TABLE OF CONTENTS LIST FOR PART 90 UHF DEVICE

APPLICANT: Tactical Electronics Corporation

FCC ID: EFO IC-F2020WN-2

TEST REPORT:

EXHIBITS CONTAINING:

GENERAL INFORMATION REQUIRED FOR TYPE ACCEPTANCE

2.1033 (c)(1)(2) Tactical Electronics Corporation will sell the FCC ID: EFO IC-F2020WN-2 VHF transceiver in quantity, for use under FCC RULES PART 22 & 90.

2.1033 (c) TECHNICAL DESCRIPTION

2.1033 (3) User Manual See Exhibit 7

2.1033 (4) Type of Emission:

11K3F2D For 12.5 kHz

For 12.5 kHz
Bn = 2M + 2DK
M = 9,600 Bits per second
D = 0.825 kHz (Peak Deviation)
K = 1
Bn = 2(9600/2) + 2(0.825)(1) = 9.6 k + 1.65 k = 11.25 k

For a 25 kHz channel
ALLOWED AUTHORIZED BANDWIDTH = 20.00 kHz

For 12.5 kHz channel
ALLOWED AUTHORIZED BANDWIDTH = 11.25 kHz.

90.209(b)(5)

2.1033 (5) Frequency Range: 450-470 MHz

(6) Power Range and Controls: There are NO user Power controls.

(7) Maximum Output Power Rating:
33 Watts.

(8) DC Voltages and Current into Final Amplifier:

POWER INPUT
See next page under output power.

(9) Tune-up procedure. The tune-up procedure is given in EXHIBIT 6.

2.1033 (10) Complete Circuit Diagrams: The circuit diagram is included as EXHIBIT 3. The block diagram is included as EXHIBIT 4.

(11) Function of each electron tube or semiconductor device or other active circuit device:
-SEE EXHIBIT 5.

(8) Instruction book. The instruction manual is included as EXHIBIT 7.

(10) Description of all circuitry and devices provided for determining and stabilizing frequency is included in the circuit description in the instruction manual.

2.1033(c)(11) A photograph or drawing of the equipment identification label is shown in Exhibit 1.

2.1033(c)(12) Photographs of the equipment of sufficient clarity to reveal equipment construction and layout and label location are shown in Exhibit 8-15.

2.1033(c)(13) For equipment employing digital modulation, a detail description of the modulation technique. This UUT uses FSK to modulate the transmitter.

2.1033(c)(14) data required for 2.1046 to 2.1057 See Below

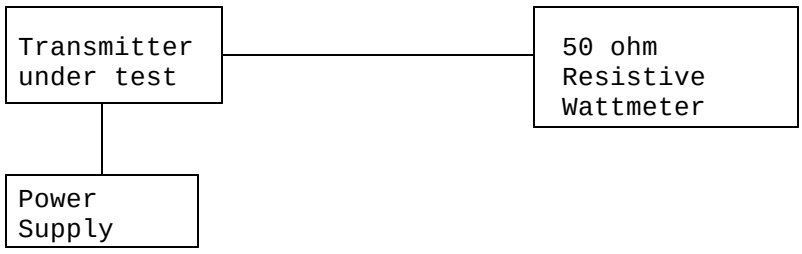
2.1046(a) RF power output.

RF power is measured by connecting a 50 ohm, resistive wattmeter to the RF output connector. With a nominal battery voltage of 12VDC, and the transmitter properly adjusted the RF output measures:

DC INPUT POWER - HIGH: (12V)(7.5A) = 90 Watts
DC INPUT POWER – LOW: (12V)(3.25A)= 39 Watts

OUTPUT POWER: HIGH - 33 Watts
LOW - 4.5 Watts

METHOD OF MEASURING RF POWER OUTPUT



2.1047(a) Voice Modulation characteristics:
NOT APPLICABLE, F2 type of emission.

2.1049 Audio Low Pass Filter
This UUT is a data radio.

2.1049 Occupied bandwidth:
90.210(c,)
For transmitters that are not equipped with an audio low pass filter pursuant to S90.211(b), the power of any emission must be attenuated below the unmodulated carrier output power as follows; (1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency(fd in kHz) of more than 5 kHz but not more than10 kHz: At least 83 log(fd/5)dB; (2)ON any frequency removed from the center of the authorized bandwidth by a displacement frequency(fd in kHz) of more than 10 kHz, but not more than 250% of the authorized bandwidth: At least 29 log(fd2/11)dB or 50 dB, whichever is the lesser attenuation; (3) On any frequency removed from the center of the authorized bandwidth by more than 250% of the authorized bandwidth: At least 43+10 log(Po)dB.

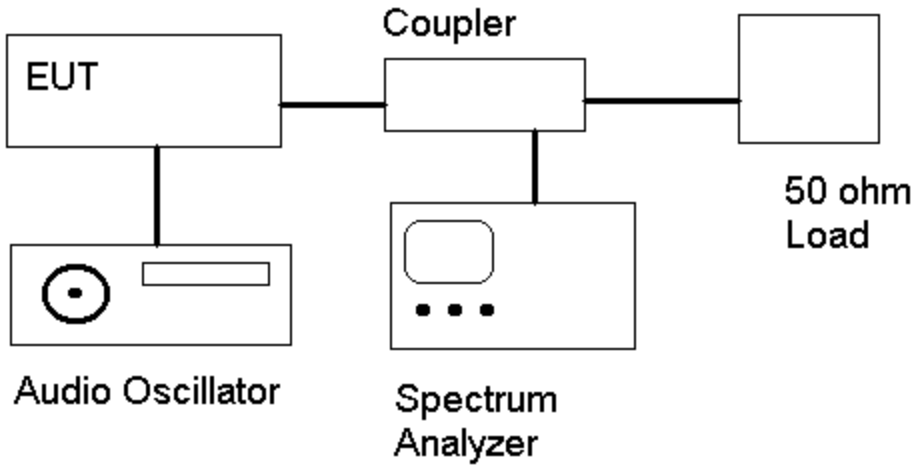
90.210(d) Emission Mask D - 12.5 kHz channel bandwidth equipment. For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:
(1) On any frequency from the center of the authorized bandwidth f0 to 5.625 kHz removed from f0: Zero dB.
(2) On any frequency from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least 7.27 (fd - 2.88 kHz) dB.
(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5 kHz: At least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.
Data in the plots show that on any frequency removed from the assigned frequency by more than 50%, but not more than 100%: At least 25dB. On any frequency removed from the assigned frequency by more than 100%, but not more than 250%: At least 35 dB. On any frequency removed from the assigned frequency by more than 250%, of the authorized bandwidth: At least 43+log(P)dB.

