

0.0

0.0 FREEWAVE Radios:

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0.1 Frequency Spectrum:

The Freewave radios are Line-of-Sight UHF frequency hopping transceivers that operate in the FCC unlicensed band from 902-928Mhz. Frequency hopping occurs at about 30ms (50-130 hz) and the BandWidth of each bin is 230.4kHz.

The frequency hopping within this band can be restricted to help minimize potential interference with other equipment. For NCAR-PAM, the frequency hop table is 'notched' from 908-922Mhz to avoid the TEP profiler of the U.of Mass. during CASES-99. Tests performed 12/21/00 with Jim Jordan of ETL revealed that this notching will not cause problems with the 915 profilers, however the slightly smaller "911-918" notch will cause some degradation by raising the noise floor in the profiler's receive band.

Note that FCC regulations require the radios use at least 50 channels for a total of 11.5 MHz utilization within the 902-928 range. Note that using a larger portion of the spectrum improves radio performance.

0.2 Reprogramming the Frequency Hopping Table:

A specific jump table can be selected using the transmission characteristics command menu, Frequency Key. This is done primarily to select the occupied band within 902-928Mhz and to help multiple pairs of radios avoid hopping into the same frequency bins simultaneously.

3) Radio Transmission Characteristics:

(0) FreqKey

Enter New Frequency Key (0-E) (F for more) f

Hop Table Parameters

(0) Hop Table Version 5

(1) Hop Table Size 112

(2) Hop Freq Offset 0

(Esc) Exit to Radio Menu
Enter Choice 0
Enter HopTable to Use (0-6)5

The choices are:

0=Standard	= 902-928 Mhz
1=Australia	= Mhz
2=International	= Mhz
3=Taiwan	= 916-920 Mhz
4=New Zealand	= 921-928 Mhz
5=NCAR Table-1	= 902-913, 918-928 Mhz
6=Brazil	= 902-915 Mhz
Not shown:	
0/F= NCAR Table-2	= 902-908.2, 921.8-928 Mhz

The 'NCAR Table-2 (avoiding 908-922Mhz) is used for normal SSSF operations. It is not one of the choices above and requires a special sequence. *To Program the NCAR-2 Wide-Hop Table (908-922)*: Use the following setup sequence:

'3'	Radio Transmission Characteristics
'0'	Freq. key
'F'	Other options
'0'	Hop table 0 Select this Option!
'112'	Hop table size
'0'	Hop Freq. offset
'F'	Then select Freq. key 15 and wider hop table

When using the 908-922 avoid table, the setup menu banner will say it is using the 'standard table'.

Shown Below: Figures 1 and 2 below are plots of the radio spectral occupation using NCAR Table-1 and NCAR Table-2. Figures 3-8 show the radio spectral occupation of the other options.

0.3 Frequency Key Usage / Avoiding Conflict between Radios:

Normally the frequency key is used to help multiple pairs of radios avoid hopping into the same frequency bins; each pair uses a different sequence. However, because the freq. key must be set to 15 to use the 908-922 avoid table a different technique is used to avoid conflicts between multiple master/slaves. Instead of using a different freq keys, use different min/max packet sizes. That essentially changes the timing of the radios so that they will 'precess' and not interfere while stepping through the same hop sequences. I.e. 1 pair set up for 8,9; another pair set up for 7,8; or some such different settings between them. *Also note, for continuous data, the best settings are 0,0 for min,max packet sizes.*

0.4 Interference:

Interference can effect the radio's performance. The 915Mhz profilers have not adversely effected Freewave communications, however, cellular telephones in the 890/935 Mhz bands can be a problem as observed by other Freewave users. These frequencies can be notched out by a conventional front-end filter. Freewave sells these filters and can customize them for specific interference outside

