

REPORT NUMBER 1847

ISSUE 2

MAY 2003

Document History	Issue Date	Reason for issue
Original Report	March 2003	
Issue 2	May 2003	pages 16-18 Frequency Stability - remeasured

## RADIO PERFORMANCE MEASUREMENTS

Paging Transmitter consisting of:

T839-20-0000 S/N 13076924 (Power Amplifier)  
 T837-26-1021 S/N 13076857 (Exciter)  
 T801-20-0000 S/N 703305 (High Stability Oscillator)  
 T808-10-0000 S/N 13064170 (Switched Mode Power Supply)

(25 kHz Channel Spacing)

**FCC ID: CASTEL0064**

in accordance with

FCC 47 CFR Parts 22 and 90

PREPARED BY:

G Pringle

\_\_\_\_\_  
 Test Technician

CHECKED & APPROVED BY:

S.A. Crompton

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 Laboratory Manager

### TELTEST Laboratories

Tait Electronics Limited

PO Box 1645

558 Wairakei Road

Christchurch 5

New Zealand

Phone: +64 3 358 3399

Fax: +64 3 358 0432

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FCC ID: CASTEL0064

NAME OF TEST: TRANSMITTER OUTPUT POWER (CONDUCTED)

TEST CONDITIONS: Ambient temperature: 22 °C  
Relative humidity: 56 %  
Standard Voltage: 120VAC

SPECIFICATION: FCC 47 CFR 2.1046

GUIDE: TIA/EIA-603 2.2.1

MEASUREMENT PROCEDURE:

1. The Equipment Under Test (EUT) was set up as shown on the following diagram.
2. The coaxial attenuator used has an impedance of 50Ω.
3. The unmodulated output power was measured by means of an RF Power meter.

MEASUREMENT RESULTS:

Manufacturers rated output power: 100W

	152.030 MHz
Power (W)	102.8
Variation from nom (%)	+2.8
Measurement uncertainty (dB)	+0.63 -0.68

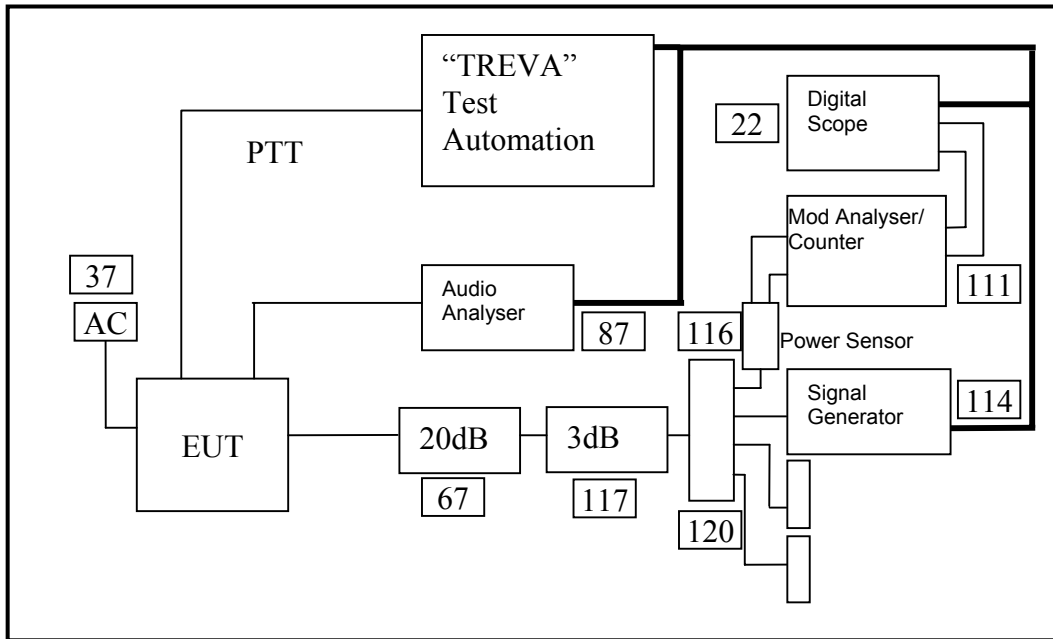
LIMIT CLAUSE: FCC 47 CFR 90.205

Radio Type: Base Station  
Frequency Band: 150 MHz -174 MHz

- (n) The output power shall not exceed by more than 20% the manufacturer's rated output power for the particular transmitter.

TEST SETUP:

See page 23 for test equipment information.



NAME OF TEST: TRANSMITTER MODULATION LIMITING  
STEADY STATE

TEST CONDITIONS: Ambient temperature: 22 °C  
Relative humidity: 56 %  
Standard Voltage: 120VAC

SPECIFICATION: FCC 47 CFR 2.1047 (b)

GUIDE: TIA/EIA-603 2.2.3

MEASUREMENT PROCEDURE:

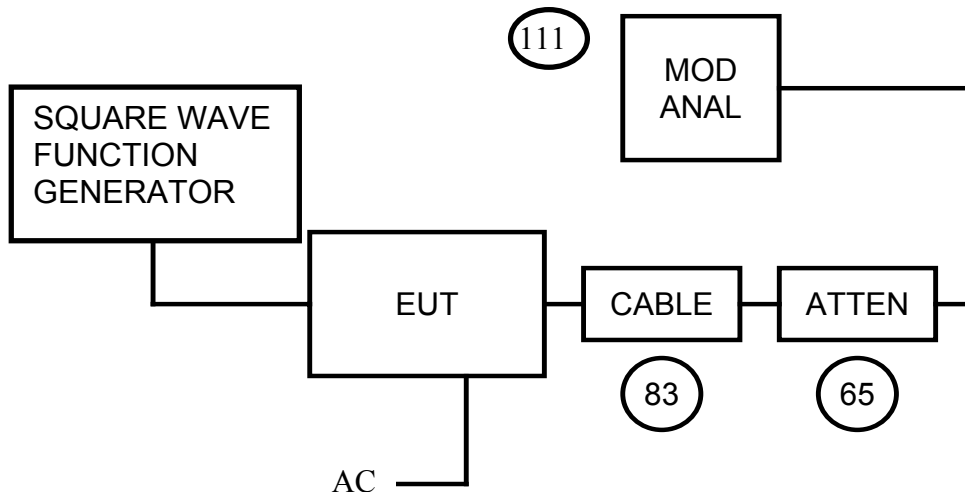
1. The Equipment Under Test (EUT) was set up as shown on the following diagram.
2. The modulation was measured with a 256, 600, 800 and 1200 Hz square wave signal applied to the data input of the transmitter at standard TTL level.
3. Measurements were made for both positive and negative deviation.

MEASUREMENT RESULTS:

See the tables on following page for 25 kHz channel spacing.

