and pass. Channels 2 and 3 are adjacent. They are *within 3 db* of one another. Likewise, channels 3 and 4, which are *immediately adjacent*, are also within 3 db of one another. Channels 4 and 5, which are *not* immediately adjacent (there is a 4 MHz guard band between them) are 12 db in level apart. But 5 and 6, which are

immediately adjacent, are within 3 db of one another.

Channels 6 and 7 are *not* immediately adjacent (in frequency). Therefore they *could be* as much as 12 db apart and still *meet* the standard. We have reverse-stepped channels 7, 8, 9, 10, 11 and 12, in 3 db increments. They are legal because *no two adjacent carriers* are more than 3 db apart in visual signal level. Twelve and 13 are also 3 db apart, although the channel 13 level is once again higher than the 12 level, since at 12 we have reached the 0 dbmv "*minimum signal level*" prescribed by 76.605 (a) (4).

It should be emphasized that this *particular* example meets the requirements, *but* your plant operation at these levels, through active amplifiers, would probably be *very poor*. Allowing channels 5 and 6 to run so much higher than 3, for example, would probably eventually cause 3 to be lost in a mixture of inner-mod and noise.

Steps:

- (1) Disconnect the subscriber drop cable from the receiver (1) and connect to the RF input jack on your calibrated FSM/SLM;
- (2) If your FSM/SLM has both peak and average detection, place in the *peak detection* mode;
- (3) Carefully peak the tuning of the FSM/SLM on the visual carrier

frequency of all channels carried on the system which are received through direct or microwave delivered off-the-air reception techniques;

- (4) Note on your testing form the make, model, and serial number (if known) of the FSM/SLM device utilized for the measurements;
- (5) This section requires that you determine that "within any 24 hour period the signal level on any channel shall not vary more than 12 db". Actually, you are making two different tests, *simultaneously*. You are determining that no two adjacent carriers are more than 3 db apart and that no two system carriers are more than 12 db apart; *and*, you are determining that no single carrier at any time varies more than 12 db within a 24 hour time span.

To follow the "letter of the rule", it would be necessary to maintain an individual chart-recorded record of the level at the measurement point on every channel on the system, for 24 hours. This would require 12 FSM/SLM units and 12 channels of chart recording apparatus to follow the "letter of the rule".

A more practical situation is to make *four measurements*, spaced approximately 6 hours apart (total of 24 hour time span), noting the test site levels on all system Class I channels for each of the measurement periods. This is the technique recommended by CATJ to conform to the "intent of the rule" as stated here.

- (6) Note on your testing form the name and title (i.e. "system owner", "technician", etc.) of the individual making the tests,

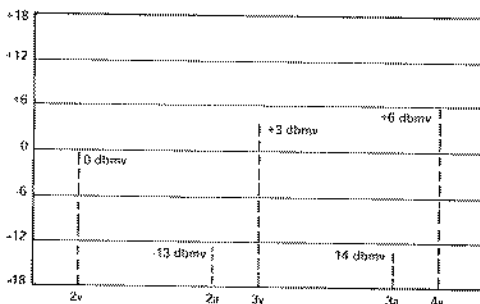


DIAGRAM 2

and the date, time and location (with street address) of the tests.

76.605 (a) (6)

This is the visual and *associated aural carrier level* measurement required for all Class I (broadcast television) channels. This section states "The RMS voltage of the aural signal shall be maintained between 13 and 17 decibels below the associated visual signal level."

See Diagram 2 here.

In this measurement example, the channel 2 visual level measures 0 dbmv. The channel 2 aural level makes spec by measuring -13 dbmv (13 db difference). The channel 3 visual carrier level measures +3 dbmv, while its

2) CATJ is considering preparing for early January distribution a comprehensive TEST BOOKLET that will include step by step instructions for all tests required (including tests required only of newer systems), and blank measurement data forms to be filled in by the individual conducting the test. The expected cost of the TEST BOOKLET will be \$25. You can indicate whether you would be interested in such a BOOKLET (and thereby help CATJ make a decision on its publication) by contacting Heather Pennington, CATJ, 4209 NW 23rd, Suite 106, Oklahoma City, Oklahoma 73107.

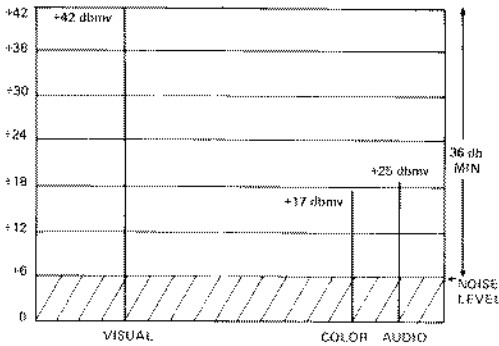


DIAGRAM 3

associated aural carrier makes spec at -14 dbmv (17 db difference). The channel 4 visual level shown measures +6 dbmv; its associated aural would have to measure between -7 dbmv and -11 dbmv to "make spec".

Steps:

- (1) Disconnect the subscriber drop cable from the receiver (1) and connect to the RF input jack on your calibrated FSM/SLM;
- (2) If your FSM/SLM has both peak and average detection, place in the *peak* reading mode;
- (3) Carefully peak the tuning on the desired (measurement) channel *visual carrier*, and make a notation on your measurement test form of the visual carrier level present. Now *repeat the measurement* on the *aural carrier* of the measurement channel, being very careful to peak on the associated aural carrier and *not* the immediate upper adjacent visual carrier, making a notation of the level measured on your measurement test form. Repeat this test on *all* Class I (broadcast) channels on the system;
- (4) Note on your testing form the make, model, and serial number (if known) of the FSM/SLM device utilized for the measurements;

- (5) Note on your testing form the name, title (i.e. "system owner", "technician", etc.) of the individual making the tests, and the date, time, and location (street address) of the tests.

76.605 (a) (6)

This is the signal-to-noise ratio test required on all Class I (i.e. off-the-air) signals first picked up within their Grade B contours. It is important to note that these tests are *required* on *all channels which* (1) you pick up at *your head end* from a broadcast transmitter that covers your cable community with a Grade B or higher level predicted signal level and, (2) any microwave channels delivered to you which are first picked off-the-air at a point within their own Grade B (or better) contour. These measurements are *not* required on any channels which you pick up off-the-air *beyond* the predicted Grade B contours (as that contour crosses, touches or includes your cable community). This section states (in part) "*The ratio of visual signal level to system noise... shall be not less than 36 decibels*". (This section also mentions co-channel interference; however, the co-channel portion of this surement requirement has been *suspended* pending further FCC/C-TAC study.)

See Diagram 3 here.

Steps:

- (1) This measurement must be made at a fairly *high* signal level measurement point in the system. The levels shown in Diagram 3 are *not* absolute; (i.e. they are intended to show that you need from 36 to 42 db more signal at the measurement point *than* the *system noise* which is what you are going to measure to make a valid measurement) It may *not* be

possible to make this measurement *accurately* with some FSM/SLM devices unless the true (absolute) input level to the FSM/SLM is in the +10 dbmv or higher range.

This measurement can be made at the *output* test point on a line extender or through a low isolation value DT (i.e. 8 or 12 db) inserted for test purposes directly after the amplified output (port) of a line extender amplifier.

- (2) This measurement must be *repeated* for all channels on the system which meet the Class I, Grade B criteria.
- (3) On *each* channel:
 - (A) Determine the *absolute level* of your visual carrier high level test point; note this level on your measurement form.
 - (B) Leaving the FSM/SLM untouched, radio, call, or signal the head end and have the antenna input signal to the processing equipment disconnected; *replace the input cable* with a 75 ohm terminating resistor (see Diagram 4).

Note: If, in the absence of input signal, your signal processor turns on a standby carrier, this standby carrier *must be disabled* for this test.

- (C) Now remove pad attention from the FSM/SLM until your FSM/SLM begins to read on-scale once again. *What you are now measuring*, with the input signal disconnected and the processor input terminated but the processor still running, is *cumulative noise* on the channel being measured. Note the *absolute level* of that

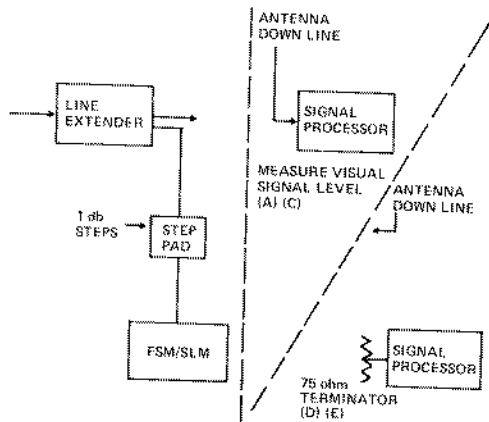


DIAGRAM 4

noise as read out from your FSM/SLM. The *numerical difference* between the signal level read when the antenna was connected to the processor and the signal level (i.e. noise level) when the signal was disconnected and replaced with a terminator is *your system signal to noise ratio* (3) for that channel. Note the noise level in absolute level and the signal to noise level (i.e. signal reads +36 dbmv, noise reads -4 dbmv; signal to noise is +36 dbmv minus -4

3) *It is necessary to compensate for the narrower bandwidth of the FSM/SLM device when measuring signal-to-noise ratios for a 4.5 MHz bandwidth TV signal. Therefore, determine what the "bandwidth compensating number is" for your particular FSM/SLM (consult your manual), or take 4.0 db to be safe, and if you measure 40 db signal-to-noise in the test, subtract either the known compensation number, or 4.0 db as a maximum, to arrive at the compensated value for the test results.*

TABLE 1

To determine the maximum permissible radiation level from your system, select from this table the frequency of the channel to be measured in the radiation tests (visual carrier given for TV channels). The levels permitted following test steps given here are shown in microvolts and in dbmv levels. If an amplifier is used **between the test dipole and the FSM/SLM**, its known **gain** must be **added** to the levels given here. Feedline losses between the dipole and the FSM must also be **added** to levels measured (i.e. if there is 1 db of feedline loss, this is 1 db **less real signal** you can measure and still meet the spec).

Channel/ Frequency	Microvolts	dbmv
2	15.65	-36
3	14.20	-37
4	12.90	-38
74 MHz	11.70	-39
5	11.20	-39
6	10.40	-40
100 MHz	8.65	-41
108 MHz	8.05	-42
165 MHz	5.25	-46
7	4.95	-46
8	4.80	-46
9	4.65	-47
10	4.50	-47
11	4.35	-47
12	4.22	-48
13	4.10	-48

dbmv, or 40 db signal to noise) on your measurement form.

- (4) There is an alternate method of performing this test, if you have reason to be suspicious of your FSM/SLM switchable pads:

- (A) At your high level test point, open the FSM way up (i.e. *take all attenuation out*) and before you connect the FSM/SLM to the test point, place a 1 db step attenuator (with all attenuation in) between the FSM/SLM and the test point.

- (B) Take attenuation out of the external 1 db step attenuator until you have a convenient *reference scale reading* (such as mid-scale or 0 db);
- (C) Peak the FSM/SLM out of more time on the visual carrier frequency, and *leave the frequency tuning knob untouched*;
- (D) Direct the head end to *disconnect* the antenna input, *replacing it* with a 75 ohm terminator at the processor input; make certain that the processor runs normally, with *no* standby carrier operating.
- (E) Now make a note of the number of db of attenuation *remaining in the external 1 db step attenuator*, and start taking out attenuation until the FSM/SLM comes *back* to your convenient reference point set in (B) above on noise alone.
- (F) The *number of db which you took out of your external attenuator* to bring the FSM/SLM back to the *same scale* reference point as in (B) above is your signal to noise ratio (3). If you began with 52 db of pad in the external attenuator, and with noise ended up with 12 db of pad in the attenuator, your signal-to-noise ratio is 52 minus 12 or 40 db (3).
- (5) Note on your test measurement form the make, model, and serial number (if known) of your FSM/SLM device utilized in this test;
- (6) Note on your testing form the name, title ("system owner", "technician", etc.) of the indivi-

dual making the tests, and the date, time, and location (street address) of the tests.

76.605 (a) (12)

This is the system radiation test required for all systems, regardless of age. This measurement is supposed to determine to your satisfaction that any signal leakage from your system does not exceed the prescribed maximums set by 76.605 (a) (12), at any point in the system. This is not, literally, a measurement which can be made at three distinct points in the system (see CATJ for November, *Measurements*). At how many points you make this measurement is entirely up to you, although you cannot escape the responsibility that your whole system shall be free of radiation in excess of the prescribed maximum.

As a practical matter, system radiation can take place (1) along trunk or distribution lines, where broken or severed outer cable conductors are found, (2) along trunk or distribution lines where connectors are improperly seated into an amplifier, line splitter, tap, terminator, etc., (3) at power supply (voltage) insertion points where AC/RF isolation has failed and signal is radiated by the power supply, power insertion device, or by the AC wiring between the power mains secondary and the AC power input to the power supply, (4) at and along subscriber drops where cable shielding is inadequate, broken or rubbed through, (5) and at the terminus of subscriber drops where a subscriber has left a line unterminated and perhaps touching some metallic object which, in turn, is re-radiating the signal in the area. Radiation can also take place when a cable drop is connected to a receiver antenna terminals (through a matching transformer) and the customer parallels the cable connection to his receiver with his own outdoor antenna. This feeds the cable RF voltages right back

up to the rooftop antenna, and it radiates over the neighborhood. This is not the cable's fault, but it is up to you to spot and see that it is corrected.

Section 76.605 (a) (12) reads (in part) "Radiation from a cable television system shall be limited to 20 microvolts per meter between 54 and 216 MHz at a distance of ten feet" and "15 microvolts per meter at a distance of 100 feet for frequencies below 54 MHz and above 216 MHz".

Microvolts per meter is a strange measurement term to most CATV operators. It does not mean "microvolts at a distance of a meter" or "microvolts per FSM"! The translation of "microvolts per meter" to "microvolts I can measure on my handy 75 ohm reference dipole" is shown here in Table One.

