Test Report:	1W03763
Applicant:	Critical Telecom 116 Research Drive, Suite 116 Saskatoon, Saskatchewan S7N 3R3
Equipment Under Test: (EUT)	Telepath Millennium 2.4
FCC ID:	NE9TM2001
In Accordance With:	**FCC Part 15, Subpart C** Direct Sequence Transmitters 902 - 928 MHz
Tested By:	Nemko Canada Inc. (Formerly KTL Ottawa Inc.) 3325 River Road, R.R. 5 Ottawa, Ontario K1V 1H2
Authorized By:	
	R. Grant, Wireless Group Manager
Date:	
Total Number of Pages:	32

Table Of Contents

Section 1. Summary Of Test Results..... 3

Section 2. General Equipment Specification..... 5

Section 3. Occupied Bandwidth..... 8

Section 4. Peak Power Output..... 12

Section 5. Spurious Emissions (Antenna Conducted)..... 13

Section 6. Spurious Emissions (Radiated)..... 17

Section 7. Transmitter Power Density..... 23

Section 8. Processing Gain..... 27

Section 9. Test Equipment List..... 29

Annex A Block Diagrams..... A1

Section 1. Summary Of Test Results

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 FCC Part 15, Subpart C, Paragraph 15.247 for Direct Sequence Spread Spectrum devices.

☒	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.
See " Summary of Test Data".

NVLAP LAB CODE: 100351-0

TESTED BY: _____ DATE: _____
Wayne Clarke, Wireless Technologist

Summary Of Test Data

Name Of Test	Para. No.	Result
Powerline Conducted Emissions	15.207 (a)	N/A
Occupied Bandwidth	15.247 (a)(2)	Complies
Peak Power Output	15.247 (b)	Complies
Spurious Emissions (Antenna Conducted)	15.247 (c)	Complies
Spurious Emissions (Radiated)	15.247 (c)	Complies
Transmitter Power Density	15.247 (d)	Complies
Processing Gain	15.247 (e)	Complies

Footnotes For N/A's: The EUT is powered by 12VDC.

Test Conditions:

Indoor Temperature: 22 °C
Humidity: 35 %

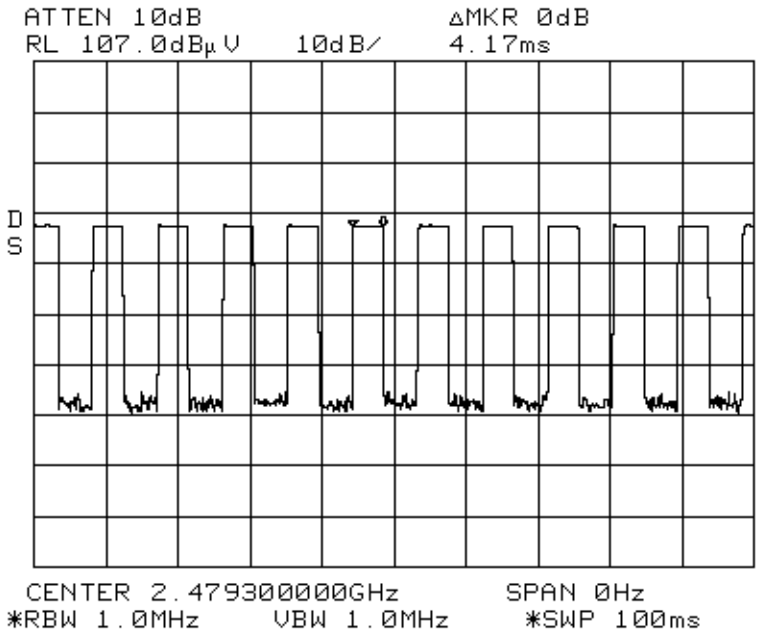
Outdoor Temperature: 12 °C
Humidity: 87 %

Section 2. General Equipment Specification

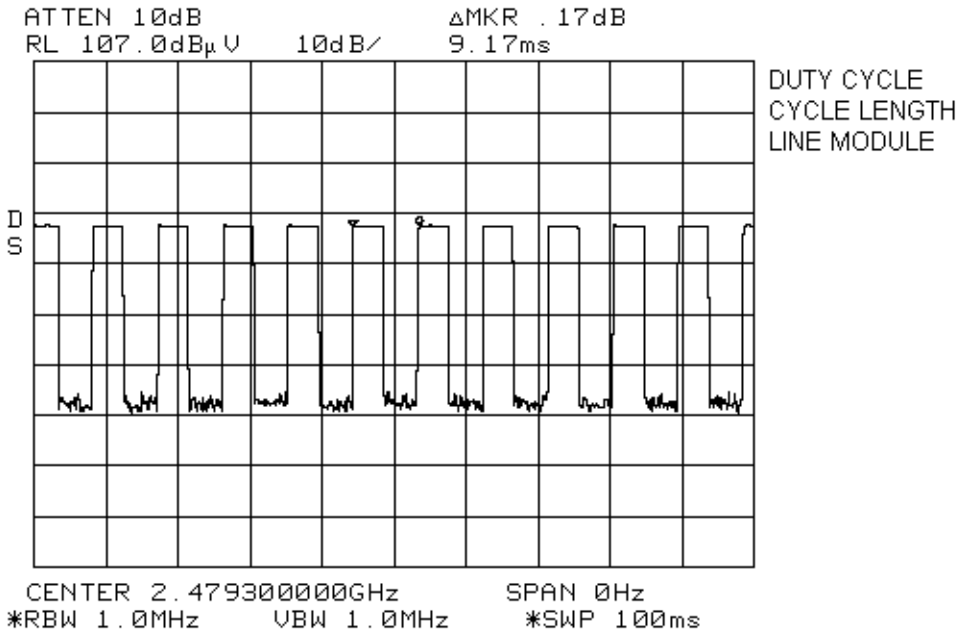
Manufacturer:	Critical Telecom
Model No.:	Millennium
Serial No.:	TML10298
Date Received In Laboratory:	April 18, 2001
Nemko Identification No.:	Item #1