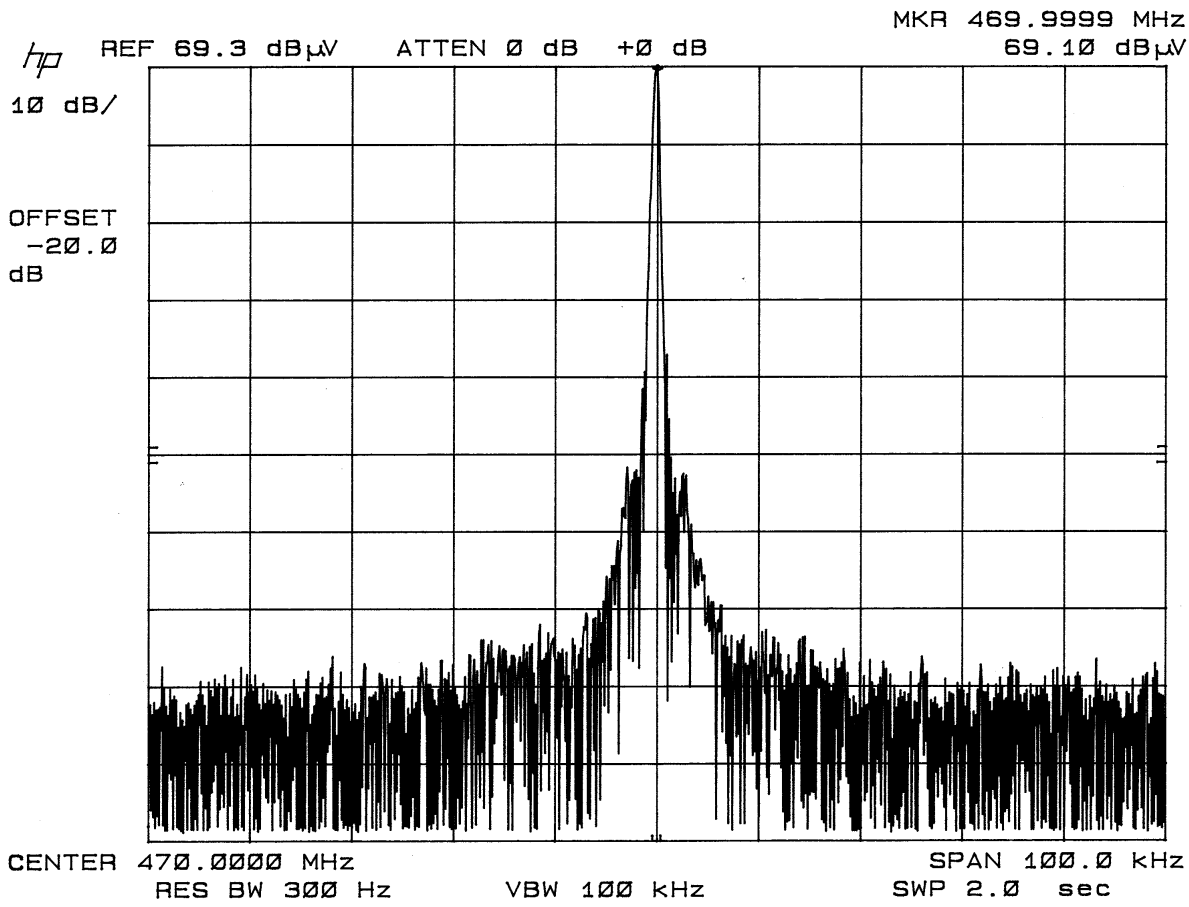
Radiotelephone transmitter with modulation limiter.

Test procedure: TIA/EIA-603 para 2.2.11 , with the exception that various tones were used.

