

RADIO PERFORMANCE MEASUREMENTS  
ON THE T2015-323 Mobile Transceiver

FCC ID: CAS2000-3231

Test Report No: 1033

Test Specification: FCC 47 Part 90

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22 May 1996

**TEST RESULTS**  
for

Tait                      T2015-323                      Mobile                      Transceiver                      Serial Number      555688

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**TRANSMITTER CARRIER OUTPUT POWER  
HIGH POWER**

TEST PARAMETERS	
AMBIENT TEMPERATURE ( °C )	22.5
RELATIVE HUMIDITY ( % )	50
RF POWER LEVEL ( Watts )	25 W
STANDARD VOLTAGE ( Volts )	13.8 V DC

**RESULTS:**

TEST CONDITIONS		TRANSMITTER POWER (W) 155.1 MHz	
T <sub>ambient</sub> °C	13.8	30.37(Max)	29.68(Min)
Maximum Power variation under Normal Test conditions (dBr)		0.85	
Measurement Uncertainty (dB)		+0.63 -0.68	

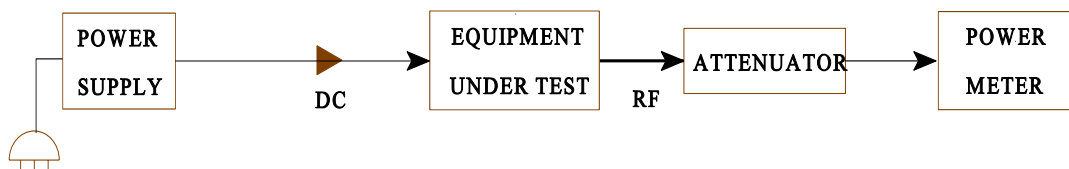
The load attached to the output terminals is a 50 ohm resistive termination.

**LIMIT CLAUSE:** FCC 47 Part 90.205  
(B)

Radio type	Frequency Band (Mhz) Max Power Limit (W)								
	25 to 100	100 to 216	216 to 470	470 to 512	806 to 824	851 to 869	896 to 901	929 to 930	935 to 940
Base	350	350	350	1000	-	2000	-	2000	2000
Mobile	300	75	75	350	-	-	-		

**TEST EQUIPMENT USED:** 2 , 4 , 5 , 15

**TEST SET-UP: RF POWER OUTPUT**



**TRANSMITTER CARRIER OUTPUT POWER  
LOW POWER**

FCC 47 Part 2.985

TEST PARAMETERS	
AMBIENT TEMPERATURE ( °C )	22.5
RELATIVE HUMIDITY ( % )	50
RF POWER LEVEL ( Watts )	5 W
STANDARD VOLTAGE ( Volts )	13.8 V DC

**RESULTS:**

TEST CONDITIONS		TRANSMITTER POWER (W) 155.1 MHz	
T <sub>ambient</sub> °C	13.8	5.79(Max)	5.75(Min)
Maximum Power variation under Normal Test conditions (dB)		0.64	
Measurement Uncertainty (dB)		+0.63 -0.68	

The load attached to the output terminals is a 50 ohm resistive termination.

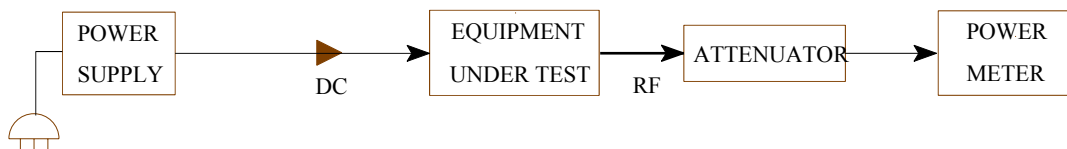
**LIMIT CLAUSE:  
(B)**

FCC 47 Part 90.205

Radio type	Frequency Band (Mhz) Max Power Limit (W)								
	25 to 100	100 to 216	216 to 470	470 to 512	806 to 824	851 to 869	896 to 901	929 to 930	935 to 940
Base	350	350	350	1000	-	2000	-	2000	2000
Mobile	300	75	75	350	-	-	-		

**TEST EQUIPMENT USED:** 2 , 4 , 5 , 15

**TEST SET-UP: RF POWER OUTPUT**



**TRANSMITTER MODULATION CHARACTERISTIC  
(A): LOW PASS FILTER RESPONSE**

TEST PARAMETERS	
AMBIENT TEMPERATURE ( °C )	22.0
RELATIVE HUMIDITY ( % )	60
RF POWER LEVEL ( Watts )	25 W
STANDARD VOLTAGE ( Volts )	13.8V DC

