NATIONAL CERTIFICATION LABORATORY

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FCC REPORT OF RADIO INTERFERENCE

for

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FCC ID: NXC-RADAR

March 25, 1999

X241 DOPPLER TRANSCEIVER
FCC ID: NXC-RADAR

DEVICE OPERATION AND CIRCUIT FUNCTIONS

March 1999

The X241 is a field disturbance sensor which emits a continuous wave unmodulated signal (N0N emission) at a single fixed frequency in the band 24075-24175 MHz (24.075-24.175 GHz). The nominal frequency is 24.15 GHz. The signal received is heterodyned, resulting in sine waves in the audio frequency range. These weak signals are amplified by 58 dB in the preamplifier. This provides a valuable output: Doppler shifted sine waves in a range of approximately 20 Hz to 20 KHz.

The device operates by connecting to a D.C. power source using the cable provided. The nominal input voltage is +12 V.D.C. The X241 is designed to accept input voltages in the range of +9 to +16 V.D.C. The power source need not be regulated as long as it stays within the allowed input voltage range. The power source should be relatively noise free.

The input power is thoroughly filtered and regulated before powering a solid-state Gunn oscillator which generates the nominal 24.15 GHz signal. The voltage regulator is U3, an LM2941C, which is set by R10 & R11 to output at 5.3 V.D.C. The regulator has built-in reverse polarity protection. Filtering is accomplished by C8, 9 & 10 and L1. Inductor L1 has a nominal voltage drop of 300mV in this circuit. Therefore, the Gunn +5V line is nominally 5.0 V.D.C. The power output of the Gunn oscillator is very minimal but sufficient for this device.

The signal from the Gunn oscillator passes into a microwave turnstile. Almost the entire signal leaves the turnstile through a permanently attached horn antenna which radiates a right-hand circularly polarized wave. The horn antenna is extremely directional and has a nominal beam width (at 3dB down) of just 12 degrees. The turnstile also provides additional harmonic suppression so that the second harmonic emission is very low and additional harmonic emissions are almost completely suppressed.

The radiated signal is reflected off objects within and near the beam. When the signal bounces off objects, the polarization reverses to left-hand circular and reenters the antenna. Transmitted and received waves actually pass through the horn antenna simultaneously. This is very practical for several reasons. Because of the polarity difference, and that moving

1.0 Introduction

This report has been prepared on behalf of Keith W. Millard to support the attached Application for Certification of a Part 15 Low-Power Intentional Radiator. The Equipment Under Test was the ***X241 Radar Gun***.

Radio-Noise Emissions tests were performed according to FCC MP-1. The measuring equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

Testing was performed at National Certification Laboratory in Ellicott City, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch. FCC acceptance was granted on May 26, 1993.

1.1 Summary

The ***X241 Radar Gun*** complies with the FCC limits (15.245) for a Field Disturbance Sensor.

2.0 Description of Equipment Under Test (EUT)

The EUT Features:

24.15 +/- .1 GHz
Operating Frequency

12 VDC Battery Power

10-20 MW Output

Conical Antenna

12 Degree Beamwidth

+/- 1 MPH Accuracy

2.1 EMI Countermeasures

No modifications were needed to comply with the Part 15.245 requirements.

3.0 Test Program

The EUT was set up during the tests in a continuous mode of transmission.

4.0 Test Configuration

The EUT was set up on the test table in a horizontal configuration and pointed directly towards the measurement antenna. Slight rotations of the test table allowed detection of the maximum field level.

Photographs and interconnection diagrams are provided in Exhibit 1.

5.0 Conducted Emissions Scheme

No AC line-conducted test performed since EUT is strictly battery powered.

6.0 Radiated Emissions Scheme

The EUT is placed on an 80 cm high 1 X 1.5 meter non-conductive motorized turntable for radiated testing on the 3-meter open area test site. The emissions from the EUT are measured continuously at every azimuth by rotating the turntable. A Standard Gain Horn Antenna is mounted on an antenna mast to determine the height of maximum emissions. Cables are varied in position to produce maximum emissions. Both the horizontal and vertical field components are measured.

The RF spectrum is searched from 30 MHz - 96.6 GHz.

The waveguide output from the horn antenna is connected to the external waveguide mixer of the spectrum analyzer via flexible waveguide tube. The detector function is set to Peak. The resolution bandwidth of the spectrum analyzer is set at 1 MHz for the range of 1 GHz-96 GHz, with all post-detector filtering no less than 10 times the resolution bandwidth. All emissions within 20 dB of the limit are recorded in the data tables.

To convert the spectrum analyzer reading into a quantified E-field level to allow comparison with the FCC limits, it is necessary to account for various calibration factors. These factors include waveguide loss (CL) and antenna factors (AF). The AF/CL in dB/m is algebraically added to the Spectrum Analyzer Voltage in dbμV to obtain the Radiated Electric Field in dBμV/m. This level is then compared with the FCC limit.

Example:

Spectrum Analyzer Volt:	VdBuV
Composite Factor:	AF/CLdB/m
Electric Field:	EdBμV/m = VdBμV + AF/CLdB/m
Linear Conversion:	EuV/m = Antilog (EdBμV/m/20)

RF EXPOSURE CALCULATION

The 4.5 cm safe distance limit for 1 mW/cm RF exposure, as shown in the user manual page 10, was calculated from **FCC OET 65 Appendix B, Table 1B** guidlines for General Population/Uncontrolled Exposure. This calculation was based on the highest EIRP possible from the system, considering maximum power and antenna gain. The formula used was:

S = (Po*G)/(4*pi*r^2)

Where: G = Ant. Gain (dBi) = 11 dBi = 12.5X
Po = Power = 20 mW
S = Power Density (mW/cm^2) = 1 mW/cm^2
r = Distance (cm) = 4.5 cm

FCC RADIATED EMISSIONS DATA

FCC ID: NXC-RADAR

CLIENT: KEITH MILLARD
EUT: X241 RADAR

FREQUENCY: 24.15 GHZ
DETECTOR: PEAK DETECTION

3-METER TEST DATE: 03/22/99

FREQ GHz	POL H/V	SPEC A dBuV	AF/CL dB/m	E-FIELD dBuV/m	E-FIELD MV/m	LIMIT MV/m	MRG dB
24.15	H	80.0	38.0	118.0	795.0	2500.0	-10.0
48.30	V	27.0	44.0	71.0	3.6	7.5	-6.5
72.45	V	22.0	44.0	66.0	2.0	7.5	-11.5
96.60	H	19.0	45.0	64.0	1.6	7.5	-13.5

TEST ENGINEER

STEVE DAYHOFF

Table 1

Support Equipment

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12 VDC Power Supply

Table 2

Interface Cables Used

None used - (No interface ports on EUT)

Table 3

Measurement Equipment Used

The following equipment is used to perform measurements:

Wavetek 2410A 1100 MHz Signal Generator	- Serial No. 1362016
EMCO Model 3110 Biconical Antenna	- Serial No. 1619
EMCO Model 3146 Log Periodic Antenna	- Serial No. 1222
FXR Microlab M638A Standard Gain Horn	- Serial No. 5113-MM
Solar 8012-50-R-24-BNC LISN	- Serial No. 924867
Solar 8012-50-R-24-BNC LISN	- Serial No. 927230
Tektronix 494AP Spectrum Analyzer	- Serial No. 54378A
Tektronix 110 GHz External Waveguide Mixer	
Motorized Turntable	
Microtech EIA-10 WR Flexible Waveguide - 2 Ft.	