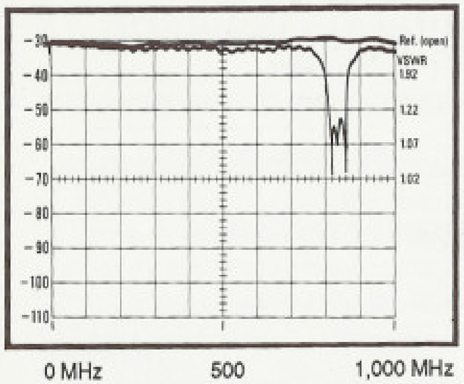
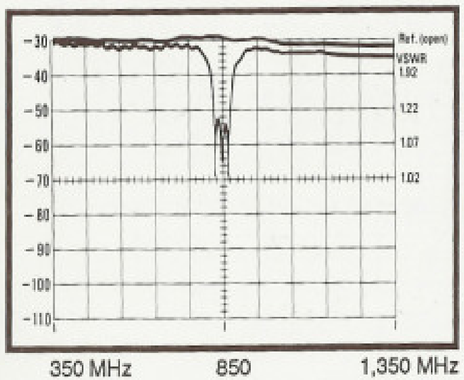


Window mounted Cellular antenna fed with 7 ft. of RG-58.

Reference = Bridge with open N to BNC adaptor.

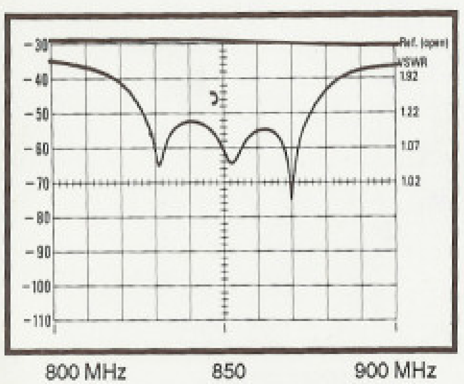
FREQUENCY = 500 MHz
ANALY DISP = FULL



Same window mounted Cellular antenna.

Analyzer center frequency moved to 850 MHz to center response curve.
FREQUENCY = 850.00

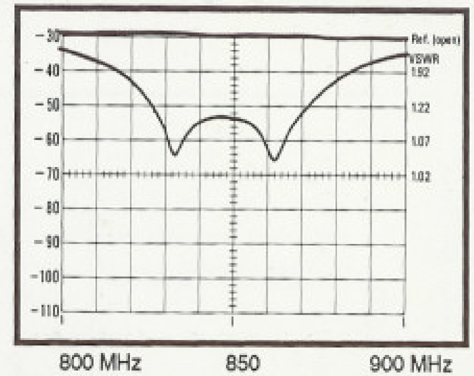
NOTE: The analyzer response is inactive above 1 GHz.



Same window mounted Cellular antenna.

ANALY DISPR reset to
10 MHz / DIV.

Of the 3 dips shown,one is caused by coax ripple, but overall VSWR is considerably better than manufacturer's 1.9 to 1 spec.

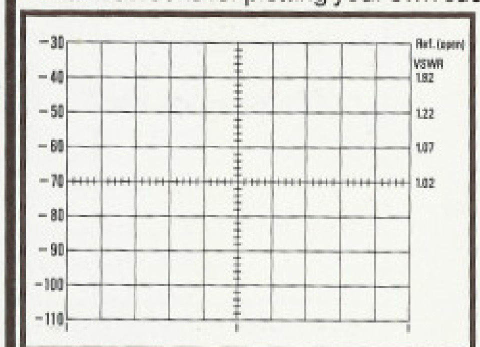


Same window mounted Cellular antenna.

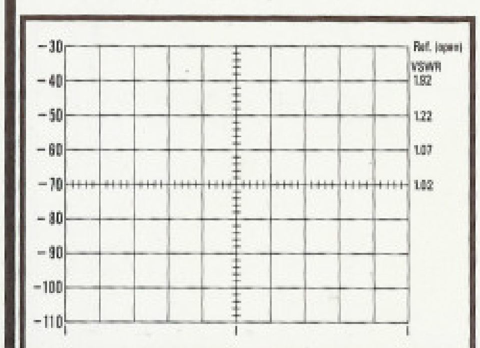
Fed with short coax (34") to reduce ripple effect.

Note that there are only **two** tuning dips. They will both move when the tuning screw on the antenna is adjusted.

Blank screens for plotting your own custom VSWR images for reference.



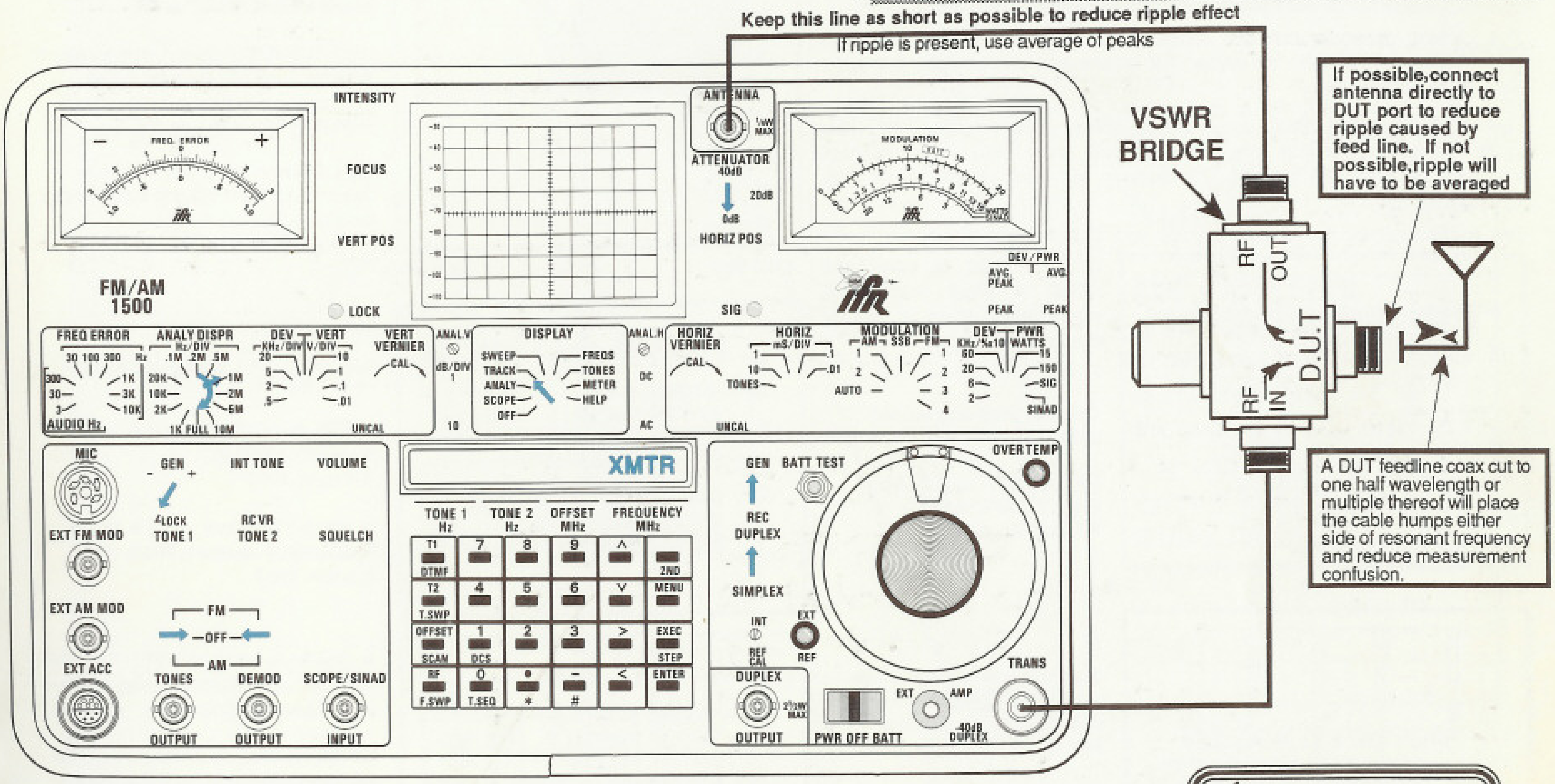
Notes



Notes

IFR FM/AM-1500

Tuning Antennas for Minimum VSWR



REMEMBER

The overall VSWR will be no better than the poorest element in the measurement.

