2.4.7 Complete Circuit Diagrams (2.983 (d) (7))

Complete circuit diagrams are found on pages 198.23 through 198.79 in the DME-900 Component Maintenance Manual included as Exhibit N of this application.

2.4.8 Instruction Book (2.983 (d) (8))

The DME-900 instruction book, known as the Component Maintenance Manual is included as Exhibit N of this application.

2.4.9 Tune-up Procedures (2.983 (d) (9))

Complete tune-up procedures are found in paragraph 10, pages 198.9 through 198.13 in the DME-900 Component Maintenance Manual included as Exhibit N of this application.

2.4.10 Frequency Stability (2.983 (d) (10))

Frequency stability of the local oscillator is $\pm$ 100 KHz as specified by the TSO Minimum Performance Standards RTCA DO-151A document.

2.4.10.1 Synthesizer/Voltage Controlled Oscillator

The synthesizer, Stabilized Master Oscillator (SMO), refer to Figure 2-7 is of the direct-divide type, using a single crystal 8 MHz reference oscillator as a frequency source. The 8 MHz reference oscillator is divided by 64 to produce a 125 KHz variable divider reference frequency. The 125 KHz reference frequency is presented to one input of the phase detector. The phase detector compares this reference frequency to the 125 KHz loop output and produces an error signal that is filtered by the loop filter. the loop filter output is a VCO control voltage that controls the L-Band VCO frequency.

The L-Band VCO is the primary frequency source for the DME receiver and transmitter. It generates two identical output signals in the range of 1025 to 1150 MHz. the L-Band VCO frequency is controlled by a closed feedback loop which consists of a divide-by-four prescaler, A variable divider, a phase detector, and a loop filter.

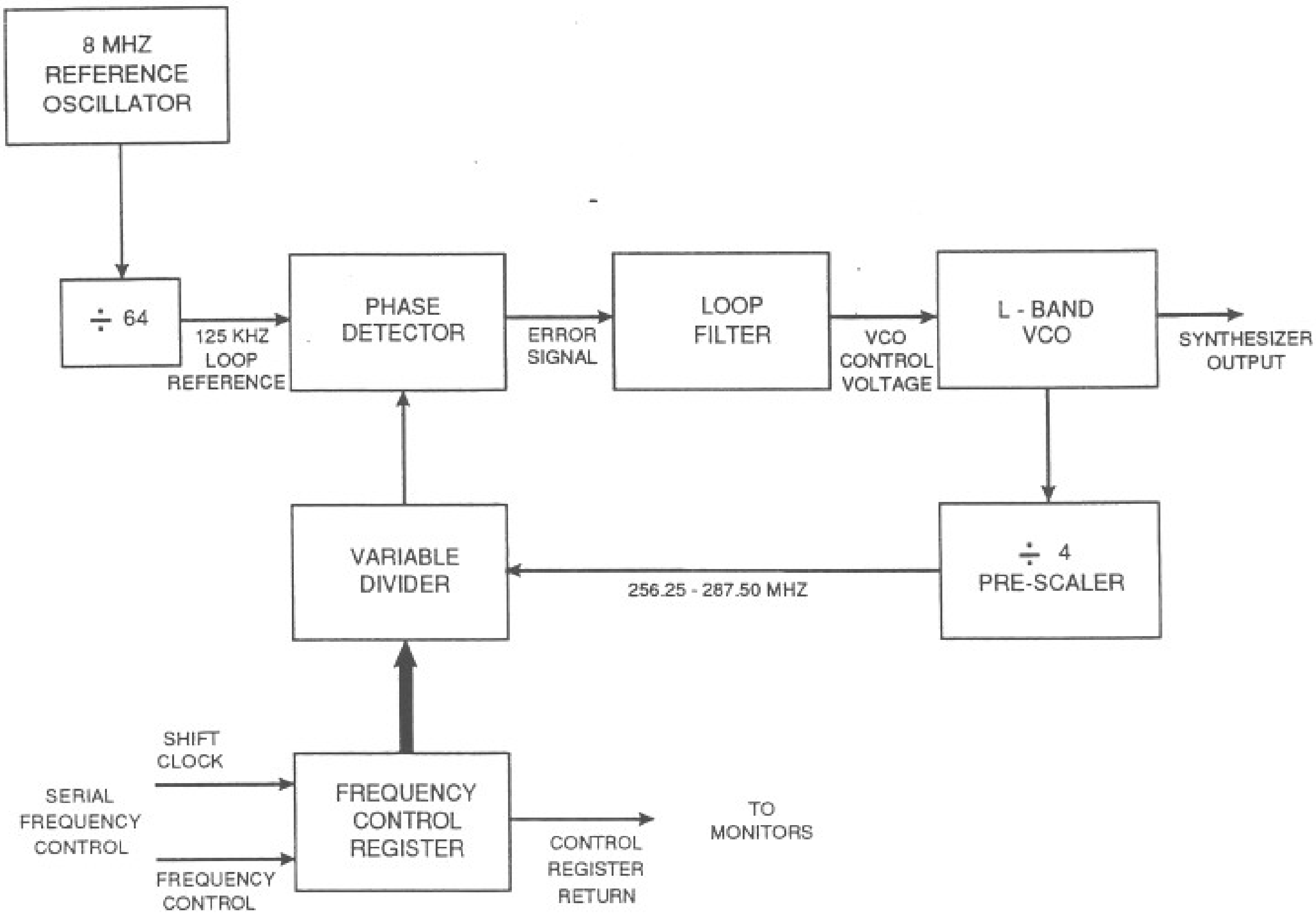

Figure 2-7 Digital Frequency Synthesizer Block Diagram

2.4.10.2 Loop Operation

In addition to the synthesizer output, the L-Band VCO, provides a second output that is fed to the divide-by-four prescaler, which produces an output signal at 256.25 to 287.5 MHz. This signal is connected to the variable divider. The divide ratio of the variable divider is selected by the frequency control register. The divide ratio is 2050 to 1 for channel 1 and 2300 to 1 for channel 126. The variable divider output approximates 125 KHz. This 125 KHz output frequency is compared to the 125 KHz reference frequency by the phase detector. If the 125 KHz output frequency differs from the 125 KHz reference frequency, the phase detector generates an error signal which is filtered and used to correct the VCO control voltage. The VCO control voltage output from the loop filter will correct the VCO frequency to the value necessary to make the 125 KHz output frequency equal to the 125 KHz reference frequency. When these two frequencies are equal, the synthesizer output will have arrived at the required L-Band frequency.

If a new channel is selected, the divide ratio of the variable divider is changed, causing the VCO control voltage to alter the synthesizer output frequency.

The divide ratio of the variable divider is controlled by the frequency control register. The frequency is serially loaded into the frequency control register from the video processor. The frequency control register also provides a control register return signal to the monitor circuits. This signal is used during channel changes to verify that the correct tuning information was received.

2.4.11 Suppression of Spurious Radiation (2.983 (d) (11))

Refer to overall block diagram Figure 2-1 .The low-pass filter prevents the radiation of high-frequency spurious energy through the antenna.

3. EQUIPMENT MEASUREMENTS (2.983 (e)

3.1 RF Power Output (2,985 (a)

The DME and test equipment were connected as shown in the Figure 3-1. A peak power measurement was made directly from the HP 8900C peak power meter using the normal calibration technique, while observing the detected transmitter pulses on the oscilloscope. Measurements were taken withe the DME in search mode on various channels for both X and Y mode transmissions.

