Radio Standard Specification
Low Power Communication Devices
C63.4-1992 and FCC Rules Part 15

1.0 General:

1.2, Exclusions to TV Broadcast Freq.	Complies

2.0 Related Documents:

Reference Documents for Application:	CFR 47, FCC Rules Part 15

3.0 Test Equipment:

Supply Voltage:	Fresh GP-23 12 volt alkaline battery
Test Equipment List	See Section 6
Signal Detector:	Peak with 11 dB, peak to average conversion.

4.0 Certification and Test Results:

Summary of Results per	See Page 1 of this Report

5.0 General Technical Requirements:

5.1 Testing Methods:	Peak Signal pulse width modulated A1D signal.
5.1 Reference Standard:	C63.4-1992 (FCC Procedure)
5.2 Modulation:	Pulse Width A1D, AM Modulation
5.3 Type of Antenna:	Integral to Transmitter PCB
5.4 External Controls:	Single Push Button No user serviceable parts except for replacement of batteries.
5.5 Accessories:	NONE
5.6 TX Bandwidth:	<0.010 % (See Section 8)
5.7 Equipment Labels:	See Section 2
5.8 Manual Disclaimer:	See attached draft copy of manual
5.9 Usage Restrictions:	Digital Pulse Code Only

6.0 Transmitter Characteristics and Tests:

6.1 Momentary Operated Devices:	Complies
6.1(a) Types of Signals:	Manual Push to Transmit
6.1(a) Automatic Activation:	N/A
6.1(a) Five Second Max. upon release:	Complies
6.1(b) Maximum Field Strength:	390 MHz = 9170 uV/mtr at 3 meters.
6.1(c) Bandwidth (20 dB down)	<0.010 % Complies
6.1(d) Frequency Stability	N/A per regulations +/- 0.125 MHz Maximum Error
6.1(e) Reduced Field Strength	N/A
6.2 Non-Momentary Operated Devices:	N/A
6.2.1 Frequency Bands:	Refer to Table 1
6.3 Restricted Bands:	Complies
6.5 Pulsed Operation:	Complies (11 dB Peak/Average) See Section 8
6.6 Wireline Conducted Emissions:	N/A
7.0 Receivers	N/A
8.0 Self Certification:	N/A
9.0 AC Wireline Conducted Emissions:	N/A
10.0 Terminated Measurement Method:	N/A
11.0 Radiated Measurement Method:	See Section 8
11.1 Measuring Distance:	Complies
11.2 Open Field Test Site:	Complies, C63.4-1992
11.3 Equipment Test Platform:	See Section 8
11.4 Measurement Method:	Complies, See Section 8
12.0 DC Power Consumption Methods:	N/A
13.0 Near Field Measurement for < 30 MHz:	N/A
14.0 Test Report Submission:	See Attached

TESTING INSTRUMENTATION AND EQUIPMENT LIST

SPECTRUM ANALYZERS:

H.P. HP8562A 1KHz to 22GHz
S/N 2913A03742 Calibrated 1/99
Due 1/00

ANTENNAS:

(2)	Ailtech DM105A T1	20-200 MHz		Tuned Dipole
	S/N 93412-105 and 93412-114	Calibrated 1/99	Due:	1/00
(2)	Ailtech DM105A T2	140-400 MHz	Tuned Dipole	
	S/N 93413-113 and 93413-117	Calibrated 1/99	Due:	1/00
(2)	Ailtech DM105A T3	400-1000 MHz	Tuned Dipole	
	S/N 93413-105 and 93414-111	Calibrated 1/99	Due	1/00
(2)	AH Systems SAS-200/511	1-12.4 GHz		Log Periodic
	S/N 118 and 124, P/Ns 2069			
(1)	AH Systems SAS-200/540		20-330 MHz	Biconical
	S/N 367 P/N 2052			

INSTRUMENTATION:

H.P. HP8656B RF Generator 100 KHz - 990 MHz
S/N A4229590 Calibrated 1/99
Due 1/00

Solar Electronics Line Impedance Stabilization Network, Type
8012-50-R-24-BNC Calibrated: 1/99
S/N 8379585 Due: 1/00

HP 8447D Broadband preamplifier, 0.1-1300 MHz
S/N 2443A03660 Calibrated: 4/99
Due: 4/00

