Nemko Test Report:	0L0528RUS1
Applicant:	L.R. Nelson Corp. One Sprinkler Lane Peoria, IL 61615-9544
Equipment Under Test: **(E.U.T.)**	EZ Pro Command
FCC ID:	NYD8600
In Accordance With:	**FCC Part 15, Subpart C, 15.247** Frequency Hopping Transmitters
Tested By:	Nemko Dallas Inc. 802 N. Kealy Lewisville, Texas 75057-3136
Authorized By:	 Tom Tidwell, RF Group Manager
Date:	
Total Number of Pages:	54

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Section 1. Summary of Test Results

Manufacturer: L.R. Nelson Corp.

Model No.: EZ Pro Command

Serial No.: None

General: **All measurements are traceable to national standards.**

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, Subpart C, Paragraph 15.247 for Frequency Hopping Spread Spectrum devices. Radiated tests were conducted is accordance with ANSI C63.4-1992. Radiated emissions are made on an open area test site. A description of the test facility is on file with the FCC.

☒ New Submission ☒ Production Unit

☐ Class II Permissive Change ☐ Pre-Production Unit

☐ Family Listing

THIS TEST REPORT RELATES ONLY TO THE ITEM(S) TESTED.

THE FOLLOWING DEVIATIONS FROM, ADDITIONS TO, OR EXCLUSIONS FROM THE TEST SPECIFICATIONS HAVE BEEN MADE.
See " Summary of Test Data".

NVLAP LAB CODE: 100426-0

TESTED BY: _____ DATE: _____

Summary Of Test Data

NAME OF TEST	PARA. NO.	SPEC.	MEAS.	RESULT
Powerline Conducted Emissions	15.207(a)	48 dBµV	N/A	N/A
Channel Separation	15.247(a)(1)	Greater of 25 kHz or 20 dB Bandwidth	85 kHz	Complies
Pseudorandom Hopping Algorithm	15.247(a)(1)	Customer Supplied	Customer Supplied	Customer Supplied
Time of Occupancy	15.247(a)(1)(ii)	≤ 0.4 sec in 30 sec	0.144 mS in 30 sec	Complies
20 dB Occupied Bandwidth	15.247(a)(1)	≤ 1 MHz		Complies
Peak Power Output	15.247(b)	4 Watts EIRP	88 mW	Complies
Spurious Emissions (Antenna Conducted)	15.247(c)	-20 dBc	N/A	N/A
Spurious Emissions (Radiated)	15.247(c)	Table 15.209(a)	See Data	Complies

Footnotes:

The device does not have a detachable antenna.

The device is battery powered.

Section 2. Equipment Under Test (E.U.T.)

General Equipment Information

Frequency Band:	☐ 902 – 928 MHz ☒ 2400 – 2483.5 MHz
Number of Channels:	75
Channel Spacing:	85 kHz
User Frequency Adjustment:	Software controlled

Description of Modification for Modification Filing

Family List Rational

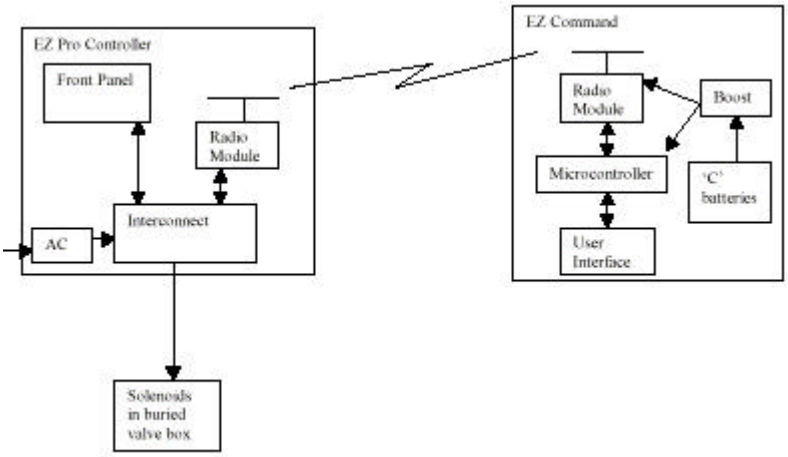
Theory of Operation

The EZ Pro is an AC Powered Irrigation Controller. The Primary input voltage is stepped down from line voltage (120VAC 60Hz Domestic, 230VAC 50Hz Export) to 24VAC (nominal), which then energizes the DC power supply and supplies power for the zones. The secondary is protected by a 1A Raychem® polyswitch (self-resetting current limiter). A microcontroller aboard the Front Panel Module controls a user interface which consists of 3 knobs and a 4 button keypad. The microcontroller keeps time using a 32kHz quartz oscillator and schedules when to turn on the appropriate zones according to what was programmed in on the user interface. The microcontroller also supplies limited diagnostic information as
to the presence or absence of a fault on a zone and discontinues opearation of a faulty zone. The outputs consist of 4 through 24 zones which can only be turned on one at a time, along with a secondary output (called the Pump/Master Valve) which may or may not be turned on based upon user programming.

86xxR models incorporate a radio module, which allows for extension of the user interface to a handheld device. The radio consists of a Zinc encased 2.4GHz Spread Spectrum Radio.

The addition of the **EZ Command** and radio modules to the system allows the user to have a mirror of the interface at the front panel to the user carrying the Command. The LCD display on the command mirrors the display on the controller, and the Command periodically sends the dial position and any key-presses.

System Diagram



Section 3. Powerline Conducted Emissions

NAME OF TEST: Powerline Conducted Emissions	PARA. NO.: 15.207(a)
TESTED BY:	DATE:

Test Results: Complies.

Measurement Data: See attached plots.

Not Applicable

Equipment Used:

Measurement Uncertainty: +/- .7 dB

Temperature: °C

Relative Humidity: %

Section 4. Channel Separation

NAME OF TEST: Channel Separation	PARA. NO.: 15.247(a)(1)
TESTED BY: David Light	DATE:3/16/01

Test Results: Complies.

Measurement Data: See 20 dB BW plot
Measured 20 dB bandwidth: 81.8 kHz
Channel Separation: 85 kHz

Measurement Uncertainty: +/- .7 dB

Test Data - Channel Separation

Data Plot **CHANNEL SEPERATION**

Page 1 of 1 Complete X

Job No.: 0L0528R Date: 3/16/01 Preliminary

Specification: 15.247 Temperature(°C): 22

Tested By: David Light Relative Humidity(%) 50

E.U.T.: EZ Pro

Configuration: Transmit modulated data

Sample Number: S08

Location: Lab 1 RBW: 3 kHz

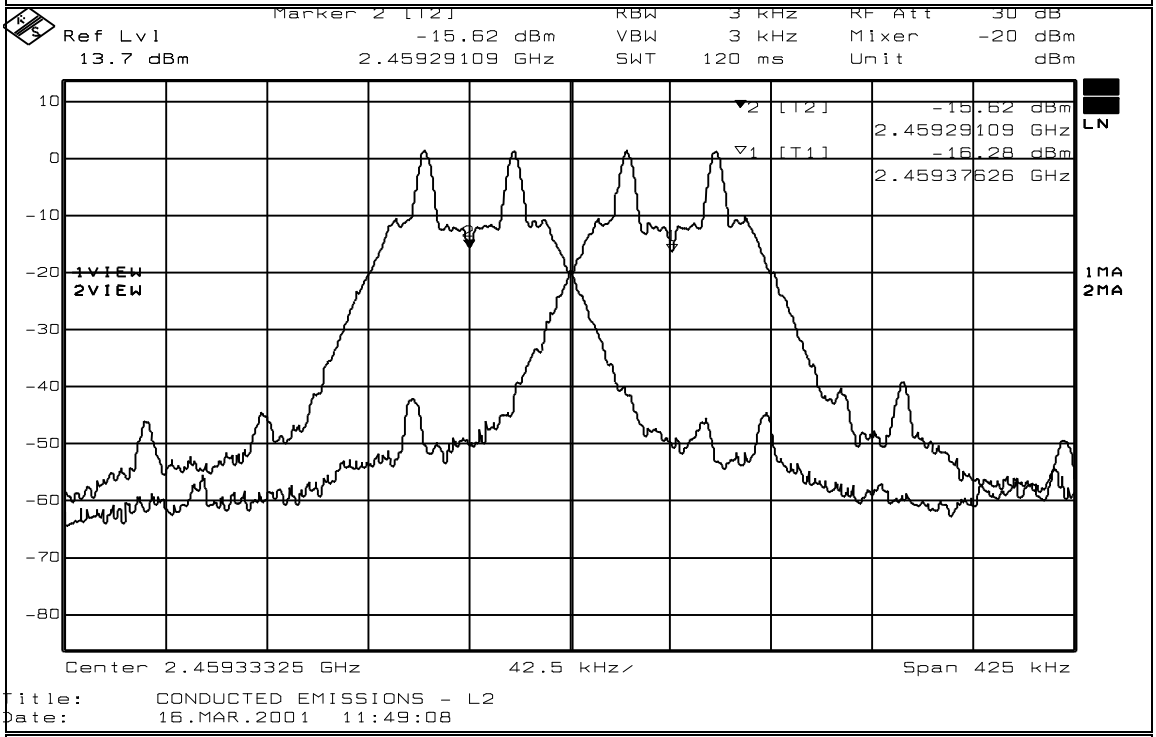
Detector Type: Peak VBW: 3 kHz

Test Equipment Used

Antenna:		Directional Coupler:	
Pre-Amp:		Cable #1:	1043
Filter:		Cable #2:	
Receiver:	1036	Cable #3:	
Attenuator #1		Cable #4:	
Attenuator #2:		Mixer:	

