Test Equipment Construction

CATJ MARKER GENERATOR

If CATV has entered a new era since its 21st birthday, it is probably the *test equipment era*. As our systems have grown more complex, and the FCC has instituted system operational standards and specifications, the requirements for tests . . . *accurate tests*, have *risen*. So *too* have test equipment prices.

Ten years ago a system operator could *get by* with a Jerrold 601-D sweep test, detector, and a handful of other instruments including an FSM and a VOM. This is no longer true.

Even the system with these basic pieces of equipment (and many still labor along *without* even these) is going to have to face up to the fact that before 1977, even the oldest, most antiquated system is going to be forced into modernization and a position of ability to maintain a system that will meet FCC specs.

To greet this not so far away eventuality, CATJ is dedicating itself to publishing a series of articles on do-it-yourself test equipment. This will be test equipment which *you can build* from scratch, yourself, on your own bench, in your own time. There will be one complete piece of test equipment each month; or a major section of a more elaborate unit.

Each unit described will be adequately detailed so that you can either (1) procure the parts on your own and build it up, or, (2) order a complete set of parts from a supplier of electronic kits.(*)

Crystal Marker & Generator

Having a good, moderately high level output, marker generator on your test bench or in the field is one of the handiest things you can do.

by
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If you have a sweep system, you already know the value of having markers; they tell you *where you are*. But if you had a marker source external from your sweep, you could also perform many other system tests.

Basically, a marker is nothing more than a carrier generator; usually crystal controlled on a specific frequency or a basic frequency plus harmonics thereof.

If you plug the marker into your sweep system, as an external (i.e. non-sweep package) marker, you can produce *marks* on your sweep display at the precise points which you require.

If you plug the marker into your system proper (see diagram 2), you can send throughout the entire system a carrier on the frequency generated by the marker. And this carrier can be very useful for determining some of the operational characteristics of your system.

Let's talk about just one of those characteristics at this point: *radiation*.

Radiation is an ugly word. In CATV, it means the transmission of a signal (or signals) from a seemingly secure inside-of-coax transmission medium to some point outside of that transmission medium, *in violation of the security* (integrity) *of the coaxial cable shielding*.

Or to put it another way, radiation is the terminology we use in this industry to describe a condition which exists, but which should not exist. A condition whereby our cable signals end up outside of the cable, being transmitted through the air *as well as* through the cable!

Under the rules and regulations of the Federal Communications Commission, radiation from our cable, fittings, amplifiers, directional and pressure taps — *in fact from anything in our plant* — is limited to the following max-

imum:

"from 54 to 216 MHz, 20 microvolts per meter at a distance of 10 feet".

In plain English language, that is darn little signal!

So little signal, in fact, that to make this measurement with a field strength meter or TV set and a dipole (*), we will more often than not run into that much signal and a whole lot more just *leaking in from television stations* in the area, even from stations that are too far away to use reliably on our cable distribution systems.

So one of the real perplexing problems presented to us, if we are to comply with Part 76.605 (a) (12), is *how do we really assure ourselves,* as we make measurements and maintain our systems, *that we are not radiating more than the prescribed maximums?*

If our on-cable channels are occupied by the same off-the-air channels, or if the off-the-air channels cover up our on-cable channels, determining which signal is coming from our lines and equipment (i.e. radiation) and which is coming in off-the-air can be a very painful, if not impossible thing to do.

But alas, like any good problem, there is a good answer.

If you build up this marker generator, you can plug-in at the head end (diagram 2) with the output of the marker, set it to the proper level, and at that point you have a carrier on the system (throughout the entire cabled community) which you can select to be on a frequency which is not occupied by an off-the-air signal.

Then you can take your dipole antenna (cut for the right frequency) and your FSM/SLM, and setting your FSM/SLM to maximum sensitivity, drive out the town looking for radiation on your *secure* frequency of your marker generator; as plugged into the system at the head end.

If you have a low band only system, you can select the marker-oscillator at 54 MHz (or even place it at 53 or 52 MHz, just *up in frequency* from the point where your low band only system starts to have amplifier gain fall off.) If you have a *low band plus FM system,* you can place your marker-generator oscillator on a frequency such as 109 MHz, right at the top of your amplifier pass-band in the plant.

