Test Data for H25TAC2001
MODEL TAC/COM 2001 REPEATER

I. INFORMATION REQUIRED UNDER PART 2

Para.

2.10033(a) This Application for Certification is filed on form 731 with all questions answered. Confidentiality is being requested for the schematic. An application fee of $495 and a request for confidentiality fee of $145 has been sent.

2.10033(b) N/A

2.10033(c)(1) The full name and address of the applicant and manufacturer for certification is:

DTC Communications Inc.
75 Northeastern Blvd.
Nashua, NH 03062

(2) The FCC Identifier of the device is H25TAC2001

(3) A copy of the operating instructions is included in the EXHIBITS.

(4) Emission: NBFM Voice – Designator: 11K2F3E
Emissions calculation is included in the EXHIBITS.

(5) Frequency Range: 150 –174 MHz

(6) Power: 1.7 Watts at 800 mA; 12 VDC (Battery)

(7) Maximum Power Rating of 2.0 Watts

(8) A linear regulator with an output voltage of 5.0 VDC powers all stages except the final amplifier, which is powered with conditioned battery voltage.

(9) A tune-up procedure is included in the EXHIBITS.

(10) A schematic diagram is included in the EXHIBITS.

(11) A drawing and photo of the equipment identification label is included in the EXHIBITS.

(12) Photographs showing the external and internal construction of the equipment is included in the EXHIBITS.

(13) N/A

(14) Test Data as required by (46)§§(47) 2.1046 through 2.1057, inclusive, is measured in accordance with the procedure setout in (48)§ 2.1041.

(15) N/A

(16) N/A

(17) N/A

II. TEST DATA

Data required by (46)§§(47) 2.1046 through 2.1057, inclusive, is measured in Accordance with the procedures setout in (48)§ 2.1041.

RF POWER OUTPUT 2.1046(a), 2.1033(c)(8)

Repeater power output measurements were made at the RF output connector at the TX output frequency (165.9375 MHz). This test was done with an unmodulated input carrier on the RX frequency (171.600 MHz) in accordance with §90.205(d) using the setup of Figure 1.

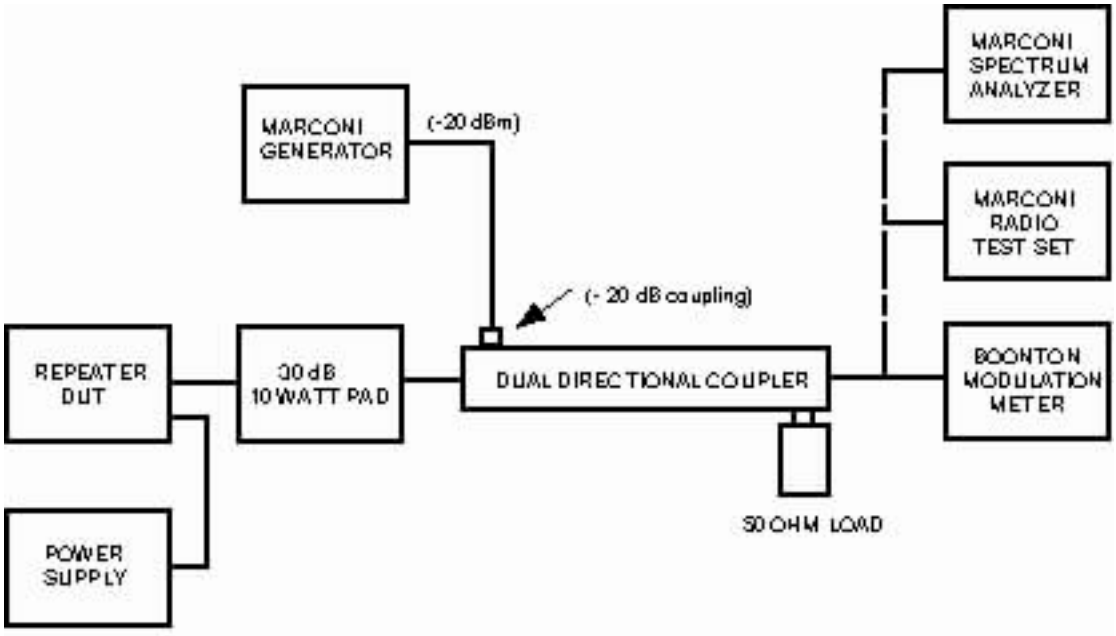


FIGURE 1

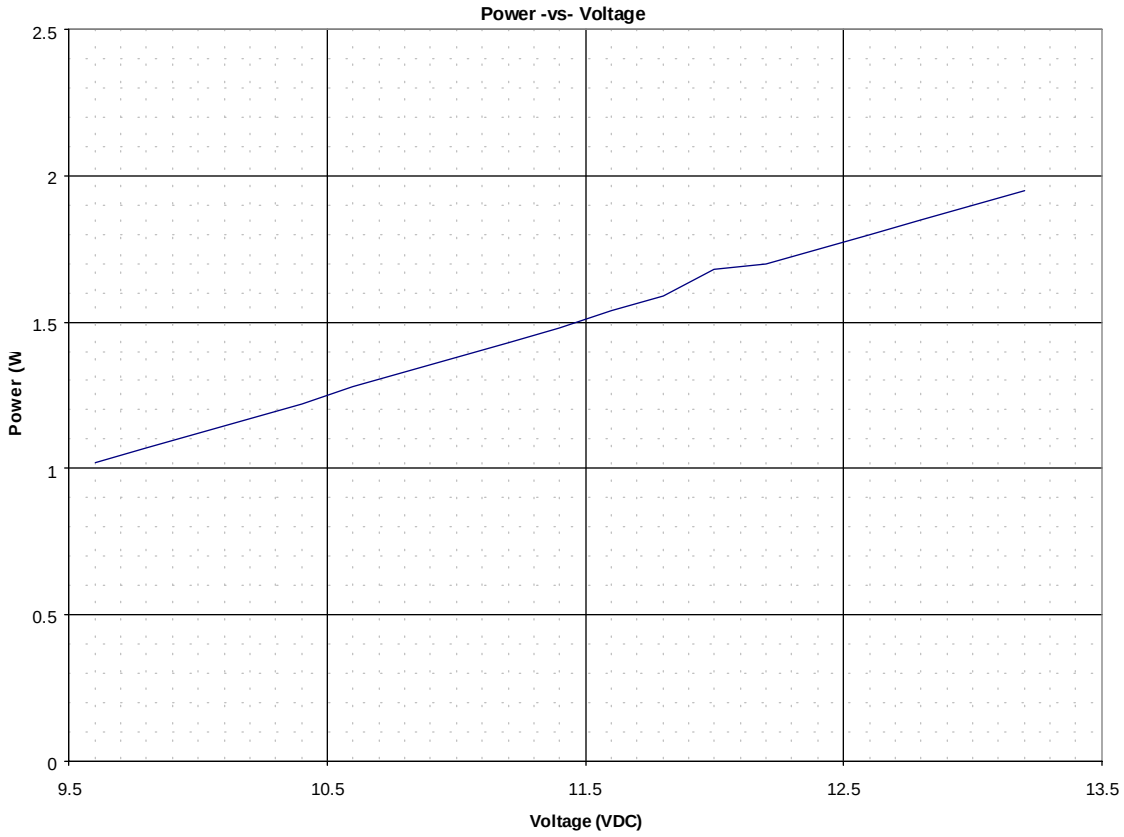
REPEATER TEST SETUP

The power output was measured with a Marconi Radio Communications Test Set, Model 2955.

The electrical characteristics of the RF load was 50 + j0 Ohms (50 ohms pure resistive).

The RF power measured was 1.7W at 12.0 VDC. Note that the TAC/COM 2001 repeater has input and output tuning bandwidths of 200 kHz respectively; power drops off quickly, either side of the desired band center due to the duplexer filter's passband.

Thus the sample complies with §90.205(d).



