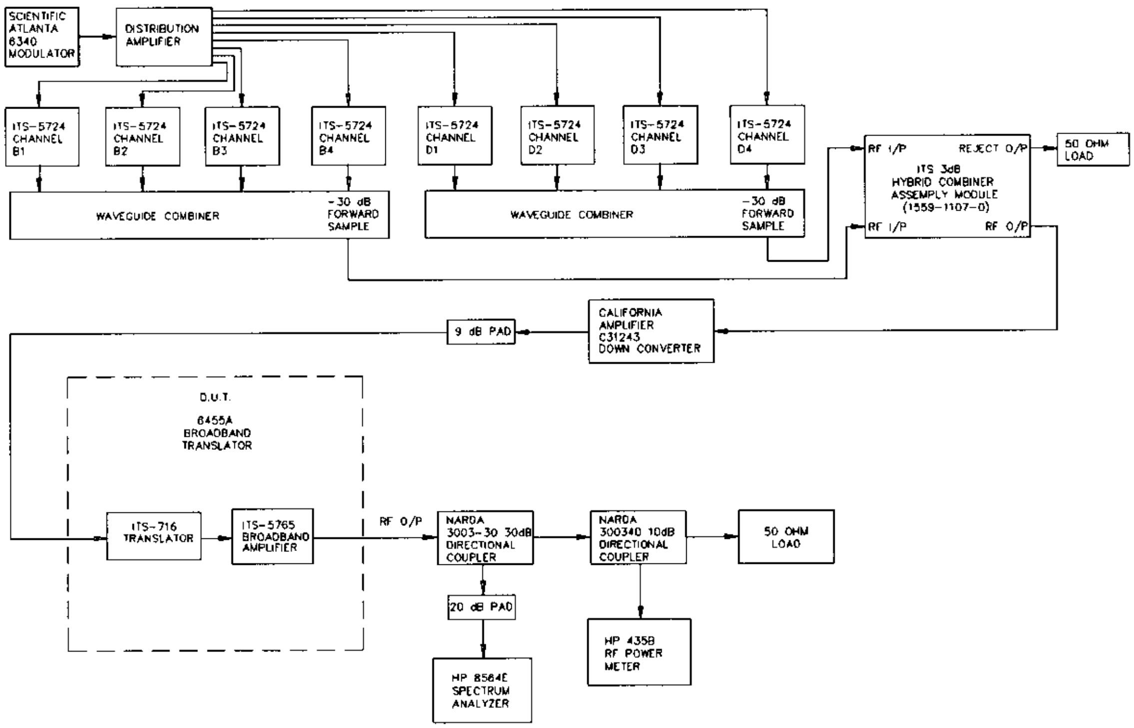
3.0 ENGINEERING DATA

3.1 RF Power Measurements

The following block diagram illustrates the test equipment set-up for RF power measurement:



Before testing the 6455A multi-channel translator, the ITS-5724 transmitters (FCC ID# CJJ79SITS-7026) used to generate the multi-channel input signal to the translator were tested and observed to meet specifications. Then, the translator was tested and observed, as illustrated in the following sections, to reliably reproduce the transmitted signals in acordance with the rules set forth in the Rules and Regulations.

3.0 ENGINEERING DATA

3.1 RF Power Measurements - continued

With eight visual carriers present, the ouput power of the 6455A translator was adjusted to rated output power (29 dBm/channel) as observed on the spectrum analyzer. With the power level properly set to 29 dBm/channel, all required tests were performed and recorded in the following sections.

