

4. TEST REPORT

4.1 RF Power Measurements

Figure 4-1 shows the test equipment setup for the RF power measurements.

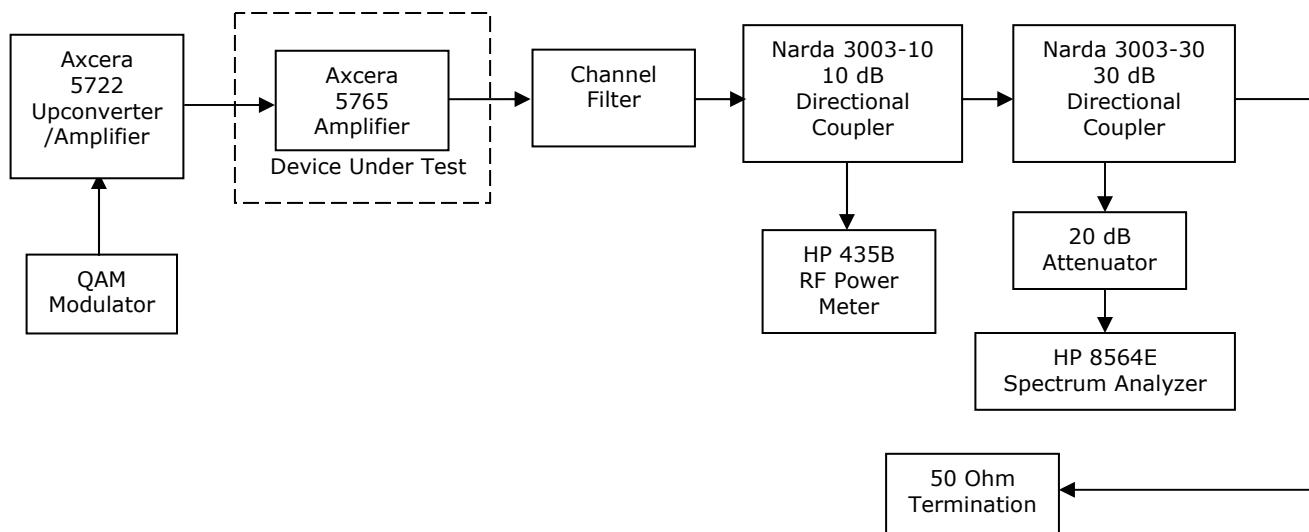


Figure 4-1. Test Equipment Setup for RF Power Measurements

The RF output signal from the upconverter/amplifier was connected to the input of the 5765 amplifier. The upconverter/amplifier was then adjusted to obtain 20 watts average RF output as observed on the power meter.

With the power level properly set to 20 watts average, all required tests were performed and recorded in the following sections.

4.2 Modulation Characteristics

The modulator tray incorporates a modulation technique known as QAM, Quadrature Amplitude Modulation, which uses two carriers, each of the same frequency, but 90° apart in phase. This means that one carrier trails the other by one fourth of a cycle. Each is then phase and amplitude modulated by a portion of the digital input signal. The two modulated signals are then combined and transmitted as a single waveform. The spectrum of a QAM signal is noise-like in appearance and has a relatively stable average power and a widely varying peak-envelope-power (PEP). The power is normally referred to in average power. QAM, used in conjunction with digital compression, provides a high bandwidth efficiency allowing a data rate of 30 MBPS in a 6 MHz channel bandwidth.