MODULATION CHARACTERISTICS 2.1047(a), 90.211(a)

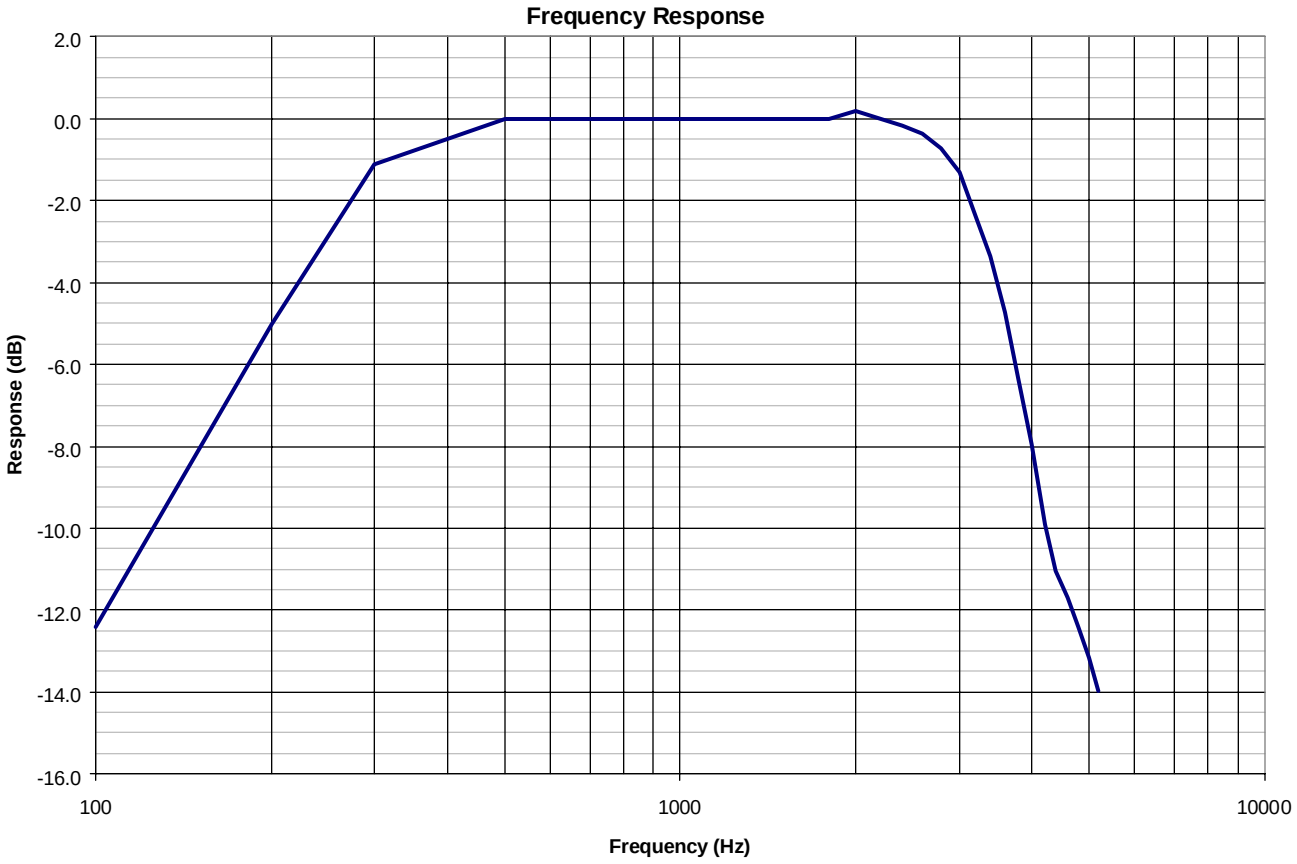
Spectrum analyzer data is included which shows that the equipment will meet the modulation requirements under §90.211(a). This transmitter is equipped with an audio low pass filter circuit.

Frequency Response

Measurement data showing the frequency response of the transmitter is tabulated and graphed below using the setup of FIGURE 1. A reference level signal of 500 Hz deviation (1/3 nominal deviation) at the frequency of maximum response (1000 Hz) was used. At each test frequency, the input deviation level was adjusted to maintain the reference output deviation. Note that the repeater is designed with a flat audio response in the audio passband. In this range, the repeater does not color the repeated transmitters original pre-emphasis curve. The Boonton 82AD modulation meter was used to measure FM deviation levels at both input and output frequencies.

TAC/COM 2001			
Frequency Response			
Deviation = 1/3 nominal (500 Hz)			
Frequency (Hz)	Deviation (Hz)	Measurement (dB)	Relative Response (dB)
100	120	41.584	-12.395
200	280	48.943	-5.036
300	440	52.869	-1.110
500	500	53.979	0.000
700	500	53.979	0.000
900	500	53.979	0.000
1000	500	53.979	0.000
1200	500	53.979	0.000
1400	500	53.979	0.000
1600	500	53.979	0.000
1800	500	53.979	0.000
2000	510	54.151	0.172
2200	500	53.979	0.000
2400	490	53.804	-0.175
2600	480	53.625	-0.354
2800	460	53.255	-0.724
3000	430	52.669	-1.310
3200	380	51.596	-2.383
3400	340	50.630	-3.349
3600	290	49.248	-4.731
3800	240	47.604	-6.375
4000	200	46.021	-7.958
4200	160	44.082	-9.897
4400	140	42.923	-11.056
4600	130	42.279	-11.700
4800	120	41.584	-12.395

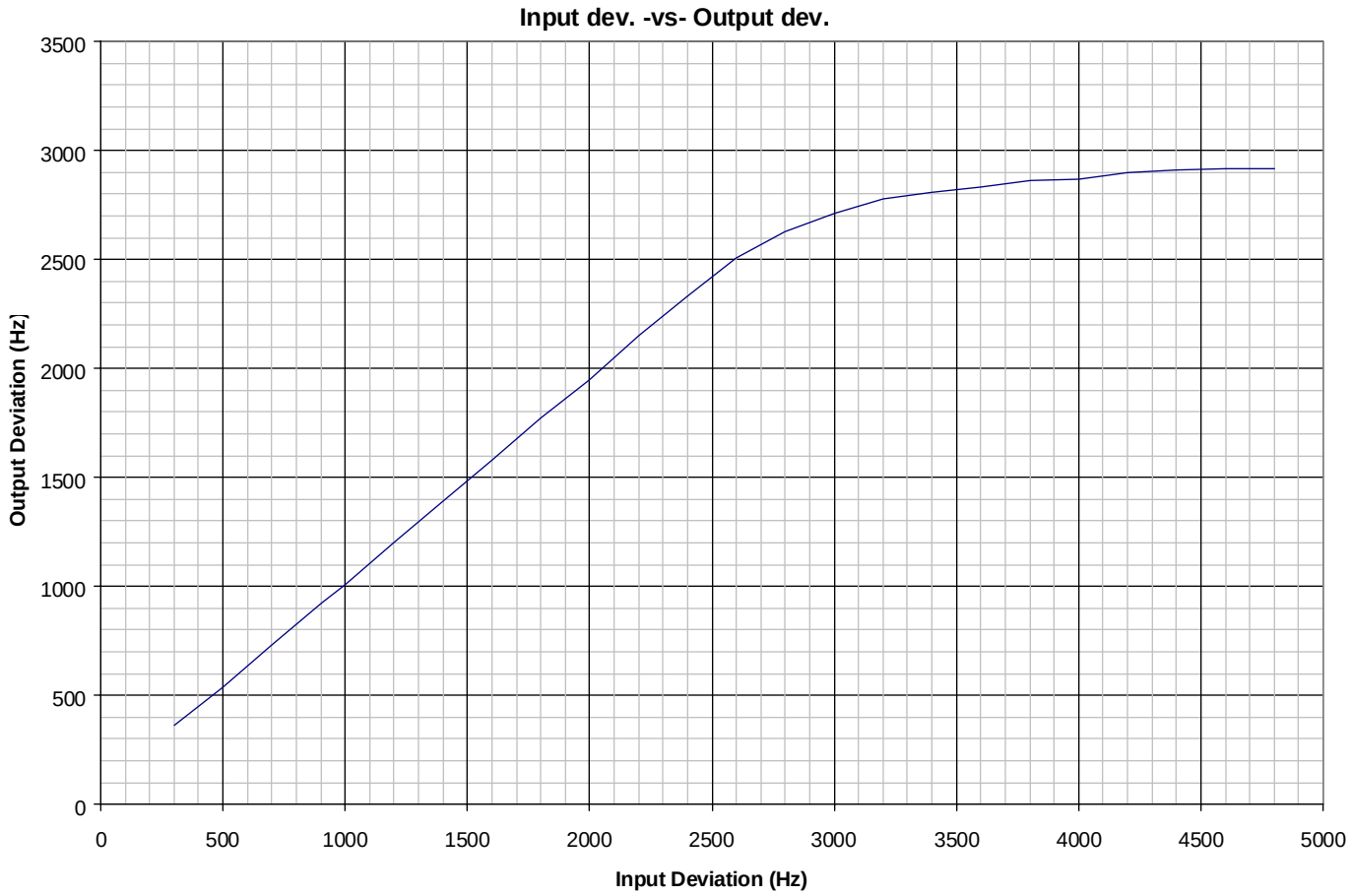
5000	110	40.828	-13.151
5200	100	40.000	-13.979