LIMIT CLAUSE: FCC 47 CFR 90.211(b)

TEST SETUP: See page 23 for test equipment information.



**512 Baud , Deviation Limit 4.5 kHz**

Positive Deviation (kHz)	Negative Deviation (kHz)	Average Peak Deviation (kHz)
4.28	4.24	4.24

**Necessary Bandwidth**

FCC 47 CFR 90.202

$$BW = 2M + 2DK$$

Where:

M = baud-rate/2

D = deviation

K = 1.2

$$\begin{aligned}
 BW &= 2 \times 512 / 2 + 2 \times 4500 \times 1.2 \\
 &= 11.3 \text{ kHz}
 \end{aligned}$$

**Emission Designation**

FCC 47 CFR 90.201

11k3F1D

**1200 Baud ,Deviation Limit 4.5kHz**

Positive Deviation (kHz)	Negative Deviation (kHz)	Average Peak Deviation (kHz)
4.35	4.24	4.28

**Necessary Bandwidth**

FCC 47 CFR 90.202

$$BW = 2M + 2DK$$

Where:

M = baud-rate/2

D = deviation

K = 1.2

$$\begin{aligned}
 BW &= 2 \times 1200 / 2 + 2 \times 4500 \times 1.2 \\
 &= 12000 \text{ Hz} \\
 &= 12.0 \text{ kHz}
 \end{aligned}$$

**Emission Designation**

FCC 47 CFR 90.201

12k0F1D

**1600 Baud ,Deviation Limit 4.5kHz**

Positive Deviation (kHz)	Negative Deviation (kHz)	Average Peak Deviation (kHz)
4.37	4.27	4.29

**Necessary Bandwidth**

FCC 47 CFR 90.202

$$BW = 2M + 2DK$$

Where:

M = baud-rate/2

D = deviation

K = 1.2

$$\begin{aligned}
 BW &= 2 \times 1600 / 2 + 2 \times 4500 \times 1.2 \\
 &= 12400 \text{ Hz} \\
 &= 12.4 \text{ kHz}
 \end{aligned}$$

**Emission Designation**

FCC 47 CFR 90.201

12k4F1D



**2400 Baud , Deviation Limit 4.5kHz**

Positive Deviation (kHz)	Negative Deviation (kHz)	Average Peak Deviation (kHz)
4.45	4.28	4.35

**Necessary Bandwidth**

FCC 47 CFR 90.202

$$BW = 2M + 2DK$$

Where:

M = baud-rate/2

D = deviation

K = 1.2

$$\begin{aligned}
 BW &= 2 \times 2400 / 2 + 2 \times 4500 \times 1.2 \\
 &= 13200 \text{ Hz} \\
 &= 13.2 \text{ kHz}
 \end{aligned}$$

**Emission Designation**

FCC 47 CFR 90.201

13k2F1D

NAME OF TEST: OCCUPIED BANDWIDTH

TEST CONDITIONS: Ambient temperature: 21.5 °C  
 Relative humidity: 58 %  
 Standard Voltage: 120VAC

SPECIFICATION: FCC 47 CFR 2.1049 (h)

GUIDE: TIA/EIA-603 2.2.11

MEASUREMENT PROCEDURE:

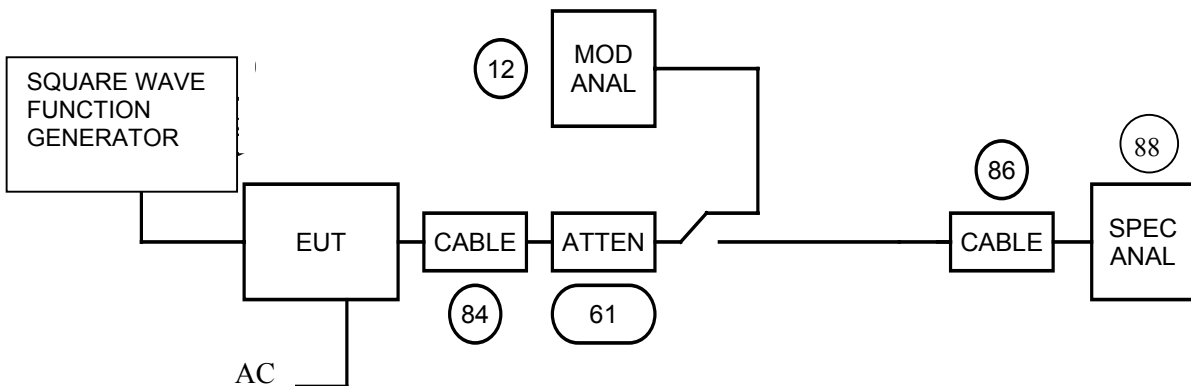
1. The Equipment Under Test (EUT) was set up as shown on the following diagram.
2. The EUT was modulated with a square wave signal simulating the appropriate Baud rates.
3. The Occupied Bandwidth was measured on the Spectrum Analyser with the controls set as shown on the following plots.

MEASUREMENT RESULTS: See the plots on following page 25 kHz channel spacing.

LIMIT CLAUSE: FCC 47 CFR 90.210

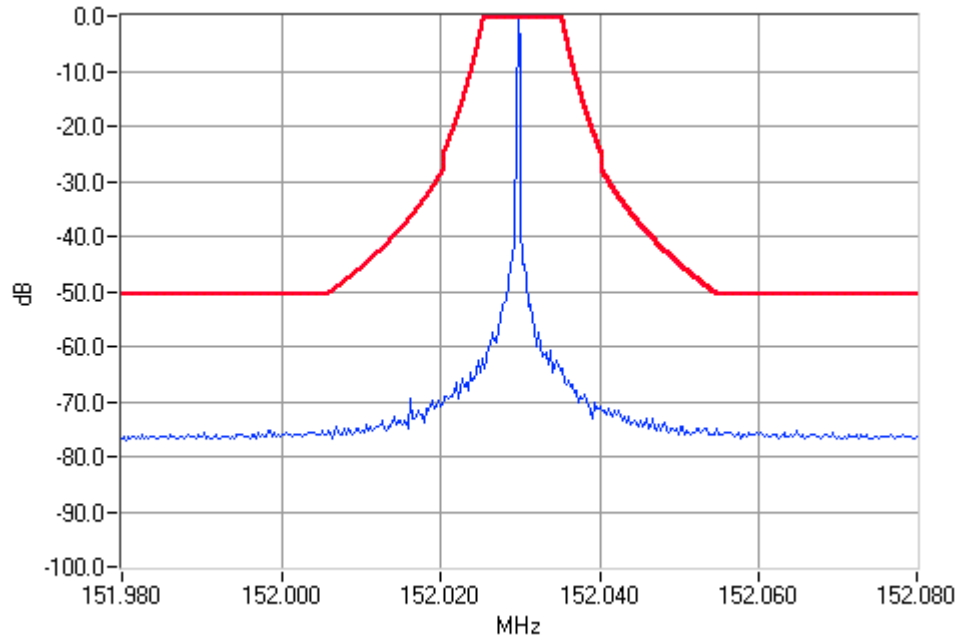
EMISSION MASK " C "	ATTENUATION (dBc)
$F_c \pm 5.0 \text{ kHz to } \pm 10.0 \text{ kHz}$	$83 \log ( f_d / 5 )$
$F_c \pm 10 \text{ kHz to } \pm 50 \text{ kHz}$	$29 \log ( f_d^2 / 11 )$ or 50 dB whichever is the lesser
$F_c > \pm 50 \text{ kHz}$	63

TEST SETUP: See page 23 for test equipment information.