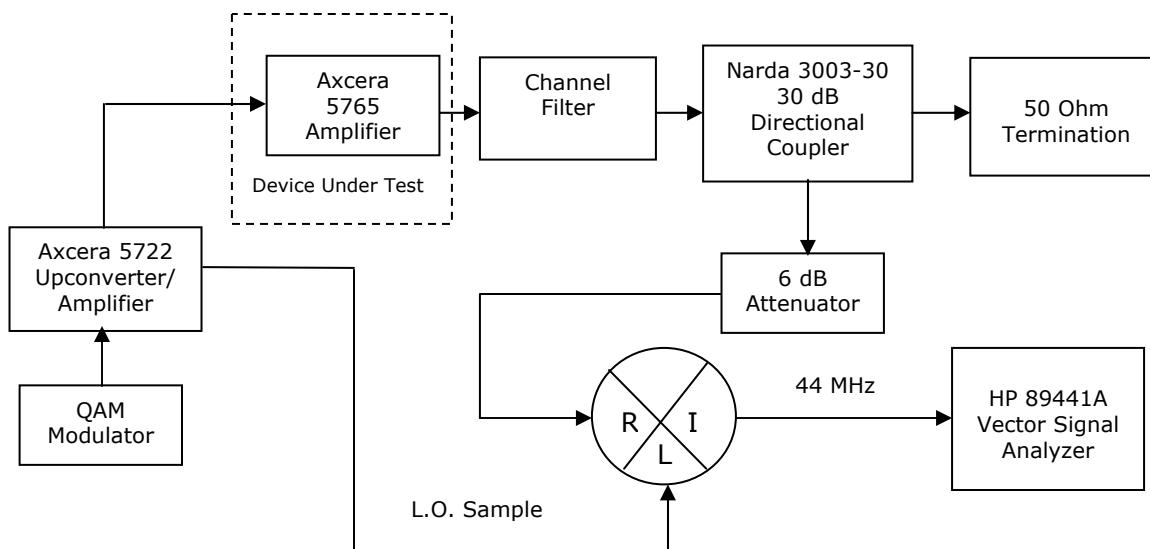


Figure 4-2. Typical QAM Demodulation Test Setup

4.3 Occupied Bandwidth

Using the test setup in Figure 4-4, with the transmitter operating at maximum power, photographs of the transmitter occupied bandwidth spectrum were taken and are shown in Figure 4-5.