Modulation Limiting

Curves showing frequency deviation output on 165.9375 MHz versus frequency deviation input on 171.600 MHz are shown below, tested at the frequency of maximum deviation (1 kHz). The repeater's output connector was connected to the input of the spectrum analyzer via a 30 dB 10Watt attenuator and the HP 778D directional coupler thru-path as shown in FIGURE 1. The input test signal at 171.600 MHz was introduced via the incident coupling arm of the directional coupler, producing an input RF level which is 70 dB below the repeaters output level. The information submitted shows the modulation limiting capability well beyond the range of properly modulated input signals. A Marconi 2041 RF Signal Generator was used to generate the NBFM modulated input signal and a Boonton 82AD modulation meter was used to measure FM deviation levels at both input and output frequencies.

TAC/COM 2001 FCC Testing					
Input Deviation -vs- Output Deviation					
Test Tone frequency = 1.0 kHz					
Input deviation level (Hz)	Output deviation level (Hz)				
300	360				
500	540				
700	730				
900	920				
1000	1010				
1200	1200				
1400	1390				
1600	1580				
1800	1770				
2000	1950				
2200	2150				
2400	2330				
2600	2510				
2800	2630				
3000	2710				
3200	2780				
3400	2810				
3600	2830				
3800	2860				
4000	2870				
4200	2900				
4400	2910				
4600	2920				
4800	2920				


Input dev. -vs- Output dev.
Output Deviation (Hz)
3500
3000
2500
2000
1500
1000
500
0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Input Deviation (Hz)

OCCUPIED BANDWIDTH 2.1049, 90.211(a)

The next series of plots are taken from a Marconi 2383 spectrum analyzer at 169.9375 MHz, the repeater's output frequency. The repeater output connector was connected to the input of the spectrum analyzer via a 30 dB 10Watt attenuator and the HP 778D directional coupler thru-path as shown in FIGURE 1. The input test signal at 171.600 MHz is introduced via the incident coupling arm of the directional coupler, producing an input RF level which is 70 dB below the repeaters output level. The Marconi generator was modulated by its internal audio generator with a sine wave at 1 kHz and 2.5 kHz at a level 16 dB above that required to produce 50% modulation (4.73 kHz based on a nominal 1.5 kHz deviation). These represent overmodulated transmitter signals, which are to be repeated. Audio levels were verified with a Boonton 82AD Modulation Meter.

Paragraph 90.210(d) states that for transmitters that are 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:

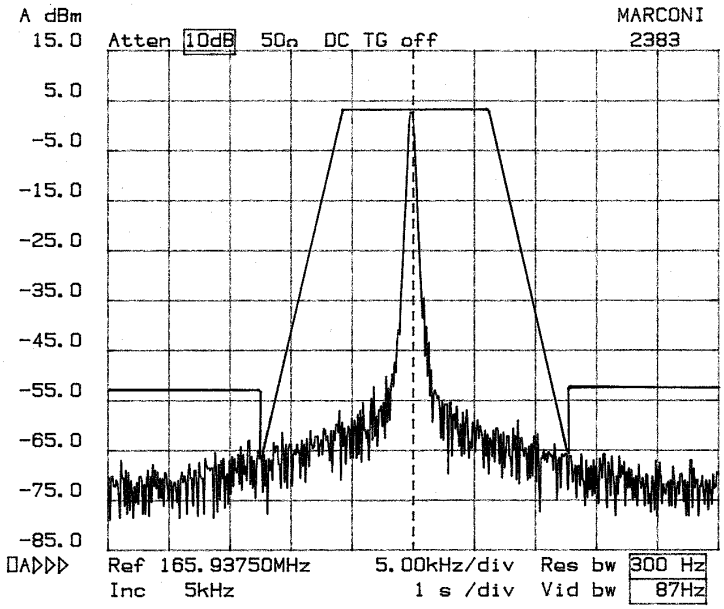
1) 0n any frequency removed from the center of the authorized bandwidth f0 to 5.625 kHz removed from f0: Zero dB.

2) 0n any frequency removed 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 7.25 (fd – 2.88 kHz) dB.

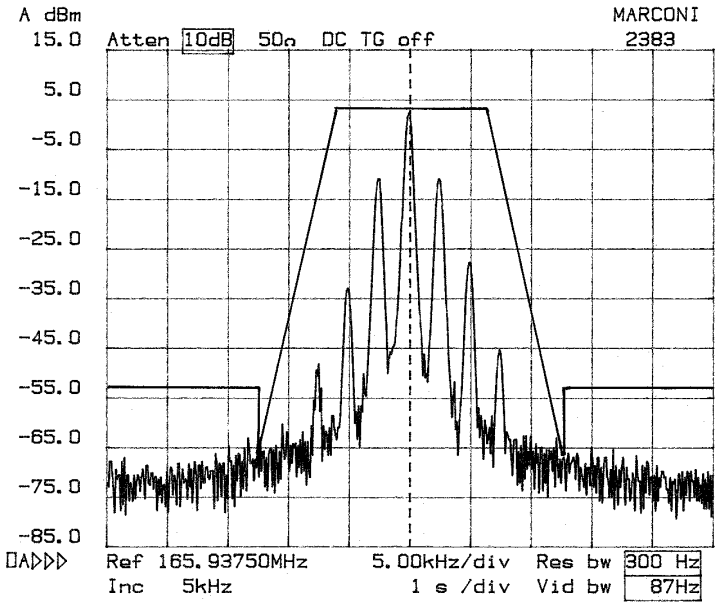
3) 0n any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5 kHz: At least 50+ log(P) or 70 dB, whichever is the lesser attenuation.

The authorized bandwidth is 12.5 kHz; the frequency of the sample was set for 165.9375 MHz.

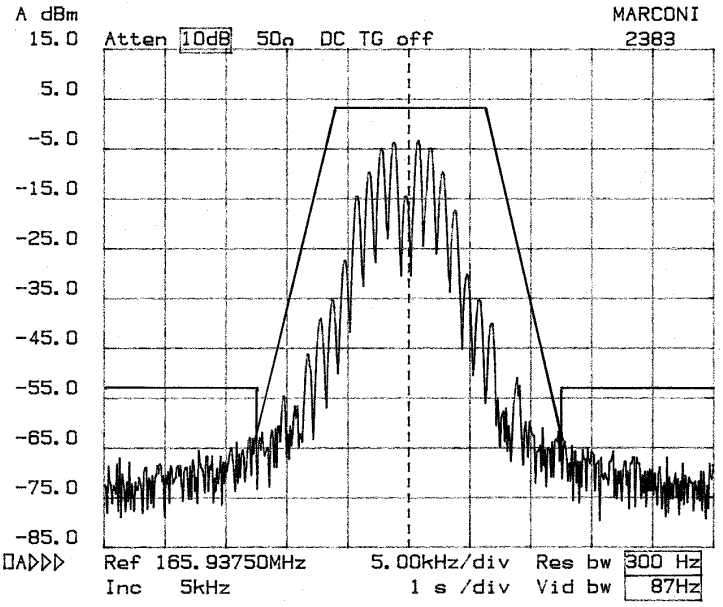
The first plot shows the unmodulated carrier. The second plot shows the modulated carrier. The mask is superimposed on both spectral plots. All emissions are below the required limits. Thus, the sample complies with 90.211(a).