Transmitter

Power Input:	10-36VDC
Frequency Range:	2412.192 to 2472.10MHz
Tunable Bands:	One
6 dB Bandwidth:	1.99MHz
Type of Modulation	GMSK
Data Rate:	14.4KBPS
Emissions Designator:	1M99F1W
Output Impedance:	50 ohm
RF Power Output (Rated):	+18dBm
Power Output Adjustment Capability:	None
Duty Cycle:	$= \left(20 \log \frac{OnTime}{100ms} \right)$ $= 20\log \left(\frac{11x4.17}{100} \right)$ $= 20\log 0.4587$ $= -6.8\text{dB}$



DUTY CYCLE
ON TIME PULSE WIDTH
LINE MODULE


ATTEN 10dB
RL 107.0dBµV
10dB/
ΔMKR .17dB
9.17ms
DUTY CYCLE
CYCLE LENGTH
LINE MODULE
D
S
CENTER 2.479300000GHz
SPAN 0Hz
*RBW 1.0MHz
VBW 1.0MHz
*SWP 100ms

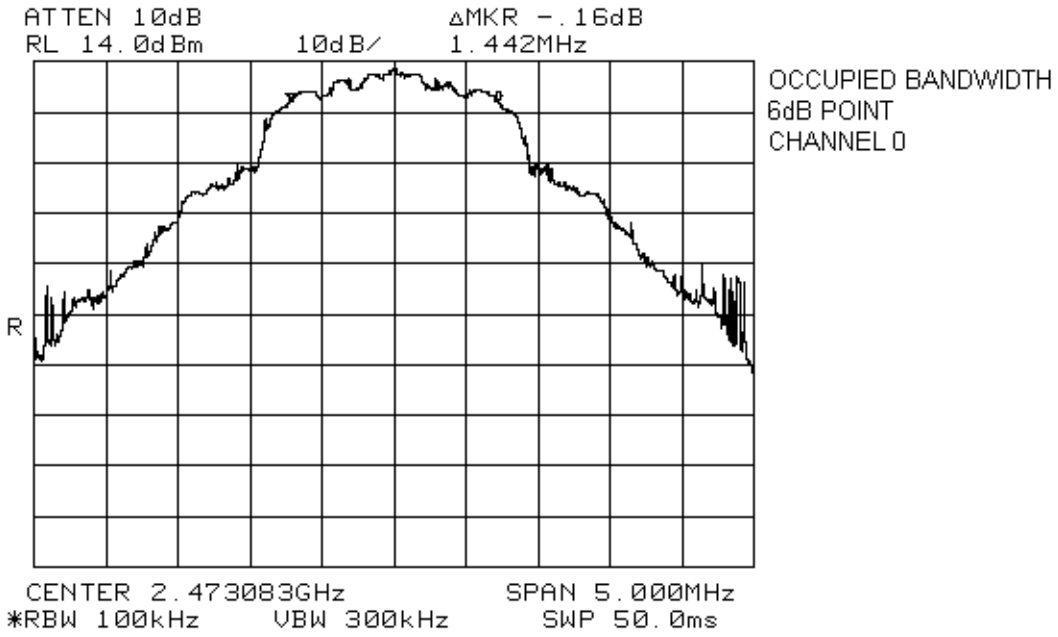
Section 3. Occupied Bandwidth

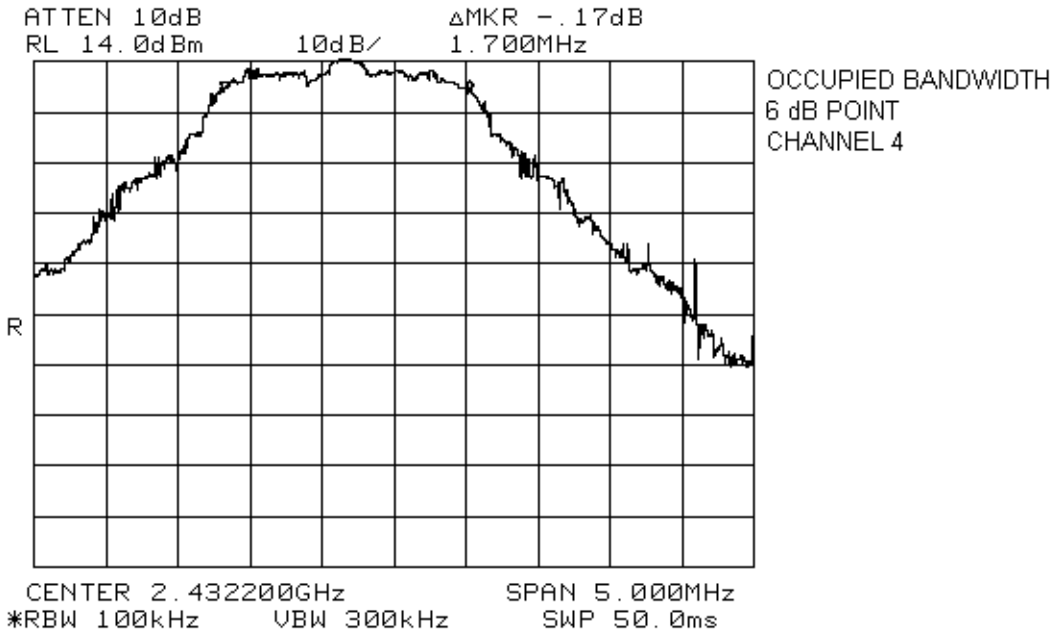
Para. No.: 15.247(a)(2)