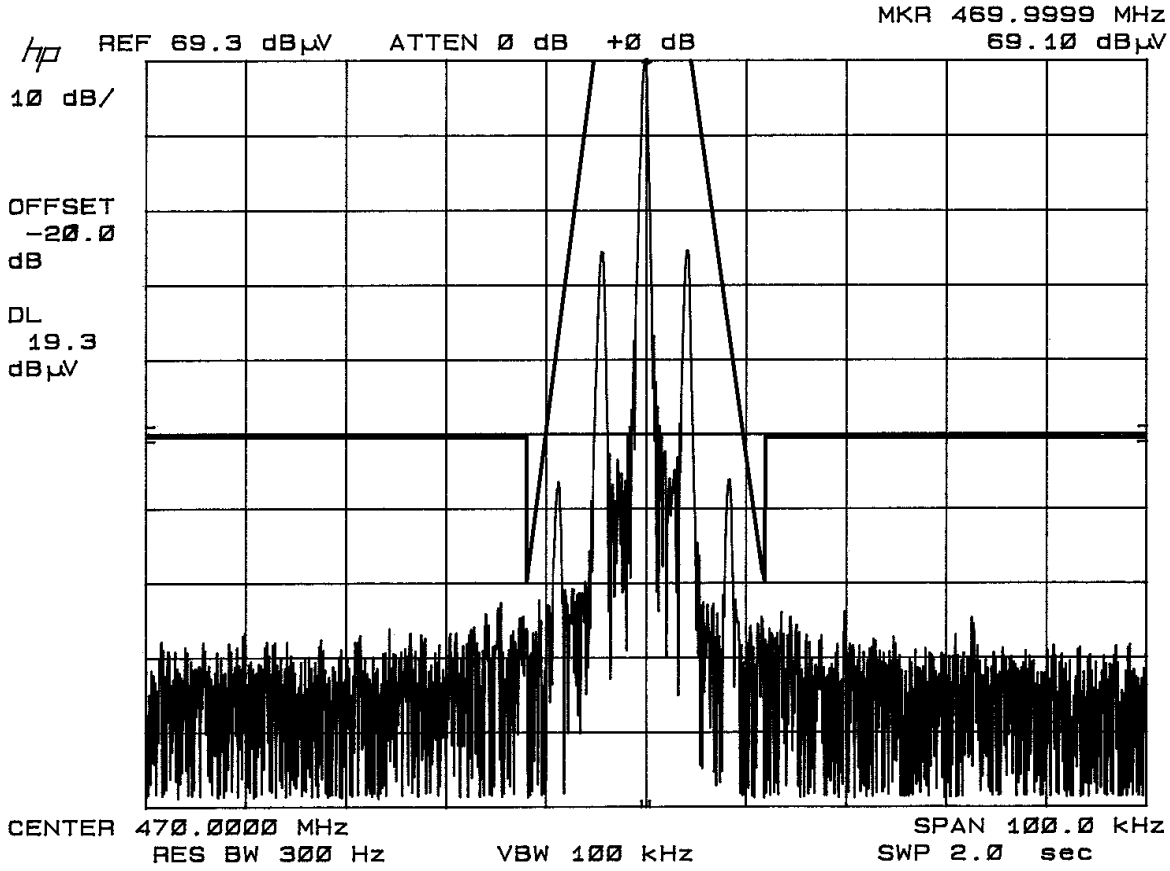
Test procedure diagram

OCCUPIED BANDWIDTH MEASUREMENT

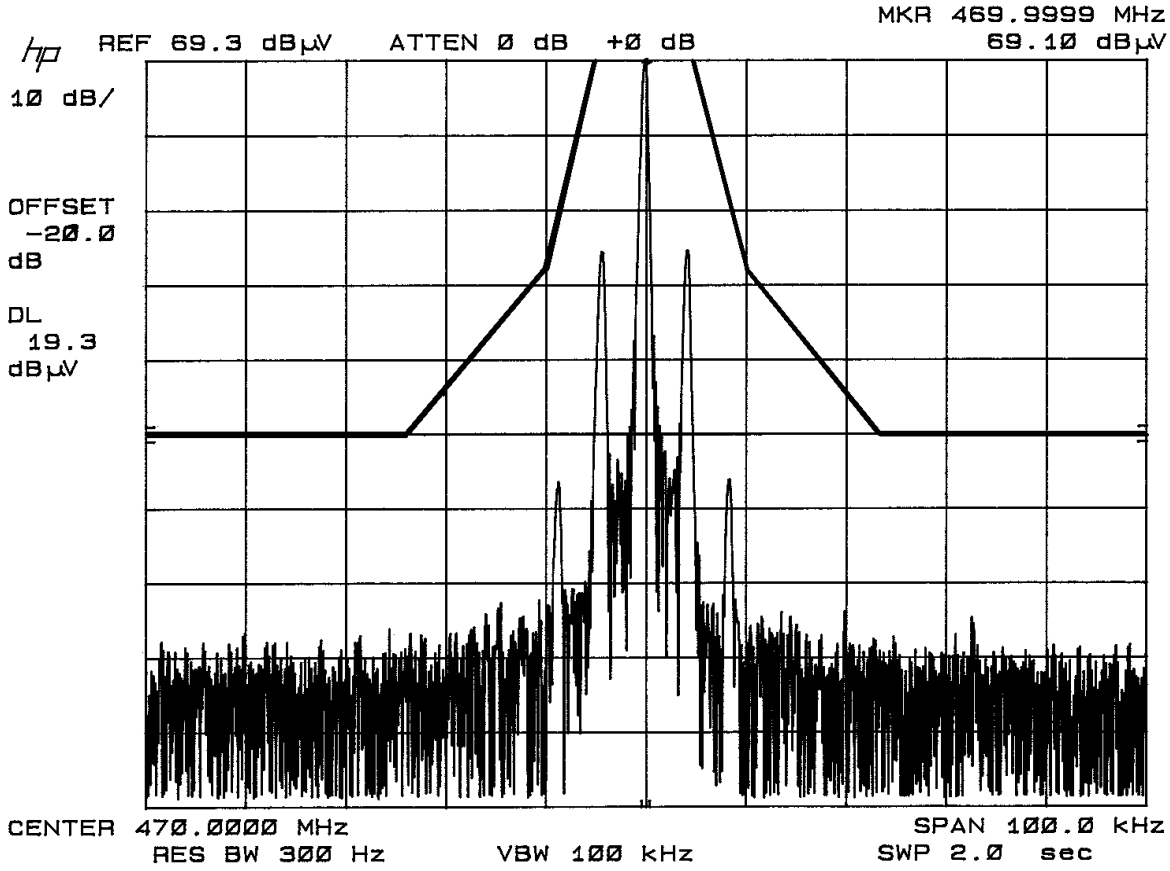



MKR 469.9999 MHz
REF 69.3 dBµV
ATTEN Ø dB +Ø dB
69.1Ø dBµV
1Ø dB/
OFFSET
-2Ø.Ø
dB
CENTER 47Ø.ØØØØ MHz
SPAN 1ØØ.Ø kHz
RES BW 3ØØ Hz
VBW 1ØØ kHz
SWP 2.Ø sec