Modulated at 2.5 kHz



Modulated at 1 kHz



SPURIOUS EMISSIONS AT ANTENNA TERMINALS 2.1053, 90.209

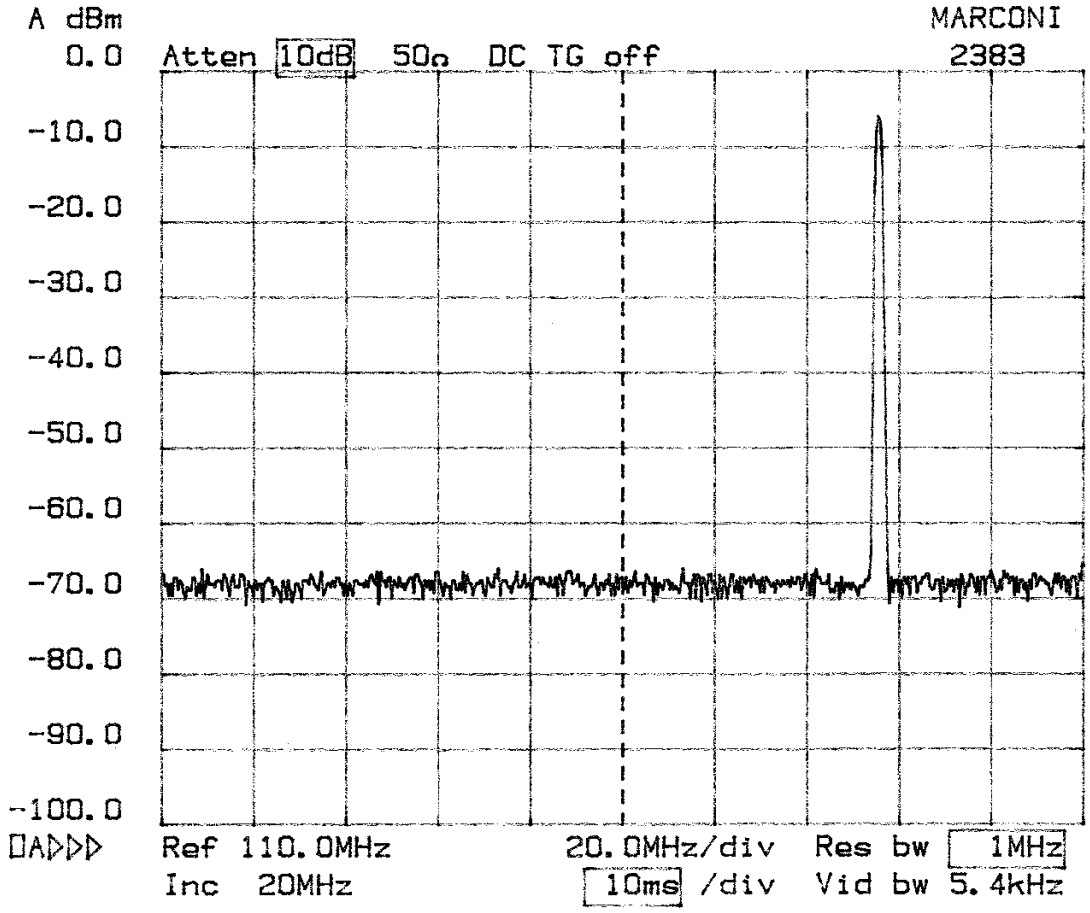
As required by §§2.1053 and 90.209, Emission Mask D, spurious emissions measurements at the antenna terminals were made using a Marconi 2383 spectrum analyzer. The repeater test box was used to directly key the repeater. The leader LAG-12S audio generator was used to provide the repeater with a 1 kHz modulation signal at a level 16 dB above that required to produce 50% modulation (4.73 kHz based on a nominal 1.5 kHz deviation). The repeater output connector was connected to a total of 40 dB of attenuation comprised of 30 dB 10Watt attenuator and a 10 dB Mini-Circuits CAT-10 attenuator connected to the input of the spectrum analyzer, via a 18-inch test cable made of RG-58 coax. The additional attenuation was required, in order to maximze the spectrum analyzers dynamic range.

The spectrum was investigated over the range 9 kHz – 1.75 GHz per §2.1057(a)(1).

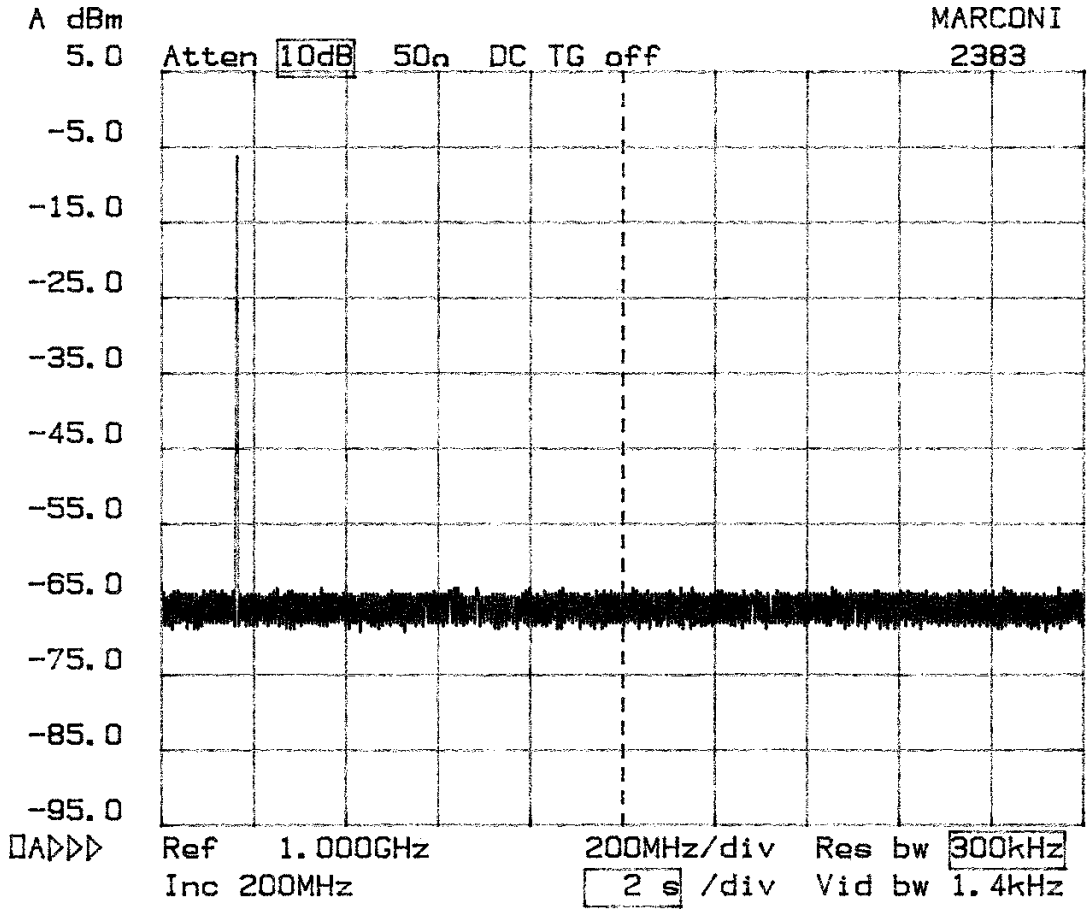
All emissions more than 250%, removed from the center of the authorized bandwidth must be attenuated by at least 50 + 10 log (P) dB below the intentional carrier. Since the maximum measured unmodulated carrier power was 2 W, this yields a minimum required attenuation of 53 dBc.

All spurious emissions are attenuated below this level.

Thus the sample complies with 2.1053 and 90.209 Emission Mask D.
This plot shows the 165.9375 MHz carrier in a span of 10 MHz – 220 MHz



This plot shows a scan from 0 to 2 GHz.