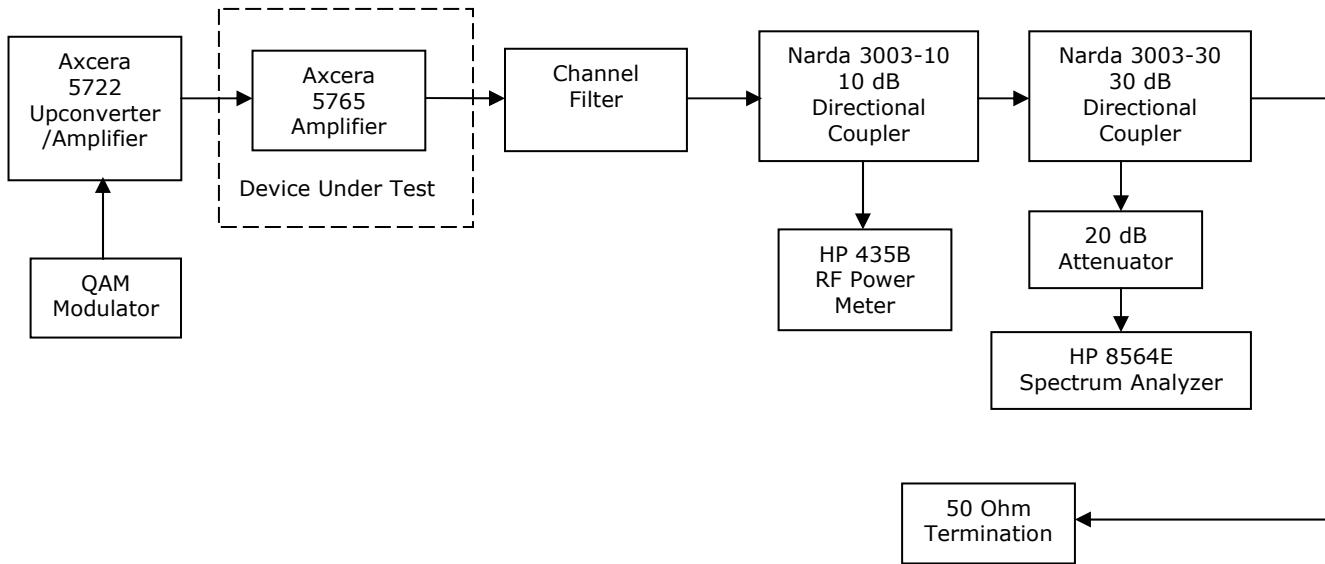


Figure 4-4. Test Setup for Occupied Bandwidth Spectrum Analysis

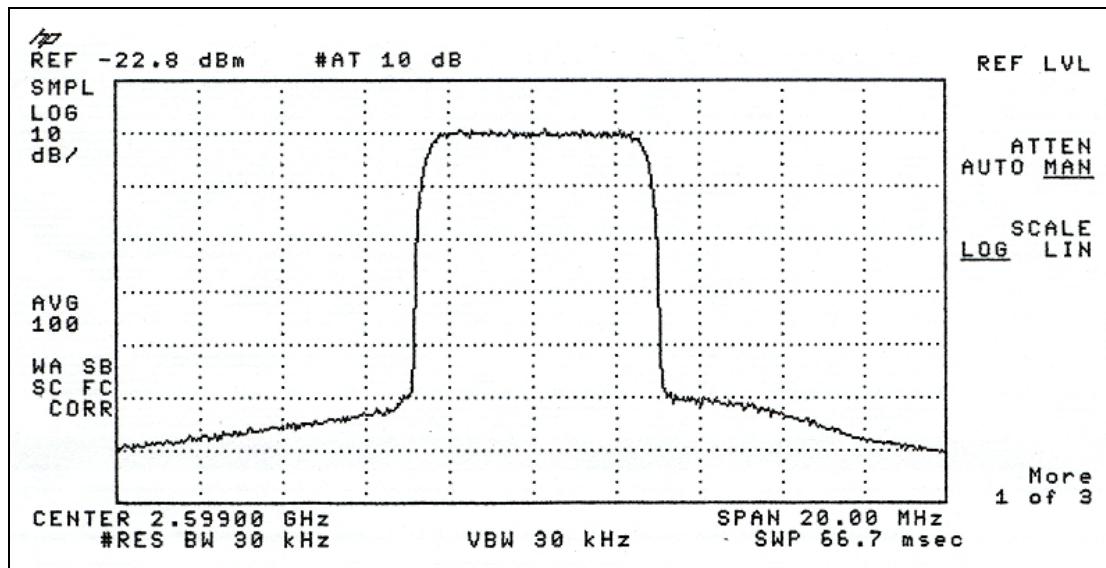


Figure 4-5. Channel Occupied Bandwidth

4.4 Conducted Spurious Emissions

Using the test setup shown in section 4.1, the spectrum outside of the specified channel was observed and the data was taken on all products above the -63 dB noise floor of the spectrum analyzer.

Spurious Emissions were observed on the analyzer at a 1.330 GHz span (see spectrum plots on the following page). With the average in band signal set as the reference, the spurious emissions were observed. The measured data is shown in the table below for 20 watts (average) output power.

This data is shown in Table 4-1 and is presented as graphs in Figure 4-9.

Table 4-1. Products Above the -63 dB Noise Floor of the Spectrum Analyzer

FREQUENCY (MHz)	SOURCE	PEAK LEVEL OBSERVED (dB)
2599.00	Center of Channel	0 dB (Reference)
44.00	IF Frequency	None Observed
2643.00	Local Oscillator	None Observed
5198.00	2 nd Harmonic	None Observed
7797.00	3 rd Harmonic	None Observed
10396.00	4 th Harmonic	None Observed
12995.00	5 th Harmonic	None Observed
15594.00	6 th Harmonic	None Observed
18193.00	7 th Harmonic	None Observed
20792.00	8 th Harmonic	None Observed
23391.00	9 th Harmonic	None Observed
25990.00	10 th Harmonic	None Observed

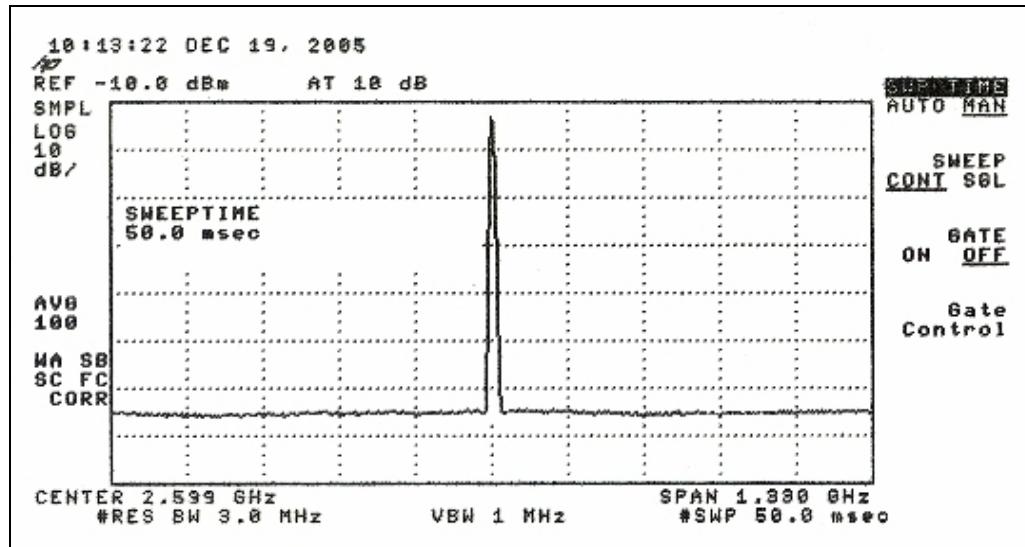


Figure 4-7. Products Above the -63 dB Noise Floor of the Spectrum Analyzer (1.330 GHz Span)