**RESULTS:**

MODULATION AUDIO LEVEL RESPONSE			
155.1 MHz			
MODULATION FREQUENCY (Hz)	Audio Output (dBm)	MODULATION FREQUENCY (Hz)	Audio Output (dBm)
100	-4.09	3500	-8.09
200	-1.20	4000	-12.63
300	-0.37	4500	-16.72
400	-0.06	5000	-20.43
500	0.04	6000	-27.07
600	0.08	7000	-33.20
750	0.07	8000	-39.3
1000	0.00	9000	-46.0
1200	-0.02	10000	-54.5
1400	0.00	11000	-62.0
1500	0.02	12500	-56.0
1700	0.12	15000	-52.6
1850	0.24	17500	-53.0
2000	0.34	20000	-54.5
2250	0.36	25000	-58.7
2500	-0.12	50000	-62.0
2750	-1.41	75000	-62.0
3000	-3.38	100000	-62.0

**PLOT:** See attached EXHIBIT C(1).

**TRANSMITTER MODULATION CHARACTERISTIC Cont.  
(A): LOW PASS FILTER RESPONSE**

FCC 47 Part 2.987

**LIMIT CLAUSE:**

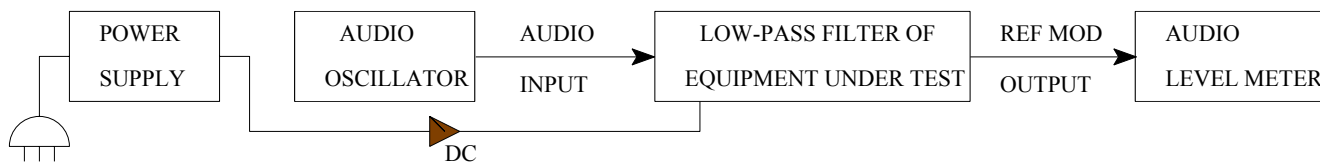
FCC 47 Part 90.211

With respect to level at 1KHz.

FCC Modulation Type	Frequency Range (MHz)	Audio Band (KHz)	Limit (dB)
VHF (D)(1)(1)	25 to 50	3 to 15	- 40 Log (fKHz/3)
	72 to 73		
	75.4 to 76	> 15	- 28
	150.8 to 174		
UHF (D)(1)(2)	450 to 512	3 to 20	- 60 Log (fKHz/3)
	806 to 824		
	851 to 869	> 20	- 50
	929 to 930		
UHF (D)(1)(3)	896 to 901	3 to 20	- 100 Log (fKHz/3)
	935 to 940		

**TEST EQUIPMENT USED:** 4 , 13 , 14

**TEST SET-UP: LOW PASS FILTER**



**TRANSMITTER MODULATION CHARACTERISTIC  
(B): MODULATOR LIMITING RESPONSE**

FCC 47 Part 2.987

TEST PARAMETERS	
AMBIENT TEMPERATURE ( °C )	20.0
RELATIVE HUMIDITY ( % )	55
RF POWER LEVEL ( Watts )	25 W
STANDARD VOLTAGE ( Volts )	13.8V DC