Additional equipment used: #802 Near Field Probe Set

Measurement Uncertainty: +/-3.6 dB



Notes: **HOP GROUP 1 - CHANNELS 39 & 40**

CHANNEL SEPERATION = 85 kHz

Section 5. Pseudorandom Hopping Algorithm

NAME OF TEST: Pseudorandom Hopping Algorithm	PARA. NO.: 15.247(a)(1)
TESTED BY: Supplied by Customer	DATE:

Test Results: Complies.

Measurement Data: See sample hopping sequence.
Number of Hopping Frequencies: 75
Number of Hopping Patterns: 8

Proposal for modification of the Nelson EZ-Pro radio system firmware to comply with pseudo-random hopping requirements of the FCC.

The Nelson EZ-Pro radio system is installed into two different types of host units: The Pro Controller (fixed, AC powered) and the EZ Programmer (mobile, battery powered). The radios are strapped by the connector wiring of the host unit into either a Master or Slave configuration. The Pro Controller contains the Master radio, and the EZ Programmer contains the Slave.

Prior to a connection attempt, a unique four-byte ID is loaded into each by the operator through the front panel user interface. This ID is used for radio addressing and connection authentication.

The Master radio is placed into a listen-only state in which it slowly hops through all available channels listening for a valid packet from a Slave radio. If one is received but does not match the stored ID, it is ignored and the radio remains in a listen-only state. The radio does not transmit during this time.

When a connection is desired, the operator activates the Slave radio, which causes it to start a transmit/receive sequence attempting to contact a Master radio. Each short transmit burst is followed immediately by a longer listen window, then the radio hops to the next channel and repeats this sequence.

When the Master radio hears a valid packet from the Slave, it validates the received ID against its own. If they match, the Master replies immediately to the Slave and is placed into “connected” mode. Upon receipt of a valid message from the Master, the Slave is now also in “connected” mode. The two radios hop in sync and continue to exchange data for the duration of the connection. This connection can be continuous, but in the interest of power savings, the Slave may terminate the connection at any time. In this case, the Master radio reverts to listen-only mode and slowly hops through all available channels listening for a valid packet from a Slave radio.

For the hopping scheme, we propose to implement a two-table lookup system. The end result is that the overall hopping pattern is much longer than the number of channels in the system.

One table, the “synthesizer table”, contains the synthesizer register values for each of the 75 channels, numbered 0-74, and the other table, the “pr pattern table” contains a long list pseudo-randomly arranged pointers to entries in the synthesizer table. This table’s length is a multiple of 75, guaranteeing that each channel is occupied an equal amount of time.

The Slave radio data header contains a pointer indicating the current index into the pr pattern table. The Master then uses this information to determine where it should hop next. The following diagram illustrates the new lookup scheme.

Synthesizer Table

```
;Hop group  0 :
  retlw   12h       ; LO= 2084
;Hop group  1 :
  retlw   16h       ; LO= 2085
;Hop group  2 :
  retlw   1ah       ; LO= 2086
;Hop group  3:
  retlw   1eh       ; LO= 2087
;Hop group  4 :
  retlw   12h       ; LO= 2084
;Hop group  5 :
  retlw   16h       ; LO= 2085
;Hop group  6 :
  retlw   1ah       ; LO= 2086
;Hop group  7:
  retlw   1eh       ; LO= 2087


;TX channel  0 :
        retlw     012h
        retlw     08Ch
        retlw     033h   ; Freq= 370.9775 MHz
;TX channel  1 :
        retlw     012h
        retlw     08Dh
        retlw     04Ah   ; Freq= 371.0625 MHz
;TX channel  2 :
        retlw     012h
        retlw     08Eh
        retlw     060h   ; Freq= 371.1475 MHz
;TX channel  3 :
        retlw     012h
        retlw     08Fh
        retlw     077h   ; Freq= 371.2325 MHz
;TX channel  4 :
        retlw     012h
        retlw     090h
        retlw     08Dh   ; Freq= 371.3175 MHz
;TX channel  5 :
```

```
        retlw   012h
        retlw   091h
        retlw   0A4h  ; Freq= 371.4025 MHz
;TX channel  6 :
        retlw   012h
        retlw   092h
        retlw   0BAh  ; Freq= 371.4875 MHz
;TX channel  7 :
        retlw   012h
        retlw   093h
        retlw   0D1h  ; Freq= 371.5725 MHz
;TX channel  8 :
        retlw   012h
        retlw   094h
        retlw   0E7h  ; Freq= 371.6575 MHz
;TX channel  9 :
        retlw   012h
        retlw   095h
        retlw   0FEh  ; Freq= 371.7425 MHz
;TX channel  10 :
        retlw   012h
        retlw   097h
        retlw   014h  ; Freq= 371.8275 MHz
;TX channel  11 :
        retlw   012h
        retlw   098h
        retlw   02Bh  ; Freq= 371.9125 MHz
;TX channel  12 :
        retlw   012h
        retlw   099h
        retlw   041h  ; Freq= 371.9975 MHz
;TX channel  13 :
        retlw   012h
        retlw   09Ah
        retlw   058h  ; Freq= 372.0825 MHz
;TX channel  14 :
        retlw   012h
        retlw   09Bh
        retlw   06Eh  ; Freq= 372.1675 MHz
;TX channel  15 :
        retlw   012h
```

```
        retlw   09Ch
        retlw   085h  ; Freq= 372.2525 MHz
;TX channel  16 :
        retlw   012h
        retlw   09Dh
        retlw   09Ch  ; Freq= 372.3375 MHz
;TX channel  17 :
        retlw   012h
        retlw   09Eh
        retlw   0B2h  ; Freq= 372.4225 MHz
;TX channel  18 :
        retlw   012h
        retlw   09Fh
        retlw   0C8h  ; Freq= 372.5075 MHz
;TX channel  19 :
        retlw   012h
        retlw   0A0h
        retlw   0DFh  ; Freq= 372.5925 MHz
;TX channel  20 :
        retlw   012h
        retlw   0A1h
        retlw   0F6h  ; Freq= 372.6775 MHz
;TX channel  21 :
        retlw   012h
        retlw   0A3h
        retlw   00Ch  ; Freq= 372.7625 MHz
;TX channel  22 :
        retlw   012h
        retlw   0A4h
        retlw   023h  ; Freq= 372.8475 MHz
;TX channel  23 :
        retlw   012h
        retlw   0A5h
        retlw   039h  ; Freq= 372.9325 MHz
;TX channel  24 :
        retlw   012h
        retlw   0A6h
        retlw   050h  ; Freq= 373.0175 MHz
;TX channel  25 :
        retlw   012h
        retlw   0A7h
```

```
        retlw   066h   ; Freq= 373.1025 MHz
;TX channel  26 :
        retlw   012h
        retlw   0A8h
        retlw   07Dh   ; Freq= 373.1875 MHz
;TX channel  27 :
        retlw   012h
        retlw   0A9h
        retlw   093h   ; Freq= 373.2725 MHz
;TX channel  28 :
        retlw   012h
        retlw   0AAh
        retlw   0AAh   ; Freq= 373.3575 MHz
;TX channel  29 :
        retlw   012h
        retlw   0ABh
        retlw   0C0h   ; Freq= 373.4425 MHz
;TX channel  30 :
        retlw   012h
        retlw   0ACh
        retlw   0D7h   ; Freq= 373.5275 MHz
;TX channel  31 :
        retlw   012h
        retlw   0ADh
        retlw   0EEh   ; Freq= 373.6125 MHz
;TX channel  32 :
        retlw   012h
        retlw   0AFh
        retlw   004h   ; Freq= 373.6975 MHz
;TX channel  33 :
        retlw   012h
        retlw   0B0h
        retlw   01Ah   ; Freq= 373.7825 MHz
;TX channel  34 :
        retlw   012h
        retlw   0B1h
        retlw   031h   ; Freq= 373.8675 MHz
;TX channel  35 :
        retlw   012h
        retlw   0B2h
        retlw   048h   ; Freq= 373.9525 MHz
```

```
;TX channel  36 :
        retlw     012h
        retlw     0B3h
        retlw     05Eh   ; Freq= 374.0375 MHz
;TX channel  37 :
        retlw     012h
        retlw     0B4h
        retlw     075h   ; Freq= 374.1225 MHz
;TX channel  38 :
        retlw     012h
        retlw     0B5h
        retlw     08Bh   ; Freq= 374.2075 MHz
;TX channel  39 :
        retlw     012h
        retlw     0B6h
        retlw     0A2h   ; Freq= 374.2925 MHz
;TX channel  40 :
        retlw     012h
        retlw     0B7h
        retlw     0B8h   ; Freq= 374.3775 MHz
;TX channel  41 :
        retlw     012h
        retlw     0B8h
        retlw     0CFh   ; Freq= 374.4625 MHz
;TX channel  42 :
        retlw     012h
        retlw     0B9h
        retlw     0E5h   ; Freq= 374.5475 MHz
;TX channel  43 :
        retlw     012h
        retlw     0BAh
        retlw     0FCh   ; Freq= 374.6325 MHz
;TX channel  44 :
        retlw     012h
        retlw     0BCh
        retlw     012h   ; Freq= 374.7175 MHz
;TX channel  45 :
        retlw     012h
        retlw     0E3h
        retlw     03Dh   ; Freq= 377.7775 MHz
;TX channel  46 :
```

```
        retlw   012h
        retlw   0E4h
        retlw   054h   ; Freq= 377.8625 MHz
;TX channel  47 :
        retlw   012h
        retlw   0E5h
        retlw   06Ah   ; Freq= 377.9475 MHz
;TX channel  48 :
        retlw   012h
        retlw   0E6h
        retlw   081h   ; Freq= 378.0325 MHz
;TX channel  49 :
        retlw   012h
        retlw   0E7h
        retlw   097h   ; Freq= 378.1175 MHz
;TX channel  50 :
        retlw   012h
        retlw   0E8h
        retlw   0AEh   ; Freq= 378.2025 MHz
;TX channel  51 :
        retlw   012h
        retlw   0E9h
        retlw   0C4h   ; Freq= 378.2875 MHz
;TX channel  52 :
        retlw   012h
        retlw   0EAh
        retlw   0DBh   ; Freq= 378.3725 MHz
;TX channel  53 :
        retlw   012h
        retlw   0EBh
        retlw   0F2h   ; Freq= 378.4575 MHz
;TX channel  54 :
        retlw   012h
        retlw   0EDh
        retlw   008h   ; Freq= 378.5425 MHz
;TX channel  55 :
        retlw   012h
        retlw   0EEh
        retlw   01Eh   ; Freq= 378.6275 MHz
;TX channel  56 :
        retlw   012h
```

```
        retlw   0EFh
        retlw   035h   ; Freq= 378.7125 MHz
;TX channel  57 :
        retlw   012h
        retlw   0F0h
        retlw   04Ch   ; Freq= 378.7975 MHz
;TX channel  58 :
        retlw   012h
        retlw   0F1h
        retlw   062h   ; Freq= 378.8825 MHz
;TX channel  59 :
        retlw   012h
        retlw   0F2h
        retlw   079h   ; Freq= 378.9675 MHz
;TX channel  60 :
        retlw   012h
        retlw   0F3h
        retlw   08Fh   ; Freq= 379.0525 MHz
;TX channel  61 :
        retlw   012h
        retlw   0F4h
        retlw   0A6h   ; Freq= 379.1375 MHz
;TX channel  62 :
        retlw   012h
        retlw   0F5h
        retlw   0BCh   ; Freq= 379.2225 MHz
;TX channel  63 :
        retlw   012h
        retlw   0F6h
        retlw   0D3h   ; Freq= 379.3075 MHz
;TX channel  64 :
        retlw   012h
        retlw   0F7h
        retlw   0E9h   ; Freq= 379.3925 MHz
;TX channel  65 :
        retlw   012h
        retlw   0F9h
        retlw   000h   ; Freq= 379.4775 MHz
;TX channel  66 :
        retlw   012h
        retlw   0FAh
```

```
        retlw   016h   ; Freq= 379.5625 MHz
;TX channel  67 :
        retlw   012h
        retlw   0FBh
        retlw   02Dh   ; Freq= 379.6475 MHz
;TX channel  68 :
        retlw   012h
        retlw   0FCh
        retlw   044h   ; Freq= 379.7325 MHz
;TX channel  69 :
        retlw   012h
        retlw   0FDh
        retlw   05Ah   ; Freq= 379.8175 MHz
;TX channel  70 :
        retlw   012h
        retlw   0FEh
        retlw   070h   ; Freq= 379.9025 MHz
;TX channel  71 :
        retlw   012h
        retlw   0FFh
        retlw   087h   ; Freq= 379.9875 MHz
;TX channel  72 :
        retlw   013h
        retlw   000h
        retlw   09Eh   ; Freq= 380.0725 MHz
;TX channel  73 :
        retlw   013h
        retlw   001h
        retlw   0B4h   ; Freq= 380.1575 MHz
;TX channel  74 :
        retlw   013h
        retlw   002h
        retlw   0CBh   ; Freq= 380.2425 MHz
```