Figure 4) Occupied Spectrum, Brazil Table

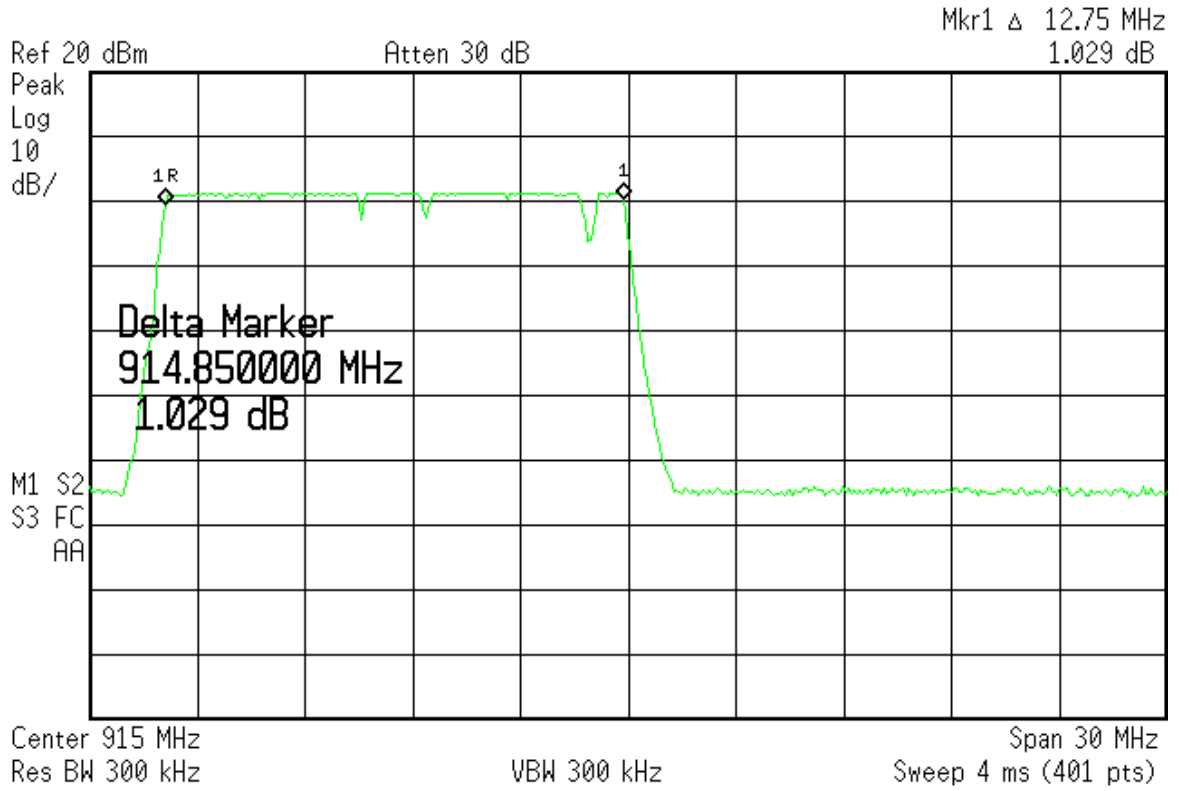


Figure 5) Occupied Spectrum, International Table

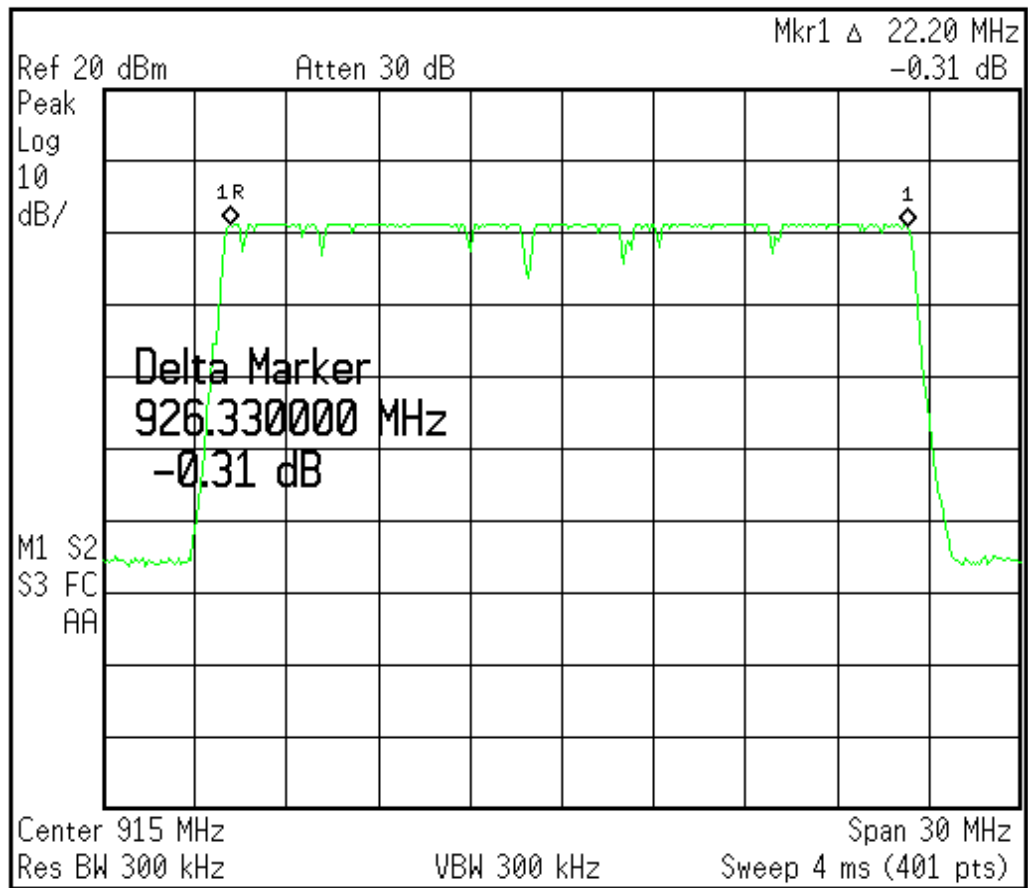


Figure 6) Occupied Spectrum, New Zealand Table

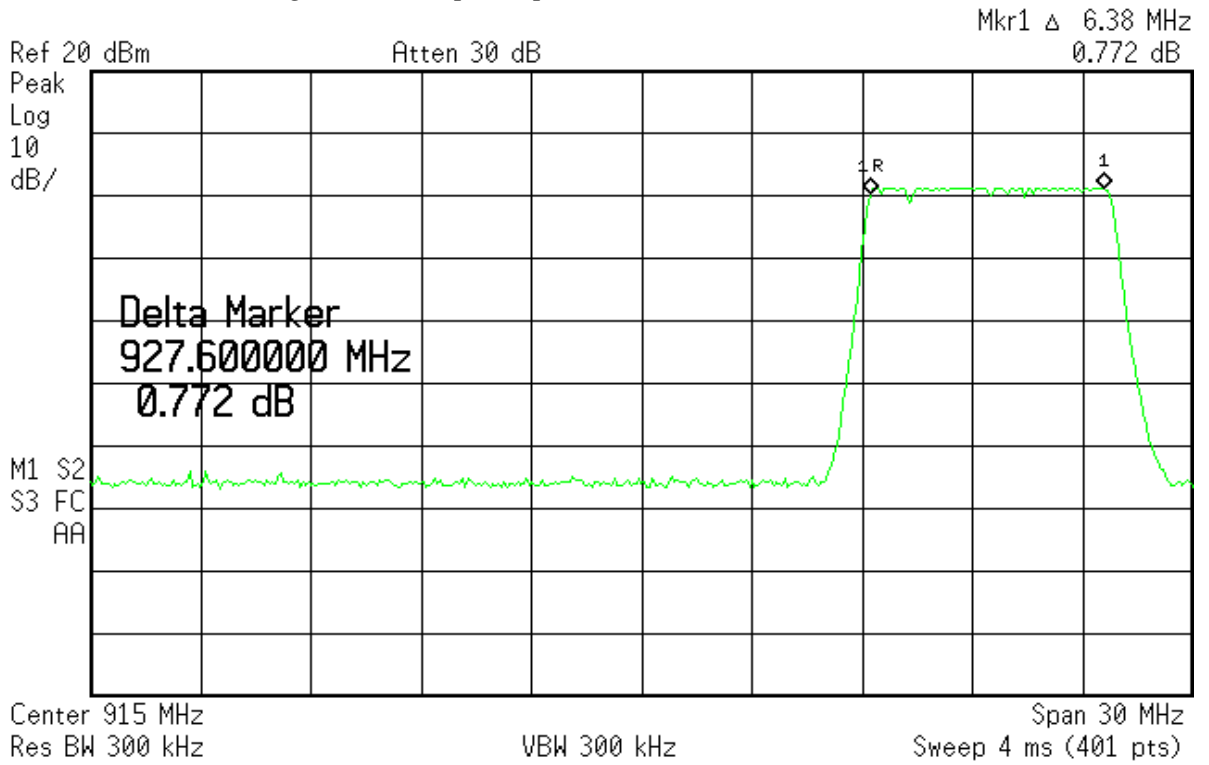


Figure 7) Occupied Spectrum, Standard Table