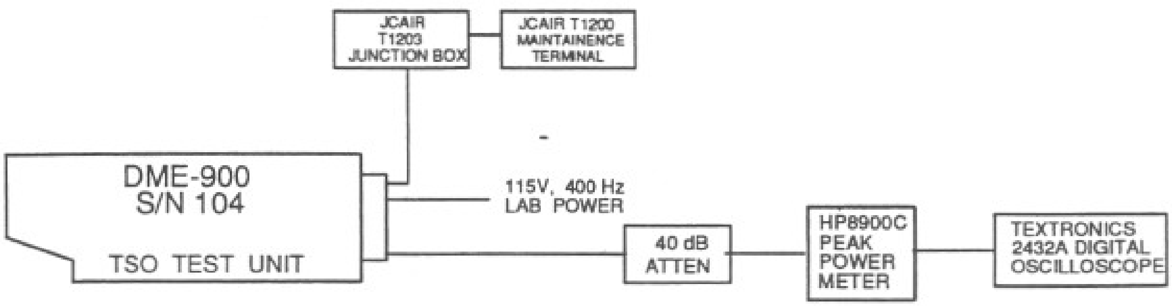

Figure 3-1 Transmitter Output Power Measurement Equipment Set-up

3.1.1 X Channel Results (GSH - 4 MARCH 94)

Channel	First Pulse	Second Pulse	TSO Limits	ARINC Limits
1	28.4 dBw	28.2 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
12	28.6 dBw	28.4 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
23	28.8 dBw	28.6 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
34	28.9 dBw	28.7 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
45	29.0 dBw	28.8 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
56	28.8 dBw	28.6 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
67	28.7 dBw	28.5 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
78	28.5 dBw	28.3 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
89	28.4 dBw	28.2 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
95	28.4 dBw	28.2 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
100	28.4 dBw	28.2 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
112	28.2 dBw	28.1 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
126	27.9 dBw	27.8 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw

* dBw = 10 Log (P in Watts)
** Limit between pulse 1 and pulse 2

3.1.2 Y Channel Results (GSH - 4 MARCH 94)

Channel	First Pulse	Second Pulse	TSO Limits	ARINC Limits
1	28.3 dBw	28.2 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
12	28.6 dBw	28.4 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
23	28.8 dBw	28.7 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
34	28.9 dBw	28.8 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
45	28.9 dBw	28.8 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
56	28.8 dBw	28.7 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
67	28.6 dBw	28.5 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
78	28.5 dBw	28.4 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
89	28.5 dBw	28.3 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
95	28.4 dBw	28.3 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
100	28.3 dBw	28.2 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
112	28.2 dBw	28.1 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw
126	27.9 dBw	27.8 dBw	* > 24 dBw ** < 1 dB	* > 25 dBw

* dBw = 10 Log (P in Watts)
** Limit between pulse 1 and pulse 2

3.2 Modulation Characteristics (2.987 (d)

The DME and test equipment were connected as shown in the Figure 3-1. The peak power meter was used to detect the transmitter pulses which were observed on the oscilloscope. Measurements were taken withe the DME in search mode on various channels for both X and Y mode transmissions. See figures 3-2 and 3-3 for plots of channel 1X and 1Y transmitter pulse pairs.

3.2.1 Channel 1X Pulse Characteristics (GSH - 8 SEPT 93)

Characteristics	First Pulse	Second Pulse	TSO Limits
Rise Time	1.33 µs	1.46 µs	<3.0 µs
Fall Time	1.63 µs	1.65 µs	<3.0 µs
Pulse Width	3.50 µs	3.44 µs	3.5 ± 0.5 µs
Pulse Top	YES	YES	Round/Smooth

3.2.2 Channel 1Y Pulse Characteristics (GSH - 8 SEPT 93)

Characteristics	First Pulse	Second Pulse	TSO Limits
Rise Time	1.34 µs	- 1.36 µs	<3.0 µs
Fall Time	1.62 µs	1.60 µs	<3.0 µs
Pulse Width	3.48 µs	3.50 µs	3.5 ± 0.5 µs
Pulse Top	YES	YES	Round/Smooth