Pseudo-random Table

```
prtable
        movlw   prtbl2<
        movwf   pclath
        movf    tall,w
        addwf   2,1
prtbl2
;seed =  6826
        retlw   25      ;0
        retlw   64      ;1
        retlw   29      ;2
        retlw   12      ;3
        retlw   45      ;4
        retlw   16      ;5
        retlw   5 ;6
        retlw   26      ;7
        retlw   59      ;8
        retlw   7 ;9
        retlw   0 ;a
        retlw   60      ;b
        retlw   2 ;c
        retlw   70      ;d
        retlw   9 ;e
        retlw   54      ;f
        retlw   46      ;10
        retlw   23      ;11
        retlw   65      ;12
        retlw   11      ;13
        retlw   44      ;14
        retlw   69      ;15
        retlw   48      ;16
        retlw   14      ;17
        retlw   47      ;18
        retlw   40      ;19
        retlw   57      ;1a
        retlw   51      ;1b
        retlw   15      ;1c
        retlw   21      ;1d
        retlw   53      ;1e
        retlw   20      ;1f
```

```
retlw   50      ;20
retlw   63      ;21
retlw   71      ;22
retlw   66      ;23
retlw   52      ;24
retlw   13      ;25
retlw   67      ;26
retlw   24      ;27
retlw   73      ;28
retlw   19      ;29
retlw   30      ;2a
retlw   3 ;2b
retlw   35      ;2c
retlw   38      ;2d
retlw   74      ;2e
retlw   41      ;2f
retlw   27      ;30
retlw   1 ;31
retlw   68      ;32
retlw   72      ;33
retlw   28      ;34
retlw   36      ;35
retlw   49      ;36
retlw   18      ;37
retlw   43      ;38
retlw   31      ;39
retlw   58      ;3a
retlw   42      ;3b
retlw   8 ;3c
retlw   34      ;3d
retlw   32      ;3e
retlw   4 ;3f
retlw   62      ;40
retlw   6 ;41
retlw   37      ;42
retlw   17      ;43
retlw   10      ;44
retlw   55      ;45
retlw   61      ;46
retlw   56      ;47
retlw   22      ;48
```

```
        retlw   39      ;49
        retlw   33      ;4a
;seed =  8866
        retlw   39      ;4b
        retlw   60      ;4c
        retlw   32      ;4d
        retlw   68      ;4e
        retlw   26      ;4f
        retlw   45      ;50
        retlw   42      ;51
        retlw   15      ;52
        retlw   46      ;53
        retlw   29      ;54
        retlw   25      ;55
        retlw   63      ;56
        retlw   54      ;57
        retlw   40      ;58
        retlw   9 ;59
        retlw   66      ;5a
        retlw   50      ;5b
        retlw   65      ;5c
        retlw   20      ;5d
        retlw   30      ;5e
        retlw   11      ;5f
        retlw   72      ;60
        retlw   7 ;61
        retlw   18      ;62
        retlw   34      ;63
        retlw   38      ;64
        retlw   19      ;65
        retlw   49      ;66
        retlw   10      ;67
        retlw   74      ;68
        retlw   52      ;69
        retlw   12      ;6a
        retlw   53      ;6b
        retlw   13      ;6c
        retlw   44      ;6d
        retlw   14      ;6e
        retlw   43      ;6f
        retlw   48      ;70
```

```
        retlw   70      ;71
        retlw   57      ;72
        retlw   21      ;73
        retlw   62      ;74
        retlw   28      ;75
        retlw   69      ;76
        retlw   37      ;77
        retlw   47      ;78
        retlw   56      ;79
        retlw   5 ;7a
        retlw   73      ;7b
        retlw   6 ;7c
        retlw   41      ;7d
        retlw   59      ;7e
        retlw   67      ;7f
        retlw   33      ;80
        retlw   24      ;81
        retlw   61      ;82
        retlw   17      ;83
        retlw   3 ;84
        retlw   27      ;85
        retlw   23      ;86
        retlw   58      ;87
        retlw   71      ;88
        retlw   51      ;89
        retlw   1 ;8a
        retlw   4 ;8b
        retlw   22      ;8c
        retlw   36      ;8d
        retlw   16      ;8e
        retlw   35      ;8f
        retlw   2 ;90
        retlw   8 ;91
        retlw   64      ;92
        retlw   0 ;93
        retlw   31      ;94
        retlw   55      ;95
;seed =  4596
        retlw   17      ;96
        retlw   26      ;97
        retlw   23      ;98
```

```
retlw   13      ;99
retlw   19      ;9a
retlw   16      ;9b
retlw   10      ;9c
retlw   51      ;9d
retlw   9 ;9e
retlw   56      ;9f
retlw   34      ;a0
retlw   2 ;a1
retlw   61      ;a2
retlw   64      ;a3
retlw   31      ;a4
retlw   46      ;a5
retlw   63      ;a6
retlw   41      ;a7
retlw   36      ;a8
retlw   68      ;a9
retlw   47      ;aa
retlw   32      ;ab
retlw   28      ;ac
retlw   54      ;ad
retlw   70      ;ae
retlw   52      ;af
retlw   48      ;b0
retlw   18      ;b1
retlw   20      ;b2
retlw   25      ;b3
retlw   71      ;b4
retlw   6 ;b5
retlw   24      ;b6
retlw   53      ;b7
retlw   58      ;b8
retlw   4 ;b9
retlw   74      ;ba
retlw   38      ;bb
retlw   69      ;bc
retlw   66      ;bd
retlw   15      ;be
retlw   44      ;bf
retlw   5 ;c0
retlw   1 ;c1
```

```
retlw   8 ;c2
retlw   33      ;c3
retlw   60      ;c4
retlw   30      ;c5
retlw   7 ;c6
retlw   73      ;c7
retlw   29      ;c8
retlw   11      ;c9
retlw   27      ;ca
retlw   3 ;cb
retlw   42      ;cc
retlw   45      ;cd
retlw   22      ;ce
retlw   40      ;cf
retlw   43      ;d0
retlw   14      ;d1
retlw   0 ;d2
retlw   37      ;d3
retlw   49      ;d4
retlw   55      ;d5
retlw   21      ;d6
retlw   62      ;d7
retlw   65      ;d8
retlw   57      ;d9
retlw   12      ;da
retlw   72      ;db
retlw   35      ;dc
retlw   59      ;dd
retlw   67      ;de
retlw   39      ;df
retlw   50      ;e0
```