CW Plot

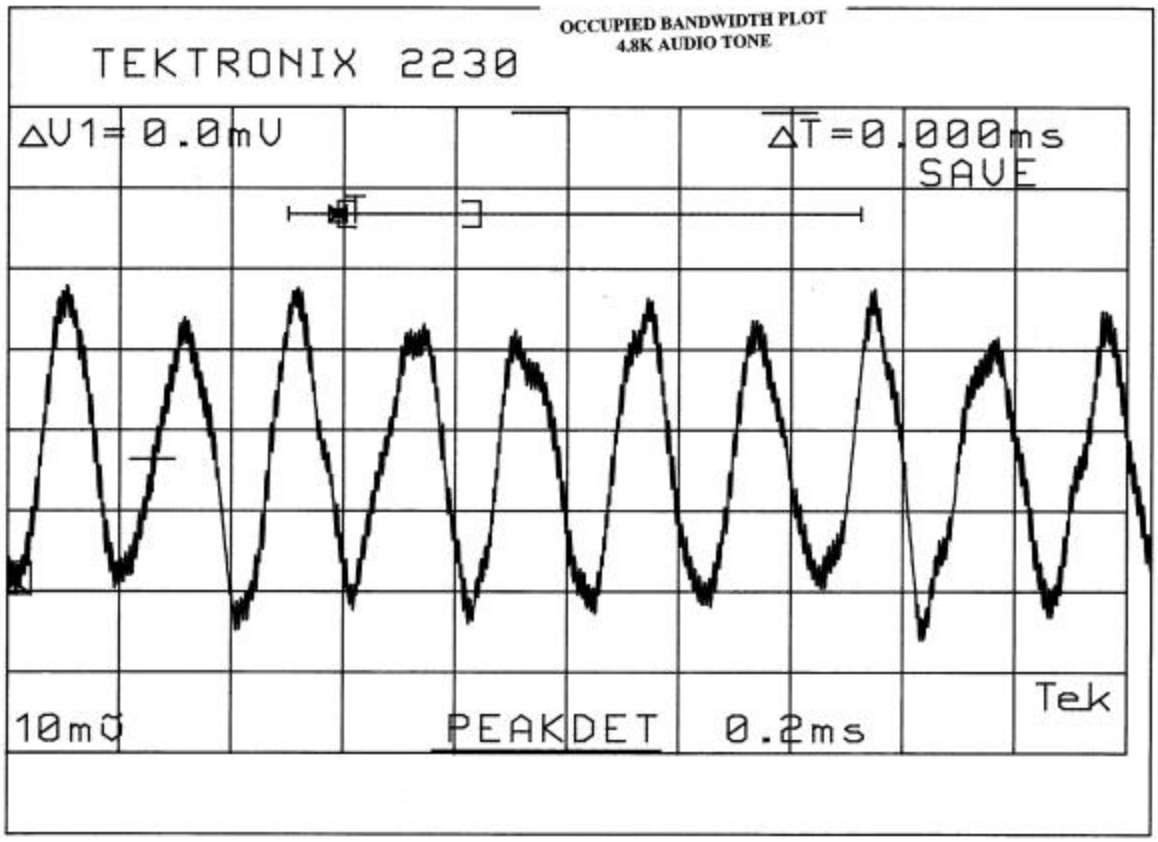


Occupied BW 4800 Hz with 825 Hz deviation
Mask D



Occupied BW 4800 Hz with 825 Hz deviation
Mask C

TACTICAL ELECTRONICS CORP.



Spectral Efficiency

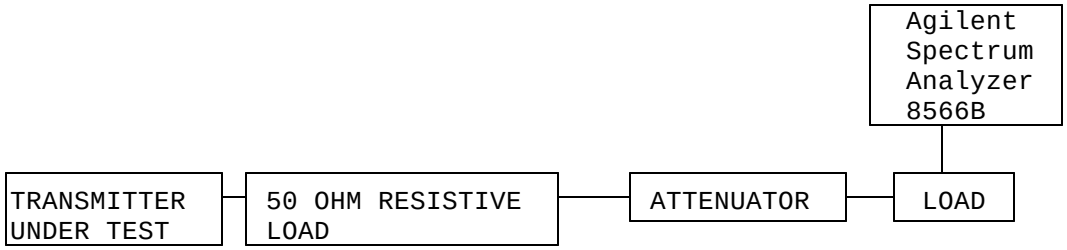
2.1051 Spurious emissions at antenna terminals(conducted):
2.1052 Data on the following page shows the level of conducted spurious responses. The carrier was modulated 100% using a 2500 Hz tone. The spectrum was scanned from 0.4 to at least the 10th harmonic of the fundamental. The measurements were made in accordance with standard TIA/EIA-603.

REQUIREMENTS: Emissions must be 43 +10log(Po) dB below the mean power output of the transmitter.

LOW: 50 + 10log(4.5) = 57 dB
HIGH: 50 + 10log(33) = 65 dB

EMISSION FREQUENCY MHz	dB BELOW CARRIER	dB BELOW CARRIER
	LOW POWER	HIGH POWER
460	0.0	0.0
920	71	65
1380	83	81
1840	87	93
2300	92	92
2760	107	115
3220	91	107
3680	79	76
4140	68	81
4600	83	92

Method of Measuring Conducted Spurious Emissions



METHOD OF MEASUREMENT: The procedure used was TIA/EIA-603 STANDARD without any exceptions. An audio generator was connected to the UUT through a dummy microphone circuit and the output of the transmitter connected to a standard load and from the standard load through a pre-selector filter of the spectrum analyzer. The spectrum was scanned from 400 kHz to at least the tenth harmonic of the fundamental using a HP model 8566B spectrum analyzer. The measurements were made using the shielded room located at TIMCO ENGINEERING INC. 849 N.W. State Road 45, Newberry, Florida 32669.

2.1053 Field strength of spurious emissions:

NAME OF TEST: RADIATED SPURIOUS EMISSIONS

REQUIREMENTS: Emissions must be 50 +10log(Po) dB below the mean power output of the transmitter.

LOW POWER: 50 + 10log(4.5) = 57 dB
HIGH POWER: 50 + 10log(33) = 65 dB

TEST DATA:

LOW POWER

Emission Frequency MHz	ATTN dBc	Margin dB
460.00	0.0	0.0
920.00	74	17
1,380.00	**	**
1,840.00	73	16
2,300.00	76	19
2,760.00	**	
3,220.00	**	**
3,680.00	80	23
4,140.00	72	15
4,600.00	77	20