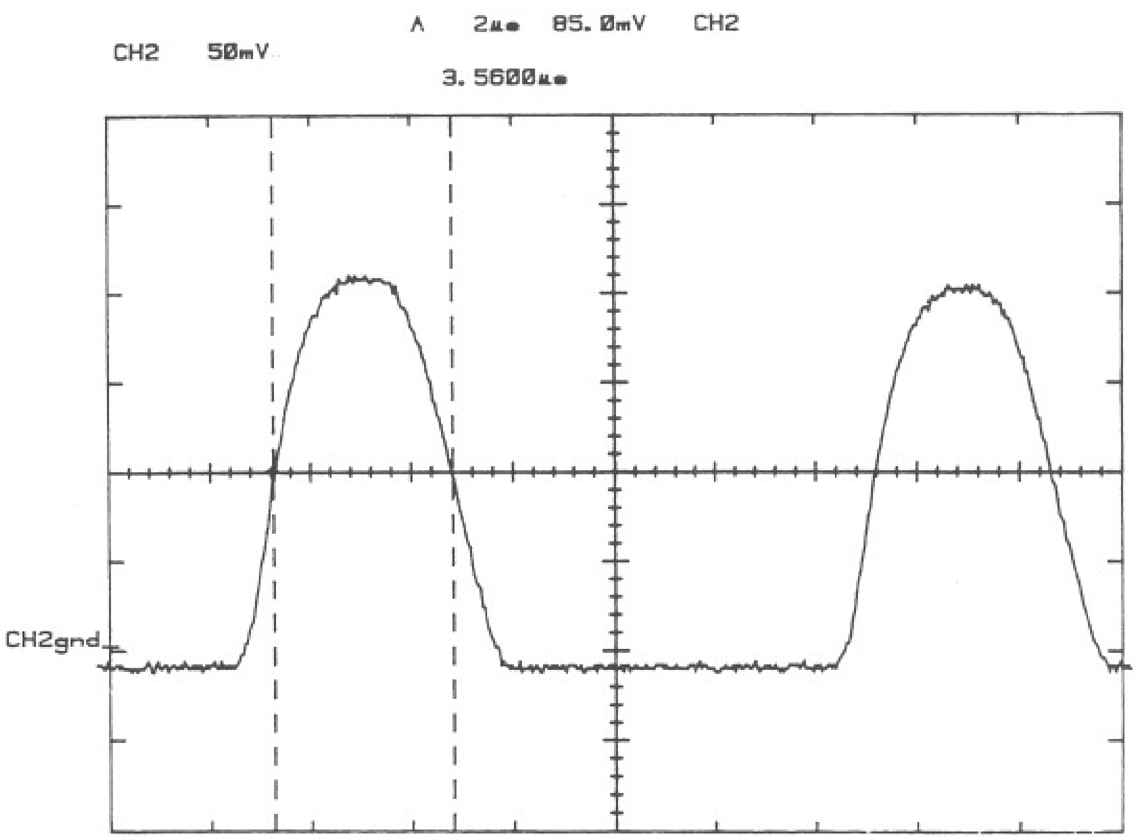

Figure 3-2 Channel 1X Pulse Pairs

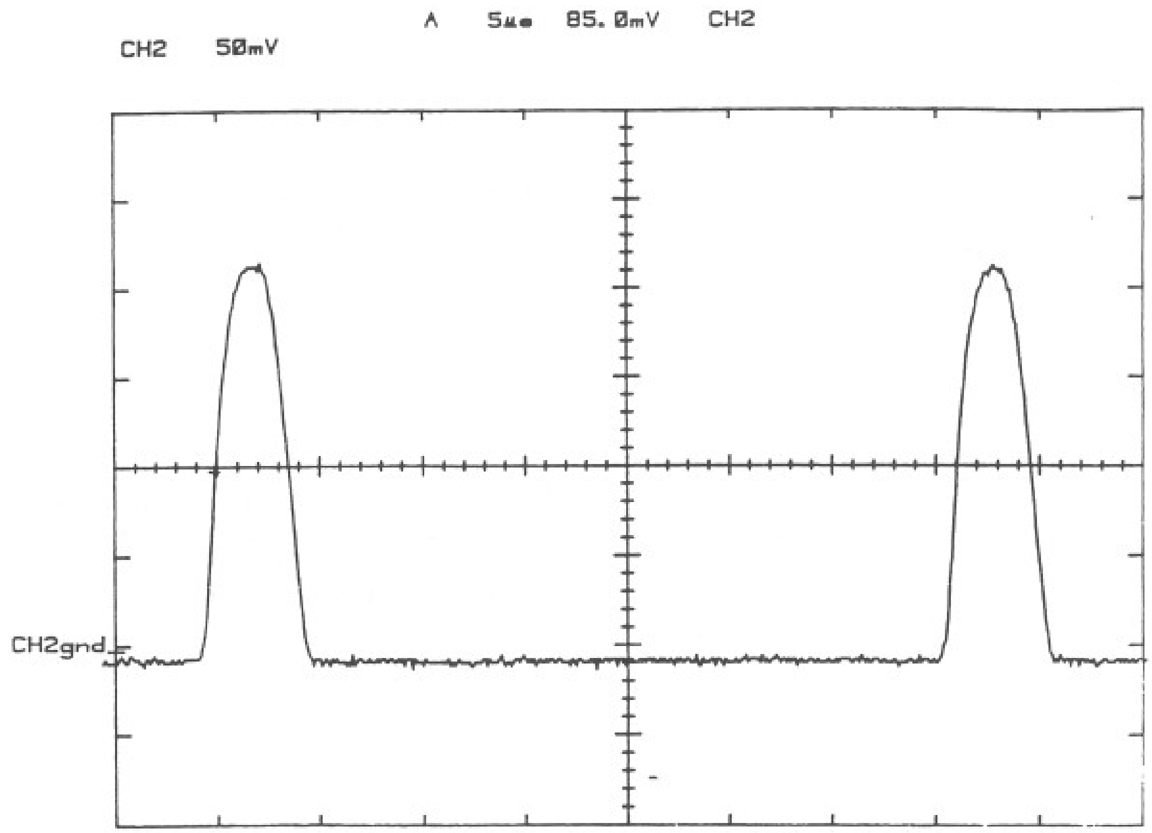

Figure 3-3 Channel 1Y Pulse Pairs

3.3 Occupied Bandwidth (2.989 (i)

The DME and test equipment were connected as shown in the Figure 3-4.
Data was taken on channels 1X, 64X, and 126X using the built-in occupied bandwidth function of the HP8591E Spectrum Analyzer. To determine the 250 KHz bandwidths, the data was obtained by using a successive approximation technique with the percent power bandwidth function until the result was 250 Khz ± 1 KHz.

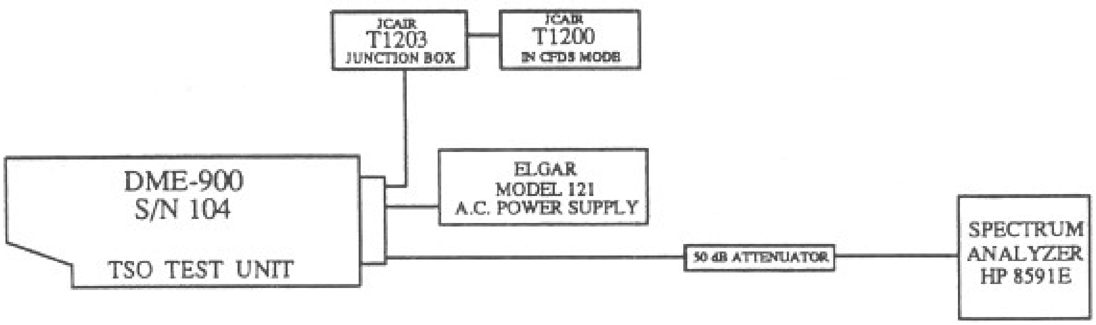

Figure 3-4 Pulse Spectrum Measurement Set-up

3.3.1 250 KHz Bandwidth

DME Channel		Energy within ± 250 KHz of Center Frequency	TSO/ARINC Limit
1	(FO = 1025 MHz)	98.8%	>90%
64	(FO = 1087 MHz)	94.6%	>90%
126	(FO = 1150 MHZ)	96.5%	>90%

3.3.2 Transmitter Spectrum

The DME TSO requirements state that the residual energy (10%) shall be equally distributed above and below center frequency and that the energy spectrum shall decay smoothly with frequency departure from center. Plots of the spectrums taken with the HP 8591E are shown in Figures 3-5 - 3-13 for channels 1X, 64Y, and 126X one each of 90%, 95%, and 99% respectively. The results of the measurements taken with the HP8591E analyzer are given below.

Results: (BME - 25 MAY 94)

Channel	90%	95%	99%
1X	330 kHz	380 kHz	662 kHz
64Y	325 kHz	385 kHz	652 kHz
126X	335 kHz	382 kHz	647 kHz