Number of channels	Average power/channel	Total Average Power
8	0.79 W	6.3 W

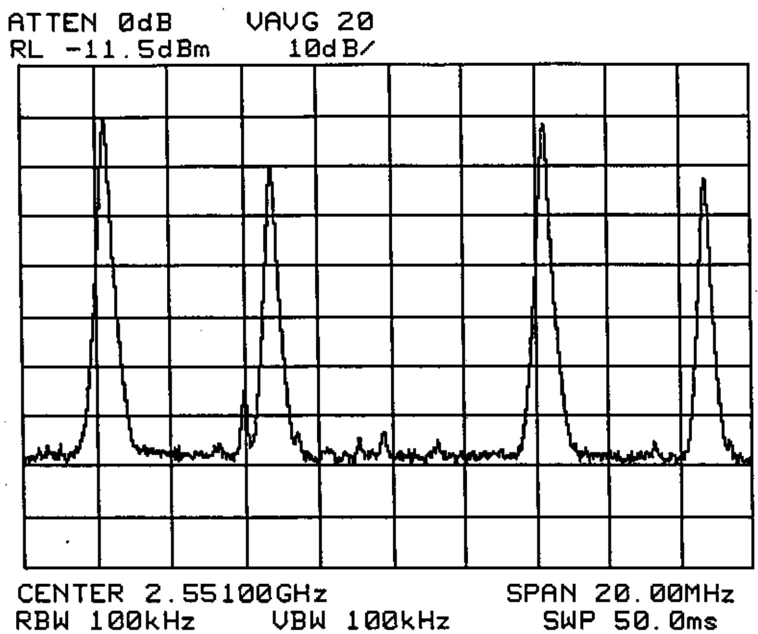
Note: The peak envelope power has been determined and observed to be six times, or 7.8 dB, above the total average power. Therefore, the maximum peak envelope power for the 6455A is approximately 37.8 watts. In addition, for multi-channel loading, , a doubling in the number of channels requires a 3 dB back-off in the peak power per channel. Also, in the case of 8 or more channels, the total average power remains constant at 6.3 watts. The average power per channel is 6.3 watts divided by the number of channels.

3.0 ENGINEERING DATA

3.3 Out-of-Band Power - continued

Using the test set-up in Section 3.1, the emissions within an unoccupied channel were observed. With the peak visual carrier set as the reference, the spurious emissions were observed recorded (see spectrum plot and table below).

Spectrum Analyzer Plot (Unoccupied Channel Emissions):



Note: The above plot shows unoccupied channel C1 (2551 MHz center channel)

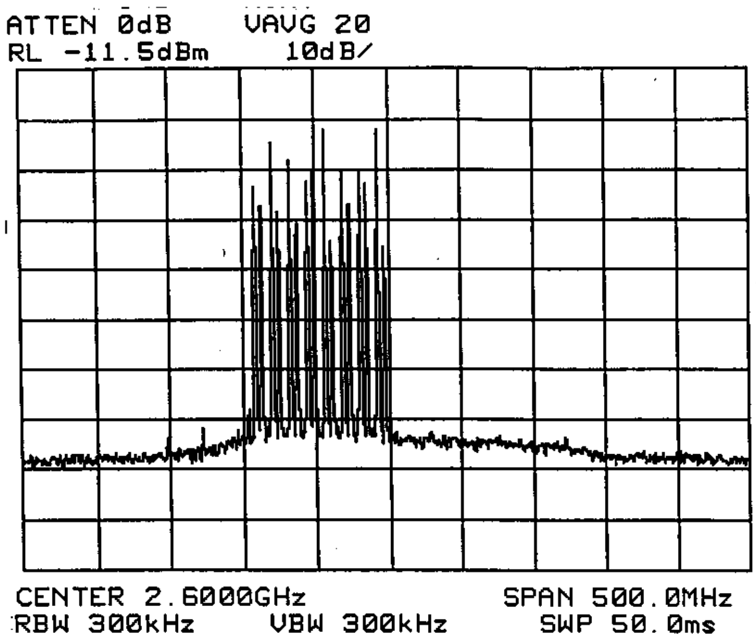
Frequency (MHz)	Source	Level Observed
2548	lower channel edge	-43.6 dB
2548.25	+250.0 KHz above lower ch edge	-63.1 dB
2549	+1.0 MHz above lower ch edge	-67.2 dB
2550	+2.0 MHz above lower ch edge	-64.6 dB
2551	center channel (3.0 MHz)	-66.5 dB
2552	-2.0 MHz below upper ch edge	-67.5 dB
2553	-1.0 MHz below upper ch edge	-66.1 dB
2553.75	-250.0 KHz below upper ch edge	-65.0 dB
2554	upper channel edge	-64.8dB

3.0 ENGINEERING DATA

3.3 Out-of-Band Power

Using the test set-up of section 3.1, the spectrum outside of the specified band was observed and the data was taken on all products above the -65 dB noise floor of the spectrum analyzer (see spectrum plot below). All spectral points were measured at the same resolution bandwidth used to establish the reference level on the analyzer.