NAME OF TEST: OCCUPIED BANDWIDTH

SPECIFICATION: FCC 47 CFR 2.1049 (h)  
MASK "C"

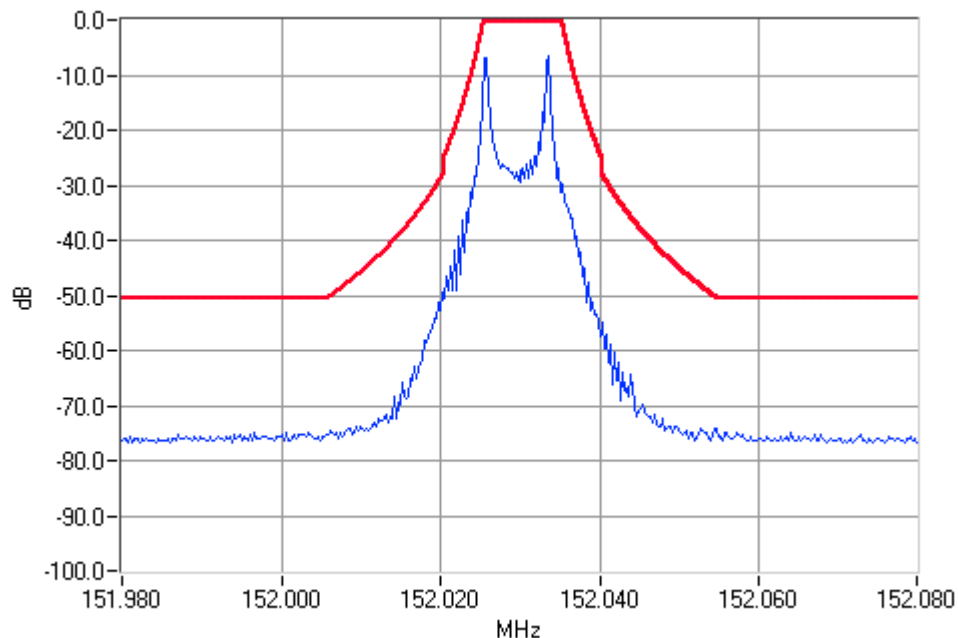


**Unmodulated 152.0300MHz Mask C 100W Pass**

100W UNMODULATED

152.030 MHz

T837-26-1021 Exciter



**Paging Modulation 152.0300MHz Mask C 100W Pass**

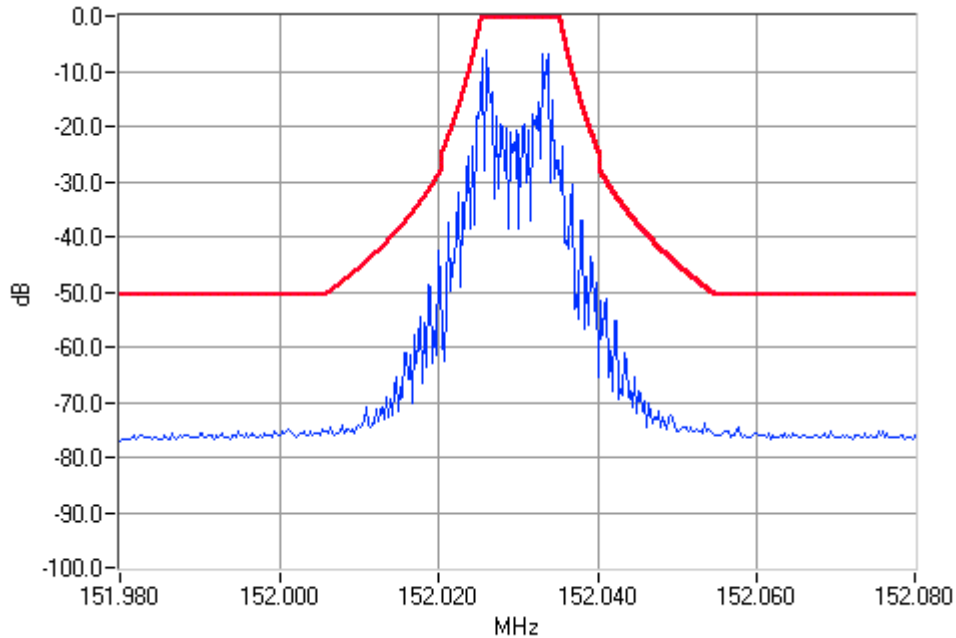
100W 512 BAUD MODULATED

152.030 MHz

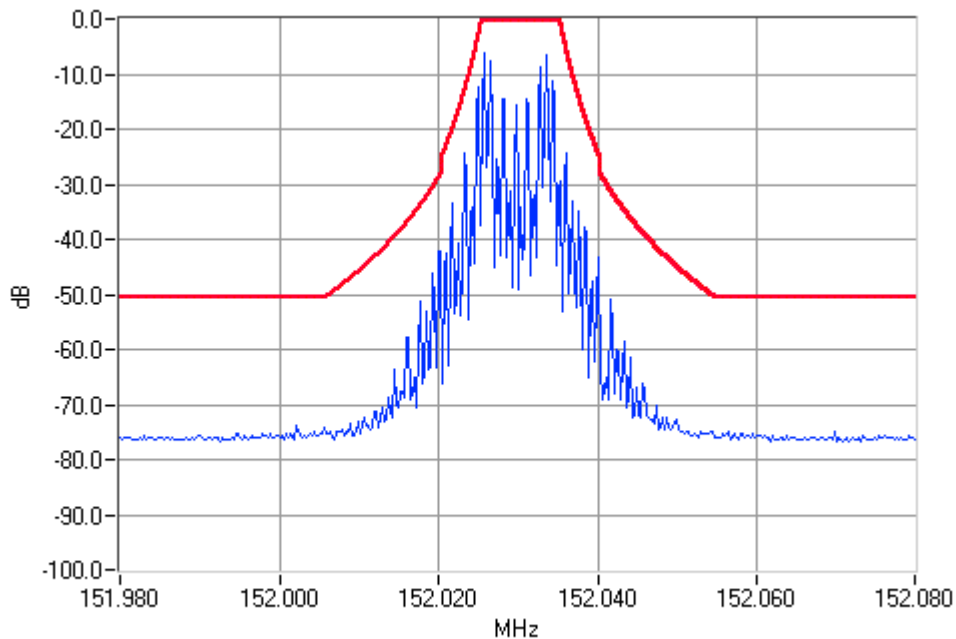
T837-26-1021 Exciter

NAME OF TEST: OCCUPIED BANDWIDTH

SPECIFICATION: FCC 47 CFR 2.1049 (h)  
MASK "C"



