



Flagler County Emergency Services

147.300 Repeater Diagnostics

Date: 20-May-2010

Attendees:

- Phil McElrath (K5BBC)
- Robbie Creal (KG4HUF)
- Rick Reuther (KC2HFL)
- Mike Lee (WB6RTH)

- Bob Pickering (KB4RSY – EOC)

Scope of Work:

- Sweep Antenna and Feed line
- Sweep Wacom 4-Cavity duplexer, re-tune if necessary
- Check Yaesu 9000 Repeater
- Check all interconnecting cables – replace as necessary
- Test System

Equipment Used / Consumables:

- IFR-500 Service Monitor
- Anritsu Sitemaster S113 Transmission System Analyzer
- Rohde Schwarz FSH-313 Spectrum Analyzer
- Soldering Iron(s), miscellaneous hand tools

- UHF Connectors w/ RG8x collets (4 units)
- SO-239 to N-Female adapter
- BNC-M to SO-259 adapter
- 10' RG-142 Teflon, Double Shield Cable

Sweep Antenna and Feed line

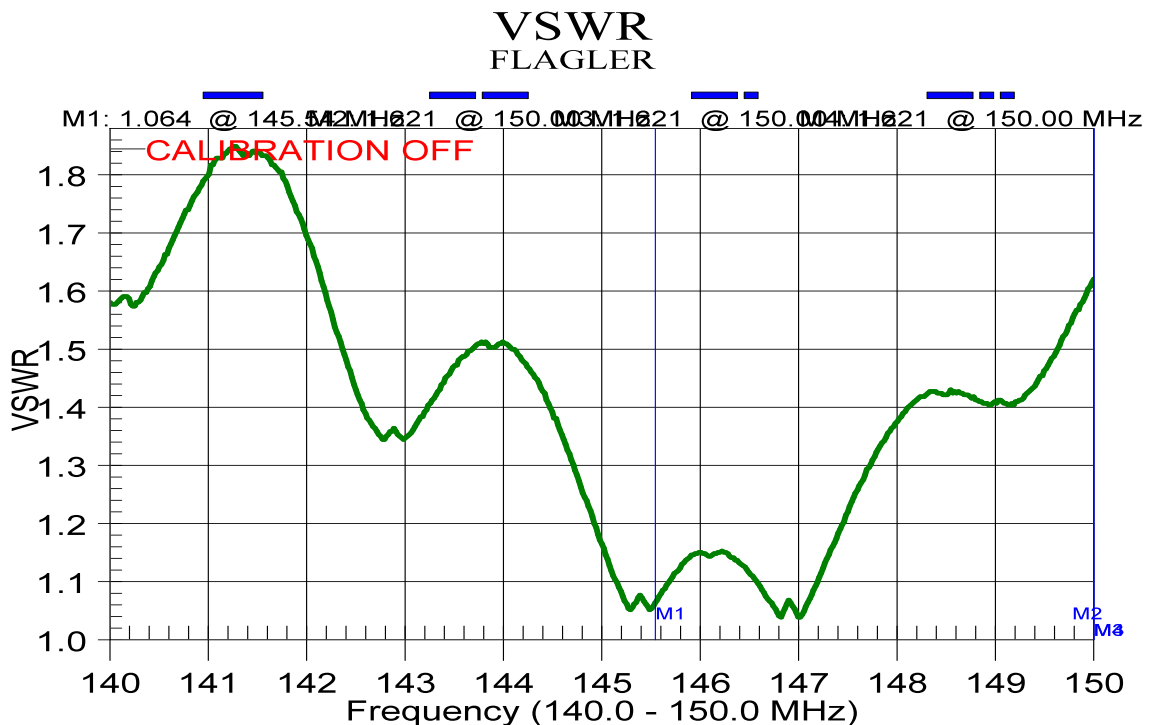
Protocol:

Antenna systems are swept with an Anritsu SiteMaster S113 at the termination of the Hardline (no jumpers). The Anritsu Sitemaster was used, although the S113 does not need to be calibrated for amateur use (only for Cell site certification).

