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CE-15
SPECTRUM MONITOR

CUSHMAN
ELECTRONICS, INC.

Serial Number 451 and up.

CE-15
SPECTRUM MONITOR

INSTRUCTION MANUAL

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ILLUSTRATIONS

UNPACKING AND INSPECTION

When unpacking the Model CE-15 Spectrum Monitor, inspect the packing box and the instrument for possible damage. The instrument was carefully inspected before shipment and should be ready to operate properly when received. Confirm satisfactory performance by following the procedures given in the Operating section of the Instruction Manual. If the equipment is damaged or fails to operate properly, file a claim with the transportation agency, or if insured separately, with the insurance company.

SECTION 1
GENERAL

INTRODUCTION

1.01 The Cushman CE-15 Spectrum Monitor is particularly designed for use in the Radio Maintenance field. It provides the user with the capability of visually monitoring a selected portion of the radio frequency spectrum for the purpose of determining spurious emissions, intermodulation interference, unwanted oscillator radiation, and harmonic levels. This instrument can monitor and audibly identify AM and FM carriers, which is particularly useful in the case of interference. It may be used to check intermodulation distortion between RF signals, do IF and RF signal tracing and may be used as a field strength receiver when using a calibrated antenna.

DESCRIPTION

1.02 The Spectrum Monitor is essentially a triple conversion superheterodyne receiver with a video display as well as an audio output demodulated from either AM or FM signals. The frequency range is from 1 to 1000 MHz. It has four scan widths, 10 kHz, 100 kHz, 1 MHz and 10 MHz per division. It also has a selectable 2 kHz bandwidth filter on the 10 kHz scan width range to reduce noise when viewing low level signals.

1.03 An LED frequency display with Coarse and Fine tuning controls provides for accuracy in setting the center frequency of the display and a graticule calibrated in 10 dB per step divisions makes it possible to view a 70 dB amplitude signal. Its high sensitivity, -115 dBm (0.4μV), permits viewing extremely low level signals.

1.04 Front panel access to an internal level and frequency reference makes it possible to maintain a level accuracy of measurement of better than ± 3 dB. It is possible to introduce an external calibrated signal from an accurate source such as a CE-6A Communications Monitor for use as a frequency calibrating marker simultaneously with the signal being monitored.

1.05 Sweep rate and IF filter controls have been eliminated. These are set to their optimum value for each range selected. A first IF of 2100 MHz eliminates problems from image frequencies, since they will be 4.2 GHz away from the frequency of interest.

1.06 The input circuits are protected by a fuse mounted in the RF input connector to guard the circuits from accidental overloads. This method of mounting makes it possible to change the fuse without getting into the instrument.

1.07 A high impedance probe may be directly connected to the input connector. A probe power supply jack is located adjacent to the RF input to provide for the use of active probes.

1.08 A 12V DC Inverter is available as a factory modification, M1, to permit operation of the CE-15 from a 12V DC supply.

ACCESSORIES AND OPTIONS

1.09 The following accessories are furnished with each Spectrum Monitor:

Whip Antenna with holder

One spare RF input fuse

dBm/Volts conversion scale

Operating and Maintenance Manual

Other accessories available:

C/E P/N	Description
Option M-1	12 Volt Inverter
2180-0165	CRT Viewing Hood
7021-0002	Probe. 500 ohm in parallel with 1 pF, to 1 GHz. 20 dB insertion loss (Tektronix 010-6056-03).
7021-0003	Probe. 5K ohm in parallel with 1 pF, to 1 GHz. 40 dB insertion loss (Tektronix 010-6057-03).
7021-0001	10 spare RF input fuses 1/8A 125V
7001-0403	Printed circuit board extender
7005-0060	Front panel cover
5287-0045	Fiberglass shipping trunk
5287-0044	Soft protective zipper cover
2346-0005	Spare antenna
1262-0001	50Ω BNC Plug Terminations