Section 6. Time of Occupancy

NAME OF TEST: Time of Occupancy	PARA. NO.: 15.247(a)(1)
TESTED BY: David Light	DATE: 3/19/01

Test Results: Complies.

Measurement Data:

Maximum Dwell Time On Any Channel: 48 mS

Test Data-Time of Occupancy

Data Plot **Time of Occupancy**

Page 1 of 2 Complete X

Job No.: 0L0528R Date: 3/19/01 Preliminary

Specification: 15.247 Temperature(°C): 22

Tested By: David Light Relative Humidity(%) 50

E.U.T.: EZ Pro Handset

Configuration: Transmit modulated data

Sample Number: S08

Location: Lab 1 RBW: Refer to Plots

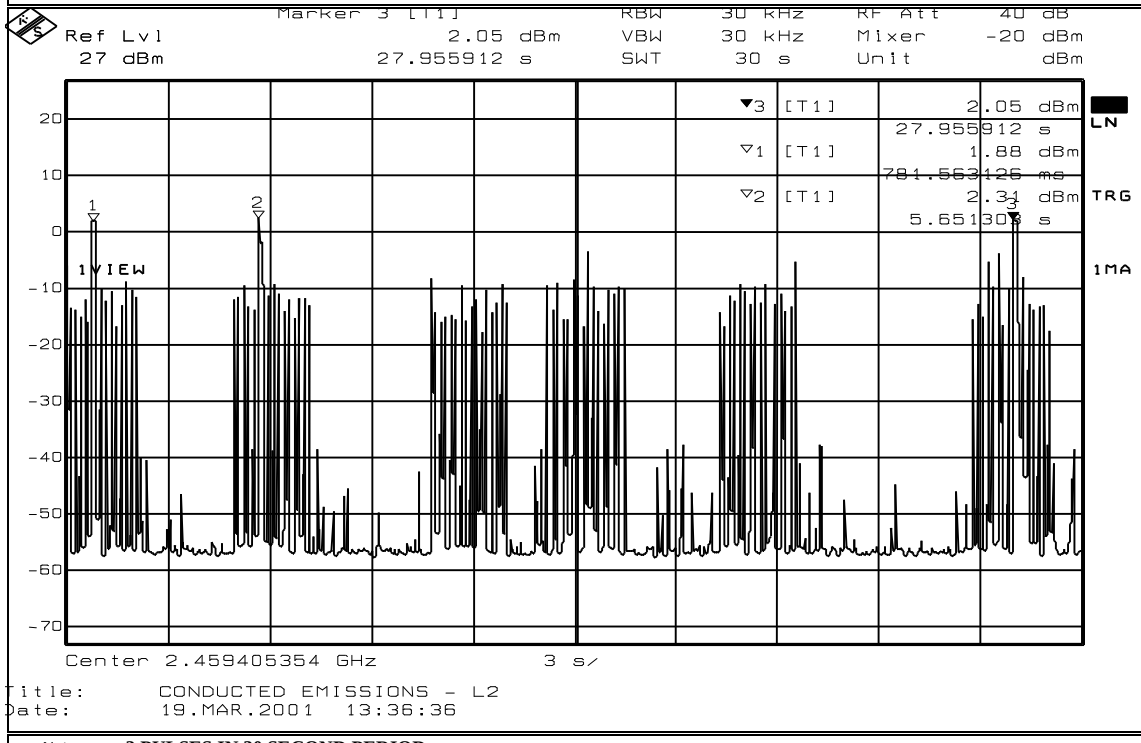
Detector Type: Peak VBW: Refer to Plots

Test Equipment Used

Antenna:		Directional Coupler:	
Pre-Amp:		Cable #1:	1043
Filter:		Cable #2:	
Receiver:	1036	Cable #3:	
Attenuator #1		Cable #4:	
Attenuator #2:		Mixer:	

Additional equipment used: #802 Near Field Probe Set

Measurement Uncertainty: +/-3.6 dB



Notes: **3 PULSES IN 30 SECOND PERIOD**

48 mS / pulse

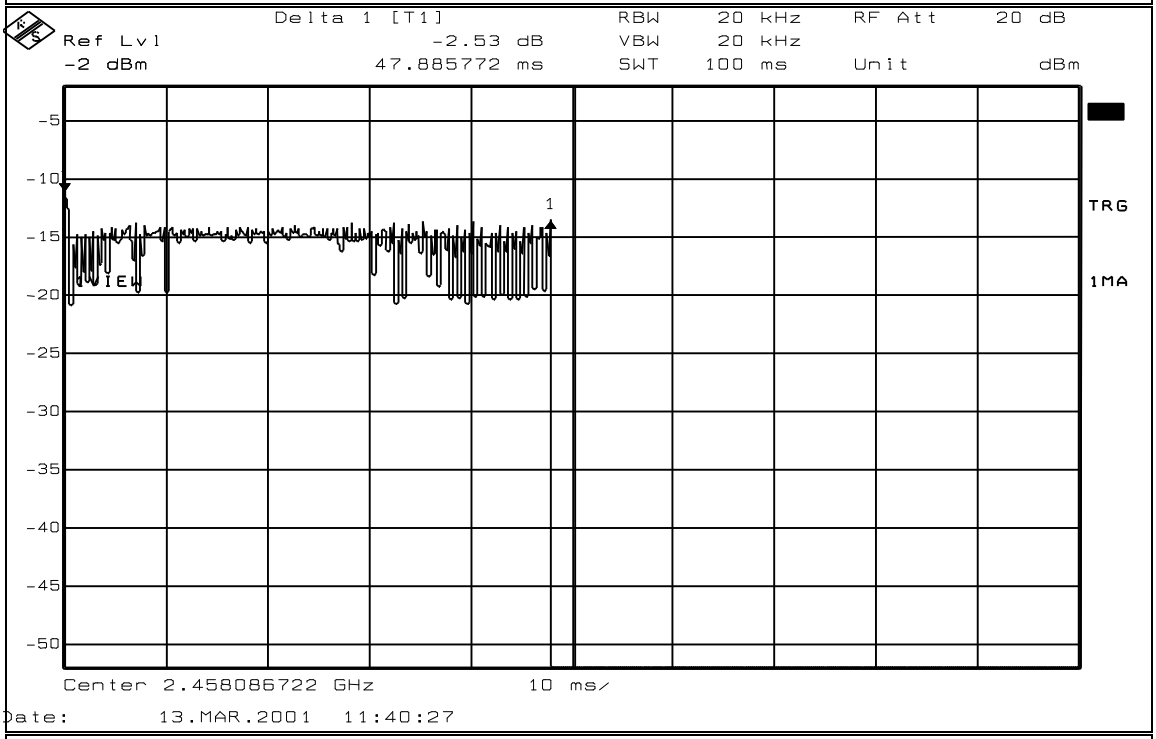
144 mS total ocupancy in 30 seconds

Test Data-Time of Occupancy

Data Plot Time of Occupancy

Page 2 of 2

Job No.: 0L0528R Date: 3/19/01
Specification: 15.2 Temperature(°C): 22
Tested By: David Light Relative Humidity(%) 50
E.U.T.: EZ Pro Hand
Configuration: Transmit modulated data