**RESULTS:**

AUDIO OUTPUT DEVIATION LEVEL (KHz)										
155.1 MHz										
I / P dBm	300		500		1000		2000		3000	
	+ve	-ve	+ve	-ve	+ve	-ve	+ve	-ve	+ve	-ve
-85	0.02588	0.03006	0.02103	0.0271	0.02904	0.01896	0.01896	0.02904	0.03296	0.02009
-80	0.03006	0.03296	0.04008	0.04101	0.06729	0.06208	0.09953	0.10913	0.09839	0.0887
-75	0.04008	0.03917	0.06426	0.06576	0.10913	0.11039	0.19184	0.19631	0.17496	0.17496
-70	0.05997	0.05727	0.10664	0.10185	0.18533	0.18321	0.34115	0.34115	0.30757	0.30757
-65	0.09182	0.0887	0.17496	0.16902	0.31473	0.31113	0.58606	0.58606	0.52232	0.52837
-60	0.15064	0.15593	0.30057	0.30057	0.54694	0.54068	1.03739	1.03143	0.92564	0.9267
-55	0.26178	0.26178	0.51635	0.51635	0.95157	0.95157	1.77599	1.76376	1.27333	1.26748
-50	0.46019	0.46019	0.91926	0.91715	1.67086	1.66894	2.0818	2.03676	1.34567	1.34567
-45	0.82402	0.81835	1.63659	1.63283	2.0274	1.91179	2.15001	2.10107	1.37069	1.36754
-40	1.20072	1.21602	2.03442	1.96083	2.11077	1.99728	2.16242	2.1132	1.37385	1.37385
-35	1.21742	1.23293	2.0274	1.96988	2.10591	1.99959	2.15993	2.1132	1.37227	1.37069
-30	1.22445	1.24865	2.01809	1.97442	2.10591	2.00189	2.16242	2.1132	1.37385	1.37543
-25	1.2301	1.26165	2.02974	1.97897	2.10591	1.99959	2.16242	2.1132	1.37702	1.37543
-20	1.23152	1.26456	2.02274	1.97897	2.10591	2.00189	2.16242	2.1132	1.37543	1.37385
-15	1.23578	1.25297	2.03676	1.96761	2.10591	1.99499	2.16491	2.11807	1.37543	1.37385
-10	1.59566	1.34567	2.0065	1.92061	1.9317	2.00189	2.11807	2.0866	1.36439	1.36597
-5	2.07224	1.9767	2.25652	2.21024	1.73756	1.77599	1.98811	1.94733	1.28956	1.28956
+0	2.22813	2.17741	2.25133	2.25393	1.77394	1.64414	1.83417	1.68244	1.19108	1.20348
+5	2.22044	2.27217	2.1749	2.24874	1.74558	1.6272	1.68051	1.41072	1.06155	1.09759
+10	2.09624	2.24357	2.06035	2.23584	1.67664	1.72361	1.4772	1.06155	0.86584	0.93313
Measurement Uncertainty (Hz)						± 37.5				

**TRANSMITTER MODULATION CHARACTERISTIC Cont.  
(B): MODULATOR LIMITING RESPONSE**

FCC 47 Part 2.987

**PLOT:** See attached EXHIBIT C(2).

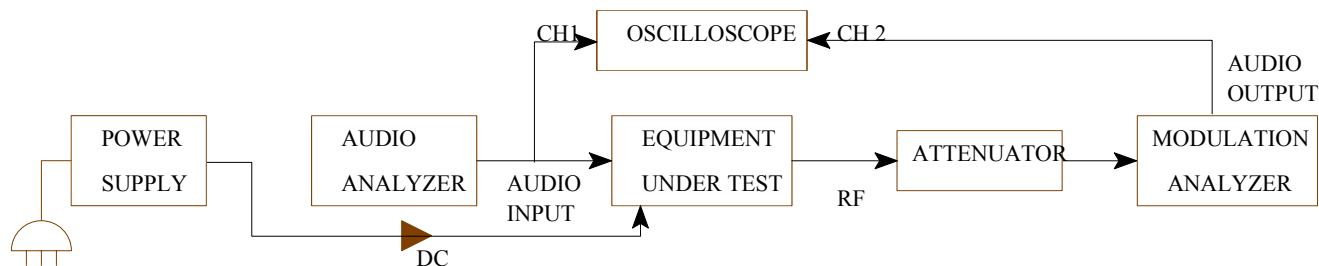
**LIMIT CLAUSE:**

FCC 47 Part 90.209

FCC Bandwidth Type	Frequency Range MHz	Max Deviation KHz
(B) (4)	< 947	2.5

**TEST EQUIPMENT USED:** 2 , 3 , 4 , 5 , 10 , 11 , 15

**TEST SET-UP: MODULATION LIMITING**





**TRANSMITTER OCCUPIED BANDWIDTH**

FCC 47 Part 2.989

TEST PARAMETERS	
AMBIENT TEMPERATURE ( °C )	21.5
RELATIVE HUMIDITY ( % )	49
RF POWER LEVEL ( Watts )	25 W
STANDARD VOLTAGE ( Volts )	13.8V DC

**(D): AUDIO MODULATION.** (Type F3E)

Transmitter modulated by a 2500 Hz signal at 16 dB above the level that resulted in 50% deviation.

**RESULTS:**

**PLOT:** See attached EXHIBIT C(3).

**(D): DIGITAL MODULATION.** (Type F2D)

Transmitter modulated by a FFSK modem signal.  
Apply a 1200 Hz Baud signal into the modem input at the level that resulted in >80% deviation.