Mini-Circuits ZFL-2000 broadband preamplifier, 10-3000 MHz
S/N Lin 001 Calibrated: 4/99
Due: 4/00

ACCESSORIES:

(2) Ailtech Rulers calibrated in MHz
4 Meter ABS Antenna Mast and Trolley
Tektronix C5C Scope Camera
Eighty Centimeter Tall, Motorized Wooden Turntable
BNC to BNC Cables - as-required

(2) 25' RG-214/U Low-loss Coaxial Cable
S/N- LIN001 & LIN002 Calibrated: 1/99
Due: 1/00

(2) 3' RG-55/U Low-loss Coaxial Cable, calibarated as part of the preamplifiers. Automatically taken into account when used with the above itemized range preamplifiers.

MEASUREMENT OF RADIO FREQUENCY EMISSION
OF CONTROL AND SECURITY ALARM DEVICES
FCC RULES PART 15, C63.4-1992 TEST PROCEDURE

I. INTRODUCTION

As part of a continuing series of quality control tests to ensure compliance with all applicable Rules and Regulations, this enclosure details the test procedures for certain radio control devices. Testing was performed at a test site located on the property of Linear Corporation, 2055 Corte del Nogal, Carlsbad, California 92009.

II. MEASUREMENT FACILITY DESCRIPTION

The test facility is a specially prepared area adequately combining the desirability of an interference free location with the convenience of nearby 120 volt power outlets, thus completely eliminating the incidence of inverter hash, so often a problem with field measurements.

III. DESCRIPTION OF SUPPORTING STRUCTURES

For Measuring Equipment - The antenna is supported on a trolley that can be raised and lowered on a mast by means of remote control to any level between 1 meter and 4 meters above the ground. For measurements at 3 meters, an antenna height (center of dipole) of about 1 meter generally yields the greatest field strength. For measurements at 1 meter, an antenna height equal to the device under test generally yields the greatest field strength. Usually, horizontal polarization yields the greatest field strength for both 1 and 3 meter measurements.

For Equipment Under Test (EUT): The equipment to be tested is supported by a wooden turntable at a height of eighty centimeters. A two axis swivel at the top of the turntable permits the unit under test to be manually oriented in the position of maximum received signal strength. The turntable can be rotated by remote control.

Test Configuration - All transmitters were located eighty centimeters above ground, at a distance of three meters from the antenna. They were each oriented for maximum radiation by rotating the turntable. The antenna was then moved vertically along the mast for optimum reception in both horizontal and vertical planes. Where no emissions were found, the antenna was also moved to one meter distance to improve system sensitivity.

All receivers were located eighty centimeters above ground, at a distance of three meters from the antenna. They were each oriented for maximum radiation by rotating the turntable. The antenna was then moved vertically along the mast for optimum reception in both horizontal and vertical planes. Generally, emissions were very close to the observed spectrum analyzer noise floor, making accurate measurement difficult because of the analyzer detector's characteristic of adding signal and noise. To better observe and measure emissions well above the noise floor, the antenna was moved in to one meter. This provides a theoretical 9.54 dB improvement in received field strength, but a possible shift from far field to near field antenna characteristics may introduce an unknown error in measurement.

All transmitters and receivers tested are typical of production units.

A Hewlett-Packard spectrum analyzer consisting of an 8562A mainframe is used for the field strength meter. A set of Ailtech DM-105 series dipoles are used for the receiving antennas up to 1 GHz. An A.H. Systems model SAS-200/511 log periodic antenna is used from 1 to 5 GHz. Since the published antenna factor includes the small amount of balun loss, this factor is not included in the equations for correcting measured values. The cable loss is added to the raw data. For measurements up to 1 GHz, a Hewlett-Packard 8447D broadband RF preamplifier is inserted between the antenna cable and spectrum analyzer input to ensure adequate system sensitivity while measuring.

From 1 GHz to 3 GHz, a Mini-Circuits ZFL-2000 broadband RF preamplifier is used instead of the HP 8447D. In many cases, the antenna is moved in to a distance of 1 meter to enhance test range sensitivity after the 3 meter data is observed. A theoretical 9.54dB improvement is realized. Please see Excel data spreadsheet for details. For a particular device and frequency, the EUT to antenna distance is specified in the Report of Measurements.