HIGH POWER

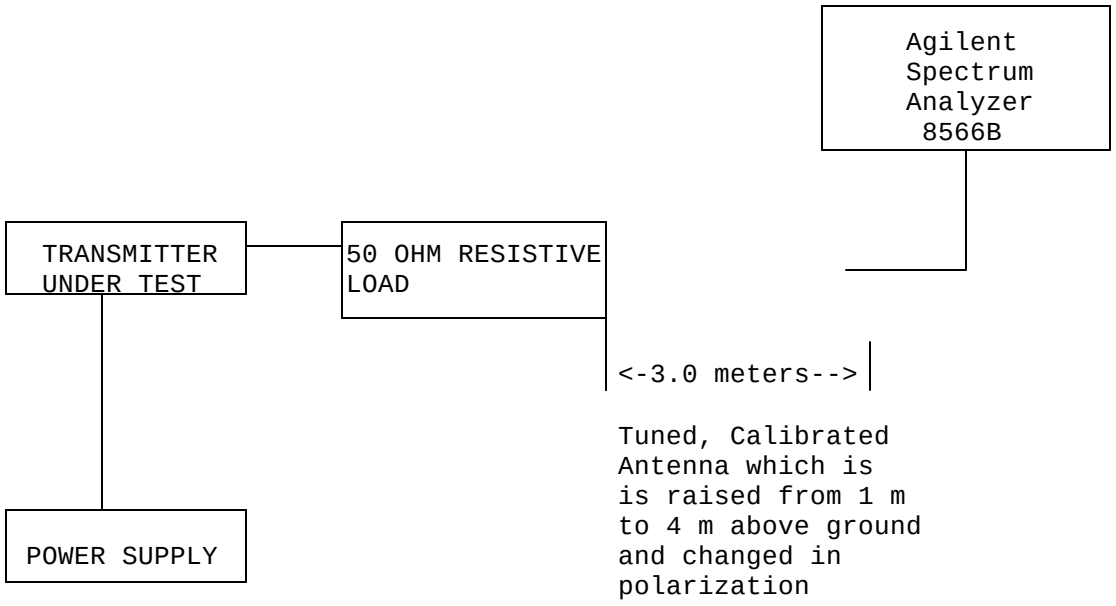
Emission Frequency MHz	ATTN dBc	Margin dB
460.00	0.0	0.0
920.00	**	
1,380.00	**	
1,840.00	**	
2,300.00	**	
2,760.00	**	
3,220.00	**	
3,680.00	80	15
4,140.00	82	17
4,600.00	**	

** THE MEASUREMENTS WERE BELOW THE LEVEL OF MEASURING EQUIPMENT.

PER FCC RULES 2.1051 “THE MAGNITUDE OF SPURIOUS EMISSIONS WHICH ARE ATTENUATED MORE THAN 20 dB BELOW THE PERMISSIBLE VALUE NEED NOT BE REPORTED.

METHOD OF MEASUREMENTS: The tabulated data shows the results of the radiated field strength emissions test. The spectrum was scanned from 30 MHz to at least the tenth harmonic of the fundamental. This test was conducted per TIA/EIA STANDARD 603 using the substitution method. Measurements were made at the open field test site of TIMCO ENGINEERING, INC. located at 849 NW State Road 45, Newberry, FL 32669.

Method of Measuring Radiated Spurious Emissions



Equipment placed 80 cm above ground
on a rotatable platform.

2.1055 Frequency stability:
90.213(a)(1)

Temperature and voltage tests were performed to verify that the frequency remains within the .00015%, 1.5 ppm specification limit, for 25 kHz spacing & 0.00025% for 12.5 kHz spacing and 0.0001% for 6.25 kHz spacing. The test was conducted as follows: The transmitter was placed in the temperature chamber at 25 degrees C and allowed to stabilize for one hour. The transmitter was keyed ON for one minute during which four frequency readings were recorded at 15 second intervals. The worse case number was taken for temperature plotting. The assigned channel frequency was considered to be the reference frequency. The temperature was then reduced to -30 degrees C after which the transmitter was again allowed to stabilize for one hour. The transmitter was keyed ON for one minute, and again frequency readings were noted at 15 second intervals. The worst case number was recorded for temperature plotting. This procedure was repeated in 10 degree increments up to + 50 degrees C.

Readings were also taken at minus 15% of the battery voltage of 12 VDC, which we estimate to be the battery endpoint.

MEASUREMENT DATA:

Assigned Frequency (Ref. Frequency): 450.000 000 MHz

TEMPERATURE_°C	FREQUENCY_MHz	PPM
REFERENCE	450.000 000	0.00
-30	449.999 923	- 0.17
-20	449.999 864	- 0.30
-10	449.999 852	- 0.33
0	449.999 992	- 0.02
+10	450.000 134	+ 0.30
+20	450.000 246	+ 0.55
+30	450.000 251	+ 0.56
+40	450.000 158	+ 0.35
+50	450.999 964	+ 0.08
-15% Battery End-Point VDC	450.000 295	+ 0.66

RESULTS OF MEASUREMENTS: The maximum frequency variation over the temperature range was –0.33 ppm to +0.56 ppm.

2.1055(a)(1) Frequency stability:
90.214 Transient Frequency Behavior

REQUIREMENTS: In the 450-500 MHz frequency band, transient frequencies must be within the maximum frequency difference limits during the time interval indicated below for 12.5 kHz Channels:

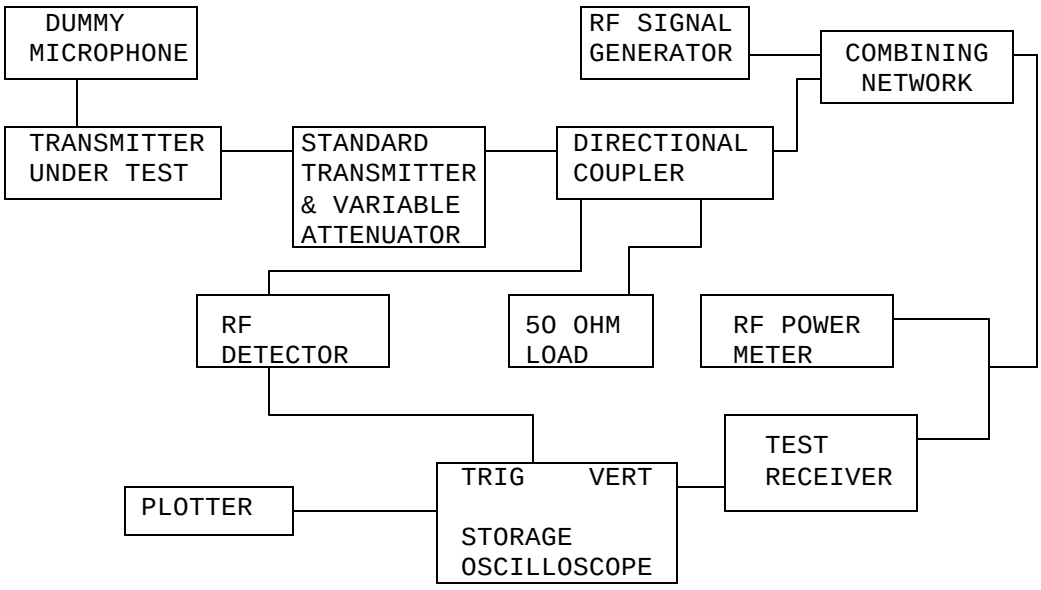
Time Interval	Maximum Frequency	Portable Radios 450-500 MHz
t1	+12.5 kHz	10.0 ms
t2	+6.25 kHz	25.0 ms
t3,t4	+12.5 kHz	10.0 ms