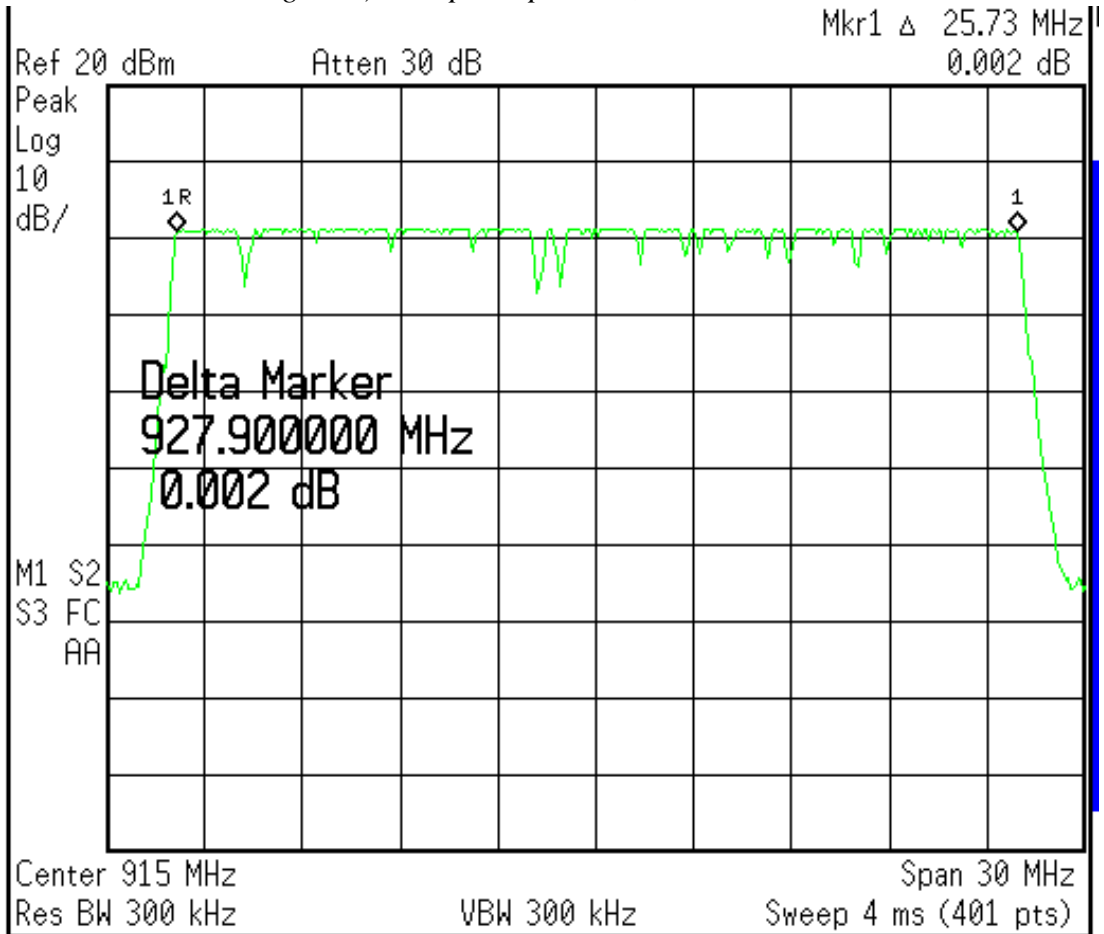
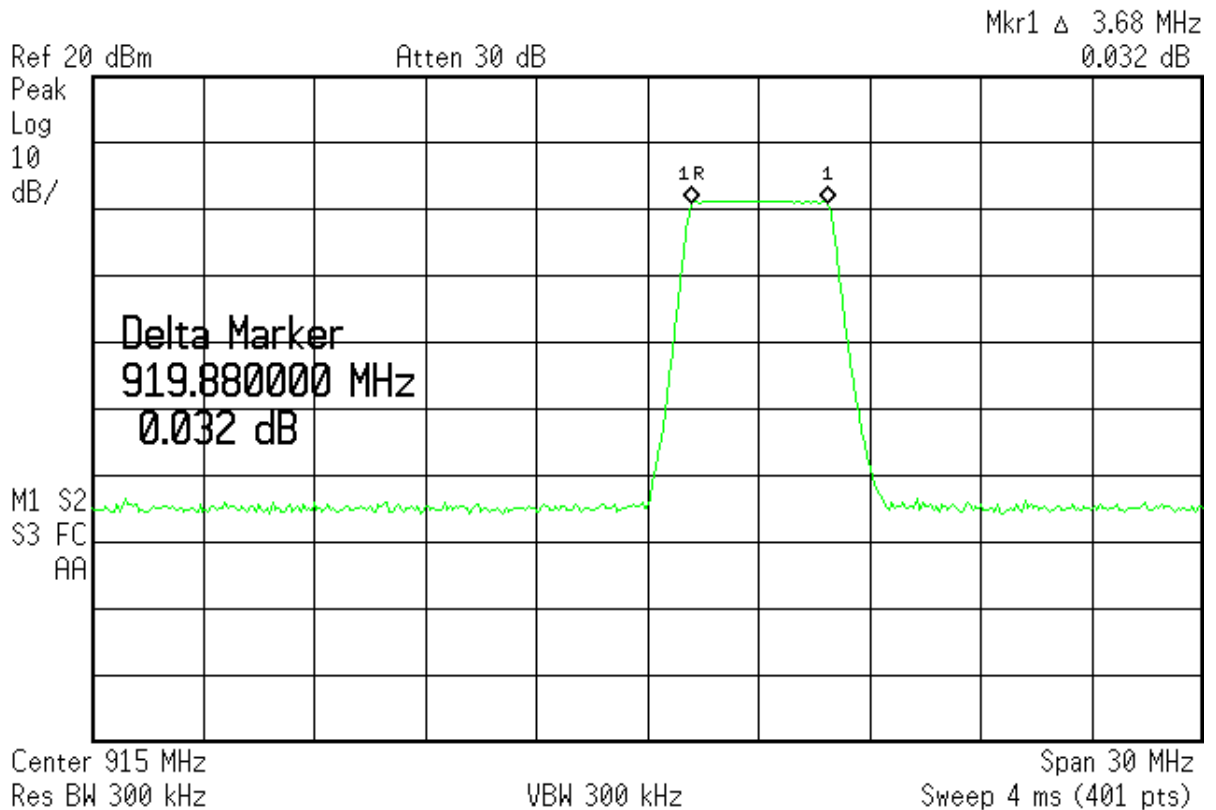


Figure 8) Occupied Spectrum, Taiwan Table



0.6 RF Power:

RF Power Output is normally 1/3W. During transmit the draw is 700mA (for either the 900 or 2.4Ghz units). In practise with handshaking, throughput, etc. the median 'continuous' power consumption would be about 350mA (115kB) or about 200mA (19.2kB). Freewave can reprogram the transmitters to output 1W (30dbm) but in effect this is never done.

Per FCC requirements, Freewave tunes each radio for the antenna and cable for which it is intended. This means individual radios will have slightly different power output levels which could cause some problems if antennas and cables are mis-matched.

Note: A Point-to-Point slave will not startup RF output until its 'Master' is linked up and downloads the configuration parameters to it.