Correction of Measured Values - The spectrum analyzer calibration is in units of dBm absolute. Published antenna factor, measured cable loss and preamplifier gain are in units of dB. All equipment is referenced to a 50 ohm characteristic impedance; therefore, any impedance terms will factor out of any calculations. Also, balun loss is included in the antenna factor, so this term will not appear in any calculation.

To obtain field strength, the reference (50 ohm system) 1 uV = 0 dBuV = -107 dBm is used.

For a given frequency: antenna factor, cable loss, preamplifier gain (if used) and a 9.54 dB gain factor (3 meters to 1 meter field strength conversion) when required are factored into the spectrum analyzer reading, resulting in a field strength in units of dBm.

Field strength reading (dBm) + 107 dB = dBuV, using 0 dBuV = 1 uV/meter at a specified distance as reference.

All of the equipment was calibrated to NBS-traceable factory specifications prior to the date of measurement.

IV MEASUREMENT PROCEDURE

Transmitters

1. Set the DIP-switch rockers of the transmitter (if needed) to all ON, jam the button in the ON position, and place the transmitter on the test stand.
2. Tune the antenna (if required).
3. Tune the spectrum analyzer.
4. Adjust the antenna height and polarization for peak field strength.
5. Rotate the turntable to orient the transmitter for the highest reading.
6. Record the observed peak emission.
7. Record the screen image (if required).

Spectrum Analyzer Control Settings:

Tuning:	As required
Bandwidth	100 KHz for Field Strength,
Scan Width:	100 KHz/div (may be different when tuning or adjusting display for photographs)
Input Attenuator:	10 dB
Scan Time:	50 mSec. sweep
Reference Level:	0 dBm
Display Mode:	Log 10 dB/division
Video Filter:	OFF
Scan Mode:	Internal
Scan Trigger:	Auto

Transmitter Duty Cycle Calculations and Time Domain Information

Rolling Code Data Format

Worst case duty cycle is computed because binary-coded pulse width type A1D modulation is used. Data rate is assumed to be 200 uSec (=1) and 400 uSec (=0) pulses in any 600 uSec data pulse time window.

Modulation rate is fixed at 1670 bits per second.

During transmission, the transmitter sequentially emits a group of 12 preamble pulses plus 66 data pulses in the form of a pulse keyed carrier. The data stream consists of preamble, header, encoded data string, fixed data string and interword pause.

The preamble and header are fixed by the manufacture of the IC. The preamble consists of a serial string of 12 bits of 50% duty cycle pulses. The on and off times are each 200 uSec. The 12 bit header is followed by one long pause of 2.0 mSec in duration.

The data string utilizes a 66 bit encoded data stream that sequentially generates a 32 bit pseudo-random rotating code with an additonal 34 bits of fixed code.

The rotating code structure has a capability of over 4000 million possible code sequences. This code structure is specifically selected such that the 32 bit pseudo-random code can never be equal to all ones or all zeroes and that on average a 50/50 mix of 1s and 0s are generated.

The fixed code is programmed by the manufacturer to represent device serialization. It consists of a serial number code, button pressed information and battery status code (optional).

REAL TIME ANALYSIS:

Each of the 34 information data pulses occupy a maximum 400 uSec duration position within a 600 uSec wide bit frame. The fixed code elapsed time equals 20.4 mSec.

DUTY CYCLE ANALYSIS (Single Data Word):

Description	Total Time	"On" Time
Preamble	4.8 mSec	2.4 E-3 Sec
Header	2.0 mSec	0 Sec
Hopping Sequence	19.2 mSec	8.1 E-3 Sec
Fixed Sequence	20.4 mSec	4.8 E-3 Sec
Inter Word Pause	10 mSec	0 Sec.
Total Transmission	56.4 mSec	15.3 E-3 Sec

In compliance with FCC Rules 15.35(c) the following duty cycle factor is used for all field strength calculations. A 56.4 mSec time window is selected with the on time ratio.

$$\frac{15.3\text{ E-3 on time}}{56.4\text{ E-3 total time}} = 0.271$$

On time to FCC reference limit

20 log (0.271) = - 11.3 dB   Duty Cycle Ratio