

**Radiated RFI Emission Tests of the Motorola 162.025 MHz Radios Currently used at the VLA and of the Kenwood 410.55/419.55 MHz Radios Proposed as a Replacement**

To: J. Ulvestad, C. Janes, B. Broilo, G. Mauger, D. Mertely, C. Carilli

From: Raul Armendariz

**Summary:**

The VLA is considering replacing the current Motorola 162.025 MHz communication radios with the Kenwood 410.55/419.55 MHz radio/repeater system for improved coverage, reliability, convenience, safety, and emergency services. RFI comparison tests of both systems were conducted in L-band, C-band, and X-band. The current Motorola system had more harmonic and harmonic-sideband RFI emissions than the proposed Kenwood system. Differences in harmonic power levels were insignificant: the current Motorola radios were 7 dB stronger in L-band and 10 dB weaker in C-band than the Kenwood mobile unit. Results are below.

<u>VLA Band</u>	<u>Current Motorola</u>	<u>Proposed Kenwood</u>
L: Full: 1340-1730 MHz Standard: 1360-1490 MHz	10 RFI spikes 5 RFI spikes	2 RFI spikes Nothing detected
C: Full: 4.5-5.0 GHz Standard: 4.81-4.91 GHz	9 RFI spikes 3 RFI spikes	3 RFI spikes Nothing detected
X: Full: 8.0-8.8 GHz Standard: 8.41-8.51 GHz	Nothing detected Nothing detected	Nothing detected Nothing detected

### **Repeater information:**

Results presented here for the Kenwood system include one handheld unit and one mobile unit. The Kenwood repeater was tested 2 weeks prior with un-terminated transmit and receive antenna ports. The strength of C-band harmonic emissions were found to be approximately the same as those for the Kenwood mobile radio; the strength of L-band harmonic emissions were found to be approximately 15 dB stronger than those from the Kenwood mobile radio.

### **Equipment setup:**

R. Armendariz, B. Broilo, and G. Mauger performed open field tests at the VLA on June 12, 2001. The VLA antennas and electronics were not used in gathering this data. The two radio systems were tested side by side with the detection antenna placed at a distance of 10 meters. The radios were elevated at an approximate height of 1m above the floor and radio antennas oriented vertically. The detection antenna was elevated at a height of 1m above the floor, oriented in cross polarization, pointed westward, and line of sight to the radios and radio antennas. The same detection equipment was used and under an identical setup while testing both radio systems. No amplifier was used in L-band, and a 36 dB gain 4-10 GHz LNA was used for C and X bands at the output of the detection antenna. Baselines were obtained with both radio systems turned off in L, C, and X bands and little or no ambient RFI was detected. L-band and C-band calibration signals were transmitted at a distance of 10m and proper operation of all equipment was confirmed. The sweeping spectrum analyzer was operated in rms max-hold mode with at least 5 sweeps per band. The handsets and mobile units were keyed sequentially with voice communication and emissions from all units presented on the same plot for each given band. No external harmonic filters were used on the radios or repeater during any testing.

### **Equipment list:**

W.J. L.P. 1-18 GHz antenna (detection antenna), AR7-18, S/N 007  
AEL 1-2.5 GHz horn antenna (transmit calibration signal), H5001, S/N 167  
AEL 2-5 GHz horn antenna (transmit calibration signal), H5101, S/N 192  
Spectrum Analyzer, Agilent 8563EC S/N 06487  
Plotter, H.P.  
15 VDC Linear Power Supply  
Signal Generator, Gigatronics 1026 S/N 283502  
Amplifier: Aydin 4-10 GHz, 36 dB gain, S/N 10791  
Cables: 1 13-foot RG223/U cable used between antenna and S.A. (tested).  
1 14-foot RG 233 cable used between calibration signal generator and horns (tested).

## **Radios tested:**

### **Motorola**

Handsets: HT90 H33HMU1124AN and P50 H43GNU6120AN

Power: 5W

Frequency: transmit/receive 162.025 MHz

Bandwidth 25 kHz

Antenna: manufacturer supplied rubber ducky

Mobile (vehicle) unit: Maxar D23TRA1000BX

Power: 18W

Frequency: transmit/receive: 162.025 MHz

Bandwidth: 25 kHz

Antenna: ¼ wave whip

### **Kenwood**

Handset: TK-360G-4 UHF FM transceiver, S/N 20900020

Power: 3.5W

Frequency: transmit: 410.55 MHz, receive: 419.55 MHz

Bandwidth: 12.5 kHz

Antenna: manufacturer supplied rubber ducky

Mobile (vehicle) unit: TK-880 UHF FM transceiver, S/N 20702597

Power: 25W

Frequency: transmit 419.55 MHz, receive: 410.55 MHz

Bandwidth: 12.5 kHz

Antenna: ¼ wave whip

Repeater: TKR-820 type 4

Power: 20W

Frequency: transmit 419.55 MHz, receive: 410.55 MHz

Bandwidth: 12.5 kHz

Filter: 5<sup>th</sup> order Butterworth, > 70 dB harmonic attenuation.