TEST PROCEEDURE: TIA/EIA TS603 PARA 2.2.19, the levels were set as follows;

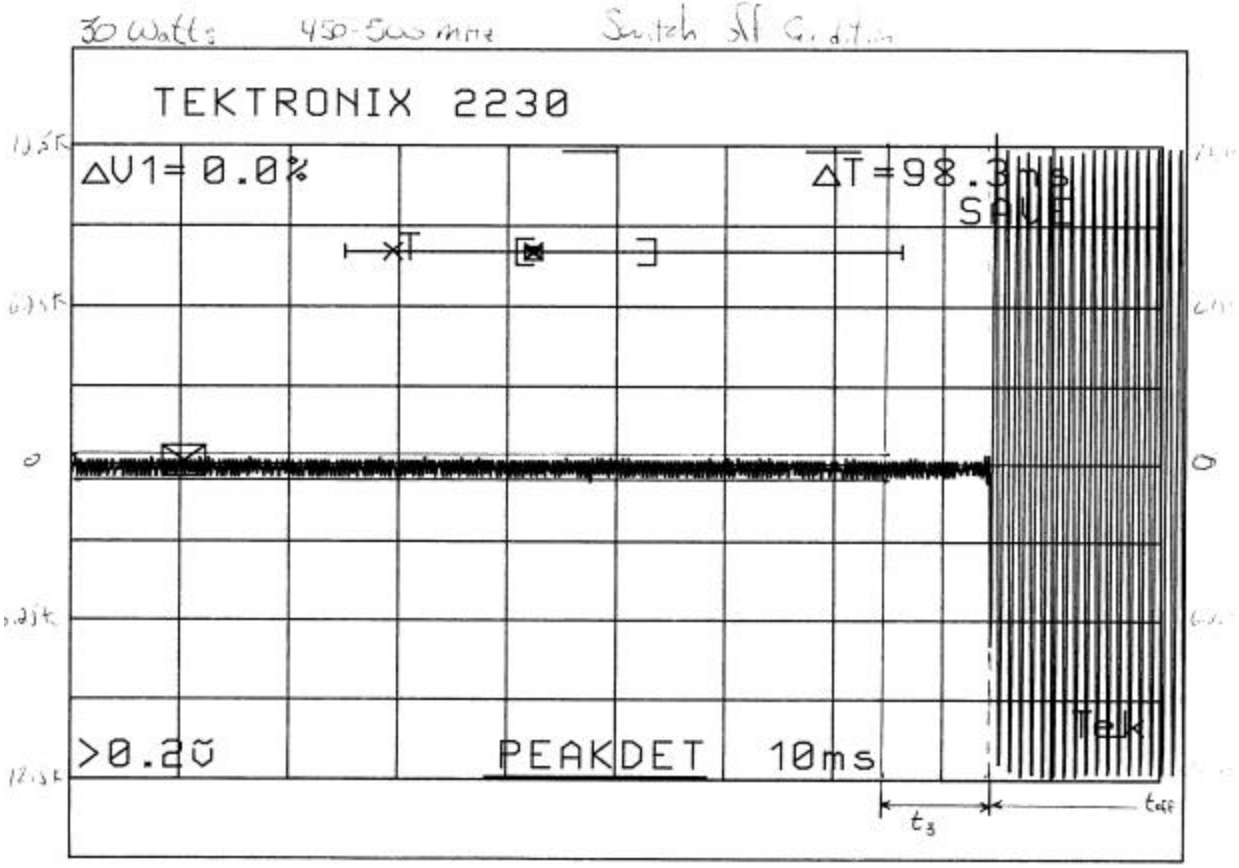
1. Using the variable attenuator the transmitter level was set to 40 dB below the test receivers maximum input level, then the transmitter was turned off.
2. With the transmitter off the signal generator was set 20 dB below the level of the transmitter in the above step, this level will be maintained with the signal generator through-out the test.
3. Reduce the attenuation between the transmitter and the RF detector by 30 dB.
4. With the levels set as above the transient frequency behavior was observed & recorded.

Note: Plots for High and low power were made and the worst case plots are presented on the following pages.