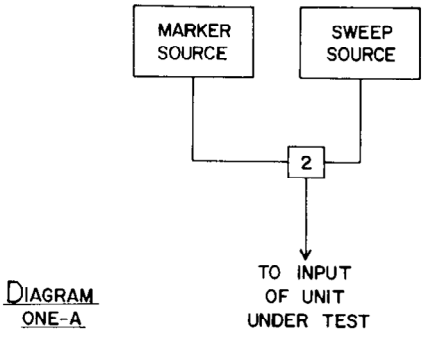


DIAGRAM ONE-A

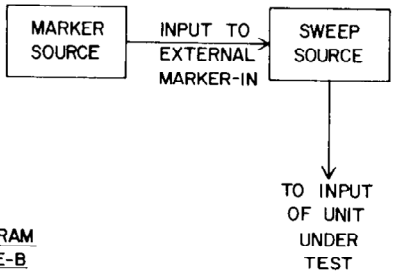


DIAGRAM ONE-B

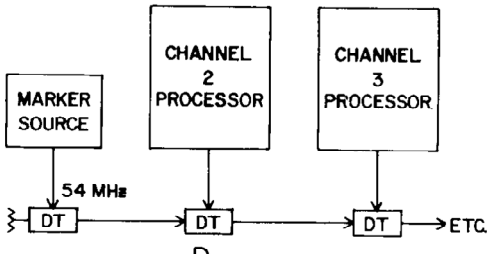


DIAGRAM TWO

* — The Federal Communications Commission recently ruled that radiation measurements can be made, under certain conditions, with a portable TV receiver and a dipole antenna. Unfortunately, this technique cannot be employed in locations where *any* off-the-air television signals are capable of being received on the channels which you will be measuring with the portable receiver and antenna.

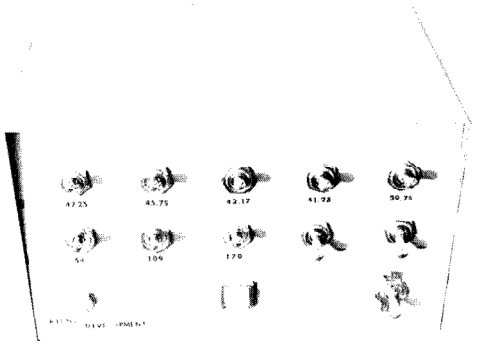
If you have an all band system, you can activate two separate marker oscillators; one at 54 or 109 MHz and another at 170 MHz, and check for radiation at both the low end and the high end.

This month's construction project details a marker oscillator package that will house up to 10 separate descrete markers; you can incorporate one at a time, or several at a time, or all 10 at once.

The initial oscillators chosen for the project are as follows:

(1) 39.75 MHz
(2) 41.25 MHz
(3) 42.17 MHz
(4) 45.75 MHz
(5) 47.25 MHz

These frequencies have been chosen for the system that uses hetrodyne signal processors; in an early issue of CATJ we will detail alignment and trouble-shooting practices for one of the most popular hetrodyne processors in use today; the Channel Commander One. Having markers to align this unit is a must-requirement.

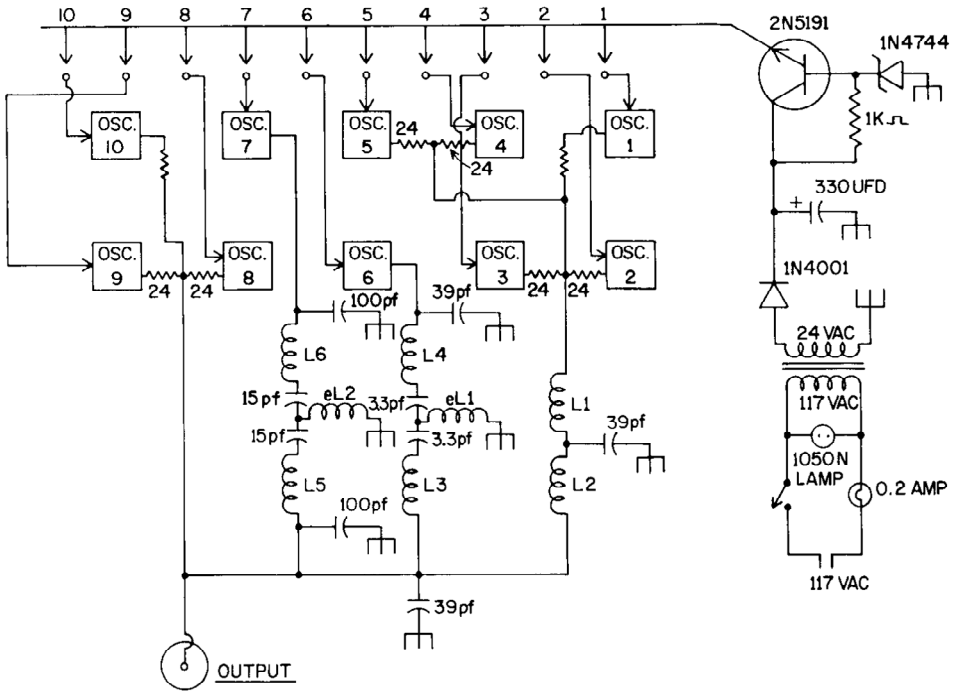


Additionally, oscillators are covered for:

(6) 54 MHz (for radiation and band edge marking)
(7) 109 MHz
(8) 170 MHz

Note that the master circuit provides for ten plug-in oscillators, operating in the 39-220 MHz region, so if you don't like the eight we have pre-chosen, you can add others or substitute at will.