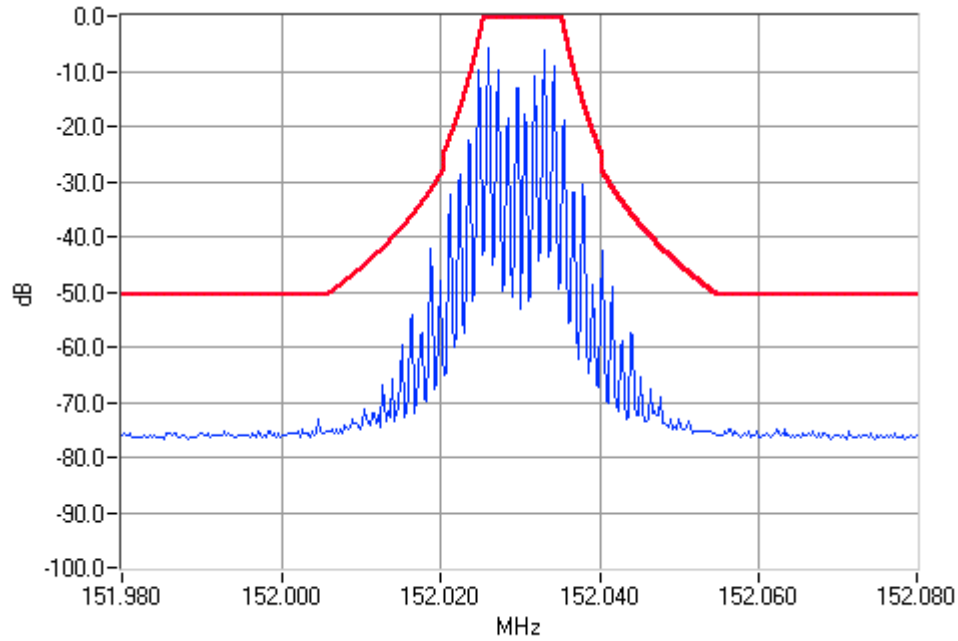
**Paging Modulation 152.0300MHz Mask C 100W Pass**  
100W 1200 BAUD MODULATED 152.030 MHz  
T837-26-1021 Exciter



**Paging Modulation 152.0300MHz Mask C 100W Pass**  
100W 1600 BAUD MODULATED 152.030 MHz  
T837-26-1021 Exciter

NAME OF TEST: OCCUPIED BANDWIDTH

SPECIFICATION: FCC 47 CFR 2.1049 (h)  
MASK "C"



**Paging Modulation 152.0300MHz Mask C 100W Pass**  
100W 2400 BAUD MODULATED      152.030 MHz  
T837-26-1021 Exciter

NAME OF TEST: SPURIOUS EMISSIONS (CONDUCTED)

TEST CONDITIONS: Ambient temperature: 21.5 °C  
 Relative humidity: 58 %  
 Standard Voltage: 120VAC

SPECIFICATION: FCC 47 CFR 2.1051

GUIDE: TIA/EIA-603 2.2.13

MEASUREMENT PROCEDURE:

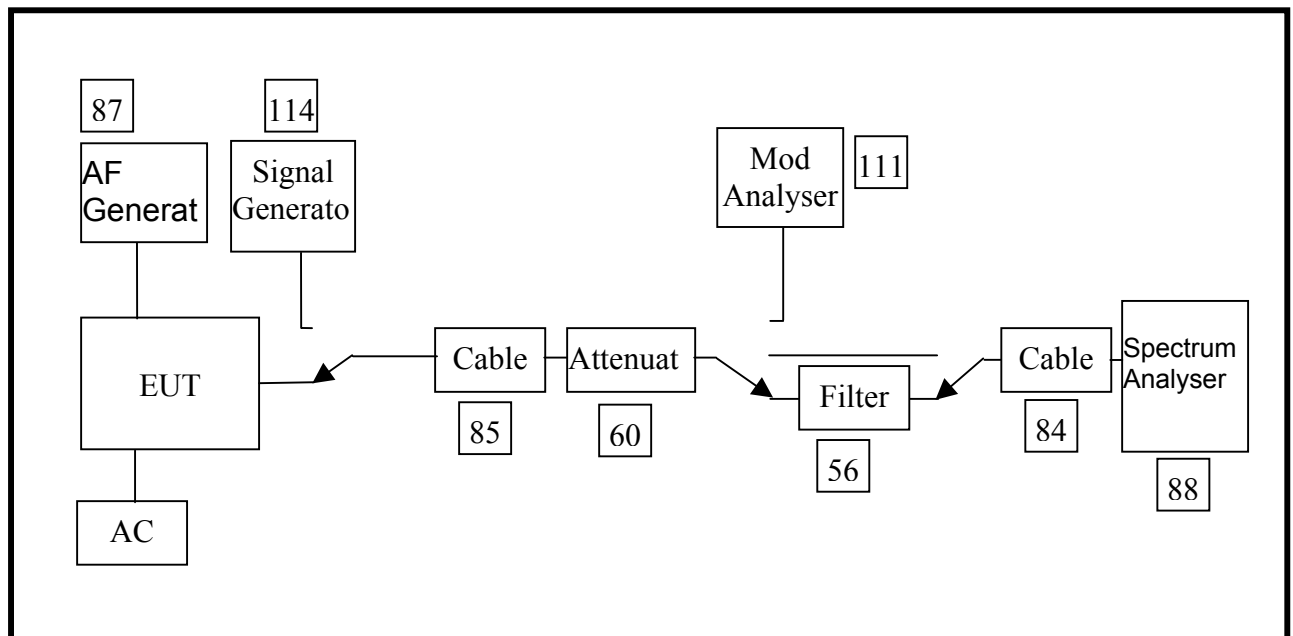
1. The Equipment Under Test (EUT) was set up as shown on the following diagram.
2. The frequency range examined was from the lowest frequency generated within the EUT to a frequency higher than the 10th harmonic:  $100 \text{ kHz} \rightarrow F_c - BW$   
 $F_c + BW \rightarrow 1.6 \text{ GHz}$
3. Spurious emissions which were attenuated more than 20dB below the limit were not recorded

MEASUREMENT RESULTS:

See the tables on following pages for 25 kHz channel spacing.