Findings:

No anomalous results were observed. The antenna and feed line were found to be in good condition, with the following additional observations:

- Measured VSWR at the repeater operating frequency of 147.300 was 1:1.15, with marginally higher VSWR on the receiver input frequency of 147.900 of 1:1.39. Both values were within limits for use in the amateur band.
- Overall resonance of the antenna was well within the 144-148mhz Amateur Band with no VSWR exceeding 1:1.5.
- Usable range of the antenna was from 142.500 to 150.000 mhz with VSWR of less than 1:1.6



Resolution: 517
Date: 05/20/2010
Model: S113C

CAL: OFF
Time: 12:11:55
Serial #: 00147013

CW: OFF

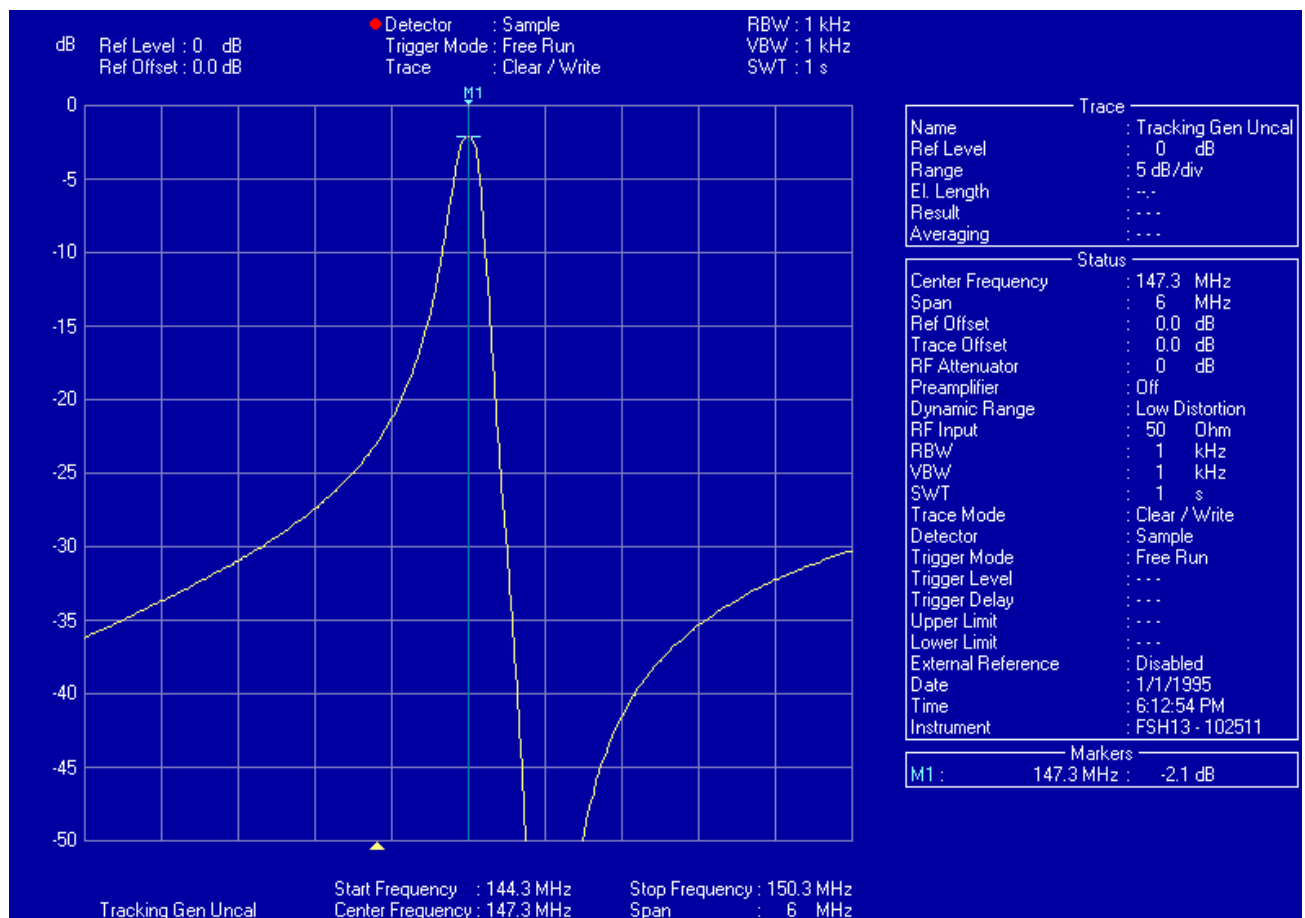
Wacom 4-Cavity duplexer

Protocol:

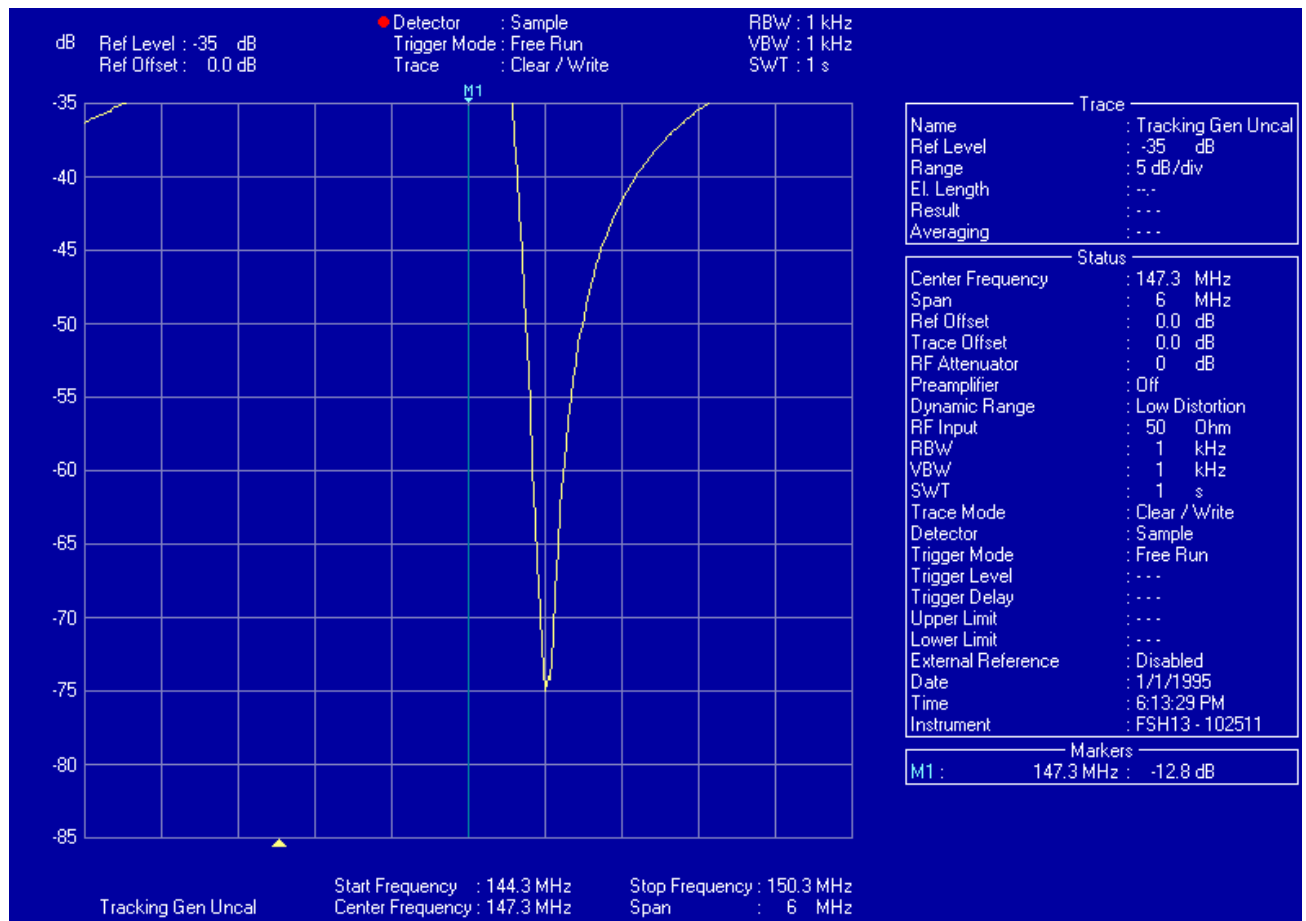
- Return Loss measurements were made on both LOW and HIGH side of the duplexer. All RL was below 24db, but was slightly off frequency (100khz).
- Frequency adjustment was made to center the maximum RL to the LOW and HIGH frequencies respectively.

Findings:

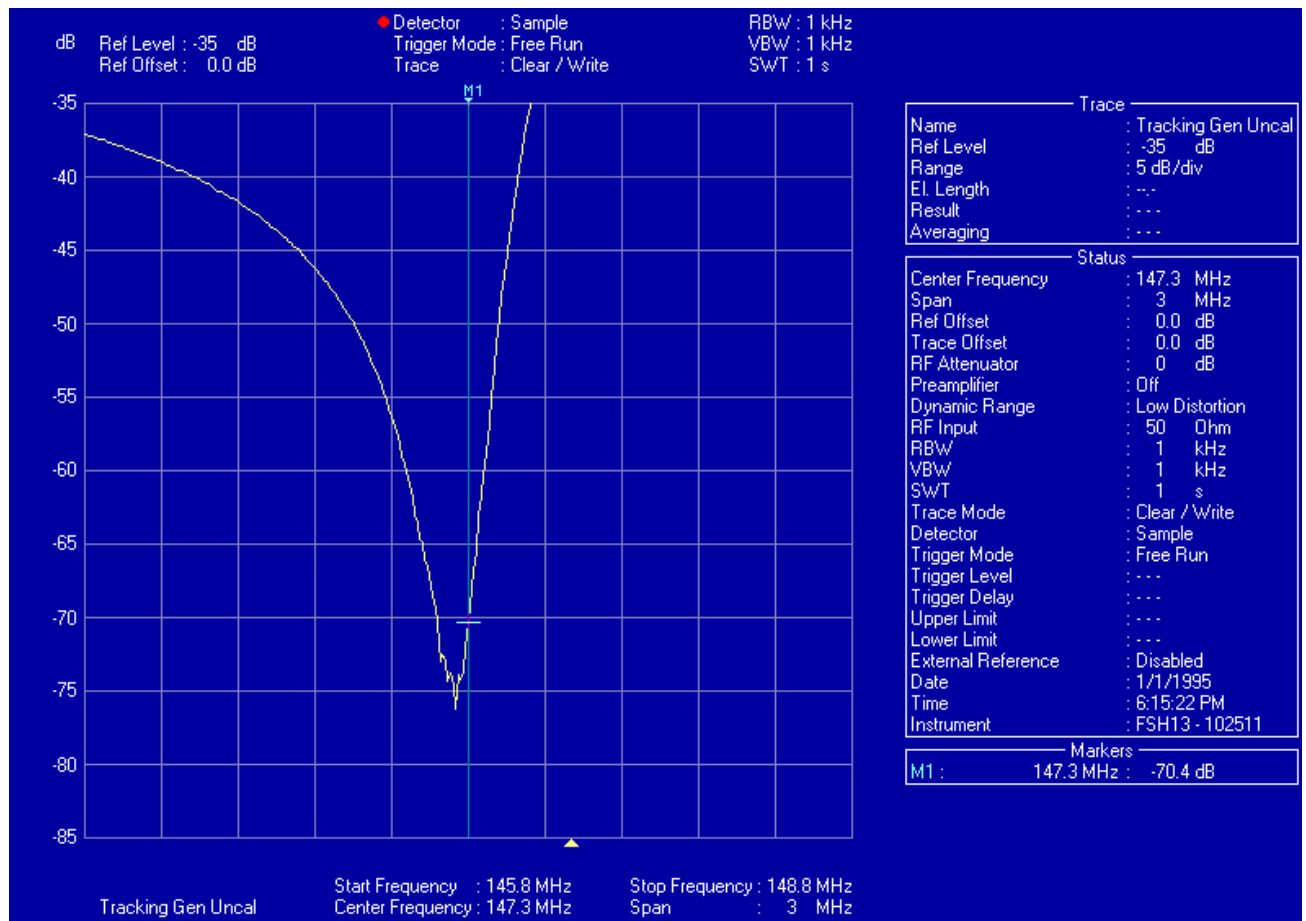
- The Wacom 4-cavity VHF duplexer was found to be **slightly off frequency** on both the LOW and HIGH sides when measuring Pass-Band.
- Notch frequencies on both sides of the duplexer were within acceptable limits. The details of the test results
- Sinclair Isolator was found to be ineffective (not tuned properly) in reducing adjacent signal into the receiver.