Steps:

- (1) Construct a 75 ohm reference dipole, following your own techniques or by following Diagram 5. The dipole should be adjustable (for frequency), which means that the A-B and C-D rods should be adjustable for length. You can do this very simply by procuring replacement telescopic rod walkie-

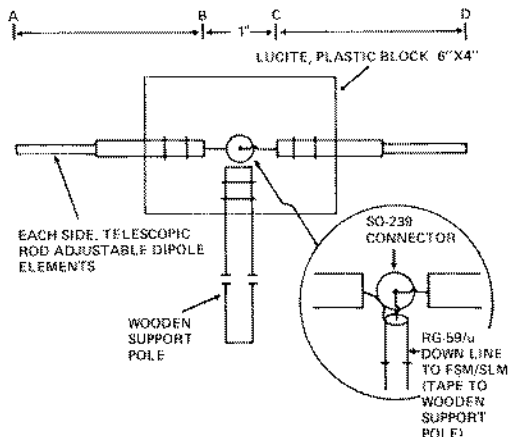


DIAGRAM 5

TABLE 2

Dipole lengths for each half of the dipole antenna are given here. The A-B and C-D distances are identical (i.e. both sides are the same) and the length must be adjusted before measurements are made on a specific frequency or channel. See Diagram 5.

Channel	A-B / C-D
2	50.1" each
3	45.2" each
4	41.2" each
74 MHz	37.4" each
5	35.9" each
6	33.3" each
100 MHz	27.7" each
108 MHz	25.6" each
165 MHz	16.8" each
7	15.8" each
8	15.3" each
9	14.8" each
10	14.3" each
11	13.9" each
12	13.5" each
13	13.1" each

talkie antennas or TV "rabbit ear" antennas, which utilize slip-together rods concentrically. The total A-B/C-D length(s) must be set (per Table 2) for each channel.

- (2) The dipole antenna must be elevated to approximately the height of the CATV line(s) being "probed" for radiation. This suggests that a wooden (i.e. insulated in case of accidental contact to AC power lines) handle of some length (10-12') is required.
- (3) The FSM is adjusted to the exact frequency of the carrier for which you are probing. Here you may have a practical problem. Unless you have unreal amounts of radiation, your chance of finding true plant radiation, while walking along the ground is slim because your dipole antenna is going to pick up

direct TV signals from transmitters within 100 miles or so. Therefore, you should select a TV channel which has no VHF station on it within say 100 miles or more (such as cable channel occupied by a UHF station); or, select a frequency that is cable utilized, such as your pilot carrier 72-76 MHz or 165 MHz or 216-220 MHz signal. By selecting a cable-carrier for probing which is *not going to conflict* with signals floating around in the air, you stand a better chance of finding radiation and not spending the day chasing down off-the-air signals. If you have no pilot carrier and every channel on your system has off-the-air broadcasters on it also, you will have to devise some method of *inserting a special test signal* on a discrete frequency at the head end. See CATJ for May, page 32 for a special low cost marker unit that will satisfy this purpose.

- (4) The next problem with detecting radiation is the *very low level* which is permissible under the "20 microvolts per meter" specs of 76.605 (a) (12); see Table 1. The end result, detecting levels which are down in the -40/-50 dbmv region, is difficult even with first rate FSM/SLM devices. If you are operating with measurements of a discrete cable-secure frequency (i.e. a pilot carrier or test carrier inserted at the head end), you can at least avoid false readings from off-the-air signals that may come floating into the dipole-FSM/SLM combination.

One solution is to employ a package such as the MID-STATES COMMUNICATIONS (4) model RD-1, a combination

dipole for measurements and 20 db flat gain amplifier which gives all signals picked up 20 db "boost" thereby making accurate FSM/SLM low level measurements possible. With such a unit in use, your *real* level becomes 20 db *lower* than your meter-read-level, of course.

- (5) With all of these problems under control, take the dipole and probe "10 feet above the ground and directly below the (cable) system components". Where vertical clearances between the cable and the ground is less than 20 feet, "lower the test dipole so that it is ten feet separation from the cable system components". With the dipole in position, "rotate the dipole at the measurement height in a vertical axis until you obtain maximum meter reading". And finally, "if there are other conductors (i.e. down guys, etc.) within ten feet the measurement antenna, find another location for your tests; one such that no other conductive materials (i.e. metallic) are within ten feet of the test antenna".
- (6) Note the readings found, and having ascertained that there are no locations in town where your plant radiates beyond the prescribed maximums;
 - (1) Note in your test measurement form the make, model and serial number of any equipment utilized in this test;
 - (2) Note on your test form the name, title ("system owner", "technician", etc.) of the individual making the tests, and the date, time and locations where tests were conducted.

This completes the tests required to have been made *initially* on or before

March 31, 1974, and which must be *repeated again* on or before March 31, 1975, by all grandfathered systems. Additionally, grandfathered systems must also complete the following *new* (this year) tests on or before March 31, 1975.

76.605 (a) (7)

This is the "hum modulation" measurement. Essentially, what you are setting out to determine is that the percentage of hum (from the AC mains power) induced into the RF signals *does not exceed* a modulation index of 5% on the RF signal(s) present. To put it another way, you are trying to ascertain whether or not AC hum, caused by the sine-wave AC power mains source, is getting into the RF (radio frequency) signals, and causing some percentage of *objectional AM* (amplitude modulation to the video (picture portion) signals).

Section 76.605 (a) (7) states "*The peak-to-peak variation in visual signal level caused by undesired low frequency disturbances (hum or repetitive transients) generated within the system, or by inadequate low frequency response, shall not exceed 5% of the visual signal level*".

In plain English, is the hum so bad that people *object* to it?

Hum modulation can get into a system at any point where AC power is introduced to equipment that handles the signal. It can even come from directional taps that pass both AC and RF! However, it normally comes from an inadequately filtered power supply; and, since no manufacturer could reasonably expect to peddle equipment that hum-modulated RF signals by 5%

4) *MID-STATE Model RD-1 combination test dipole and 20 db gain flat amplifier sells for \$166. Contact Mid-State Communications, P.O. Box 203, Beech Grove, Indiana 46107.*

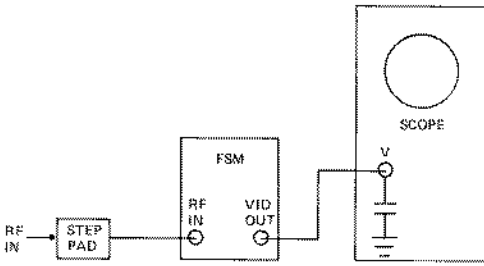


DIAGRAM 6

(or more), we must assume that if we have hum modulation on our pictures, *something has broken down* in the equipment during service-usage.

A 5% hum modulation maximum (limit) is very *generous* of the FCC. This amounts to a modulating signal that is 26 db lower in level than the desired video signal; and most of us recognize that a 26 db ratio between (say) desired signal and noise, or desired signal and co-channel is *objectionable*.

The plain facts are that while section 76.605 (a) (7) states "(hum) . . . shall not exceed 5% . . .", if any of the RF carriers in our system even *approach* 5% hum modulation in real life, our cable office phone rings off the hook (or nobody is watching that channel!).

If the purpose of testing is to *determine compliance* with the rules, then making compliance with 76.605 (a) (7) is very simply done. "Turn on a TV set at the test measurement point, and switch through the channels. Do you see any 60 cycle hum bars in the picture?" If you do, but they are *very faint*, you are well *under* 5% hum mod. If they are *objectionable*, you are approaching 5% or exceeding it. It sounds like a very "*subjective*" kind of test analysis, and truthfully, it is. This type of interference is *not* one on which differently calibrated eyeballs read different results. Virtually *anyone* can spot 60 cycle hum bars in the picture, and if you can't see them there, you are just as certain you are *under* 5% hum mod limits as you

would be after setting up a scope to make a test.

What CATJ is suggesting is that 76.605 (a) (7) compliance can be made by most systems by giving it a "*subjective eyeball test*". Then if you are "*seeing hum*" you should proceed on with the more critical test to be described here. It should be noted that this kind of subjective (eyeball) testing is *under serious consideration* by the C-TAC panel (Panel 2) and that pending the final results of C-TAC Panel 2, the Commission is "holding pat" on two *other* measurement areas which require equipment more sophisticated (and expensive) than the average quality FSM/SLM.

Steps:

- (1) Set up test setup as shown in Diagram 6. A relatively high level test point is required. You must make this measurement on a carrier on the system that has no normal modulation (i.e. not a TV carrier, although a standby carrier could be used). This could be an unmodulated pilot carrier, or a special AØ (unmodulated) test oscillator inserted at the head end. Your purpose is to determine if the unmodulated carrier has any (hum) modulation present (5).
- (2) Set the FSM/SLM to the frequency of the AØ (unmodu-

5) Any unmodulated carrier which you insert on your system, or make use of if already there (i.e. pilot carrier), to check for the presence of hum modulation must be clean of any hum modulation itself. If the power supply for a pilot carrier (for example) is not adequately filtered, and the result is a hummy pilot carrier, this test cannot be conducted until the test carrier is itself clean of hum at the head end before it goes into the plant distribution system.

lated) carrier. Connect the video output jack on the FSM/SLM to the vertical input of a DC coupled scope with moderately good sensitivity (at least down to 50 millivolts per division). *Note: Do not attempt to make this measurement without a CD coupled scope.* Bypass the vertical input jack on the scope with a .02 μF disc capacitor to the scope chassis ground to insure no locally induced hum goes into the vertical input. Operate the FSM/SLM on its battery supply to eliminate that possibility of hum introduction.

- (3) See Diagram 7. Set the scope to AC line sync (60 cycles); set the scope to DC. Set the scope to 0.1 V per cm range. Adjust the vertical centering of the scope for a straight line resting even with the bottom graticule on the scope screen (this assumes a scope screen graticule of 10 cm for the grid display, which is common). This is 7A.
- (4) Now connect the output of the FSM/SLM video-out jack to the vertical input of the scope. Adjust the in-line pad, manual gain or IF gain control on the FSM/SLM to produce a horizontal line that centers across the top (tenth) graticule line on the scope screen. This is 1 volt signal to the scope from the FSM/SLM. See 7B.
- (5) Switch the scope to the next highest range (50 millivolts or 0.05 V per cm range). Full screen display would now be 0.5 volts. Switch to the AC coupling position for the scope. Center the horizontal display for ease of reading and note the top and bottom extremities of the sine wave display. If it is not more than two graticule divi-

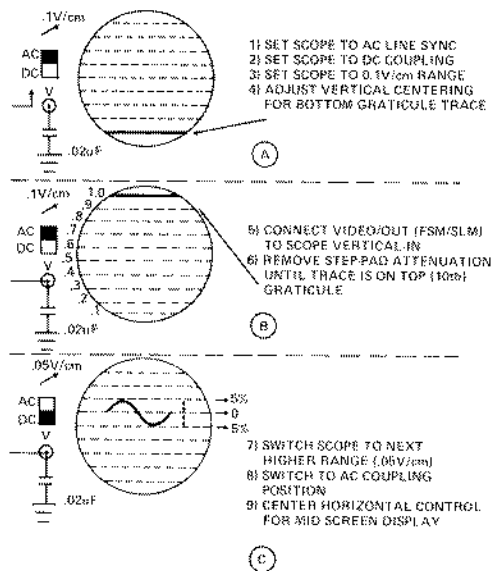


DIAGRAM 7

sions high (on a ten division screen, see Diagram 7C), you are 5% or less hum modulated on the A_0 carrier.

- (6) If you wish to measure the absolute percentage of modulation, you can probably read down to 2.5% (hum) modulation in the 50 millivolts per division range by simply interpolating between scope graticule (horizontal) marks. If your scope has a 25 millivolts per division (.025 V/cm) range, this would expand the visual scale from two divisions height for 5% modulation to two divisions height for 2.5% modulation.

NOTE: Your FSM/SLM may not have a 1 volt peak-to-peak output level ability in the video output jack. The Jerrold 727, for example, is 0.8 volt peak to peak, while the Delta-Benco FST-4 is 0.5 volt peak-to-peak. These specs are for a full scale (i.e. meter scale) reading however, and since we are not really interested in the real level through the FSM/SLM but are interested only in a full scope display,

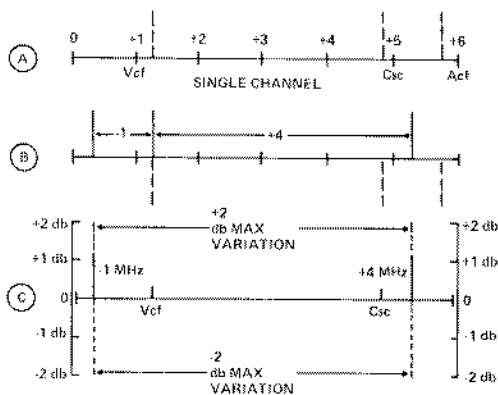


DIAGRAM 8

to get 1 volt p/t/p out of a unit that has a lower *rated* output, simply run the instrument at some *input attenuation-OUT level* which produces the 1 volt video output required for step (3) here.

- (7) Note on your test measurement form the make, model, and serial number (if known) of any equipment utilized in the test.
- (8) Note on your test form the name, title ("system owner", "technician", etc.) of the individual making the tests, date, time and location where the tests were conducted.

