

1.0 INTRODUCTION

This report contains all the required data for type acceptance of the Communication Microwave Corp model SBSA-50C television transmitter. The data presented was taken from tests performed on a production transmitter tuned to operate on ITFS channel D-4 (2590 – 2596 MHz). Other information required for type acceptance, such as circuit diagrams and descriptions, photographs, and tune-up and maintenance procedures may be found in the Comwave SBSA-50C instruction manual. The transmitter design and resultant test data reflect the revised MMDS/ITFS requirements imposed November 1, 1991.

2.0 CERTIFICATION OF DATA

FCC Paragraph 2.909 (d)

Having personally conducted the tests contained in this report, I certify that the statements and data submitted are true and correct to the best of my knowledge.

Paulo Correa
Director of Engineering
Communication Microwave Corp

3.0 TEST EQUIPMENT

FCC Paragraph 2.947 (d)

The following is a list of major test equipment, which was used in testing the SBSA-50C transmitter for this report:

- | | |
|-------------------------|------------------|
| 1) Spectrum Analyzer | HP Model 8564E |
| 2) Spectrum Analyzer | HP Model 8593E |
| 3) Power Meter | HP Model 436A |
| 4) Frequency Counter | HP Model 5350B |
| 5) Digital Multimeter | Fluke Model 87 |
| 6) TV Demodulator | TEK Model 1450-1 |
| 7) Audio Analyzer | TEK Model VM700 |
| 8) NTSC Test Set | TEK Model VM700 |
| 9) NTSC Video Generator | TEK Model 1910 |
| 10) Oscilloscope | TEK Model 2215 |
| 11) Test Oscillator | HP 651B |

4.0 DESCRIPTION OF EQUIPMENT

FCC Paragraph 2.983

- | | | |
|----|----------------------------|--|
| 1) | Type of Emission | Visual – 5M75C3F
Aural – 250KF3E |
| 2) | Frequency Range | 2000 – 2700 MHz |
| 3) | Operating Range | 10-50 watts peak visual
0.3 – 1.5 watts average aural |
| 4) | Power Rating | 50 watts peak visual
1.58 watts average aural |
| 5) | E & I on Final | Drain voltage 10 V
Drain current 2.2 A each |
| 6) | Function of Active Devices | |

The following is a list of active devices in the RF and LO chains of the transmitter. The relative position of each device may be found by referring to the transmitter block diagram in the technical manual.

Microwave Upconverter/Amplifier

Microwave Synthesizer Board 35-063-02

- | | |
|--------|------------------------|
| U1 | Dual Modulus Prescaler |
| U2 | Synthesizer |
| U3 | Comparator |
| U4 | Regulator |
| U5, U7 | Dividers |
| U6 | Operational Amplifier |

Voltage Controlled Oscillator Board 33-291-01

- | | |
|----|----------------------------------|
| U1 | Voltage Controlled
Oscillator |
| U2 | RF Amplifier |
| U3 | Operational Amplifier |
| U4 | Microwave Prescaler |
| U6 | 5 V Voltage Regulator |
| U7 | Shunt Regulator |

Distribution Amplifier Board 40-207-01

- | | |
|----|---------------|
| U1 | RF Amplifier |
| U2 | RF Amplifier |
| U8 | 5 V Regulator |

IF Processor Board 33-315-01

- | | |
|-----------------------------|------------------------|
| D1, D2, D3,
D4, D11, D12 | Attenuator Diodes |
| D5, D6, D7,
D8 | Linearity Correctors |
| U1, U2, U4 | IF Amplifier |
| D9 | Protection Diode |
| U3 | Voltage Regulator |
| U6 | Operational Amplifiers |