Notes: **1 PULSE =48 Ms (Base)**

Section 7. Occupied Bandwidth

NAME OF TEST: Occupied Bandwidth	PARA. NO.: 15.247(a)(1)(i)
TESTED BY: David Light	DATE:3/16/01

Test Results: Complies.

Measurement Data: See attached plots.

Measurement Uncertainty: +/- 0.7 dB

Test Data – Occupied Bandwidth

Data Plot **20 dB Bandwidth**

Page 1 of 3 Complete X

Job No.: 0L0528R Date: 3/16/01 Preliminary

Specification: 15.247 Temperature(°C): 22

Tested By: David Light Relative Humidity(%) 50

E.U.T.: EZ Pro

Configuration: Transmit modulated data

Sample Number: S08

Location: Lab 1 RBW: 3 kHz

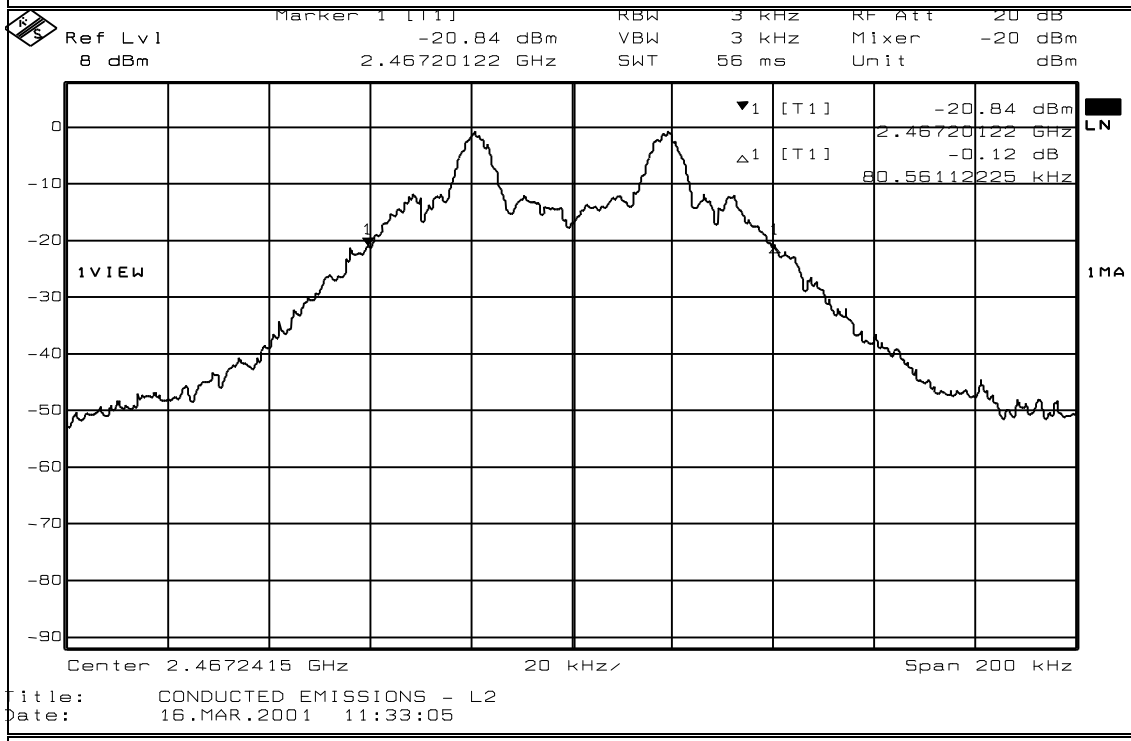
Detector Type: Peak VBW: 3 kHz

Test Equipment Used

Antenna:		Directional Coupler:	
Pre-Amp:		Cable #1:	1043
Filter:		Cable #2:	
Receiver:	1036	Cable #3:	
Attenuator #1		Cable #4:	
Attenuator #2:		Mixer:	

Additional equipment used: #802 Near Field Probe Set

Measurement Uncertainty: +/-3.6 dB



Notes: **Highest channel**

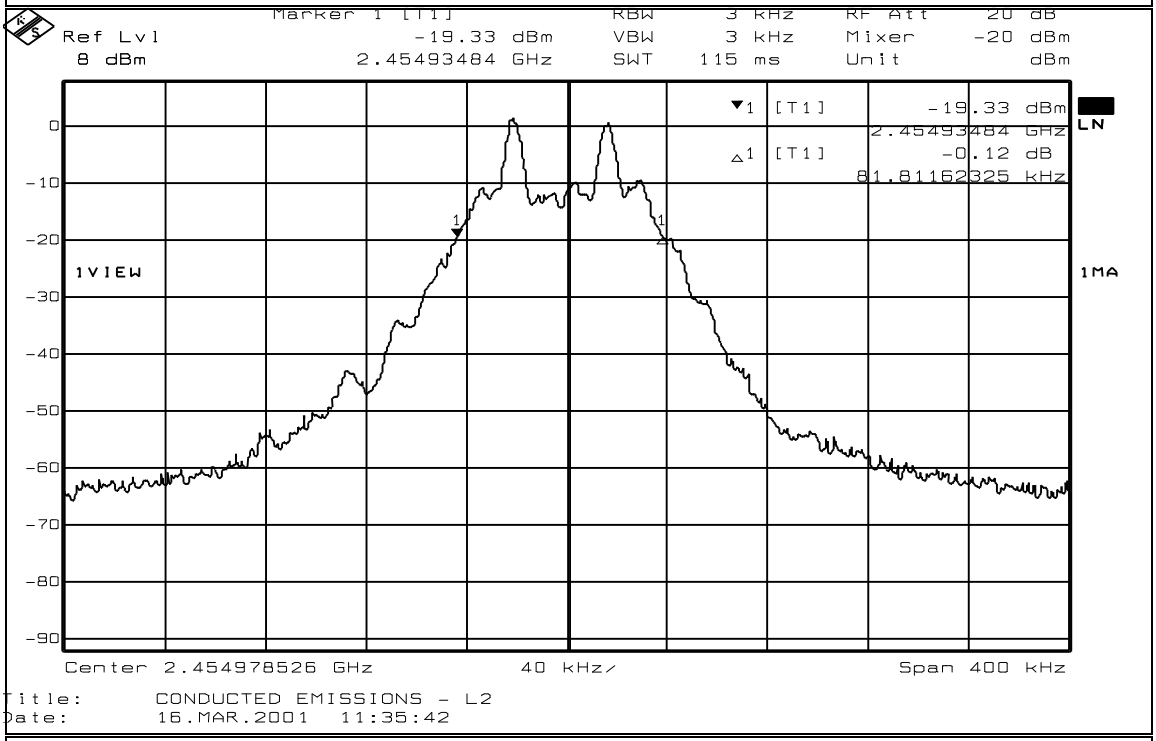
HOP GROUP 7 - CHANNEL 74

Test Data – Occupied Bandwidth

Data Plot 3 Bandwidth

Page 2 of 3

Job No.: 0L0528R Date: 3/16/01
Specification: 15.2 Temperature(°C): 22
Tested By: David Light Relative Humidity(%) 50
E.U.T.: EZ Pro
Configuration: Transmit modulated data