Beware of inter-series adaptors, especially home-made ones.

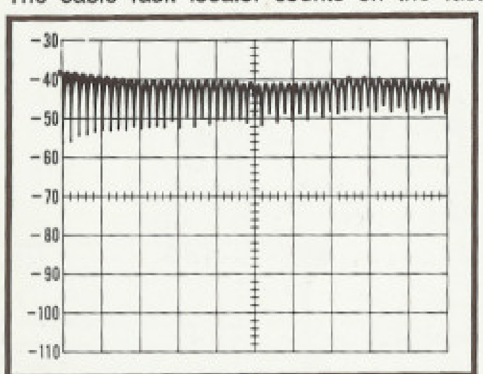
[1] VSWR bridge source:
Model 62NF50, 10-1000 MHz
$325, June 1986
Wiltron
805 E. Middlefield Road
P.O. Box 7290
Mountain View, CA 94042
(415) 969-6500

Cable Fault Location and Finding Tuned Stub Lengths

The tracking generator plus the computation power in the 1500 simplifies cable fault location. With the cable fault locator, you can pinpoint the exact distance to a fault.

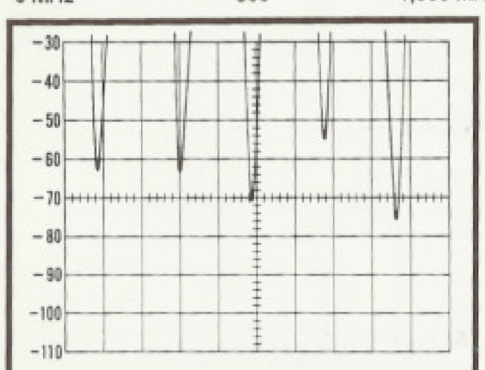
Fortunately most cable faults are shorts or opens, rarely are they 50Ω. You know that when you look into a shorted half wave stub at its resonant frequency, it looks like a short. Conversely, an open quarter wave stub looks like a short.

The cable fault locator counts on the fact that a discontinuity, normally either a short or open, will reflect a short every half wavelength when a swept frequency is applied.



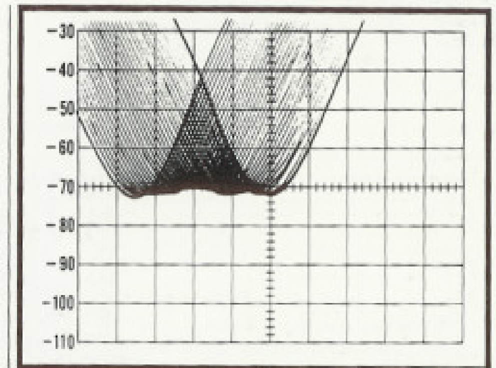
Unknown cable attached with "T" at **TRANS** port.

FREQUENCY: 500.00 MHz
ANALY DISPR: FULL
RF Output: -40 dBm



Same unknown cable as above but the horizontal resolution has been expanded by resetting **ANALY DISPR to 10M.**

Vertical resolution is increased by switching to **1dB/DIV.**

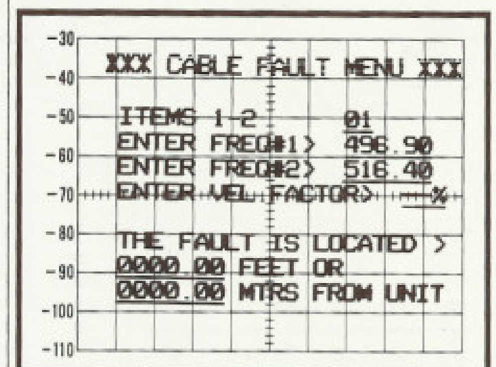


Same unknown cable as left column scope photos. Further horizontal expansion by setting **ANALY DISPR** to **1M**.

Jog **FREQUENCY** down .1 MHz per step to bring the closest dip to center screen.

Record **FREQ.** (example: **496.9**)

Jog **FREQUENCY** up until next dip is centered. Hit **ENTER** key to save that freq. and release keypad.

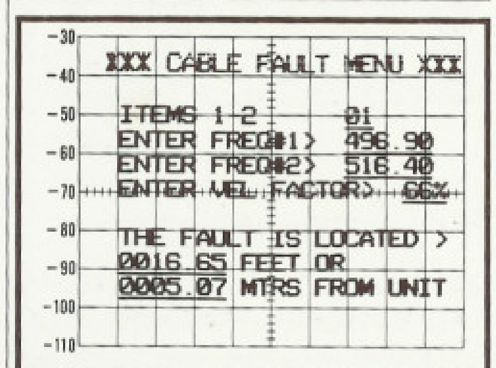


Switch **DISPLAY** to **FREQS**.

Key **MENU**, ^,^,^ to bring up **CABLE FAULT MENU**.

ENTER, **>**, then key in the freq. you *recorded* in **FREQ #1**.
Example: **496.9**

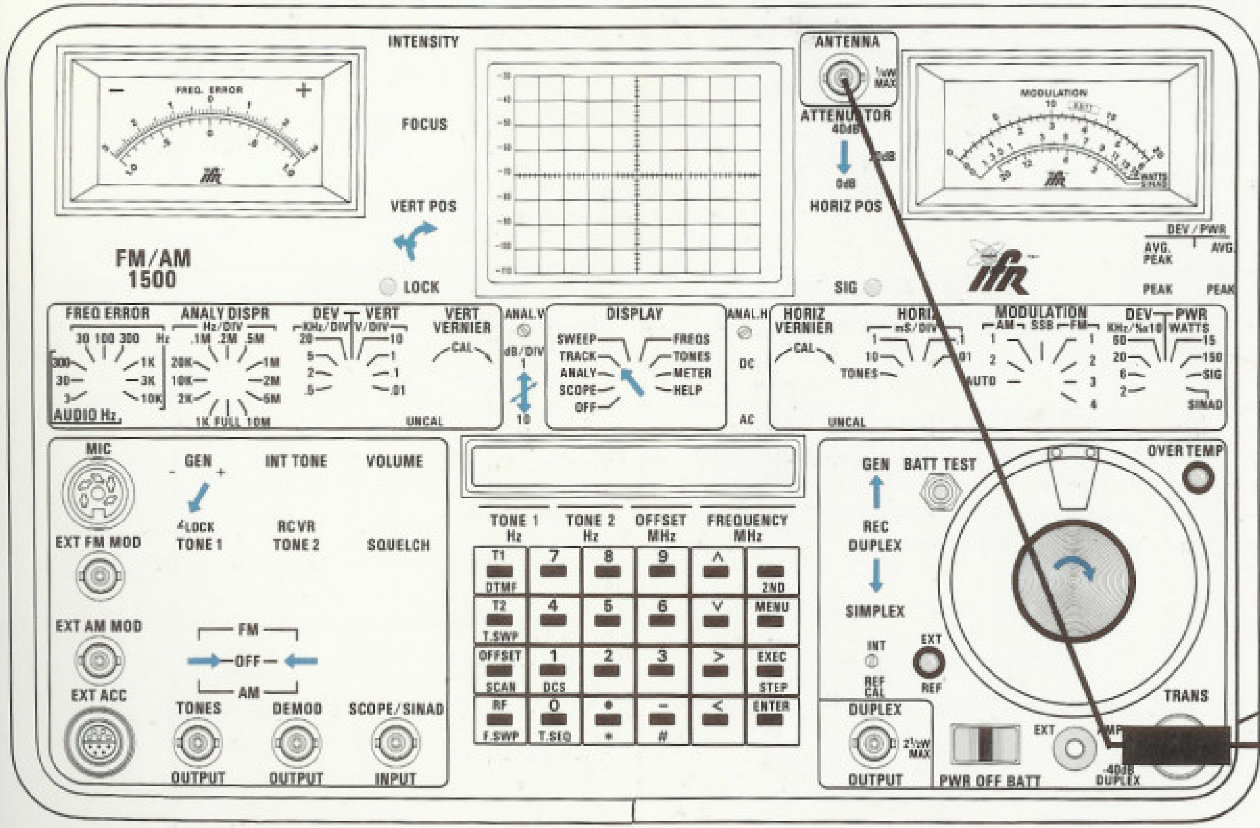
>, then key in the freq. saved in the **FREQUENCY** window in **FREQ #2**.
Example: **516.4**