1.10 The specifications for the CE-15 Spectrum Monitor are given in Table 1-1.

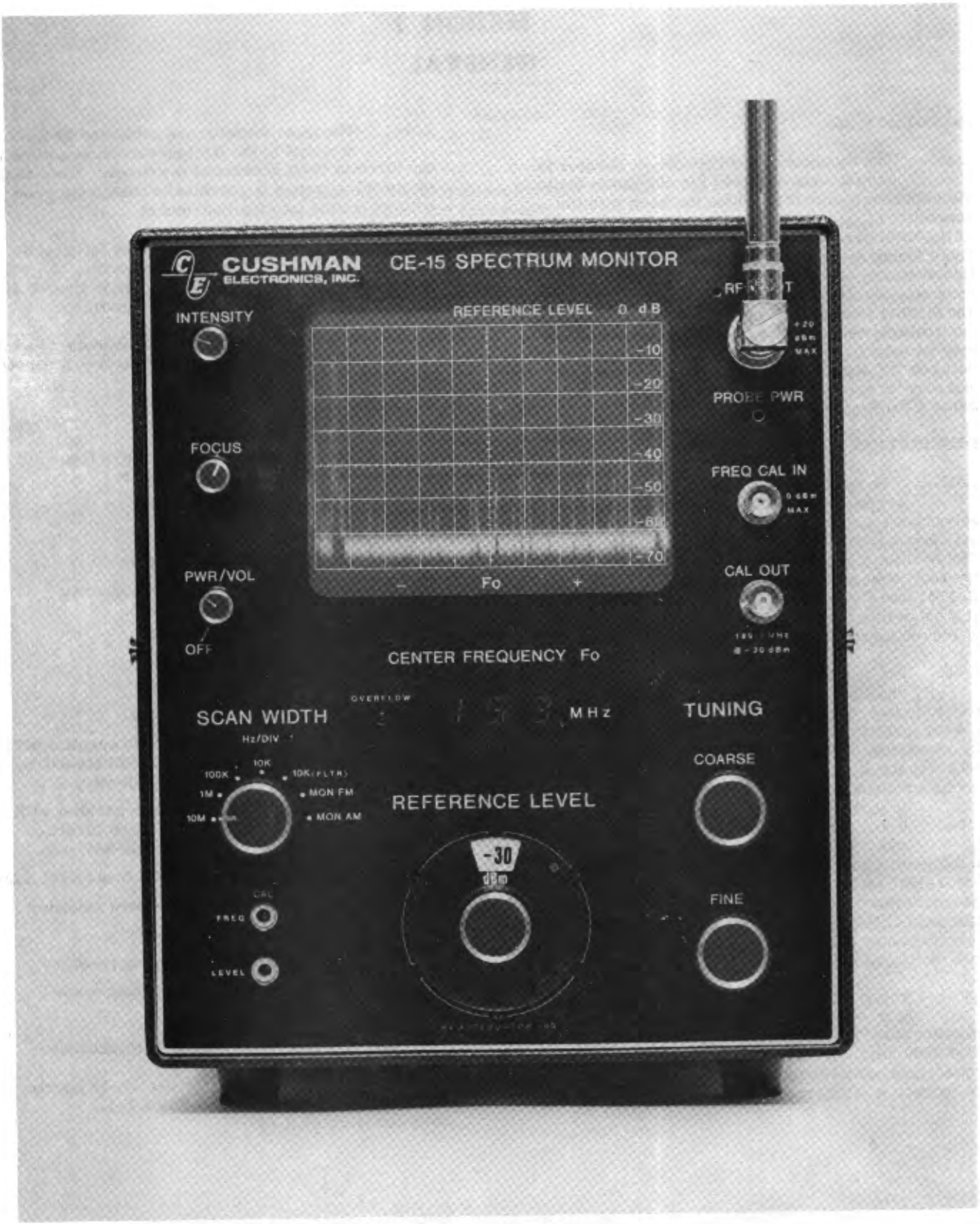

Figure 1-1. CE-15 Spectrum Monitor

Table 1-1. CE-15 Spectrum Monitor Specifications

ITEM	CHARACTERISTIC
FREQUENCY	
Range	1-1000 MHz (usable to 100 kHz)
Accuracy, F_o 5-1000 MHz	±5 MHz
Drift, after 2 hours warm-up	50 kHz/5 min, typical
LEVEL	
Range ≥5 MHz	-115 to +20 dBm
<5 MHz	-95 to +20 dBm
Accuracy, 1-1000 MHz, S/N ≥15 dB, after internal calibration at -10 dBm REF LEVEL in SCAN WIDTH mode selected	±3 dB
DYNAMIC RANGE	
Total	135 dB
Level range for specified Level Accuracy	F_o ≥5 MHz / F_o <5 MHz
10 kHz/cm Filter	-100 to +20 dBm / -80 to +20 dBm
10 kHz/cm	-100 to +20 dBm / -70 to +20 dBm
100 kHz/cm	-90 to +20 dBm / -70 to +20 dBm
1 MHz/cm	-80 to +20 dBm / -60 to +20 dBm
10 MHz/cm	-80 to +20 dBm / -80 to +20 dBm
Spurious response, (no input signal) 1-1000 MHz	≤-100 dBm
IF rejection (0-1000 MHz)	>70 dB
Image rejection (0-1000 MHz)	>70 dB
VIDEO DISPLAY	
Log Display Range	≥70 dB
Resolution, two signals having ≤50 dB difference in amplitude	
Scan Width	
10 kHz/cm FLTR	10 kHz separation
10 kHz/cm	10 kHz separation
100 kHz/cm	60 kHz separation
1 MHz/cm	0.8 MHz separation
10 MHz/cm	1 MHz separation
Noise sidebands, 50 kHz away in 10 kHz/cm FLTR mode	>70 dB down
Sweep Rate	
Scan Width	
10 kHz/cm FLTR	1 Hz ± 15%
10 kHz/cm	10 Hz ± 15%
100 kHz/cm	20 Hz ± 15%
1 MHz/cm	20 Hz ± 15%
10 MHz/cm	20 Hz ± 15%
Horizontal Linearity	± 5%
Graticule	7 x 10 cm, 10 dB/cm, 2 dB minor divisions

Table 1-1. CE-15 Spectrum Monitor Specifications (cont'd)

ITEM	CHARACTERISTIC
INPUT	
RF INPUT (fuse protected) FREQ CAL IN	
Impedance	50Ω nominal
Maximum input level	+20 dBm
Maximum input DC	±50 volts
L.O. leakage (1.9 GHz)	-40 dBm nominal
Connector	BNC
OUTPUTS	
CAL OUT	
Impedance	50Ω nominal
Level	-30 dBm nominal
Frequency	189.3 MHz ± 0.1%
Connector	BNC
DEMOD OUT (rear panel)	
Impedance	600Ω nominal
Level, 50% AM or 6 kHz P-P FM (1 kHz Mod. rate)	0.1V P-P nominal
3 dB bandwidth, FM	90 Hz - 5.4 kHz nominal
3 dB bandwidth, AM	20 Hz - 4.5 kHz nominal
Connector	BNC
Speaker	
Power, 50% AM or 6 kHz P-P FM	0.1 watt max
Squelch	-50 dB video display level nominal
PROBE POWER	+10V DC, 0.1A maximum
POWER REQUIREMENTS	
Standard	115/230V AC, ±10%, 50-400 Hz, 30VA