Antenna: no antenna used on repeater transmit or receive ports during tests.

Actual antenna planned for use on VLA barn: type DB420, max lobe 10.4 dBi gain directed SW and SE at +120 and +240 degrees from true North.

6/12/01

# PLOT 1: L-BAND Current RADIOS (162.025 MHz)

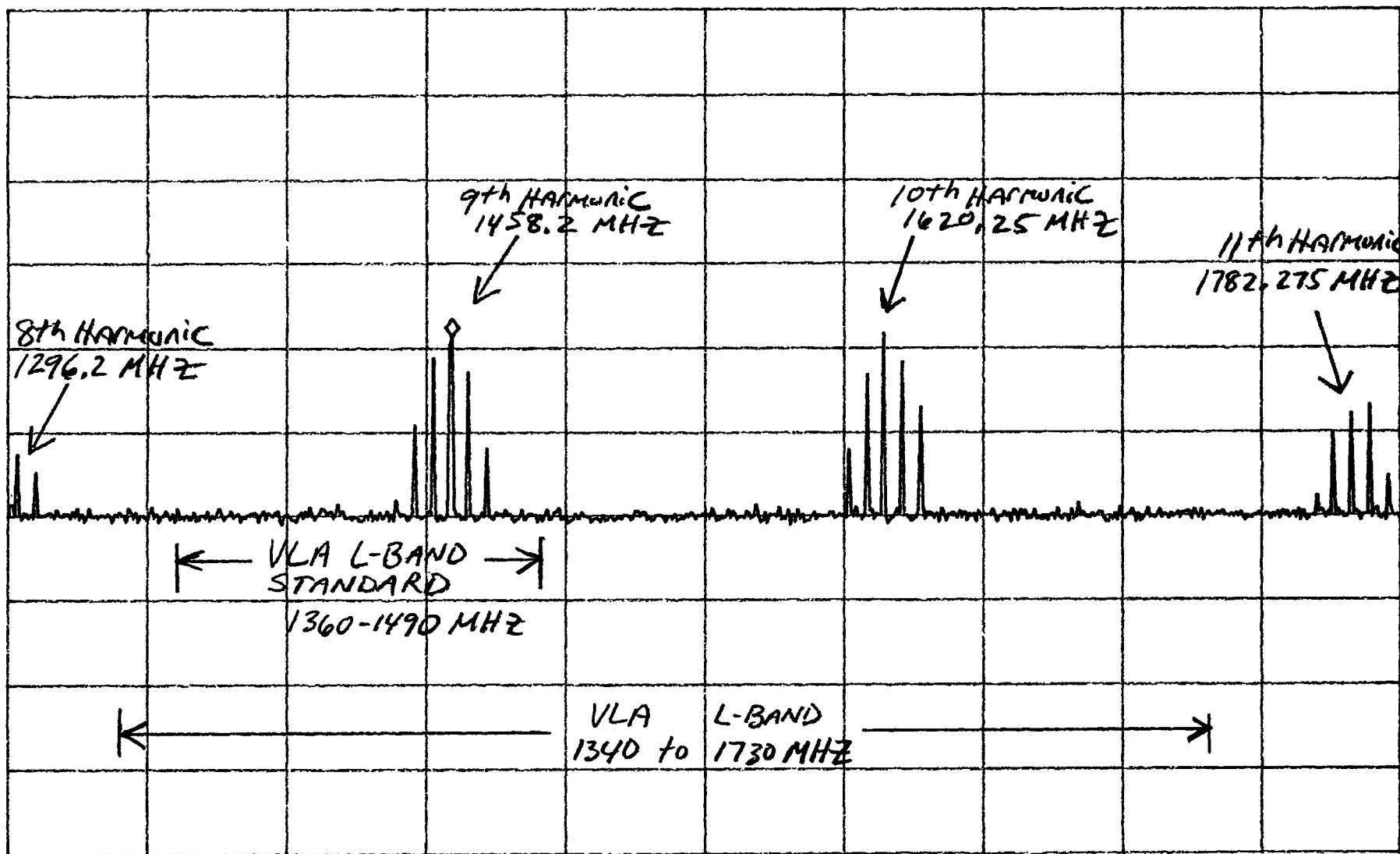
\*ATTEN 0dB

MKR -78.50dBm

RL -40.0dBm

10dB/

1.4592GHz



CENTER 1.5500GHz

SPAN 500.0MHz

\*RBW 10kHz

VBW 10kHz

SWP 13.0sec

CURRENT MOTOROLA RADIOS: MAXAR, HT90, AND P50.