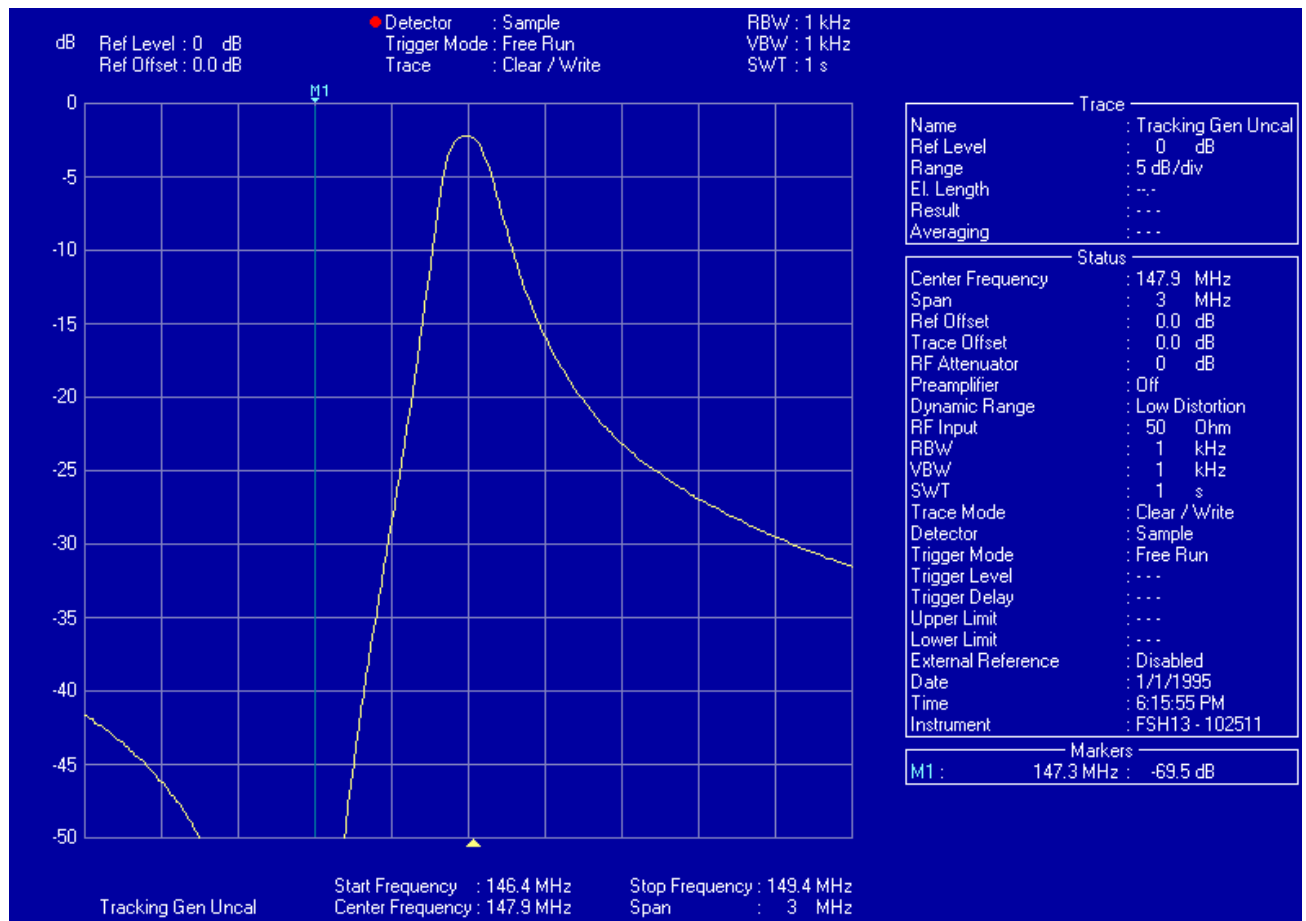
Transmit PASS at 147.300mhz , Insertion Loss of 2.1db,
Reject notch +600khz at 147.900mhz



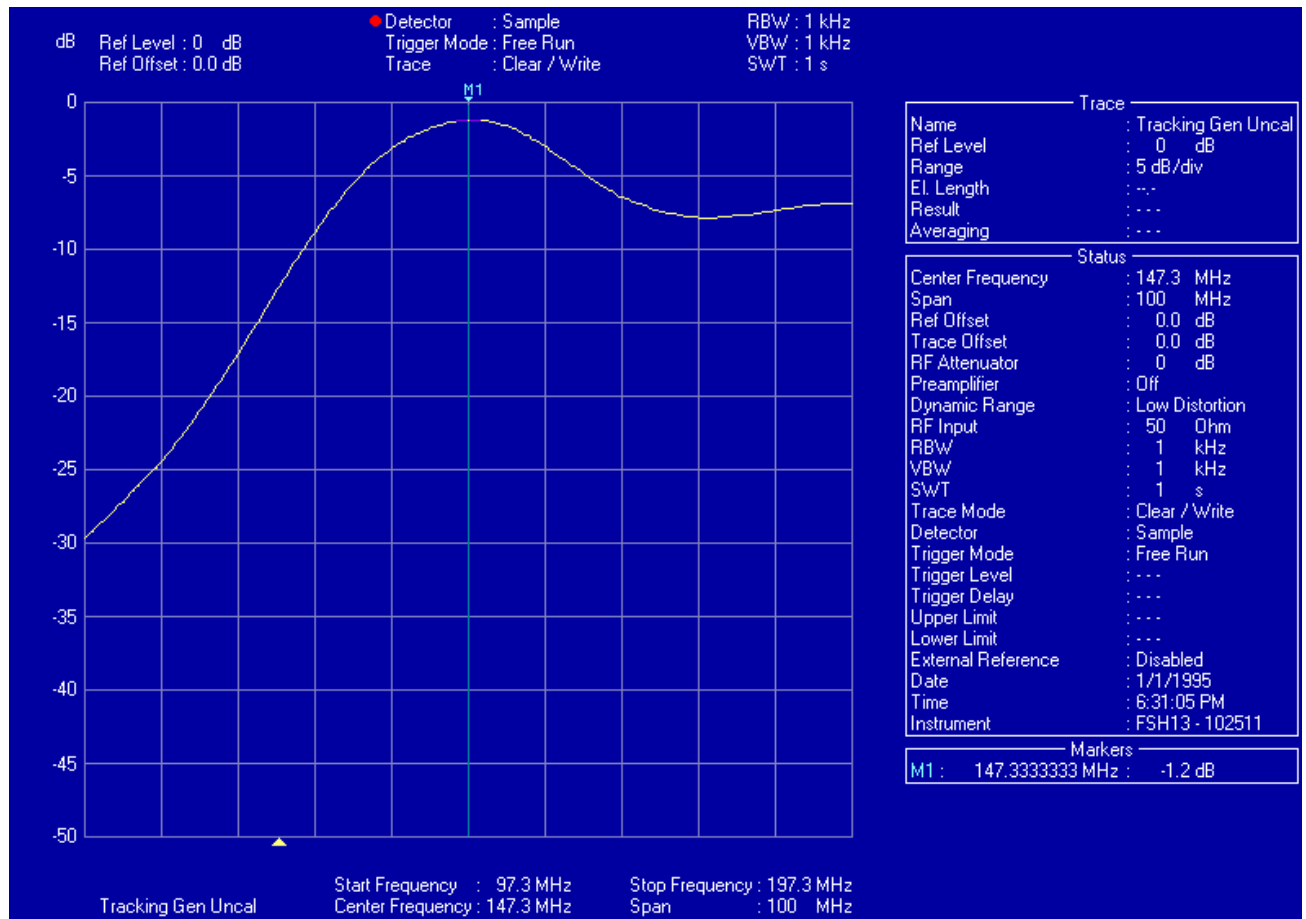
Reject NOTCH at 147.900mhz (Receiver side), overall performance of 128db



