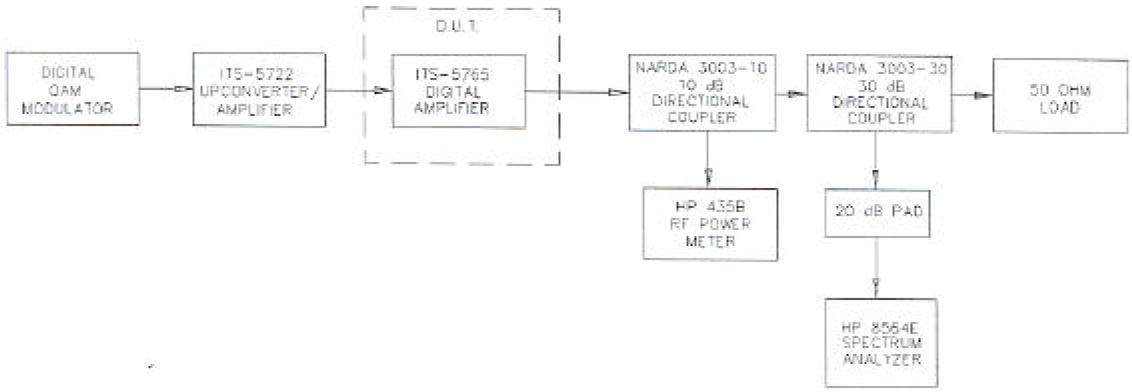
3.0 ENGINEERING DATA

3.1 RF Power Measurement

The following block diagram illustrates the test equipment set-up for setting the output power:



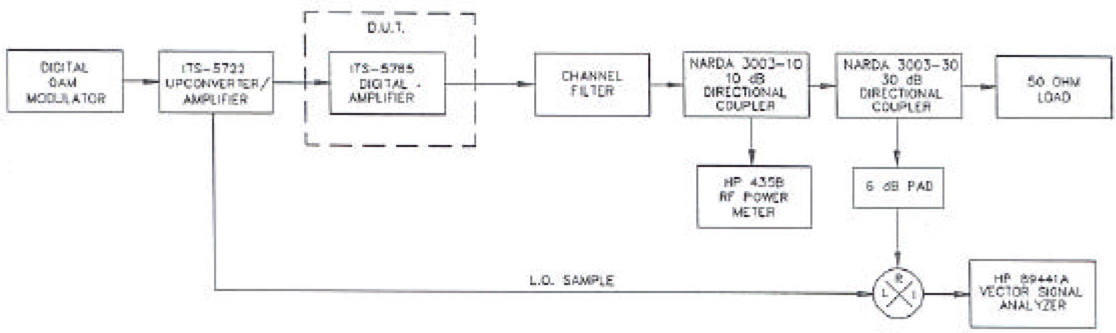
The digital 64 QAM output signal from the driver transmitter was connected to the input of the ITS-5765 Amplifier. Next, the driver transmitter was adjusted to obtain 25 watts (average) at the RF output of the amplifier as observed on the power meter. This level was used to establish a reference level on the analyzer. The transmitter's front panel LCD power meter was adjusted to read 100 % external power.

With the power level set to 25 watts (average), all required test were performed and recorded in the following sections.