6/12/01

# PLOT 2: L-BAND NEW RADIOS (410.55 MHz / 419.55 MHz)

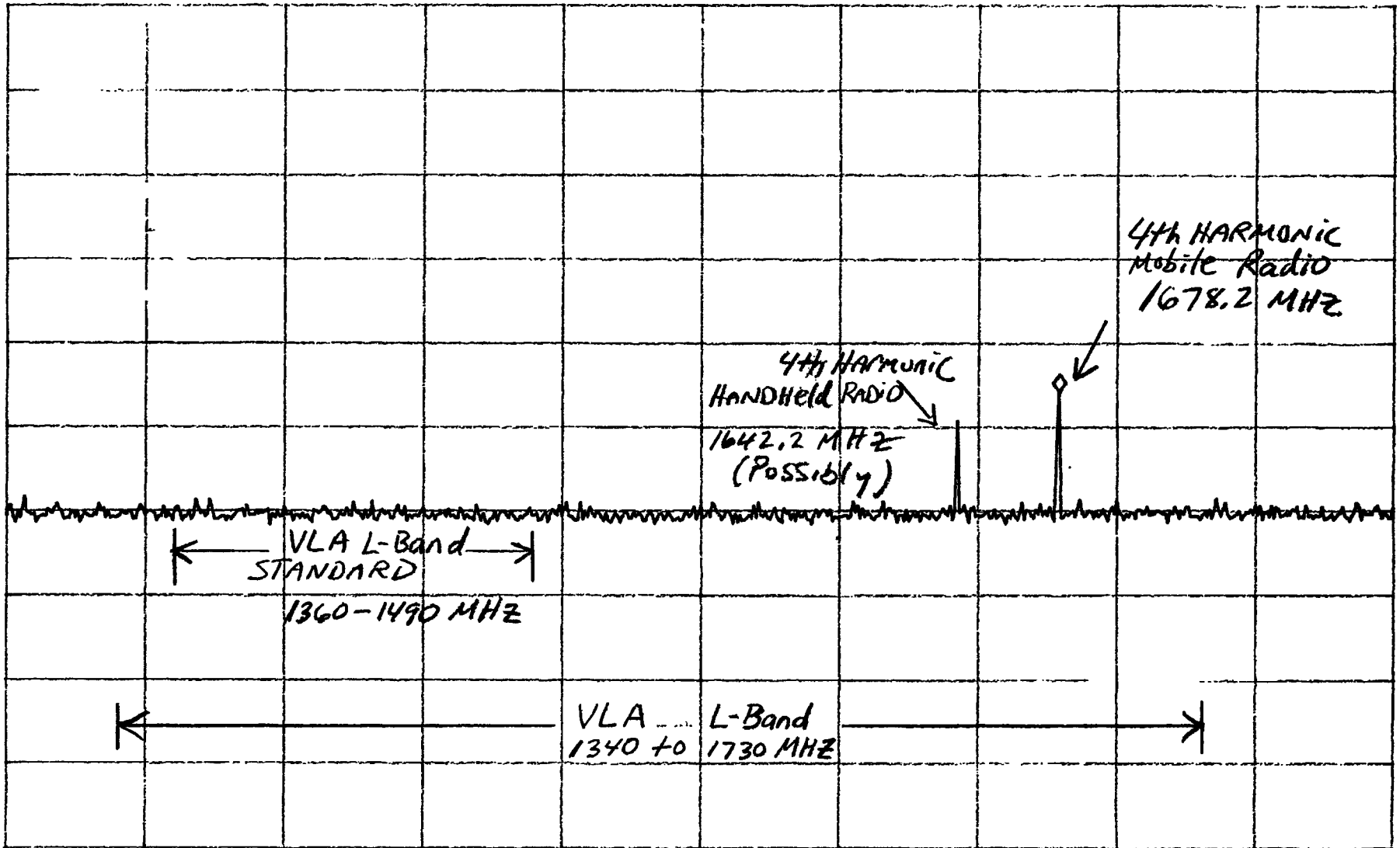
\*ATTEN 0dB

MKR -85.67dBm

RL -40.0dBm

10dB/

1.6792GHz



CENTER 1.5500GHz

SPAN 500.0MHz

\*RBW 10kHz

VBW 10kHz

SWP 13.0sec

PROPOSED Kenwood Radios: TK-880 AND TK-360 G