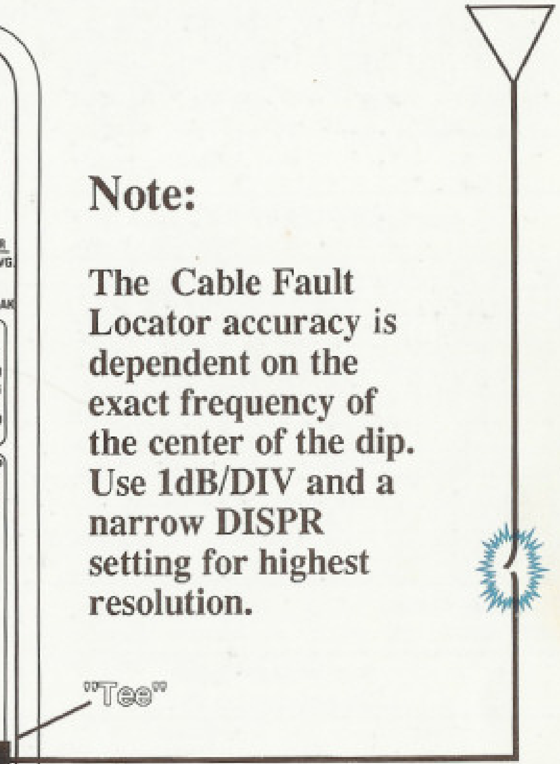


>, then key in the two digit **VEL. FACTOR** based on cable dielectric, see table on facing page. (example: **66%**)

ENTER will complete the function and the calculated distance to the fault in feet and meters will be displayed.

Cable Fault Location and Finding Tuned Stub Lengths





Note:

The Cable Fault Locator accuracy is dependent on the exact frequency of the center of the dip. Use 1dB/DIV and a narrow DISPR setting for highest resolution.

Using the Cable Fault calculator for determining coax stub length:

Suppose you want to cut a half wave stub of RG-58 coax at 153 MHz. Just enter **0** MHz in **FREQ #1** and **153** MHz in **FREQ #2**. You know from experience that RG-58 is polyethelene, so enter **66** in the **VEL. FACTOR** window. When you hit the ENTER key, the actual coax length for the half wave stub will be displayed. Fine tuning: Set the FREQUENCY to 153.00 and cut coax to center the dip.

VELOCITY FACTOR

Cable Dielectric	Velocity
Solid Polyethelene	65.9%
Foam Polyethelene	80.0%
Foam Polystyrene	91.0%
Air Space Polyethelene	84-88%
Solid Teflon	69.4%
Air Space Teflon	85-90%

Measuring Center Frequency Insertion Loss and 3dB Points on Cavities

The tracking generator/spectrum analyzer provides an instant graphic readout of loss across the band for duplexers and cavities. The 1 dB/DIV range allows resolution to .5 dB.

Conversion Chart
dB down vs % power loss

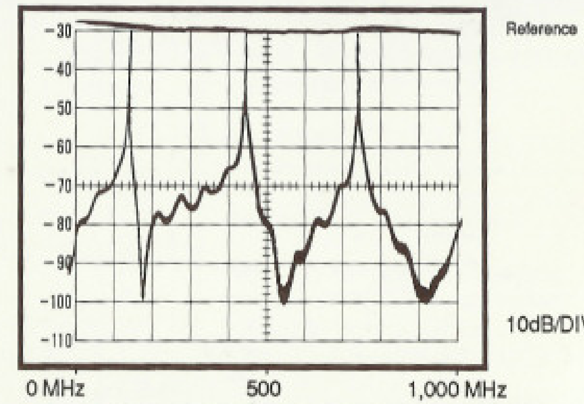
dB	%	dB	%	dB	%
.10	2.3	1.0	20.6	2.5	43.7
.20	4.5	1.1	22.4	3.0	50.0
.25	5.3	1.2	24.1	4.0	60.2
.30	6.7	1.3	25.9	5.0	68.4
.40	8.8	1.4	27.6	6.0	74.9
.50	10.9	1.5	29.2	7.0	80.0
.60	12.9	1.6	30.8	8.0	84.2
.70	14.9	1.7	32.4	9.0	87.5
.75	15.9	1.8	33.9	10.0	90.0
.80	16.8	1.9	35.4	15.0	96.8
.90	18.7	2.0	36.9	20.0	99.0

Conversion Chart
Power ratios to dB

Power Ratio	dB	Power Ratio	dB
0.10	-10	1.00	0
0.13	-9	1.26	1
0.16	-8	1.58	2
0.20	-7	2.00	3
0.25	-6	2.51	4
0.32	-5	3.16	5
0.40	-4	4.00	6
0.50	-3	5.01	7
0.59	-2	6.31	8
0.74	-1	7.94	9
1.00	0	10.00	10

These photos show various curves produced by a single VHF bandpass cavity which is also usable at UHF. (All photos are multiple exposures to show reference.)

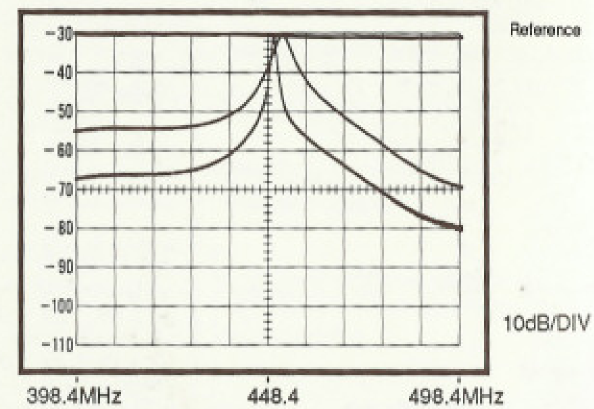
FULL DISPR shows filter's pass capability at 3 frequencies.



Triple exposure photo

FREQUENCY is reset to desired 448.4MHz.

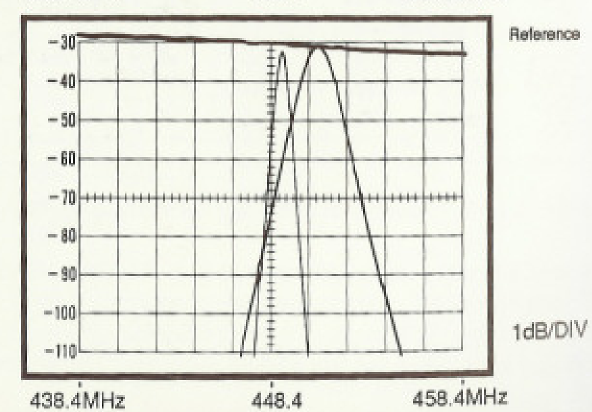
When **DISPR** is reduced to **10 MHz,** two different coupling loop positions are found that provide about the same insertion loss but produce a difference in the shape of the curve.