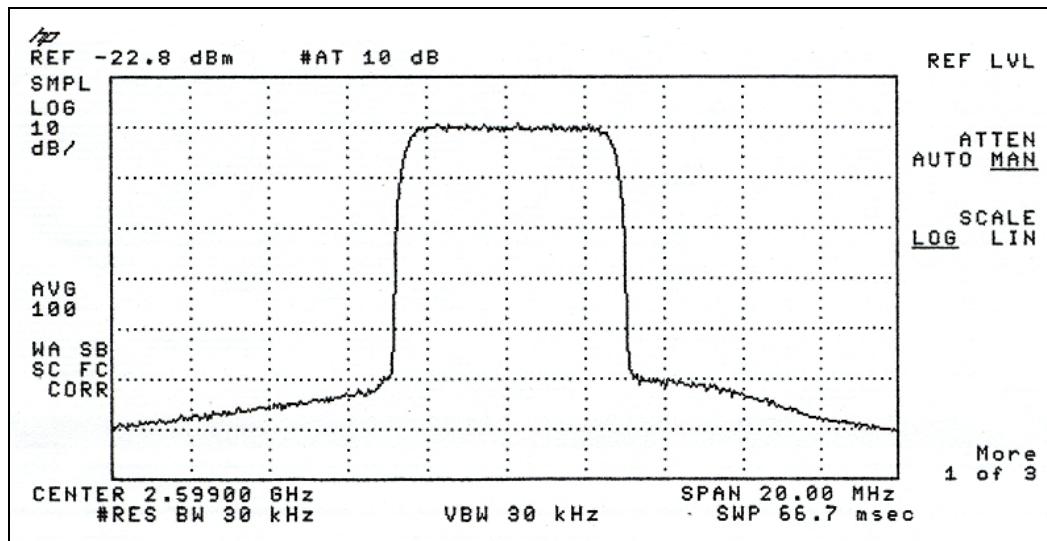


Figure 4-8. Conducted Spurious Emissions (before channel/band stop filter)

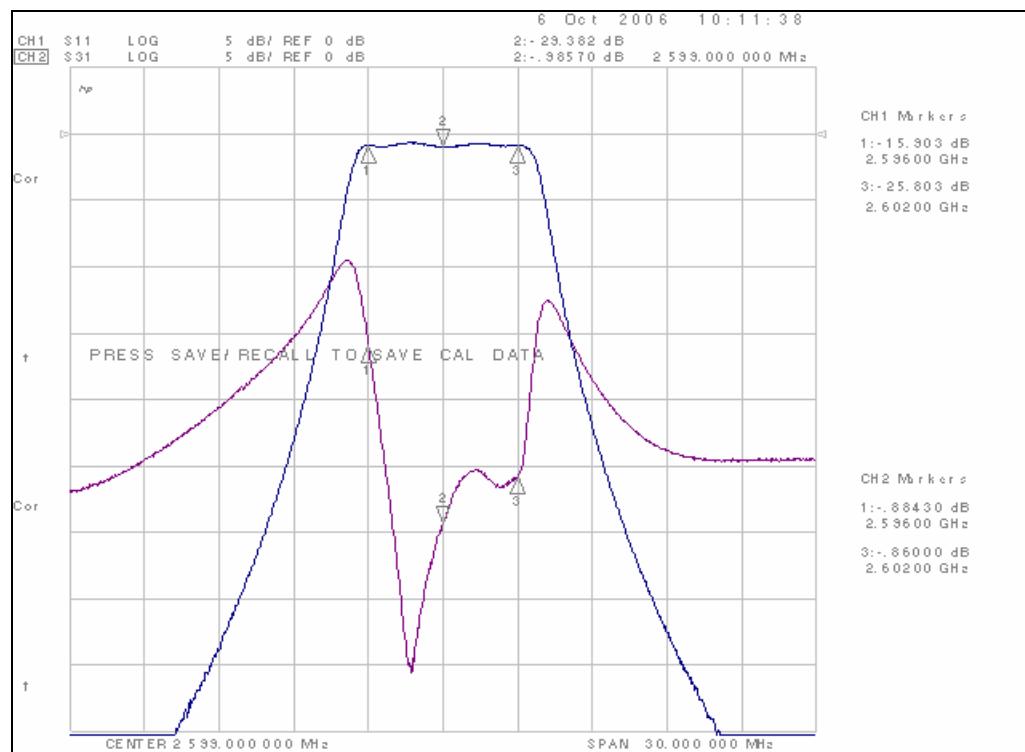


Figure 4-9. Conducted Spurious Emissions
 (Filter response of channel filter)