76.605 (a) (8)

This is the measurement of the "in channel response" of each Class I (off-the-air) signal utilized on the system. At the time that this report is being prepared for publication (late October), there is the *rumored* possibility

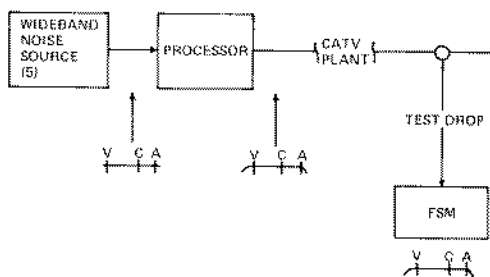


DIAGRAM 10

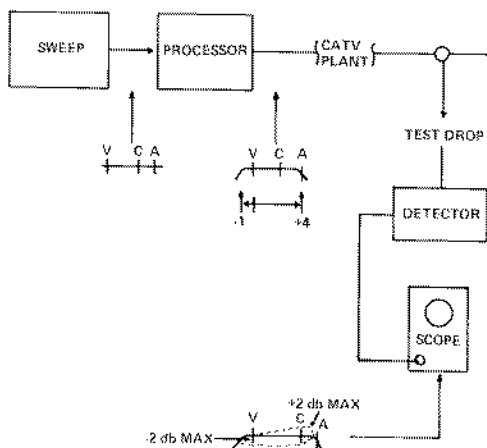


DIAGRAM 9

that the FCC *may postpone* the effective date (i.e. this year) requirement of this test pending additional C-TAC study or pending further definition of how this test is to be conducted.

This section states "The channel frequency response shall be within a range of ± 2 decibels for all frequencies within -1 MHz and $+4$ MHz of the visual carrier frequency."

See Diagram 8. A single television channel is 6.0 MHz wide. Within that 6.0 MHz bandwidth, the *visual carrier frequency* is 1.25 MHz above the lower channel edge. The *color sub-carrier frequency* is 4.83 MHz above the lower channel edge, and the *aural carrier frequency* is 5.75 MHz above the lower channel edge (and 0.25 MHz below the upper channel edge). Section 76.605 (a) (8) states that "within -1 MHz and $+4$ MHz the processed channel shall be gain-flat within ± 2 db". See Diagram 8B and 8C. What we are really protecting with the ± 2 MHz flatness spec is the video modulation region of the channel. In *theory*, the lower (AM) sideband of the TV transmission (i.e. that portion below the visual carrier frequency) is *filtered out at the transmitter* (in something called a Lower Vestigial Sideband Filter) and the *contribution* to the reproduced television picture on the TV receiver of

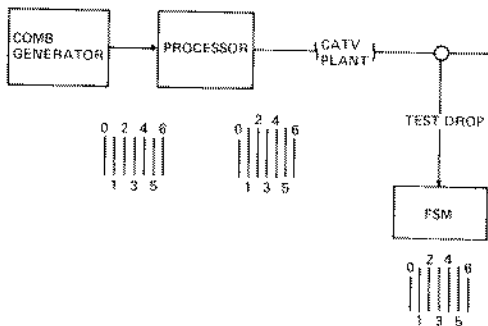


DIAGRAM 11

any of the modulation energy that is below (in frequency) the visual carrier frequency is questionable at best. However, the requirement at the present time (6) is that we maintain processing flatness to a point -1 MHz below the visual carrier frequency, plus or minus 2 db.

To measure our "in-channel" flatness, we have to determine first of all from where we start measuring. The FCC has not yet defined the "input test point" (6), but it appears logical that they will do so soon and that it will be "the input to the signal processor unit" when the CATV system has hard performance data available on the bandpass characteristics of any and all frequency selective equipment appearing before the processor input. This would usually include the bandpass characteristics of any and all frequency selective equipment appearing before the processor input. This would usually include the bandpass characteristics of the antenna, a pre-amplifier if one is used, and any bandpass filters or traps that are external to the processor unit.

For our purposes here we are considering the input test insertion point to be the input to the processor. See Diagrams 9, 10, 11, and 12.

Steps:

- (1) Some type of flat reference signal must be inserted into the processor input. This can be a sweep (Diagram 9), a wideband

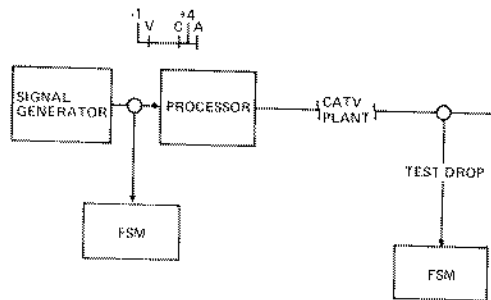


DIAGRAM 12

noise generator (Diagram 10), a 1 MHz comb generator (Diagram 11), or a tuneable frequency-accurate signal generator (Diagram 12).

The procedure is to insert the flat reference signal into the processor input, and then go down the line to your test measurement point and see whether the flat input has become tilted more than ± 2 db at any point between the visual carrier frequency -1 MHz and the visual carrier frequency +4 MHz.

While it is possible that some degree of tilting might take place cumulatively between the output of the head end and the plant output at your test measurement point (i.e. within the trunk and distribution portion of the plant itself), it is extremely unlikely that it would ever accumulate to more than ± 2 db. Keep in mind the plant is the "picture of broadband flatness", and that even variations which may creep in are seldom abrupt within a 6 MHz bandpass area, even on a cumulative basis.

6) The FCC is considering changing the -1 MHz to +4 MHz bandwidth to -0.75 MHz to +4 MHz. However, at the present time, the rules remain unchanged.

The most likely spot for "tilt" of the processed channel to occur is in the headend signal processing equipment. This suggests that if you insert a *flat reference signal* at the input to the processor, and then measure how much "out of flat" it has become at the output of the head end, that you will have nailed down 99% or more of the likely out-of-flat portion of your system. Still, the requirements call for measurement between the input point (which we suggest should be the *processor input*) and the test measurement point (which the FCC says must be no fewer than three points, one of which shall be the longest system drop by cable distance from the head end); to comply with the "letter of the rules", that is where the measurements must be made.

- (2) If your *reference signal inserted into the input is flat* (and you must determine this *before* proceeding out into the plant for test measurement point checks), the only step remaining is to go into the plant and check what has happened to the flat input. If you insert a broadband sweep at the head end (Diagram 9), detect that sweep and display it (with markers to denote the visual carrier frequency and the color and aural carrier frequencies, or 1 MHz markers to allow you to count down 1 and up 4). If you insert a wideband noise source (7) you can detect the noise output of the channel with an FSM/SLM. However, you have the problem of knowing *precisely* where "down 1 and up 4" are with a noise source, since most FSM/SLM devices cannot be that accurately, as frequency

readout devices. You also have the problem of separating that specific channel of noise from adjacent channels of signal. Your noise source must be at least 0 dbmv into the processor, and +10 dbmv is better yet, to assure proper output level (i.e. normal output is required) from the processor. If you insert 1 MHz combs from a comb generator (Diagram 11), you have a built-in frequency marking device which you can display (i.e. read out) on an FSM/SLM or on a spectrum analyzer. If you use a comb generator, the FSM/SLM is set to the *visual carrier frequency* with the TV signal being processed, then the comb generator is *substituted* for the normal input at a 0/+10 dbmv comb level. Slowly tune the FSM/SLM *down in frequency* (About 0.25 MHz) until you come to the first "comb carrier". This is now visual carrier frequency (Vcf) *minus* 0.25 MHz, and the *next* one down will be the Vcf *minus* 1.25 MHz. If it is within the +/- (and it should be *minus*) 2 db spec, you are *0.25 MHz to the good* with your low side roll off. The same procedure counting *up* will get you the Vcf *plus* 4 MHz, and it (as well as all in between) should also be +/- 2 db from the comb that was 0.25 MHz below the true Vcf. Finally, if you use a tuneable signal generator for your test input signal source, adjust it, *on the visual carrier frequency*, to +10 dbmv output to match the nor-

7) Wideband noise sources are available from SADELCO (299 Park Avenue, Weehawken, N.J. 07087) and VITEK (200 Wood Avenue, Middlesex, N.J. 08846).

mal processor input level, and make *certain* the processor output level is "normal". Read the signal level on the FSM/SLM at the *test measurement point*. Then dial the signal generator to a frequency that is 1 MHz *lower* (i.e. $V_{cf} - 1$ MHz) than the visual carrier, and determine that the level *to the processor* is unchanged from the V_{cf} *input level* inserted. Measure that level on your FSM/SLM at the *test measurement point* (it should be ± 2 db and will probably be minus). Now go back to V_{cf} *plus 1 MHz* and repeat the test, again being sure the signal generator output is identical to the same generator output (i.e. *same as processor input*) as you ran on the V_{cf} . Read and note the level at the test measurement point. Repeat the test at V_{cf} *plus 2 MHz*, V_{cf} *plus 3 MHz*, and V_{cf} *plus 4*

MHz. Note the results with each test:

- (3) Recall that this "in channel flatness test" must be repeated for *every* channel which you first pick up within the Grade B (or higher grade) signal contour.
- (4) Note on your test measurement form the make, model, and serial number of any test equipment employed in the tests;
- (5) Note on your test form the name, title ("system owner", "technician", etc.) of the individual making the tests, and date, time, and location where the test measurements were made;
- (6) *NOTE:* Because we have chosen to *insert* the test (flat) reference signal *at the processor input*, we must also make numerical allowances for any *frequency selective equipment* preceding that input point. This requires that you have *in your*

B/W CRT PRICE INCREASE

Look for very dramatic price increase in black and white cathode ray tubes (CRT's) soon. Virtually all U.S. production of black and whites has come to a halt and off-shore producers are jacking up the price accordingly.

If you have been putting off stocking up on spare CRT's for your black and white monitors, you may want to consider doing it soon to beat the sure-to-come price increase (perhaps 50% or more) just around the corner.

ARVIN MODEL 500B TO BE REVIEWED

When we set out to create the four-part series on field strength meters for CATJ, we had heard rumors of the Arvin 500B meter. We had seen one on display at the NCTA show in Chicago last April, but to our knowledge at that time, none had been produced. We have subsequently been contacted by Arvin who reports, "More than sixty of these units have been shipped, and we want you to review our unit."

We expect to receive an Arvin 500B sometime in December. The review of the instrument will appear in CATJ in February or March. This is quite an unusual instrument with thirty-six push button channels, and twin calibrated rotary attenuators in place of the usual 20 db (wide) log scale. Plus or minus 1 db accuracy is claimed. We will see how it does in comparative tests.

ATTENTION STATE/REGIONAL ASSOCIATIONS

CATJ is putting together a new type of free (no charge) technical news service for state and regional associations which publish occasional or regular member news letters or bulletins. Here is how we envision the service working. We will dispatch, once per month, the latest FCC news, rule changes, and other newsworthy material to your news letter or bulletin editor. You are free to use any of it, all of it, or none of it as you wish. Our purpose is simple enough . . . to give you the benefit of our national news-gathering facilities, and to make it possible for you to publish an up-to-date news letter for your state and regional members. There is no charge or obligation for this service. However, we must know to whom we should send this material! So please do the following—bring this service to the attention of the individual in your association who is responsible for publishing and distributing your association news letter or bulletin; ask that individual to put CATJ on your association news letter/bulletin mailing list; and we will do the rest, including adding your association to our free CATV Association News Service mailing list. Address your complimentary copy of your publication to:

CATJ NEWS SERVICE, % CATJ
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OKLAHOMA CITY, OK. 73107

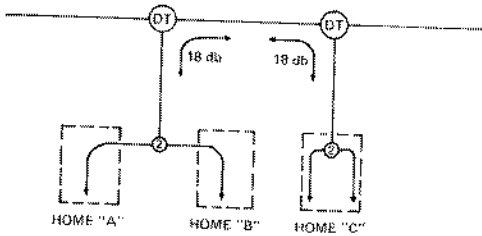


DIAGRAM 13

files flatness data from the manufacturer of any antenna, pre-amplifier, filters, etc. which may be inserted into the line ahead of the processor. In the event that your tests show you are -1.5 db at (for example) minus 1 MHz, between the processor input and the test measurement point, and your cumulative antenna and pre-amp flatness data shows you are minus another 1.0 db at minus 1.0 MHz (reference Vcf), then your whole in-channel flatness spec becomes -1.5 plus -1.0 or a true minus 2.5 db. This would be out of spec with 76.605 (a) (8). Data relating to the whole package of equipment must be a part of your test measurement form data.

76.605 (a) (11)

This is the "isolation between subscriber terminals" measurement. This section specifies a specific number (18 db), but it also notes that in case "18 db is not adequate isolation" that "isolation... shall be sufficient to prevent reflections caused by open-circuit or short-circuited subscriber terminals" causing picture degradation at any other subscriber terminal.

The section reads, "The terminal isolation provided each subscriber shall be not less than 18 decibels, but in any event, shall be sufficient to prevent reflections... from producing visible pic-

ture impairments at any other subscriber terminal."

Most passive devices (directional taps in particular) manufactured since 1969 have no difficulty meeting and exceeding this spec by a wide margin. Most splitter devices manufactured since that period, and more especially the hybrid splitter devices, have no problem with that spec. Older directional taps and non-hybrid splitters of that earlier vintage, or even more recent vintage, may have some problems here.

See Diagram 13. Between any two subscribers, there must be at least 18 db of terminal isolation. It is also likely that the Commission intended that between any two terminals, even if they are for a single subscriber, there shall be no less than 18 db terminal isolation (although the rules are unclear on this point). Two-way (Four-way, etc.) splitters are easily checked as shown in Diagram 14. The normal tap connections are reversed so that the input is terminated and the drop signal coming to the house is connected to one of the output ports. The FSM is connected to the other output port (in the case of a two-way device) and the absolute level is read on the FSM/SLM. This is compared with the absolute level measured at the terminus of the drop (at the input to the splitter) and it should be down 18 db or more. In this situation, we are using the drop level signal voltage as our reference level, thereby avoiding hauling in a signal generator.