Inverter, optional	11.5 - 15V DC at 3A
MECHANICAL	
Height	9.5 inches (24.1 cm)
Width	8.6 inches (21.8 cm)
Length	18.4 inches (46.7 cm)
Weight	30 lbs. (13.6 kg)
Temperature	
Operating	0 to 55°C
Storage	-40° to +75°C

SECTION 2
OPERATION

CONTROLS AND INDICATORS

2.01 The location of the front panel controls can be seen in Figure 1-1. In Table 2-1 the function and a brief description of the controls is given. Figure 2-1 is a sketch showing the rear panel controls and connectors.

OPERATION

Initial Set-Up and Calibration

2.02 Connect line cord to an AC source. When first put into service make certain that line voltage switch on rear panel is set to show the line voltage of the AC source and that correct fuse is in the holder. For 12V DC operation disconnect the line cord from the instrument and slide the metal door over the AC connector to expose the banana jacks. Connect battery to the two jacks observing polarity, positive to the red jack. Set the line switch to 12V position.

2.03 Set the INTENSITY control maximum CCW and turn PWR/VOL control CW just out of the detent position. Set SCAN WIDTH to 1 MHz, REFERENCE LEVEL to -30 dBm, COARSE and FINE tuning for a CENTER FREQUENCY of 189 MHz. Connect a BNC connector cable from CAL OUT to RF INPUT.

2.04 Turn the INTENSITY control CW for a trace of suitable brilliance.

CAUTION

Prolonged display of a stationary signal or trace of high intensity may damage the phosphor of the CRT screen. Therefore the trace brilliance should not be set higher than is necessary for comfortable viewing.

2.05 Center the CAL signal on the F_0 line with the COARSE and FINE TUNING controls. Using a small screwdriver adjust the CAL FREQ adjust control for a CENTER FREQUENCY F_0 display of 189 MHz. (Make certain display is the 189 MHz Cal signal and not a harmonic, negative frequency or the First L.O. See Operation Note 1 and 2.) Set the REFERENCE LEVEL control to -10 dBm. Set the SCAN WIDTH control for the Scan Width to be used in making the next level measurement. Adjust the screwdriver-set CAL LEVEL control until the peak of the Reference signal is at the -20 dB line of the graticule. Disconnect the BNC cable from the RF INPUT and the CAL OUT connectors. The instrument is now ready for use.