FIELD STRENGTH OF SPURIOUS RADIATION 2.1053 and 90.209
(Performed by Retlif Testing Laboratories)

Test Conditions:

Exciter Keying Direct Via Test Interface cable
Standard temperature and Humidity
Battery Power: 12 VDC via Battery
Radiation into shielded load.

Test Equipment — See Retlif Test Instruments List

Minimum Standard — §2.1053 The power of any emission shall be attenuated below the carrier power (P) by at least (50 + 10log P) dB or 70 dB, whichever is the lesser attenuation.

Theoretical Calculation of Radiated Power Limit below 1000 MHz

The emissions limit is expressed in terms of equivalent power that would have to be fed into a dipole antenna in order to produce the same electric field strength.

Based on the maximum rated output power of 0.25W and the formula E = SQRT (30GPt)/R

Where:
E = Electric Field Intensity in V/m
G = Antenna Gain = 1.64
Pt = Power in Watts
R = Distance from test sample to antenna in Meters = 3

E = SQRT (49.2 X 0.25)/3 = 2.02 V/m = 126.10 dBuV/m

Attenuation Requirement: §2.1053 requires that the spurious radiated emissions be attenuated at least 50 + 10 log (2W) = 53 dB below the unmodulated carrier field strength.

Limit @ 3m = 126.10 – 53 dB = dBuV/m

Theoretical Calculation of radiated Power Limit above 1000 MHz

For all emissions above 1000 MHz, the source of the emission is assumed to be isotropic. Therefore the antenna gain G = 1 and the limit is reduced slightly to:

Limit @ 3m = 123.97 – 53 dB = dBuV/m

Retlif Laboratories calculated the actual limit to be:

77.37 dBuV/m

Test Result — Complies. The strongest spurious emission is at the seventh harmonic of the 158.030 MHz test frequency with a level of 58.86 dBuV/m @ 3m. This is more than 18 dB below the limit.

Retlif Testing Laboratories
101 New Boston Road, Goffstown, NH 03045
603-497-4600 - Fax: 603-497-5281

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795 Marconi Avenue
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516-737-1600 Fax 516-737-1497
(A NY Corporation)

BRANCH LABORATORY
11 Harts Lane, Suite H
East Brunswick, NJ 08816
732-257-0600 Fax 732-257-8663
(A N.J. L.L.C.)

ENGINEERING OFFICE
27777 Franklin Road
Southfield, MI 48034
248-213-0255 Fax 248-213-0257

March 14, 2001

DTC Communications, Inc.
75 Northeastern Blvd.
Nashua, NH 03062

Attention: Mr. Mike Murphy

Dear Sir:

Enclosed you will find Data Package R-3749N covering the testing of the Tactical Repeater, Model No. TAC-COM-2001-P, Serial No. AK418 to the requirements of FCC Parts 2 & 90. This testing was performed against Purchase Order Number 70999.

Test setup photographs and drawings, equipment lists, and test data are included for each test method performed on the above test sample.

Thank you for this opportunity to be of service to you. Should you have any questions concerning this data or the actual testing of your unit, please do not hesitate to contact us.

Sincerely,

RETLIF TESTING LABORATORIES

Amanda M. Lackey
Publications

Enc. (as stated)

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ENGINEERING OFFICE
27777 Franklin Road
Southfield, MI 48034
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DATA PACKAGE
FOR

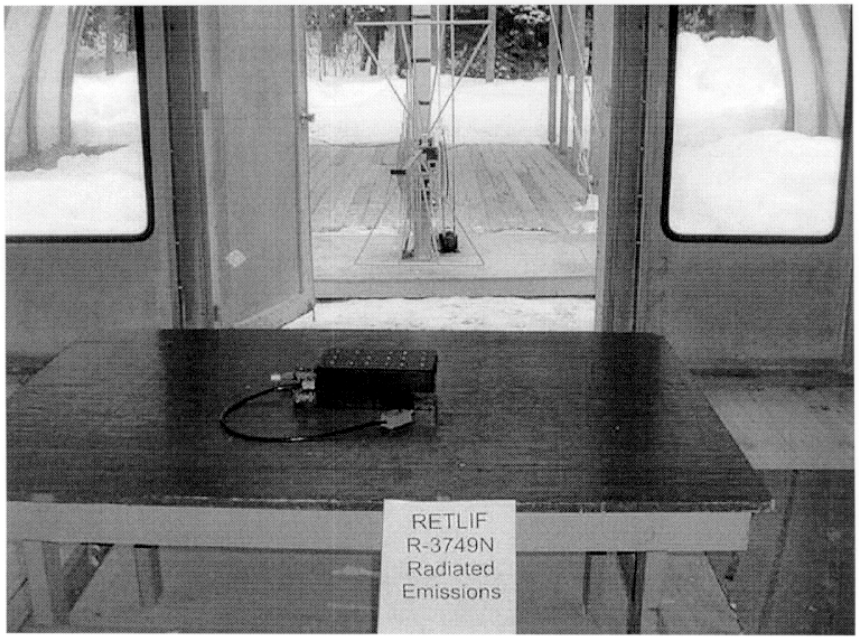
Tactical Repeater

Model No. TAC-COM-2001-P
Serial No. AK418

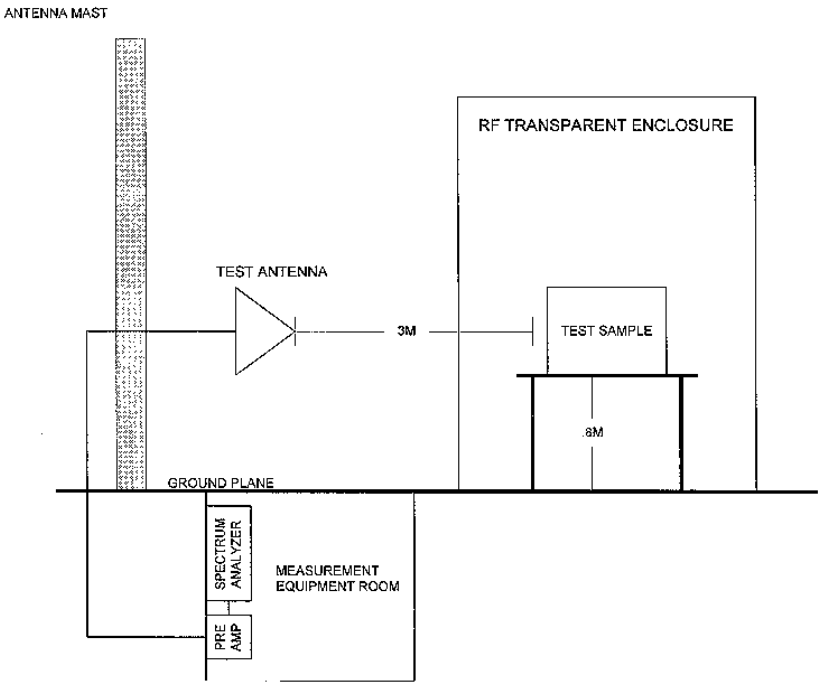
SHOWING COMPLIANCE WITH RADIATED EMISSIONS

Customer Name:	DTC Communications, Inc.
Customer P.O.:	70999
Data Package No.:	R-3749N
Package Date:	March 14, 2001
Test Start Date:	February 23, 2001
Test Finish Date:	February 28, 2001
Test Technician(s):	Tim Firkowski
Test Engineer:	John Monahan
Data Prepared By:	Amanda Lackey
Supervisor:	Scott Wentworth

TEST SETUP PHOTOGRAPH
RADIATED EMISSIONS



DRAWING NO. RCISPR11-RE GENERAL TEST SETUP, TEST METHOD
RADIATED EMISSIONS



Retlif Testing Laboratories

DATA PACKAGE No. R-3749N

EQUIPMENT LIST

Radiated Emissions

EN	Type	Manufacturer	Description	Model No.	Cal Date	Due Date
4202	Biconilog	EMCO	26 MHz - 2 GHz	3142	7/10/00	7/10/01
713	EMI Test Receiver	Rohde & Schwarz	20 Hz - 26.5 GHz	ESI26	3/9/00	3/9/01

Part 90 Transmitter Spurious (Intentional Radiator)