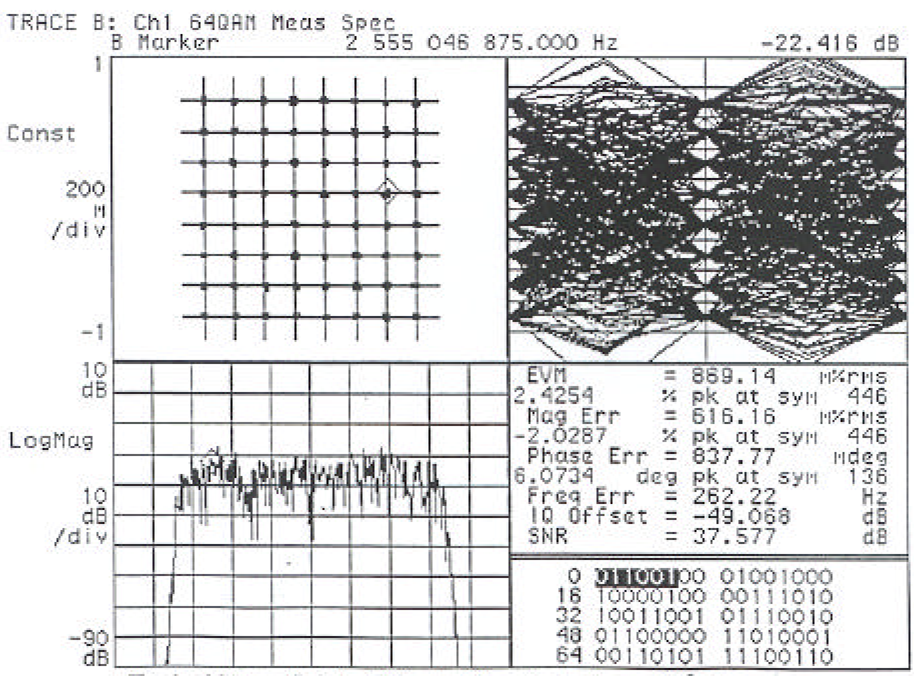
3.0 ENGINEERING DATA

3.2 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.



Typical QAM Demodulation Test Set-up



Typical Demodulated Vector Signal Analyzer Display

3.0 ENGINEERING DATA

3.2 Modulation Characteristics - continued

Constellation Diagram	(Upper left box) This diagram displays the in-phase signal (I) on the x-axis versus the quadrature phase signal (Q) on the y-axis. The points shown on the constellation vector diagram correspond only to the symbol clock time. These points are commonly referred to as detection decision points and are called symbols. Constellation diagrams help identify such things as amplitude imbalance, quadrature error or phase noise.
Eye Diagram	(Upper right box) Eye diagrams are commonly used in digital communication systems and help identify problems such as ISI (inter-symbol interference) and jitter. The eye diagram is the display of I (real) or Q (imaginary) signal versus the time that is triggered by the symbol clock.
Spectrum Display	(Lower left box) This display shows the spectrum of the QAM modulated signal and is useful for determining and adjusting the frequency response of the signal.
Error Vector Magnitude	(Lower right box) This parameter indicates the magnitude of the vector which connects the I Q reference signal phasor to the I Q measured signal phasor. The error vector magnitude (EVM) is computed by the square root of the sum of the squares for each complex pair of points, in the time record, normalized to a reference point.
Magnitude Error	(Lower right box) This parameter indicates the difference in amplitude between the I Q reference signal and the I Q measured signal. Magnitude error is an indication of the quality of the amplitude component of the modulated signal. Magnitude error might indicate a high incidental AM modulation on the signal.
Phase Error	(Lower right box) This parameter indicates the difference in phase between the I Q reference signal and the I Q measured signal. The magnitude of the parameter is an indication of the quality of the phase component of the modulated signal. Phase error might be attributed by high incidental FM modulation on the signal.
Frequency Error	(Lower right box) This parameter indicates the carrier frequency error in relation to the analyzer's center frequency and is measured in Hz. Typical examples of frequency error are errors in RF frequency, LO frequency or digitizer clock rate.

3.0 ENGINEERING DATA

3.2 Modulation Characteristics - continued

I Q Offset (Origin Offset) (Lower right box) This parameter indicates the magnitude of the carrier feedthrough (if the carrier is 100% suppressed, the I Q offset is zero). Carrier feedthrough is an indication of the balance of the I Q modulator used to generate the modulated signal. If the modulator is balanced, the carrier is nulled by the RF spectrum. Imbalance in the I Q modulator results in carrier feedthrough and appears as an origin offset in the constellation diagram.