A directional tap installed on the distribution cable cannot be easily checked in this fashion since you cannot easily disconnect the tap from the line. The best method of checking the DT is to go to "Home A" and hook-up a signal generator at the terminus of the tap, feeding a signal generator carrier (on some non-TV frequency such as within the FM band) into the tap drop cable. Then go to another home ("Home B") connected to the same DT

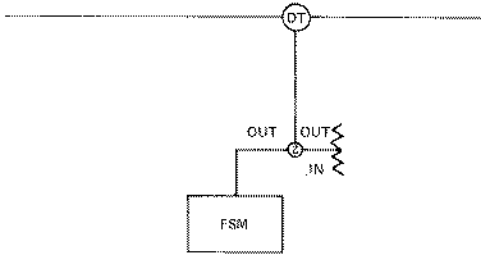


DIAGRAM 14

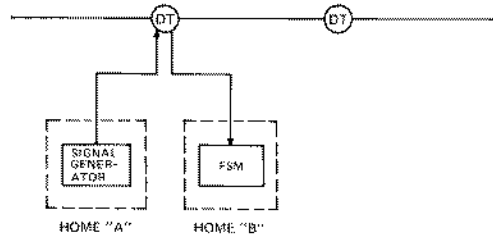


DIAGRAM 15

and hook the FSM/SLM to the end of that drop terminus (Diagram 15). Measure the signal level present, *referenced against the signal level fed into the drop terminus* at "Home A". It should be down at least 18 db. Yes, the combined drop cable losses *add* to the isolation of the DT in this case, and *this is perfectly acceptable* as a part of the total isolation between "Homes A and B"; for purposes of Section 76.605 (a) (11).

Steps:

- (1) Connect a known reference signal, from either the cable system or from a signal generator, to one *output* port of a two (or more) port passive device;
- (2) Connect an FSM/SLM to another *output* port on the same device, and measure the signal level present;
- (3) Note on your test measurement form the make, model, and serial number of any equipment employed in making this test;
- (4) Note on your test measurement form the name, title ("system owner", "technician", etc.) of the individual making the tests, date, time, and location where the test measurements were made.

SUMMARY

This completes the test measurements required for all grandfathered systems for the 1974/1975 year. These measurements *must be completed* and in your files before midnight March 31, 1975.

A few additional tests, required of new systems which began operation after March 31, 1972, are not included in this report.

However, CATJ has outlined a complete test measurements notebook, which consists of complete instructions on "how to make the tests" (including tests not covered here), plus adequate forms to make the tests in your system and record the results. We envision that *if* such a TEST BOOKLET were published and distributed, that it would be available for three ring binder useage so that you can add pages as required. Checking on the costs of printing and distributing such booklets, we find that in quantities of 100 or so that we are talking about something in the area of \$25 *per* TEST BOOKLET. A firm decision has *not* been made to publish this at this time, *although you can indicate whether such a booklet would be helpful to you and whether you would be "likely to purchase one if made available"* by contacting CATJ. Address your "vote" to Heather Pennington, CATJ, 4209 NW 23rd, Suite 106, Oklahoma City, Oklahoma 73107.

JERROLD 727 / SADELCO FS-3SB / MID-STATE SLIM INSTRUMENTS

Rolling Right Along

In Part One of this series, appearing in the October issue of CATJ, we discussed the design and operating principals behind *most* of the FSM/SLM instruments on the market today. In Part Two of this series, appearing in the November issue of CATJ, we discussed proper interpretation and use of the dbmv scale and the relationship with microvolt readings, and we reviewed the features of the Delta-Benco FST-4 and Blonder-Tongue FSM-2 instruments.

In the third part of this series we will review the features of three additional instruments: the Sadelco FS-3SB, the Jerrold 727, and the Mid-State Communications SLIM. In the November issue we noted, "None of the five units we will be reviewing are even similar." That probably raised a few eyebrows in CATV land.

However, *the statement is accurate*. The Delta-Benco unit (FST-4) is basically a "plain vanilla SLM" without many frills. It has (as reported in November) good accuracy for absolute measurements and scale tracks well. The Blonder-Tongue FSM-2 is the only VHF-UHF unit on the market (i.e. you can't buy it *without* UHF coverage included) and it has a number of unusual features such as average reading detection. The Sadelco FS-3SB, reviewed this month, is the *smallest* unit on the market and it has good absolute read-

ing accuracy. *Unlike* all other meters, it utilizes a *30 db scale* (i.e. individual meter ranges) which takes a little getting used to if you have used other meters extensively. The Jerrold 727, reviewed this month, has a host of operating conveniences that make it perhaps the most versatile unit in the group. The Mid-State Communications Model SLIM is the *least* traditional meter of all; it is capable of the best long term *highly accurate* absolute level measurements.

Selecting an FSM/SLM for your own system useage is not a simple matter. In fact, the *more* you know about each of the meters available to the market, the more difficult the choice *may* become!

SADELCO FS-3SB

The Sadelco FS-3 series of meters are the most compact CATV instruments currently offered in the industry, *with high absolute read out accuracy*. Their size suggests they are installer meters. Their performance specifications suggest they rate high for head end, trunk, and distribution line applications.

The size, with carrying case, is 9" x 6.5" x 4", and the weight is under 6 pounds. This is from 30-50% of the size and weight of other meters that have similar performance specifications. While the small size and light weight

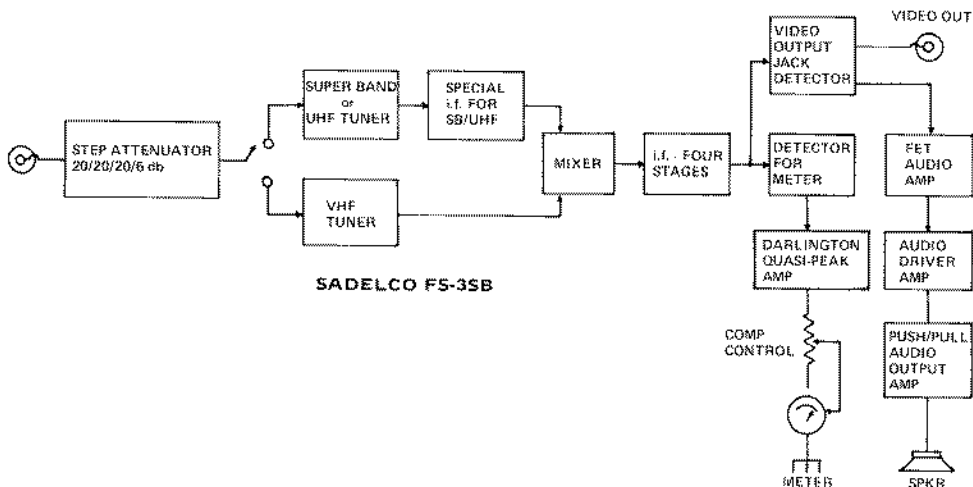


DIAGRAM 1

are fine features, we suspect that many CATV operators have *passed* the unit by *believing* it was merely a fancy installer's meter.

The FS-3 series units are available in two models. The FS-3B is a VHF and UHF version, covering 54-216 MHz and 470-812 MHz. The VHF portion is included in the second version, Model FS-3SB, *along with* super band coverage of 216-300 MHz. What Sadelco has done is design a separate tuning head for the super band and UHF bands, and they give you the *option* of one, or the other, *in addition to* the standard VHF coverage. (Two other versions, the FS-719B which covers VHF and UHF, and the FS-733B which covers the VHF only and *is* designated as an installers meter, are also available.)

Thus the FS-3 series is not unlike the basic design parameters of the two units described in the November CATJ. There *is* a basic VHF range sandwiched between an all-band precision step attenuator (in the front end) and a fixed gain i.f. Additional spectrum coverage is offered by adding a second (optional) tuning head (see Diagram 1.)

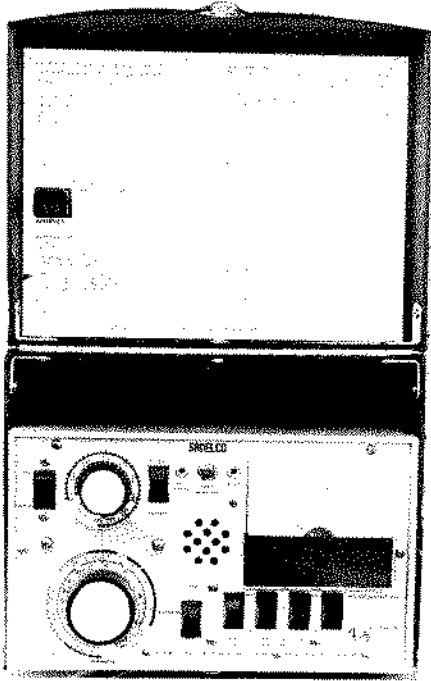
The step attenuator has three 20 db switches and one 6 db switch. Accord-

ing to Harry Sadel, the switches are double wiper switches cast on a glass epoxy base, with gold plated contacts. "What about switch wear?", we asked. He replied, "For some reason CATV people like to strip RG-59 *right over the top* of their FSM instruments and that means that small pieces of copper braid fall into the interior of the switches. So we added some plastic coverings called glamour caps which prevent the debris from falling into the switches."

Sadelco recesses the switches *back* from the panel, using longer switch toggle arms than most attenuators, which according to Mr. Sadel "improves isolation of the switch for direct RF pick up".

"What is your experience with the input F connector life cycle?", we asked. "It really depends upon the user ...", noted Mr. Sadel, "...a fellow that shoves it in at an angle with lots of force may wear one out in two months time."

Of course, this is not unique to the Sadelco meter. *Any* chassis mounting female F connector has that problem. We asked Mr. Sadel about making it easier to change out the connector. He told us, "Our next production run of



SADELCO Model FS-3SB comes in carrying case; covers VHF and super band regions

meters will have a small trap door *behind* the fitting to make it possible to change the fitting out, without taking the whole attenuator apart."

A switch selects either the standard VHF coverage (54-216 MHz), or the optional super band, or UHF tuning head. It should be noted that *another* adapter, the MK-2 Low Frequency Adapter, covers 4.5 to 54 MHz and the meter tunes 110 MHz higher than the real frequency. In the super band or UHF tuner position, an extra i.f. stage is added to compensate for tuner losses that rise rapidly above 216 MHz. The extra i.f. stage is bypassed in the normal VHF position.

The *mixer* in the FS-3 series is a transistor (bi-polar). This makes a more complicated, circuit wise, RF to i.f. conversion than a diode mixer, but Mr. Sadel believes it is worth it. He notes, "Ahead of the mixer we have a 54-216 MHz bandpass filter which includes a varactor diode that compen-

sates for temperature changes on the filter."

In the VHF mode, there are *four i.f. stages* operating on 42.5 MHz (*Note:* earlier FS-3 series, before the "B" versions, had a 30.0 MHz i.f.). In the super band and UHF tuning modes, the extra i.f. stage makes a total of five in the unit.

A novel approach to i.f. stage tuning is shown in Diagram 2—a representation of the FS-3 i.f. The *only tuning on the stage* is the circuit combination of L1 and C2, where L1 is the 42.5 MHz (i.f.) inductance. R1, across L1, adjusts (lowers) the "Q" of the tuned circuit. The output coupling to the next stage is through capacitor C3, and impedance from the output of stage 1 to the input of stage 2 is set with capacitor C4. Thus much of the tuning is "set" or nonadjustable, which contributes to "greater stability per stage". A thermistor is added in the emitter circuit to correct for temperature effects.

Additionally, a *control voltage* (Sadel calls it an AGC voltage) derived

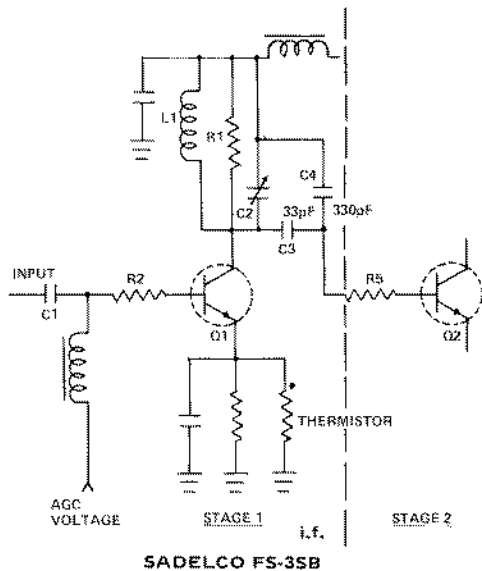


DIAGRAM 2

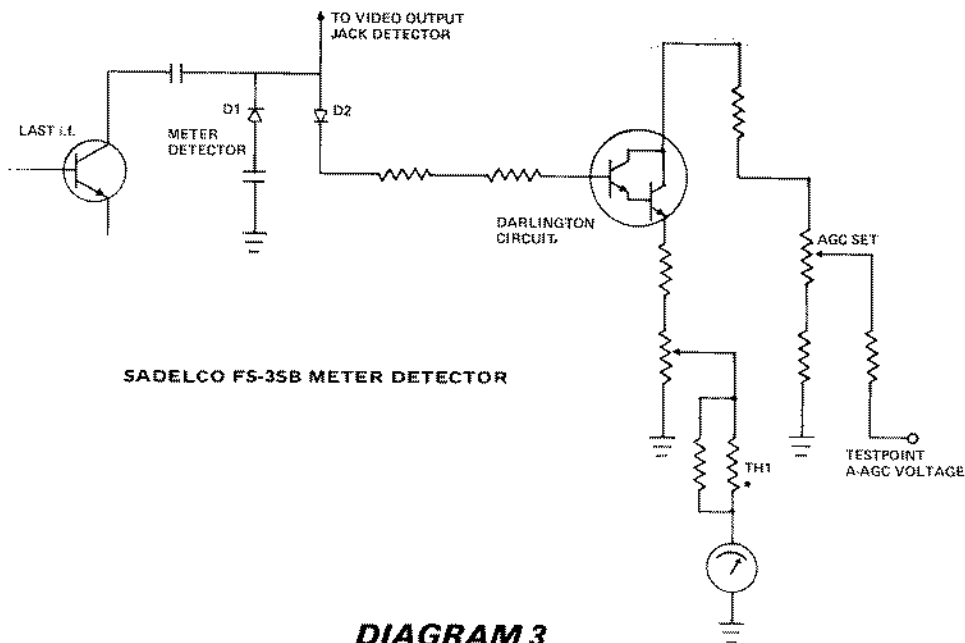


DIAGRAM 3

in the Darlington Quasi-Peak circuit, is fed back to the first three i.f. stages to maintain stable stage gain. The *video output detector* jack is driven *directly* from the output of the last i.f. amplifier, providing approximately 0.7 volts peak to peak for driving a scope or chart recorder.