LIMIT CLAUSE: FCC 47 CFR 90.210  
 See the tables on following pages.

TEST SETUP: See page 23 for test equipment information.



NAME OF TEST: SPURIOUS EMISSIONS (CONDUCTED)  
 SPECIFICATION: FCC 47 CFR 2.1051  
 EXCITER T837-26-1021

25 kHz channel spacing	152.030 MHz @ 100W	Emission Mask C
Emission Freq MHz	Level dBm	Level dBc
153.0245	-24.8	-74.8
172.0300	-29.2	-79.2
No other emissions were detected at a level greater than 20 dB below the limit		

LIMITS:

Carrier Output Power Watts	Emission Mask "C" $43 + 10\log_{10}(P_{\text{Watts}})$	
100W	63dBc	-13 dBm

NAME OF TEST: TRANSMITTER FREQUENCY STABILITY (TEMPERATURE)

TEST CONDITIONS: Ambient temperature: 22 °C  
 Relative humidity: 47 %  
 Standard Voltage: 120VAC

SPECIFICATION: FCC 47 CFR 2.1055 (a) (1)

GUIDE: TIA/EIA-603 2.2.2

MEASUREMENT PROCEDURE:

1. The Equipment Under Test (EUT) was set up as shown on the following diagram.
2. The EUT was tested for frequency error from -30°C to +50°C in 10°C increments.
3. The frequency error was recorded in parts per million (PPM)

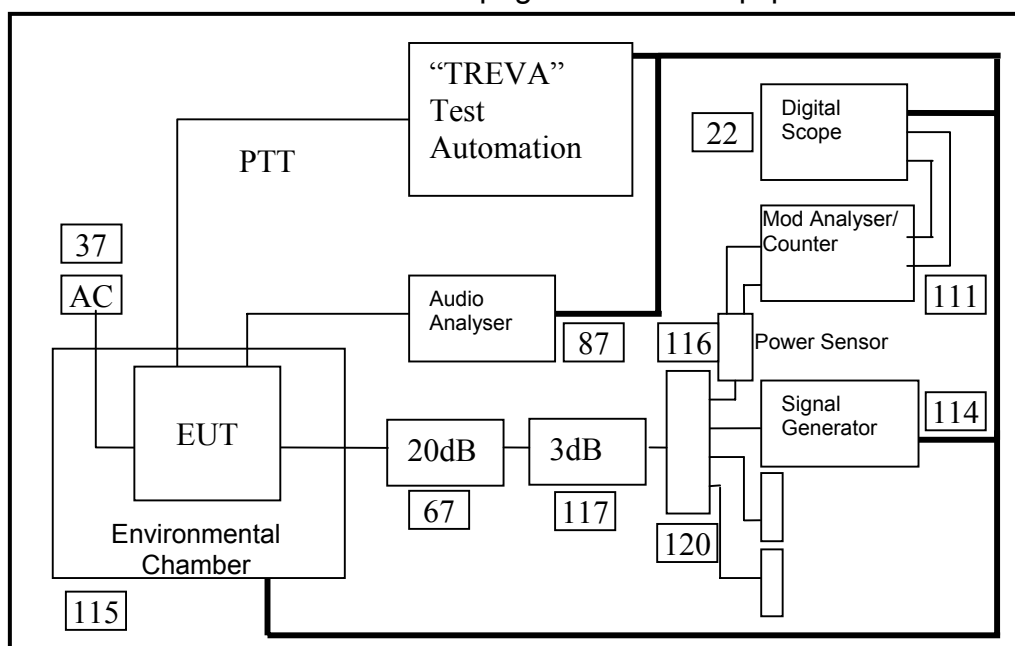
MEASUREMENT RESULTS:

See the plot on the following page.

LIMIT CLAUSE: FCC 47 CFR 90.213  
 Frequency 152.030 MHz

Channel Spacing (kHz)	Frequency Error (PPM)
25	5.0

TEST SETUP: See page 23 for test equipment information.

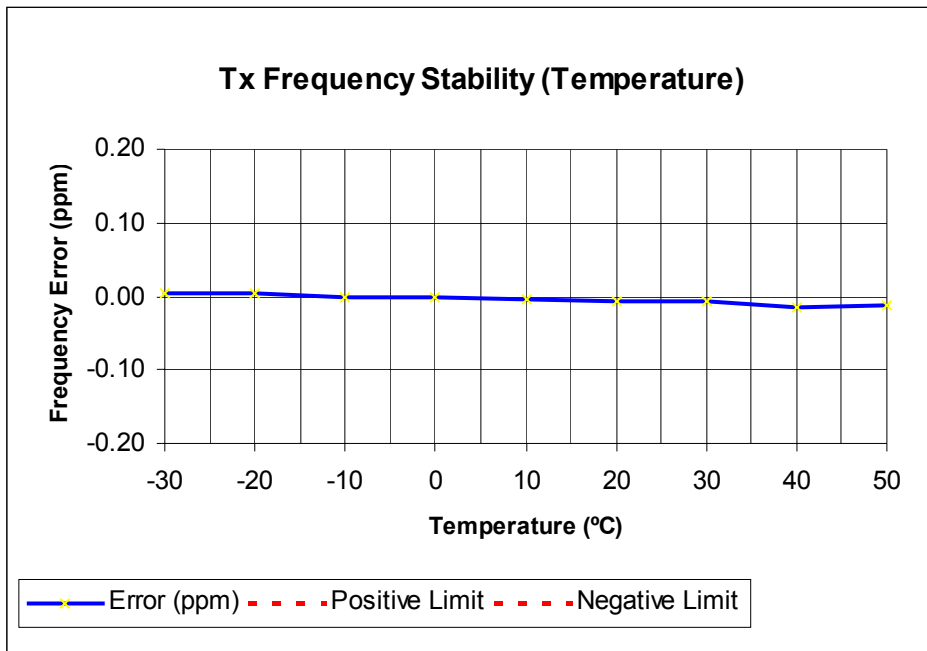




NAME OF TEST: TRANSMITTER FREQUENCY STABILITY (TEMPERATURE)

SPECIFICATION: FCC 47 CFR 2.1055 (a) (1)

Frequency 152.030 MHz



**Exciter T837-26-1021**

NAME OF TEST: TRANSMITTER FREQUENCY STABILITY (VOLTAGE)

TEST CONDITIONS: Ambient temperature: 22 °C  
 Relative humidity: 54 %  
 Standard Voltage: 120VAC

SPECIFICATION: FCC 47 CFR 2.1055 (d) (1)

GUIDE: TIA/EIA-603 2.2.2

MEASUREMENT PROCEDURE:

1. The Equipment Under Test (EUT) was set up as shown on the following diagram.
2. The EUT was tested for frequency error at an input voltage to the power supply of 85% to 115%, by means of AC Power supply and Variac
3. The frequency error was recorded in parts per million (PPM)