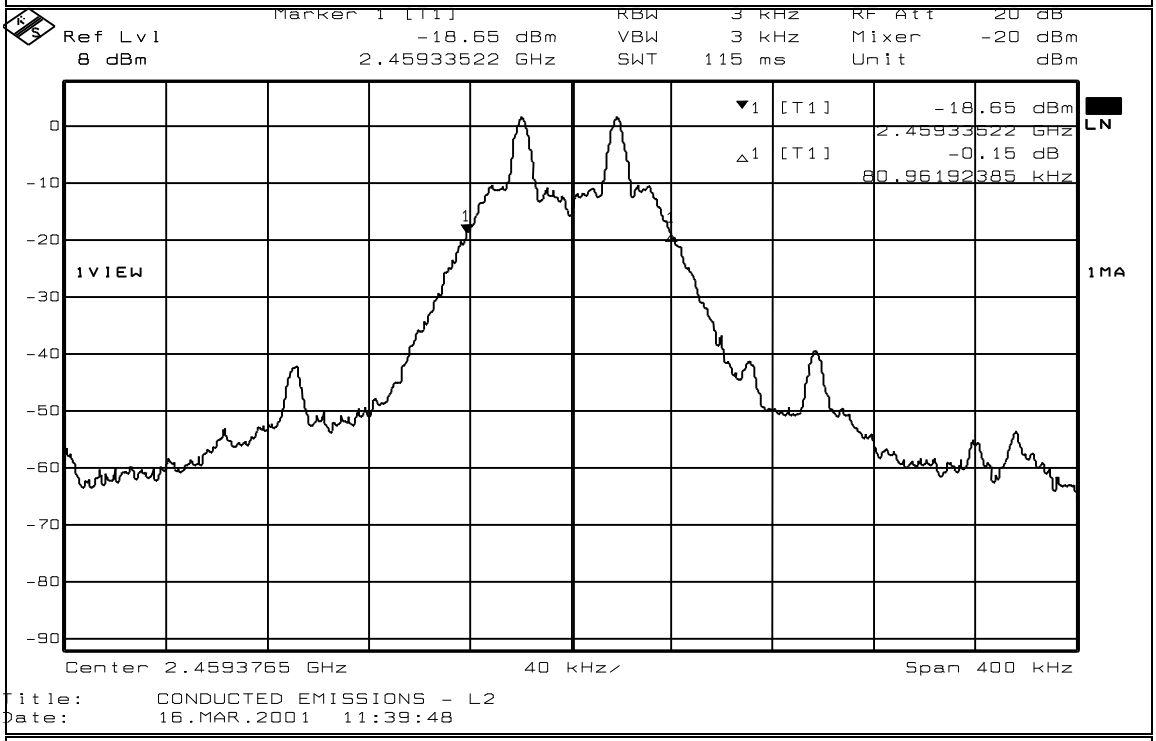
Notes: **Lowest Channel**
HOP GROUP 0 - CHANNEL 0

Test Data – Occupied Bandwidth

Data Plot **20 dB Bandwidth**

Page 3 of 3

Job No.: 0L0528R Date: 3/16/01
Specification: 15.247 Temperature(°C): 22
Tested By: David Light Relative Humidity(%) 50
E.U.T.: EZ Pro
Configuration: Transmit mo



Notes: **Mid Channel**
HOP GROUP 1 - CHANNEL 40

Section 8. Peak Power Output

NAME OF TEST: Peak Power Output	PARA. NO.: 15.247 (b)
TESTED BY: David Light	DATE: 3/14/01

Test Results: Complies.

Measurement Data: See attached plots.
Detachable antenna? ☐ Yes ☒ No
If yes, state the type of non-standard connector used:

Antennas: ///

Model	Type	**Manufacturer**	**Gain (dBi)**	**E.I.R.P. (dBm)**
Peak power output at antenna port(dBm):				

Note: Refer to measurement data in Section 10-Spurious Emissions (Radiated)

Measurement Uncertainty: +/- .7 dB

Section 9. Spurious Emissions (Antenna Conducted)

NAME OF TEST: Spurious Emissions (Antenna Conducted)	PARA. NO.: 15.247(c)
TESTED BY:	DATE:

Test Results: Not Applicable

Measurement Data: See attached plots.

Measurement Uncertainty: +/- 0.7 dB

Section 10. Spurious Emissions (Radiated)

NAME OF TEST: Spurious Emissions (Radiated)	PARA. NO.: 15.247(c)
TESTED BY: David Light	DATE:3/14/01

Test Results: Complies.

Measurement Data: See attached table.

Duty Cycle Calculation:

20 log(47.9mS/100mS) = <u>-6.4 dB</u> Duty Cycle Correction

Refer to plot for data

Measurement Uncertainty: +/- 0.7 dB

Test Data - Radiated Emissions (Restricted Bands)

Radiated Emissions

Page 1 of 1

Job No.: 0L0528R Date: 3/13/01
Specification: 15.247 Temperature(°C): 22
Tested By: David Light Relative Humidity(%) 50
E.U.T.: EZ PRO MOBILE
Configuration: TX AT LO, MID & HI CHANNELS
Sample Number:
Location: AC 3 RBW: 1 MHz
Detector Type: Peak VBW: 3 kHz

Test Equipment Used

Antenna: 993 Directional Coupler: #N/A
Pre-Amp: 1016 Cable #1: 1484
Filter: 1482 Cable #2: 1485
Receiver: 1036 Cable #3: #N/A
Attenuator #1 #N/A Cable #4: #N/A
Attenuator #2: #N/A Mixer: #N/A

Measurement Uncertainty: +/- 1.6 dB

Frequency (GHz)	Meter Reading (dBuV)	Antenna Factor (dB)	Cable Loss (dB)	Pre-Amp Gain (dB)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Comment
4.931	28.6	33.8	4.3	32.8	33.9	54	-20.1	Horizontal
7.397	25.8	35.9	5.3	33	34.0	54	-20.0	Horizontal - Noise Floor
12.328	27.2	40.2	7.3	36.7	38.0	54	-16.0	Horizontal - Noise Floor
4.931	32.1	33.8	4.3	32.8	37.4	54	-16.6	Vertical
7.397	38.2	35.9	5.3	33	46.4	54	-7.6	Vertical
12.328	28.3	40.2	7.3	36.7	39.1	54	-14.9	Vertical
4.91	28.1	33.8	4.3	32.8	33.4	54	-20.6	Horizontal
7.365	34.3	35.9	5.3	33	42.5	54	-11.5	Horizontal
12.274	27.2	40.2	7.3	36.7	38.0	54	-16.0	Horizontal - Noise Floor
4.91	32.7	33.8	4.3	32.8	38.0	54	-16.0	Vertical
7.365	36.4	35.9	5.3	33	44.6	54	-9.4	Vertical
12.274	28.3	40.2	7.3	36.7	39.1	54	-14.9	Vertical
4.916	34	33.8	4.3	32.8	39.3	54	-14.7	Vertical
7.374	37.8	35.9	5.3	33	46.0	54	-8.0	Vertical
12.29	28.5	40.2	7.3	36.7	39.3	54	-14.7	Vertical
4.916	27.8	33.8	4.3	32.8	33.1	54	-20.9	Horizontal
7.374	34.4	35.9	5.3	33	42.6	54	-11.4	Horizontal
12.29	27.2	40.2	7.3	36.7	38.0	54	-16.0	Horizontal - Noise Floor

Notes: -6 dB correction added to meter reading

Test Data - Radiated Emissions

Field Strength of Spurious Emissions

Page 1 of 1 — Complete X — Preliminary

Job No.: 0L0528R — Date: 3/12/01
Specification: 15.247 — Temperature(°C): 22
Tested By: Tom Tidwell — Relative Humidity(%) 50
E.U.T.: MOBILE UNIT
Configuration: TX FULL POWER - LYING ON BACK (WORST CASE)
Sample No:
Location: AC 3 — RBW: 1 MHz — Measurement
Detector Type: Peak — VBW: 30 kHz — Distance: 3 m

Test Equipment Used

Antenna: 993 — Directional Coupler:
Pre-Amp: — Cable #1: 1484
Filter: — Cable #2: 1485
Receiver: 1036 — Cable #3:
Attenuator #1 — Cable #4:
Attenuator #2: — Mixer:
Additional equipment used:
Measurement Uncertainty: +/-3.6 dB