RETLIF TESTING LABORATORIES

TABULAR DATA SHEET

Test Method:	Spurious Radiated Emissions 30 MHz to 1.7 GHz		
Customer:	DTC Communications, Inc.	Job No:	R-3749N
Test Sample:	Tactical Repeater		
Model No:	TAC-COM-2001-P	Serial No:	AK418
Test Specification:	FCC Part 2 & 90 Paragraph: 2.1053 & 90.210		
Operating Mode:	Continuously Transmitting		
Technician:	T. Firkowski	Date:	2/23/01
Notes:	Detector Function: Peak Test Distance = 3m Harmonic Limit per Emission Mask D of paragraph 90.210		

Test Frequency	Harmonic Frequency	Ant Position/ EUT axis	Meter Reading	Correction Factor	Corrected Reading					Limit at 3 Meters
MHz	MHz		dBuV	dB	dBuV/m					dBuV/m
165.97										
-	331.95	-	-	-	-					84.40
-	497.92	-	-	-	-					I
-	663.89	-	-	-	-					I
-	829.87	-	-	-	-					I
-	995.84	-	-	-	-					I
-	1161.81	-	-	-	-					I
-	1327.79	-	-	-	-					I
-	1493.76	-	-	-	-					I
-	1659.74	-	-	-	-					84.40

No EUT emissions were observed throughout the given frequency spectrum.

Data Sheet 1 of 1 R-3749N

Part 15 Spurious Receiver (Unintentional Radiator)

For reference only: All receiver spurs are below the FCC Part 15 , Subpart B, Class B limits.

RETLIF TESTING LABORATORIES

TABULAR DATA SHEET

Test Method:	Radiated Emissions 30 MHz to 1.7 GHz		
Customer:	DTC Communications, Inc.	Job No:	R-3749N
Test Sample:	Tactical Repeater		
Model No:	TAC-COM-2001-P	Serial No:	AK418
Test Specification:	FCC Part 15, Subpart B, Class B Paragraph: 15.109 (a)		
Operating Mode:	Continuously Receiving		
Technician:	T. Firkowski	Date:	02/23/2001
Notes:	Detector Function: Quasi-Peak <1GHz, Peak >1GHz Test Distance = 3m		

Test Frequency	Antenna Position	Turntable Position	Meter Reading	Correction Factor	Corrected Reading				Converted Reading	Limit at 3 Meters
MHz	(H/V)-Height	Degrees	dBuV	dB	dBuV/m				uV/m	uV/m
30.00	-	-	-	-	-				-	100.00
I	-	-	-	-	-				-	I
I	-	-	-	-	-				-	I
I	-	-	-	-	-				-	I
88.00	-	-	-	-	-				-	100.00
88.00	-	-	-	-	-				-	150.00
I	-	-	-	-	-				-	I
I	-	-	-	-	-				-	I
I	-	-	-	-	-				-	I
216.00	-	-	-	-	-				-	150.00
216.00	-	-	-	-	-				-	200.00
I	-	-	-	-	-				-	I
I	-	-	-	-	-				-	I
I	-	-	-	-	-				-	I
960.00	-	-	-	-	-				-	200.00
960.00	-	-	-	-	-				-	500.00
I	-	-	-	-	-				-	I
I	-	-	-	-	-				-	I
I	-	-	-	-	-				-	I
2000.00	-	-	-	-	-				-	500.00

No EUT emissions were observed throughout the given frequency spectrum.

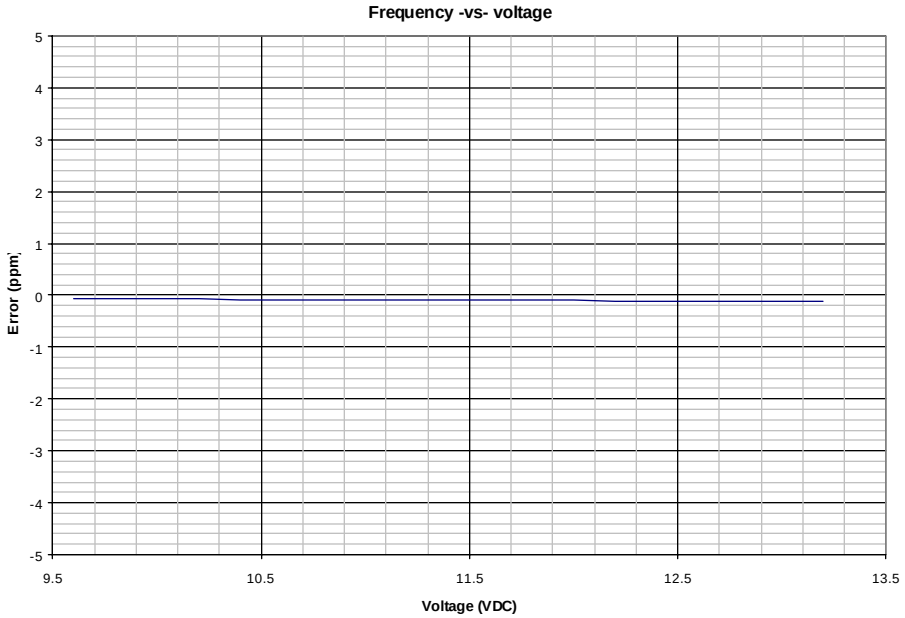
FREQUENCY STABILITY 2.1055, 90.213, 90.214

Frequency stability measurements were made over the temperature range of –30° C to +60° C by directly keying the exciter with a test interface cable. Variations of the primary DC voltage were varied by 20 % lower and 10% higher than the rated voltage range (9.6-13.2 VDC) using the KIKSUI power supply. Frequency measurements were made using a direct (20 dB attenuated) connection to a Systron Donner model 6420 frequency counter with a frequency accuracy of better than 0.1 ppm.

Environmental conditions were accomplished with an environmental chamber the Associated Systems BK-1101.The temperature was first lowered to -30° C and then increased in 10° C increments. At each temperature, short- term transient effects were monitored and no adverse effects were noted. The frequency was recorded fifteen seconds after the turn on of the transmitter. The TAC/COM 2001's transmitter is well within the 5 ppm limit.

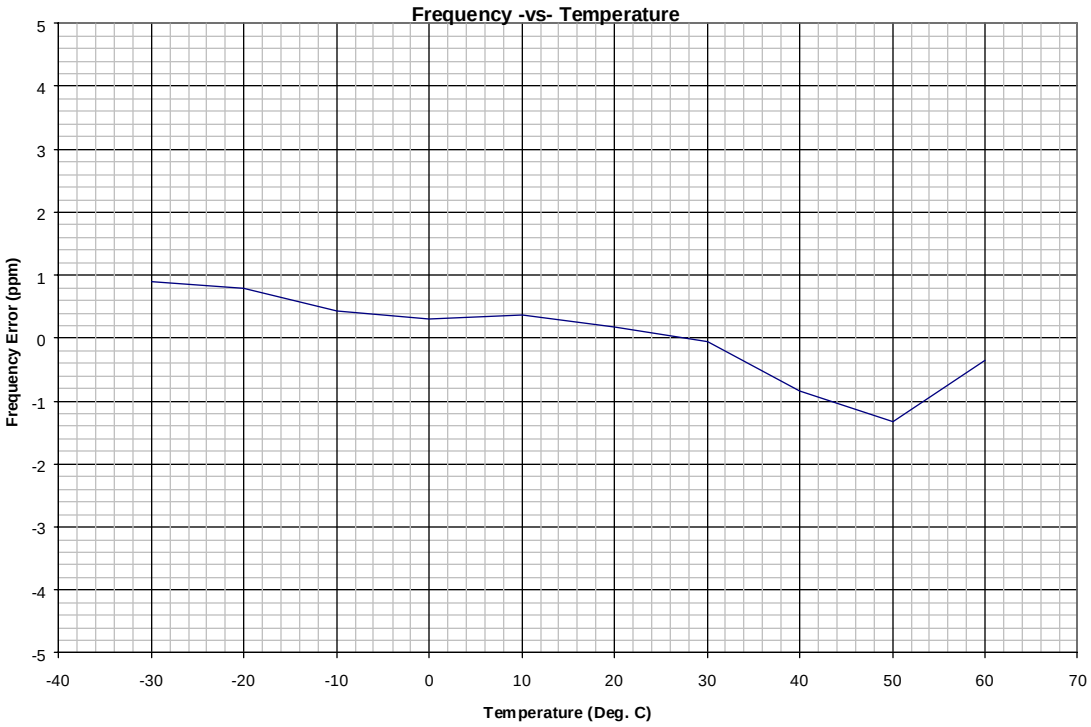
The table below shows frequency variations vs. power supply input voltage data.