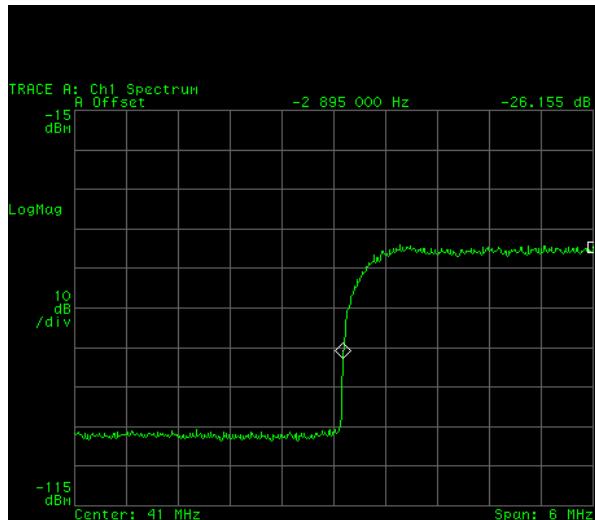
Part 27.53 of the Rules states:

27.53 (l)(3) *Prior to transition and thereafter solely within the MBS, and notwithstanding paragraph (l)(2) of this section, the maximum out-of-band power of a digital transmitter operating on a single 6 MHz channel with an EIRP in excess of -9 dBW employing digital modulation for the primary purpose of transmitting video programming shall be attenuated at the 6 MHz channel edges at least 25 dB relative to the licensed average 6 MHz channel power level, then attenuated along a linear slope to at least 40 dB at 250 kHz beyond the nearest channel edge, then attenuated along a linear slope from that level to at least 60 dB at 3 MHz above the upper and below the lower licensed channel edges, and attenuated at least 60 dB at all other frequencies.*

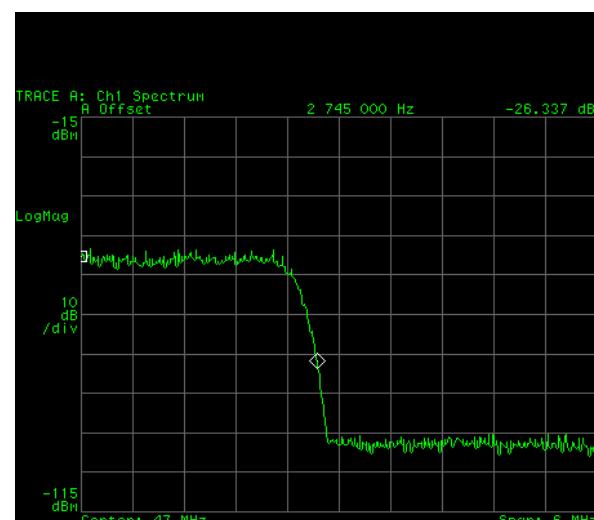
27.53 (l)(6) *Measurement procedure. Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e. 1 MHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.*

Mask data was measured for the filter with results plotted at 10 kHz steps. At 250 kHz from the channel edge, the out of band power needs to be down 25 dB from the total channel power. Since we are less than 1 MHz from the channel edge, this power must be integrated over at least one percent of the emission bandwidth.

First, we measured the emission bandwidth (see the attached plots). It is 5.64 MHz.



Left Marker: -2.895 MHz from Center.



Right Marker: +2.745 MHz from Center.

For convenience we will integrate over 60 kHz, which meets the requirement that we integrate over at least 1%. To determine the out of band power, the amplifier IMD was added to the filter response and the power was summed over 60 kHz to give the total out of band power at 250 kHz from the channel edge. The data is below:

Frequency	Filter Response (dB)	Amp IMD	Total	Power
2595970000	-0.911804199	-49	-49.9118042	1.02052E-05
2595980000	-0.894439697	-49	-49.8944397	1.0246E-05
2595990000	-0.905029297	-49	-49.9050293	1.02211E-05
2596000000	-0.892913818	-49	-49.89291382	1.02496E-05
2596010000	-0.880432129	-46	-46.88043213	2.05096E-05
2596020000	-0.903625488	-43	-43.90362549	4.0704E-05
2596030000	-0.866455078	-42	-42.86645508	5.16838E-05
				Total 1.549E-04

The total channel power can be found by multiplying the power in 10 kHz by the number of 10 kHz subsections in the occupied bandwidth. There are 561 10 kHz sections in the occupied channel bandwidth. The ratio between in band and out of band power in dB is: $10 * \log(1.542E-04/561) = -65.5$ dB

At 250 kHz from the channel edge, the requirement is that we are down by 40 dB.

Frequency	Filter Response (dB)	Amp IMD	Total	Power
2595720000	-1.151489258	-50	-51.15148926	7.67098E-06
2595730000	-1.112121582	-50	-51.11212158	7.74084E-06
2595740000	-1.104064941	-50	-51.10406494	7.75521E-06
2595750000	-1.091430664	-50	-51.09143066	7.7778E-06
2595760000	-1.096435547	-50	-51.09643555	7.76884E-06
2595770000	-1.058776855	-50	-51.05877686	7.8365E-06
2595780000	-1.053039551	-50	-51.05303955	7.84686E-06
				Total 5.44E-05

The total channel power can be found by multiplying the power in 10 kHz by the number of 10 kHz subsections in the occupied bandwidth. There are 561 10 kHz sections in the occupied channel bandwidth. The ratio between in band and out of band power in dB is: $10 * \log(1.72E-04/561) = -70.1$ dB.