Each marker is crystal controlled and turned on and off separately by front panel



switches. Individual output level controls are mounted on each marker-oscillator board so you have a range of control over the individual marker outputs.

All marker-oscillators plug into a master or *mother board* which fits down along the bottom of the standard enclosure chosen. The mother board provides the RF (signal) mixing, isolation between oscillators so that tuning (or turning on and off) one does not interact with another one, and a common way to power each board (marker-oscillator) as it plugs into the sockets provided.

Once the mother board is completed, with the power supply and the case, you can add marker-oscillators as your needs dictate. That is, you need only spend the money for the markers you need as you require them. Start off with only one, if that is what you need. But the expansion is there for up to 10 individual oscillators when the unit is "*full*".

The unit has a well regulated power supply, and the output level through the front-panel F fitting is relatively high; +50 dbmv is typical.

Construction

Begin by mounting all of the hardware, switches and output connnector, fuse holder, and so on. No hole template is given in this description, but one is provided with the parts kit should you decide to use the parts kit.

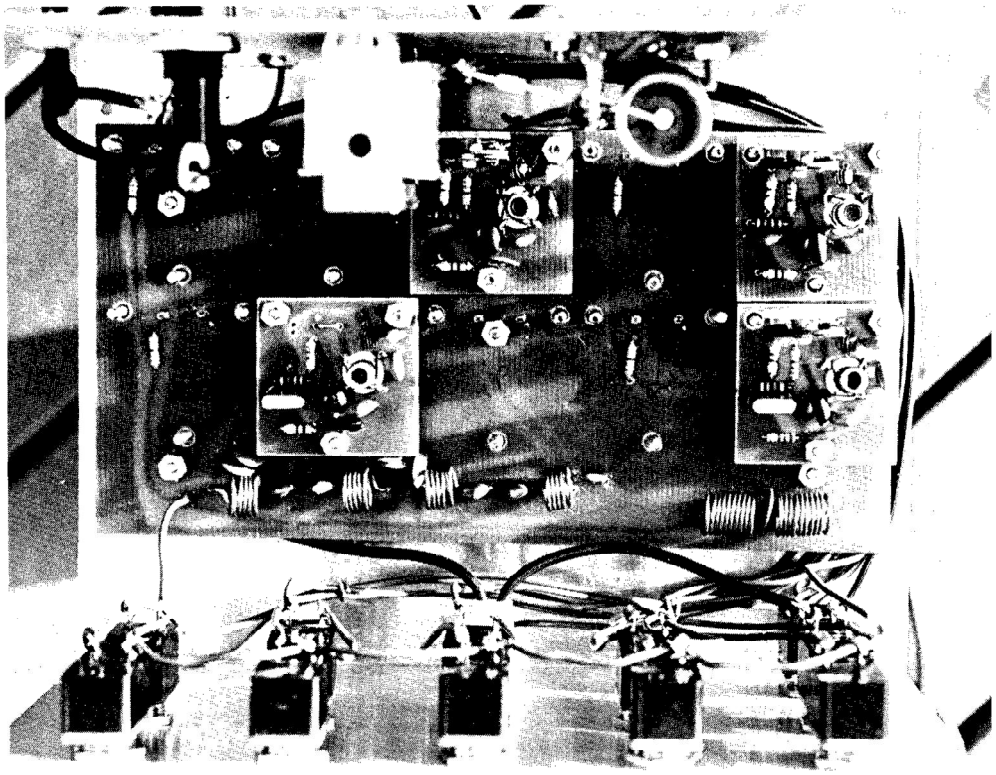
See figure one; this illustrates how the power supply transistor (2N5191) is mounted. Note that a mica insulator is installed between the transistor case and the metal container wall.

Power supply parts can be mounted on the container back wall as shown in the photographs. Exact locations are not critical, but long leads should be avoided in *any* VHF construction project; even in the power supply!

Now proceed to wire up the *mother board* in this sequence:

(1) Place all of the called for resistors in place; and solder them into position.

(2) Next place all of the disc ceramic capacitors in place, and solder them into position.