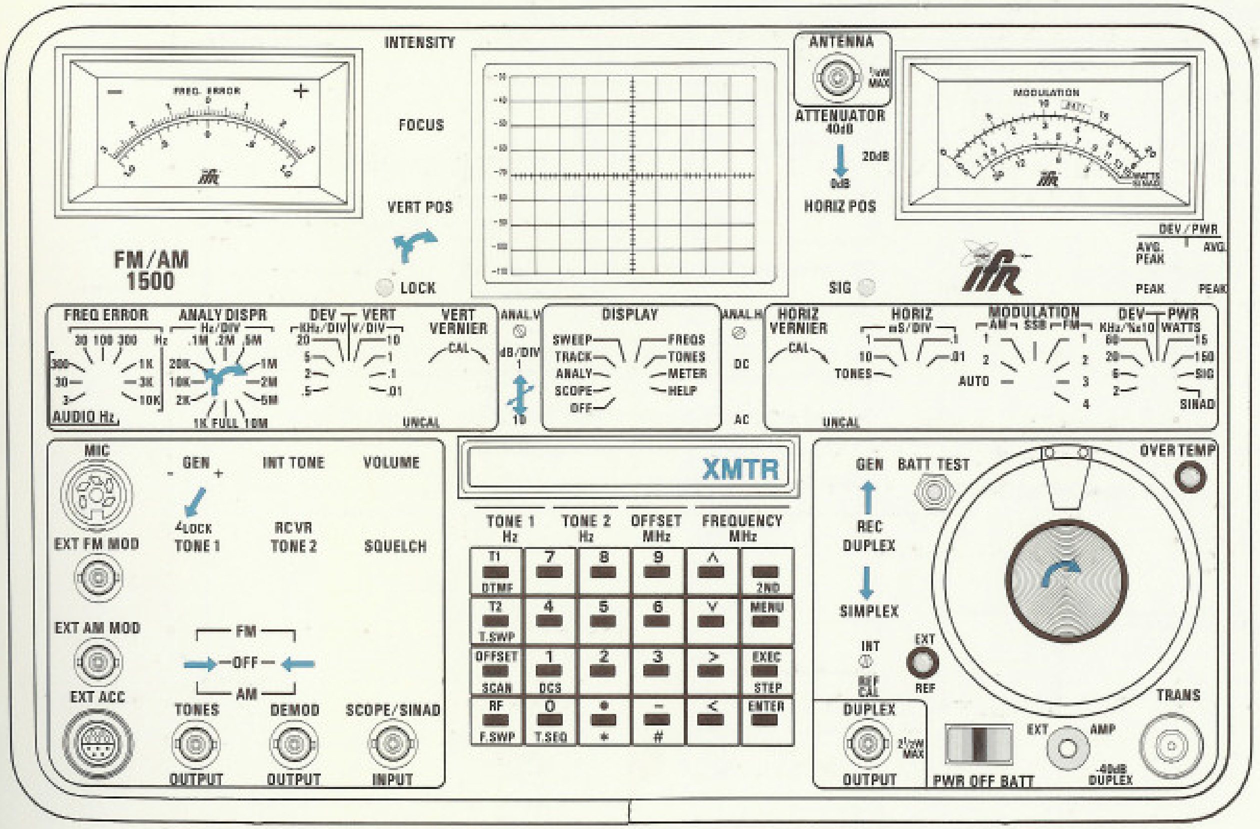
Triple exposure photo

DISPR is reduced to **2 MHz/DIV.**
dB/DIV reset to **1dB.**
VERT POS. used to re-reference cables.
It now becomes evident that the coupling loop positions also pull the frequency slightly.

Coupling loops are set for the sharper peak and the frequency is retuned to the center with the tuning rod.

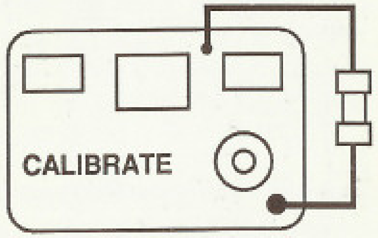


Measuring Center Frequency Insertion Loss and 3dB Points on Cavities

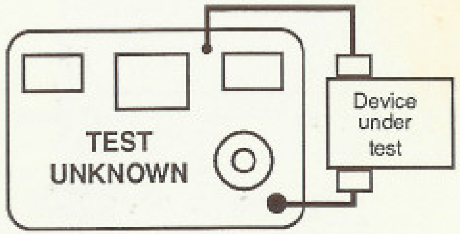


Be sure to calibrate out the combined slight variations of connecting cable losses, generator output and analyzer sensitivity when you change frequency if you're trying to split hairs on a measurement.

Test setup for swept frequency measurement



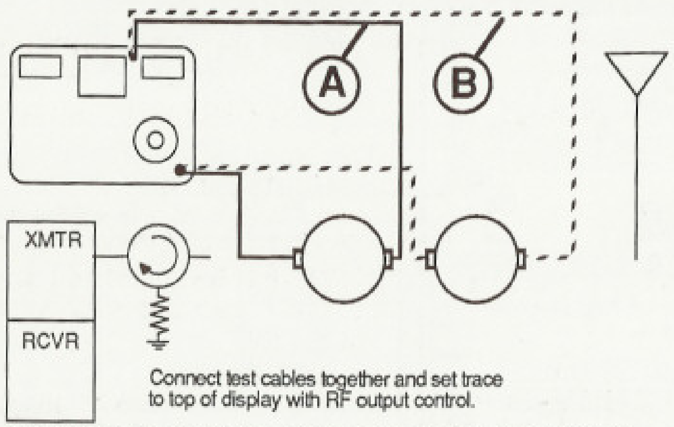
Calibrate out the test cable loss at each frequency. Connect your test cables together and reset the RF output control to bring the trace back to your reference point.



APPLICATION NOTE

Transmitter Cavity Alignment

The tracking generator / spectrum analyzer function provides an instantaneous display of all the information needed to tune cavities and duplexers quickly and accurately.

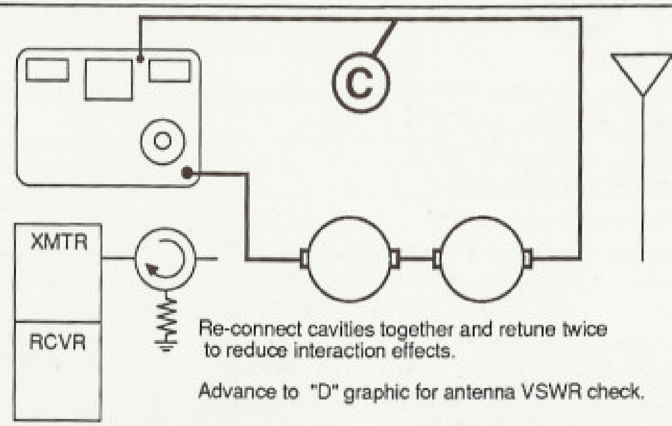


Connect test cables together and set trace to top of display with RF output control.

Re-connect as shown by "A" and tune cavity closest to transmitter first.

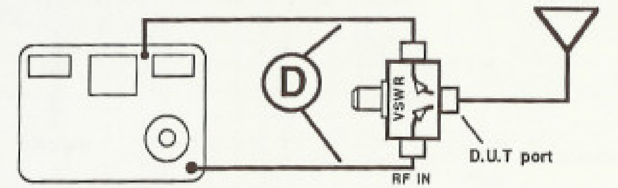
Re-connect as shown by "B" and tune second cavity.

Advance to graphic below for next step.



Re-connect cavities together and retune twice to reduce interaction effects.

Advance to "D" graphic for antenna VSWR check.



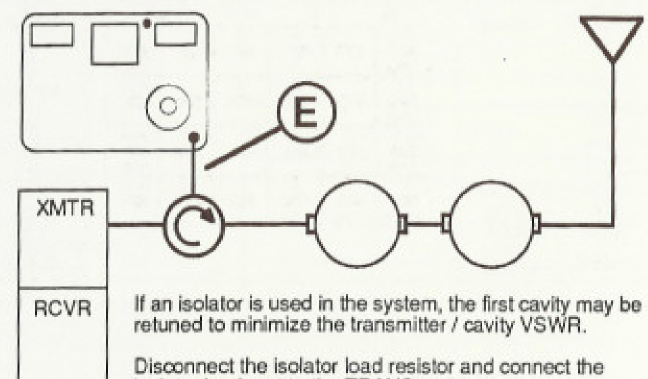
Run antenna VSWR test.