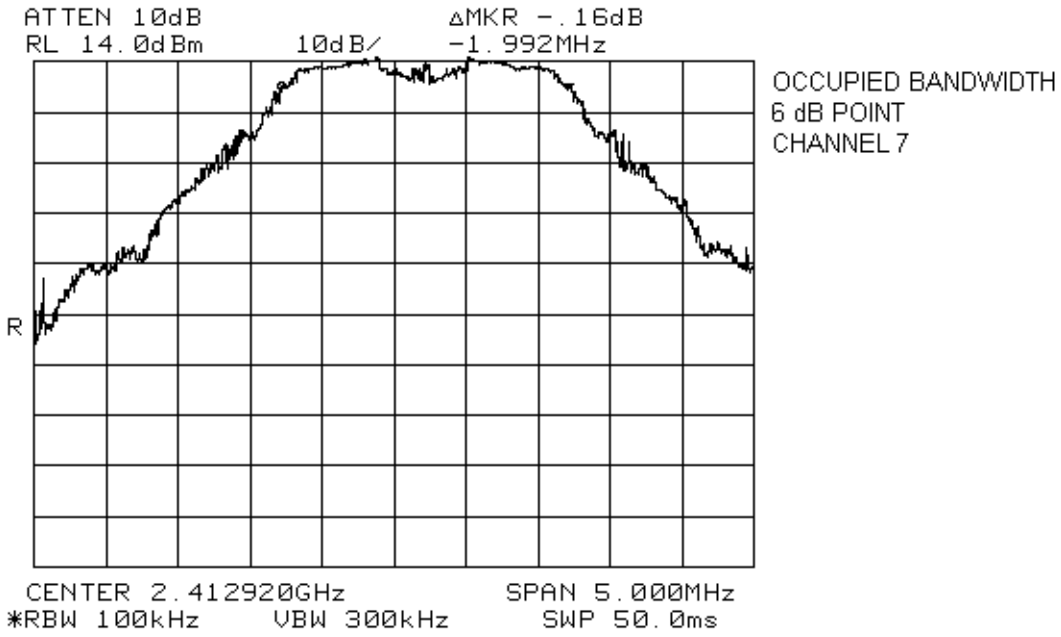
Test Performed By: Wayne Clarke	**Date of Test:** April 19, 2001

Test Results: Complies. The 6 dB bandwidth is 1.99MHz.
See attached graphs.

Measurement Data: See attached graphs.


ATTEN 10dB
RL 14.0dBm
10dB/
ΔMKR -.16dB
1.442MHz
OCCUPIED BANDWIDTH
6dB POINT
CHANNEL 0
R
CENTER 2.473083GHz
SPAN 5.000MHz
*RBW 100kHz
VBW 300kHz
SWP 50.0ms


ATTEN 10dB
RL 14.0dBm
10dB/
ΔMKR -.17dB
1.700MHz
OCCUPIED BANDWIDTH
6 dB POINT
CHANNEL 4
R
CENTER 2.432200GHz
SPAN 5.000MHz
*RBW 100kHz
VBW 300kHz
SWP 50.0ms


ATTEN 10dB
RL 14.0dBm
10dB/
ΔMKR -.16dB
-1.992MHz
R
OCCUPIED BANDWIDTH
6 dB POINT
CHANNEL 7
CENTER 2.412920GHz
SPAN 5.000MHz
*RBW 100kHz
VBW 300kHz
SWP 50.0ms

Section 4. Peak Power Output

Para. No.: 15.247(b)

Test Performed By: Wayne Clarke	**Date of Test:** April 23, 2001

Test Results: Complies. The maximum peak power output of the transmitter is 18.7dBm.

Measurement Data: Detachable antenna? ☒ Yes ☐ No

If yes, state the type of non-standard connector used at the antenna port: Reverse TNC Connector.

Antenna Gain is 8dBi.

Channel	Average Power dBm	Duty Cycle dB	Peak Power
Ch. 0	13.0	+3.4	16.4dBm
Ch. 4	14.8	+3.4	18.2dBm
Ch. 7	15.3	+3.4	18.7dBm

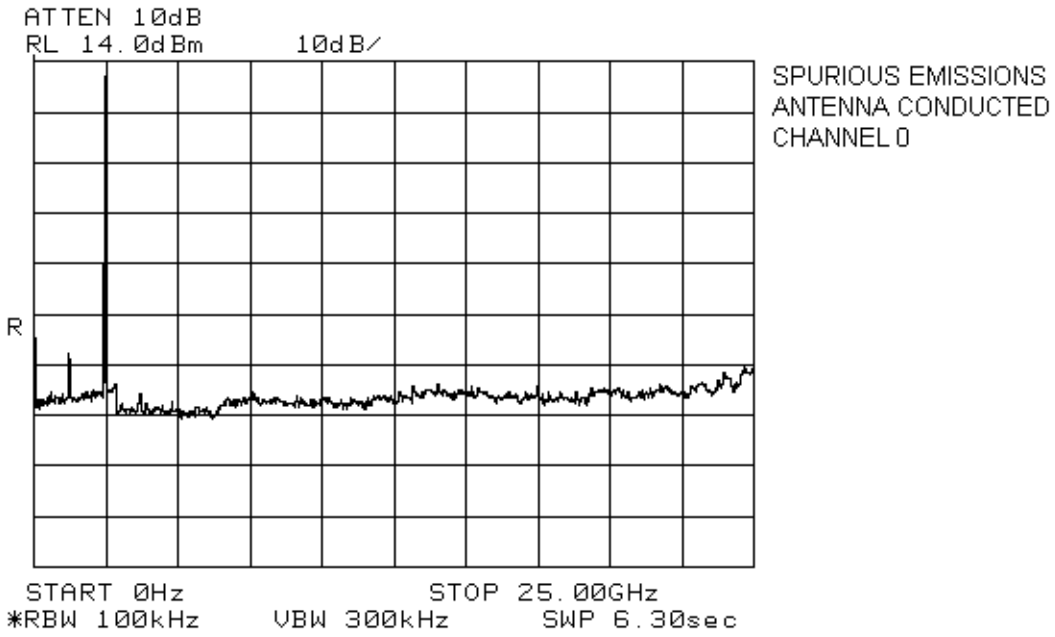
Section 5. Spurious Emissions (Antenna Conducted)