Q2	Transistor Switch
D10	IF Attenuator
UHF Upconverter Module 09-058-02	
U1	IF to UHF Mixer
U2	IF to UHF Mixer
U3	RF Amplifier
U4	RF Amplifier
Upconverter Synthesizer Board 34-007-02	
U1	Voltage Comparator
U2	PAL
U3	Synthesizer IC
U4	Comparator
U5	Pre Scaler
U6	Operational Amplifier
U8	Voltage Controlled Oscillator
U7, U10, U11	RF Amplifier
U12	Voltage Regulator
D1, D2, D3	Diode
U9	Power Splitter
Driver Module 04-128-01	
Visual Mixer Board 40-060-04	
D1, D2	Visual IF to RF Mixer
Q1	RF Amplifier
Amplifier #1 Board 40-102-04	
Q2	RF Amplifier
Q3	RF Amplifier
Amplifier #2 Board 40-103-04	
Q4	RF Amplifier
Q5	RF Amplifier
Prefinal Amplifier Board 04-250-01	
Q1	RF Amplifier
Final Amplifier Board 04-254-01	
Q1	RF Amplifier
Q2	RF Amplifier
Q3	RF Amplifier
Q4	RF Amplifier
Q5	RF Amplifier
Q6	RF Amplifier
Q7	RF Amplifier
Q8	RF Amplifier
Driver Module 04-060-01	
Aural Mixer Board 40-060-04	
D1, D2	Aural IF to RF Mixer
Q1	RF Amplifier
Amplifier #1 Board 40-102-04	
Q2	RF Amplifier

Q3	RF Amplifier
Amplifier #2	Board 40-103-04
Q4	RF Amplifier
Q5	RF Amplifier
Aural Amplifier	Board 04-249-2G60-02
Q1	RF Amplifier
Q2	RF Amplifier
Q3	RF Amplifier

- | | | |
|-----|---|----------------------|
| 7) | Circuit Diagrams | See Technical Manual |
| 8) | Instruction Books | Included |
| 9) | Tune Up Procedures | See Technical Manual |
| 10) | Description of Oscillator Circuit and Frequency Stability Devices | See Technical Manual |
| 11) | Describe Limiters | Not used. |
| | Describe Spurious Suppression Circuits | Not used |
| 12) | Describe Digital Modulation Circuits | Not used |

8.0 OVERALL ATTENUATION CHARACTERISTICS

FCC Paragraph 2.987/2.989/73.687

Visual Output Power	50 watts peak sync
% Video Modulation	87.5%
Type Video Modulation	Per FCC 73.687 (a) (4)
Aural Output Power	0 watts
Method of Measurement	Per FCC 73.687 (a) (2) & (4)

Overall Modulation:

Modulation Frequency (MHz)	Detected Output (dB)
0.2 (reference)	0
0.5	-0.32
0.75	-1.34
1.25	-6.02
2.1	-5.85
3.0	-6.52
3.58	-6.02
4.18	-6.20

9.0 FREQUENCY RESPONSE

FCC Paragraph 2.987/2.989/73.687 (a) (2)
November 1, 1991, ITFS/MMDS Ruling

Visual Output Power	50 watts peak sync
% Video Modulation	87.5%
Type Video Modulation	Per FCC 73.687 (a) (4)
Aural Output Power	0 watts
Method of Measurement	Per FCC 73.687 (a) (2) & (4)

Frequency Response:

Output Frequency (MHz)	Sidebands (MHz)	Relative to +200 KHz (dB)	Relative to Visual Carrier (dBc)
2586.50	-4.75	-48.63	-65.49
2587.07	-4.18	-41.78	-58.64
2587.67	-3.58	-39.41	-56.27
2588.25	-3.00	-41.44	-58.30
2589.00	-2.25	-43.04	-59.90
2590.00	-1.25	-21.85	-38.71
2590.50	-0.75	-0.94	-17.80
2590.75	-0.50	-0.14	-17.00
2591.25	Visual Carrier		Reference
2591.75	+0.50	+0.32	-16.54
2592.50	+1.25	+0.07	-16.79
2593.25	+2.00	+0.17	-16.69
2594.25	+3.00	-0.50	-17.36
2594.83	+3.58	0.00	-16.86
2595.43	+4.18	-0.14	-17.00
2596.00	+4.75	-15.13	-31.99
2596.50	+5.25	-49.60	-66.46
2597.25	+6.00	-50.44	-67.30
2598.00	+6.75	-50.37	-67.23

Spectrum Analyzer Settings:

Center Frequency	2591.25
Span	13.00 MHz
Log/Div	10 dB
Resolution BW	30 KHz
VBW	3 MHz
Sweep	43.3 msec

10.0 ENVELOPE DELAY

FCC Paragraph 73.687 (a) (3)

Visual Output Power	50 watts peak sync
% Visual Modulation	87.5%
Type Video Modulation	Per FCC 73.687 (a) (4)
Aural Output Power	0 watts
Method of Measurement	Per EIA RS-240, Section B (12c)
Delay vs. Frequency	