Connect VSWR bridge as shown.

Leaving the D.U.T. port open as a reference, adjust RF output control to position display trace on top graticule line at center screen.

Connect antenna to measure return loss. Refer to pages 38-41 for VSWR measurement details.

Advance to graphic below.

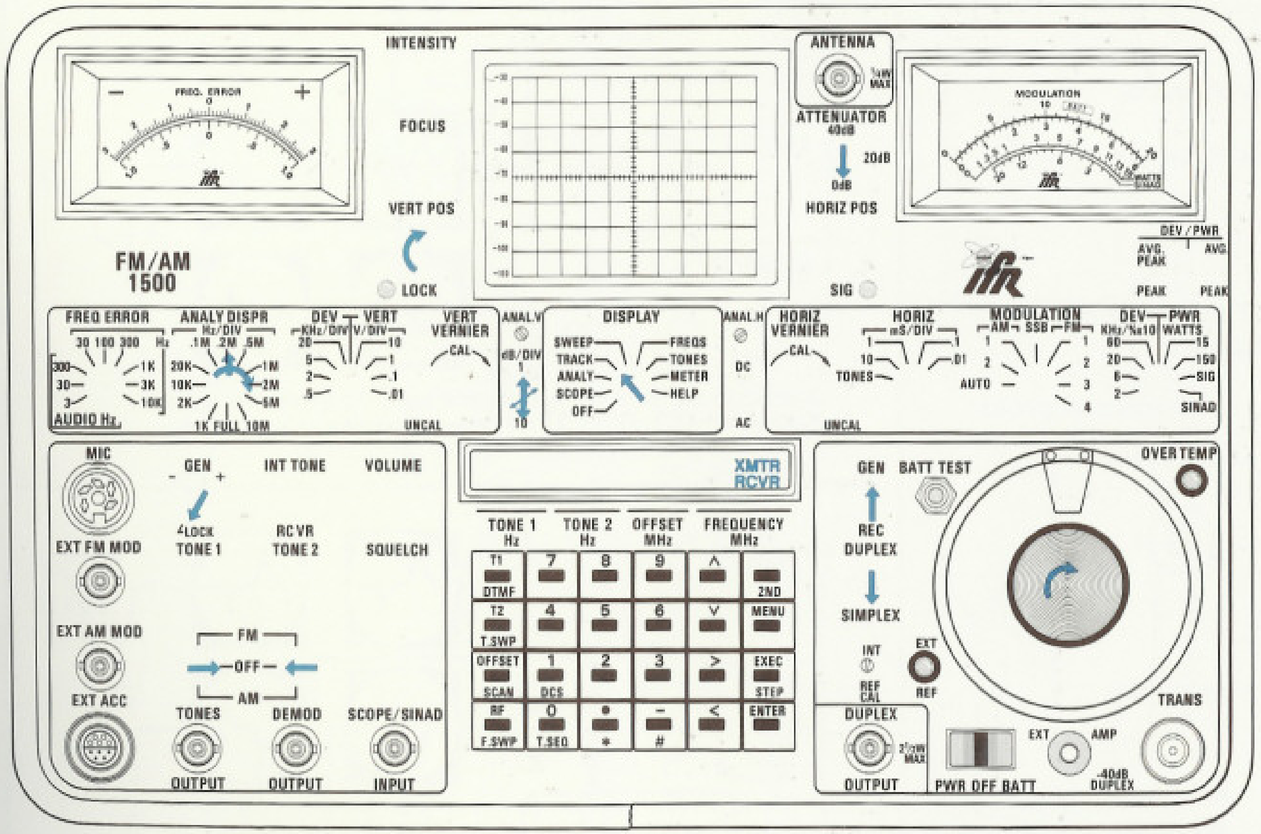


If an isolator is used in the system, the first cavity may be retuned to minimize the transmitter / cavity VSWR.

Disconnect the isolator load resistor and connect the isolator load port to the TRANS port.

Set the DEV / PWR switch to 15 WATTS.
Key transmitter and tune cavity closest to transmitter for minimum reflected power as read on the wattmeter.

Transmitter Cavity Alignment



Connect as shown in graphic **A** on facing page.

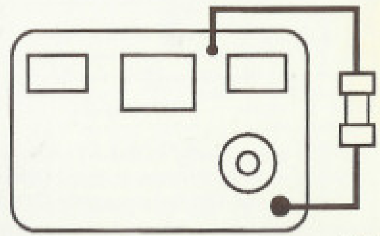
With 1500's **FREQUENCY** set to the transmitter frequency, an obvious peak should be visible on the display.

FINE TUNING

If peak is close to center of screen, decrease **ANALY**zer **DISPeR**sion to increase resolution so you can tune the cavity to center the peak exactly *on* frequency.

Increase the vertical resolution by switching to **1 dB/DIV** and bringing trace back on screen with **VERT**ical **POS**ition control.

For any loss measurements, you should always "calibrate out" the test cable loss at each frequency. Connect your test cables together and reset the RF output control to bring the trace back to your reference point.



Bandpass / Band Reject Duplexer Alignment

Guidelines for cavity testing

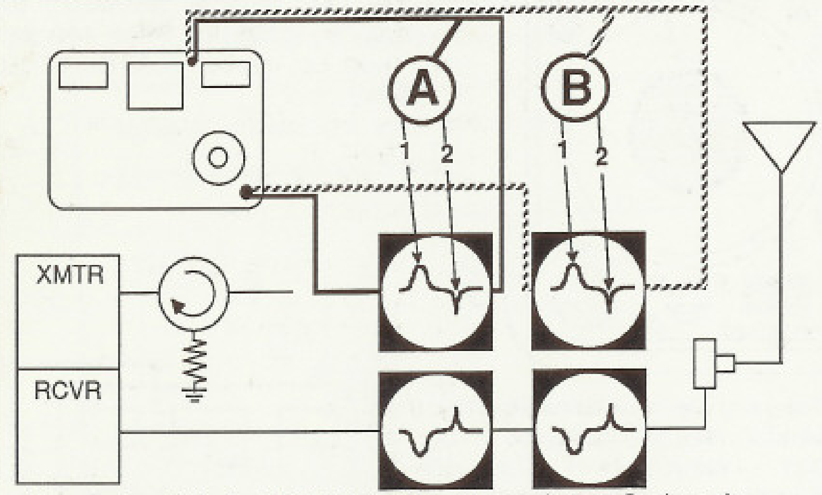
Read and follow cavity maker's tuning recommendations.

Make an outline of the system components and frequencies and label all cables.

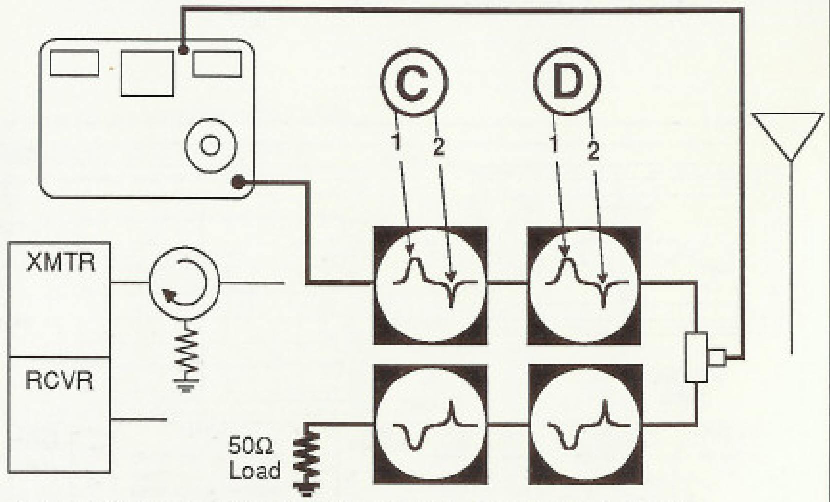
Use double shielded or semi-rigid coax.

Use **GOOD** connectors, avoid PL-259's / UHF connectors and inter-series adaptors. Keep connectors bright and clean.