The *meter reading circuit detector* is a pair of diodes in a voltage doubling circuit. The detected voltage drives a Darlington circuit at a very high input impedance (to the Darlington), which allows the meter to read quasi-peak voltages that include the *sync pulses*, as well as the video information voltage. A thermistor in the Darlington output, along with a manual compensator adjust, completes the circuit to drive the meter. The detector and Darlington circuit, along with a manual compensator adjust, completes the circuit to drive the meter. The detector and Darlington circuit through the meter is shown in Diagram 3.

Sadelco does *not* provide the user with a great surplus of material on the FS-3 series instruments. Until *very* re-

cently, the *only* data the user received was the card placed inside the carrying case cover. We are advised that a *comprehensive manual* is now ready and that past purchasers, as well as new purchasers, will be able to get into their instruments by careful reading of the manual.

A couple of users with whom we talked in researching this report complained that they had trouble finding what was inside the "box". We mentioned this to Harry Sadel and he advised, "With the *new manual*, and the *schematic now available*, everyone should be happy." Past purchasers are advised to contact Sadelco for a copy of the new manual (mention your serial number when writing), and a schematic (upon request).

Another outfit with whom we talked specializes in top quality instrument repairs. They noted, "We just quit servicing the Sadelco meters because we could not get any information from the factory to assist in servicing." Mr. Sadel responded, "Naturally we believe *we are best equipped* to service

FS-3SB SCALE ACCURACY TESTS

Specified Accuracy: +/- 1.0 db

Test Input Level: +10 dbmv

Input Types: CW (unmodulated) carrier;
Modulated channel 9 carrier

Input Levels (True)	CW Carrier Reading	Modulated TV Reading
---------------------	--------------------	----------------------

+10	+10	+10
+ 9	+ 9	+ 9
+ 8	+ 8	+ 8
+ 7	+ 7	+ 7
+ 6	+ 6	+ 6
+ 5	+ 5	+ 5
+ 4	+ 4	+ 4
+ 3	+ 3	+ 3
+ 2	+ 2	+ 2
+ 1	+ 1.3	+ 1.5
0	0	0
- 1	- 1	- 1
- 2	- 2.2	- 2
- 3	- 3.2	- 3
- 4	- 4.2	- 4
- 5	- 5.2	- 5
- 6	- 6.5	- 6
- 7	- 7.8	- 7.2
- 8	- 8.8	- 8.2
- 9	- 9.5	- 9.2
-10	-10.8	-10.2
-11	-11.5	-11.2
-12	-12.5	-12.2
-13	-13.5	-13.2
-14	-15.0	-14.2
-15	-16.0	-15.2
-16	-17.0	-16.5
-17	-18.0	-17.5
-18	-19.1	-18.5
-19	-20.0	-19.5
-20	-21.7	-20.5

Note: Bold type is out of spec.

these instruments, primarily because we know them best. These are highly compact meters and there is not much room to work in them. We would hate to see an instrument damaged by someone getting in there with a 250 watt soldering gun!"

The FS-3 meters are powered by four 9 volt batteries. Sadelco recommends the Alkaline type, and quotes 50 hours of continuous duty use on a fresh set of Alkalines. By comparison, they quote 16 hours of use on a set of standard (drug store variety) 9 volt cells. The meter draws 17 mA of current with audio "off" and 30 mA of current (worst case) with the audio button depressed. The voltage supplied through-

out the unit is 10.2 volts DC, and the regulator stops regulating at 12.5 volts.

A companion 110 volt AC adapter is available for under \$14. Unlike some of the instruments we are discussing, it is *not a charging device*.

In Part One of this series we pointed out that virtually all instruments available measure a basic -40 to -20 dbmv range, and the range is varied by switching in precision pads in front of that basic electronics range. We also pointed out that the typical scale reads a voltage *window* (i.e. range) of 20 db, such as 0 dbmv to +20 dbmv, and so on.

Alas, this is *not so* with the Sadelco instruments. The FS-3SB (and others in the Sadelco series) have *30 db range-scales* (as opposed to 20 db voltage windows), and the basic range is double scaled as -32 dbmv to +2 dbmv (which is *described* as a -30 to 0 dbmv range), *and* as a 10 microvolt to 1,000 microvolt range (which happens to be a 40 db "window").

This tends to *confuse* the user. Is he buying an instrument which reads levels as low as -32 dbmv, which is 25 microvolts, or an instrument that reads levels as low as -40 dbmv, which is 10 microvolts?

The scale (see photo here) reads: No Attenuation -30 to 0 dbmv. However, across the top of the meter face is a *microvolt scale* that reads: 0 / 50 / 100 / 200 / 500 / 1k.

Actually, *both are correct*. In the dbmv world, the meter is calibrated (i.e. the meter face is scale-marked) from -32 dbmv (low end) to +62 dbmv (high end). This is a 94 db scaled range.

At the same time, the user can read relative levels (if not absolute levels) *below* -32 dbmv using the microvolt scale across the top of the meter face. We do not feel *this is adequately explained in the instruction card shipped with the instrument*.

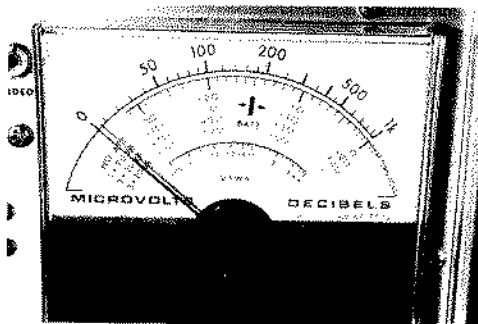
On the first scale range, with *no* attenuation switched in, the FS-3SB

reads from -32 dbmv to +2 dbmv, or 25 microvolts, to 1,259 microvolts. This makes the range 170% as wide as the standard 20 db per range instrument. On one hand, you don't throw pads as often, but on a meter face that measures just 2 inches wide from -32 dbmv to +2 dbmv the opportunity for visual readout error is increased.

On the next scale range, *with 20 db of pad switched in*, the meter reads from -12 dbmv to +22 dbmv. On the third scale range, *with 40 db of pad switched in*, the meter reads from +8 dbmv to +42 dbmv. In the final meter scale range, the meter reads from +28 dbmv to +62 dbmv with 60 db of pad switched in.

There is yet *one more pad* switch, a 6 db attenuator. If you do not use it until you reach a real voltage level of +62 dbmv, then by sliding it in, your top end scale *becomes* +68 dbmv (62 +6), or you can use it at any time when you want to make a quick 6 db relative check or comparison. When all 68 db of pad is in, the final 6 db is *not* reflected on the meter face; you have to add it on top of the reading you see represented on the scale.

Summarizing the meter scale face and read out window range, the meter is best thought of as a *30 db per scale-range instrument*. That is, forget for ranging purposes the 2 db spill over on the meter scale on the low and top end of the ranges. Once you accept this as a 30 db per scale range instrument, you can quickly see that when you are employing 20 db step attenuators, *the scales overlap*. If you get up to a *real* level of +20 dbmv with one pad inserted, which is full scale to the right, placing a second 20 db attenuator in reduces the scale indication from *full* scale to *one-third of full scale*. This is handy since you are not going from feast (meter pinning signal level) to famine (needle barely moving above the low end of the scale) each time you throw a 20 db pad into the circuit.



FS-3SB meter face is 30 db (plus) and is keyed to attenuator positions

If you are accustomed to standard 20 db per scale range meters, you may find this a little difficult to get used to, but once you do, you might like the difference.

FS-3SB Absolute Level Checks

Recall in our November issue we explained that all five instruments being reviewed were checked simultaneously for absolute accuracy, and for scale reading accuracy (i.e. tracking). All of the instruments were referenced to a Measurements 950 standard we chose for this purpose. The tests were repeated several times and the average of the readings taken. (See November CATJ for a full explanation of the technique employed.)

The FS-3SB has *no user tuning compensator*. Therefore, the accuracy of the unit depends *entirely* upon the accuracy aligned in at the factory, and the accuracy maintained in normal operation.

The absolute level checks are made with a CW (unmodulated) carrier. The relative differences *between* this form of source and a properly modulated source depends entirely upon the ability of the detector to track to *peak modulation* present. In *most* present day instruments, the difference is inconsequential.

UNIT: Sadelco FS-3SB
SPECIFIED ACCURACY:
+/- 1.0 db *

Test Input Level: 0 dbmv, CW
(*0 degrees F to 120 degrees F;
these are *new specs* from Sadelco)

Channel	Average	Worst Case
2	0.0	0.0
6	+0.3 db	+0.8 db
7	+0.2 db	+0.3 db
13	+0.3 db	+0.5 db
W	+0.8 db	+1.2 db

Thus for absolute accuracy, the FS-3SB rates very high. Across the VHF range, even allowing for the *optical error* likely with a relatively small meter face, the meter maintains accuracy throughout the range well within its specified accuracy. The worst case reading at channel W (+1.2 db over 0 dbmv) is within the accuracy of the *test set up* we employed in making the measurements.

FS-3SB Scale Accuracy Checks

As was explained in the November issue, a methodology was devised for checking individual 20 db (or 30 db) scale range accuracy. The Measurements 950 CW generator was set at +10 dbmv output and a precision 1 db step attenuator (20 db or 30 db total range) was stepped from no pad to 20 db (or 30 db) of pad in line, *1 db at a time*. With the addition of each 1 db of pad, the indicated level on the SLM instrument was noted, and the extent of *compliance with the test source signal level* was determined. Then because some detectors read modulated carriers *better* than CW carriers, *the same test was repeated* utilizing a stable off-the-air signal which had also been adjusted to +10 dbmv level to the SLM. Again, the actual indicated real level was noted for each 1 db of step. Both tests were done on VHF channel 9, one after the other in quick succession.

The FS-3SB, because of its 30 db log range, is at least 10 db wider (or larger) than all other instruments checked. Logically, if an instrument has difficulty maintaining scale linearity over 20 db of range, 30 db of scale range should be just that much more difficult.

In the case of the FS-3SB, the tracking errors were minimal (among the *lowest* noted in the five instruments). This was true in spite of the fact that the physical size of the meter is quite small, and interpolating between 1 db marks is probably no better than to the nearest 0.3/0.4 db. The results are shown here in Table 1.

The worst case errors with the FS-3SB are with unmodulated carriers with an error of -1.7 db at the far left side of the scale (see -20 reading in Table 1). With properly modulated carriers, the worst case error is 0.5 db at +1 and from -17 to -20. Note that the +1 range error reading affects both the CW and modulated carriers at that point on the scale. For modulated carriers, the degree of error is well within +/- 1.0 db accuracy specified *throughout the 30 db range*.

What We Didn't Like

When we received the FS-3SB, we followed the instructions and installed the four Alkaline batteries. We checked the battery voltage and, finding it adequate, left the instrument on for a few minutes while searching for a 59 jumper to plug in a signal source. When we returned two or three minutes later, an acid smelling smoke was pouring from the SLM. We quickly turned the power switch off, but the smoke continued. We frantically flipped the unit over to take it out of the carrying case (having initially installed the batteries, we had put it back together in the case) to remove the three phillips head screws that secure the battery case door in place. When we got all four screws loose and

the battery case exposed, we found that the batteries were *too hot* to even touch—obviously a dead short in the battery supply line *ahead* of the switch. Whether the switch was on or off, the batteries were *seeing* chassis ground.

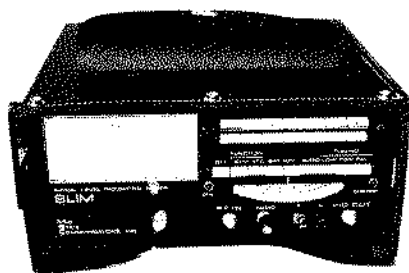
It took us perhaps three minutes, from the time we discovered the problem, until we had the case apart and the batteries *pried* loose. The heat generated by the batteries had begun to *melt* the plastic liner that holds the batteries in place and that was the source of the smoke (and smell). In ten minutes we found the problem (a solder bridge on the battery hot line) and cleared it.

This could happen, because at the factory the FS-3SB is checked out on a *bench* power supply, which has a separate hot line from the *AC adapter power input jack* on the front panel to the switch. The battery line is apparently *not tested* at the factory.

We hesitate to guess what might have happened had we not stayed around after turning on the unit. As it was, the plastic liner had only minor damage, and after nearly one full hour, the batteries had cooled to the point where we could handle them to re-install them in the case.

In this exercise, we noted three things:

- (1) The long screw which holds the meter in the carrying case needs to have a retainer nut, or clip, *to keep you from losing the screw* after freeing it from the SLM. In the field, we think the chances are good you might lose it, and thereby run the risk of not properly re-attaching the SLM to the case. The first time you forgot, it would fall out of an open case and onto the ground.
- (2) The three phillips head screws which hold the battery com-



MID-STATE COMMUNICATIONS Model SLIM comes in leather carrying case and features manual plus push button tuning

partment lid have the same fault; they need a retainer nut, or clip, to keep you from losing or misplacing them.

- (3) Finally, it would be nice, based upon our experience, to have the factory check out the battery supply line just as they do the AC adapter input line to be certain that a solder bridge is not present. A man could ruin an expensive set of Alkaline batteries if he was not careful, and he might have *additional troubles* if the batteries ran long enough (and hot enough) to completely melt the plastic liner! Incidentally, the batteries checked out just fine *after* cooling off, and we used them for the balance of the tests and for more than a month of intermittent use around the lab, before returning the meter to Sadelco.

MID-STATE COMMUNICATIONS SLIM

The most unique SLM instrument to be reviewed as a part of this series is the Mid-State Communications Model SLIM.