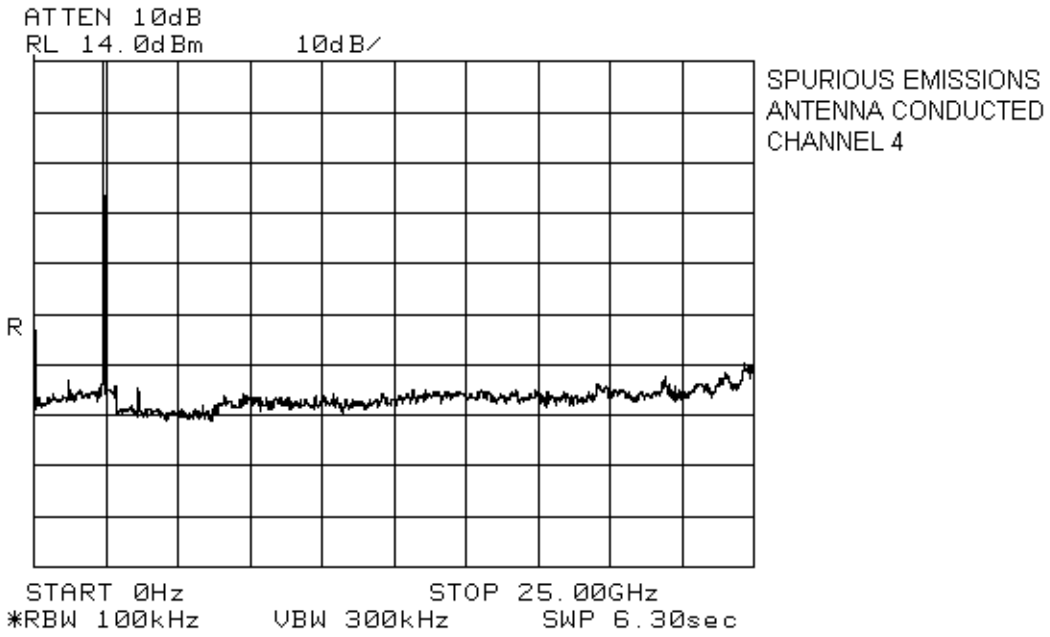
Para. No.: 15.247

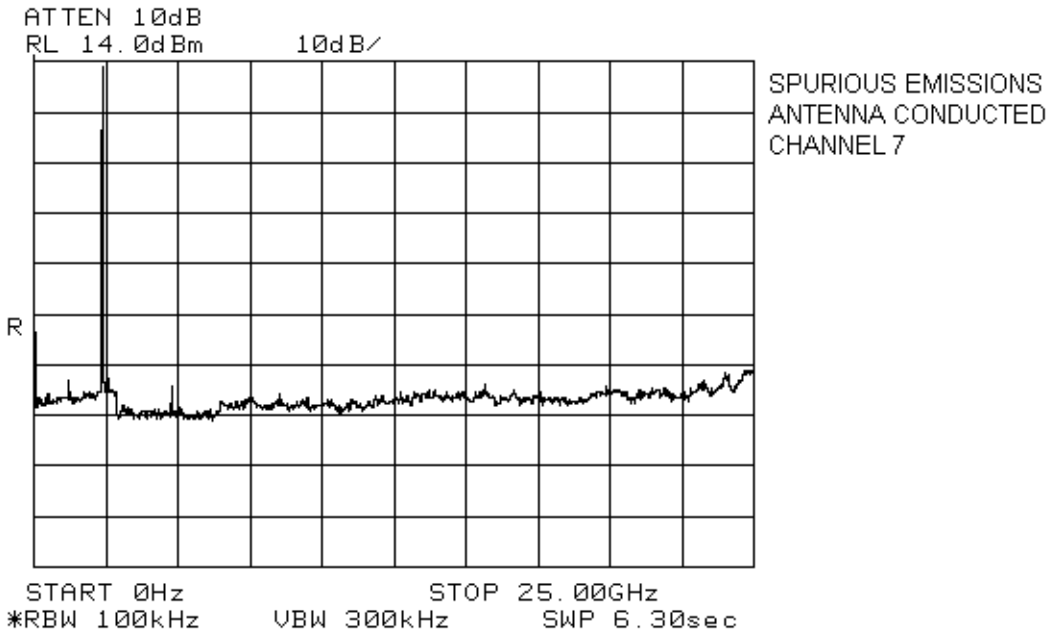
Test Performed By: Wayne Clarke	**Date of Test:** April 19, 2001

Test Results: Complies.

Measurement Data: See attached graphs.


ATTEN 10dB
RL 14.0dBm
10dB/
R
SPURIOUS EMISSIONS
ANTENNA CONDUCTED
CHANNEL 0
START 0Hz
STOP 25.00GHz
*RBW 100kHz
VBW 300kHz
SWP 6.30sec


ATTEN 10dB
RL 14.0dBm
10dB/
SPURIOUS EMISSIONS
ANTENNA CONDUCTED
CHANNEL 4
R
START 0Hz
STOP 25.00GHz
*RBW 100kHz
VBW 300kHz
SWP 6.30sec


ATTEN 10dB
RL 14.0dBm
10dB/
R
SPURIOUS EMISSIONS
ANTENNA CONDUCTED
CHANNEL 7
START 0Hz
STOP 25.00GHz
*RBW 100kHz
VBW 300kHz
SWP 6.30sec

Section 6. Spurious Emissions (Radiated)

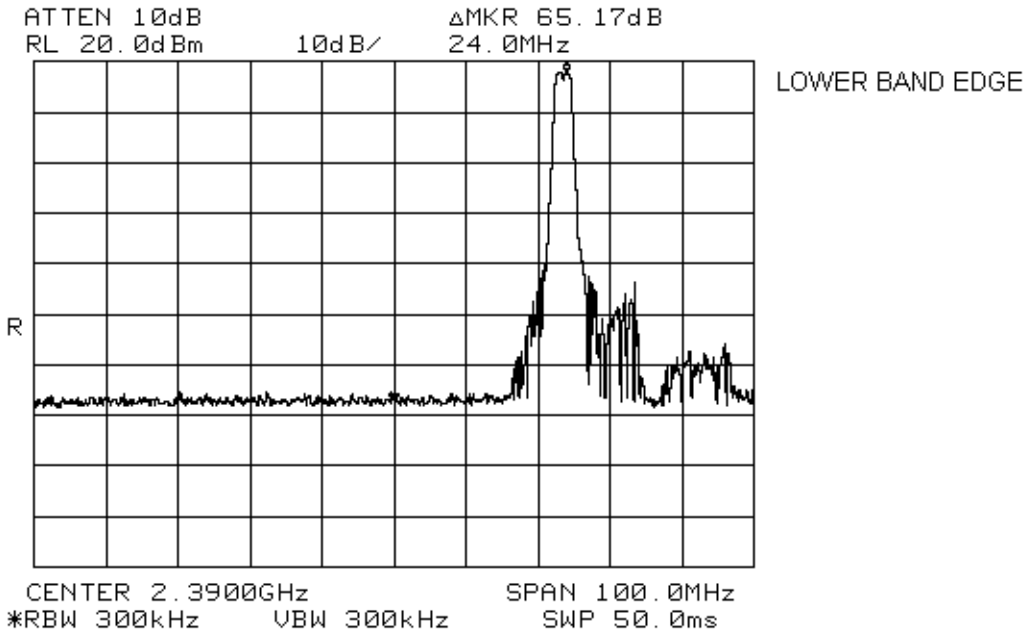
Para. No.: 15.247(c)