The requirement at 1 MHz from the channel edge changes. The out of band energy must be integrated over 1 MHz, not 1% of the bandwidth.

Frequency	Filter Response (dB)	Amp IMD	Total	Power
2594500000	-10.99462891	-50	-60.99462891	7.95311E-07
2594510000	-10.88427734	-50	-60.88427734	8.15779E-07
2594520000	-10.79003906	-50	-60.79003906	8.33674E-07
2594530000	-10.69482422	-50	-60.69482422	8.52153E-07
2594540000	-10.58349609	-50	-60.58349609	8.7428E-07
2594550000	-10.49902344	-50	-60.49902344	8.91451E-07
2594560000	-10.40576172	-50	-60.40576172	9.10802E-07
2594570000	-10.29833984	-50	-60.29833984	9.33611E-07
2594580000	-10.2109375	-50	-60.2109375	9.52591E-07
2594590000	-10.11132813	-50	-60.11132813	9.74692E-07
2594600000	-10.00585938	-50	-60.00585938	9.98652E-07
2594610000	-9.906738281	-50	-59.90673828	1.02171E-06
2594620000	-9.8125	-50	-59.8125	1.04412E-06
2594630000	-9.705078125	-50	-59.70507813	1.07027E-06
2594640000	-9.604003906	-50	-59.60400391	1.09547E-06

2594650000	-9.500976563	-50	-59.50097656	1.12177E-06
2594660000	-9.38671875	-50	-59.38671875	1.15167E-06
2594670000	-9.295898438	-50	-59.29589844	1.17601E-06
2594680000	-9.182617188	-50	-59.18261719	1.20709E-06
2594690000	-9.08984375	-50	-59.08984375	1.23315E-06
2594700000	-8.993652344	-50	-58.99365234	1.26077E-06
2594710000	-8.896972656	-50	-58.89697266	1.28915E-06
2594720000	-8.791503906	-50	-58.79150391	1.32084E-06
2594730000	-8.690429688	-50	-58.69042969	1.35194E-06
2594740000	-8.573242188	-50	-58.57324219	1.38892E-06
2594750000	-8.467773438	-50	-58.46777344	1.42306E-06
2594760000	-8.361328125	-50	-58.36132813	1.45837E-06
2594770000	-8.265136719	-50	-58.26513672	1.49103E-06
2594780000	-8.167480469	-50	-58.16748047	1.52494E-06
2594790000	-8.0546875	-50	-58.0546875	1.56506E-06
2594800000	-7.960449219	-50	-57.96044922	1.59939E-06
2594810000	-7.866210938	-50	-57.86621094	1.63448E-06
2594820000	-7.747558594	-50	-57.74755859	1.67975E-06
2594830000	-7.650390625	-50	-57.65039063	1.71775E-06
2594840000	-7.545166016	-50	-57.54516602	1.75988E-06
2594850000	-7.449707031	-50	-57.44970703	1.79899E-06
2594860000	-7.341796875	-50	-57.34179688	1.84425E-06
2594870000	-7.228759766	-50	-57.22875977	1.89288E-06
2594880000	-7.139160156	-50	-57.13916016	1.93234E-06
2594890000	-7.041259766	-50	-57.04125977	1.9764E-06
2594900000	-6.936523438	-50	-56.93652344	2.02464E-06
2594910000	-6.839355469	-50	-56.83935547	2.07045E-06
2594920000	-6.737304688	-50	-56.73730469	2.11968E-06
2594930000	-6.633056641	-50	-56.63305664	2.17117E-06
2594940000	-6.524902344	-50	-56.52490234	2.22592E-06
2594950000	-6.423828125	-50	-56.42382813	2.27833E-06
2594960000	-6.304931641	-50	-56.30493164	2.34157E-06
2594970000	-6.201660156	-50	-56.20166016	2.39792E-06
2594980000	-6.085205078	-50	-56.08520508	2.46309E-06
2594990000	-5.981201172	-50	-55.98120117	2.52278E-06
2595000000	-5.883544922	-50	-55.88354492	2.58015E-06
2595010000	-5.780517578	-50	-55.78051758	2.64209E-06
2595020000	-5.686523438	-50	-55.68652344	2.6999E-06
2595030000	-5.590332031	-50	-55.59033203	2.76037E-06
2595040000	-5.488525391	-50	-55.48852539	2.82584E-06
2595050000	-5.393066406	-50	-55.39306641	2.88864E-06
2595060000	-5.294189453	-50	-55.29418945	2.95516E-06
2595070000	-5.206787109	-50	-55.20678711	3.01524E-06
2595080000	-5.120117188	-50	-55.12011719	3.07601E-06
2595090000	-5.028076172	-50	-55.02807617	3.1419E-06
2595100000	-4.928466797	-50	-54.9284668	3.2148E-06