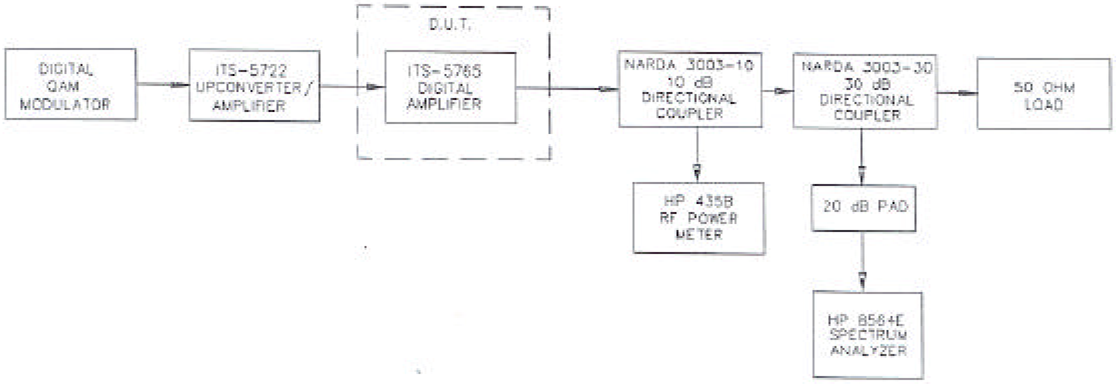
Signal to Noise Ratio (Lower right box) The signal to noise ratio (SNR) is the average symbol power of the transmitted waveform relative to the noise power. The noise power includes any term that causes the symbol to deviate from the ideal state position, such as additive noise, distortion and ISI (inter-symbol interference).

Detected Data (Lower right box) The binary data in the box represents the detected or recovered data from the digitally modulated signal.

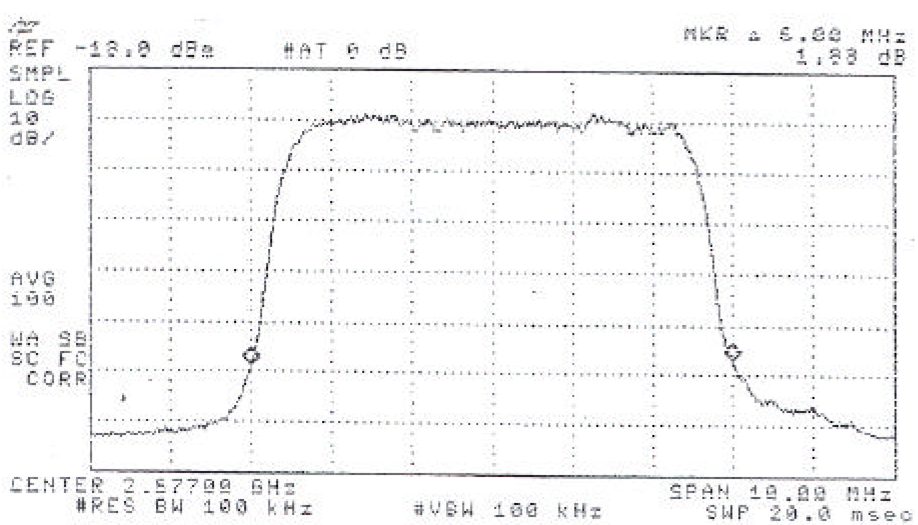
3.0 ENGINEERING DATA

3.3 Occupied Bandwidth

Using the following test set-up, the amplifier was operated at maximum power and a plot of the occupied bandwidth spectrum was taken.



Spectrum Analyzer Plot (Occupied Bandwidth):



As indicated by the markers at the channel edges on the above plot, the occupied bandwidth of a quadrature amplitude modulated signal is approximately 6 MHz.