Test Performed By: Wayne Clarke	**Date of Test:** April 18, 2001

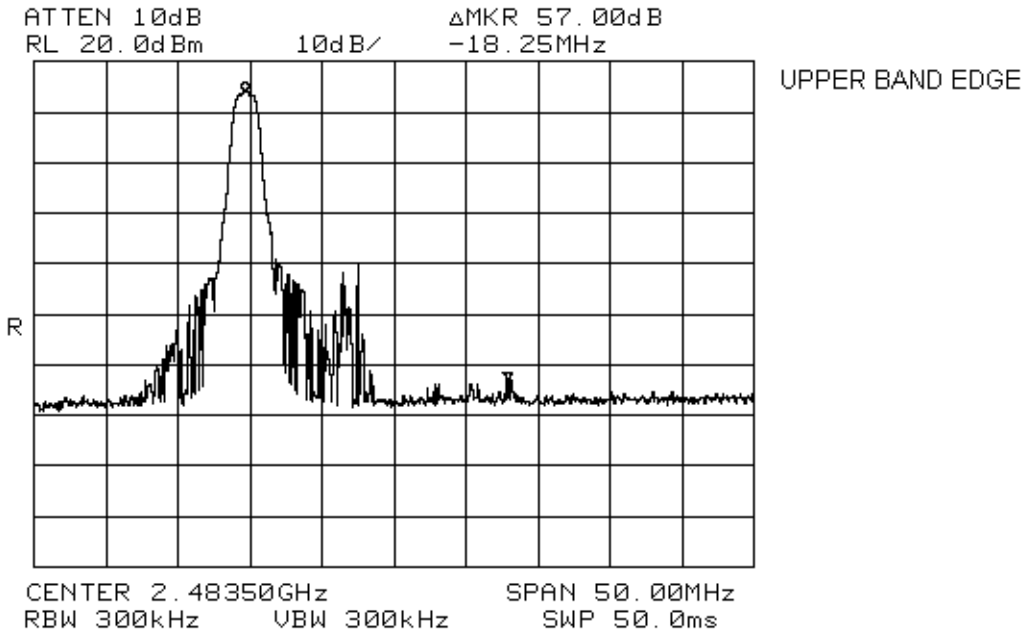
Test Results: Complies. The worst-case emission level is 50.1 dBµV/m @ 3m at 4824.384MHz. This is 3.9dB below the specification limit.

Measurement Data: See attached graphs.

The spectrum was searched up to the 10^{th} harmonic of the fundamental frequency of operation.



Peak Band Edge Emission: 124.4dBµV – 65.2 = 59.2dBµV/m @ 3m.
Average Band Edge Emission: 124.4dBµV – 65.2 – 6.8 = 52.4dBµV/m @ 3m.



Peak Band Edge Emission: 108.7dBµV – 57.0 = 51.7dBµV/m @ 3m.
Average Band Edge Emission: 108.7dBµV – 57.0 – 6.8 = 44.9dBµV/m @ 3m.

Test Data - Radiated Emissions (Peak)

Test Distance (meters) : 3		Range: A		Receiver: 8565E		RBW(kHz): 1000		Detector: PEAK	
Freq. (MHz)	**Ant. ***	**Pol. (V/H)**	**RCVD Signal (dBµV/m)**	**Ant. Factor (dB)****	**Amp. Gain (dB)*****	**Dist. Corr. (dB)**	**Field Strength (dBµV/m)**	**Limit (dBµV/m)**	**Margin (dB)**
CHANNEL 0									
2472.1	HN2	V	67.5	36.4			103.4		
2472.1	HN2	H	72.3	36.4			108.7		
4944.2	HN2	V	56.5	44.2	-55.2		45.5	74.0	28.5
4944.2	HN2	H	59.3	44.2	-55.2		48.3	74.0	25.7
CHANNEL 4									
2440.28	HN2	V	68.1	36.2			104.3		
2440.28	HN2	H	80.0	36.2			116.2		
4880.56	HN2	V	64.7	43.9	-55.4		53.2	74.0	20.8
4880.56	HN2	H	65.0	43.9	-55.4		53.5	74.0	20.5
CHANNEL 7									
2412.192	HN2	V	70.3	36.1			106.4		
2412.192	HN2	H	88.3	36.1			124.4		
4824.384	HN2	V	68.7	43.7	-55.5		56.9	74.0	17.1
4824.384	HN2	H	65.7	43.7	-55.5		53.9	74.0	20.1

Notes:
B/C = Biconical, B/L = Biconilog, L/P = Log-Periodic, H = Horn, D/P = Dipole
* Re-measured using dipole antenna.
** Includes cable loss when amplifier is not used.
*** Includes cable loss.
( ) Denotes failing emission level.
N.D. = Not Detected

Test Data - Radiated Emissions (Average)