2595110000	-4.827148438	-50	-54.82714844	3.29068E-06
2595120000	-4.727539063	-50	-54.72753906	3.36702E-06
2595130000	-4.635742188	-50	-54.63574219	3.43895E-06
2595140000	-4.528320313	-50	-54.52832031	3.52507E-06
2595150000	-4.435302734	-50	-54.43530273	3.60139E-06
2595160000	-4.350830078	-50	-54.35083008	3.67212E-06
2595170000	-4.256347656	-50	-54.25634766	3.75288E-06
2595180000	-4.162353516	-50	-54.16235352	3.83499E-06
2595190000	-4.073486328	-50	-54.07348633	3.91428E-06
2595200000	-3.978759766	-50	-53.97875977	4.00059E-06
2595210000	-3.895996094	-50	-53.89599609	4.07756E-06
2595220000	-3.806396484	-50	-53.80639648	4.16256E-06
2595230000	-3.725097656	-50	-53.72509766	4.24121E-06
2595240000	-3.655761719	-50	-53.65576172	4.30947E-06
2595250000	-3.565673828	-50	-53.56567383	4.3998E-06
2595260000	-3.479003906	-50	-53.47900391	4.48848E-06
2595270000	-3.399902344	-50	-53.39990234	4.57098E-06
2595280000	-3.308227539	-50	-53.30822754	4.6685E-06
2595290000	-3.239624023	-50	-53.23962402	4.74283E-06
2595300000	-3.145751953	-50	-53.14575195	4.84646E-06
2595310000	-3.050170898	-50	-53.0501709	4.95431E-06
2595320000	-2.966918945	-50	-52.96691895	5.05019E-06
2595330000	-2.903076172	-50	-52.90307617	5.12498E-06
2595340000	-2.846069336	-50	-52.84606934	5.1927E-06
2595350000	-2.764892578	-50	-52.76489258	5.29067E-06
2595360000	-2.6953125	-50	-52.6953125	5.37612E-06
2595370000	-2.624145508	-50	-52.62414551	5.46494E-06
2595380000	-2.559204102	-50	-52.5592041	5.54727E-06
2595390000	-2.489990234	-50	-52.48999023	5.63639E-06
2595400000	-2.43737793	-50	-52.43737793	5.70509E-06
2595410000	-2.385742188	-50	-52.38574219	5.77332E-06
2595420000	-2.274780273	-50	-52.27478027	5.92273E-06
2595430000	-2.222045898	-50	-52.2220459	5.99509E-06
2595440000	-2.185058594	-50	-52.18505859	6.04636E-06
2595450000	-2.12121582	-50	-52.12121582	6.1359E-06
2595460000	-2.091186523	-50	-52.09118652	6.17848E-06
2595470000	-2.036743164	-50	-52.03674316	6.25642E-06
2595480000	-1.99017334	-50	-51.99017334	6.32387E-06
2595490000	-1.943664551	-50	-51.94366455	6.39195E-06
2595500000	-1.887512207	-50	-51.88751221	6.47513E-06

Total = 3.02E-04 Out of band = $10 * \log(3.02E-04 / 561) = -62.7 \text{ dB}$

The out of band at 1 MHz from the channel edge is -62.7 dB below the transmitter power, which exceeds the requirement by a large margin. Frequencies further from the channel edge will be attenuated even further due to the additional attenuation through the output filter.

Transmitter Power (W): 25

Channel Filter Insertion Loss (dB): -1.0

Transmitter Power after Channel Filter (W): 20

4.5 Radiated Emissions

Using the test setup shown in Figure 4-10, with the transmitter operating at full power, the spectrum analyzer was moved 20 meters from the transmitter and connected to a dipole antenna cut to the IF frequency (44 MHz). This antenna was oriented to maximize the received level and the data was recorded. The antenna was then cut to the carrier frequency, local oscillator frequency and the second through tenth harmonic frequencies of the transmitter, and all of the signals received, were maximized by antenna orientation and their absolute levels were recorded.

The spectrum analyzer had a maximum sensitivity of -110 dBm during these tests.