Spectrum Analyzer Plot/500 MHz Span (Out-of-Band Power):



Frequency (MHz)	Source	Level Observed
2500 - 2690	operating band	0 dB (reference)
2500	lower band edge	-62.0 dB
2499.75	-250.0 KHz below band edge	-63 dB
2497	-3.0 MHz below band edge	-63 dB
2480	-20.0 MHz below band edge	-64 dB
<2480	--	-63 dB (max)
2690	upper band edge	-64 dB
2690.25	+250.0 KHz above band edge	-64 dB
2693	+3.0 MHz above band edge	-64 dB
2671	+20.0 MHz above band edge	-64 dB
5000 - 5380	2nd harmonic frequencies	-65 dB
7500 - 8070	3rd harmonic frequencies	-65 dB
10000 - 10760	4th harmonic frequencies	-65 dB
12500 - 13450	5th harmonic frequencies	-65 dB
15000 - 16140	6th harmonic frequencies	-65 dB
17500 - 18830	7th harmonic frequencies	-65 dB
20000 - 21520	8th harmonic frequencies	-65 dB
22500 - 24210	9th harmonic frequencies	-65 dB
25000 - 26900	10th harmonic frequencies	-65 dB

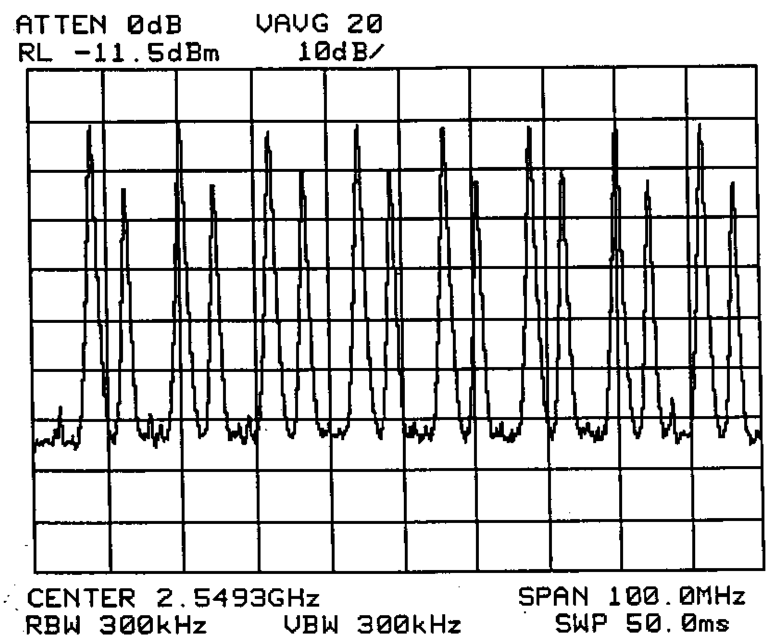
3.0 ENGINEERING DATA

3.2 Occupied Bandwidth

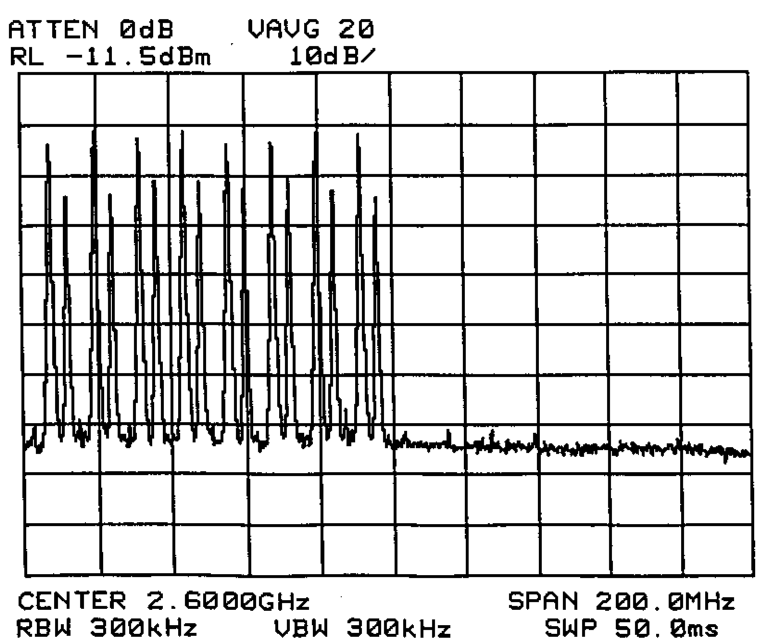
Using the test set-up in Section 3.1, with the booster operating at rated output power and with eight input signals (B1, B2, B3, B4, D1, D2, D3, D4) present, the analyzer was set to a span of 100 MHz and a reference level was established (see plot below). Then the analyzer was adjusted to a span of 200 MHz and the occupied bandwidth (2500.0 MHz - 2690.00 MHz) was observed and recorded below.

Note: The 190 MHz bandwidth permits a maximum of thirty one 6MHz channels.

Spectrum Analyzer Plot/100 MHz Span (Reference level):



