

**Nemko Test Report:** 2L0439RUS1

**Applicant:** Graviton  
9820 Towne Centre Drive  
San Diego, CA 92121

**Equipment Under Test:** DART-2400RT  
(E.U.T.) Model#: 0225

**In Accordance With:** FCC Part 15, Subpart C, 15.247  
Direct Sequence Spread Spectrum Transmitters

**Tested By:** Nemko Dallas Inc.  
802 N. Kealy  
Lewisville, Texas 75057-3136

**Authorized By:**



Tom Tidwell, RF Group Manager

**Date:** 10/4/2002

**Total Number of Pages:** 37

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**Section 1. Summary of Test Results**

Manufacturer: Graviton

Name: DART-2400RT

Model No.: 0225

Serial No.: Unit 4

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 Direct Sequence Spread Spectrum devices. Radiated tests were conducted in 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

**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. None  
See "Summary of Test Data".

**NVLAP LAB CODE: 100426-0**

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**Summary Of Test Data**

NAME OF TEST	PARA. NO.	SPEC.	RESULT
Powerline Conducted Emissions	15.207(a)	48 dB $\mu$ V	Complies
Minimum 6 dB Bandwidth	15.247(a)(2)	>500 kHz	Complies
Maximum Peak Power Output	15.247(b)(1)	<1 Watt	Complies
Spurious Emissions (Antenna Conducted)	15.247(c)	-20 dBc/100kHz	N/A
Spurious Emissions (Restricted Bands)	15.247(c)	< 74 dBuV/m Peak < 54 dBuV/m Avg	Complies
Peak Power Spectral Density	15.247(d)	+8 dBm/3kHz	Complies

**Footnotes:**

The device is DC powered but was tested with the AC adapter provided by client

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FCC PART 15, SUBPART C

DIRECT SEQUENCE SPREAD SPECTRUM TRANSMITTER

*EQUIPMENT: DART-2400RT Model#: 0225*

PROJECT NO.: **2L0439RUS1**

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

### **General Equipment Information**

**Frequency Band:**

- 902 – 928 MHz
- 2400 – 2483.5 MHz
- 5725 – 5850 MHz

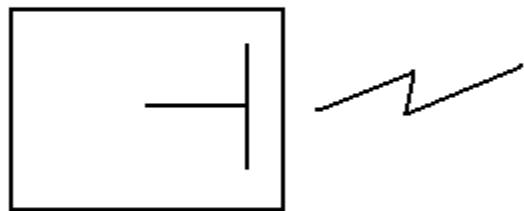
**User Frequency Adjustment:**

Software controlled

## Theory of Operation

The DART product is an RS-232 to RF translator designed to interface to a serial device. The radio operates in the 2.4 GHz band and is powered by a 10 - 30 VDC power supply. Any RS232 data received on the RX pin will be transmitted via the radio to a Graviton Multi-Services Gateway (MSG). Any data received from an MSG via the radio will be retransmitted on the TX pin on the serial interface.

## System Diagram



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DIRECT SEQUENCE SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: DART-2400RT Model#: 0225

PROJECT NO.: 2L0439RUS1

### **Section 3. Minimum 6 dB Bandwidth**

NAME OF TEST: Minimum 6 dB Bandwidth	PARA. NO.: 15.247(a)(2)
TESTED BY: David Light	DATE: 8/23/2002

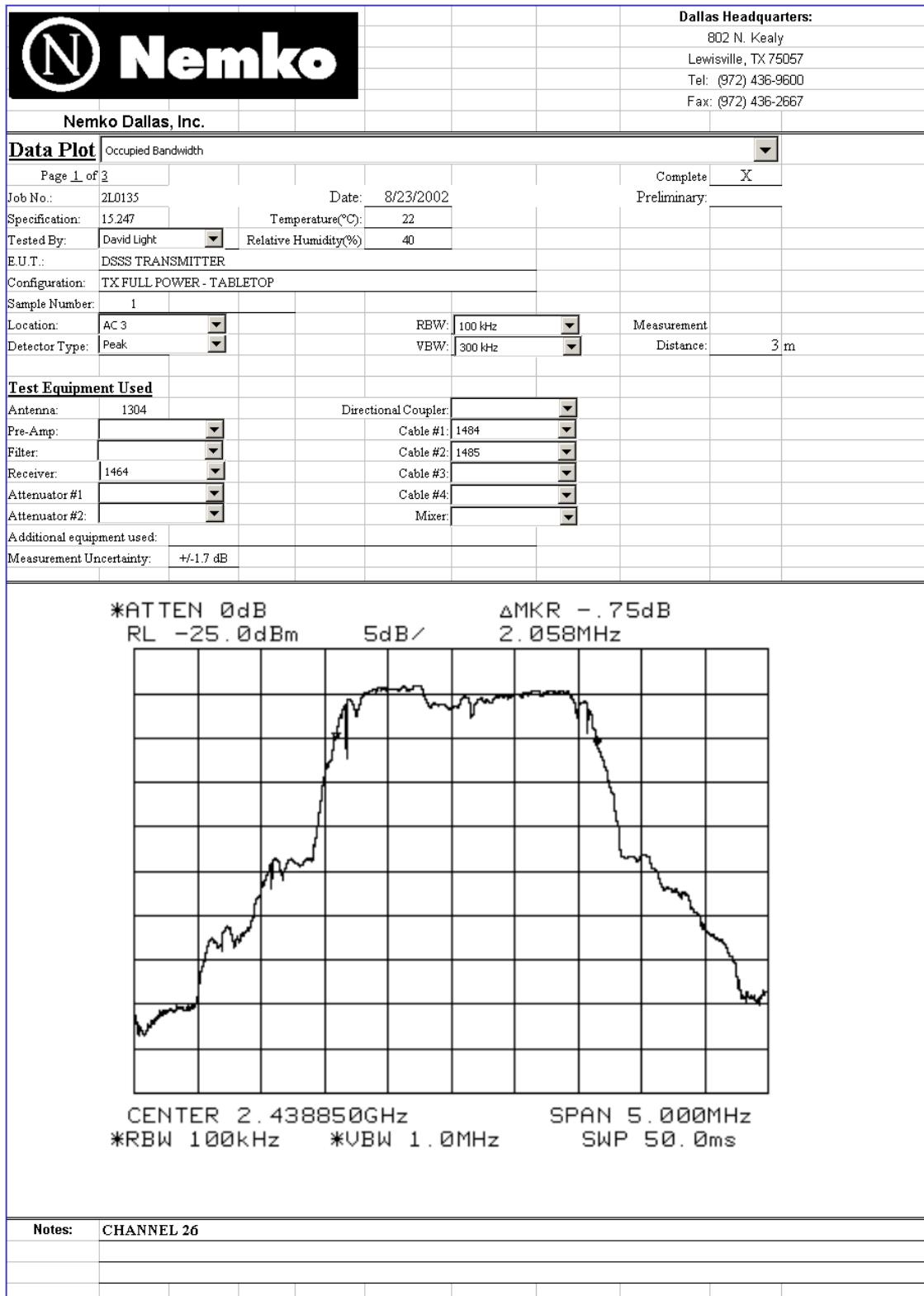
**Test Results:** Complies.

