A

Application for
Class 2 Permissive Change

ADTRAN, Inc.
Tracer 10BaseT Rackmount
Model: 4280TRACRN64L1

47 CFR, Part 15, Subpart C, §15.247
for
Spread Spectrum Transmitters

FCC ID: HDCTRACERT1L7

Report Date: February 15, 2001

Test Dates: November 7 – November 9, 2000
January 4 – January 5, 2001

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1.0 General Description

1.1 Product Description

The ADTRAN TRACER is a digital microwave radio that uses spread spectrum technology for medium, and short-haul dual T1 communication link.

TRACER provides a digital communications link using Direct Sequence Spread Spectrum (DSSS) coding and Quadrature Phase Shift Keying (QPSK) modulation. TRACER is suited for Cellular/PCS T1 infrastructure, thin-route telco infrastructure, and fast turn-up construction of permanent or temporary applications. It is also ideal for applications such as emergency/disaster recovery, data/voice infrastructure for utility and public service companies, and building-to-building/campus-to-campus connectivity for voice, data and video.

TRACER is composed of two primary components, a Baseband Processor and a radio frequency converter (RFC). The RFC may be mast-mounted up to 350 feet from the Baseband Processor, using a single, RG-8 size coax. All signaling and power functions between the Baseband Processor and RFC are provided over this single coax connection. The Baseband Processor is housed in a 1U (1.75"), 19", 6 pound package that is suitable for rack or tabletop installation.

The TRACER transports two T1 digital signals in any format and provides two industry standard DS1 or DSX-1 digital signal interfaces. A separate maintenance channel is transported in addition to the T1 signal, and provides control for remote configuration and monitoring. The maintenance channel is supported over the link.

TRACER provides frequency agility by allowing one of two channel plans to be selected. Individual part numbers are assigned for the various channel configurations of the RFC for simplicity in factory ordering, but there is no difference in hardware components. Ten spreading codes are available for interference protection.

The transmitter at one end (TxA) of a link will transmit in the lower half of the spectrum. Consequently the receiver at the other end will receive in the lower half of the band and transmit in the upper half. Thus, a system will operate in one of two frequency plans – transmit in the upper and receive in the lower or vice versa. These two plans are called Plan A and Plan B. One end of a path will be on Plan A and the other will be on Plan B. Shipment of a link will consist of an A and a B unless otherwise specified.

Plan A transmits in the band from 2400 to 2441 MHz, and Plan B transmits in the band from 2441 to 2483.5 MHz.

RF block diagrams of the BBP and RFC sections are located on pages 5 and 19 of the Product Specifications in Exhibit 5.

The EUT grounding requirements are outlined on Page 13 of the User’s Manual located in Exhibit 8 of this report.

All antennas for use with this transmitter are located in Exhibits 2, 3, and 4.

1.2 Related Submittal(s) Grants

This is a single Application for a Class 2 Permissive Change.

1.3 Test Methodology

Radiated emission measurements were performed according to the procedures in ANSI C63.4 (1992). All radiated measurements were performed in a 10 meter semi-anechoic chamber. For each scan, the procedure for maximizing emissions in Section 4.3 were followed. All radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "**Justification Section**" of this application.

1.4 Test Facility

The facility used to collect the radiated data is located at 1950 Evergreen Blvd., Suite 100, Duluth, Georgia. This test facility is registered with the FCC under registration number 99512.

2.0 System Test Configuration

2.1 *Justification*

The system was configured for testing in a typical fashion (as a customer would normally use it). The Radio Frequency Converter (RFC) and the Baseband Processor (BBP) portions of the EUT were mounted together in a 19” metal telecom rack and configured with cables typically provided by ADTRAN, Inc. Two frequency plans are available for use. Switching a pair of coaxial cables located within the RFC causes the TRACER to toggle between Plan A and Plan B. Both plans were tested for radiated and conducted spurious emissions. These configurations represent typical installations of this system. During testing, all cables were manipulated to produce the worst case emissions.

For this permissive change, only a single antenna was measured for radiated spurious emissions. Because the spurs for this antenna were the same level or better than those measured during the initial testing, the other antennas were not investigated. Please reference FCC ID# HDCTRACERT1L7 for the initial filing and the contained data. During testing, the transmit antenna under test was positioned at a fixed height of 1 meter.

For simplicity of testing, the EUT was configured to transmit continuously. The EUT was configured to transmit a typical maximum data stream during testing. Both frequency plans offered with this device were tested.

2.2 *EUT Exercising Software*

There was no special software to exercise the device. For simplicity of testing, the unit was configured to transmit continuously.

2.3 Special Accessories

There are no special accessories for compliance of this product.

2.4 Equipment Modifications

Any modifications installed previous to testing by ADTRAN, Inc. will be incorporated in each production model sold/leased in United States

No modifications were installed by Intertek Testing Services, Inc.