Spectrum Measurements

2.06 Connect the signal to be observed to the RF INPUT connector, observing the maximum level restrictions. Tune the COARSE and FINE controls to the frequency of the desired signal and center it on the CRT display. Set the REFERENCE LEVEL for a display peaked within the graticule area and better than 15 db above the residual noise.

2.07 Set the SCAN WIDTH to a band that will include the other signals of interest, harmonics, spurious, interference. Read relative levels on the CRT graticule. Use the REFERENCE LEVEL control to attenuate high levels or to bring up low level signals. The absolute level is the algebraic sum of the dial and the graticule readings. The frequencies of the various signals seen, relative to the F_0 frequency can be determined by applying the Hz/Div setting of the SCAN WIDTH switch. Refer to Operation Note 3 for use of the red dot and red lines around the REFERENCE LEVEL control.

Higher Resolution

2.08 If it is desired to obtain better resolution between signals that are close together, the SCAN WIDTH switch should be set to 10 kHz (FLTR). This adds a 100 Hz video filter which increases the usable sensitivity as well as increasing the resolution.

Audio Monitoring

2.09 If it is desired to listen to the modulation on a signal for identification purposes, tune the signal to the F_0 line on the CRT graticule, step SCAN WIDTH switch down to 10 kHz and set signal to the Reference Level on the graticule. When stepping down on the SCAN WIDTH switch, readjust the signal to the F_0 line $\pm$ 1/2 of one small division at each step, to prevent signal from being lost. For FM step the SCAN WIDTH switch down to MON FM or for AM step down to MON AM. Signal modulation will now be heard on the built-in speaker. The squelch turn on level is at the -50 dB graticule line.

Marker Usage

2.10 When it is desired to identify some point on a waveform display, connect the output of an accurately calibrated signal generator, such as the CE-6A to the FREQ CAL IN connector, observing the maximum level limitations. Adjust the signal generator level to provide a suitable marker and adjust frequency until the marker is at the point of interest. The frequency may now be read from the signal generator setting. A counter can be used to check the generator frequency if greater accuracy is desired.

Table 2-1. Controls, Indicators and Connectors

ITEM	DESCRIPTION	FUNCTION
INTENSITY	Potentiometer	Adjusts CRT grid bias to control trace brilliance.
FOCUS	Potentiometer	Adjusts CRT electrode potentials to control trace line thickness.
PWR/VOL	Switch/Potentiometer	Controls AC to power supply. Adjusts speaker amplifier gain.
SCAN WIDTH	Switch	Selects sweep rate and bandpass filters for optimum display.
CAL FREQ	Trimpot	Sets Fo CAL OUT reference frequency.
LEVEL	Trimpot	Sets level to CAL OUT reference level.
REFERENCE LEVEL	Switch	Controls Input Attenuator. Level relative to 0 dB Reference line on CRT graticule.
CENTER FREQUENCY F_0	LED Display	Indicates frequency in MHz to which RF circuits are tuned, refers to F_0 line on CRT graticule.
CRT Graticule	Plastic	Vertically 10 dB per division, horizontally according to setting of SCAN WIDTH switch.
TUNING, COARSE - FINE	Potentiometer	Coarse adjustment of first LO. Fine adjustment of first LO.
RF INPUT	BNC Connector	Input to RF attenuator. Contains RF fuse (F1001)
PROBE PWR	Pin jack	+10V DC at 0.1A for active probe.
FREQ CAL IN	BNC Connector	Input to Input attenuator through a 20 dB pad.
CAL OUT	BNC Connector	Frequency and Level reference for instrument calibration.
REAR PANEL		
DEMOD OUT	BNC Connector	FM/AM Demodulated output
2A	Fuse	Internal 10V DC supply
3A/12V DC	Fuse	External 12V DC supply
1/2A 115V AC 1/4A 230V AC	Fuse	External AC supply
	AC Connector	115/230V AC external supply
12V DC	Banana jacks	12V DC external supply