**Measurement Data:** See 6 dB BW plot  
Measured 6 dB bandwidth: 2.158 MHz

**Equipment Used:** 1464-1484-1485-1304

**Measurement Uncertainty:** +/- 0.7 dB

## Test Plots – 6 dB Bandwidth

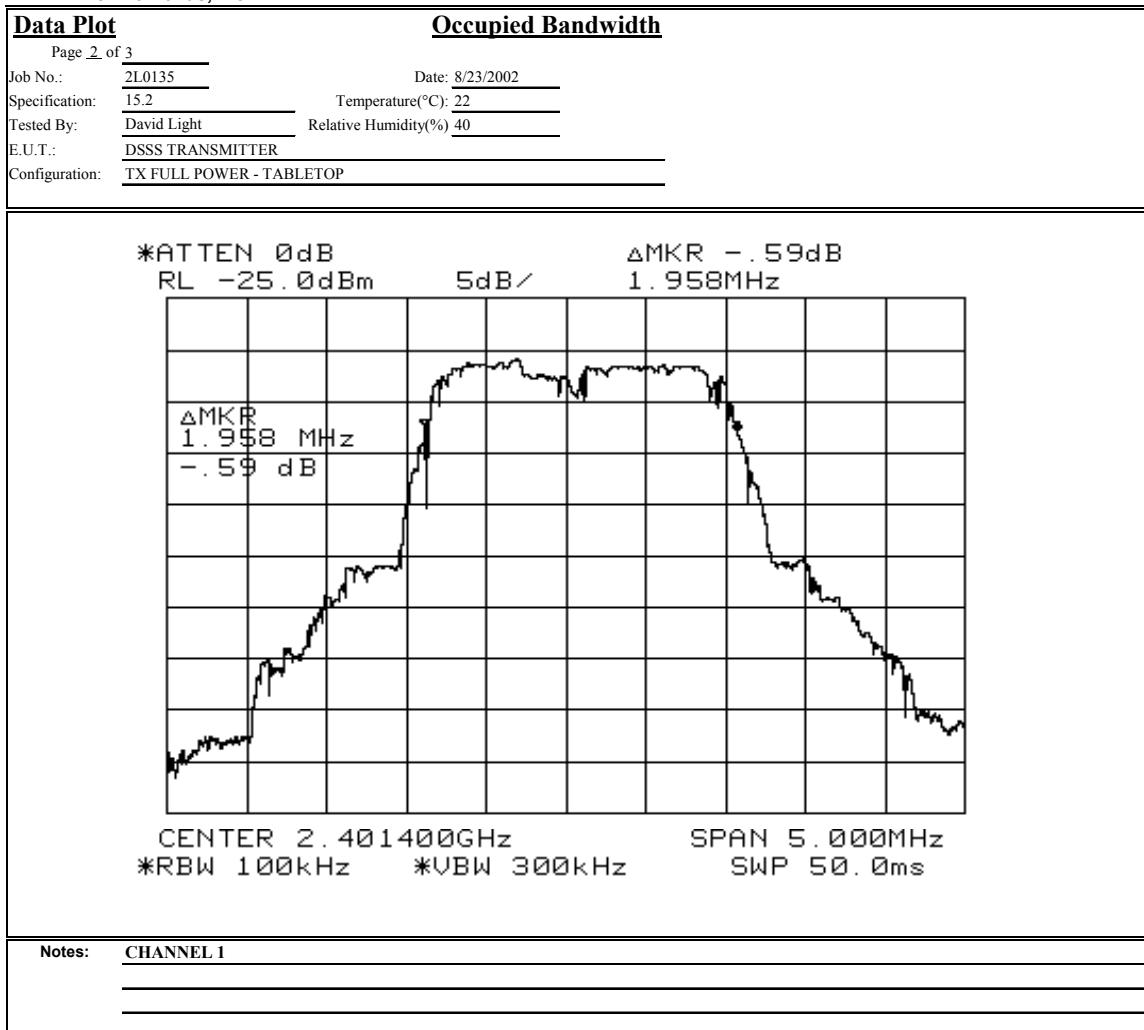


## Test Plots – 6 dB Bandwidth



Dallas Headquarters:  
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Tel: (972) 436-9600  
Fax: (972) 436-2667