Spectrum Analyzer Plot/200 MHz Span (Occupied Bandwidth):

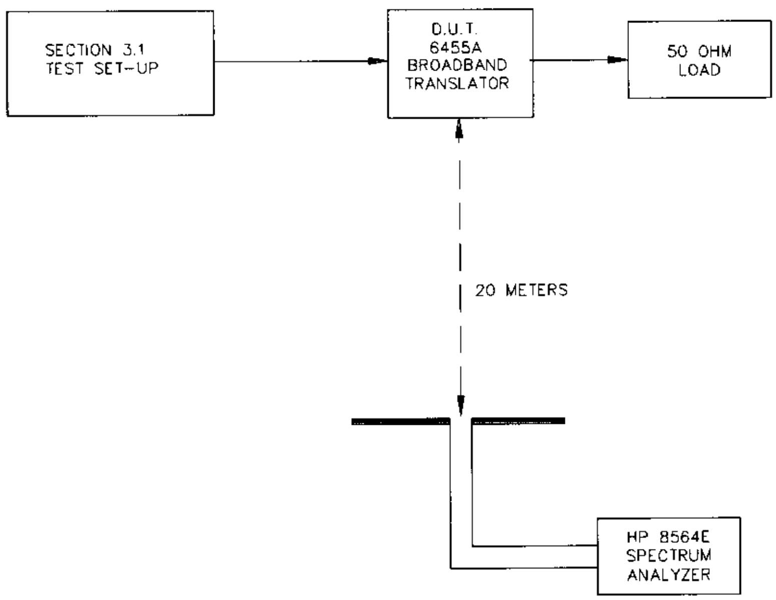


3.0 ENGINEERING DATA

3.5 Radiated Emissions

Using the test set-up below, with the translator oerating at full output power (6.3 W total average) and with eight input signals, the spectrum analyzer was moved 20 meters from the booster and connected to a dipole antenna cut to the visual carrier frequency of B1 (2507.25 MHz). This antenna was oriented to maximize the received level, and the data was recorded. The antenna was then cut to the remaining seven center channel frequencies and the second through the tenth harmonic frequencies and all signals received were maximized by antenna orientation, and their absolute levels were recorded (see table below).

Test Set-up:



MEASURED LEVELS

Frequency (MHz)	**Source**	**Level Observed (into 50 Ω)**
2500 - 2690	operating band	None Observed
5000 - 5380	2nd harmonic frequencies	None Observed
7500 - 8070	3rd harmonic frequencies	None Observed
10000 - 10760	4th harmonic frequencies	None Observed
12500 - 13450	5th harmonic frequencies	None Observed
15000 - 16140	6th harmonic frequencies	None Observed
17500 - 18830	7th harmonic frequencies	None Observed
20000 - 21520	8th harmonic frequencies	None Observed
22500 - 24210	9th harmonic frequencies	None Observed
25000 - 26900	10th harmonic frequencies	None Observed

3.0 ENGINEERING DATA

3.5 Radiated Emissions - continued

Note: The spectrum analyzer had a maximum sensitivity of -100 dBm during these tests.