MEASUREMENT RESULTS:

Channel Spacing (25 kHz)  Supply Voltage	Frequency Error (ppm) @ 152.030 MHz		
	102 VAC	120 VAC	138 VAC
T837-26-1021 Exciter	-0.005	-0.005	-0.005
Limit (ppm)	5.0	5.0	5.0

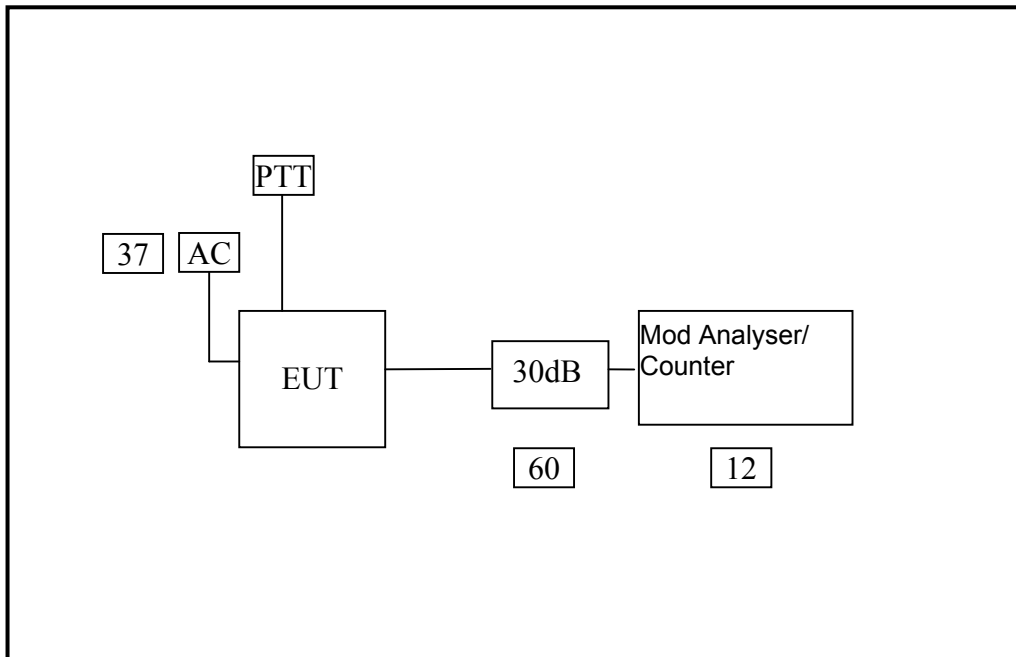
LIMIT CLAUSE: FCC 47 CFR 90.213

Frequency Range 152.030 MHz

Channel Spacing (kHz)	Frequency Error (PPM)
25	5.0

TEST SETUP:

See page 23 for test equipment information.



NAME OF TEST: TRANSIENT FREQUENCY BEHAVIOUR

TEST CONDITIONS: Ambient temperature: 22 °C  
 Relative humidity: 56 %  
 Standard Voltage: 120VAC

SPECIFICATION: FCC 47 CFR 90.214

GUIDE: TIA/EIA-603 2.2.19

MEASUREMENT PROCEDURE:

1. The Equipment Under Test (EUT) was set up as shown on the following diagram.
2. Measurements and plots were made following the TIA/EIA procedure.

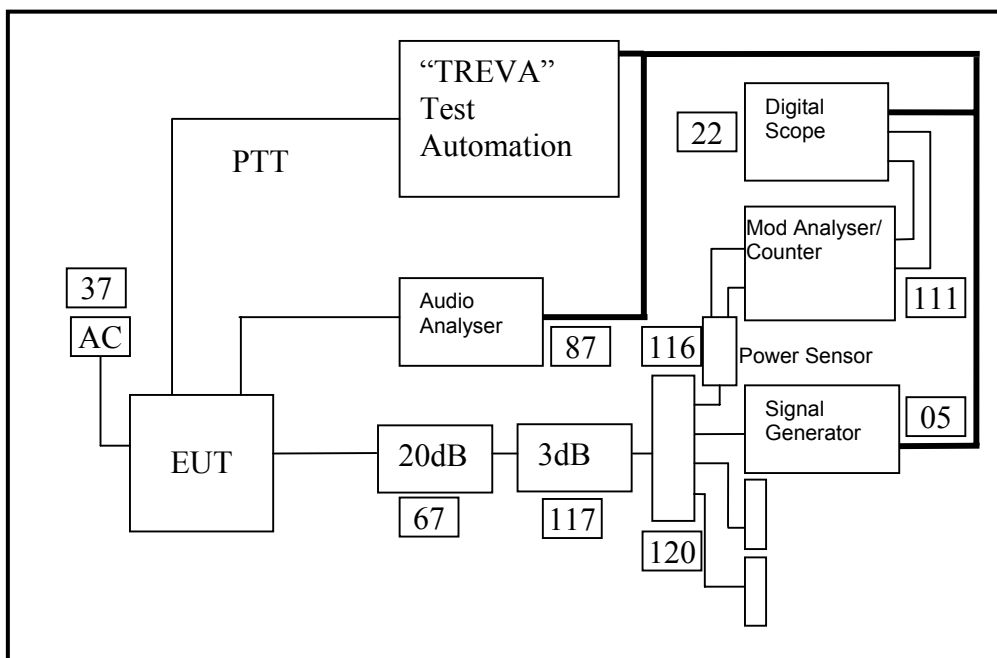
MEASUREMENT RESULTS:

See the tables and plots on the following pages.

LIMIT CLAUSE: FCC 47 CFR 90.214

See the tables on the following pages.

TEST SETUP: See page 23 for test equipment information.



NAME OF TEST: TRANSIENT FREQUENCY BEHAVIOUR

SPECIFICATION: FCC 47 CFR 90.214

25.0 kHz CHANNEL SPACING

FREQUENCY	T837-26-1021 152.030 MHz @ 100W Tx	
TRANSIENT RESPONSE PERIOD	CARRIER PEAK VARIATION FROM NOMINAL	
	KEY ON (kHz)	KEY OFF (kHz)
t1	-0.4	N/A
t2	-0.4	N/A
t3	N/A	0.3
t2 → t3 ppm	-2.9	
ERROR LIMIT (t2 → t3) ppm	5.0	