Old Reject NOTCH – off frequency at 147.270mhz (5db performance loss)



Receiver PASS Performance – 147.900mhz, insertion loss of 2.1db
 Transmit notch at 147.300mhz, reject performance of 69.5db



Pass Characteristics of Sinclair Ferrite Isolator

At 147.300mhz (Transmit Fx), provides only 1.2db of insertion loss – roll-off below transmit frequency of -17db at 30mhz BELOW Transmit (Taken offline, since it provides NO additional isolation)

Check Yaesu VXR-9000 Repeater

Protocol:

- IFR-500 connected to Receiver port, no speaker connection for SINAD measurement (approximate). 1khz Tone=ON, Variable Tone= 123hz (PL). Generator on calibrated IFR-500 incremented until a signal clarity of approximately 12db SINAD was reached. Resulting signal strength recorded.
- IFR-500 connected to Transmitter port. Repeater transmits on each of the available channels. Resulting transmit power output is recorded for each channel.

Findings:

- Receiver Sensitivity of **.35uv**, 1khz tone, 12db SINAD (approximate)
- Transmit Powers of :
 - Channel-1: **50w**
 - Channel-2: **25w**
 - Channel-3: **10w**
 - Frequency Accuracy within: 20hz at 147.300

Check Interconnecting Cables

Receiver to duplexer

Findings:

- Receiver jumper cable to Duplexer HIGH port was originally RG-58A/U. Although not a factor for attenuation at VHF, this cable only contains about 70% shield and will allow transmit power to “leak” into the receiver.

Resolution:

- Existing RG-58A/U cable (1/4”) was replaced with RG-142 (Silver, double-shield, 100% coverage) with PL-259 on both ends.
- SO-239 to BNC adapter was used on the repeater receiver port.