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DIRECT SEQUENCE SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: DART-2400RT Model#: 0225 PROJECT NO.: 2L0439RUS1

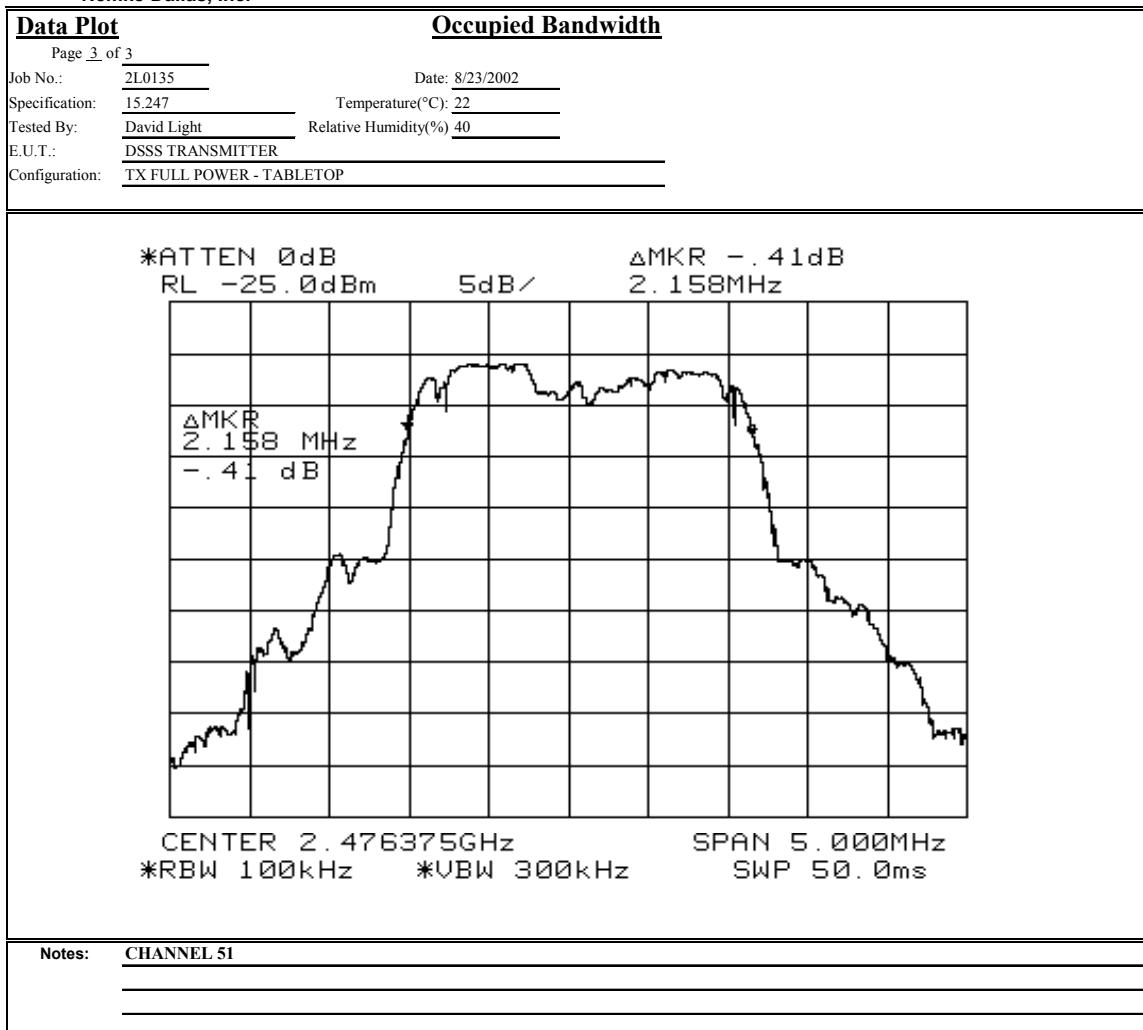
**Test Plots – 6 dB Bandwidth**



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DIRECT SEQUENCE SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: **DART-2400RT Model#:** 0225

PROJECT NO.: **2L0439RUS1**

## **Section 4. Maximum Peak Output Power**

NAME OF TEST: Maximum Peak Output power	PARA. NO.: 15.247(b)(1)
TESTED BY: David Light	DATE: 8/23/2002

**Test Results:** Complies.

**Measurement Data:** Data taken radiated

**Antennas:** Integral

The rf power output was monitored over the entire 10 V – 30 Vdc range and no variation in rf power output was noted.