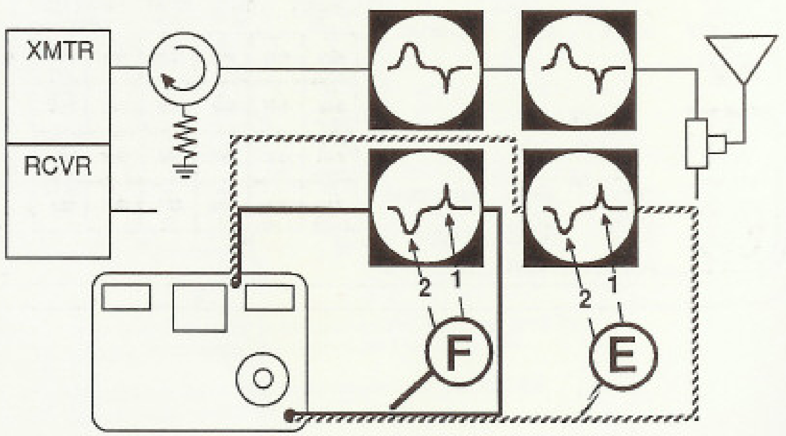
Double peaking is usually caused by incorrect length connecting coax.



Align each cavity in the A1- A2- B1- B2 sequence shown. Go through the tuning sequence at least twice to minimize interaction effects. Advance to top right graphic for next step



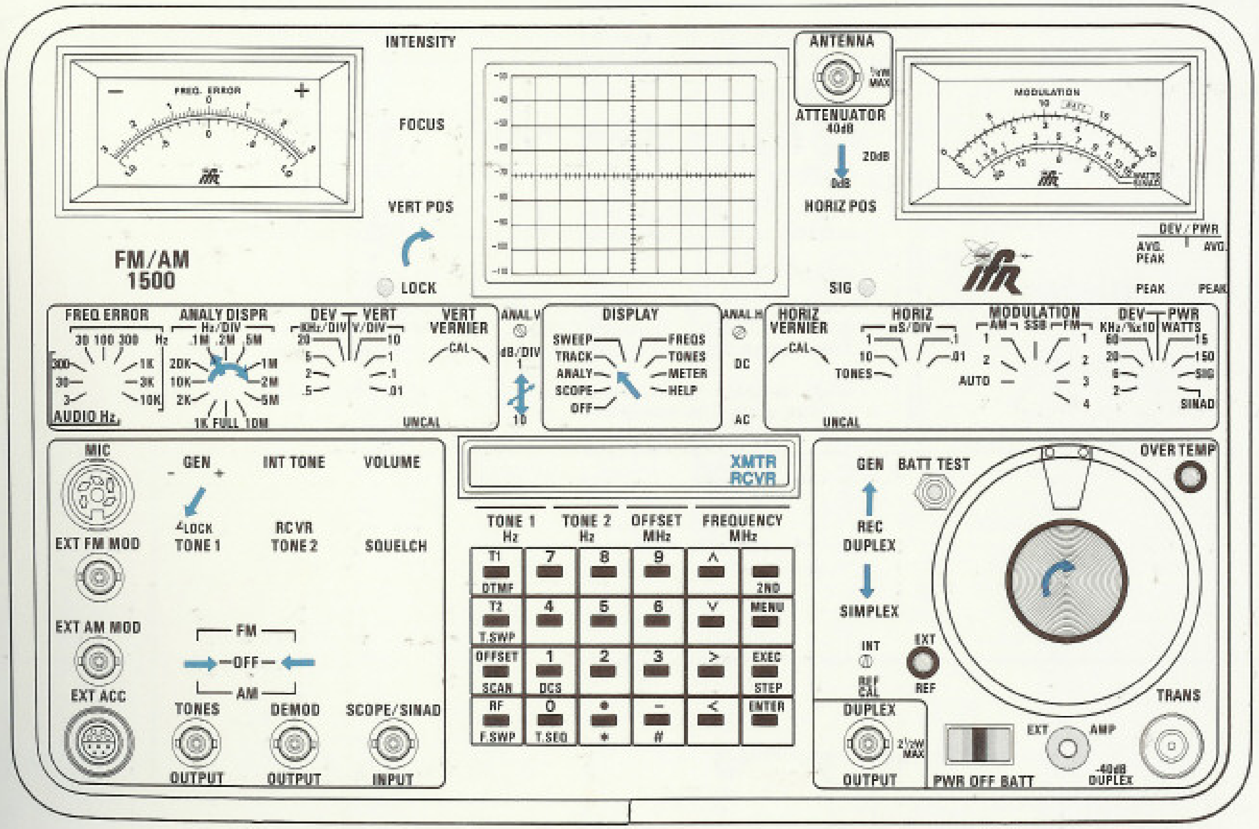
Connect to the duplexed system as shown. Load receiver output. Retune in the C1- C2 - C3 - C4 sequence shown at least twice. Advance to graphic below for receiver cavity tuning.



Tune receiver cavities in the E1 - E2 - F1- F2 sequence shown (twice). Re-connect the duplexer system and run a desense test. (see page 50-51)

IFR FM/AM-1500

Bandpass / Band Reject Duplexer Alignment



By using the **RF SCAN** function, you only need program the transmitter and receiver frequencies once. When you run the **RF SCAN** program and stop the scan, a single keystroke will toggle the 1500 from the transmitter to the receiver frequency.

Switch the **DISPLAY** to **FREQS.**

Call up the **RF SCAN MENU** by keying **MENU**, and the **^** key until **RF SCAN MENU** appears.

Enter the menu by **ENTER, >.**

Key in the transmitter frequency. Example: **454.4, ENTER.**

Advance to **ITEM 02** by keying **^.**

A **>** will get you into the **FREQ** field.

Key in the receiver frequency. Example: **459.4, ENTER.**

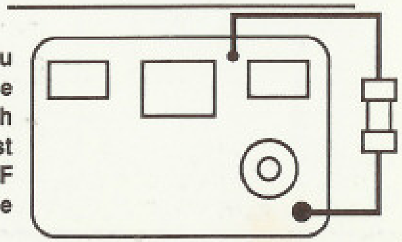
Now that you have the two frequencies programmed in, switch the **DISPLAY** back to **TRACK.**

Run the **RF SCAN** program by **EXEC, 2ND, SCAN, 1, -** (THRU), **2, •** (LOOP). **ENTER** will start the scan which will alternate between the two center frequencies continously.

Stop the scan by keying **2ND, STEP.**

Now you can step from transmit to receive with a single **^** keystroke.

For any loss measurements, you should always "calibrate out" the test cable loss at each frequency. Connect your test cables together and reset the RF output control to bring the trace back to your reference point.



Measuring receiver desense in a duplexed system

Duplexer tuning is not complete until a receiver desense test has been completed.

There are several possibilities that can contribute to desensitization when the transmitter is keyed.

- Routing the transmitter coax too close to the receiver.
- Cable lacking sufficient shielding, use double shielded coax.
- Inadequate shielding between the transmitter and receiver sections within the radio.
- Poor connections at any point in the system can also cause desense.

TEST PROCEDURE

Connect as shown below with the 50Ω load and run SINAD test. (see pages 10-11 for SINAD testing)

Record the RF level required to produce12dB SINAD sensitivity.

Key transmitter. The amount that you need to *increase* the RF level to get back to 12dB SINAD is the desense figure due to the transmitter sideband noise.