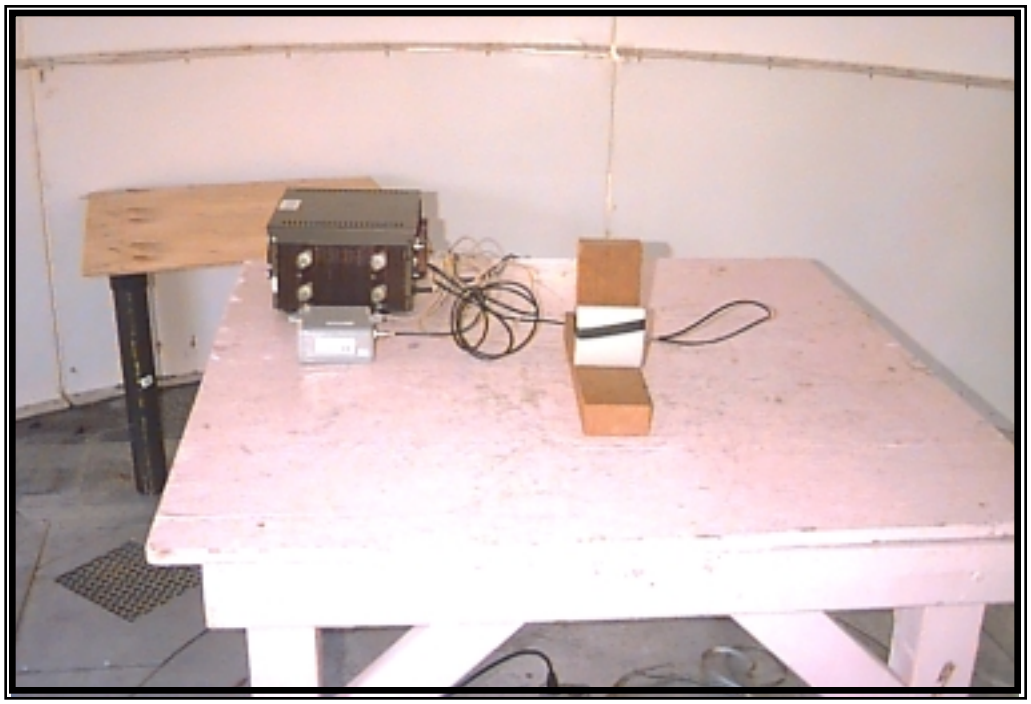
Test Distance (meters) : 3		Range: A		Receiver: 8565E		RBW(kHz): 1000		Detector: AVERAGE	
Freq. (MHz)	**Ant. ***	**Pol. (V/H)**	**RCVD Signal (dBµV/m)**	**Ant. Factor (dB)****	**Amp. Gain (dB)*****	**Duty Cycle. (dB)**	**Field Strength (dBµV/m)**	**Limit (dBµV/m)**	**Margin (dB)**
CHANNEL 0									
4944.2	HN2	V	56.5	44.2	-55.2	-6.8	38.7	54.0	15.3
4944.2	HN2	H	59.3	44.2	-55.2	-6.8	41.5	54.0	12.5
CHANNEL 4									
4880.56	HN2	V	64.7	43.9	-55.4	-6.8	46.4	54.0	7.6
4880.56	HN2	H	65.0	43.9	-55.4	-6.8	46.7	54.0	7.3
CHANNEL 7									
4824.384	HN2	V	68.7	43.7	-55.5	-6.8	50.1	54.0	3.9
4824.384	HN2	H	65.7	43.7	-55.5	-6.8	47.1	54.0	6.9

Notes:

B/C = Biconical, B/L = Biconilog, L/P = Log-Periodic, H = Horn, D/P = Dipole
* Re-measured using dipole antenna.
** Includes cable loss when amplifier is not used.
*** Includes cable loss.
( ) Denotes failing emission level.
N.D. = Not Detected

Radiated Photographs (Worst Case Configuration)

Front View



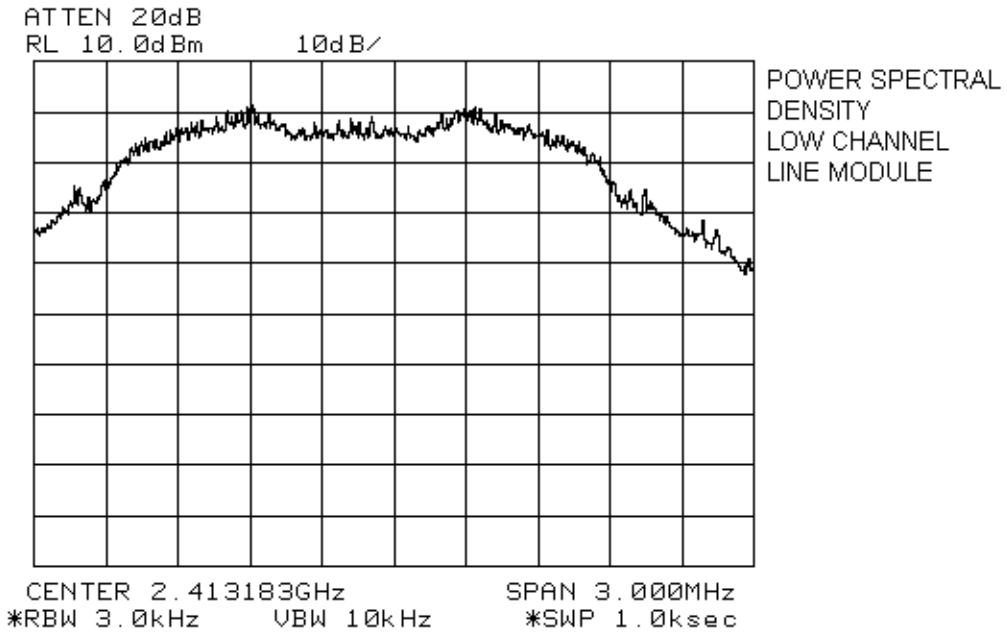
Section 7. Transmitter Power Density

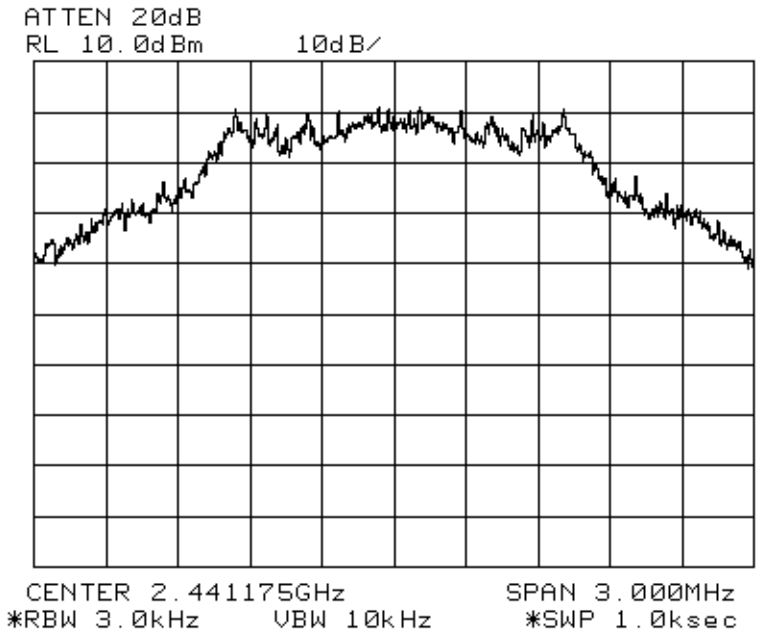
Para. No.: 15.247(d)