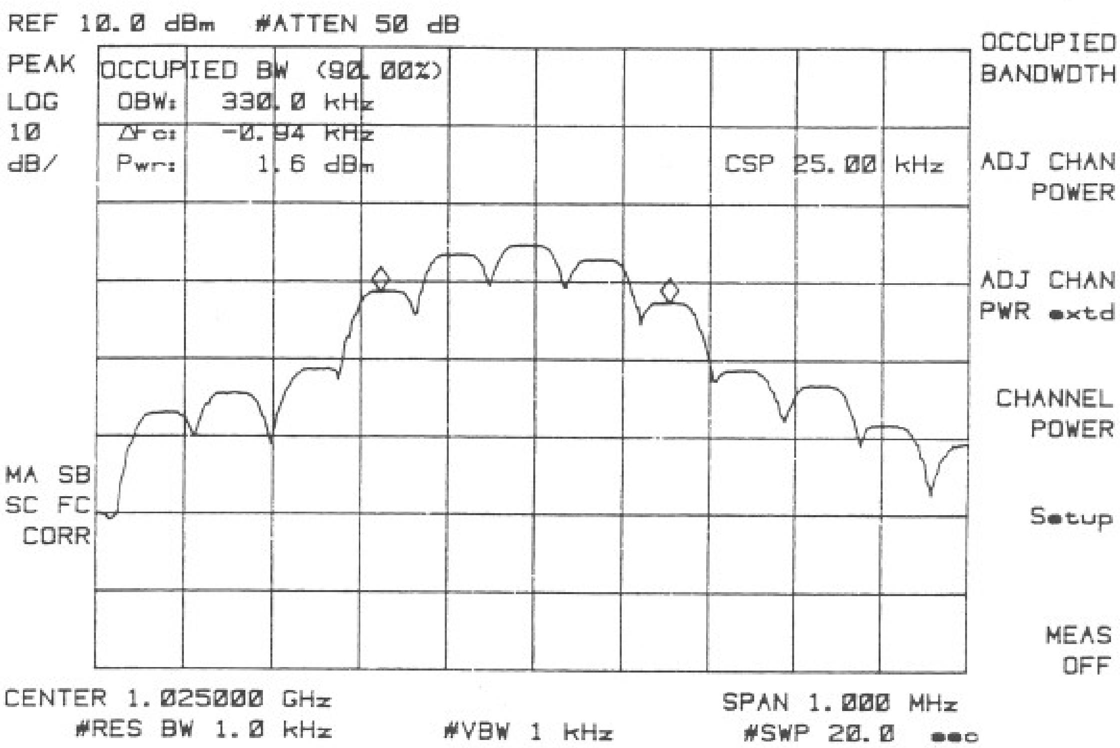

Figure 3-5 Pulse Spectrum of Channel 1X Showing 90% Occupied Bandwidth

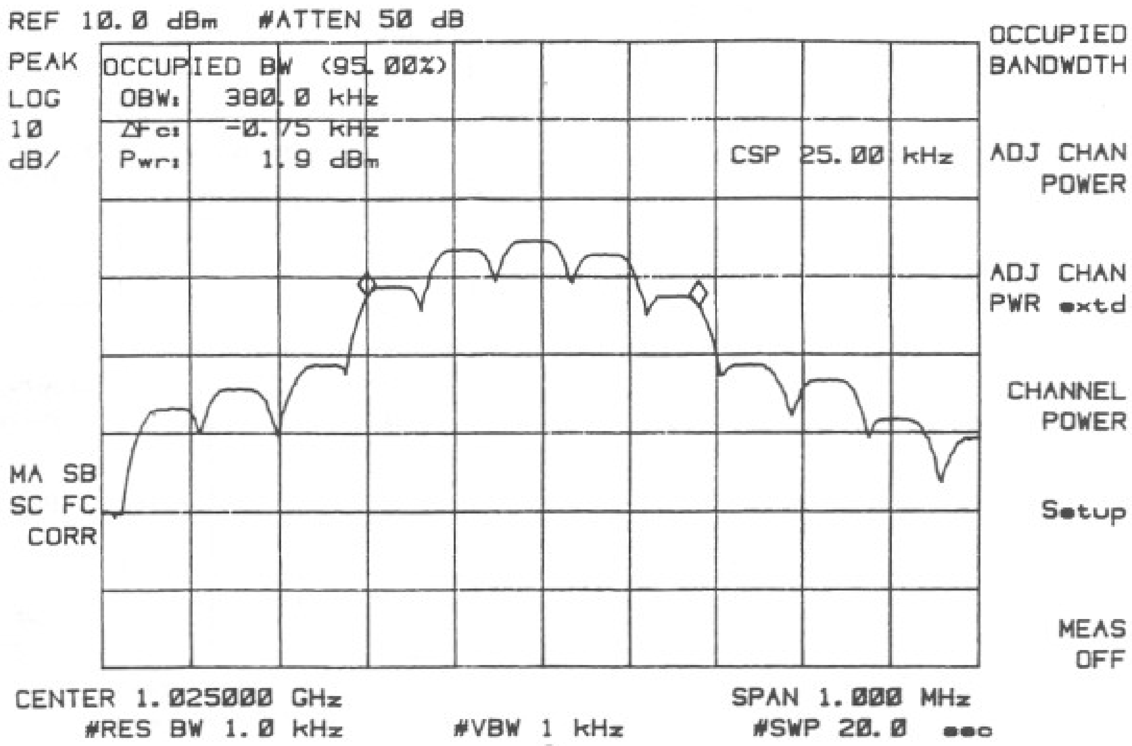

Figure 3-6 Pulse Spectrum of Channel 1X Showing 95% Occupied Bandwidth

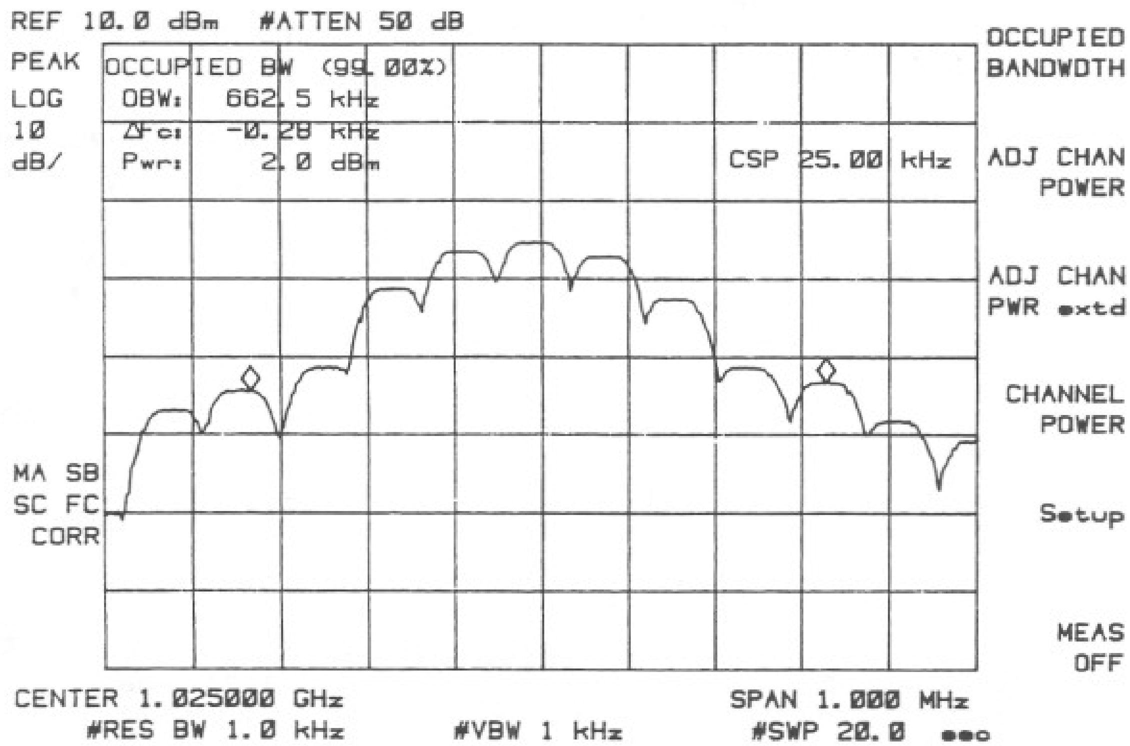

Figure 3-7 Pulse Spectrum of Channel 1X Showing 99% Occupied Bandwidth

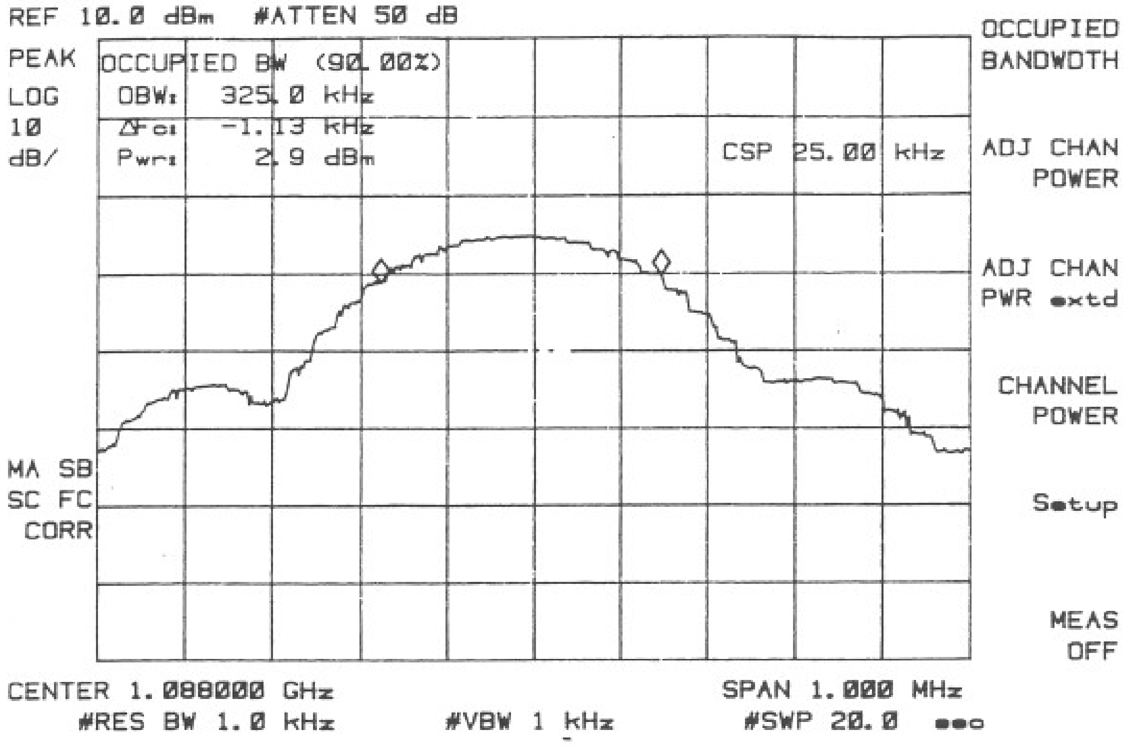

Figure 3-8 Pulse Spectrum of Channel 64Y Showing 90% Occupied Bandwidth

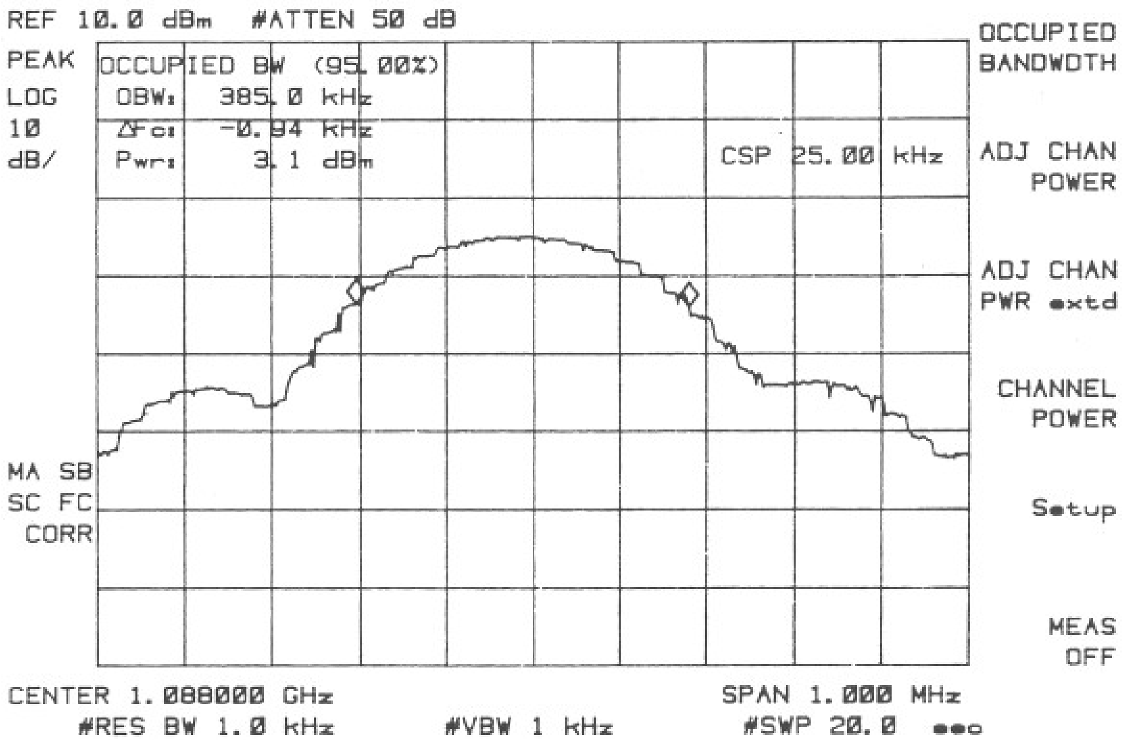

Figure 3-9 Pulse Spectrum of Channel 64Y Showing 95% Occupied Bandwidth

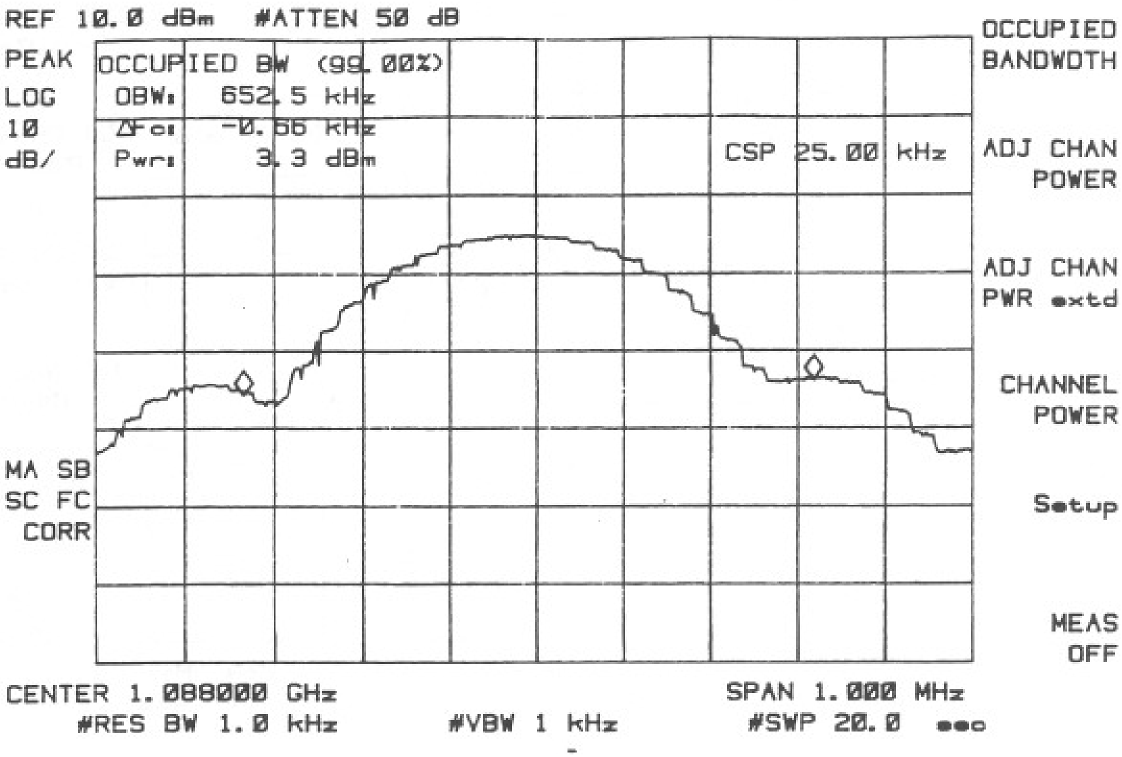