Frequency (MHz)	Delay (ns)
0.2 (reference)	0
0.5	0
1.0	-20.0
1.5	0
2.1	+10.0
2.5	-10.0
3.0	-50.0
3.2	-60
3.4	-80
3.58	-115
4.0	>-150
4.18	>-150

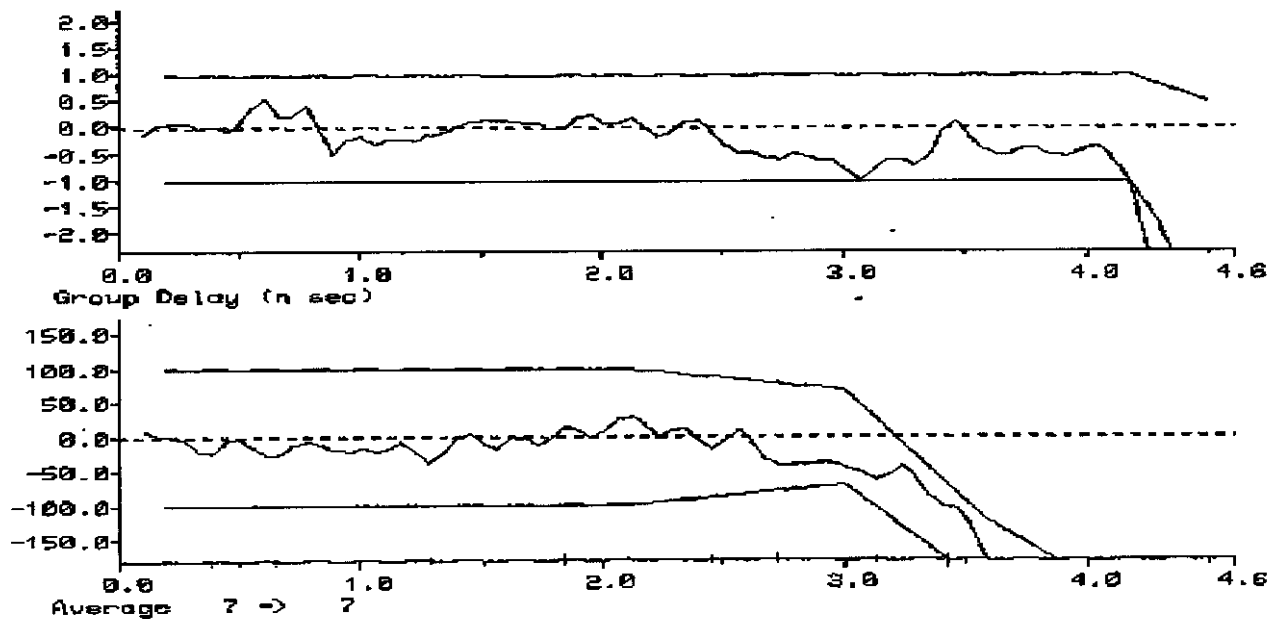
TEST DATA

Channel A COMWAVE

28-Feb-97 11:43:48

Group Delay & Gain (NTSC)
Field = 1 Line = 38
Amplitude (dB) (Ref. at 0.28 MHz)

Wfm --> Sin X/X



11.0 DIFFERENTIAL PHASE AND GAIN

FCC Paragraph 73.687 (a) (9)/73.682 (a) (20) (vii)

Visual Output Power	50 watts peak sync
% Video Modulation	87.5%
Type Video Modulation	Per EIA RS-240, Section B (10c) & (11c)
Aural Output Power	1.58 watts average
Method of Measurement	Per EIA RS-240, Section B (10c) & (11c)
Differential Phase	1.04
Differential Gain	1.41

TEST DATA

Channel A COMWAVE

28-Feb-97 11:48:01

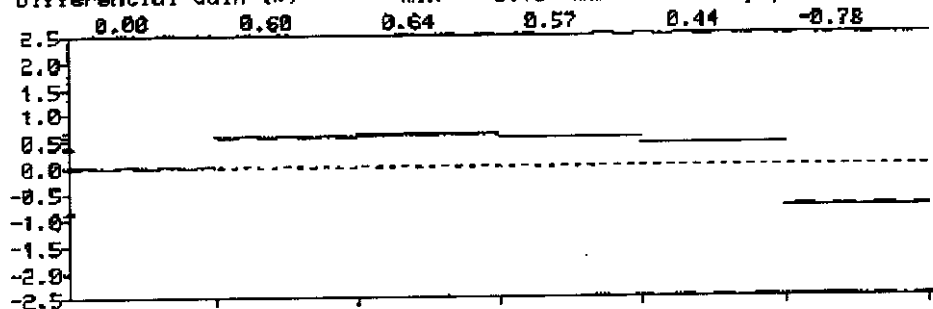
DG DP (NTSC)