Measurement Uncertainty: +/- 0.7 dB

## Test Data – Power Output

 Nemko Dallas, Inc.		<b>Dallas Headquarters:</b> 802 N. Kealy Lewisville, TX 75057 Tel: (972) 436-9600 Fax: (972) 436-2667								
<b>Peak Power (EIRP)</b>										
Page <u>1</u> of 1		Job No.: 2L0135R		Date: 8/23/2002		Complete <input checked="" type="checkbox"/> X		Preliminary <input type="checkbox"/>		
Specification: 15.247(b)		Temperature(°C): 24								
Tested By: David Light		Relative Humidity(%) 40								
E.U.T.: DSSS TRANSMITTER										
Configuration: Tabletop - Tx full power										
Sample No:										
Location: AC 3		RBW: 5 MHz				Measurement				
Detector Type: Peak		VBW: 5 MHz				Distance: 3 m				
<b>Test Equipment Used</b>										
Antenna: 1304		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 (dBi)		EIRP (dBm)	EIRP (mW)	Polarity	Comments
										Channel 51
										Highest allowable channel
2476.47	-28.5	37.0		0	8.9		17.4	54.95	H	
2476.47	-26.2	34.2		0	8.9		16.9	48.60	V	
										Channel 26
2439	-24.8	37.0		0	8.9		21.1	128.82	H	
2439	-25.3	34.2		0	8.9		17.8	59.80	V	
										Channel 1
										Lowest allowable channel
2401.53	-28.0	37.0		0	8.9		17.9	61.66	H	
2401.53	-28.9	34.2		0	8.9		14.2	26.10	V	
Notes: _____										

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DIRECT SEQUENCE SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: DART-2400RT Model#: 0225

PROJECT NO.: 2L0439RUS1

## Section 5. RF Exposure

NAME OF TEST: RF Exposure	PARA. NO.: 15.247(b)(4)
TESTED BY: David Light	DATE: 8/23/2002

**Test Results:** Complies.

**Antenna type:** Integral

**Measurement Data:** Attached



### Prediction of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density

P = power input to the antenna

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna

Maximum peak output power at antenna input terminal: 21.10 (dBm)

Maximum peak output power at antenna input terminal: 128.825 (mW)

Antenna gain(typical): 0 (dBi)

Maximum antenna gain: 1 (numeric)

Prediction distance: 20 (cm)

Prediction frequency: 2400 (MHz)

MPE limit for uncontrolled exposure at prediction frequency: 1 (mW/cm<sup>2</sup>)

Power density at prediction frequency: 0.025629 (mW/cm<sup>2</sup>)

**The device has an integral antenna.**

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DIRECT SEQUENCE SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: DART-2400RT Model#: 0225

PROJECT NO.: 2L0439RUS1

## **Section 6. Spurious Emissions (radiated)**

NAME OF TEST: Spurious Emissions	PARA. NO.: 15.247 (c)
TESTED BY: David Light	DATE: 8/23/2002

**Test Results:** Complies.

**Note:** The spectrum was searched 30 MHz to the 10<sup>th</sup> harmonic of the carrier frequency. All emissions within 20 dB of the specification limit were reported.

**Measurement Data:** See attached table.

**Duty Cycle Calculation:**

Duty Cycle correction factor(dB) =  $20 \log (\text{rf}_{\text{ON}} \text{ in ms} / 100\text{ms})$

**Measurement Uncertainty:** +/- 0.7 dB

## Test Data – Radiated Spurious Emissions



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Restricted Band Emissions								
Page 1 of 2								
Job No.:	2L0135R		Date: 8/23/02					
Specification:	15.247		Temperature(°C): 22					
Tested By:	David Light		Relative Humidity(%) 40					
E.U.T.:			DSS TRANSMITTER					
Configuration:			TABLE TOP - FULL POWER					
Sample Number:	1							
Location:	AC 3		RBW: 1 MHz					
Detector Type:	Refer to data		VBW: 1 MHz Peak / 10 Hz Average					
Test Equipment Used								
Antenna:	1304		Directional Coupler: #N/A					
Pre-Amp:	#N/A		Cable #1: 1484					
Filter:	1482		Cable #2: 1485					
Receiver:	1464		Cable #3: #N/A					
Attenuator #1	#N/A		Cable #4: #N/A					
Attenuator #2:	#N/A		Mixer: #N/A					
Additional equipment used:								
Measurement Uncertainty:	+/- .7 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
								Ch 51 (Highest)
2.4835	32.3	28.2	3.1	0.0	63.6	74	-10.4	Horizontal-Peak
2.4835	21.7	28.2	3.1	0.0	53.0	54	-1.0	Horizontal-Peak
4.9530	43.8	33.7	4.3	29.6	52.2	54	-1.8	Horizontal-Average
7.4290	42.5	36.2	5.5	34.1	50.1	54	-3.9	Horizontal-Average
12.3820	42.7	39.9	7.3	32.7	57.2	74	-16.8	Horizontal-Peak
12.3820	31.3	39.9	7.3	32.7	45.8	54	-8.2	Horizontal-Average
2.4835	34.7	28.2	3.1	0.0	66.0	74	-8.0	Vertical-Peak
2.4835	22	28.2	3.1	0.0	53.3	54	-0.7	Vertical-Peak
4.9530	43.7	33.7	4.3	29.6	52.1	54	-1.9	Vertical-Average
7.4290	41.8	36.2	5.5	34.1	49.4	54	-4.6	Vertical-Average
12.3820	42.3	39.9	7.3	32.7	56.8	74	-17.2	Vertical-Peak
12.3820	31.5	39.9	7.3	32.7	46.0	54	-8.0	Vertical-Average
								Ch 1 (Lowest)
4.8020	44.8	33.2	4.2	30.1	52.1	54	-1.9	Vertical-Peak
12.0080	43.5	40.0	7.3	33.5	57.3	74	-16.7	Vertical-Peak
12.0080	31.8	40.0	7.3	33.5	45.6	54	-8.4	Vertical-Average
4.8020	43	33.2	4.2	30.1	50.3	54	-3.7	Horizontal-Peak
12.0080	43.3	40.0	7.3	33.5	57.1	74	-16.9	Horizontal-Peak
12.0080	31.7	40.0	7.3	33.5	45.5	54	-8.5	Horizontal-Average
Notes:								

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## FCC PART 15, SUBPART C

## DIRECT SEQUENCE SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: DART-2400RT Model#: 0225 PROJECT NO.: 2L0439RUS1

## Test Data – Radiated Spurious Emissions



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## ~~Radiated Spurious Emissions~~

Page 1 of

### Continuation Page

Job No.:

CEB 47, Part 15

Date: 5/1

Table I

Relative Humidity(%) 5

E.U.I..