Most of what you have learned about SLM instruments *cannot* be applied to the SLIM. The SLIM simply does things differently than most meters, and the circuit designers threw away

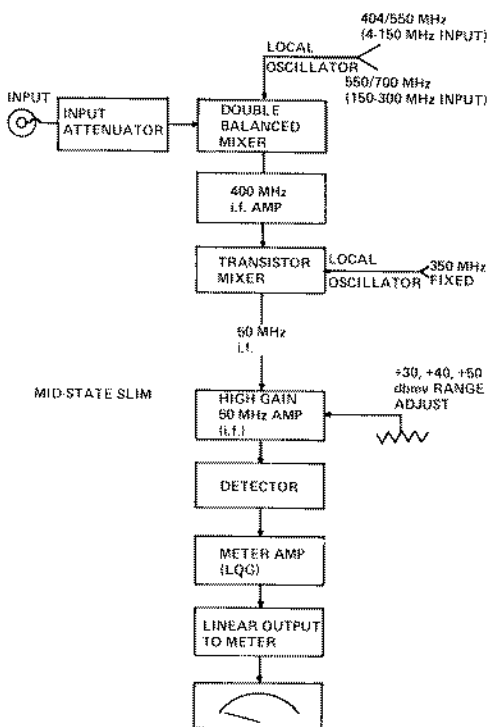


DIAGRAM 4

the book when they started to design the SLIM.

Look at Diagram 4. The basic principal of an input attenuator is maintained with the SLIM. However, mechanically it functions differently than other attenuators. As you rotate a large knob that protrudes from the left side of the case, you step a rotary attenuator control. The sealed attenuator works in 10 db ranges, and the meter face has been specially designed so that two numbers rotate into view in two windows as you rotate the knob. For example, the window on the left reads -5, and the window on the right reads +5 (see photo). This means that you are reading -5 at the mark directly under the -5 window reading, and +5 directly under the window reading +5. In the *next* position (lower) the left window reads -15, and the right window reads -5 (dbmv). In the next

position (upper) the left window reads +5, and the right window reads +15 (dbmv).

Thus, the age old problem of "what range am I in" is solved by simply reading out what the range indicator in the window tells you. There are nine positions on the rotary switch attenuator which take you from a scale range reading of -40/-20 dbmv (window reads -35 left and -25 right) to a scale reading of +40/+60 dbmv (window reads +45 left and +55 right).

The use of the *10 db per step rotary attenuator* (90 db of scale range) is similar to the Delta-Benco FST-4 reviewed in November.

Now back to Diagram 4. Note that the output of the input attenuator goes to a double balanced mixing device. The double balanced mixer is fairly new on the CATV scene, and it has a number of design advantages over simpler transistor or diode mixers. These advantages include *freedom from false mix products* (i.e. freedom from mixer created undesired signals of its own), and high stability.

The double balanced mixer has an initial i.f. input of 400 MHz. It derives this by mixing the desired input signal (such as 100 MHz) with a local oscillator signal that is operating at 400 MHz + *the input frequency* (400 + 100 or 500 MHz in our example). The local oscillator operates in the range 404 to 550 MHz for input signals in the 4-150 MHz range, and in the range 550-700 MHz for input signals in the 150-300 MHz region. *Thus, the input frequency range of the SLIM is 4 to 300 MHz.*

The SLIM i.f. of 400 MHz, which is *above* the tuning range, is a departure from normal instruments reviewed to date. The main purpose is to eliminate images and other unwanted "garbage" that results in *any* mixer. When you mix a 500 MHz local oscillator and a 100 MHz input signal, in the double balanced mixer (or any other type of mixer), you actually have *at least two*

outputs from the mixer; one is 500 minus 100, or 400 MHz, and the other is 500 plus 100, or 600 MHz. By selecting a high (i.e. UHF range) initial i.f., the difference between the two products (i.e. 400 MHz and 600 MHz) is such that the desired one (400 MHz) can easily be filtered out and selected from the undesired one (600 MHz). By placing the initial i.f. range well above the tuning range of the instrument, there is very little opportunity for any of the undesired mixer products to get through the balance of the circuit and to the meter detector to give false readings on the meter.

After 400 MHz filtering, the output of the 400 MHz double balanced mixer is fed through a 400 MHz amp to a second mixer. This mixer is a conventional transistor mixer, and in addition to the 400 MHz i.f. input, it also has a 350 MHz local oscillator input. The result is a second i.f. of 50 MHz (400 minus 350.). This double conversion technique is widely employed in communication receivers for high selectivity and stability. The 50 MHz i.f. is a high gain series of IC stages, and it is from here that most of the gain and selectivity comes. The SLIM has greater selectivity than most instruments on the market; you can read 200 kHz spaced FM (band) carriers, of the same relative amplitude.

AFC (automatic frequency control) is applied in the 50 MHz i.f. amplifier, which means the SLIM stays locked on the desired carrier, even if you bump the dial or do not set it (manually) "right on". This takes a little getting used to, since most users of SLM instruments have grown accustomed to "tweaking the tuning knob" for peak indicated reading. The "tweaking" is electronic in the SLIM. Simply get close to the carrier frequency, and the AFC locks on and keeps it tuned for maximum signal level at all times.

Following the 50 MHz second i.f. amplifier is a detector and a logarithmic

mic amplifier, which converts the input signal to a linear signal for the linear meter. It is worth noting that SLIM does indeed have a linear scale; that is, the first 10 db on the left side of the scale takes up exactly as much meter face as the right 10 db (both take up 50% of the scale).

Manual Tuning Vs. Push Buttons

The SLIM has two tuning methods available. One is a manual system, using a "flywheel" arrangement wherein the channel and carrier desired is tuned with a large white circular dial that protrudes out of the front of the instrument (see photo). You select either low range (4-150 MHz) or high range (150-300 MHz) in the MANUAL tuning mode and dial up the carrier you need. The ranges are marked in black engraving on the white wheel, and the visual carrier locations on the dial are marked with a pinkish color engraving. When you operate MANUAL and in the AFC mode, you need to get "close" to the carrier for the AFC to lock on and peak your tuning automatically.

Let's assume you tune up channel 5 video. You adjust the rotary pad on the input and note your level, then to check the audio you move the dial to the audio carrier position and note the level.

However, in the push button select mode, you push up channel 5 on the



SLIM has 14 push button frequencies plus manual tuning, and host of function buttons

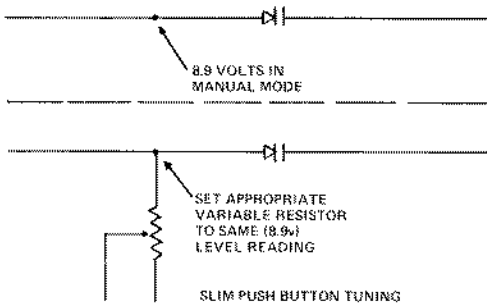


DIAGRAM 5

selector switch (see photo) and note the level. Then to check the audio, you simply push the SouND button and the meter *shifts* the 350 MHz local oscillator for the second i.f., so that rather than being 350 MHz, it is now 345.5 MHz. This shifts the audio carrier to the 50 MHz i.f. mid band point, and the instrument now reads the aural carrier level *automatically*.

In the push button channel select mode, there are fourteen push buttons available. They are programmed to the fourteen channels you wish. As the photo shows, this selection can include low band, mid band, high band, and super band. Or, it could include just the twelve standard VHF channels and a pilot carrier or two. The push button selectors are easily *re-tuned* to other carrier frequencies in the tuning range. All of the push buttons are *varactor diode tuned*, and to change a setting you simply go into the indicated test point with a VTVM (or high impedance VOM) and note the tuning voltage level present (such as 8.9 volts on our example, Diagram 5) in the *MANual tuning mode*. Then, you set the voltage on the appropriate varactor diode by measuring same with the VTVM/VOM and setting the appropriate variable resistor that corresponds to that varactor diode. Simply making the varactor track to the proper voltage setting re-tunes the push button (programmable) varactor tuning for each channel. This is a simple

procedure that takes as long to explain as it takes to do it. Thus the fourteen push button programmable tuning can be changed at will in the field with modest test equipment capable of measuring a reference voltage at two points and setting one point to correspond to the other.

Because you have either video or aural carrier level measurements available at the touch of a button in the programming mode, you actually have twenty-eight carriers (14 x 2) which you can measure and validate about as fast as you can push the fourteen buttons. Since each is AFC locked, the readings are accurate (without human tuning error) each time they are taken.

Other Push Buttons

As the photo shows, the row of buttons across the top (fourteen in all) select the channel you wish to measure. There is another row of push buttons across the bottom; these relate to extra functions which the SLIM contains.

- (1) ON/off selects power on or off for the unit;
- (2) VM/SLM selects either the signal level meter (SLM) or a 0-100 volt AC or DC voltage meter. This works in conjunction with + and - banana jacks on the front panel, and with this you can check line AC voltage present using the 0-100 volt scale on the bottom of the meter;
- (3) AFC/off selects the AFC feature, which will normally run turned on;
- (4) CHK/bat is the battery condition checking function. A small mark on the meter in the upper right hand edge indicates the battery is charged at or above the operating level required;
- (5) CHK/sn—see box here;
- (6) ON/audio selects an audio and speaker combination which al-

SLIM SCALE ACCURACY TESTS

Specified Accuracy: ± 0.5 db *

Test Input Level: +10 dbmv

Input Types:

CW (unmodulated) carrier;

Modulated channel 9 carrier

(* Factory settable to ± 0.25 db; field settable to ± 0.5 db with common CATV test equipment)

NOTE: All other meters tested were set for a full scale reading of +10 dbmv and 20 db of pad was inserted, 1 db at a time, to check the accuracy of the 20 db range. On specific advice of Mid-State, the SLIM test was prepared by setting the full scale to +20 dbmv, and supplying a mid-scale +10 db in 1 db steps and up 10 db in 1 db steps. In effect, the meter was set dead-on at mid-scale and variation checked 10 db in both directions. The results are shown, and out of spec variations are noted in bold face type.

Input Level (True)	CW Carrier Reading	Modulated TV Carrier
+20 dbmv	+19.7 dbmv	+19.7 dbmv
+19	+18.8	+18.8
+18	+17.8	+17.8
+17	+16.8	+16.8
+16	+15.9	+15.9
+15	+14.9	+14.9
+14	+13.9	+13.9
+13	+13.0	+13.0
+12	+12.0	+12.0
+11	+11.5	+11.3
+10	+10.0	+10.0
+9	+9.2	+9.1
+8	+8.2	+8.1
+7	+7.3	+7.2
+6	+6.3	+6.2
+5	+5.4	+5.3
+4	+4.4	+4.3
+3	+3.6	+3.5
+2	+2.7	+2.6
+1	+2.1	+2.0
0	+1.0	+0.9

Note: Bold type measurements are out of spec.

- allows you to listen to the carrier present;
- (7) HI/low selects whether you are tuning 4-150 or 150-300 MHz in the MANUAL tuning mode;
 - (8) MAN/pgm selects whether you are tuning by push buttons or by MANUAL tuning;
 - (9) SND/pix selects either video carrier or aural carrier in the push button mode.

MEASURING NOISE WITH SLIM

Much of the complicated compensation calculation to compute system noise as a function of bandwidth is removed with the SLIM instrument.

When you are measuring system noise (i.e. no RF signal level present), you push in the S/N CHK button. This does the following:

- (1) Switches detection to the averaging detector (as opposed to peak detection in most instruments);
- (2) Raises the gain in the meter drive to precisely compensate for the difference between the i.f. bandwidth and the 4.0 MHz standard bandwidth.

Thus, when you set up on a channel with the SLIM and check the signal level, switch off the signal at the head end and check for noise, you are reading on the SLIM meter the true noise level for a 4.0 MHz bandwidth. There are no user computations to make, or compensating factors to take into account.

The signal to noise ratio then becomes the db difference between the signal level (as read by the instrument in its peak detection mode) and the noise level (as read by the instrument in its average detection mode); and that is pretty nifty!

SLIM Absolute Level Checks

Absolute level check accuracy with the SLIM was performed in the same manner as previously described SLM instruments. There is no tuning compensation, and the accuracy of the meter is determined at the factory, not by the user utilizing a manual compensation control.

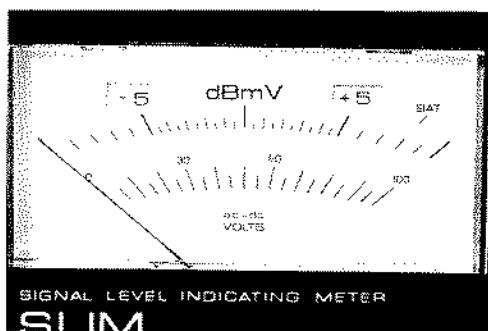
UNIT: Mid-State SLIM

Specified Accuracy: ± 0.25 db *

Test Input Signal: 0 dbmv, CW

(* ± 0.5 db specified with normally available CATV test equipment; better readings with high quality equipment.)

Channel	Average	Worst Case
2	0.0	0.0
6	0.0	0.0
7	+0.05 db	+0.1 db
13	+0.05 db	+0.1 db
W	+0.05 db	+0.1 db



SLIM 20 db. meter scale corresponds to rotary attenuator settings shown in two windows

For absolute level accuracy, the SLIM rates the highest of any of the five instruments we reviewed. The ability to accurately judge errors on the order of 0.1 db, even on the easily read SLIM meter face, is probably beyond the qualitative ability of any individual's eyesight! At any rate, the absolute level accuracy test results were *well within* the ± 0.25 db specified accuracy of the instrument.

It should be pointed out that the SLIM meter face has *1 db per marked division increments* from the far left side of the scale to the first 5 db mark. Then it has *0.5 db per mark divisions* for the next 10 db of scale range, and ends up again with marks every 1 db, for the far-right 5 db.

Mid-State urges you to center your readings, where possible, in the *middle 50%* of the scale range (i.e. between -5 and +5 on the 20 db wide scale centered at a hypothetical zero). Tracking errors due to meter movement inaccuracies are minimized in *this portion* of the scale range, but vary slightly on *either extreme* of the scale. This is good advice for any instrument of course, although as our CATJ tests have shown, not all units have the same scale-tracking errors, nor are all errors at the same point on the scale itself.