Wfm --> NTC-7 Composite

Field = 1 Line = 38

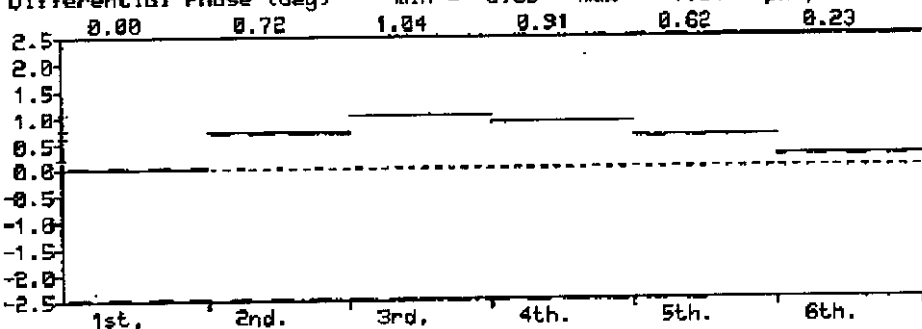
Differential Gain (%)

min = -0.78 max = 0.64 p-p/max = 1.41



Differential Phase (deg)

min = 0.00 max = 1.04 pk-pk = 1.04



Average 32 -> 32

12.0 AURAL OCCUPIED BANDWIDTH

FCC Paragraph 2.202 (e) (5)

Visual Output Power	50 watts peak sync
% Video Modulation	87.5%
Type Video Modulation	Standard 10 riser staircase
Aural Output Power	1.58 watts average
% Aural Modulation	85% (21.25 KHz)
Aural Modulation Signal	15 KHz
Method of Measurement	Bandwidth was read at 0.5% (-23 dB) of mean
(Bn = 2M + 2DK):	power on a spectrum analyzer
Aural Occupied Bandwidth	80 KHz

13.0 AURAL FREQUENCY RESPONSE

FCC Paragraph 73.687 (b) (10)

Visual Output Power	50 watts peak sync
% Video Modulation	87.5%
Type Video Modulation	Standard 10 riser staircase
Aural Output Power	1.58 watts average
% Aural Modulation	100%, 50% and 25%
Aural Modulation Signal	50 Hz to 15 KHz
Aural Frequency Response	

Frequency (Hz)	Output Relative to 1 KHz (dB) 100% Mod
50	-0.53
100	-0.53
400	-0.44
1000	0.0
3000	+4.08
5000	+7.60
7000	+9.54
12000	+13.62
15000	+16.12

14.0 SPURIOUS EMISSIONS AT ANTENNA TERMINALS

FCC Paragraph 2.991, 2.997, 21.908 (b)
November 1, 1991, ITFS/MMDS Ruling

Visual Output Power	50 watts peak sync
% Video Modulation	87.5%
Type Video Modulation	Per EIA RS-240, Section A (6c)
Aural Output Power	1.58 watts average
% Aural Modulation	0%
Spectrum Analyzer Setting	The Spectrum Analyzer setting used in conducting the spurious emissions test at the equipment output terminals was as follows

Frequency Span	2 MHz per Division
Center Frequency	Adjusted continuously for 10 MHz to 10 GHz
Resolution Bandwidth	100 KHz
Video Filter	Out
Input Attenuator Setting	Input level was set for a full-scale calibration of the visual carrier 2591.25 MHz. All other frequencies were referenced to this point.