Figure 3-10 Pulse Spectrum of Channel 64Y Showing 99% Occupied Bandwidth

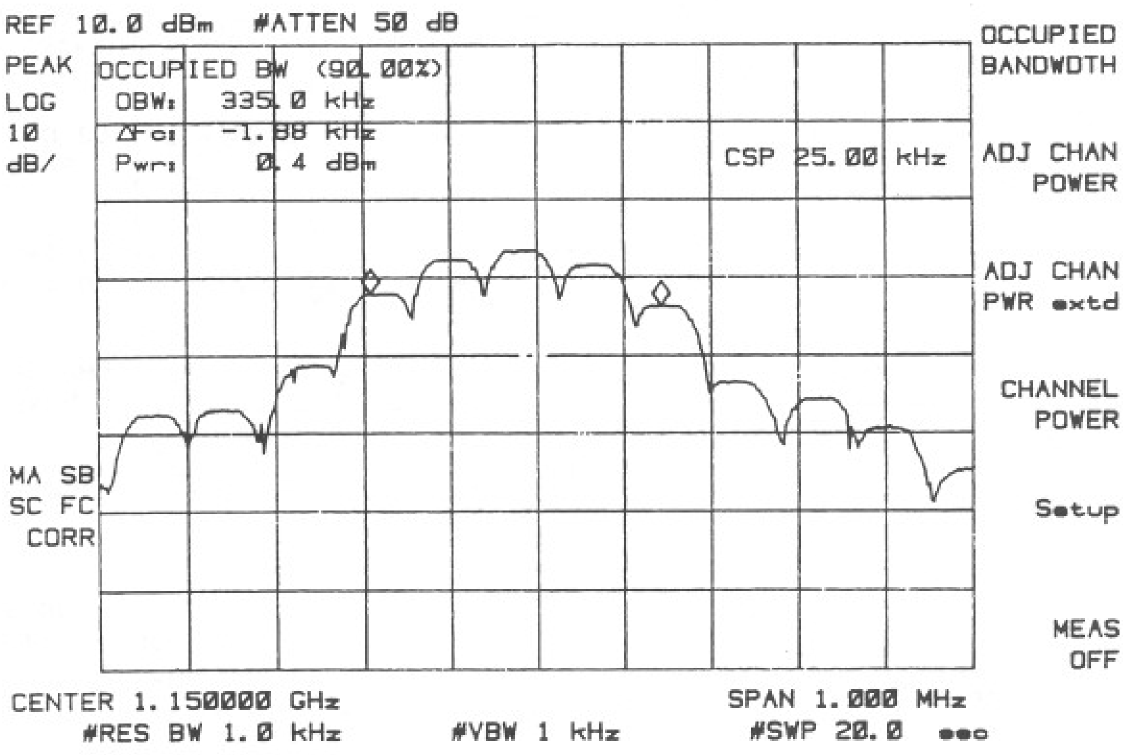

Figure 3-11 Pulse Spectrum of Channel 126X Showing 90% Occupied Bandwidth

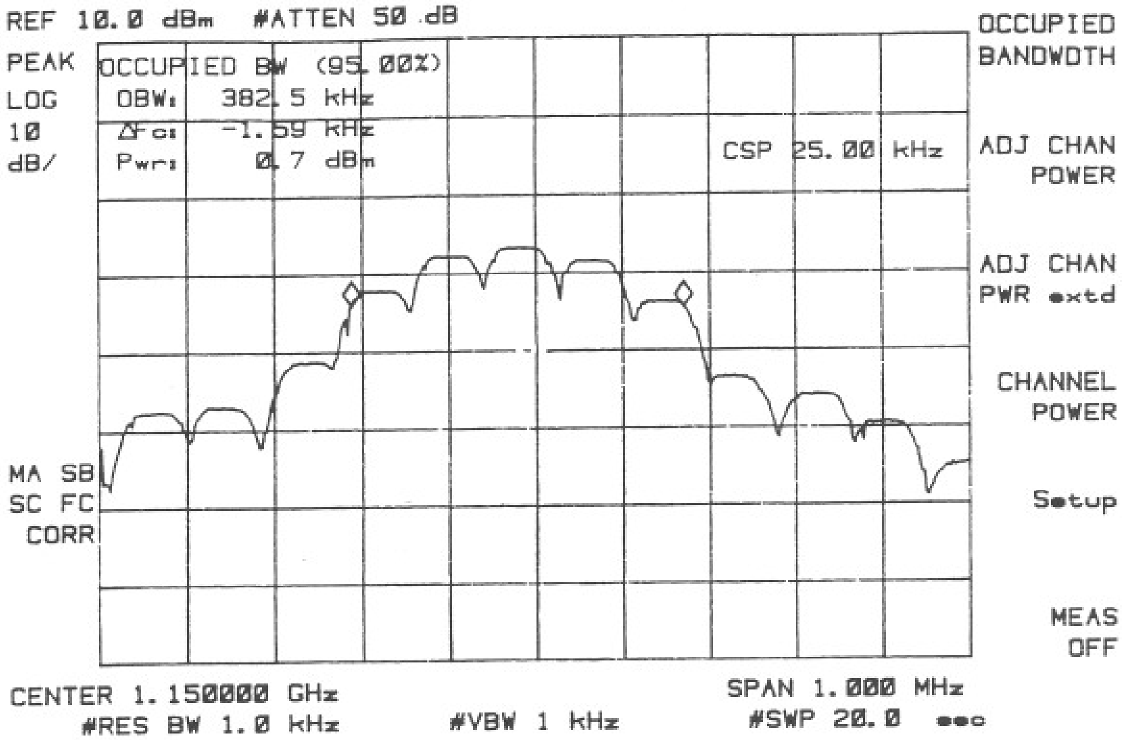

Figure 3-12 Pulse Spectrum of Channel 126X Showing 95% Occupied Bandwidth

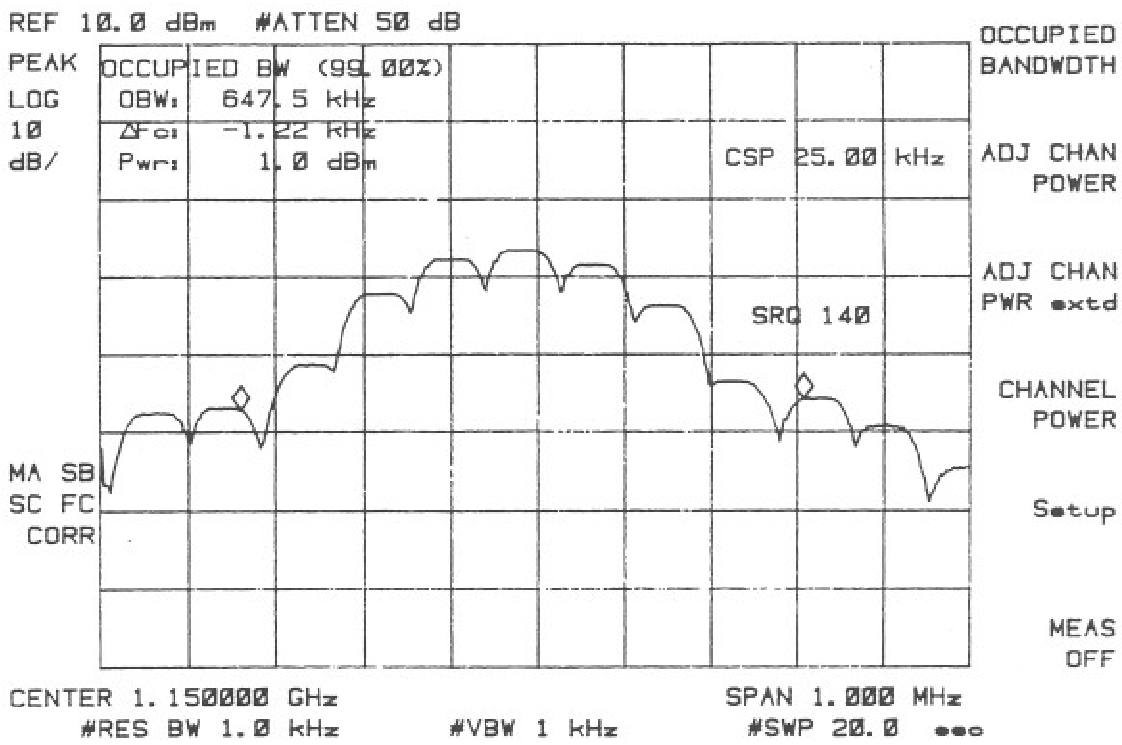

Figure 3-13 Pulse Spectrum of Channel 126X Showing 99% Occupied Bandwidth

3.3.3 Emission Limitations (87.139 (3))

Part 87, section 87.193 requires the transmitter power to be attenuated by 40 dB when the frequency is removed by 250% of the authorized bandwidth. The