Transmitter to duplexer

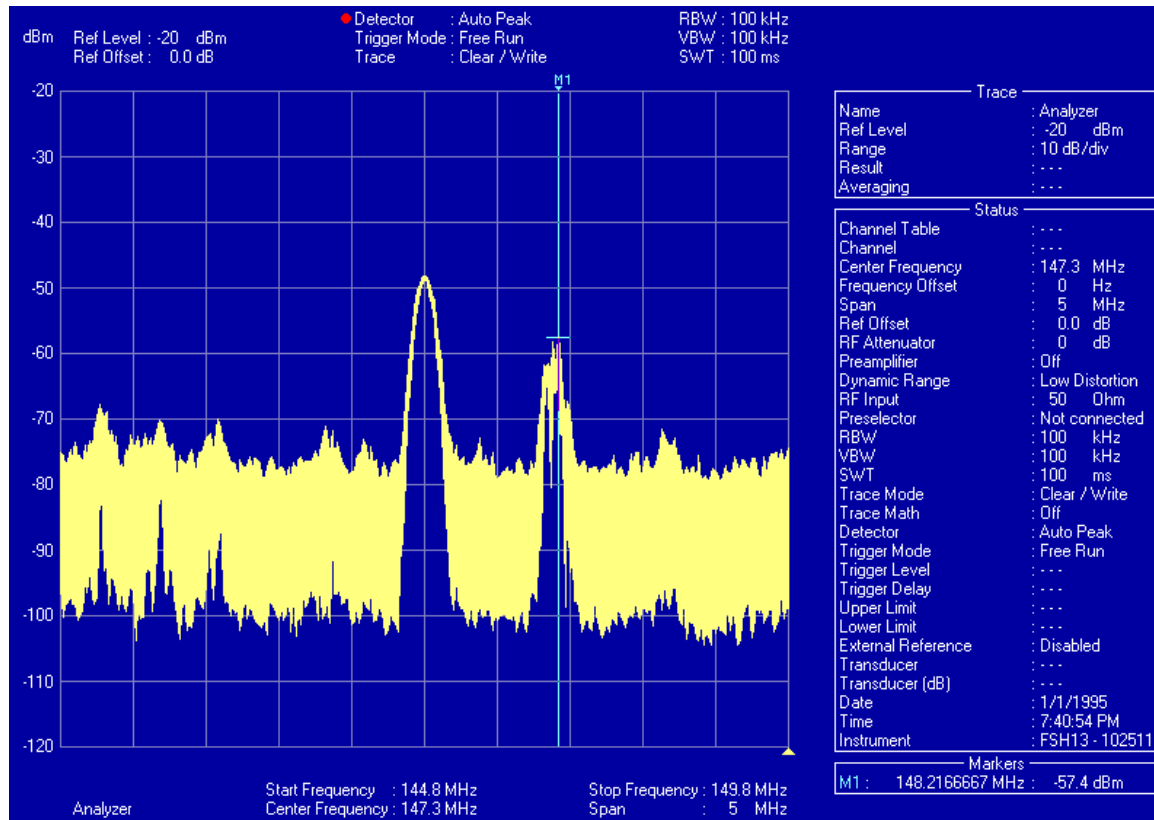
Findings:

- Transmit jumper cable to Duplexer LOW port was originally RG-8A/U. Although not a factor for attenuation at VHF, this cable only contains about 85% shield and will allow transmit power to “leak” into the surrounding area (not a factor if the receiver cable is 100% shield).

Resolution:

- Existing RG-8A/U cable (1/2”) was replaced with RG-142 (Silver, double-shield, 100% coverage) with PL-259 on both ends.
- SO-239 to N-Mail adapter was used on the repeater transmitter port.

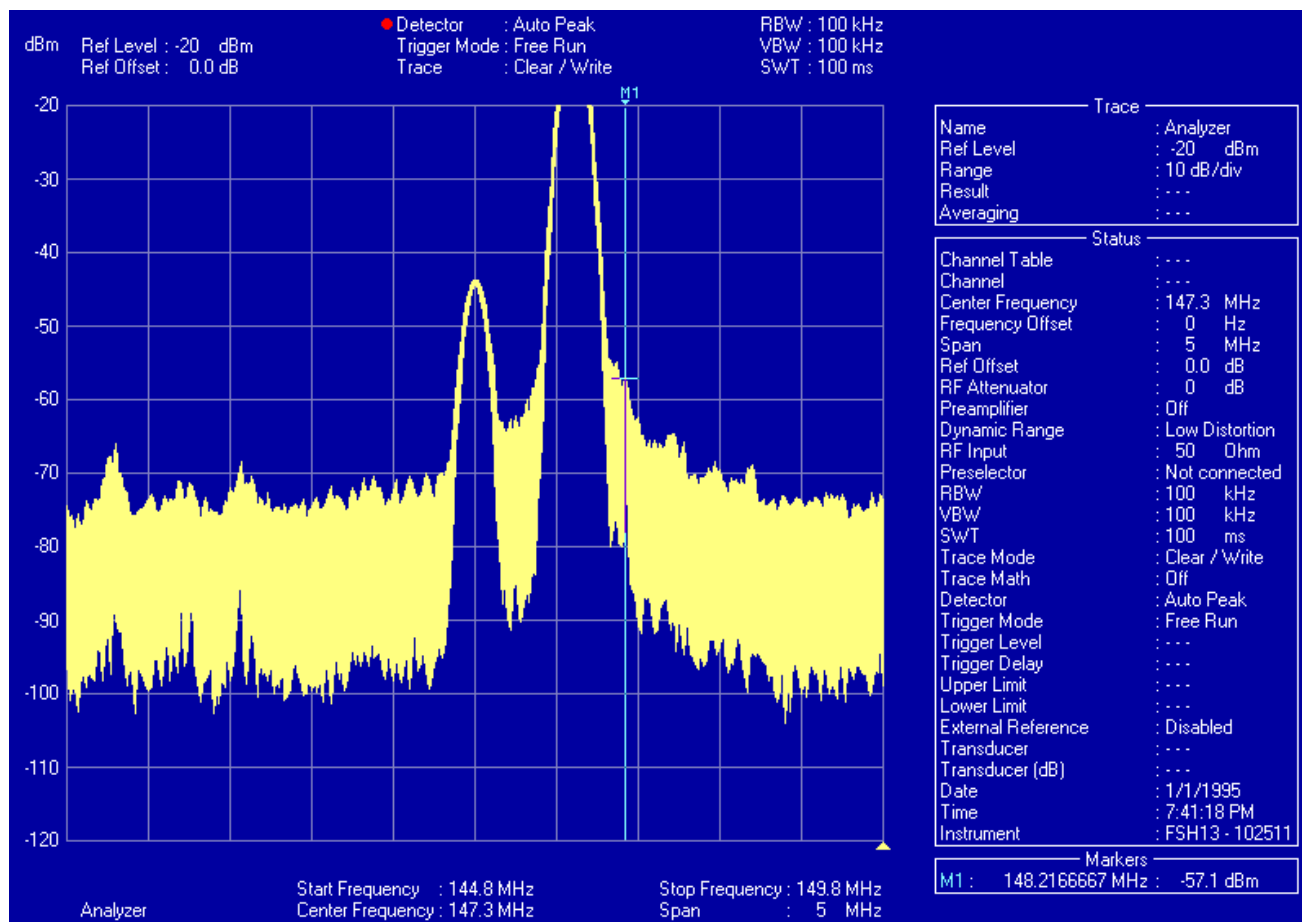
Test #1 – Near Channel Sweep with Spectrum Analyzer