**RESULTS:**

**PLOT:** See attached EXHIBIT C(3).

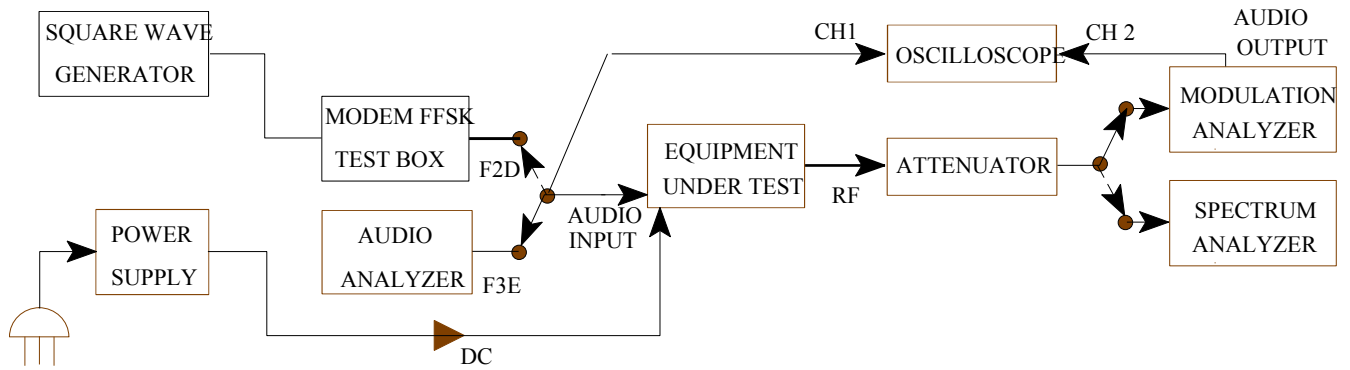
**LIMIT CLAUSE:**

FCC 47 Part 90.210

FCC Bandwidth Type	Frequency Range MHz	Audio Bandwidth KHz	Power versus Frequency Mask	
			Frequency Limitation	Power Level
D	150 to 174	11.25 (NB)	$f_c < f < f_c \pm 5.625 \text{ KHz}$	-0 dBc
			From $f > f_c \pm 5.625 \text{ KHz}$	-20 dBc
	to $f < f_c \pm 12.5 \text{ KHz}$		-64 dBc	
	$f_c \pm 12.5 \text{ KHz} < f$		-64 dBc	
	421 to 512			

TEST EQUIPMENT USED: 2 , 3 , 4 , 5 , 9 , 10 , 11 , 14 , 15

TEST SET-UP: OCCUPIED BANDWIDTH



**TRANSIENT FREQUENCY BEHAVIOUR  
HIGH POWER**

FCC 47 Part 90.214

TEST PARAMETERS	
AMBIENT TEMPERATURE ( °C )	22.5
RELATIVE HUMIDITY ( % )	61
RF POWER LEVEL ( Watts )	25 W
STANDARD VOLTAGE ( Volts )	13.8V DC

**RESULTS:**

FREQUENCY	155.1 MHz	@	5.0 PPM
TRANSIENT RESPONSE PERIOD	CARRIER, PEAK VARIATION FROM NOMINAL		
	KEY "ON" ( Hz)	KEY "OFF" ( Hz)	
t1	875.89	N/A	
t2	437.50	N/A	
t3	N/A	819.64	
t2~t3	437.50		
ERROR LIMIT (t2~t3)	775.5		

Confirm that during periods "t1" and "t3" the frequency difference does not exceed the value of one channel separation.	YES	NO
	€	
Confirm that during period "t2" the frequency difference does not exceed half a channel separation.	YES	NO
	€	
Confirm that during the period "t2" to "t3" the frequency difference does not exceed the frequency error limit.	YES	NO
	€	

**PLOT:** See attached Exhibit C (4), for key "ON", and attached Exhibit C (5), for key "OFF".

**LIMIT CLAUSE:** FCC 47 Part 90.214

TRANSIENT PERIODS	MAXIMUM FREQUENCY DIFFERENCE (KHz)	FREQUENCY RANGES (MHz)		
		ALL EQUIPMENT		
		150 to 174	450 to 500	500 to 512
t1 (ms)	± 12.5	5.0	10.0	20.0
t2 (ms)	± 6.25	20.0	25.0	50.0
t3 (ms)	± 12.5	5.0	10.0	10.0

**TRANSIENT FREQUENCY BEHAVIOUR  
LOW POWER**

FCC 47 Part 90.214

TEST PARAMETERS	
AMBIENT TEMPERATURE ( °C )	22.5
RELATIVE HUMIDITY ( % )	61
RF POWER LEVEL ( Watts )	5 W
STANDARD VOLTAGE ( Volts )	13.8 VDC