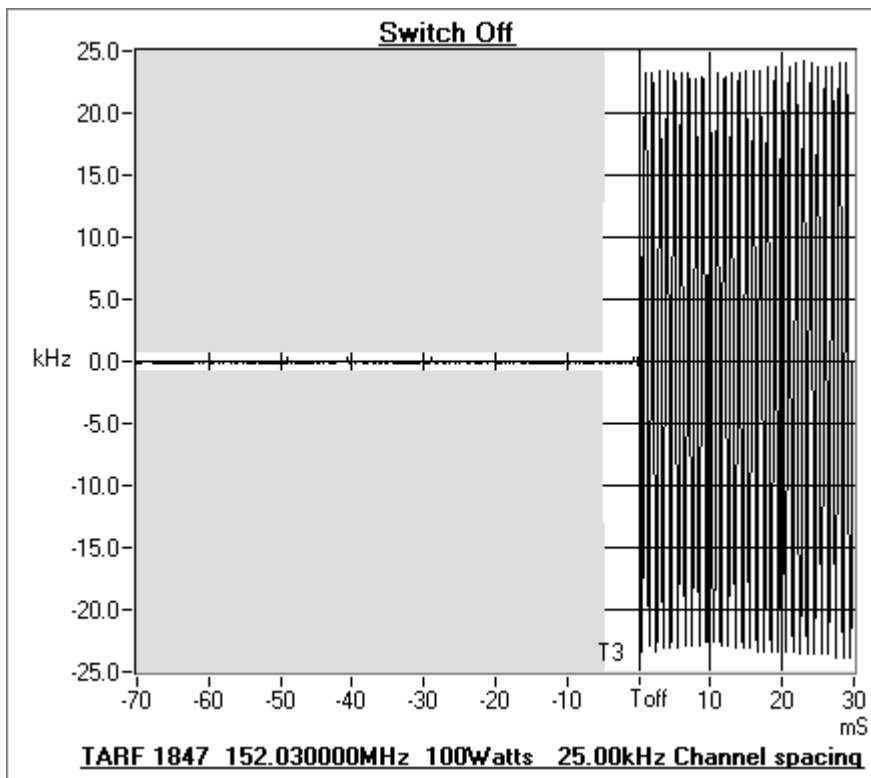
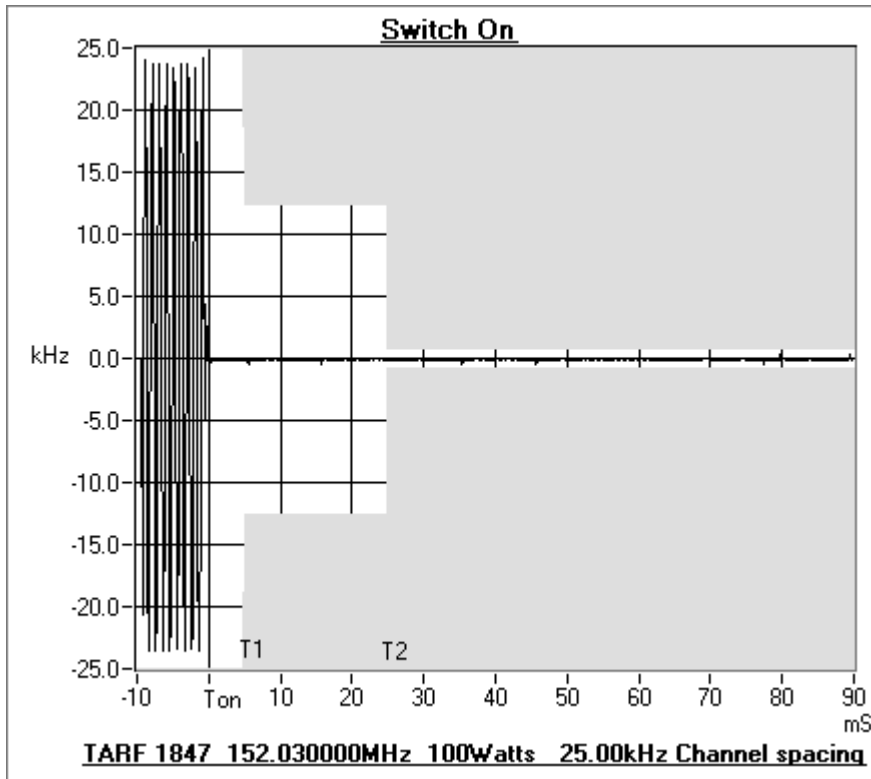
Confirm that during periods t1 and t3 the frequency difference does not exceed the value of one channel separation.	YES	NO
	y	
Confirm that during the period t2 the frequency difference does not exceed half a channel separation.	YES	NO
	y	
Confirm that during the period t2 to t3 the frequency difference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

LIMITS: 25.0 kHz CHANNEL SPACING

TRANSIENT PERIODS	MAXIMUM FREQUENCY DIFFERENCE (kHz)	FREQUENCY RANGE 150 → 174 MHz
t1 (ms)	±25.0	5.0 ms
t2 (ms)	±12.5	20.0 ms
t3 (ms)	±25.0	5.0 ms