Finally, it should be noted that the SLIM employs a tripartite detection system. For video output, a video detector driven from the output of the 50 MHz i.f. produces 1 volt peak to peak at the video

output jack, with full (meter) scale readings. For audio output, two *separate* detectors are operating simultaneously. AM signals (i.e. the amplitude modulated TV video carriers) are detected in one detector, while FM signals (i.e. the audio of TV broadcasts and FM broadcasts) are detected in a standard discriminator circuit. The AM/FM twin detection system functions automatically, with the audio appearing at the speaker from (through) the detection system that actually recovers audio from the detector at the end of the i.f. string.

What We Didn't Like

For all of its complex functions, the SLIM is not a terribly complicated unit. A good part of this is due to the abundant use of IC's, where real circuit complexity is hidden.

Any device heavily populated with IC devices tends to *look* more and more (in real life) like its block diagram. Ultimately, an *all IC device* is nothing but a series of IC "blocks" plugged together to form a total unit. The SLIM *begins* to approach this ultimate device, and this cuts way down on complex circuitry.

With that thought in mind, we *are* disappointed in the manual for the SLIM. Even with the heavy IC useage, which greatly simplifies explanation of what happens within the box, the manual falls short of being adequate. We can appreciate Mid-State not being anxious to release a *full* schematic with a full parts list, but we think it should be *standard* practice to include a *fully* understandable schematic *up to the point* of taking each IC apart, and then provide a "walk through" in the text of how the whole package of IC's (and descretes, of which there are still hundreds) functions together.

Secondly, we were somewhat surprised to find the knob on the rotary attenuator was at *best* a factory reject. We are not accusing Mid-State of buying seconds; we are suggesting that *someone* should have caught the *stripped out*

threads in the plastic knob before the unit got to CATJ. Finding a suitable knob to replace the stripped knob on the attenuator select switch was no problem, but the Delta-Benco FSM-C4 calibrator from which we "borrowed" the replacement looks kind of naked without its original knob!

Thirdly, we are *less than pleased* with the way the snap-on cover for the face plate was engineered. When you set the meter down on the bench (as opposed to standing it up on its back side), the snap-off cover is tilted back *underneath* the instrument. This is awkward, even though the cover swivels *more or less* out of the way. We would *suggest* that if the case were re-designed slightly to allow the cover to fold up *over the instrument*, rather than down *under* the instrument, it would serve *double* duty by providing a shield of sorts against sun light and precipitation; and it would insure that the cover would not get busted and cracked sitting underneath the unit.

Lastly, we were most upset with the scale meter accuracy in the *1 db step tests*. While the instrument passed absolute accuracy tests with flying colors, it did *not* track as well as we think it can or should. *Perhaps* this was a problem with the unit we were provided for test and evaluation. The manual provides *ample alignment data* to correct for scale tracking errors, and while we were tempted to have a go at it to see if we could improve things, we did *not* do so. So, for the moment, we must assume the tracking error is correctable, and that somebody merely slipped up when the unit we evaluated was passed through QC.

JERROLD 727

The Jerrold 727 has been on the CATV scene for approximately seven years. When it was *first* introduced, it was the hands down winner as the *most* modern, *most* sophisticated, and *most* complete CATV test instrument ever introduced to the industry.

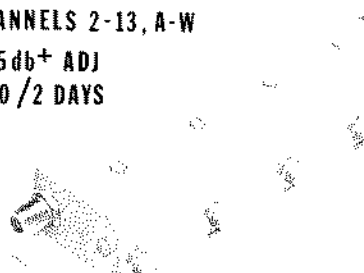
COMPLETE CATV FILTER SOURCE

- VHF-BPF
- ADJACENT BPF
- T-BAND BPF
- CO-CHANNEL ELIMINATORS
- CHANNEL DROPPERS
- TRAPS
- YOUR SPECIALS

MICROWAVE FILTER Co. Inc.
SEE REPLY CARD ADJACENT PAGE

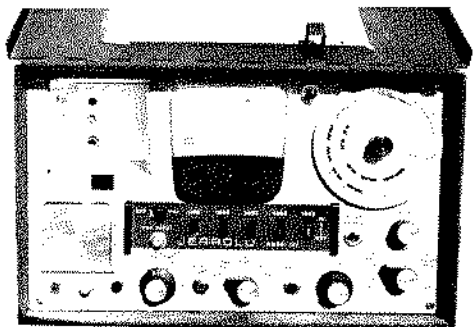
3303 SERIES

ADJACENT CHANNEL BPF
CHANNELS 2-13, A-W
25db+ ADJ
\$140 / 2 DAYS



3160 SERIES

FINEST AVAILABLE
GENERAL PURPOSE BPF
2-13, A-W
\$75 / SHIP TODAY
(ASK FOR LIST OF USERS)



JERROLD 727 comes in metal case and has provision for UHF tuner (not shown here)

Because it was designed before IC's came down the pike by the trainload, and before the later generations of high gain transistors, there are many design trade offs in the present day 727 which someone starting out from scratch today would not employ.

Still, by the same token, it *has withstood the test of time*, and like most Jerrold equipment, it has become a standard for the industry. As we researched this series for CATJ and talked at length with design engineers for other instruments, we kept running into the "ghosts of the 727". An example will suffice to illustrate our point.

"Why have you chosen to spec i.f. selectivity in that manner?", we asked a competitive design engineer, of his own meter specs. "Because that is the way Jerrold does the 727 specs . . .", we were told, and he added almost as an afterthought, "You know, that really is not the best way to do it." It is doubtful that he had previously really considered why specs were written that way.

When you go into a market that has such an established leader as Jerrold in CATV, you find yourself spec-warring against the leader. If you don't, *the marketplace will do it for you.*

The 727 appears to do more things than any other instrument on the market today; or at least its manual tells you *how to do more things* with it than any of the others do. The *fact* is that *most* of the instruments *will* make the same measurements as the 727, but the competition

falls short by simply not giving adequate instruction in the manuals.

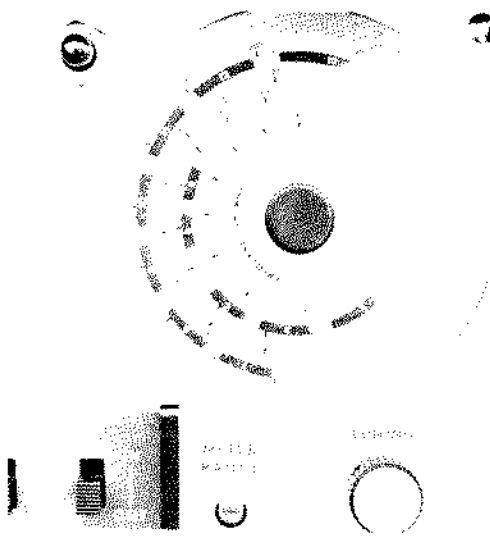
See Diagram 6. Like all instruments we reviewed, the first device the input signal "sees" is the attenuator. The 727 attenuator has five slide switches — one 10 db step and four 20 db steps.

The general front panel appearance of the 727 is a little misleading; it looks very complicated. There are fourteen user oriented controls. In actual normal useage, you seldom utilize more than four of these controls at a time, or for a single measurement set up from a cold start.

The range selector switch picks out *one of four* input frequency ranges: 5-50 MHz, 54-108 MHz, 108-162 MHz and 162-216 MHz. The coverage is continuous from 5 to 216 MHz in the basic instrument, *less a 4 MHz span between 50 and 54*. The sub-band coverage (below 50 MHz) is standard on only one other instrument: the Mid-State SLIM.

Each of the four normal input ranges (a UHF range is an optional extra) have their own input bandpass filter. The filter, following the attenuator, is designed to keep out-of-range chosen signals from making their way into the mixer.

Following the input filters, the mixer circuit employs a balanced mixer circuit.



VHF region on 727 is covered in four ranges with provision for UHF tuner

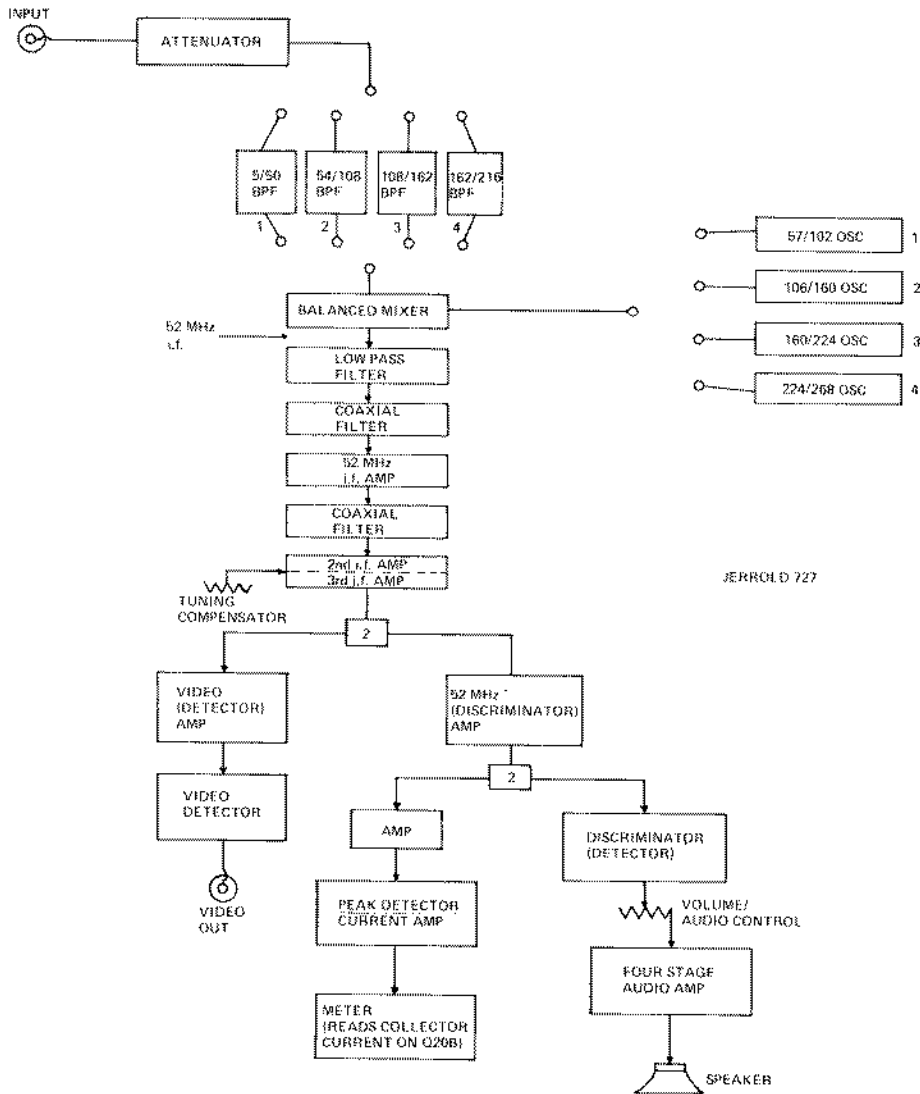


DIAGRAM 6

The balanced mixer is made up of *four matched diodes*, a forerunner to the concept of the double balanced mixers found in more recently designed equipment. See Diagram 7.

The range selector switch which picks the appropriate input bandpass filter also selects the appropriate *range tuning local oscillator*. In the case of tuning 54 to 108 MHz (so called low band), the variable local oscillator tunes 106 to 160 MHz,

or 52 MHz above the desired signal frequency. There are four ranging oscillators, each corresponding to an input filter range.

The output of the balanced mixer is at the i.f. range, 52.0 MHz. This relatively high frequency i.f. was chosen by Jerrold because it offers a method of tuning the sub-band region (below 50 MHz) without any "holes", plus the standard VHF ranges (54-216 MHz). The output of the

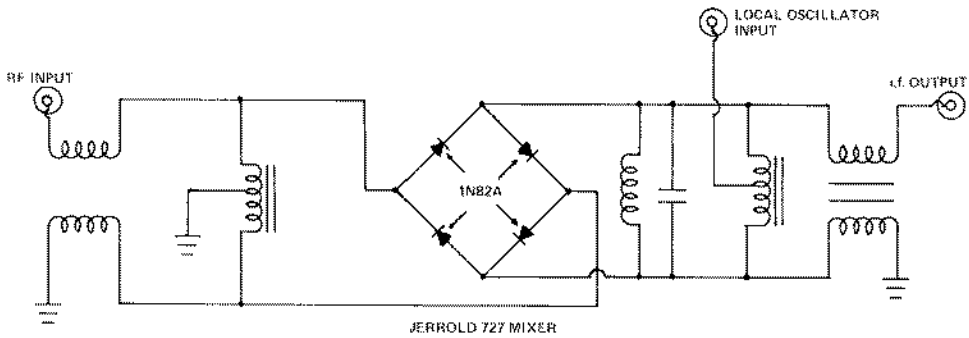


DIAGRAM 7

mixer passes first through a low pass filter thereby shutting out any signals above the 52 MHz i.f., which might happen to fall back into the lower extremes of the VHF tuning range, and then through a Hi-Q coaxial filter.

Up to this point, we have selectivity being established at the *input filter to the mixer*, and through a *low pass filter* out of the mixer, and then through a quite *selective coaxial resonator*. A 52 MHz i.f. amplifier is the first active amplifier in the unit. It is followed, after a single stage of amplification, by yet *one more filter stage* of filtering—a second coaxial resonator also operating at 52 MHz.

Following this coaxial resonator, the signal is amplified in a pair of bi-polar stages (at 52 MHz). Relatively speaking, in comparison to other instruments in the SLM field, the three stages of tuned/selective i.f. (RF) amplification are on the low (quantity) side. Since *total gain* must come from either i.f. amplification, or DC amplification, or a total of the two, it is obvious that Jerrold opts to get their gain at someplace other than pure i.f. The tuning compensator adjustment operates in the third i.f. (Q203) to provide *manual control* over absolute level reading accuracy.