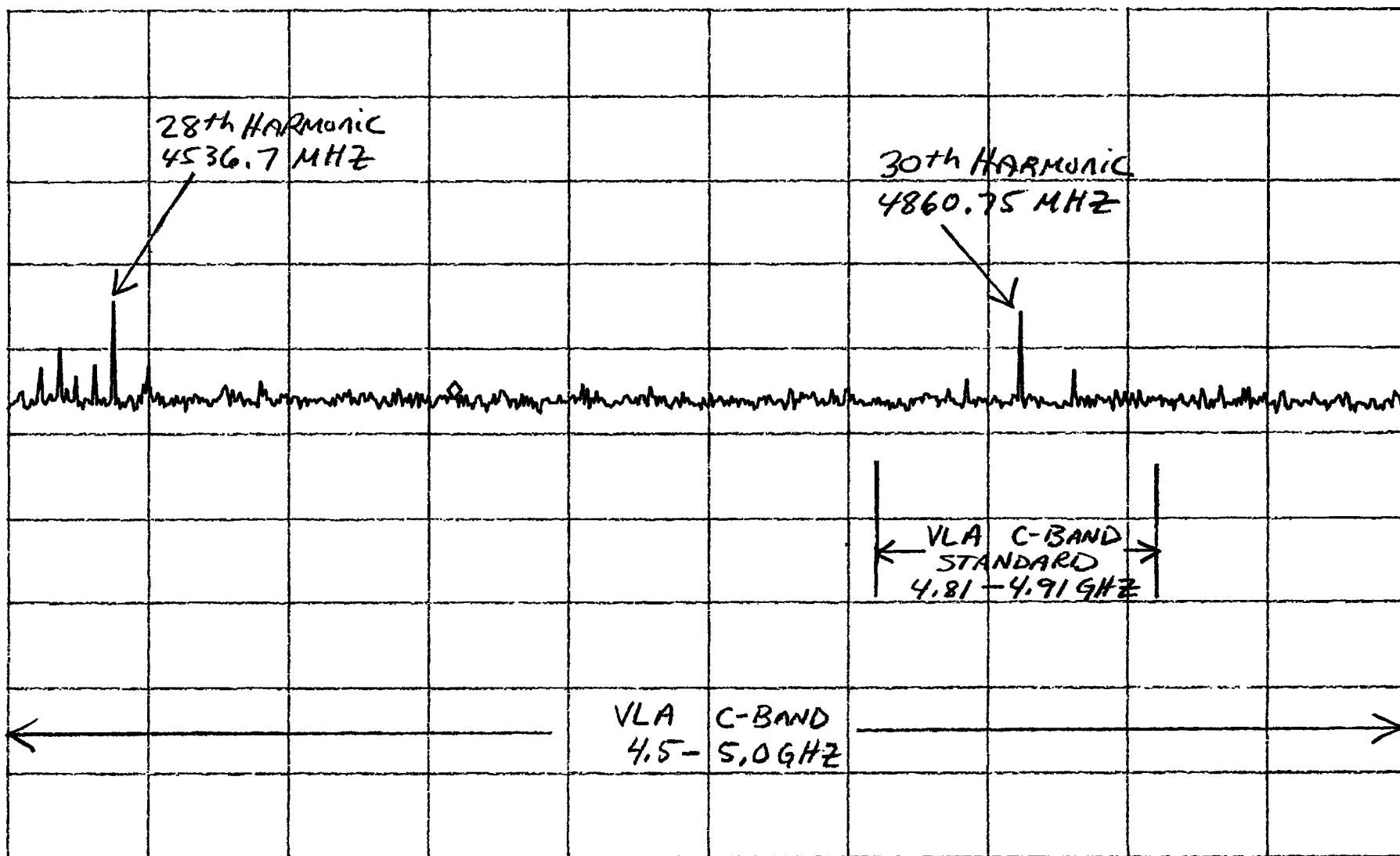
6/12/01

# PLOT 3: C-BAND CURRENT RADIOS (162.025 MHz)

ATTEN 10dB  
RL -40.0dBm

10dB/

MKR -85.83dBm  
4.6592GHz



CENTER 4.7500GHz

SPAN 500.0MHz

\*RBW 10kHz

VBW 10kHz

SWP 13.0sec

CURRENT MOTOROLA RADIOS: MAKAR, HT90, AND P50