These levels were then compared to the following reference level:

If all of the transmitter's power (6.3 Watts) was radiated by an isotropic radiator, the power density at 20 meters would be:

$$Pd = Pt/4_{\pi} R^2 = 6.3/4_{\pi} (20)^2 \cong 1.2534\text{x}10^{-3} \text{ w/m}^2$$

Using a dipole transmitting antenna increases this by 1.64 to:

$$1.64 * 1.2534\text{x}10^{-3} = 2.0555 \text{ x}10^{-3} \text{ w/m}^2$$

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

$$2.0555 \text{ x}10^{-3} * 1.64 * \lambda^2/4_{\pi} = 3.81 \text{ x}10^{-6} \text{w} = -54.2 \text{ dBw} = -24.2 \text{ dBm}$$

Therefore, with a carrier reference level of -24.2 dBm, and a analyzer measurement threshold of -100 dBm, no measured values exceeded a level of:

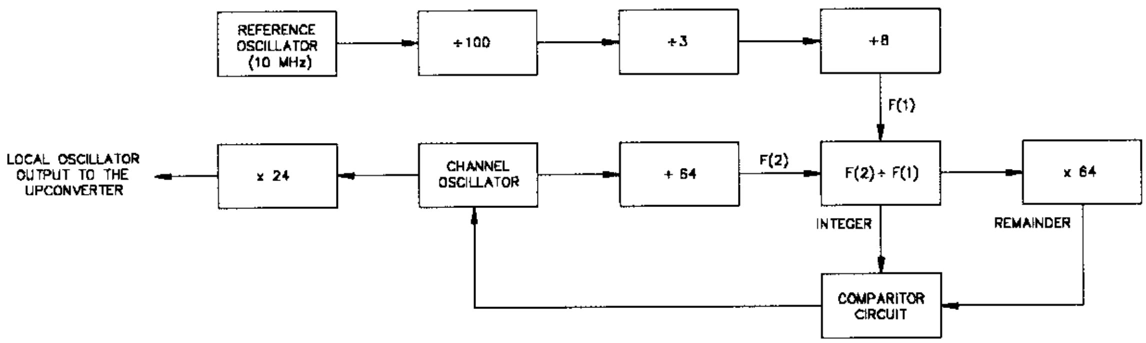
-100 dBm -(-24.2 dBm) = <u>-75.8 dBc</u>

3.0 ENGINEERING DATA

3.6 Frequency Stability

Channel Oscillator Analysis

The following is the functional block diagram for phase-locking the channel oscillator:



F_r = Reference oscillator frequency
F_{co} = Channel oscillator frequency
E_r = Reference oscillator error
E_{co} = Channel oscillator error

$F(1) = F_r/2400$
$F(2) = F_{co}/64$

$F(2)/F(1) = 37.5 \times (F_{co}/F_r)$ (Equation 1)

The comparitor circuit sends an error voltage to the channel VCXO, which maintains the value derived by equation 1. If error is introduced to the reference oscillator (E_r), the comparitor offsets the channel VCXO in a manner that preserves the relationship in equation 1. This offset is defined as the channel oscillator error (E_{co}). The following is an algebraic definition for the channel oscillator error:

$37.5 \times (F_{co} + E_{co})/(F_r + E_r) = 37.5 \times F_{co}/F_r$
$(F_{co} + E_{co})/(F_r + E_r) = F_{co}/F_r$
$F_r \times (F_{co} + E_{co}) = F_{co} \times (F_r + E_r)$
$F_r \times E_{co} = F_{co} \times E_r$

$E_{co} = E_r \times (F_{co}/F_r)$ (Equation 2)

The local oscillator (L.O.) frequency is 24 times the channel oscillator, or $24 \times F_{co}$. The RF output frequency is the upper product of mixing the L.O. with the superband input signal (F_{input}) The following is the algebraic expression for the output frequency:

$RF = [24 \times F_{co}] + F_{input}$ or,
$RF = [24 \times (F_{co} + E_{co})] + F_{input}$ (error introduced into the equation)

3.0 ENGINEERING DATA

3.6 Frequency Stability - continued

Based on the above equation, the following equation gives the expression for the error in the output RF:

$RF_{error} = [24 \times E_{co}]$

Substituting equation 2 into the above error equation yields the following:

$RF_{error} = [24 \times (E_r \times F_{co}/F_r)]$ (Equation 3)

Substituting the channel oscillator frequency (94.91667 MHz), and the reference oscillator frequency (10.0 MHz) into equation 3 yeilds:

F_r = 10 MHz F_{co} = 113.625 MHzE_{if} = 440 Hz

RF_{error} = 227.80 x E_r (Equation 4)

The 10 MHz reference oscillator was placed in a Thermotron temperature test chamber, and the temperature was varied from -30°C to +50°C. The frequency of the oscillator was measured at 10°C increments up to +50°C. The oscillator was allowed a reasonable amount of time to stabilize at each temperature increment. The data on the following pages records the reference oscillator frequency over a the temperature range and a calculation of the output frequency error. This data indicates that the transmitter's output frequency is within the FCC tolerance for this service.

3.0 ENGINEERING DATA

3.6 Frequency Stability - continued

OSCILLATOR TEMPERATURE STABILITY DATA

TEMP. (°C)	10.00 MHz Reference Oscillator	Reference Oscillator Error (E_r)	Output Frequency Error (227.80 x E_r)
-30	10.000001.2 MHz	1.2 Hz	273.46 Hz
-20	10.000001.0 MHz	1.0 Hz	227.80 Hz
-10	10.000000.8 MHz	0.8 Hz	182.24 Hz
0	10.000000.5 MHz	0.5 Hz	113.90 Hz
+10	10.000000.0 MHz	0.0 Hz	0.0Hz
+20	10.000000.0 MHz	0.0 Hz	0.0Hz
+30	10.000000.4 MHz	0.4 Hz	91.12 Hz
+40	10.000000.1 MHz	0.1 Hz	22.78 Hz
+50	10.000000.7 MHz	0.7 Hz	159.46 Hz

3.0 ENGINEERING DATA

3.6 Frequency Stability - continued

FREQUENCY STABILITY VS. LINE VOLTAGE

Line Voltage (VAC at 60 Hz)	10.00 MHz Reference Oscillator	Reference Oscillator Error (E_r)	Output Frequency Error ($227.80 \times E_r$)
95V	10.000000 MHz	0 Hz	0 Hz
115V	10000000 MHz	0 Hz	0 Hz
135V	10000000 MHz	0 Hz	0 Hz

3.0 ENGINEERING DATA

3.8 Test Equipment

MODEL	MANUFACTURER	DESCRIPTION	SERIAL #
8564E	Hewlett Packard	Spect. Analyzer 9 KHz - 40 GHz	3619A02932
8714B	Hewlett Packard	Network Analyzer .01 GHz - 40 GHz	US35490400
3003-30	Narda	30 dB Directional Coupler	20873
300340	Narda	10 dB Directional Coupler	1453
435A	Hewlett Packard	RF Power Meter	1601A03842
8481B	Hewlett Packard	30 Watt Power Sensor	3318A09253
77	Fluke	Digital Multimeter	81000244
8401	Termaline	Coaxial Resistor	6622
C31243	Californai Amplifier	Low Noise Downconverter	24866

5.0 CERTIFICATION OF TEST DATA

This equipment has been tested in accordance with the requirements contained in the appropriate Commission regulation. To the best of my knowledge, these tests were performed using measurement procedures consistent with industry or Commission standards and demonstrate that the equipment complies with the appropriate standards. Each unit manufactured, imported or marketed, as defined in the Commission's regulations, will conform to the sample(s) tested within the variations that can be expected due to quantity production and testing on a statistical basis. I further certify that the necessary measurements were made by Information Transmission Systems Corp., 375 Valley Brook Road, McMurray, Pennsylvania 15317.

David Urban

Dave Urban, Chief Engineer

Todd Anderson

Todd Anderson, Engineer