Spurious Emissions

Frequency (MHz)	Amplitude (dBc)	Relative to Peak Visual (MHz)
2591.25	0 Visual Carrier	(reference)
2587.67	-64 Visual Carrier	-3.58
2586.75	-63 Visual Carrier	-4.5
2584.09	<-70 Visual Carrier	-7.16
2594.83	-16 Visual Carrier	+3.58
2595.75	-15 Aural Carrier	+4.50
2598.41	<-70 Visual Carrier	+7.16
2600.25	-64 Visual Carrier	+9.00
395.00	-65 UHF LO	-2196.25
2242.00	-65 Microwave LO	-349.25
5182.50	<-70 Harmonic	x 2
7773.75	<-70 Harmonic	x 3
10365.00	<-70 Harmonic	x 4
12956.25	<-70 Harmonic	x 5
15547.50	>-70 Harmonic	x 6
18138.75	>-70 Harmonic	x 7
20730.00	>-70 Harmonic	x 8
23321.25	>-70 Harmonic	x 9
25912.50	>-70 Harmonic	x 10

REF 14.0 DBM

AT 30 DB

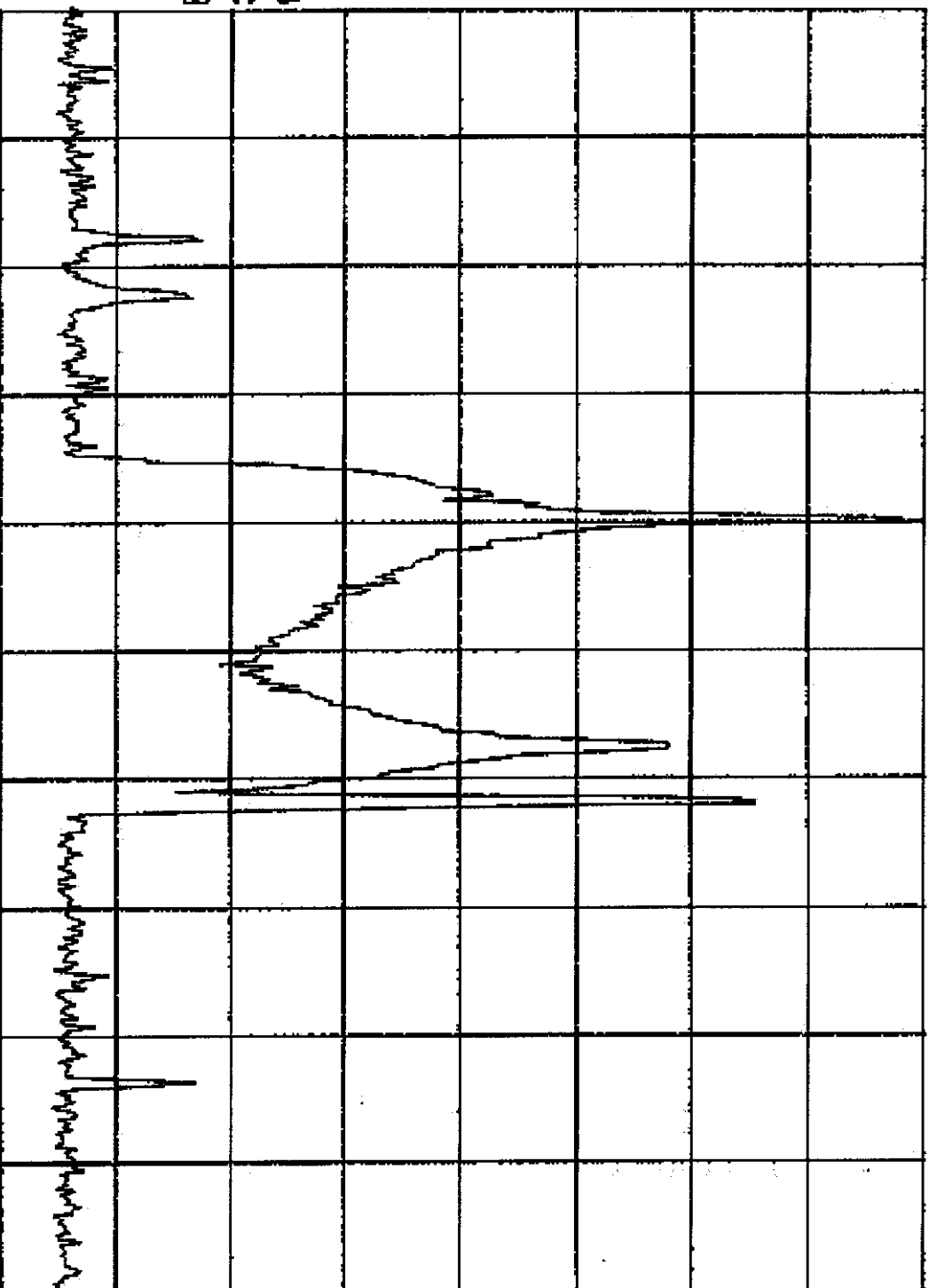
PEAK

LOG

10

DB/

VA SB
SC FC
CORR



CENTER 2.59388 GHz
#RES BW 30 KHZ

VBW 30 KHZ

SPAN 25.00 MHz
SWP 83.3 msec

COPY
ANALOG

COPY
DIGITAL

RELEASE
BUSS

15.0 FIELD STRENGTH OF SPURIOUS RADIATION

FCC Paragraph 2.993, 2.997

Visual Output Power	50 watts peak sync
% Video Modulation	87.5%
Type Video Modulation	Standard 10 riser staircase
Aural Output Power	1.58 watts average
% Aural Modulation	0%
Spectrum Analyzer Setting	The Spectrum Analyzer setting used to measure the spurious emissions at 10 meters from the transmitter was set as follows
Frequency Span	1 MHz per Division
Center Frequency	Adjusted continuously from 10 MHz to 10 GHz
Resolution Bandwidth	10 KHz
Video Bandwidth	10 KHz
Analyzer Noise Threshold	>-89 dBm

Method of Measurement:

Absolute power of the spurious radiation was measured on a spectrum analyzer at a distance of 10 meters from the transmitter. The radiation was received with a half-wave dipole antenna (gain = 2.15 dB) and measured as an absolute power level; therefore, all measurements include the dipole gain. The relative levels of the received spurious signals were calculated with respect to the absolute power level of the transmitter's visual output received with a dipole at 10 meters. The visual received power level was calculated using:

$$\text{Received Level @ 10 meters (dBm)} = \text{EIRP (dBm)} - \text{Path Loss (dB)} + 2.15 \text{ dB}$$

$$\begin{aligned}\text{Path Loss (dB)} &= 20 \log \text{distance(Km)} + 20 \log \text{frequency (2591.25/1000)(GHz)} + 92.4 \text{ dB} \\ &= 20 \log (.010 \text{ Km}) + 20 \log (2.59125) + 92.4 \text{ dB} \\ &= 60.67\end{aligned}$$

$$\begin{aligned}\text{EIRP (dBmW)} &= 47 \text{ dBm (tx output)} + 2.15 \text{ dB (transmit dipole gain)} \\ &= 49.15 \text{ dBm}\end{aligned}$$

$$\begin{aligned}\text{Received Level} &= \text{EIRP dBm} - \text{Path Loss dB} + 2.15 \text{ dB} \\ &= -9.37\end{aligned}$$

The Electric Field Intensity E(v/m) incident on a receive dipole antenna was found using:

$$\begin{aligned}
 E \text{ (v/m)} &= \text{Antilog} \left[\frac{(\text{Received Level} - 2.15 \text{ dB}) - 20 \log \text{ wavelength(m)} + 6.75}{20} \right] \\
 &= \text{Antilog} \frac{-9.37 \text{ dBm} - 20 \log [0.115774\text{m}] + 6.75}{20} \\
 &= \text{Antilog } 0.6979
 \end{aligned}$$

$$E = 4.987$$

Spurious Radiation:

The following measurements of radiation were taken and are given in terms of absolute and relative to the visual carrier

MHz	Absolute Received (dBm)	Absolute Field Intensity (v/m)	Relative to Level visual, dBc
2591.25	-79	0.006685	N/A
2242.00	*Below analyzer threshold	N/A	<-89
45.75	*Below analyzer threshold	N/A	<-89
41.25	*Below analyzer threshold	N/A	<-89
395.00	*Below analyzer threshold	N/A	<-89
Harmonics	*Below analyzer threshold	N/A	<-89

* Analyzer threshold = -89 dBm

The range of examination in these tests was from 10 MHz to 27 GHz.

16.0 FREQUENCY STABILITY

FCC Paragraph 2.995 (a) (3)/ 74.950 (a)/ 21.908, 21.101 (a)

Method of Measurement:
Channel

The modulator and upconverter were
tested individually per FCC 21.995.