Test Performed By: Wayne Clarke	**Date of Test:** April 23, 2001

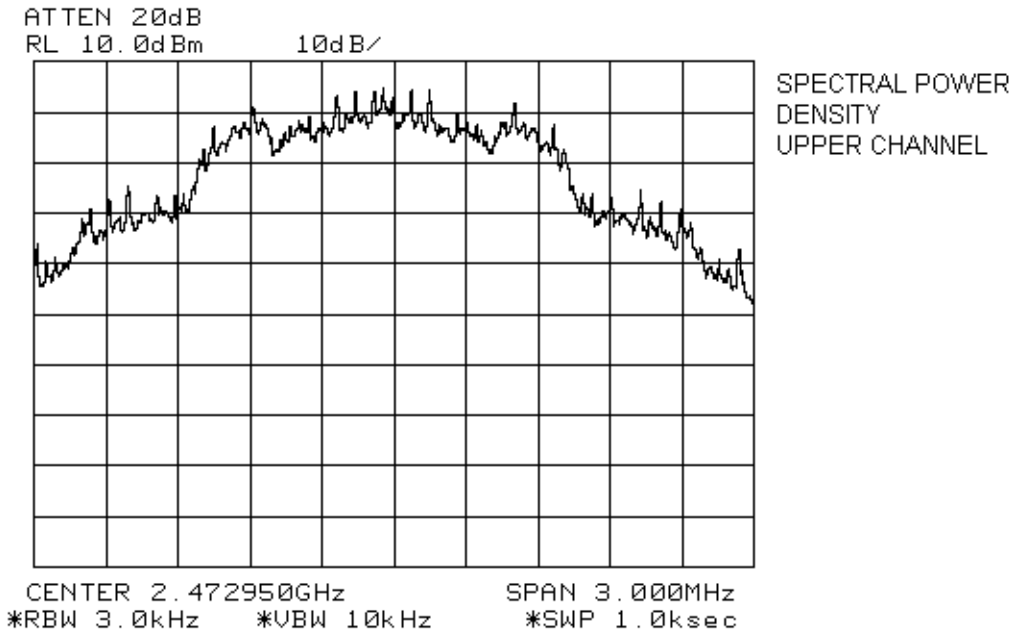
Test Results: Complies.

Measurement Data: See attached graphs.


ATTEN 20dB
RL 10.0dBm
10dB/
POWER SPECTRAL
DENSITY
LOW CHANNEL
LINE MODULE
CENTER 2.413183GHz
SPAN 3.000MHz
*RBW 3.0kHz
VBW 10kHz
*SWP 1.0ksec



POWER SPECTRAL
DENSITY
MIDDLE CHANNEL
LINE MODULE


ATTEN 20dB
RL 10.0dBm
10dB/
SPECTRAL POWER
DENSITY
UPPER CHANNEL
CENTER 2.472950GHz
SPAN 3.000MHz
*RBW 3.0kHz
*VBW 10kHz
*SWP 1.0ksec

Section 8. Processing Gain

Para. No.: 15.247(e)

Test Performed By: Wayne Clarke	**Date of Test:** April 23, 2001

Test Results: Complies. The manufacturers stated processing gain of the system is 11.5 dB.

Measurement Data: See attached data. (Customer Supplied Data)

Processing Gain Data

Each actual burst cycle also includes two guard times to allow for both propagation and RF transceiver switching time. More specifically, G1 is a 32-bit delay between the time when the master stops transmission and the slave commences transmission; G2 is a 32-bit delay between the time when the slave stops transmission and the master commences transmission as shown in Figure 4. These guard times allow for a 375 µs delay. The total burst cycle is 768 bits long, including 12 bits internal delay (transmitter turns off 6 bits after the last data bit is latched into the transmitter, the master and slave therefore contribute a total of 12-bit internal delay).

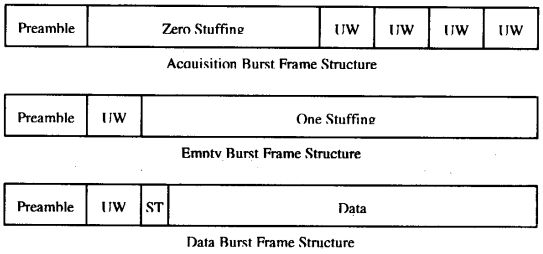


Figure 4: Burst Frame Structure

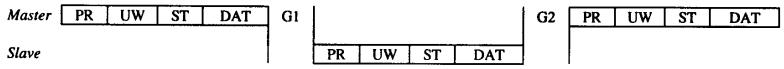


Figure 5: Master/Slave Frame Relationship

4.2 Direct Sequence Spread Spectrum

Transceiver logic spreads the 85.33 kbps data frames with a chip rate of 1.365 Mbps to achieve a process gain of approximately 11.5 dB. Consecutive data frame bit-pairs are encoded as one of four symbols each with a unique 32-bit PN sequence. Data is further randomized by modulus-2 addition with a 2047-bit PN sequence. This operation smoothes the output spectrum of the transmitted signal and eliminates discrete spectral components.

Each of eight channels corresponds to a unique set of four PN sequences. All PN sequences are listed in Table 1.

Table 1: PN Sequences

Channel	Symbol			
	A	B	C	D
0	0xD6AD88D6	0x5598D6A5	0x96CAF149	0x67396869
1	0x68CAA59E	0xDC8F4654	0xF1A8CBA4	0xF4405D7A
2	0x8C3CF515	0xA153ACD5	0x77066437	0xC18A55ED
3	0xE9ADEBD8	0xC61E7A8A	0x4DF29B0C	0x1368D79A
4	0x78D465D2	0xAC5AD2B2	0xC4823B50	0x655D9D14
5	0x50BAA739	0xBB83321B	0x42A759AB	0x8CE2E3C3
6	0x054C5513	0x8EA24F87	0xD435C92B	0x4F5168B5
7	0x83E80A70	0xF33C8196	0x129596FA	0x087A249A