**RESULTS:**

FREQUENCY	155.1 MHz	@	5.0 PPM
TRANSIENT RESPONSE PERIOD	CARRIER, PEAK VARIATION FROM NOMINAL		
	KEY "ON" ( Hz)	KEY "OFF" ( Hz)	
t1	910.71	N/A	
t2	531.25	N/A	
t3	N/A	875.89	
t2~t3	437.50		
ERROR LIMIT (t2~t3)	775.5		

Confirm that during periods "t1" and "t3" the frequency difference does not exceed the value of one channel separation.	YES	NO
	€	
Confirm that during period "t2" the frequency difference does not exceed half a channel separation.	YES	NO
	€	
Confirm that during the period "t2" to "t3" the frequency difference does not exceed the frequency error limit.	YES	NO
	€	

**PLOT:** See attached Exhibit C (6), for key "ON", and attached Exhibit C (7), for key "OFF".

**LIMIT CLAUSE:** FCC 47 Part 90.214

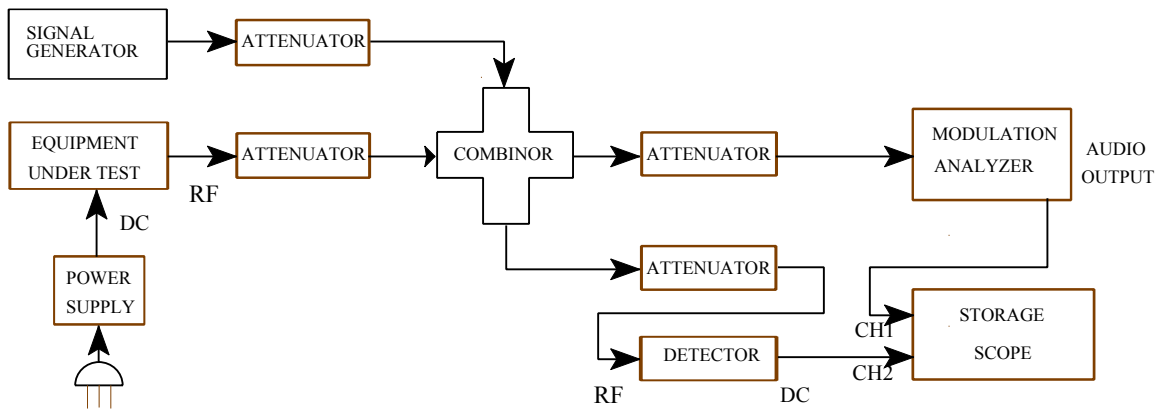
TRANSIENT PERIODS	MAXIMUM FREQUENCY DIFFERENCE (KHz)	FREQUENCY RANGES (MHz)		
		ALL EQUIPMENT		
		150 to 174	450 to 500	500 to 512
t1 (ms)	± 12.5	5.0	10.0	20.0
t2 (ms)	± 6.25	20.0	25.0	50.0
t3 (ms)	± 12.5	5.0	10.0	10.0

TRANSIENT FREQUENCY BEHAVIOUR cont

FCC 47 Part 90.214

TEST EQUIPMENT USED: 1 , 2 , 4 , 5 , 8 , 10 , 11 , 15 , 16 , 17 , 18 , 19

TEST SET-UP: TRANSIENT FREQUENCY



**TRANSMITTER SPURIOUS EMISSIONS (CONDUCTED)  
HIGH POWER**

FCC 47 Part 2.991

TEST PARAMETERS	
AMBIENT TEMPERATURE ( °C )	20.5
RELATIVE HUMIDITY ( % )	60
RF POWER LEVEL ( Watts )	25
STANDARD VOLTAGE ( Volts )	13.8 V DC

**RESULTS:**

FREQUENCY OF SPURIOUS EMISSION MHz		SPURIOUS EMISSION LEVEL (dBm)
Harmonic	$f_c = 155.1$ MHz	43.98 dBm
N/A	152.6756	-39.8
$2 * f_c$	310.2	No emissions were detected that had a level greater than 20dB below the limit.
$3 * f_c$	465.3	
$4 * f_c$	620.4	
$5 * f_c$	775.5	
$6 * f_c$	930.6	
$7 * f_c$	1085.7	
$8 * f_c$	1240.8	
$9 * f_c$	1395.9	
$10 * f_c$	1551	
UNCERTAINTY (dB)		

**LIMIT CLAUSE:**

FCC 47 Part 90.210

FCC Bandwidth Type	Frequency Range MHz	Audio Bandwidth KHz	Power versus Frequency Mask	
			Frequency Limitation	Power Level
D(3)	< 947	11.25(NB)	$f_c \pm 12.5$ KHz < f	-20 dBm