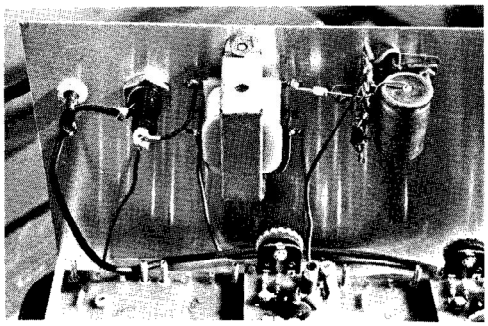


(3) Now place all of the coil inductors (L1—L6) into position and solder them into position.

(4) Next prepare all of your switch wires and solder them to their respective locations on the board. The ends to be connected onto the switches will be completed later.

(5) Now install the 4-40 x ¾ inch screws into position at each oscillator plug in location (one screw goes on two corners, and a third in the middle of the opposite side, to hold the oscillator in place), and thread-on a ¼ inch spacer. The spacer acts to keep the screw in place and it also provides a stand-off support for the oscillator boards to be added.

(6) Take one of the oscillators, noting that the pre-wired and tested oscillator boards available as a part of the kit offering have contact pins (two per oscillator board). Place a Molex connector over each pin, and then slide the oscillator board into position over the three 4-40 x ¾ inch screws previously soldered into position.



With the oscillator board *in position* on the mounting screws, the Molex connectors will protrude through the *mother board*. Turn the *mother board* over, and solder the Molex connector points to the board where they stick through.

Repeat the process for all of the ten oscillator positions; resulting in all ten positions being ready for boards to be "plugged in".

(7) Now mount the *mother board* to the chassis using 4-40 x ¼ spacers and 4-40 screws and nuts.

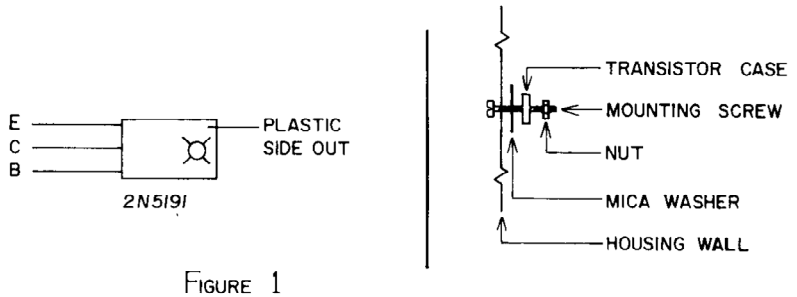


FIGURE 1

SPARE	109	39.75	41.25	47.25
SPARE	54	170	42.17	45.75
L6	L5	L4	L3	L2 L1

FIGURE 2 – MOTHER BOARD LAYOUT

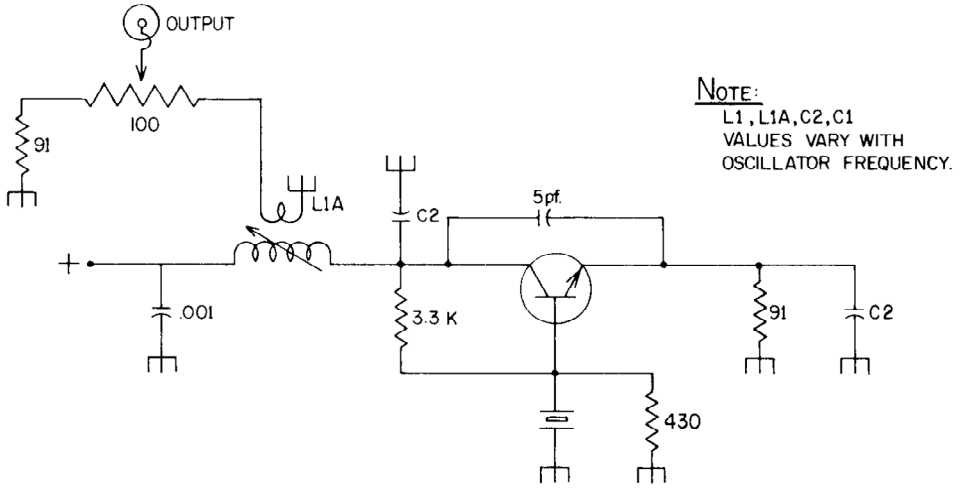
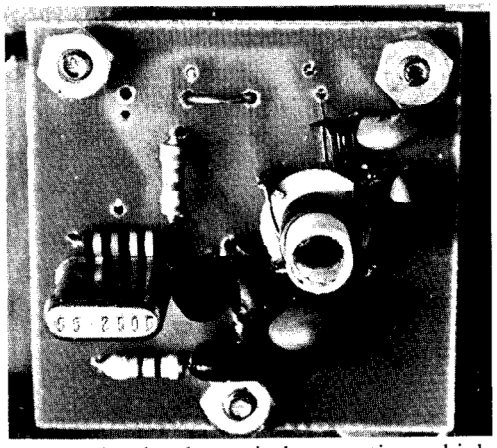