## DSS TRANSMITTER

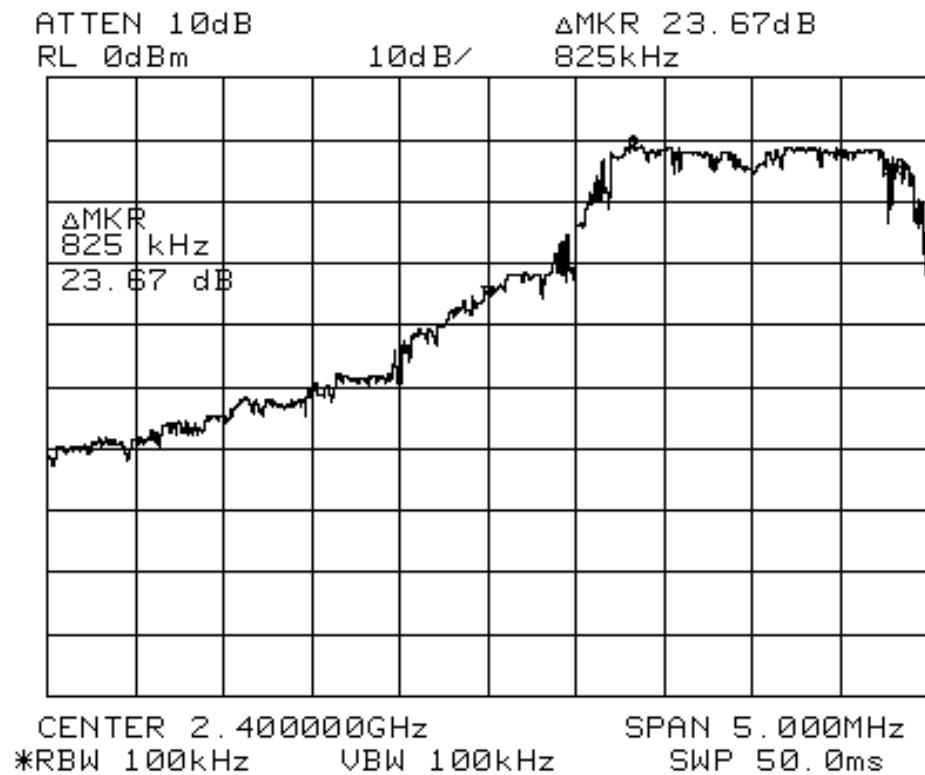
**Nemko Dallas**

FCC PART 15, SUBPART C

DIRECT SEQUENCE SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: DART-2400RT Model#: 0225 PROJECT NO.: 2L0439RUS1

**Test Plot – Lower band edge**



Lower Bandedge

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DIRECT SEQUENCE SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: DART-2400RT Model#: 0225 PROJECT NO.: 2L0439RUS1

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**Radiated Photographs (Worst Case Configuration)**



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DIRECT SEQUENCE SPREAD SPECTRUM TRANSMITTER

*EQUIPMENT: DART-2400RT Model#: 0225*

PROJECT NO.: **2L0439RUS1**

## **Section 7. Peak Power Spectral Density**

NAME OF TEST: Peak Power Spectral Density	PARA. NO.: 15.247(d)
TESTED BY: David Light	DATE: 8/23/2002

**Test Results:** Complies.

**Measurement Data:** See attached plots.

**Measurement Uncertainty:** +/- 0.7 dB

## Test Data – Peak Power Spectral Density



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<b>SPECTRAL DENSITY</b>											
Page <u>1</u> of 1				Complete <input checked="" type="checkbox"/> X							
Job No.:	2L0135			Date:	8/23/2002			Preliminary <input type="checkbox"/>			
Specification:	15.247			Temperature(°C):	22						
Tested By:	David Light			Relative Humidity(%)	40						
E.U.T.:	DSSS TRANSMITTER										
Configuration:	TX FULL POWER - TABLETOP										
Sample Number:	1			RBW:	3 kHz						
Location:	AC 3			VBW:	3 kHz			Measurement Distance <u>3</u> m			
Detector Type:	Peak										
<b>Test Equipment Used</b>											
Antenna:	1304			Directional Coupler:	#N/A						
Pre-Amp:	#N/A			Cable #1:	1484						
Filter:	#N/A			Cable #2:	1485						
Receiver:	1464			Cable #3:	#N/A						
Attenuator #1	#N/A			Cable #4:	#N/A						
Attenuator #2:	#N/A			Mixer:	#N/A						
Additional equipment used: _____											
Measurement Uncertainty: +/- .7 dB											
Frequency (GHz)	Meter Reading (dBm)	Antenna Factor (dB)	Cable Loss (dB)	Pre-Amp Gain (dB)	Conversion Factor	Corrected Reading (dBuV/m)	ERP (mW)	EIRP (dBm)	Polarity	Comments	
2.43885	-41.3	28.2	3.1	0	107.0	97	1.50	1.77	H	Mid channel	
2.4014	-43	28.2	3.1	0	107.0	95	1.02	0.07	H	Low channel	
2.476	-43.5	28.2	3.1	0	107.0	95	0.91	-0.43	H	High channel	
Notes: _____											

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DIRECT SEQUENCE SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: DART-2400RT Model#: 0225