authorized bandwidth for the DME is calculated 800 KHz (1 MHz channel seperation - 2 X 100 KHz transmitter frequency stability). The limit is then calculated to be 2.0 Mhz. A plot of the spectrum taken with the HP 8591E is shown in Figures 3-13a for channel 64X indicating the transmitter output to be attenuated by 40 dB 780 KHz removed from the assigned frequency.

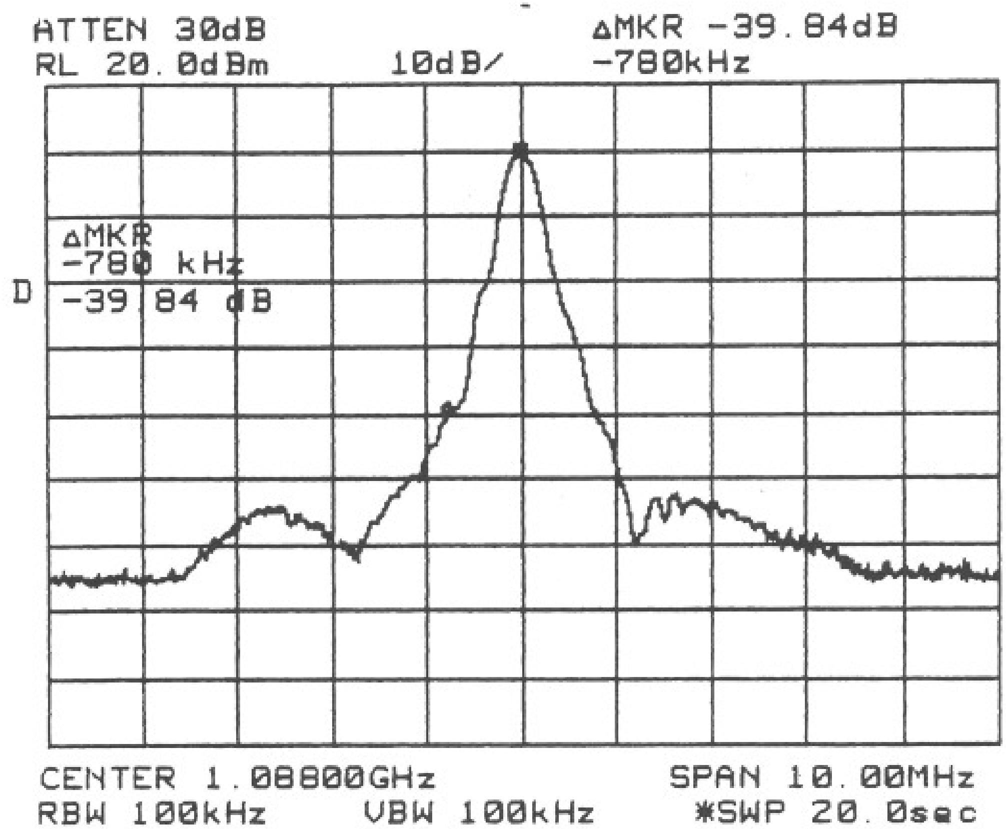

Figure 3-13a Pulse Spectrum of Channel 64X Showing Spectrum Width @ -40 dB

3.4 Spurious Emissions at the Antenna Terminals (2.991)

The DME and test equipment were connected as shown in the Figure 3-14.