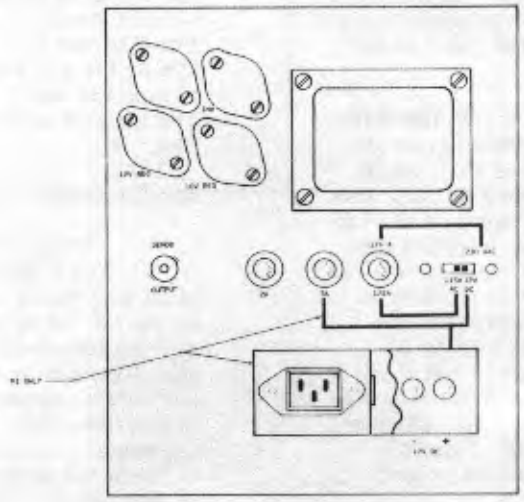

Figure 2-1. CE-15 Rear Panel

SERVICE OR REPAIR

2.11 In the event that factory service or repair is required, contact the Cushman Electronics Customer Service Department for further service information or to make arrangements for shipment to the factory or to a Service Center. The factory address is:

Cushman Electronics, Inc.
Customer Service Department
830 Stewart Drive
Sunnyvale, California 94086
Telephone: (408) 739-6760

2.12 Cushman Electronics repair service is also available at the following service centers:

Anderson Associates
204 Bedford Euless Road West/Suite H
Hurst, Texas 76053
Telephone: (817) 268-2327

B. C. S. Associates, Inc.
940 North Fern Creek Avenue
Orlando, Florida 32803
Telephone: (305) 896-4881

B. C. S Associates, Inc.
1310 Beaman Place
Greensboro, North Carolina 27408
Telephone: (919) 273-1918

Ossman Instruments Service Corp.
6666 Old Collamer Road
East Syracuse, New York 13057
Telephone: (315) 437-7245

Reshal Associates, Inc.
219 West University Drive
Arlington Heights, Illinois 60004
Telephone: (312) 398-7660

Tele-Radio
301 Supertest Road
Downsview P. O.
Toronto, Ontario, Canada M3J2M4
Telephone: (416) 661-3221

PREPARATION FOR SHIPMENT

2.13 It is recommended that the shipping box and foam packaging be kept in case it becomes necessary to ship the instrument to the service point or factory for service or repair. (Contact Cushman Electronics Customer Service Department before returning an instrument).

2.14 The following is a general guide for repackaging the instrument for shipment.

NOTE

If the instrument is to be shipped, attach a tag to the instrument identifying the owner and indicate the service or repair to be accomplished. Include the model number and full serial number of the instrument. In any correspondence, always identify the instrument by model number and serial number.

2.15 If the original container is to be used, proceed as follows:

a. Place the instrument in the original container. (If the original container is not available, one can be purchased from Cushman Electronics).

b. Make sure that the container is well sealed with strong tape.

2.16 If the original container is not used, proceed as follows:

a. Wrap the instrument in plastic or heavy paper before placing in an inner container.

b. Place the instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.

c. Mark the shipping container: "DELICATE ELECTRONIC INSTRUMENT", "FRAGILE".

OPERATION NOTES

1. For improved accuracy in setting the CAL FREQUENCY to the F_0 line, rotate the COARSE control fully CCW, then fully CW, then fully CCW, then to the CAL signal display. This removes slight hysteresis from the YIG oscillator.

2. If there is any doubt as to the location of the 189 MHz signal on the display, disconnect the CAL signal from the RF input. Rotate the CENTER FREQUENCY F_0 control toward zero frequency, until the L. O. signal appears. Set the SCAN WIDTH to 10 MHz and then set the L. O. signal exactly one division (10 MHz) to the left of the F_0 line on the graticule. Adjust the CAL FREQ control until the CENTER FREQUENCY F_0 display reads 010 MHz. Reconnect the CAL signal to the RF INPUT and rotate CENTER FREQUENCY F_0 control toward 189 MHz. The first signal that appears will be the 189 MHz CAL signal.

3. The red dot on the dial, with the red marked RF ATTENUATION dB ranges, indicates the amount of input RF Attenuation switched in. The -30 and -20 dBm REFERENCE LEVEL positions may be set for either 0 or 20 dB RF Attenuation and the -10 and 0 dBm positions for either 20 or 40 dB. If spurious signals due to high level overload are seen, they may be reduced or eliminated by switching to the same level with the increased RF Attenuation. To verify that spurious signals are generated externally, note that they remain at the same relative level when switching between two RF Attenuator positions, most desirably between -30, -30; -20, -20; etc. If there is a marked change, they are being generated in the Mixer due to interfering signal overload. (Increased IF gain is automatically switched in to compensate for the increased RF Attenuation).

K4XL's  BAMA

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