Frequency (MHz)	Meter Reading (dBm)	Correction Factor (dB)		Pre-Amp Gain (dB)	Substitution Antenna Gain (dBd)	Limit (dBm)	ERP (dBm)	ERP (mW)	Polarity	Comments
2455	-35.4	34.1		0	6.9	36.0	5.5	3.548134	V	CARRIER - LO CH.
9819.6	-50.0	40.4		36.3	10.5	-15.6	-35.4	0.000291	V	NOISE FLOOR
14729.4	-47.2	48.1		34.1	10.1	-15.6	-23.1	0.004909	V	NOISE FLOOR
17184.3	-50.2	47.0		34.5	11.7	-15.6	-25.9	0.002547	V	NOISE FLOOR
2454.9	-24.3	36.7		0	6.9	36.0	19.2	83.752928	H	CARRIER - LO CH.
9819.6	-48.1	42.6		36.3	10.5	-15.6	-31.3	0.000745	H	
14729.4	-47.2	48.7		34.1	10.1	-15.6	-22.5	0.005610	H	NOISE FLOOR
17184.3	-50.2	50.5		34.5	11.7	-15.6	-22.5	0.005662	H	NOISE FLOOR
2458.1	-24.4	36.7		0	6.9	36.0	19.1	81.846479	H	CARRIER - MID CH.
9832.4	-50.0	42.6		36.3	10.5	-15.6	-33.2	0.000481	H	NOISE FLOOR
14748.5	-47.0	48.7		34.1	10.1	-15.6	-22.3	0.005875	H	NOISE FLOOR
17206.6	-50.0	50.5		34.5	11.7	-15.6	-22.3	0.005929	H	NOISE FLOOR
2458.1	-35.7	34.1		0	6.9	36.0	5.2	3.311311	V	CARRIER - MID CH.
9832.4	-50.0	40.4		36.3	10.5	-15.6	-35.4	0.000291	V	NOISE FLOOR
14748.5	-47.0	48.1		34.1	10.1	-15.6	-22.9	0.005140	V	NOISE FLOOR
17206.6	-50.0	47.0		34.5	11.7	-15.6	-25.7	0.002667	V	NOISE FLOOR
2465.55	-36.5	34.1		0	6.9	36.0	4.4	2.754229	V	CARRIER - HI CH.
9862.2	-50.0	40.4		36.3	10.5	-15.6	-35.4	0.000291	V	NOISE FLOOR
14793.3	-47.0	48.1		34.1	10.1	-15.6	-22.9	0.005140	V	NOISE FLOOR
17258.9	-50.0	47.0		34.5	11.7	-15.6	-25.7	0.002667	V	NOISE FLOOR
2465.55	-24.1	36.7		0	6.9	36.0	19.4	87.700082	H	CARRIER - HI CH.
9862.2	-50.0	42.6		36.3	10.5	-15.6	-33.2	0.000481	H	NOISE FLOOR
14793.3	-47.0	48.7		34.1	10.1	-15.6	-22.3	0.005875	H	NOISE FLOOR
17258.9	-50.0	50.5		34.5	11.7	-15.6	-22.3	0.005929	H	NOISE FLOOR

Notes: SCANNED HARMONICS OF CARRIER TO THE 10TH HARMONIC EXCLUDING THOSE FREQUENCIES THAT FALL IN THE RESTRICTED BANDS OF OPERATION PER 15.205 (Limit is -20 dBc from lowest carrier measured)

Test Data – Duty Cycle

Data Plot DUTY CYCLE

Page 1 of 1 Complete X

Job No.: 0L0528R Date: 3/13/01 Preliminary

Specification: 15.247 Temperature(°C): 22

Tested By: David Light Relative Humidity(%) 50

E.U.T.: EZ PRO - MOBILE

Configuration: HOPPING

Sample Number:

Location: Lab 2 RBW: Refer to plots

Detector Type: Peak VBW: Refer to plots

Test Equipment Used

Antenna: Directional Coupler:

Pre-Amp: Cable #1: 1043

Filter: Cable #2:

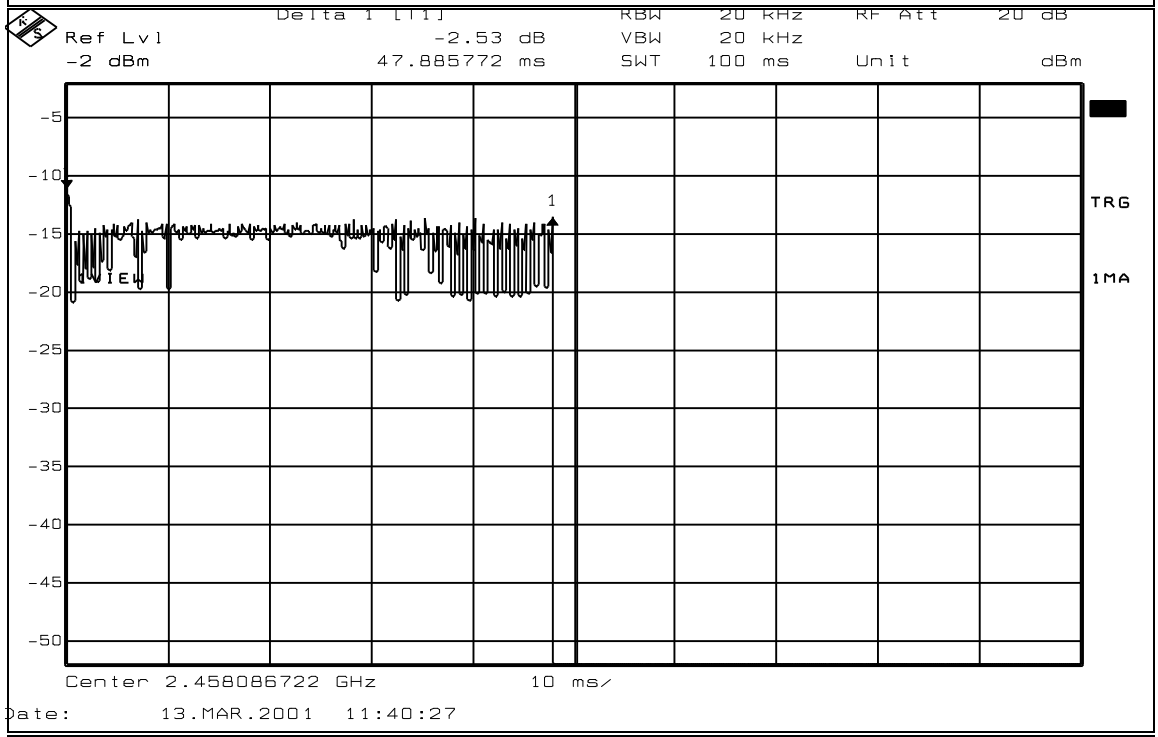
Receiver: 1036 Cable #3:

Attenuator #1 Cable #4:

Attenuator #2: Mixer:

Additional equipment used: NEAR FIELD PROBE #802

Measurement Uncertainty: +/-3.6 dB



Notes: **20 log(47.9mS/100mS) = -6.4 dB Duty Cycle Correction**

Radiated Photographs (Worst Case Configuration)

FRONT VIEW

REAR VIEW

Section 11. Test Equipment List

ASSET	Description	Manufacturer Model Number	Serial Number	Cal. Date	Cal. Due
993	Horn antenna	A.H. Systems SAS-200/571	XXX	07/16/99	07/16/01
1036	SPECTRUM ANALYZER	ROHDE & SCHWARZ FSEK30	830844/006	06/14/99	06/14/01
1043	Flexable cable 1m	Astrolab Inc. 32027-2-29094K-1M	0	01/29/01	01/29/02
802	Near Field Probe Set	EMCO 7405	103	CNR	CNR
1482	Band Pass Filter	K & L 11SH10-4000/T12000-0/0	2	Cal B4 Use	N/A
1016	AMPLIFIER	HEWLETT PACKARD 8449A	2749A00159	05/24/00	05/24/01
1484	Cable 2.0-18.0 Ghz	Storm PR90-010-072	N/A	05/25/00	05/25/01
1485	Cable 2.0-18.0 Ghz	Storm PR90-010-216	N/A	05/25/00	05/25/01

ANNEX A - TEST DETAILS

NAME OF TEST: Powerline Conducted Emissions	PARA. NO.: 15.207(a)

Minimum Standard: The R.F. that is conducted back onto the AC power line on any frequency within the band 0.45 to 30 MHz shall not exceed 250µV (48 dBµV) across 50 ohms.

NAME OF TEST: Channel Separation	PARA. NO.: 15.247(a)(1)

Minimum Standard: Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

NAME OF TEST: Pseudorandom Hopping Algorithm	PARA. NO.: 15.247(a)(1)

Minimum Standard: The system shall hop to channel frequencies that are selected from a pseudorandomly ordered list of hopping frequencies. Each frequency must be used equally on average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their transmitters and shall shift frequencies in synchronization with the transmitted signals.

NAME OF TEST: Time of Occupancy PARA. NO.: 15.247(a)(1)(ii)

Minimum Standard:

Frequency Band (MHz)	20 dB Bandwidth	No. of Hopping Channels	Average Time of Occupancy
902 - 928	<250 kHz	50	=<0.4 sec. in 20 sec.
902 – 928	=>250 kHz	25	=<0.4 sec. in 10 sec.
2400 – 2483.5	-----	75	=<0.4 sec. in 30 sec.
5725 – 5850	-----	75	=<0.4 sec. in 30 sec.

Method Of Measurement:

The spectrum analyzer is set as follows:

RBW: 1 MHz
VBW: = RBW
Span: 0 Hz
LOG dB/div.: 10 dB
Sweep: Sufficient to see one hop time sequence.
Trigger: Video

The occupancy time of one hop is measured as above. The average time of occupancy is calculated over the appropriate period of time from above table (10, 20, or 30 seconds).