2.1055 Frequency stability:
90.214 Transient Frequency Behavior
(Continued)

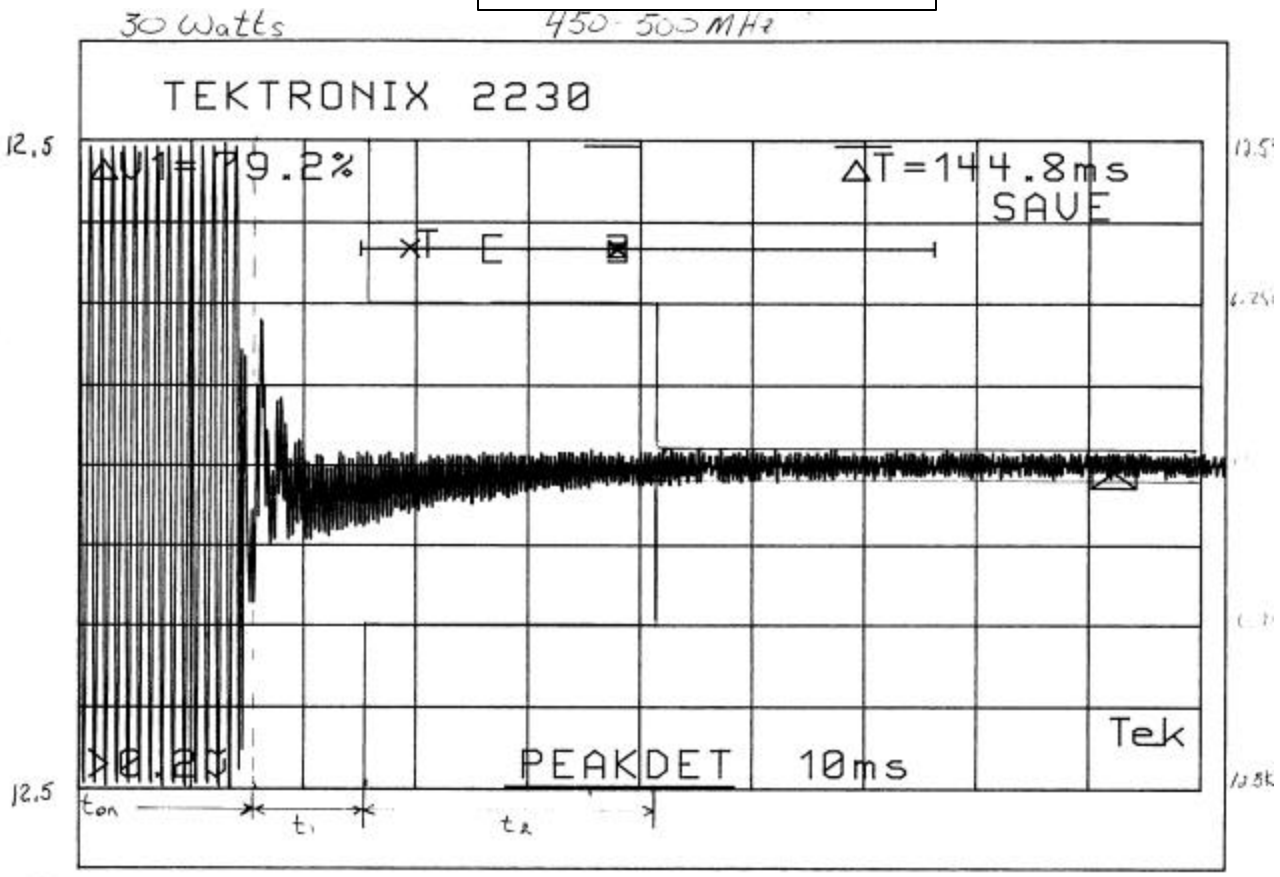


Transient Frequency
12.5K



Turn Off Time

Transient Frequency
12.5K



Turn On Time

$W := 33.0$ power in Watts $D := 1$ Duty Factor in decimal % (1=100%)

$E := 1.0$ exposure time in minutes $U := 6$ (use 6 for controlled and 30 for uncontrolled)

$$Wexp := W \cdot D \cdot \left\{ \frac{E}{U} \right\} \qquad PC := \frac{E}{U}$$

$PC = 0.167$ percent on time

$Wexp = 5.5$ Watts

$Po := 5500$ mWatts $dBd := -2.15$ antenna gain $f := 490$ Frequency in MHz

$G := dBd + 2.15$ gain in dBi

$Gn := 10^{\frac{G}{10}}$ gain numeric $S := \frac{f}{300}$ controlled exposure

$Gn = 1$ $S = 1.633$

$$R := \sqrt{\frac{(Po \cdot Gn)}{(4 \cdot \pi \cdot S)}} \qquad Rinches := \frac{R}{2.54}$$

$R = 16.37$ distance in centimeters required for compliance

$Rinches = 6.445$

MPE CALCULATION

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Calulation based on the following.
Power Output of 33 Watts
Transmit time of 1 minute out of every 6 minutes.
Quarter wave antenna.
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Equipment List

	DEVICE	MFGR	MODEL	SERNO	CAL/CHAR DATE	DUE DATE or STATUS
X	3-Meter OATS	TEI	N/A	N/A	Listed 12/22/99	12/22/02
	3/10-Meter OATS	TEI	N/A	N/A	Listed 3/26/01	3/26/04
X	Receiver, Beige Tower					
X	Spectrum Analyzer (Tan)	HP	8566B Opt 462	3138A07786 3144A20661	CAL 8/31/01	8/31/02
X	RF Preselector (Tan)	HP	85685A	3221A01400	CAL 8/31/01	8/31/02
X	Quasi-Peak Adapter (Tan)	HP	85650A	3303A01690	CAL 8/31/01	8/31/02
	Receiver, Blue Tower					
	Spectrum Analyzer (Blue)	HP	8568B	2928A04729 2848A18049	CHAR 10/22/01	10/22/02
	RF Preselector (Blue)	HP	85685A	2926A00983	CHAR 10/22/01	10/22/02
	Quasi-Peak Adapter (Blue)	HP	85650A	2811A01279	CHAR 10/22/01	10/22/02
	Biconnical Antenna	Electro-Metrics	BIA-25	1171	CAL 4/26/01	4/26/03
	Biconnical Antenna	Eaton	94455-1	1096	CAL 10/1/01	10/1/02
X	Biconnical Antenna	Eaton	94455-1	1057	CHAR 3/15/00	3/15/01
	BiconiLog Antenna	EMCO	3143	9409-1043		
X	Log-Periodic Antenna	Electro-Metrics	LPA-25	1122	CAL 10/2/01	10/2/02
	Log-Periodic Antenna	Electro-Metrics	EM-6950	632	CHAR 10/15/01	10/15/02
	Log-Periodic Antenna	Electro-Metrics	LPA-30	409	CHAR 10/16/01	10/16/02
	Dipole Antenna Kit	Electro-Metrics	TDA-30/1-4	152	CAL 3/21/01	3/21/02
	Dipole Antenna Kit	Electro-Metrics	TDA-30/1-4	153	CHAR 11/24/00	11/24/01
X	Double-Ridged Horn Antenna	Electro-Metrics	RGA-180	2319	CAL 12/19/01	12/19/02
	Horn Antenna	Electro-Metrics	EM-6961	6246	CAL 3/21/01	3/21/02
	Horn Antenna	ATM	19-443-6R	None	No Cal Required	
	Passive Loop Antenna	EMC Test Systems	EMCO 6512	9706-1211	CHAR 7/10/01	7/10/02
	Line Impedance Stabilization . . .	Electro-Metrics	ANS-25/2	2604	CAL 10/9/01	10/9/02