A strong signal adjacent to the Amateur Band at approximately 148.22 was observed inside the room where the repeater is currently housed. Source of the signal is currently unknown, but it is possible that it is a signal-mix or intermodulation from various sources in the room. More research is required in order to isolate the source and to find a cure.

Undetermined as to whether the adjacent signal was present PRIOR to the VXR-9000 being powered-on. Need to test in the near future (see Action Items).

Test #2 – Intermod Sweep with Spectrum analyzer



The transmit signal is shown here at the middle (Vertical) line at a level of approximately -43dbm (over-the-air measurement). Adjacent (almost at the receiver input frequency) is a signal which is over -10dbm, or approximately 33dbm STRONGER than the repeater output (from within the room). This can only be possible if the signal is a mix with other signals within the radio room (VHF pager, other VHF signal, etc.). More research is necessary to isolate and cure the problem.

At the point, we know that the following are in good working-order:

- Antenna
- Feed line (both VSWR of better than 1:1.3)
- Duplexer (isolation better than 85db)
- Interconnecting cables (new, RG-142)
- Repeater Receiver (.35uv sensitivity)
- Repeater Transmitter (subject to additional testing)

Conclusions and Next Steps

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At the point, we know that the following are in good working-order:

- Antenna
- Feed line (both VSWR of better than 1:1.3)
- Duplexer (isolation better than 85db)
- Interconnecting cables (new, RG-142)
- Repeater Receiver (.35uv sensitivity)
- Repeater Transmitter (subject to additional testing)

Recommended Next Steps

Following are the recommended next-steps for resolving the problem with the 147.300 repeater system performance:

- Perform a Spectrum Sweep of the room, while the repeater is POWERED-OFF
 - If the adjacent frequency is still observed, then we know that there is a signal source from within the room (or outside) that is causing intermod or interference. Try Intermod Filter or Frequency Change (Below)
 - If the adjacent frequency is NOT observed, then there might be a mixing product inside the VXR-9000 that is not typical.
 - If intermod IS observed, test by replacing the VXR-9000 with a VXR-7000 tuned to the 147.300+ frequency.
 - If the problem persists, then we have intermod that might be mixing with the Local Oscillator in the VXR series of repeaters.
 - If the problem is resolved, there is likely a problem with the Local Oscillator missing in the VXR-9000 repeater.
- Add an Intermod Filter to the Repeater Receiver
 - Add a DCI Systems Filter (Model 146-4H) which will eliminate any out-of-band signals above 148mhz. This may not be sufficient to kill the signal at 148.22, since the skirts of the filter are only about 6db down at 149.000mhz.
- If none of the above appears to resolve the problem, we may need to request a frequency change to a frequency which does not cause harmful mixing products to the receiver input