6/12/01

# PLOT 4: C-BAND New Radios (410.55 MHz / 419.55 MHz)

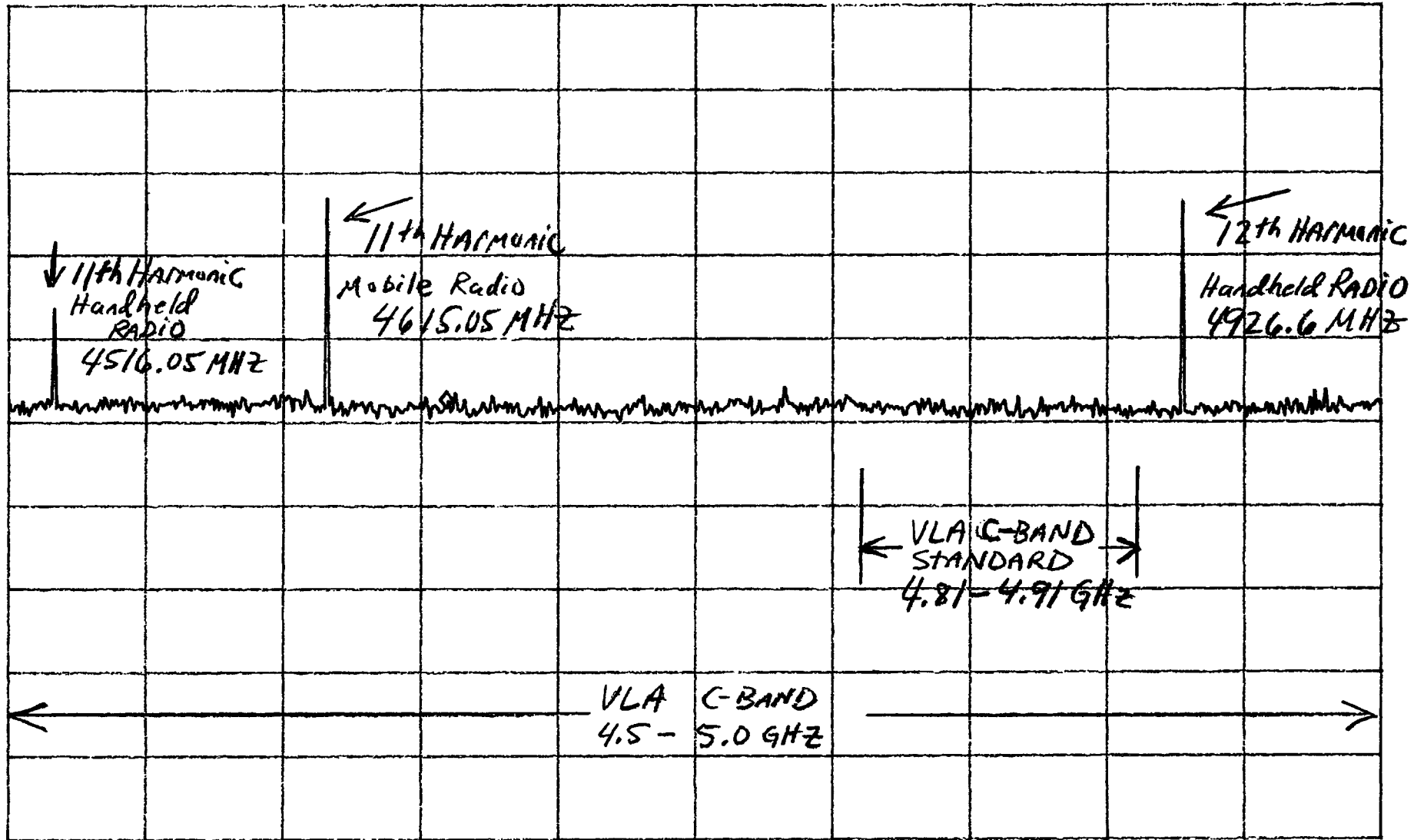
\*ATTEN 0dB

MKR -88.17dBm

RL -40.0dBm

10dB/

4.6592GHz



CENTER 4.7500GHz

SPAN 500.0MHz

\*RBW 10kHz

VBW 10kHz

SWP 13.0sec

PROPOSED KENWOOD RADIOS; TK-880 AND TK-3609