**REMARKS:** No emissions were detected that had a level greater than 20dB below the limit.

**TRANSMITTER SPURIOUS EMISSIONS (CONDUCTED)  
LOW POWER**

FCC 47 Part 2.991

TEST PARAMETERS	
AMBIENT TEMPERATURE ( °C )	20.5
RELATIVE HUMIDITY ( % )	60
RF POWER LEVEL ( Watts )	5
STANDARD VOLTAGE ( Volts )	13.8 V DC

**RESULTS:**

FREQUENCY OF SPURIOUS EMISSION MHz		SPURIOUS EMISSION LEVEL (dBm)
Harmonic	$f_c = 155.1$ MHz	36.99 dBm
$2 * f_c$	310.2	No emissions were detected that had a level greater than 20dB below the limit.
$3 * f_c$	465.3	
$4 * f_c$	620.4	
$5 * f_c$	775.5	
$6 * f_c$	930.6	
$7 * f_c$	1085.7	
$8 * f_c$	1240.8	
$9 * f_c$	1395.9	
$10 * f_c$	1551	
UNCERTAINTY (dB)		

**LIMIT CLAUSE:**

FCC 47 Part 90.210

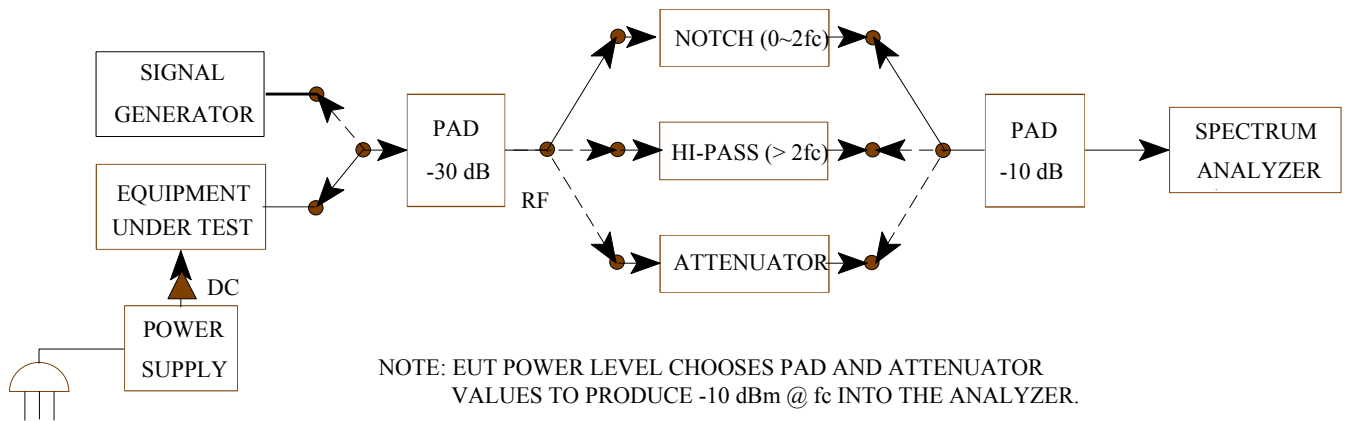
FCC Bandwidth Type	Frequency Range MHz	Audio Bandwidth KHz	Power versus Frequency Mask	
			Frequency Limitation	Power Level
D(3)	< 947	11.25(NB)	$f_c \pm 12.5 \text{ KHz} < f$	-20 dBm

**REMARKS:** No emissions were detected that had a level greater than 20dB below the limit.

**TRANSMITTER SPURIOUS EMISSIONS (CONDUCTED) Cont.  
HIGH POWER**

**TEST EQUIPMENT USED:** 4, 5, 9, 11, 12, 16

**TEST SET-UP: TX CONDUCTED**





**TRANSMITTER SPURIOUS EMISSIONS (RADIATED)  
HIGH POWER**

FCC 47 Part 2.993

TEST PARAMETERS	
AMBIENT TEMPERATURE ( °C )	24.0
RELATIVE HUMIDITY ( % )	50
RF POWER LEVEL ( Watts )	25 W
STANDARD VOLTAGE ( Volts )	13.8 V DC

**RESULTS:**

FREQUENCY OF SPURIOUS EMISSION (MHz)		SPURIOUS EMISSION LEVEL (dBm)	
Harmonic	$f_c = 155.1$ MHz	Max power @ $f_c =$	43.98 dBm
$2 * f_c$	310.2	No emissions were detected that had a level greater than 20dB below the limit.	
$3 * f_c$	465.3		
$4 * f_c$	620.4		
$5 * f_c$	775.5		
$6 * f_c$	930.6		
$7 * f_c$	1085.7		
$8 * f_c$	1240.8		
$9 * f_c$	1395.9		
$10 * f_c$	1551		
UNCERTAINTY (dB)			