EXAMPLE

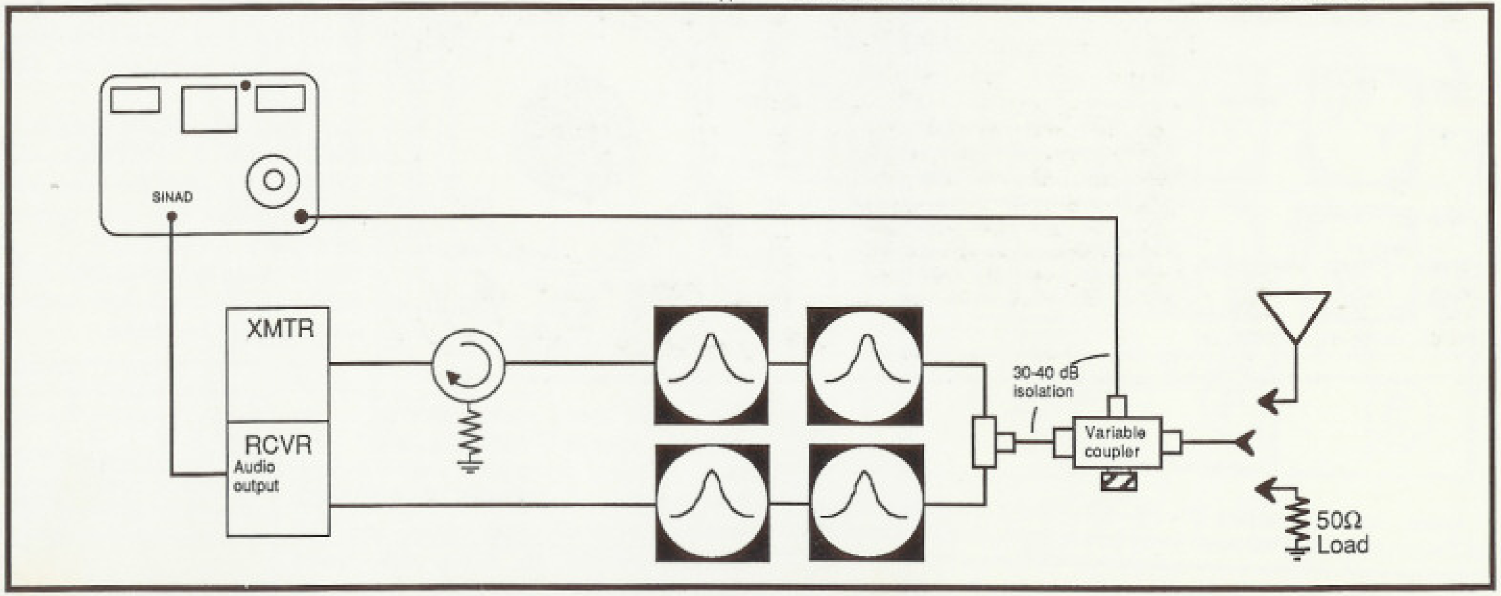
50Ω: 12dB SINAD,Transmitter unkeyed	= -85 dBm
50Ω: 12dB SINAD,Transmitter keyed	= -80 dBm
Receiver desense due to sideband noise	= 5 dB

Connect the antenna and re-run the SINAD test with the transmitter keyed to determine combined system desense caused by Tx sideband noise and the antenna.

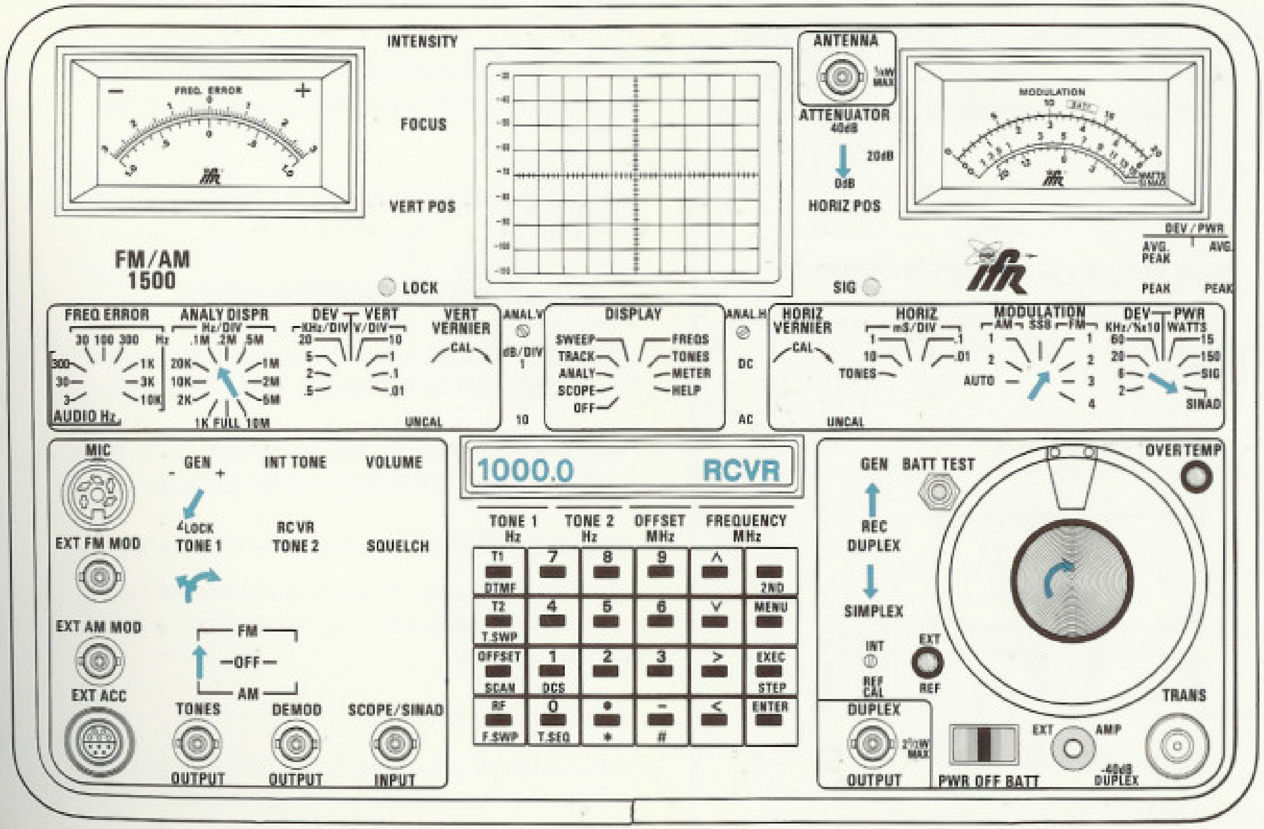
EXAMPLE

50Ω: 12dB SINAD, Transmitter unkeyed	= -85 dBm
Ant: 12dB SINAD, Transmitter keyed	= -72 dBm
Total system receiver degradation	= 13 dB

Thus if the basic receiver sensitivity was	-115 dBm or .4 µv.
subtract system degradation	13 dB
Effective sensitivity is	-102 dBm or 1.8 µv.

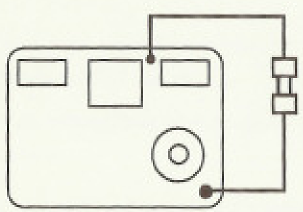


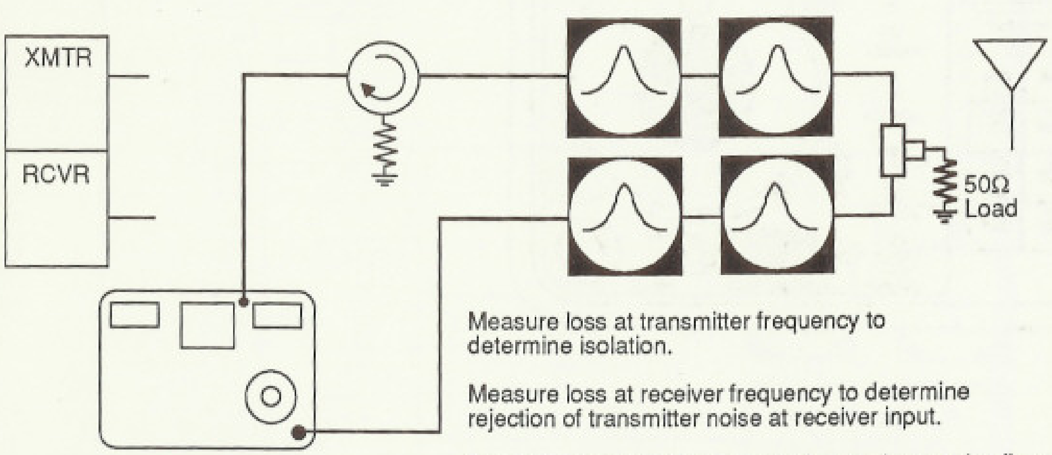
Measuring receiver desense in a duplexed system



Measuring receiver isolation at Tx & Rx frequencies

Isolation, expressed in dB, is very important in the operation and maintenance of duplexed systems. Adequate isolation must be assured to prevent receiver degradation due to transmitter sideband noise.