6/12/01

# PLOTS: X-BAND New RADIOS (410.55 MHz / 419.55 MHz)

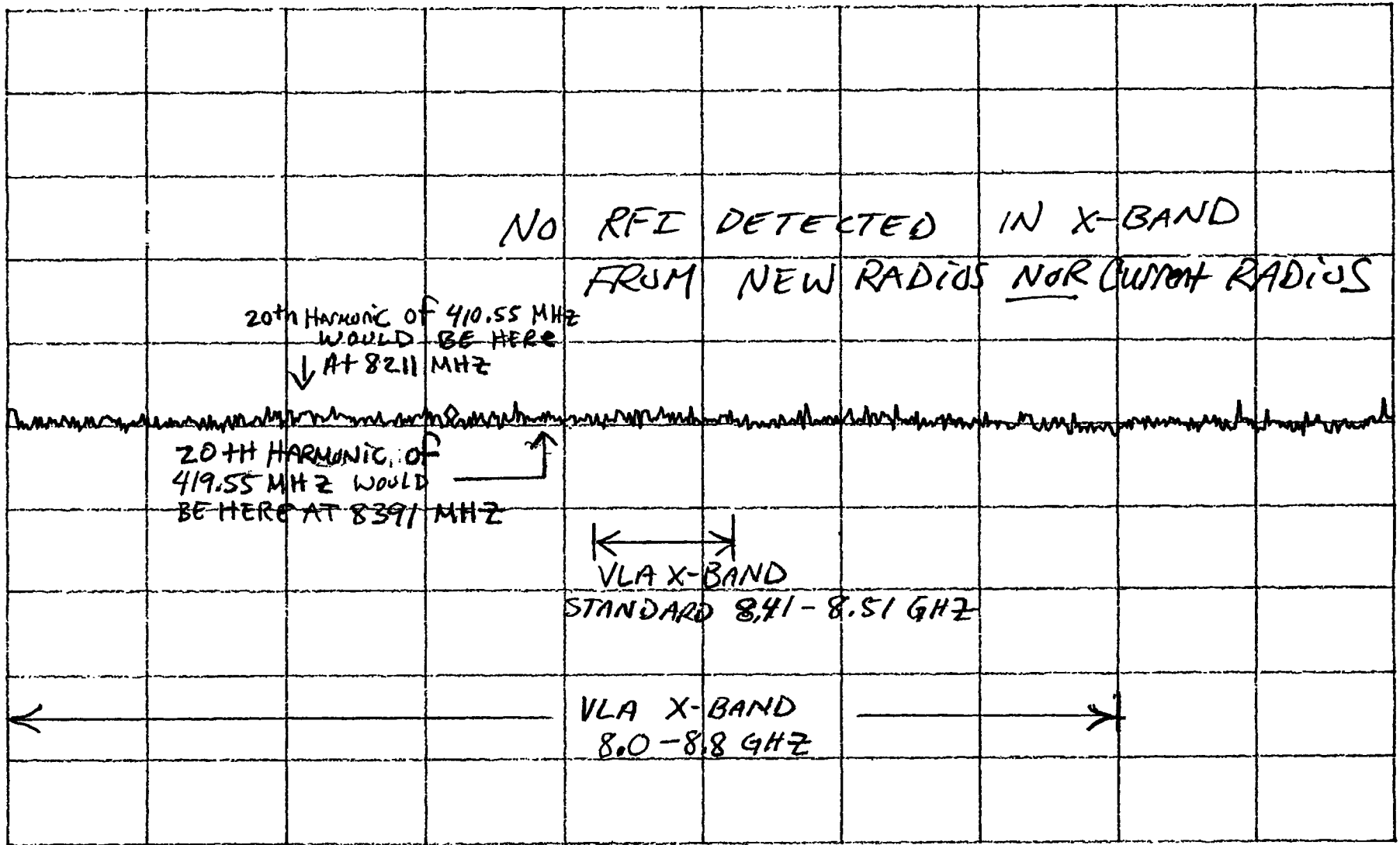
\*ATTEN 0dB

MKR -89.50dBm

RL -40.0dBm

10dB/

8.318GHz



CENTER 8.500GHz

SPAN 1.000GHz

\*RBW 10kHz

VBW 10kHz

SWP 25.0sec

PROPOSED KENWOOD RADIOS: TK-880 AND TK-360 G