**LIMIT CLAUSE:** FCC 47 Part 90.210

FCC Bandwidth Type	Frequency Range MHz	Audio Bandwidth KHz	Power versus Frequency Mask	
			Frequency Limitation	Power Level
D(3)	< 947	11.25(NB)	$f_c \pm 12.5$ KHz < f	-20 dBm

**REMARKS:** No emissions were detected that had a level greater than 20dB below the limit.

**TRANSMITTER SPURIOUS EMISSIONS (RADIATED)  
LOW POWER**

FCC 47 Part 2.993

TEST PARAMETERS	
AMBIENT TEMPERATURE ( °C )	24.0
RELATIVE HUMIDITY ( % )	50
RF POWER LEVEL ( Watts )	5 W
STANDARD VOLTAGE ( Volts )	13.8 V DC

**RESULTS:**

FREQUENCY OF SPURIOUS EMISSION (MHz)		SPURIOUS EMISSION LEVEL (dBm)	
Harmonic	$f_c = 155.1$ MHz	Max power @ $f_c =$	36.99 dBm
$2 * f_c$	310.2	No emissions were detected that had a level greater than 20dB below the limit.	
$3 * f_c$	465.3		
$4 * f_c$	620.4		
$5 * f_c$	775.5		
$6 * f_c$	930.6		
$7 * f_c$	1085.7		
$8 * f_c$	1240.8		
$9 * f_c$	1395.9		
$10 * f_c$	1551		
UNCERTAINTY (dB)			

**LIMIT CLAUSE:** FCC 47 Part 90.210

FCC Bandwidth Type	Frequency Range MHz	Audio Bandwidth KHz	Power versus Frequency Mask	
			Frequency Limitation	Power Level
D(3)	< 947	11.25 (NB)	$f_c \pm 12.5$ KHz < f	-20 dBm

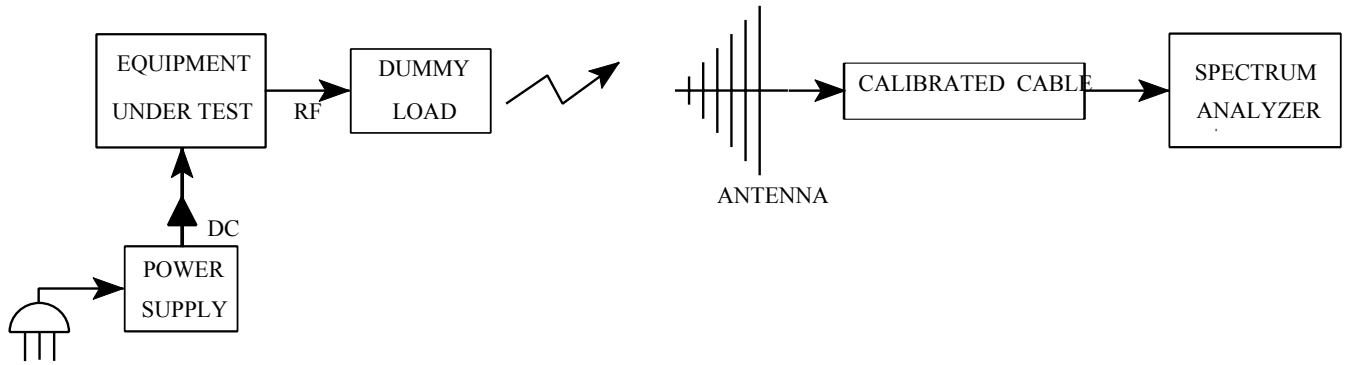
**REMARKS:** No emissions were detected that had a level greater than 20dB below the limit.