Each radio can be reprogrammed for to edit the Radio Transmission Characteristics, RF Xmit Power between a level from 0-9. These levels are used primarily to keep from over-saturating the transceivers while in the near field from each other during checkout. The power output levels are not linear. Figures 3-6 show the levels recorded for one radio in June 2000. Approximate maximum-hold output levels recorded by Spectrum Analyzer (3/29/97) are noted below but these are lower than levels measured in June 2000. The difference is probably that all radios have had newer software and some electronics since 1997.

Nominal RF Power Output for the 'Radio Transmit Parameters' settings:

Pwr Setting	0	5	9	Hopping-Range
3/1997 dbm range	12-15	20-24	23.5-27	921-928
6/2000 dbm range	-7 to -9	25-26	30-31	

Attenuation of the signals was relatively sharp: 1-Mhz out-of-band the signals were down ~4-6db, and 2-Mhz out they were attenuated ~14-16db.

Figure 3)

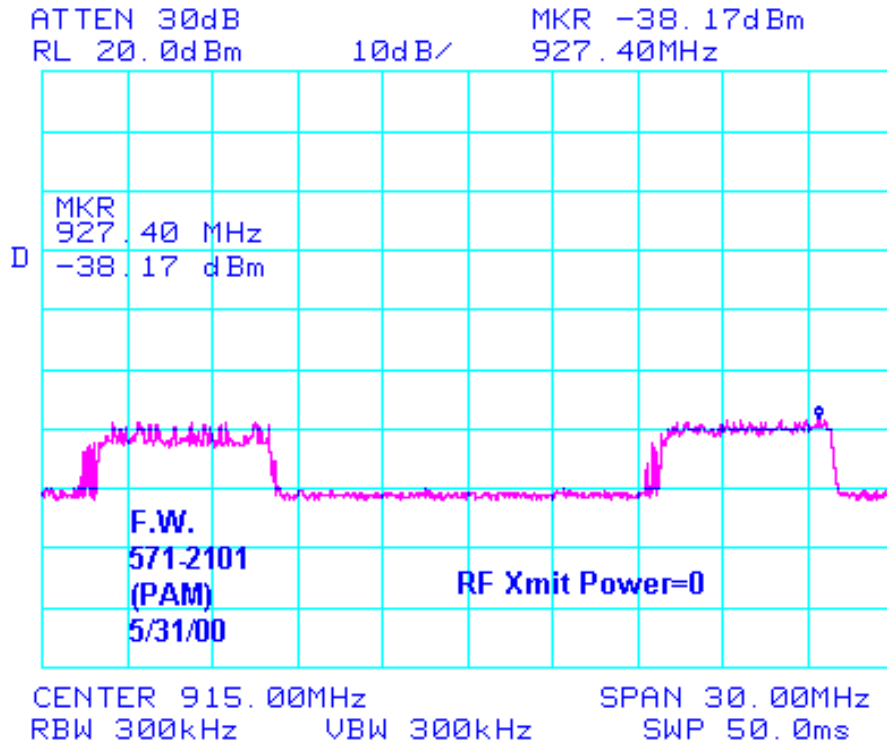
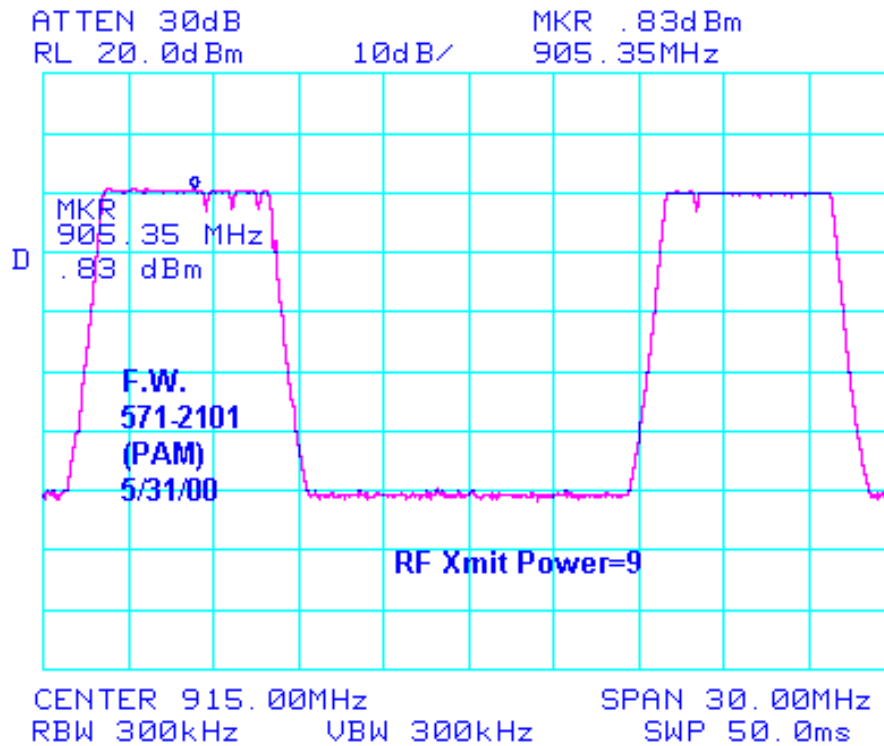