TAC/COM 2001			
Frequency Stability over voltage			
Test Frequency (MHz) =			**165.9375**
Voltage (VDC)	Frequency (delta Hz)	Error (ppm)	
9.6	-10	-0.06026	
9.8	-10	-0.06026	
10	-11	-0.06629	
10.2	-12	-0.07232	
10.4	-15	-0.0904	
10.6	-15	-0.0904	
10.8	-16	-0.09642	
11	-17	-0.10245	
11.2	-16	-0.09642	
11.4	-15	-0.0904	
11.6	-16	-0.09642	
11.8	-17	-0.10245	
12	-17	-0.10245	
12.2	-18	-0.10847	
12.4	-19	-0.1145	
12.6	-20	-0.12053	
12.8	-20	-0.12053	
13	-20	-0.12053	
13.2	-21	-0.12655	



The plot below shows the frequency vs. temperature data.

TAC/COM 2001			
Frequency -vs- Temperature			
Test Frequency (MHz) = 165.9375			
Temperature (degree C)	Frequency delta (Hz)	Error (ppm)	
-30	150	0.903955	
-20	130	0.783427	
-10	70	0.421846	
0	50	0.301318	
10	60	0.361582	
20	30	0.180791	
30	-10	-0.06026	
40	-140	-0.84369	
50	-220	-1.3258	
60	-60	-0.36158	



DTC TEST INSTRUMENTS

Type	Manufacturer	Model No.
Radio Test Set	Marconi Instruments	2955
RF Signal Generator	Marconi Instuments	2041
Spectrum Analyzer	Marconi Instruments	2383
Deviation Meter	Boonton	82AD
Multimeter	Hewlett Packard	34401A
DC Power Supply	O.K Industries	PS732
DC Power Supply	KIKSUI	PAB 18-3-A
Audio Generator	Leader	LAG-12S
Directional Coupler	Hewlett Packard	778D
Frequency Counter	Systron Donner	6420
RMS Voltmeter	Hewlett Packard	3400A
30 dB 10W Attenuator	Wienchell	33-30-34
10 dB ½ W Attenuator	MiniCircuits	CAT-10
Temperature Chamber	Associated Systems	BK-1101

Repeater Test Interface Box DTC –1
(Allows Repeater Exciter to be directly keyed and modulated without an input signal)

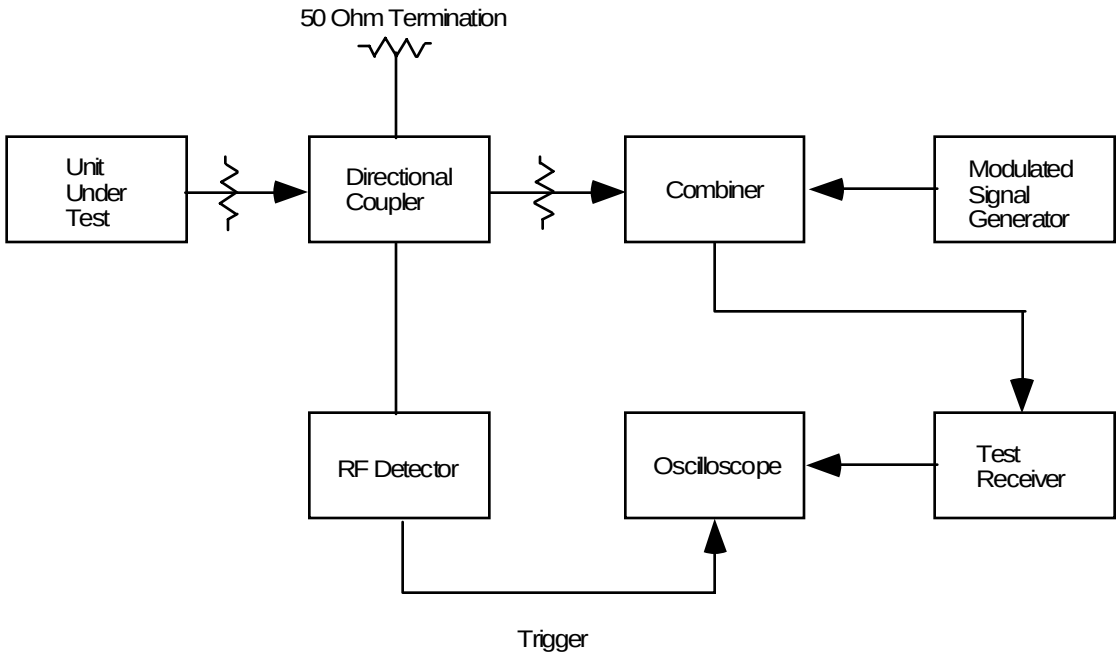
TRANSIENT FREQUENCY BEHAVIOR 90.214
(Performed by Retlif Testing Laboratories)

The transient frequency behavior test was carried out in accordance with TIA/EIA 603 §2.2.19 method of measurement §3.2.19 standard. This test measures the amount of time required for the unmodulated higher amplitude test sample to “capture” or “release” a weaker 25 kHz FM modulated test signal during key-up and key-down. This is an indirect method of measuring the time that it takes for a transmitter to come on-channel and allows transition effects to be recorded. The repeater was powered up and down manually with the test interface cable and the power supply positive terminal. A fast responding diode detector acts as a trigger signal for the oscilloscope.

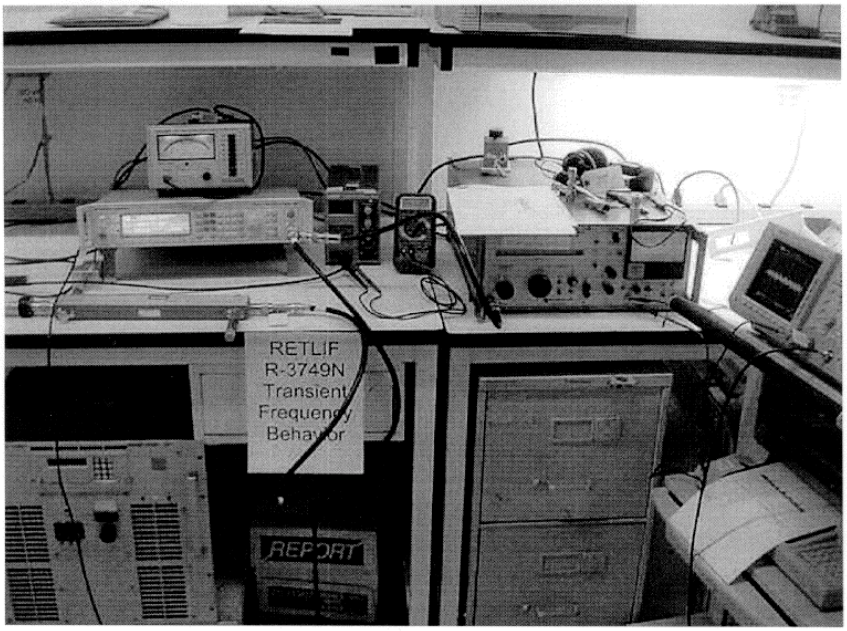
As shown in the oscilloscope plots, three time periods are observed. The t_1, t_2, t_3 mask limits are superimposed on the data runs. These plots indicate the t_{on} and t_{off} points and the related frequency displacement. The frequency difference remained within the limits of 90.213 between t_2 and t_3. The test sample comes on-frequency smoothly and remains within the limits of the mask.