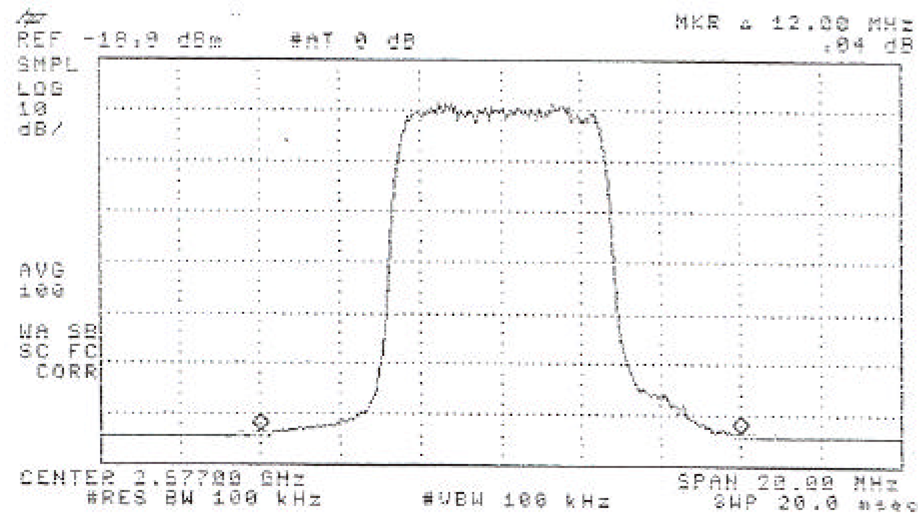
3.0 ENGINEERING DATA

3.4 Out-of-Band Power

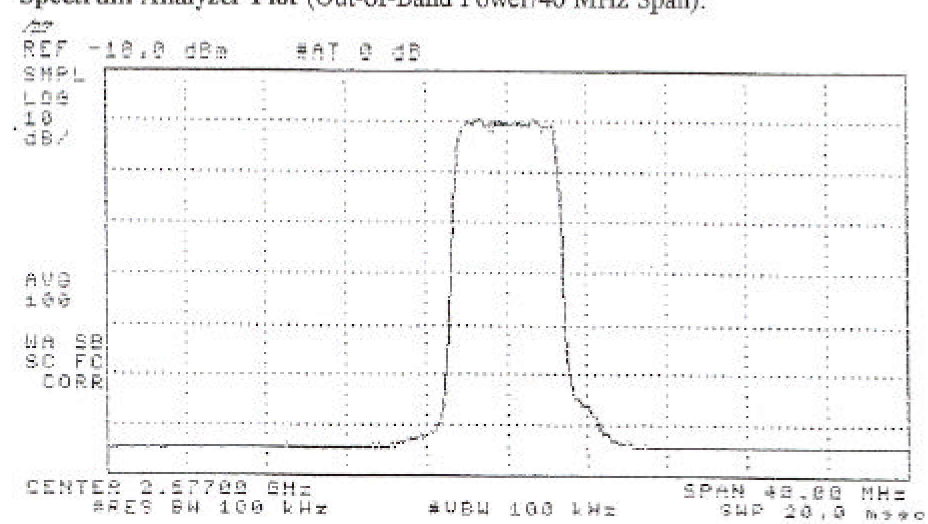
Using the test set-up shown in section 3.3, the spectrum outside of the specified channel was observed and the data was taken on all products above the -64 dB noise floor of the spectrum analyzer. The measured data is shown in the table on the following pages for 25 watts average output power.

Spurious Emissions were observed on the analyzer at both 20 MHz and 40 MHz span (see spectrum plots below). With the average in band signal set as the reference, the spurious emissions were observed (see table on the following page).

Spectrum Analyzer Plot (Out of Band Power/20 MHz Span):



Spectrum Analyzer Plot (Out-of-Band Power/40 MHz Span):



As indicated by the markers 3.0 MHz above and below the channel edges, the Out-of-Band Power is below -60 dB per FCC Rules and Regulations.

3.0 ENGINEERING DATA

3.4 Out-of-Band Power - continued

Frequency	Source	Level Observed
2677.00 MHz	Center of Channel	0 dB (reference)
44 MHz	IF	None Observed
2721.00 MHz	Local Oscillator	None Observed
22674.00 MHz	Lower Channel Edge	-46 dB
22680.00 MHz	Upper Channel Edge	-45dB
2671.00 MHz	3 MHz Below Channel	-63 dB
2683.00 MHz	3 MHz Above Channel	-63 dB
5354.00 MHz	2nd Harmonic	None Observed
8031.00 MHz	3rd Harmonic	None Observed
10708.00 MHz	4th Harmonic	None Observed
13385.00 MHz	5th Harmonic	None Observed
16062.00 MHz	6th Harmonic	None Observed
18739.00 MHz	7th Harmonic	None Observed
21416.00 MHz	8th Harmonic	None Observed
24093.00 MHz	9th Harmonic	None Observed
26770.00 MHz	10th Harmonic	None Observed