FIGURE 3



(8) Wire in the switches, noting which switch position goes to which oscillator board position (figures 2 and 4). Use an ohm meter to trace which wire goes to which oscillator, or if you are going to wire up the kit parts, the wires are color coded. Wires to each oscillator module connect to one side of the appropriate switch while the opposite side of the switch is wired in series with all other switches (figure 5) and then to the emitter of the 2N5191 (figure 4).

Wire up your pilot light and power switch (figure 4); and your unit is ready to test.

Adjustments

Marker-oscillator generator adjustments are very simple. Following the board layout in figure two, plug in your oscillator(s).

(All oscillators utilized with the kit procedure have been pre-constructed, and tested. If you follow figure 3 and construct your own oscillators, you will have to first test the oscillator to ensure that it is functioning properly, and is on frequency.)

Connect the output of your marker-oscillator unit to the *marker input* (external marker input) connector on your sweep system. If your sweep unit does not have an external marker input access fitting, follow the instructions given in diagram 1.

Set your sweep display so that you are approximately sweeping the region which your oscillators will mark.

Now turn on one marker-oscillator at a time and observe where it marks your sweep display. The 100 ohm potentiometer in the output leg of each plug in oscillator adjusts the level of that marker. The markers can be adjusted for different output level ranges as follows:

(1) To adjust the output level of the 109 MHz marker, disconnect the marker-oscillator output from the sweep and reconnect it to your FSM/SLM. Turn on that 109 MHz marker and tune in your FSM to this carrier.

By inserting an insulated plastic tuning tool between the turns on coils L5 and L6, you can *peak* the output level (maximize) of the 109 MHz oscillator by spreading coil turns. It should peak at approximately +50 dbmv.

Turn off the 109 MHz marker-oscillator and repeat the coil spreading process for peak output level from the 170 MHz oscillator; by spreading the turns on L3 and L4.

The unit is now ready to use.

Other Uses

Few people realize how useful a low power (marker) oscillator can be. In addition to the service bench marking applications, and the source for radiation tests, a low powered signal source can be useful in antenna measurements. A future article will describe how this test oscillator and a simple antenna can be useful in phasing complex antenna arrays for co-channel elimination.

Placed into permanent service at the head end, on a frequency not in regular service, its stable operation will provide an excellent *reference signal* throughout the entire CATV plant for plant performance monitoring.

Next Month

Our series on test equipment construction will continue with the introduction of a 12 channel crystal controlled marker generator with 4.5 MHz and 3.58 MHz modulation.

(*) Kits or PC boards described in CATJ are available from a packager of kits through CATJ; to CATJ specifications. To order the kits described in this article:

Terms — payment with order.

Price — for complete kit of parts, PC board, housing and instructions for the Marker kit (but *less* any oscillators) — $30.00 post-paid.

For any of the oscillators specified (39.75 MHz, 41.25 MHz, 42.17 MHz,

45.75 MHz, 47.25 MHz, 54.0 MHz, 109 MHz, 170 MHz) — $15.00 each, prewired and tested.

Order — send order with payment to KITS, Community Antenna Television Journal, 4209 NW 23rd, Oklahoma City, Oklahoma 73107. Specify exact kit and oscillator required.

PARTS LIST - MARKER

1 - LMB chassis box, #685
11 - SPST switches
1 - 117VAC pilot light
1 - F61A connector
1 - power cord
1 - fuse holder
1 - fuse (3AG, 0.2 amp)
1 - 24 VAC secondary, 117 VAC primary power transformer Radio Shack #273-1386
1 - 5 position terminal strip, center grounded
1 - 1N4001
1 - 1N4744 zener
1 - 2N5191
1 - 330 MFD at 64 volt electrolytic
1 - 1k ½ watt resistor
8 - 24 ohm, ¼ watt resistors
2 - 100 pf ceramic caps
2 - 3.3 pf ceramic caps
3 - 39 pf ceramic caps
2 - 15 pf ceramic caps
46 - 4-40 x ¾ bolts
46 - ¼" spacers 4-40 threaded
20 - Molex connectors
1 - solder lug
4 - 4-40 nuts
1 - plastic grommet