Figure 6)



0.7 Antennas / Cable

LMR400 Cable from Times Wire and Cable: Attenuation at 900Mhz=

RG8 = 6-dB/100ft.

LMR400 = 4-dB/100ft

Antenna Placement: Note, Omni antennas placed in a line will have a NULL off either end, so don't be fooled if you do not have good rf quality in those directions to the remote. Height is everything!

Yaggi Antennas: 6-element, 10dB nominal gain at 900Mhz

10-dB angle H-plane=45-degrees, E-plane=55-degrees. So at these angles, it basically cancels the +10dB of the yaggi's gain.

Omni Unipole: Antenex Inc. (www.antenex.com) model EB8965C is a Black Elevated Feed Mobile Antenna with 5DB of gain covering 896-970Mhz. The basic broadcast pattern for the antenna is Omni-directional but the actual shape depends on its mounting and location.

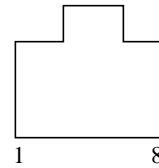
0.8 Wiring:

EVE cable to Freewave. Note wire colors may vary.

Freewave-Signal	DE9-Plug	EVE-RJ45
Carrier Detect	1	

Tx (from F.W.)	2	5 (green)
Rx (to F.W.)	3	6 (yellow)
DTR	4	
Gnd	5	4 (red)
DSR	6	
open	7	
CTS	8	
open	9	

EVE RJ-45 Connector:



Front View of RJ45
Male Cable Plug

Power Connector:

Current: ~ 100-150 mA
D/C power plug polarity:



0.9 Configuration for Point-Multipoint Operation

Protocol: N,8,1, DTR/RTS on, no parity, settable baud (Normally 19200)

(0) Operating Mode:

3 (Slave Multipoint)

..or..

2 (Master Multipoint)

(1) Baud Rate: 19.2

(2) Call Book ids:

base station 'master' should hold the s/n of each remote 'slave'.

'point-to-point' should have the s/n of the corresponding radio it talks with.

(3) Radio Transmission Characteristics:

(0) FreqKey: 5 (0-f are possible)

(1) Max Packet Size: 8 (136 bytes)

(2) Min Packet Size: 9

(3) Xmit Rate: 1 (normal mode, 0=diagnostic)

(4) RF Data Rate: 3 (3 for more solid link for distant stations, 2 for higher throughput)

(5) RF Xmit Power: 9 (or lower,9=highest)

(6) Slave Security 0

(7) RTS to CTS 0

(8) Retry Timeout 255

(9) Low Power Mode 0

(5) MultiPoint Parameters:

(0) Number Repeaters: 0 No Repeaters in this case!

(1) Master Packet Repeat: 0

(2) Max Slave Retry: 9

(3) Retry Odds: 1

(4) DTR Connect: 0

(5) Repeater Frequency: 0

(6) Network ID 255

(7) Reserved

(8) MultiMaster Sync 0

(9) PPS Enable Delay 255

(A) Slave/Repeater 0

(B) Diagnostics 0

(C) Subnet ID disabled

(D) Radio ID not set