NAME OF TEST: TRANSIENT FREQUENCY BEHAVIOUR

SPECIFICATION: FCC 47 CFR 90.214



**TEST EQUIPMENT LIST**

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	Manufacturer	Model Number	Serial No	Tait ID
1	Signal Generator	Hewlett Packard	HP8642B (Opt 001)	2512A00176	E3064
2	Signal Generator	Hewlett Packard	HP8648A	3430U00344	E3579
3	Signal Generator	Agilent	E4422B	GB40050320	E3788
4	Signal Generator	Hewlett Packard	HP8648C	3443U00543	E3558
5	Signal Generator	Rohde & Schwarz	SMY01 1062.5502.11	841736/019	E3553
10	Spectrum Analyser	Hewlett Packard	HP8596E (Opt 140)	3346A00213	E3427
11	Modulation Analyser	Hewlett Packard	HP8901B (Opt 002)	2441A00393	E3073
12	Modulation Analyser	Rohde & Schwarz	FMA0852.8500.52	842541/001	E3554
13	Audio Analyser	Hewlett Packard	HP8903A	2308A02597	E3074
14	Power Head	Hewlett Packard	HP11722A	2320A00688	E3307
15	Power Meter	Rohde & Schwarz	NRVS 1020.1809.02	841954/005	E3555
16	Power Sensor	Rohde & Schwarz	URV5- Z4 395.1619. 55	841.498/003	E3557
20	Power Supply	Hewlett Packard	HP6032A	2441A-0041Z	E3075
21	Power Supply	Rohde & Schwarz	NGS M32/10 192.0810.31	Fnr 434	E3556
22	Oscilloscope	Tektronics	TDS340	B013611	E3585
23	Universal Counter	Goldstar	FC2015U -	600801	E3550
24	Environ. Chamber	Contherm	Spatial Cal	E3397	E3397
24	Environ. Chamber	Contherm	Temp Control	E3397	E3397
25	Whirling Hygrometer	Casella	3156/82	TA004	TA004
30	Directional Coupler	Hewlett Packard	HP778D-012	1144 07392	E3292
31	4 Port Combiner (CAST)	Rohde & Schwarz	DVU4,3W 201.4018.03	300.729/47	E3623
32	4 Port Combiner	Rohde & Schwarz	DVU4, 3W 201.4018. 03	300.971/28	E3572
33	3 Port Combiner	Weinschel	1506A, 1W	LD858	E3672
34	Mixer Spurious Emission	Tait	(3. 2GHz# Rfx#4.0 GHz)	E3661	E3661
35	Mixer Transient ACP	Minicircuits	ZAD-1177031	ZAD-11	E3394
36	Voltmeter	Hewlett Packard	HP3478A	2545A25838	1559
37	Variac	Yamabishi	S-260-5	TX-533	E1737
38	Rx & Tx, RF Paths	Tait	CAST Interface	E3067	E3067
40	Reference Dipoles	Emco	3121C DB1	9510-1164	E3559
41	Biconical Antenna	Emco	3110B	9307-1680	E3033
42	Reference Horn Antenna	Emco	DRG3115	9512-4638	E3560
43	Horn Antenna	Emco	DRG3115	2084	E3076
44	Corner 175-420 MHz	Ailtech	DM105A-T2	J1417-103	E3031
45	Corner 400-1000 MHz	Ailtech	DM105A-T3	J1418-108	E3036
46	S-LINE TEM CELL	Rohde & Schwarz	1089.9296.02	338232/003	E3636
50	Amplifier 1MHz-1000MHz	Amplifier Research	25W1000A	20444	E3637
51	Amplifier 10kHz-250MHz	Amplifier Research	25A250	16373	E3570
52	Amplifier +21.7 dB	Tait	ZFL-1000LN	E3660	E3360
53	RF Filter 21.4M (CAST)	Tait	NDK21G-6DT	E3069	E3069
54	RF Filter 21.4M (ACP)	Tait	NDK21G-6DT	RA-7'	E3249
55	Filter Notch	Tait		N/A	-
56	Filter High Pass	Tait	4 MHz	N/A	-
57	Filter Low Pass	Tait	MHz	N/A	-
60	RF Attenuator 250W	Weinschel	45-30-34	JW663	E3386
61	RF Attenuator 150W	Weinschel	40-20-33	CJ404	E3387
62	RF Attenuator 150W	Weinschel	57-10-34	LB590	E3674
63	RF Attenuator 150W	Weinschel	40-06-34	KV457	E3561
64	RF Attenuator 50W	Weinschel	24-10-34	AZ0401	E3388
65	RF Attenuator 50W	Weinschel	24-20-44	AW1266	E3562
66	RF Attenuator 25W	Weinschel	33-20-33	BD5871	E3673
67	RF Attenuator 150W	Weinschel	40-20-33	CJ405	E3733
70	RF Load 150W	Bird	8166	524	E3625
71	RF Load 50W	Weinschel	F1426	BF0487	E3675
72	RF Load 50W	Weinschel	F1426	AE2490	E3624

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73	RF Termination 20W	Deltec		118.001	E3626
74	RF Termination 2W	MCL	NTRM-50	951215	E3574
75	RF Termination 2W	MCL	NTRM-50	954214	E3575
76	RF Termination 2W	MCL	NTRM-50	954214	E3576
80	20m Coax Cable	Intelcom	RG214/U-50(Ext Cal)	CBL01	E3659
81	2m Coax Cable	Intelcom	RG213/U-50 (Ext Cal)	CBL02	E3658
82	3m Coax Cable BLUE)	Suhner	Sucoflex 104A	25033/4A	E3694
83	1m Coax Cable (BLUE)	Suhner	Sucoflex 104A	25006/4A	E3693
84	1m Coax Cable (BLUE)	Suhner	Sucoflex 104A	25005/4A	E3692
85	1m Coax Cable (BLUE)	Suhner	Sucoflex 104A	25004/4A	E3691
86	1m Coax Cable (BLUE)	Suhner	Sucoflex 104A	25003/4A	E3690
87	Audio Analyser	Hewlett Packard	HP8903B	2818A04275	E3710
88	Spectrum Analyser	Hewlett Packard	HP8562E	3821A00779	E3715
89	Field Strength Meter	Holaday	HI-422	95661	E3630
90	Power Supply	Hewlett Packard	HP6012B	2524A00616	E3712
91	20m Coax Cable		RG214/U-50 (Ext Cal)	CBL01	E3404
92	LISN	Emco	3825/2	9204-1961	E3040
93	EMC Test Instr	Schaffner	BEST +A	199825-010SC	AT183
94	ESD Test Set	Haefely	PSD 25B	082 999 24	E3629
95	Vehicle Conducted Immunity Test Set	Schaffner	NSG 5000	IN5094-090	E3506
96	Burst Generator	Schaffner	NSG5003	AR5194-151	E3508
97	Battery Simulator	Schaffner	NSG 5004	IN1695-003	-
98	RF Injection Probe	Fischer	F120-9	121	-
99	BER Meter	Datatool	5000	9405003	-
100	Oscilloscope	Tektronics	TDS380	B017095	E3782
101	Coupler Decoupler Network	MEB	S15	10344	E3563
102	Coupler Decoupler Network	MEB	S1/50	10328	E3564
103	Coupler Decoupler Network	MEB	AF2	10967	E3565
104	Coupler Decoupler Network	MEB	M3-1	12207	E3566
105	Coupler Decoupler Network	MEB	S25	10762	E3567
105	Coupler Decoupler Network	MEB	T2	10778	E3568
106	Coupler Decoupler Network	MEB	M2	10701	E3569
107	Benchlink	Hewlett Packard	E4444A Ver A.01.06	19980701	
108	GPIB Software	National Instruments	Ver 1.6	500739A-00	
109	Labview	National Instruments	Ver 5.1.1	500573J-00	
110	Wavestar	Tektronix	WSTR31 Ver 2.4	063-2173-04	
111	Modulation Analyser	Hewlett Packard	HP8901B (Opt 002)	3704A05837	E3786
112	Signal Generator	Agilent	ESG4000B	GB40050320	E3788
113	Hi Level Mixer	Tait			E3933
114	Signal Generator	Rohde & Schwarz	SML03 1090.3000.13	100597	E4050
115	Environ. Chamber	Contherm	5400 RHSLT.M	1416	E4051
116	Power Head	Hewlett Packard	HP11722A	2716A02037	1575
117	RF Attenuator	Weinschel	Model 1	BL9950	
118	RF Attenuator	Weinschel	Model 1	BL9958	
119	RF Attenuator 150W	Weinschel	40-20-23	MF817	
120	RF Splitter Combiner	Minicircuits	ZFSC-4-1	-	
121	RF Splitter Combiner	Minicircuits	ZFSC-4-1	-	
122	RF Splitter Combiner	Minicircuits	ZFSC-4-1	-	