UHF LO (Upconverter)	395.00 MHz
I.F. Frequency (Modulator)	- 45.75 MHz
	349.25 MHz
Microwave L.O. (Synthesized)	2242.00 MHz
On Channel Frequency	2519.25 MHz

Frequency Stability over Temperature: Modulator

Temp. (C)	Visual (MHz)	Aural (MHz)	4.5 MHz Error (Hz)	Visual Carrier Error (Hz)
+50	45.749972	41.249974	-2	-28
+40	45.750035	41.250030	+5	+35
+30	45.750124	41.250112	+12	+124
+20	45.750164	41.250146	+18	+164
+10	45.750238	41.250208	+30	+238
0	45.750297	41.250272	+25	+297
-10	45.750268	41.250242	+26	+268
-20	45.750161	41.250145	+16	+161
-30	45.749879	41.249896	-17	-121

1
297
25
30
352

Frequency Stability over AC Input Voltage: Modulator

AC Line (V)	Visual (MHz)	Aural (MHz)	4.5 MHz Error (Hz)	Visual Carrier Error (Hz)
85	45.749971	41.249972	-1	-29
90	45.749998	41.249996	+2	-2
95	45.750002	41.250002	0	+2
100	45.750003	41.250001	+2	+3
110	45.750004	41.250001	+3	+4
115	45.750004	41.250001	+3	+4
120	45.750003	41.250001	+2	+3
130	45.750004	41.250001	+3	+4
135	45.750004	41.250000	+4	+4

30

Frequency Stability over Temperature: Microwave Upconverter PLL Local Oscillator

Temp. (C)	Oscillator (MHz)	Error (Hz)
+50	2196.000051	+51
+40	2196.000039	+39
+30	2196.000031	+31
+20	2196.000018	+18
+10	2196.000015	+15
0	2196.000010	+10
-10	2196.000012	+12
-20	2196.000025	+25
-30	2196.000035	+35

1
352
51
15
418
5
100 Hz

Frequency Stability over AC Input Voltage: Microwave Upconverter PLL Local Oscillator

AC Line (V)	Local Oscillator Frequency (MHz)	Error (Hz)
95	2195.999985	-15
100	2196.000011	+11
110	2196.000011	+11
115	2196.000010	+10
120	2196.000011	+11
125	2196.000010	+10
130	2196.000011	+11
135	2196.000011	+11

NOTE:

Frequency stability of the microwave synthesizer was totally dependent on the accuracy and stability of the 10 MHz reference oscillator. This is a purchased item with 1×10^{-7} minimum stability specification.

Frequency Stability over Temperature: UHF Upconverter PLL Local Oscillator

Temp. (C)	Oscillator (MHz)	Error (Hz)
+50	395.000065	+65
+40	395.000067	+67
+30	395.000067	+67
+20	395.000067	+67
+10	395.000065	+65
0	395.000065	+65
-10	395.000065	+65
-20	395.000066	+66
-30	395.000066	+66

Combining the worst case of modulator, UHF oscillator, and microwave oscillator frequency shift result in a 222 Hz channel error. This represents accuracy, which is well within the required channel $\pm 1,000$ Hz tolerance requirement set on November 1, 1991, for ITFS/MMDS transmitters. The aural carrier also remained within the required $4.5 \text{ MHz} \pm 1,000$ Hz tolerance.

Frequency Stability over AC Input Voltage: UHF Upconverter PLL Local Oscillator

AC Line (V)	Local Oscillator Frequency (MHz)	Error (Hz)
95	394.999995	-5
100	394.999996	-4
110	394.999995	-5
115	394.999996	-4
120	394.999996	-4
125	394.999996	-4
130	394.999995	-5
135	394.999996	-4

NOTE:

Frequency stability of the UHF Upconverter Local Oscillator was totally dependent on the accuracy and stability of the 10 MHz reference oscillator. This is a purchased item with 1×10^{-7} minimum stability specification.

17.0 SUMMARY

This report demonstrates that the SBSA-50C television transmitter meets or exceeds the FCC type acceptance criteria. Peak output power was verified with direct measurement of power at microwave. Measurement of spurious emissions at the RF output revealed no emissions above -60 dBc. Field strength measurements of spurious emissions revealed no detectable emissions down to the analyzer noise threshold of <-89 dBm. Frequency stability tests of the modulator and the voltage controlled crystal oscillator/multiplier over variations in temperature or input AC line voltage showed a maximum worst case frequency shift of 222 Hz.