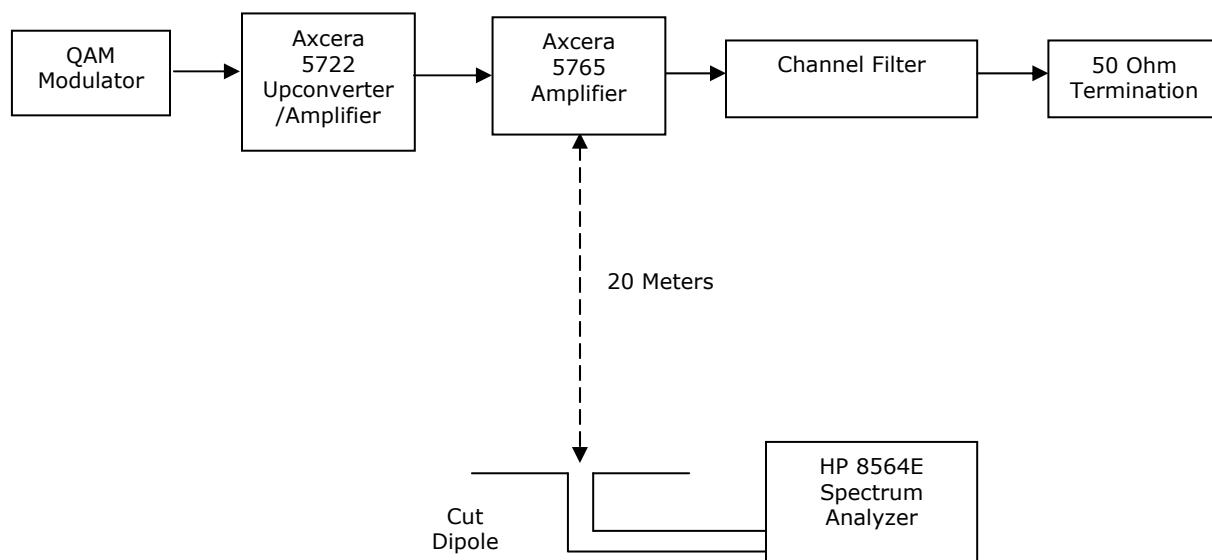


Figure 4-10. Test Setup for Measuring Radiated Emissions

FREQUENCY (MHz)	SOURCE	PEAK LEVEL OBSERVED (dB)
44.00	IF Frequency	None Observed
2599.00	Center of Channel	- 58 dB
2643.00	Local Oscillator	None Observed
5198.00	2 nd Harmonic	None Observed
7797.00	3 rd Harmonic	None Observed
10396.00	4 th Harmonic	None Observed
12995.00	5 th Harmonic	None Observed
15594.00	6 th Harmonic	None Observed
18193.00	7 th Harmonic	None Observed
20792.00	8 th Harmonic	None Observed
23391.00	9 th Harmonic	None Observed
25990.00	10 th Harmonic	None Observed

Table 4-4. Radiated Emissions Data

If all of the amplifier's power (20 Watts) was radiated by an isotropic radiator, the power density at 20 meters would be:

$$P_d = P_t / 4\pi R^2 = 20 / 4\pi (20)^2 = .004 \text{ w/m}^2$$

Using a dipole-transmitting antenna increases this by 1.64 to:

$$1.64 \times .004 = .00656 \text{ w/m}^2$$

If a dipole receive antenna of area $1.64 \times \pi^2 / 4\pi$ is used to receive the signal, the received level would be:

-19.4 dBm

Therefore, the measured value was at the following relative level:

<u>Frequency</u> (MHz)	<u>Relative Measured Level</u> (Ref = -19.4 dBm)
2599.00 MHz	-38.6 dB

The cabinet radiation was also checked with the receive dipole antenna cut to 2599 MHz, within very close proximity to the trays of the transmitters, and the received level that was recorded at no time exceeded a power density in excess of +0.0 dBm.

This level is far less than the current or proposed standard for safe radiation levels.

4.7 Test Equipment

The test equipment that was used to analyze the Axcera 5765 system is listed in Table 4-6.

Table 4-6. Test Equipment

MODEL	MANUFACTURER	DESCRIPTION	SERIAL #
8564E	Hewlett-Packard	Spect. Analyzer 9 KHz-40 GHz	Rental
8595E	Hewlett-Packard	Spect. Analyzer 9 KHz-6.5 GHz	3543A01613
3003-30	Narda	Directional Coupler	41991
3003-10	Narda	Directional Coupler	09049
435B	Hewlett-Packard	30 Watt Power Head	2732009080
2349A	Hewlett-Packard	30 dB Directional Coupler	3318A05525
2230	Tektronix	Oscilloscope	2230B025251
1992	Racal-Dana	Frequency Counter	950304
8135	Bird	50 Ohm Termination	8520
79	Fluke	Digital Multi-meter	56660032
89441A	Hewlett-Packard	Vector Sig. Analyzer (IF Section)	3416A01020
89441A	Hewlett-Packard	Vector Sig. Analyzer (RF Section)	3415A00333