**TRANSMITTER SPURIOUS EMISSIONS (RADIATED)**

FCC 47 Part 2.993

**TEST EQUIPMENT USED:** 4 , 5 , 9 , 11 , 20 , 24 , 25 , 26

**TEST SET-UP: TX RADIATED**



**TRANSMITTER FREQUENCY STABILITY**

FCC 47 Part 2.995

TEST PARAMETERS	
RF POWER LEVEL ( Watts )	25
STANDARD VOLTAGE ( Volts )	13.8

**RESULTS:**

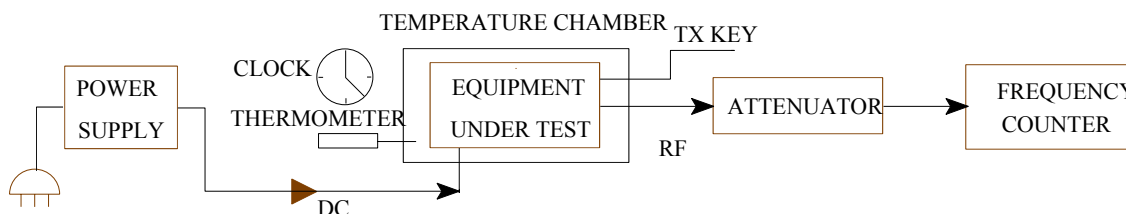
FREQUENCY 155.1	FREQUENCY ERROR (ppm)		
CHAMBER TEMP	11.7	13.8	15.9
-30.0 °C	-0.31	-0.29	-0.33
-20.0 °C	-0.13	-0.13	-0.14
-10.0 °C	0.20	0.20	0.19
+00.0 °C	0.45	0.46	0.46
+10.0 °C	0.40	0.40	0.39
+20.0 °C	-0.37	-0.35	-0.39
+30.0 °C	-0.45	-0.43	-0.48
+40.0 °C	-1.09	-1.05	-1.11
+50.0 °C	-1.63	-1.61	-1.65
Measurement Uncertainty (Hz)	± 21.4		

**LIMIT CLAUSE:** FCC 47 Part 90.213

CHANNEL SPACING	Frequency Band (Mhz) Error Limit (ppm)	
	150 - 174	421 - 512
25KHz	5.0	5.0
12.5KHz	5.0	2.5

**TEST EQUIPMENT USED:** 2 , 4 , 5 , 6 , 15

**TEST SET-UP: FREQUENCY STABILITY**



## TEST EQUIPMENT CALIBRATION STATUS

To facilitate inclusion on each page, the test equipment used is identified (numbered) and listed against the related test in the report.

No	Equipment Type	Model number		Serial Number	Cal Due
1	Signal Generator	HP 8642B (Opt 001)		2512A00176	10/01/97
2	Signal Generator	HP 8656A (Opt 001)		2131A01474	30/10/96
3	Signal Generator	HP 8656A		2142A02103	16/01/97
4	Modulation Analyser	HP 8901B (Opt 002)		2441A00393	04/10/96
5	Audio Analyser	HP 8903A		2308A02597	08/01/97
6	Power Supply	HP 6032A		2441A-0041	13/10/96
7	Controller	HP 9836		2143A00703	N/A
8	Environmental Chamber	Contherm		E3397	17/02/97
9	Mixer	Minicircuits ZAD-11		77008	N/A
10	4 Port Combiner	Rhode & Schwarz		300971/28	28/06/96
11	Spectrum Analyser	HP8596E (Opt 140)		3346A00213	09/01/97
12	Filter Notch	Tait	100 - 250	E3541	Before Use
13	Filter High Pass	Tait	270 Mhz	E3382	30/11/96
14	Filter Low Pass	Tait	Mhz	N/A	30/11/96
15	Attenuator	Weinschell 45-30-34		JW663	31/01/97
16	Attenuator	Weinschell 40-20-33		CJ404	31/01/97
17	Attenuator	Weinschell 24-10-34		AM3603	31/01/97
18	Plotter	HP 7440A		2539A53151	N/A
19	Oscilloscope	Phillips PM3350		9444-033-50400	03/05/96
20	4 Port Combiner	Rhode & Schwarz		300729/47	28/06/96
21	Signal Generator	HP8665A(Opt 01,08,10)		3026A00501	11/09/96
22	Mixer	Minicircuits ZAD-11		77031	N/A
23	Directional Coupler	HP778D-012		1144A07392	31/01/97
24	Filter 21.4MHZ	Tait		3249	
25	RF Attenuators	JFW 50P-076			31/01/97
26	RF Attenuators	JFW 50P-077			31/01/97
27	RF Filters	NDK 21G-6DT			

28	RF Amplifier	Tait		
29	Antenna	Emco 3102	2572	
30	Antenna	Biconical	9307-1680	
31	Antenna	Singer 93490-1	523	
32	Antenna	Emco DRG 3115	2084	
33	Antenna	Ailtech DM 105A-T2	J1417-103	
34	Antenna	Ailtech DM 105A-T3	J1418-108	
35	RF Load	Weinschel F1426	AE2490	31/01/97
36	Power Supply	Tait T348/16	198120	Cal on use
37	Power Supply	Tait T348	119093	Cal on use