Section 9. Test Equipment List

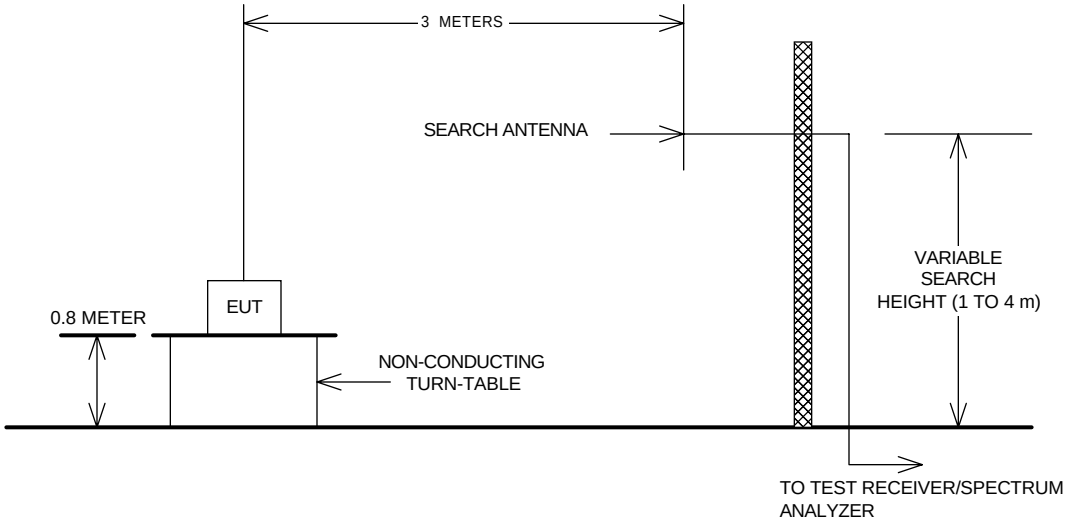
CAL CYCLE	EQUIPMENT	MANUFACTURER	MODEL	SERIAL	LAST CAL.	NEXT CAL.
1 Year	Spectrum Analyzer	Hewlett Packard	8565E	FA000981	June 16/00	June 16/01
1 Year	Dipole Antenna Set	EMCO #1	3121C	FA000814	Apr. 16/01	Apr. 16/02
1 Year	Horn Antenna	EMCO	3115	4336	Dec. 1/00	Dec. 1/01
NCR	Power Supply	Astron	VS50M	FA000478	NCR	NCR
2 Year	RF AMP	Narda	5 - 18GHz	FA001409	Nov. 9/99	Nov. 9/01
2 Year	RF AMP	Narda	18 - 26.5GHz	FA001550	July 7/00	July 7/02
2 Year	RF AMP	Narda	26.5 - 40GHz	FA001556	July 24/00	July 24/02
1 Year	RF AMP	JCA	4-8 GHz	FA001497	May 31/00	May 31/01

NA: Not Applicable
NCR: No Cal Required
COU: CAL On Use

Annex A

Block Diagrams

Test Site For Radiated Emissions

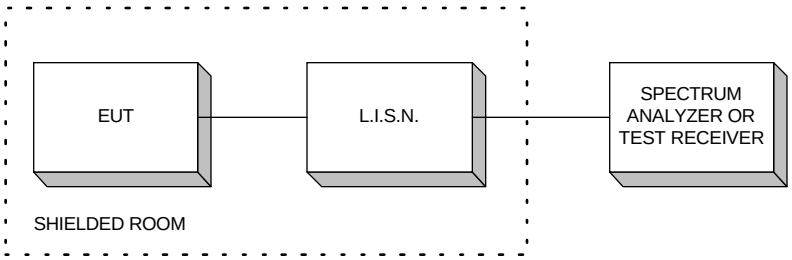


Below 1 GHz
Peak detector.
RBW = 100 kHz

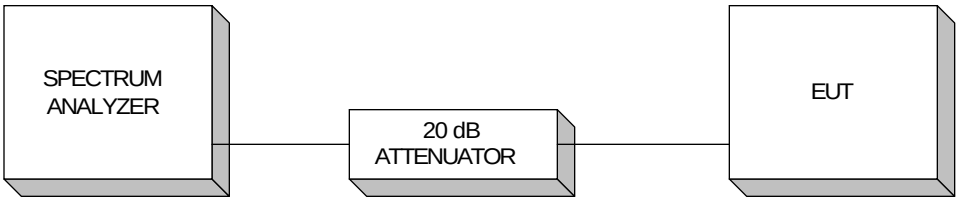
Above 1 GHz For Peak Emission Levels
Peak detector
RBW = 1 MHz
VBW = >RBW

Above 1 GHz For Average Emission Levels
Peak detector
RBW = 1 MHz
VBW = 10 Hz

Conducted Emissions

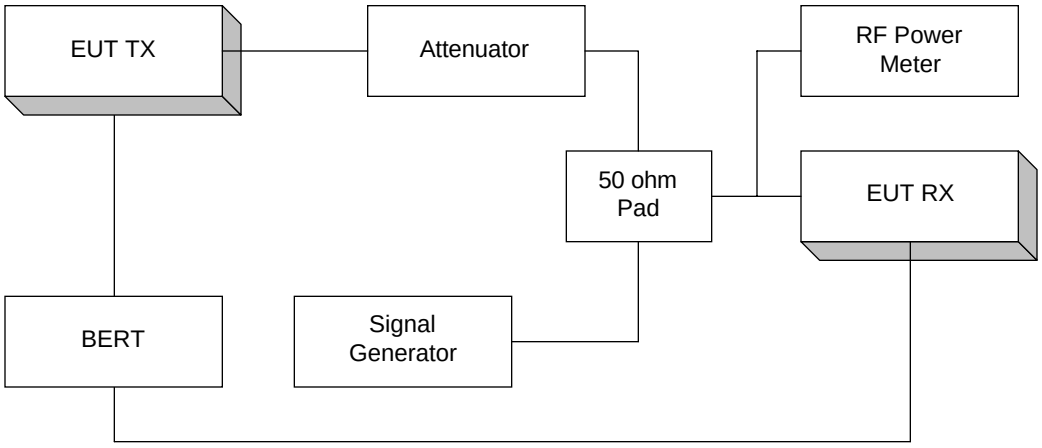


Transmitter Power Density & Peak Power At Antenna Terminals



If the EUT has an integral (non-detachable) antenna, the above test is performed as a radiated measurement and the result is reported as EIRP.

Processing Gain



NOTE: This is a typical setup. The setup may vary slightly since many devices have BER test functions built into the device.