BLOCK DIAGRAM

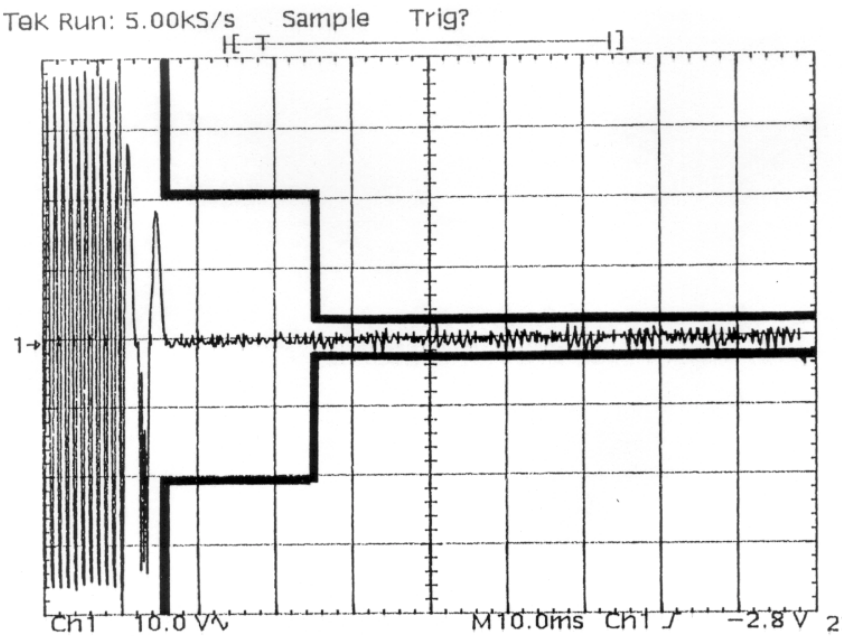
Transient Frequency Behavior 90.214



TEST SETUP PHOTOGRAPH
TRANSIENT FREQUENCY BEHAVIOR



ri	**Retlif Testing Laboratories**
	DATA PACKAGE No. R-3749N

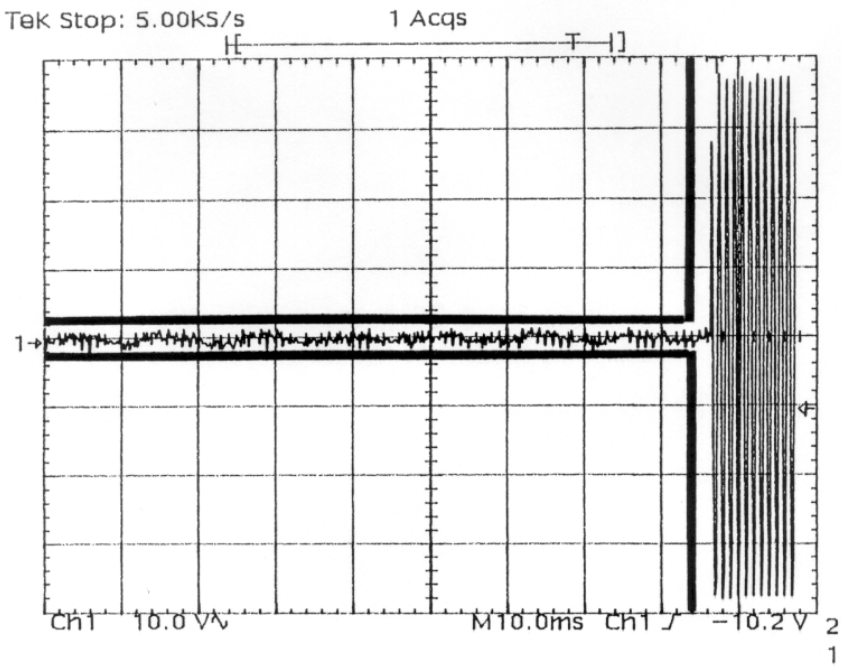


Customer:	DTC Communications, Inc.
Test Sample:	Tactical Repeater
Model No:	TAC-COM-2001-P
Test Method:	FCC Part 90.214, Transient Frequency Behavior (On)
Notes:	

Date: 2/23/01 Tech: T. Firkowski Sheet 1 of 3

Retlif Testing Laboratories

Report No. R-3749N

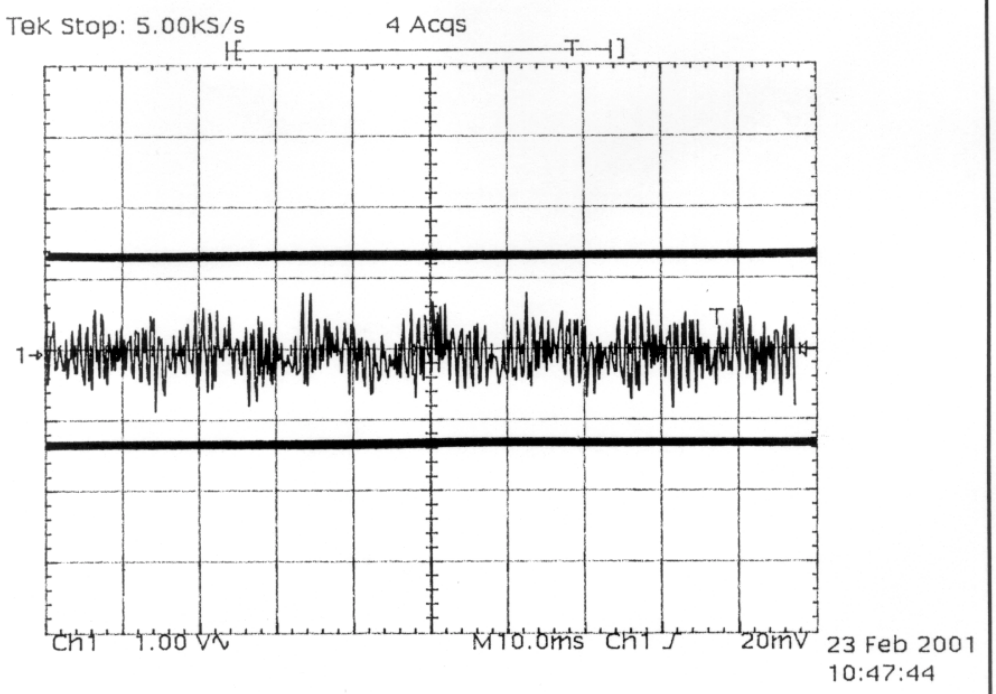


Customer:	DTC Communications, Inc.
Test Sample:	Tactical Repeater
Model No:	TAC-COM-2001-P
Test Method:	FCC Part 90.214, Transient Frequency Behavior (Off)
Notes:	

Date: 2/23/01 Tech: T. Firkowski Sheet 3 of 3

Retlif Testing Laboratories

Report No. R-3749N



Customer:	DTC Communications, Inc.
Test Sample:	Tactical Repeater
Model No:	TAC-COM-2001-P
Test Method:	FCC Part 90.213, Frequency Stability
Notes:	

Date: 2/23/01 Tech: T. Firkowski Sheet 3 of 3

Retlif Testing Laboratories

Report No. R-3749N

EQUIPMENT LIST

Transient Frequency Behavior

EN	Type	Manufacturer	Description	Model No.	Cal Date	Due Date
073	Interference Analyzer	Electro-Metrics	10 kHz - 1 GHz	EMC-25	3/31/00	3/31/01
3117	Power Supply	B&K Precision	0-30 Vdc, 3.0 A	1630	2/23/00	2/23/01
3233	Graphics Plotter	Hewlett Packard	N/A	7470A	4/11/00	4/11/01
4001	Oscilloscope	Tektronix	N/A	TDS 520A	3/14/00	3/14/01
4004	RF Millivoltmeter	Boonton Electronics	10 KHz - 1.2 GHz	92B	10/5/00	10/5/01
4910	Tee Adapter	Bruel and Kjaer	10 kHz - 1 GHz	91-14A	10/5/00	10/5/01
4937	10X Probe	Tektronix	500 MHz	P6139A	1/26/01	1/26/02
4961	Attenuator	Narda	DC - 18 GHz	757C-30dB	10/2/00	10/2/01
520N	Digital Multimeter	Wavetek	N/A	25XT	1/24/01	7/24/01
530A	AM/FM Signal Generator	Marconi Instru.	10 kHz - 1.2 GHz	2023	7/5/00	7/5/01

END OF REPORT