Data was taken on channel 64X with the unit transmitting 100 Pulse Pairs per Second (PPS) in maintenance mode. The 100 PPS mode was used to present a worse case scenario, 80 PPS being the maximum interrogation rate during normal operation. The maximum magnitude of emissions allowed is calculated to be -43 dBm based on a duty cycle of 0.08% (100 PPS X 2 Pulses X 4 micro second pulses X 100). Plots of the data taken every 550 MHz from 5.0 to 12,050 MHz are included below in Figures 3-15 through 3-38.

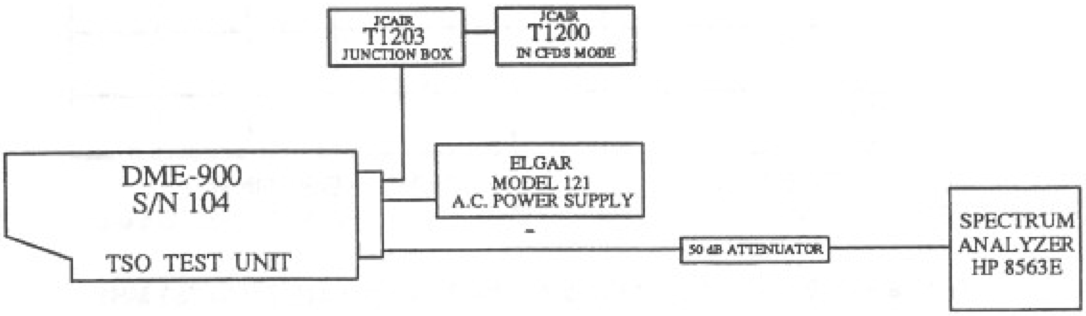

Figure 3-14 Equipment Set-up For Measuring Emissions At The Antenna Port

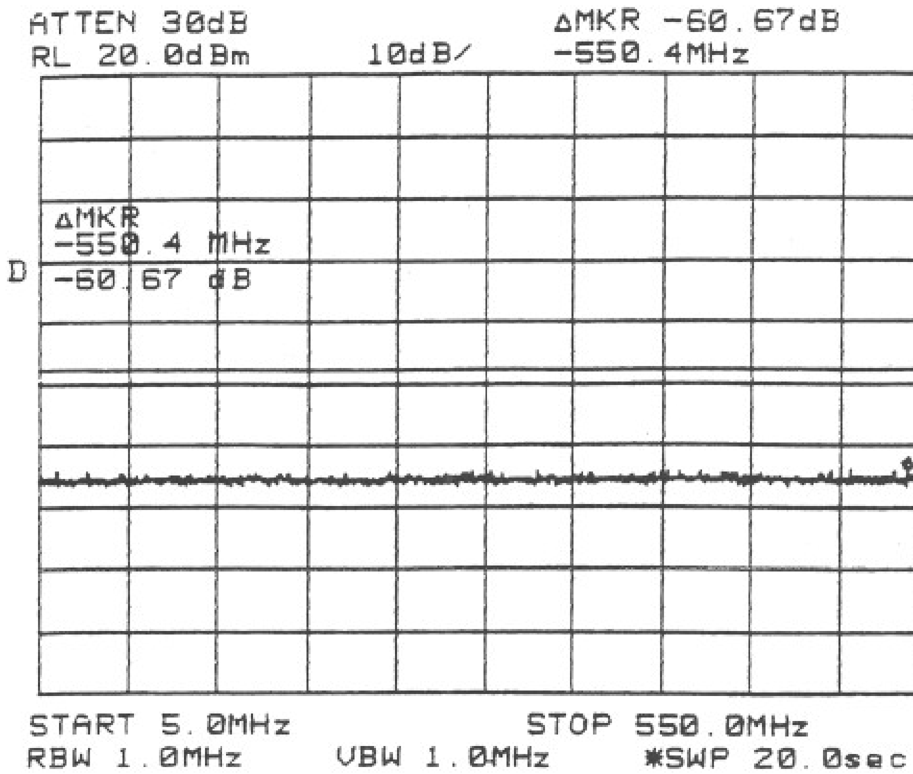