PROJECT NO.: 2L0439RUS1

## **Section 8. Powerline Conducted Emissions**

NAME OF TEST: Powerline Conducted Emissions	PARA. NO.: 15.207(a)
TESTED BY: David Light	DATE: 8/29/2002

**Test Results:** Complies.

**Measurement Data:** See attached plots.

**Measurement Uncertainty:** +/- 1.7 dB

## Test Plots – Powerline Conducted Emissions



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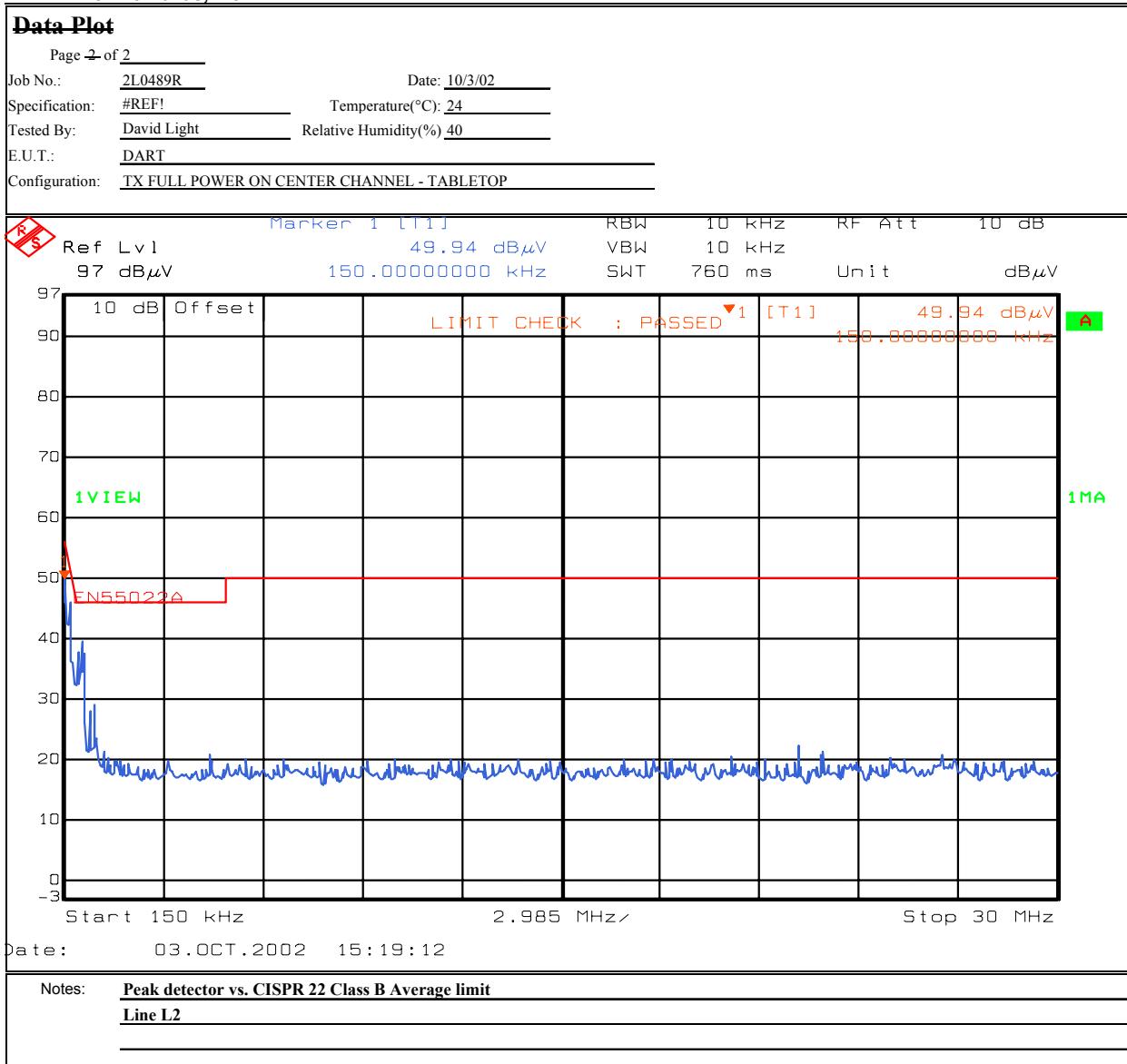
Data Plot		Powerline Conducted Emissions																																																																																																																																										
Page 1 of 2		Complete <input checked="" type="checkbox"/> X Preliminary _____																																																																																																																																										
Job No.:	2L0489R	Date: 10/3/02																																																																																																																																										
Name of Test:	Powerline Conducted Emissions	Temperature(°C):		24																																																																																																																																								
Tested By:	David Light	Relative Humidity(%):		40																																																																																																																																								
E.U.T.:	DART																																																																																																																																											
Configuration:	TX FULL POWER ON CENTER CHANNEL - TABLETOP																																																																																																																																											
Sample Number:	1																																																																																																																																											
Location:	Lab 5																																																																																																																																											
Detector Type:	Peak																																																																																																																																											
<b>Test Equipment Used</b>																																																																																																																																												
L.I.S.N.:	969	Directional Coupler:																																																																																																																																										
Limiter:	674	Cable #1:		1328																																																																																																																																								
Filter:	704	Cable #2:		1534																																																																																																																																								
Receiver:	1036	Cable #3:																																																																																																																																										
Attenuator #1	_____	Cable #4:																																																																																																																																										
Attenuator #2:	_____	Mixer:																																																																																																																																										
Additional equipment used: _____																																																																																																																																												
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<table border="1"> <tr> <td colspan="2">Ref Lvl</td> <td colspan="2">Marker 1 [111]</td> <td>RBW</td> <td>10 KHz</td> <td>RF Att</td> <td>10 dB</td> </tr> <tr> <td colspan="2">97 dB<math>\mu</math>V</td> <td colspan="2">48.83 dB<math>\mu</math>V</td> <td>VBW</td> <td>10 KHz</td> <td></td> <td></td> </tr> <tr> <td colspan="2"></td> <td colspan="2">150.00000000 KHz</td> <td>SWT</td> <td>760 ms</td> <td>Unit</td> <td>dB<math>\mu</math>V</td> </tr> <tr> <td>97</td> <td>10 dB</td> <td>Offset</td> <td></td> <td>LIMIT CHECK</td> <td>: PASSED ▼1</td> <td>[T1]</td> <td>48.83 dB<math>\mu</math>V</td> </tr> <tr> <td>90</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>150.00000000 KHz</td> </tr> <tr> <td>80</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>70</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>60</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>50</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>40</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>30</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>20</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>10</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>0</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>-3</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td colspan="2">Start 150 KHz</td> <td colspan="2">2.985 MHz</td> <td colspan="2">Stop 30 MHz</td> <td colspan="2"></td> <td></td> </tr> </table>												Ref Lvl		Marker 1 [111]		RBW	10 KHz	RF Att	10 dB	97 dB $\mu$ V		48.83 dB $\mu$ V		VBW	10 KHz					150.00000000 KHz		SWT	760 ms	Unit	dB $\mu$ V	97	10 dB	Offset		LIMIT CHECK	: PASSED ▼1	[T1]	48.83 dB $\mu$ V	90							150.00000000 KHz	80								70								60								50								40								30								20								10								0								-3								Start 150 KHz		2.985 MHz		Stop 30 MHz				
Ref Lvl		Marker 1 [111]		RBW	10 KHz	RF Att	10 dB																																																																																																																																					
97 dB $\mu$ V		48.83 dB $\mu$ V		VBW	10 KHz																																																																																																																																							
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Start 150 KHz		2.985 MHz		Stop 30 MHz																																																																																																																																								