Avg. time of occupancy = (period from table/duration of one hop)/no. of channels multiplied by the duration of one hop.

For instance:

If a 2.4 GHz system has a measured hop duration time of 1 msec. and uses 75 channels, then the average time of occupancy would be:

(30 sec./.001 sec.)/75 chan. = 400 x 1 msec. = 400 msec. or 0.4 sec. in 30 sec.

NAME OF TEST: Occupied Bandwidth	PARA. NO.: 15.247(a)(2)

Minimum Standard:

Frequency Band (MHz)	Maximum 20 dB Bandwidth
902 - 928	500 kHz
2400 – 2483.5	1 MHz
5725 – 5850	1 MHz

Method Of Measurement:

The spectrum analyzer is set as follows:

RBW: At least 1% of span/div.
VBW: >RBW
Span: Sufficient to display 20 dB bandwidth
LOG dB/div.: 10 dB
Sweep: Auto

Number of channels tested:

Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

NAME OF TEST: Peak Power Output PARA. NO.: 15.247(b)

Minimum Standard:

Frequency Band (MHz)	No. of Hopping Channels	Maximum Peak Power Output at Antenna Port
902 - 928	at least 50	1 watt
902 – 928	25 - 49	0.25 watts
2400 – 2483.5	75	1 watt
5725 – 5850	75	1 watt

If transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point to point operation may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceed 6 dBi.

Systems operating in the 5725 – 5850 MHz band that are used exclusively for fixed, point-to-point operation may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

Direct Measurement Method For Detachable Antennas:
If the antenna is detachable, a peak power meter is used to measure the power output with the transmitter operating into a 50 ohm load. The dBi gain of the antenna(s) employed shall be reported.

Calculation Of EIRP For Integral Antenna:

If the antenna is not detachable from the circuit then the Peak Power Output is derived from the peak radiated field strength of the fundamental emission by using the plane wave relation $GP/4\pi R^2 = E^2/120\pi$ and proceeding as follows:

$$P = \frac{E^2 R^2}{30G} = \frac{E^2 3^2}{30G}$$

where,

P = the equivalent isotropic radiated power in watts
E = the maximum measured field strength in V/m
R = the measurement range (3 meters)
G = the numeric gain of the transmit antenna in relation to an isotropic radiator

The RBW of the spectrum analyzer shall be set to a value greater than the measured 20 dB occupied bandwidth of the E.U.T.

Number of channels tested:

Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

NAME OF TEST: Spurious Emissions at Antenna Terminals PARA. NO.: 15.247(c)

Minimum Standard: In any 100kHz bandwidth outside the frequency band in which the transmitter is operating, emissions shall be at least 20 dB below the fundamental emission or shall not exceed the following field strength limits. Emissions falling in the restricted bands of 15.205 shall not exceed the following field strength limits:

Frequency (MHz)	Field Strength (µV/m @ 3m)	Field Strength (dB @ 3m)
30 - 88	100	40.0
88 - 216	150	43.5
216 - 960	200	46.0
Above 960	500	54.0

THE SPECTRUM WAS SEARCHED TO THE 10th HARMONIC

Method Of Measurement:

30 MHz - 10th harmonic plot
RBW: 100 kHz
VBW: 300 kHz
Sweep: Auto
Display line: -20 dBc

Lower Band Edge
RBW: At least 1% of span/div.
VBW: >RBW
Span: As necessary to display any spurious at band edge.
Sweep: Auto
Center Frequency: 902 MHz, 2400 MHz, or 5725 MHz
Marker: Peak of fundamental emission
Marker Δ: Peak of highest spurious level below center frequency.

Upper Band Edge
RBW: At least 1% of span/div.
VBW: >RBW
Span: As necessary to display any spurious at band edge.
Sweep: Auto
Center Frequency: 928 MHz, 2483.5 MHz, or 5850 MHz
Marker: Peak of fundamental emission
Marker Δ: Peak of highest spurious level above center frequency.

Number of channels tested:

Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

NAME OF TEST: Radiated Spurious Emissions PARA. NO.: 15.247(c)

Minimum Standard: In any 100kHz bandwidth outside the frequency band in which the transmitter is operating, emissions shall be at least 20 dB below the fundamental emission or shall not exceed the following field strength limits:

Emissions falling in the restricted bands of 15.205 shall not exceed the following field strength limits:

Frequency (MHz)	Field Strength (mV/m @ 3m)	Field Strength (dB @ 3m)
30 - 88	100	40.0
88 - 216	150	43.5
216 - 960	200	46.0
Above 960	500	54.0

THE SPECTRUM WAS SEARCHED TO THE 10th HARMONIC

15.205 Restricted Bands

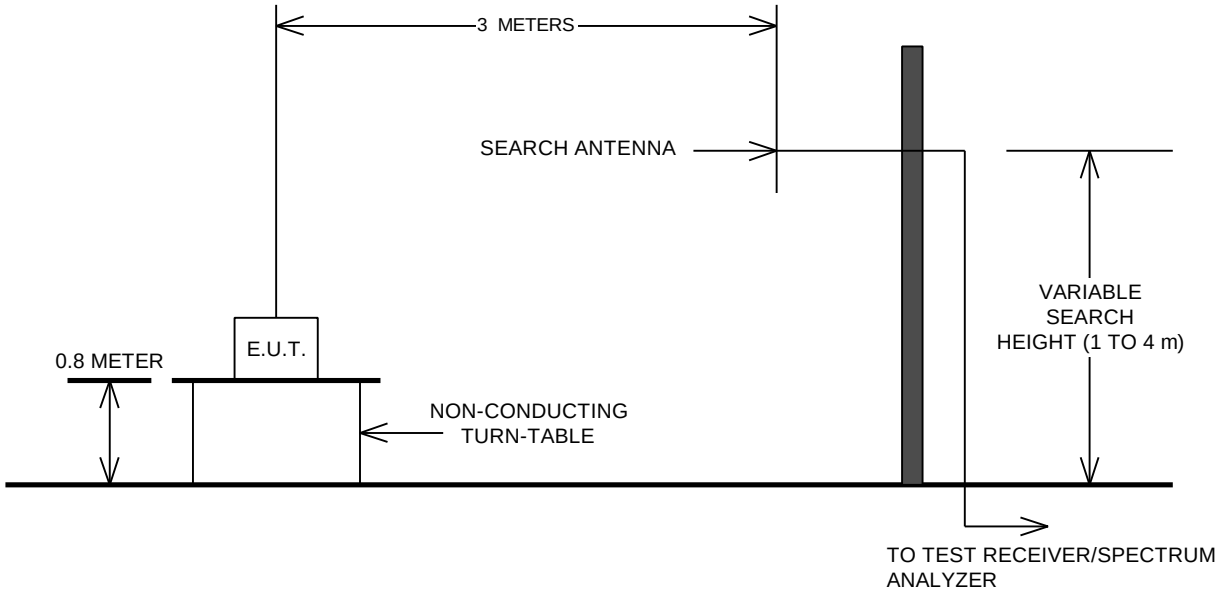
MHz	MHz	MHz	GHz
0.09-0.11	16.42-16.423	399.9-410	4.5-5.25
0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.125-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2655-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41	1718		

Number of channels tested:

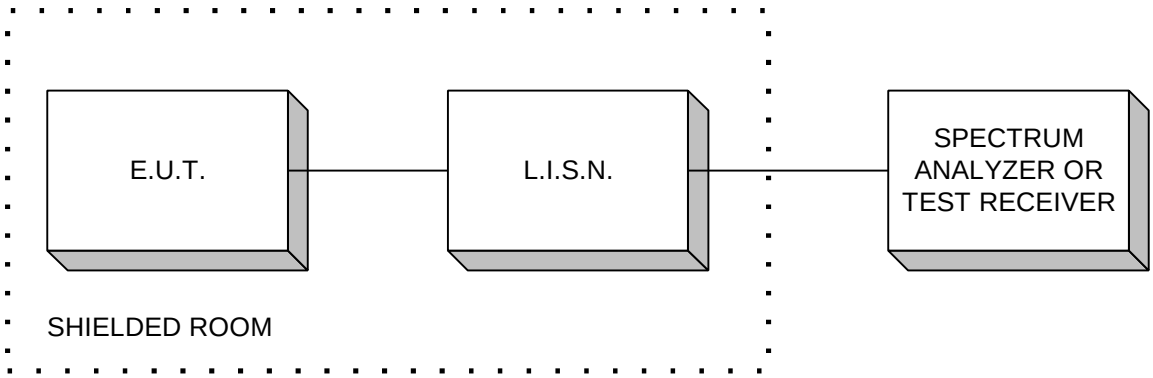
Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

ANNEX B - TEST DIAGRAMS

Test Site For Radiated Emissions



Conducted Emissions



Peak Power At Antenna Terminals