	DEVICE	MFGR	MODEL	SERNO	CAL/CHAR DATE	DUE DATE or STATUS
	Line Impedance Stabilization . . .	Electro-Metrics	EM-7820	2682	CAL 3/16/01	3/16/02
	Termaline Wattmeter	Bird Electronic Corporation	611	16405	CAL 5/25/99	(5/25/00)
	Termaline Wattmeter	Bird Electronic Corporation	6104	1926	CAL 12/12/01	12/12/02
	Oscilloscope	Tektronix	2230	300572	CHAR 2/1/01	2/1/02
	Temperature Chamber	Tenney Engineering	TTRC	11717-7	CHAR 1/22/02	1/22/03
	AC Voltmeter	HP	400FL	2213A14499	CAL 10/9/01	10/9/02
	AC Voltmeter	HP	400FL	2213A14261	CHAR 10/15/01	10/15/02
	AC Voltmeter	HP	400FL	2213A14728	CHAR 10/15/01	10/15/02
X	Digital Multimeter	Fluke	77	35053830	CHAR 1/8/02	1/8/03
	Digital Multimeter	Fluke	77	43850817	CHAR 1/8/02	1/8/03
	Digital Multimeter	HP	E2377A	2927J05849	CHAR 1/8/02	1/8/03
	Multimeter	Fluke	FLUKE-77-3	79510405	CAL 9/26/01	9/26/02
	Peak Power Meter	HP	8900C	2131A00545	CHAR 1/26/01	1/26/02
	Digital Thermometer	Fluke	2166A	42032	CAL 1/16/02	1/16/03
	Thermometer	Traulsen	SK-128		CHAR 1/22/02	1/22/03
X	Temp/Humidity gauge	EXTech	44577F	E000901	CHAR 1/22/02	1/22/03
	Frequency Counter	HP	5352B	2632A00165	CAL 11/28/01	11/28/02
	Power Sensor	Agilent Technologies	84811A	2551A02705	CAL 1/26/01	1/26/02
	Injection Probe	Fischer Custom Communications	F-120-9A	270	CAL 6/1/01	6/1/02
	Service Monitor	IFR	FM/AM 500A	5182	CAL 11/22/00	11/22/01
	Comm. Serv. Monitor	IFR	FM/AM 1200S	6593	CAL 11/12/99	11/12/00
	Signal Generator	HP	8640B	2308A21464	CAL 11/15/01	11/15/02
	Modulation Analyzer	HP	8901A	3435A06868	CAL 9/5/01	9/5/02

	DEVICE	MFGR	MODEL	SERNO	CAL/CHAR DATE	DUE DATE or STATUS
	Power Line Coupling/ Decoupling Network	Fischer Custom Communications	FCC-801-M2-16A	01048	CAL 8/29/01	8/29/02
	Power Line Coupling/ Decoupling Network	Fischer Custom Communications	FCC-801-M3-16A	01060	CAL 8/29/01	8/29/02
	VHF/UHF Current Probe	Fischer Custom Communications	F-52	130	CAL 8/30/01	8/30/02
	Passive Impedance Adapter	Fischer Custom Communications	FCC-801-150-50-CDN	01117 & 01118	CAL 8/29/01	8/29/02
	Radiating Field Coil	Fischer Custom Communications	F-1000-4-8/9/10-L-1M	9859	CAL 10/15/98	10/15/99
	Near Field Probe	HP	HP11940A	2650A02748	CHAR 2/1/01	2/1/02
	BandReject Filter	Lorch Microwave	5BR4-2400/ 60-N	Z1	CHAR 3/2/01	3/2/02
	BandReject Filter	Lorch Microwave	6BR6-2442/ 300-N	Z1	CHAR 3/2/01	3/2/02
	BandReject Filter	Lorch Microwave	5BR4-10525/ 900-S	Z1	CHAR 3/2/01	3/2/02
	High Pas Filter	Microlab	HA-10N		CHAR 10/4/01	10/4/02
	Audio Oscillator	HP	653A	832-00260	CHAR 3/1/01	3/1/02
	Frequency Counter	HP	5382A	1620A03535	CHAR 3/2/01	3/2/02
	Frequency Counter	HP	5385A	3242A07460	CHAR 12/11/01	12/11/02
	Preamplifier	HP	8449B-H02	3008A00372	CHAR 3/4/01	3/4/02
	Amplifier	HP	11975A	2738A01969	CHAR 3/1/01	3/1/02
	Egg Timer	Unk			CHAR 2/28/01	2/28/02
	Measuring Tape, 20M	Kraftixx	0631-20		CHAR 2/28/01	2/28/02
	Measuring Tape, 7.5M	Kraftixx	7.5M PROFI		CHAR 2/28/01	2/28/02
	EMC Immunity Test System	Keytek	CEMASTER	9810210		
	AC Power Source	California Instruments	1251RP	L05865		
	AC Power Source	California Instruments	PACS-1	X71484		
	Isotropic Field Probe	Amplifier Research	FP5000	22839		
	Isotropic Field Probe	Amplifier Research	FP5000	300103		

	DEVICE	MFGR	MODEL	SERNO	CAL/CHAR DATE	DUE DATE or STATUS
	Capacitor Clamp	Keytek	CM-CCL	9811359	No Cal Required	
	Amplifier	Amplifier Research	10W1000B	23117	No Cal Required	
	Field Monitor	Amplifier Research	FM5004	22288	No Cal Required	
	ELF Meter	F. W. Bell	4060	Not serialized		
	Coaxial Cable #51	Insulated Wire Inc.	NPS 2251-2880	Timco #51	CHAR 1/23/02	1/23/03
	Coaxial Cable #64	Semflex Inc.	60637	Timco #64	CHAR 1/24/02	1/24/03
	Coaxial Cable #65	General Cable Co.	E9917 RG233/U	Timco #65	CHAR 1/23/02	1/23/03
	Coaxial Cable #106	Unknown	Unknown	Timco #106	CHAR 1/23/02	1/23/03