## Test Plots – Powerline Conducted Emissions



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**Nemko Dallas**

FCC PART 15, SUBPART C

DIRECT SEQUENCE SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: DART-2400RT Model#: 0225 PROJECT NO.: 2L0439RUS1

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**Test Setup Photos – Powerline Conducted Emissions**



**Section 9. Test Equipment List**

Nemko ID	Description	Manufacturer Model Number	Serial Number	Calibration Date	Calibration Due
1464	Spectrum analyzer	Hewlett Packard 8563E	3551A04428	01/02/01	01/03/03
1484	Cable 2.0-18.0 Ghz	Storm PR90-010-072	N/A	07/15/02	07/15/03
1485	Cable 2.0-18.0 Ghz	Storm PR90-010-216	N/A	07/15/02	07/15/03
1016	Pre-Amp	HEWLETT PACKARD 8449A	2749A00159	07/15/02	07/15/03
1304	HORN ANTENNA	ELECTRO METRICS RGA-60	6151	07/30/01	07/31/03
1036	SPECTRUM ANALYZER	ROHDE & SCHWARZ FSEK30	830844/006	12/18/01	12/19/03
674	LIMITER	HP 11947A	3107A02200	CBU	N/A
969	lisn	Schwarzbeck 8120	8120281	08/09/02	08/09/03
704	FILTER, HIGH PASS, 5 KHz	SOLAR 7930-5.0	933126	01/17/02	01/17/03
1328	CABLE, .5m	KTL RG223	N/A	03/05/02	03/05/03
1534	CABLE, 9M	KTL RG223	NA	08/06/02	08/06/03

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FCC PART 15, SUBPART C

DIRECT SEQUENCE SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: DART-2400RT Model#: 0225

PROJECT NO.: **2L0439RUS1**

## **ANNEX A - TEST DETAILS**

**Nemko Dallas**

FCC PART 15, SUBPART C

DIRECT SEQUENCE SPREAD SPECTRUM TRANSMITTER

*EQUIPMENT: DART-2400RT Model#: 0225*

PROJECT NO.: **2L0439RUS1**

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 250 $\mu$ V (48 dB $\mu$ V) across 50 ohms.

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FCC PART 15, SUBPART C

DIRECT SEQUENCE SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: DART-2400RT Model#: 0225 PROJECT NO.: 2L0439RUS1

NAME OF TEST: Minimum 6 dB bandwidth

PARA. NO.: 15.247(a)(2)

**Minimum Standard:** The minimum 6 dB bandwidth shall be at least 500 kHz

NAME OF TEST: Maximum Peak Output Power

PARA. NO.: 15.247(b)(1)

**Minimum Standard:** The maximum peak output power shall not exceed 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

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FCC PART 15, SUBPART C

DIRECT SEQUENCE SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: **DART-2400RT Model#: 0225**PROJECT NO.: **2L0439RUS1**

The RBW of the spectrum analyzer shall be set to a value greater than the measured 6 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

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FCC PART 15, SUBPART C

DIRECT SEQUENCE SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: DART-2400RT Model#: 0225 PROJECT NO.: 2L0439RUS1

NAME OF TEST: RF Exposure

PARA. NO.: 15.247(b)(4)

**Minimum Standard:** Systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines stipulated in 1.1307(b)(1) of CFR 47.