Figure 3-15 Spurious Emissions At The Antenna Port, 5.0 to 550 MHz

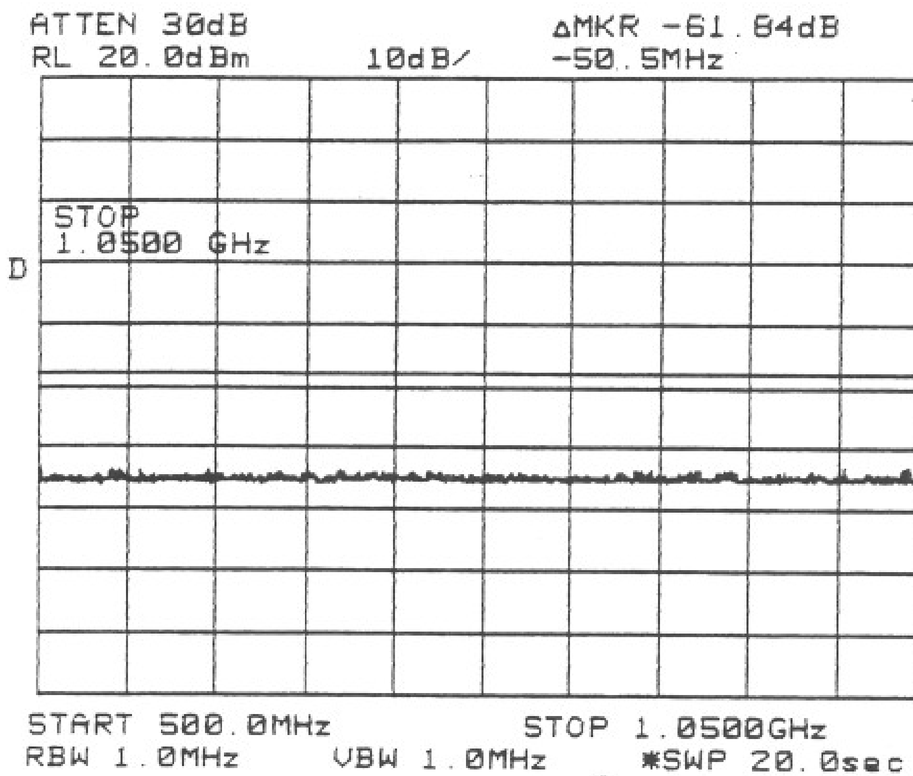

Figure 3-16 Spurious Emissions At The Antenna Port, 500 to 1050 MHz

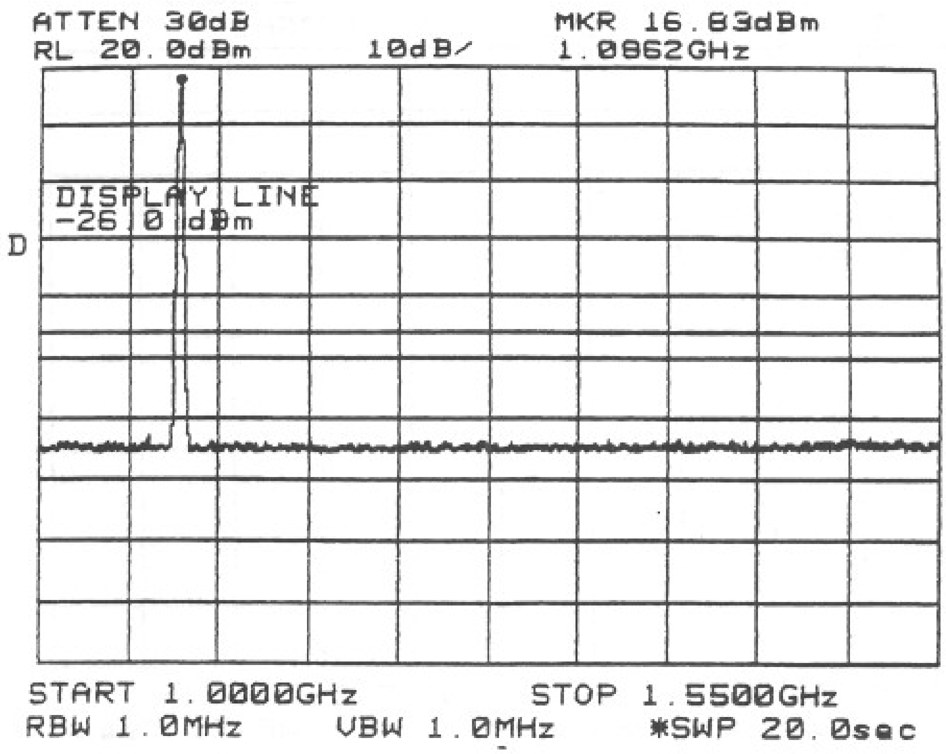

Figure 3-17 Spurious Emissions At The Antenna Port, 1,000 to 1,550 MHz

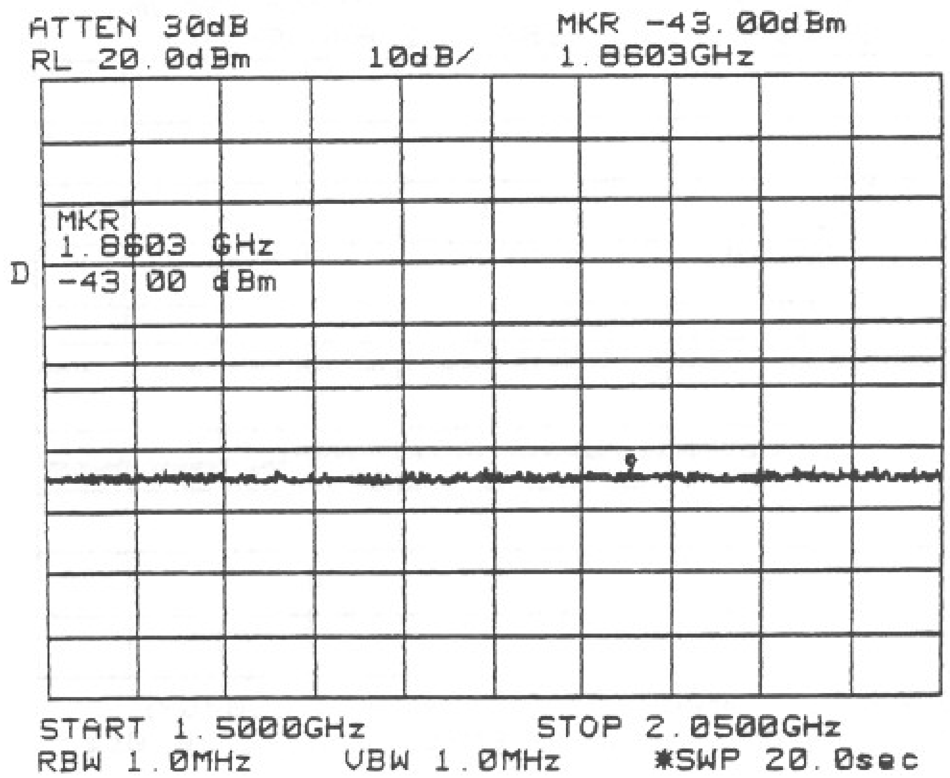

Figure 3-18 Spurious Emissions At The Antenna Port, 1,500 to 2,050 MHz

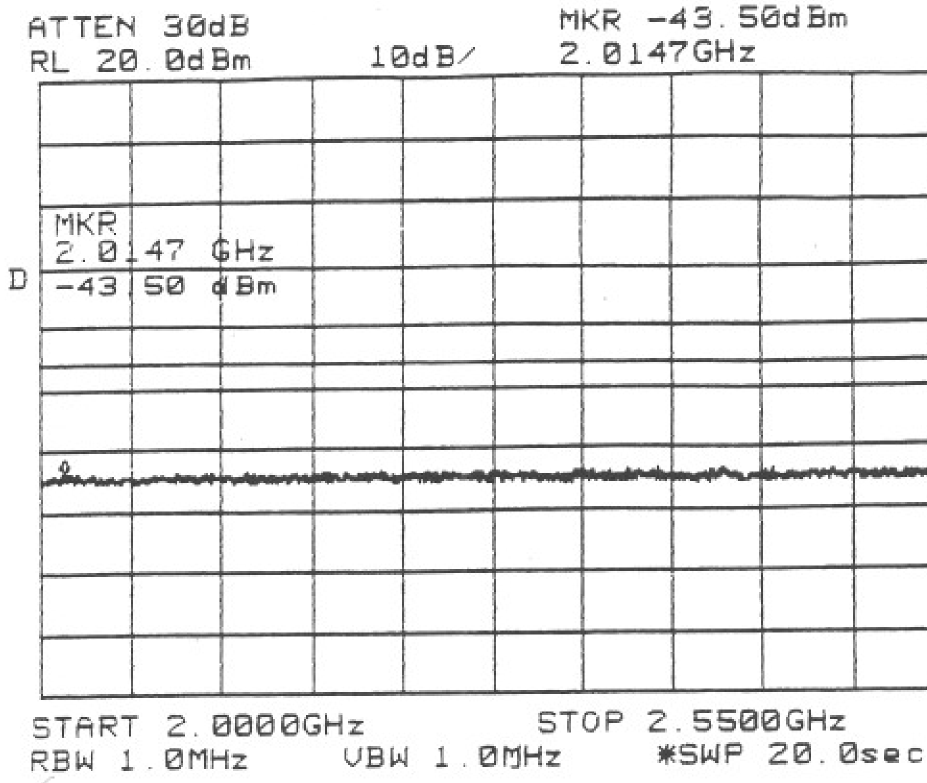

Figure 3-19 Spurious Emissions At The Antenna Port, 2,000 to 2,550 MHz

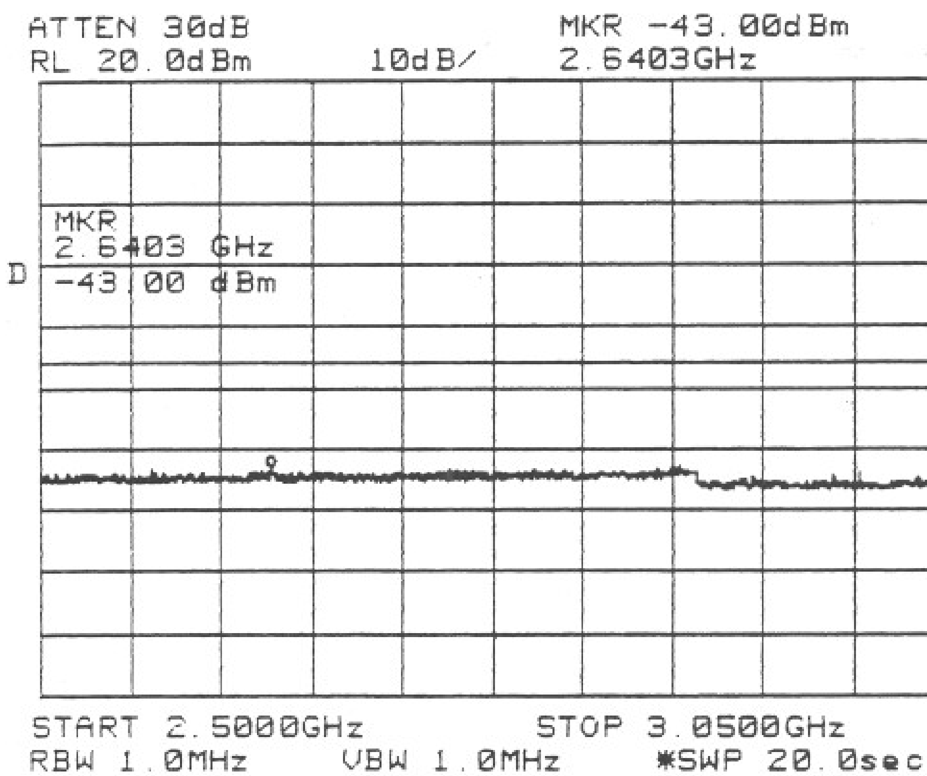

Figure 3-20 Spurious Emissions At The Antenna Port, 2,500 to 3,050 MHz