Out of the third and last 52 MHz (i.f.) amplifier, the signal goes *one of two ways*. On one "leg" it is amplified at 52 MHz again, and then detected in a diode detector for presentation to the video output jack. The video peak to peak level

available here, at full (meter) scale reading, is 0.8 volt peak to peak. On the other "leg" out of the 52 MHz i.f., the signal is once again amplified at 52 MHz, and then fed into a twin diode discriminator circuit (CR202/CR203) where the FM signals are detected. This includes television audio signals. The detected audio signals are passed through a volume control, and then to four stages of audio amplification for delivery to the speaker.

In *another "split"* in the 52 MHz signal, after the 52 MHz (Discriminator) amplifier, yet another 52 MHz amplifier "sees" the signal. This amplifier drives a double bi-polar stage that doubles as a peak detector and a *current amplifier* (Q207/Q208). The signal level indicating meter is located in the *collector circuit* of Q208. Current drawn by this stage passes *through the meter element* and is read by the meter. The amount of current drawn by the stage depends upon the amount of voltage (in the form of RF signal) applied to the stages ahead of it. A pot in the stage controls the *calibration* of the current reading stage (meter). Two diodes in the same stage compensate for thermatic changes.

Operations

The 727 operates in a fairly conventional manner (it might be said that they *pioneered* the system and that others have adopted the "conventional manner"). The user (1) selects VHF or UHF with a slide switch, (2) selects the tuning

range with a rotary control, (3) adjusts the tuning compensator for the proper calibration of the instrument for the channel to be tuned, and (4) tunes the tuning dial for peak reading. The tuning compensator is customized to each unit with a covermounted chart which gives calibration adjustments of the compensator for all of the VHF channels, plus sub-band and mid-band ranges covered.

The audio volume control has a *switch* on it, adjacent to the very low volume position of the pot. Turned off, the audio amplifier, which draws considerable current, is shut down.

The powering system for the 727 is interesting, primarily because it is so versatile. The unit operates from a front panel switch and has selectable (1) internal (rechargeable NiKad) battery supply, (2) external battery (DC) source, or (3) an AC (110 volt) source from commercial power mains. Additionally, the AC mains position can be simply swapped between 110 (115) VAC or 220 (230) VAC.

The rechargeable supply has the ability to power normal operation "*when the unit is put on charge every night*". Nickel cadmium cells are strange animals; they like to be used on occasion, and *when they set un-used*, they drain off charge at relatively unpredictable rates. When one cell of the battery drains off at a *higher rate* than another cell of the same battery, a point is reached where something called *reverse-charging* takes place. Here, the stronger cells start to charge the weaker cells, and the ultimate ending to this tale is that the reverse-charged cells are damaged.

We measured current drain on this supply at 34 mA of draw, when the SLM is operated with the audio control off. Turning the audio control on, but not opening up any audio volume, the SLM draws approximately 36mA. With the audio turned up full, the SLM draws approximately 52 mA of current. This is at a battery voltage (measured) of 12.5 volts. Incidentally, should you be tempted to "read" by the dial light, pressing the dial

light switch increases current drain to 80 mA, or more than double normal drain! In the charging mode, -18 volts (DC) is supplied to the NiKad cells. The regulated supply voltage for the unit is -10.0 volts (DC). The battery is rated at 600 mA/hour, and 12.5 volts fully charged.

There is one more clever circuit in the 727 — a *meter range indicating switch*. Any meter with a plurality of ranges, and a mixture of 10 and 20 db slide attenuator switches, *runs the risk of confusing the user* as to the range scale he is operating in at the moment. Jerrold *solves* this with something they call a "Meter Range" switch. By pressing the Meter Range switch, the meter needle deflects to some static point on the scale and "points to" a notation on the meter face which tells you that you are in the (for example) +10 dbmv range for a mid-scale (0 db indicated) reading.

Comprehensive Manual

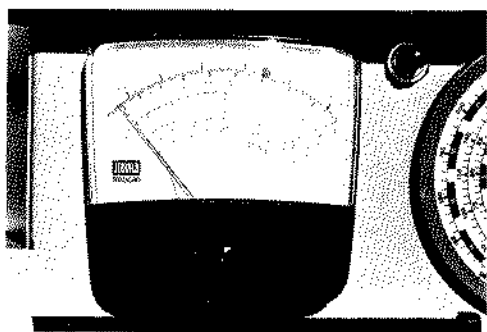
The 727 manual is about as *comprehensive* as you could want. It takes you through, step by step, such diverse measurements as:

- (1) Field Intensity Surveys
- (2) Gain and Loss
- (3) System Noise Levels
- (4) Noise Calibration
- (5) Cross Modulation
- (6) Hum Modulation
- (7) Sync Clipping

The manual also takes you through the design and maintenance of the 727. The maintenance and calibration sections are especially complete, and while Jerrold recommends factory re-alignment in several instances, *they are not afraid to tell you how to do much of it yourself*, if you have the test equipment and guts to tackle it.

COMP Control

It should be noted that the tuner compensation control (COMP), which allows you to set the compensation for the channel you are measuring so you can obtain the best *absolute* reading accuracy, also



727 meter face scale is 20 db and is keyed to attenuator settings by color

doubles (when pulled out) as a manual gain control. This is quite useful in the measurement of sync compression and hum measurements.

727 Absolute Level Checks

The methodology of our testing procedures has been repeated to the point of being repetitious. We will not bore you again with the details.

UNIT: Jerrold 727

Specified Accuracy: +/- 1.5 db at 25 degrees C *

Test Input Signal: 0 dbmv, CW

(* +/- 3 db from -18 degrees C to + 60 degrees C)

Channel	Average	Worst Case
2	+1.2 db	+1.5 db
6	+1.4 db	+1.8 db
7	+1.1 db	+1.2 db
13	+1.0 db	+1.1 db

The particular 727 we evaluated could be brought back to full accuracy with the tuning compensator control in all cases. However, for the measurements measured and reported above, the tuning compensator was set at the *factory calibration settings* recommended on the alignment card.

The scale accuracy measurements, shown here in tabular form, confirm what one close inspection of the 727 meter face should suggest to you. *Jerrold does not intend*, or recommend, that you try to make any measurements in the *far left side* of the scale. Notice in the photo of the meter face that the scale in the -10 to

-5 portion of the range is *not* marked off in individual db markings. Jerrold is trying to tell you something here, and our scale accuracy tests confirm that something.

In the full scale (+ 10) down to the - 5 region, or for 15 db of meter scale, the tests conducted found the meter to be +/-1.5 db for a modulated TV carrier (far right column in tabular report). *This is the spec for the unit.* Below the -5 point on the meter scale, the accuracy drifts out of spec in a hurry. After wading through three months on SLM/FSM instruments, you shouldn't have to be told this again, but we will for the record.

If you are depending upon your SLM/FSM to give you an accurate reading of any type, relative or absolute, make all of your measurements in the center portion of the meter scale, and always right of center. This is, with most instruments, between 0 db (relative) and +5/6 db (relative) on the meter face. This is the meter scale region where the meter stands the best chance of giving you accurate readouts.

What We Didn't Like

Unlike other instruments provided to CATJ for test, the 727 didn't have any of its parts fall off, or electronics go ablaze as we set out to test it. *We plugged it in, and it worked;* and unlike other instruments we have faulted for skimpy manuals, the 727 manual is a textbook.

Still, there is the gnawing feeling that the meter *falls short.* After thinking about all of the tests conducted, and the side by side comparisons performed, we finally came to the conclusion that the reason we felt the meter fell short was simply because *it does fall short* in performance. Strictly speaking, it does not meet its spec *all* across the board. On the *low end* of the 20 db wide range scale, it goes *way* out of spec in a hurry. Still, that alone is *not enough* to fault the 727; at *least* one other instrument checked was as bad, or worse, in that department.

What *bothers* us most about the 727 is that *it is a Jerrold instrument,* and we,

like the whole industry, have grown up expecting Jerrold to set the pace for the rest of the industry to follow. Yes, we remember that the 727 was around before most of the others compared here were even on the drawing boards. That is probably what bothers you most. The 727, as good as it is, and the work horse that it is, is possibly . . . just possibly, past the logical point in time where it should be retired and replaced with a more modern instrument.

Summary

In the first three parts of this series, CATJ has set out to open a dialogue on the signal level meter reading device. Virtually the whole industry turns on the ability of system personnel to operate their SLM/FSM's accurately. We don't believe for a minute that what we have said in these first three articles is the final word on meters. We happen to know that we have more in store for next month.

We have attempted to make the basic operating parameters of the SLM/FSM more evident to the end user—you—the tech, engineer, or owner/operator. In doing this, we hope you will feel freer to query the various instrument manufacturers in greater depth, and with greater understanding, about the instruments they now provide, and those which they will provide us as an industry in the next generation of instruments.

If you ask more questions of the meter suppliers and designers, you may force them to explore new methods of measurements undreamed of today. If the questions run full circle, the next generation of meters we review, many years hence, will show the results of your increased interest in this very important phase of the cable television industry.

In our fourth part of this series, in the January issue, we will explore several instruments available to the industry for calibration of SLM/FSMs, and we will look into the Texscan/Jerrold VSM-1 instrument, a cross between an SLM and a spectrum analyzer.

727 SCALE ACCURACY TESTS

Specified Accuracy:

+/- 1.5 db at 25 degrees C*

Test Input Level: +10 dbmv

Input Types:

CW (unmodulated) carrier;

Modulated channel 9 carrier

(* +/- 3 db -18 degrees C to +60 degrees C)

Input Level (True)	CW Carrier Reading	Modulated TV Carrier
+10 dbmv	+10 dbmv	+10 dbmv
+ 9	+ 9	+ 9.1
+ 8	+ 8.1	+ 8.1
+ 7	+ 7.2	+ 7.1
+ 6	+ 6.3	+ 6.2
+ 5	+ 5.4	+ 5.2
+ 4	+ 4.5	+ 4.2
+ 3	+ 3.7	+ 3.3
+ 2	+ 2.9	+ 2.5
+ 1	+ 2.3	+ 2.0
0	+ 1.0	+ 0.6
- 1	0	- 0.2
- 2	- 0.7	- 1.1
- 3	- 1.3	- 2.0
- 4	- 2.0	- 2.7
- 5	- 2.8	- 3.2
- 6	- 3.2	- 4.0
- 7	- 4.0	- 4.5
- 8	- 4.5	- 5.0
- 9	- 5.0	- 5.5
-10	- 5.5	- 6.0

Note: Bold type is out of spec.

JERROLD 727

Frequency Range

VHF 5-216 MHz

UHF 470-890 MHz (optional extra)

Full Scale Sensitivity:

100 microvolts to

3.0 volts in 10

ranges

Input Impedance: 75 ohms

Selectivity

at 3 db points, +/- 0.3 MHz

at 46 db points, +/- 1.5 MHz

Accuracy: +/- 1.5 db at 25 degrees C

Temperature Range: -18 degrees C to + 60 degrees C

Power Requirements:

Rechargeable NiKad battery,
external 12.6 VDC, 110 VAC, or
220 VAC

Weight: 15 pounds

Size: 8½" high, 13¼" wide, 8¾" deep

Battery Drain: 34 mA audio off

Minimum Battery Voltage Required: 11.0 volts

Price Range: \$763.55

SADELCO, INC. FS-3SB

Frequency Range
VHF : 54-216 MHz
SB :216-300MHz
Full Scale Sensitivity:
1,000 microvolts
to 2.5 volts in
four ranges
Input Impedance: 75 ohms
Selectivity:
at 3 db points, +/- 0.25 MHz
at 35 db points, +/- 1.5 MHz
Accuracy: +/- 1.0 db
Temperature Range: 0 to 120 degrees F
Power Requirements: four 9 volt cells, or
optional AC adaptor
Weight: under 6 pounds, with case
Size: 9" wide, 6.5" deep, 4" high
Battery Drain: 17 mA
Minimum Battery Voltage Required: 12.5
volts
Price Range: \$475.00 CATV List

MID-STATE COMMUNICATIONS SLIM

Frequency Range: 4-300 MHz
Full Scale Sensitivity:
100 microvolts to
1.0 volt in 9 ranges
Input Impedance: 75 ohms
Selectivity:
at 3 db points, +/- 200 kHz
at 56 db points, +/- 1.5 MHz
Accuracy: +/- 0.25 db
(settable to +/- 0.5 db with common CATV
test equipment)
Temperature Range: -18 to +50 degrees C
Power Requirement: Rechargeable Gel-
Cell, 1.5 amp hour capacity, 12 volt
Weight: 15 pounds with battery, with case
Size: 12 $\frac{3}{4}$ " wide x 12 $\frac{1}{2}$ " deep x 6" high, with
case
Battery Drain: 80 mA with audio off; 130 mA
with audio on and turned up full volume
Minimum Battery Voltage Required: 11.9
volts
Price Range: \$970.00 with case

ONCE MORE — PEAK DETECTORS

As pointed out in November CATJ (page 15), getting a peak reading detector to track over a 20 db range is no easy trick. The fact is, that given *different* input drive voltage levels to the detector, the detector efficiency *varies*. It usually has *more* efficiency at higher drive levels, which in turn means that if the meter electronics is calibrated to read correctly (i.e. with compensation for the detector efficiency changes) in *one portion of its curve*, such as the *high* end of the scale, the detector inefficiencies jump up and bite you for the other (low scale) readings.

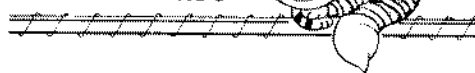
Jerrold points this out in their 727 manual by suggesting that when you are using the 727 for noise level measurements that you compensate by a chart they provide, which in their case *also* includes changes in bandwidth and peak vs. average readings for noise vs. real signals.

Another manufacturer *apparently* sets his meter to read slightly high at the high end (i.e. +10 might be really +9.5), and slightly low at the low end (i.e. -10 might really be -9.5), but right-on *in the middle* (i.e. 0 would be really 0).

We point this out so that when you are making *comparative readings*, you will remember that *whole meter accuracy is a function* of where on the 20 (or 30) db scale your needle reads. If *ultimate* accuracy is what you are after, juggle your input to your SLM so that the meter (needle) is reading *in the mid-scale* to mid-scale plus 4-5 db region.

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Size 17" x 13½" x 12"

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