NAME OF TEST: Spurious Emissions(conducted)

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 ( $\mu$ V/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 IS SEARCHED TO THE 10th HARMONIC OF THE HIGHEST FREQUENCY GENERATED IN THE EUT.**

**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  $\Delta$ : 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  $\Delta$ : 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 ( $\mu$ V/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

NAME OF TEST: Transmitter Power Density

PARA. NO.: 15.247(d)

**Minimum Standard:** The transmitted power density averaged over any 1 second interval shall not be greater than +8 dBm in any 3 kHz bandwidth.

**Method Of Measurement:** The spectrum analyzer is set as follows:

RBW: 3 kHz

VBW: >3 kHz

Span: => measured 6 dB bandwidth

Sweep: Span(kHz)/3 (i.e. for a span of 1.5 MHz the sweep rate is  $1500/3 = 500$  sec.

LOG dB/div.: 2 dB

**Note:** For devices with spectrum line spacing =< 3 kHz, the RBW of the analyzer is reduced until the spectral lines are resolved. The measurement data is normalized to 3 kHz by summing the power of all the individual spectral lines within a 3 kHz band in linear power units.

#### **For Devices With Integral Antenna:**

For devices with non-detachable antennas, the received field strength is peaked and the spectrum analyzer is set as above. The peak emission level is then measured and converted to a field strength by adding the appropriate antenna factor and cable loss. This field strength is then converted to an equivalent isotropic radiated power using the same method as described for Peak Power output.

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: Processing Gain

PARA. NO.: 15.247(e)

**Minimum Standard:** The processing gain shall be at least 10 dB.

**Method Of Measurement:** The CW jamming margin method was used to determine the processing gain. A CW signal generator is stepped across the passband of the receiver in 50 kHz increments. At each point the signal generator level required to obtain the recommended bit error rate is recorded. The jammer to signal ratio (J/S) is then calculated. The worst 20% of the J/S points is discarded. The lowest remaining J/S ratio is used to calculate the processing gain.

#### Calculation Of Processing Gain:

The processing gain was determined by measuring the jamming margin of the E.U.T. and using the following formula:

$$\text{Jamming Margin} = G_p - (S/N)_{\text{out}} - L_{\text{sys}}$$

For a receiver using non-coherent detection the value  $(S/N)_{\text{out}}$  is calculated using the formula:

$P_e = (1/2)\text{EXP}\{-E/2N_0\}$  where  $P_e$  is the probability of error (minimum Bit Error Rate required for proper operation).

$E/N_0$  is  $(S/N)_{\text{out}}$

for example, for a bit error rate of  $10^{-4}$  a S/N ratio of 12.3 dB is required.

$L_{\text{sys}}$  (system losses) is assumed to be 2 dB.

$$\text{Therefore } G_p = M_j + (S/N)_{\text{out}} + L_{\text{sys}}$$

Measurement performed at a channel in the center of the operating band of the EUT.

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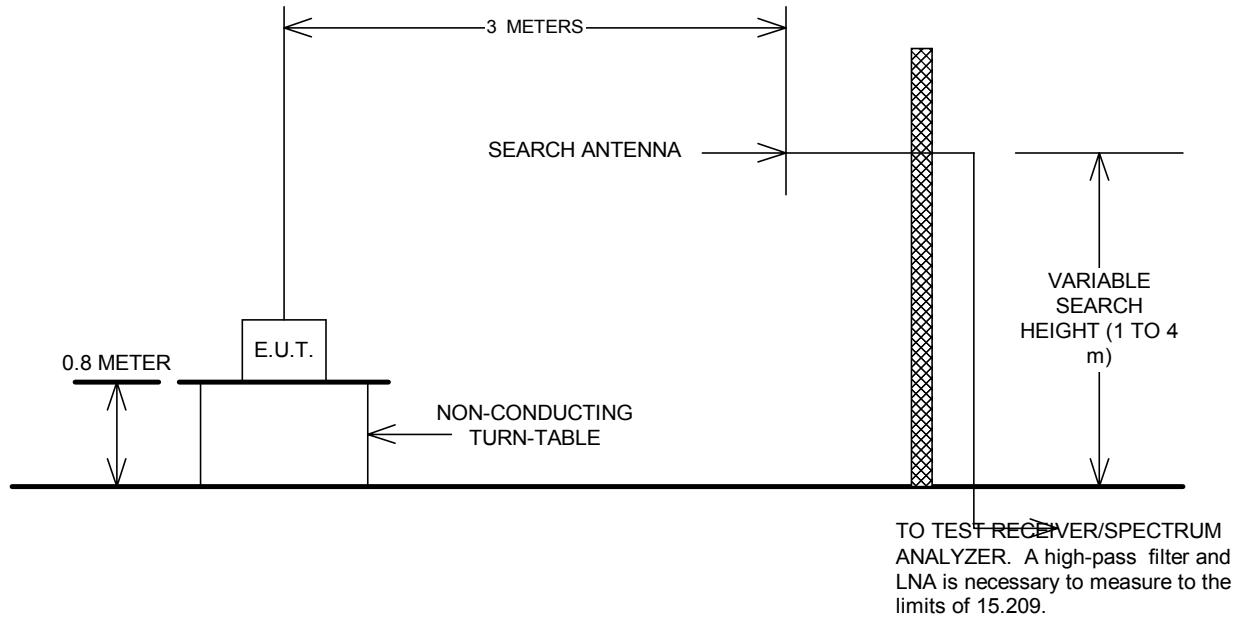
DIRECT SEQUENCE SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: DART-2400RT Model#: 0225

PROJECT NO.: **2L0439RUS1**

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**ANNEX B - TEST DIAGRAMS**

**Test Site For Radiated Emissions****Minimum 6 dB Bandwidth****Peak Power Spectral Density****Conducted Emissions**