3.0 ENGINEERING DATA

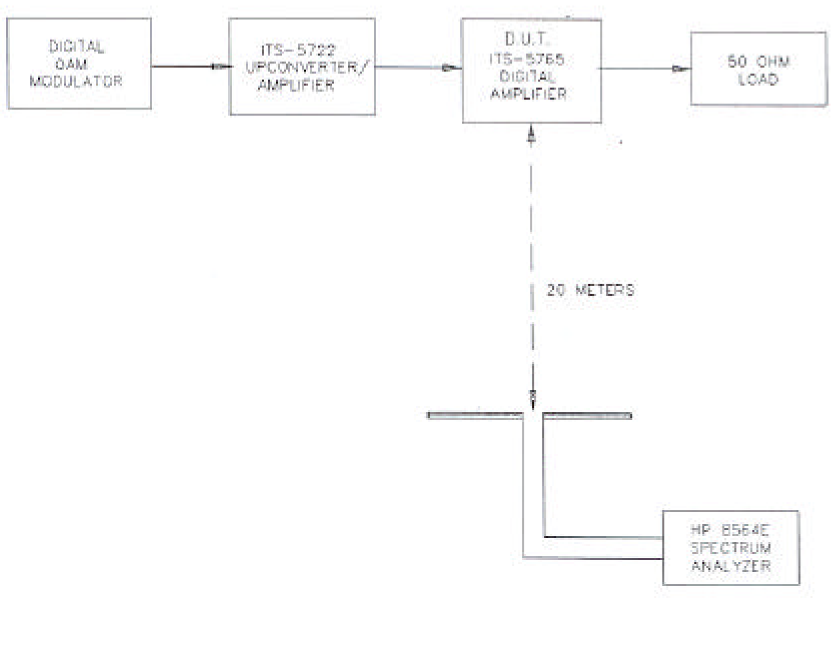
3.5 Radiated Emissions

Using the test set-up below, with the amplifier operating at 25 watts output power and at a carrier frequency of 2677.00 MHz, the spectrum analyzer was moved 20 meters from the booster 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 channel frequency, LO, and the second through the tenth harmonic frequencies of the transmitter and all signals received were maximized by antenna orientation, and their absolute levels were recorded.

With these various antennas the frequency spectrum was observed and the following data was recorded:

Frequency (MHz)	Source	Level Observed (Into 50 Ω)
44.00	IF	None Observed
2677.00	Center of Channel	-58 dB
2721.00	Local Oscillator	None Observed
5354.00	2nd Harmonic	None Observed
8031.00	3rd Harmonic	None Observed
10708.00	4th Harmonic	None Observed
13385.00	5th Harmonic	None Observed
16062.00	6th Harmonic	None Observed
18739.00	7th Harmonic	None Observed
21416.00	8th Harmonic	None Observed
24093.00	9th Harmonic	None Observed
26770.00	10th Harmonic	None Observed

Test Set-up:



3.0 ENGINEERING DATA

3.5 Radiated Emissions - Continued

If all of the amplifier's power (25 Watts) was radiated by an isotropic radiator, the power density at 20 meters would be:

$Pd = Pt/4\pi R^2 = 25/4\pi (20)^2 \cong 4.9736x10^{-3}$ w/m^2

Using a dipole transmitting antenna increases this by 1.64 to:

$1.64 * 4.9736x10^{-3} = 8.1567x10^{-3}$ w/m^2

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

$8.1567 x10^{-3} * 1.64 * \lambda^2/4\pi = 13.37 x10^{-6}$ w = - 48.7 dBw = -18.7 dBm

Therefore, the measured values were at the following relative levels:

Frequency (MHz)	Relative Measured Level (Ref = -15.3 dBm)
2677.00 MHz	42.7

The cabinet radiation was also checked with the receive dipole antenna cut to 2677.00 MHz, within very close proximity to the transmitter's trays, and the received level recorded at no time exceeded a level in excess of -10 dBm. The power density at this level would then be:

$Pr/A = 5.7x10^{-3}$ mW/cm^2

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

3.0 ENGINEERING DATA

3.6 Test Equipment

MODEL	MANUFACTURER	DESCRIPTION	SERIAL #
8564E	Hewlett Packard	Spect. Analyzer 9 KHz-40 GHz	Rental
8595E	Hewlett Packard	Spect. Analyzer 9 GHz- 6.5 GHz	3543A01613
3003-30	Narda	Directional Coupler	41991
3003-10	Narda	Directional Coupler	09049
435B	Hewlett Packard	RF Power Meter	2732009080
2349A	Hewlett Packard	30 Watt Power Head	3318A05525
2230	Tektronix	Oscilloscope	2230B025251
1992	Racal-Dana	Frequency Counter	950304
8135	Bird	50 Ohm Termination	8520
79	Fluke	Digital Multimeter	56660032