TEST PROCEDURE

Connect as shown below. Set controls as shown on facing page.

Calibrate your cables by connecting them together and setting the trace to the top graticule line on the display.

Note the RF output dial setting, it should be close to -30 dBm.

Re-connect as shown in the bottom graphic.

Increase the RF output to 0 dBm and read the analyzer display at center screen (Tx freq.) for isolation.

Add the increase in RF output(≈-30 dBm) to the dBm reading on screen to determine **total** isolation.

Change **FREQUENCY** to the receiver frequency.

Measuring attenuation at the receiver frequency will determine the isolation from transmitter noise at the receiver frequency.

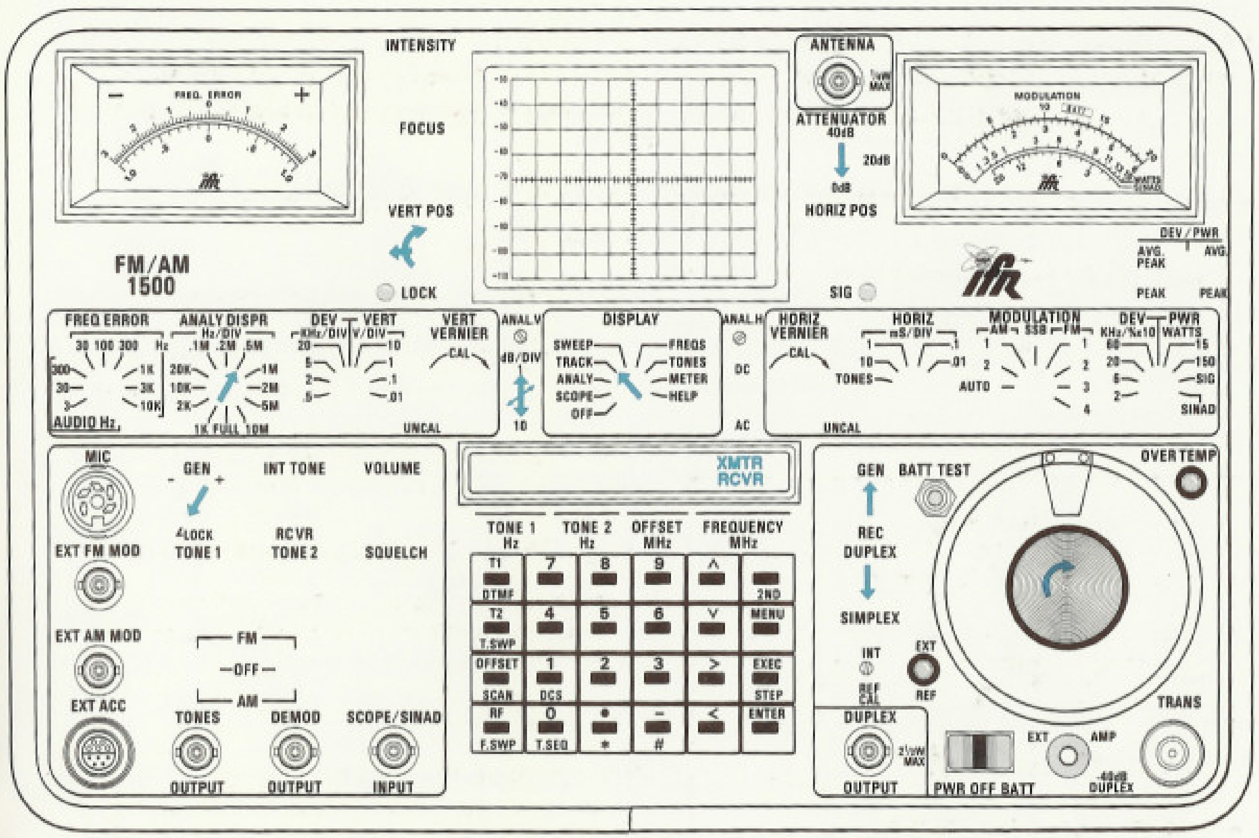
Switch **DISPLAY** to **ANALY.**

While watching the noise floor near the receiver frequency, replace the 50Ω load with the antenna. Watch for on-channel or close-in desense indicated by an increase in the noise floor.

Key any transmitters nearby that are suspected intermod producers.

Re-connect transmitter and key both the suspect and this transmitter, looking for desense.

Measuring receiver isolation at Tx & Rx frequencies



Measuring Tx noise suppression at Rx frequency

Incoming inspection of new equipment is a good investment. No matter the stature, size or reputation of the manufacturer, bad radios *do* get into the field.

By measuring and recording the important performance parameters in a maintenance log *before* you install the equipment, you can establish a reference point that will be very helpful in future servicing.

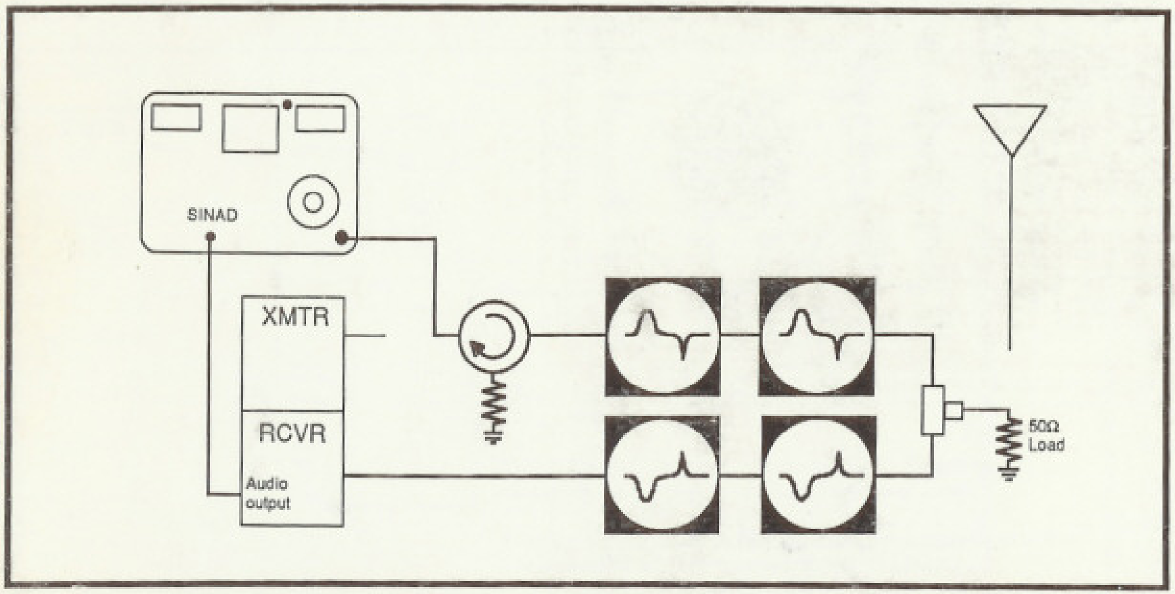
TEST PROCEDURE

Perform receiver SINAD test. (see pages 10-11)

Record SINAD sensitivity.

Connect signal generator output (**TRANS**) to cavity or isolator nearest transmitter.

Raise RF output to re-achieve 12 dB SINAD. The difference is the transmitter noise suppression capability of the duplexer system.



EXAMPLE

12 dB SINAD of receiver	-112 dBm
12 dB SINAD through duplexer assembly	-10 dBm
Transmitter noise suppression	-92 dB

IFR FM/AM-1500

Measuring Tx noise suppression at Rx frequency