2.5 *Support Equipment List and Description*

The FCC ID's for all equipment, plus descriptions of all cables used in the tested system (including inserted cards, which have grants) are:

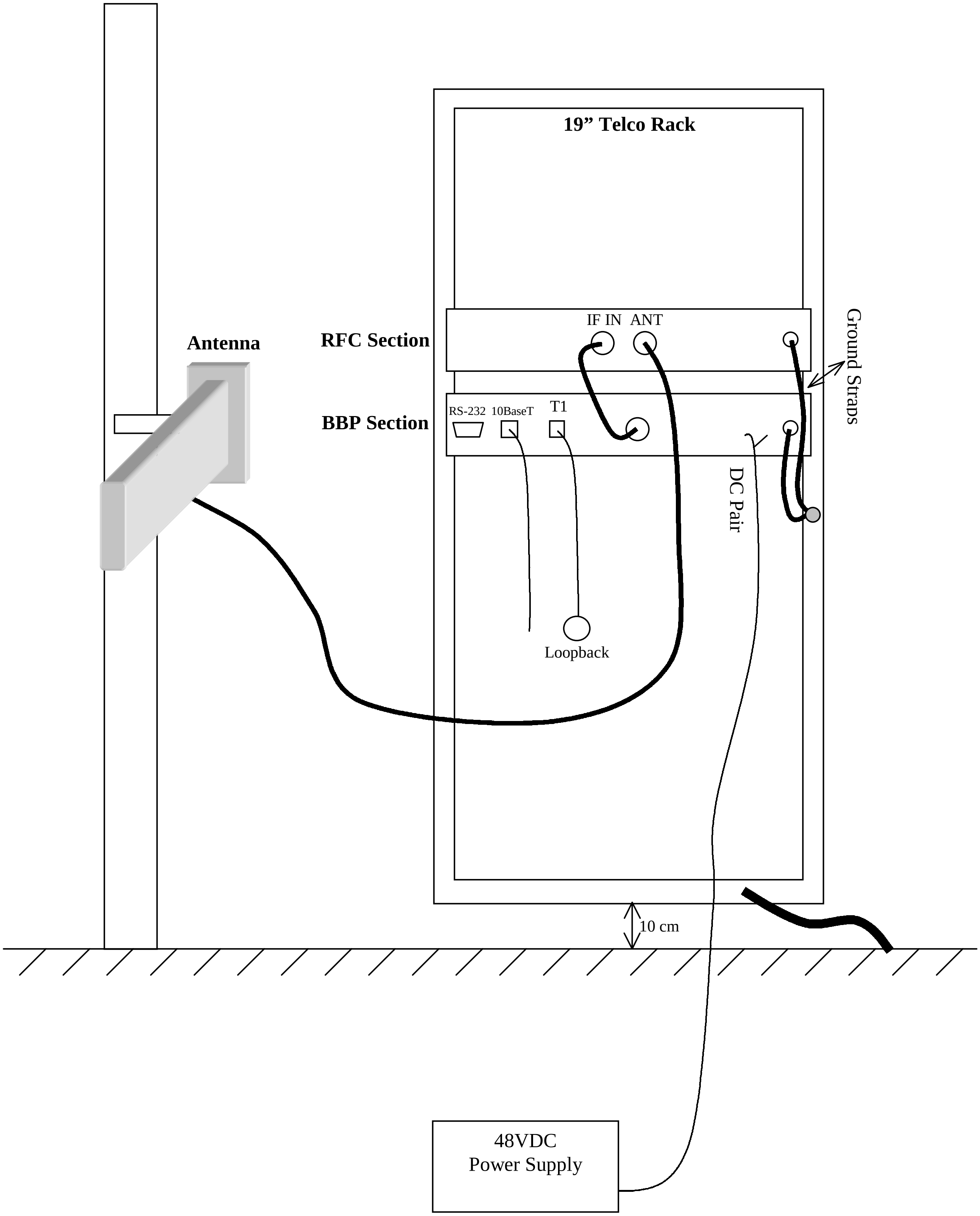
Equipment:

No support equipment was necessary to operate and exercise the TRACER.

Cables:

DC Pair, 5 meters, unshielded
RG-58 coaxial cable, 0.4 meters, (BBP to RFC), N-type connectors
RG223 coaxial cable, 1.5 meters (RFC to 50 Ohm Termination), N-type connectors
Category 3 UTP, 1.5 meters, (T1 connection)
Category 5 UTP, 1.5 meters, (10BaseT connection)

2.6 Test Configuration Block Diagram



3.0 Test Results

Data is included of the worst case configuration (the configuration which resulted in the highest emission levels). A sample calculation, configuration photographs, data tables and plots of the emissions are included.

3.1 Emission Bandwidth

The bandwidth was measured to be approximately 22 - 25 MHz. The following plots were taken with a resolution bandwidth (RBW) of 100 kHz and a video bandwidth (VBW) of 300 kHz. The maximum level of the emission was measured to be 120 dBµV. Markers were displayed 6 dB down from the maximum peak of the fundamental.

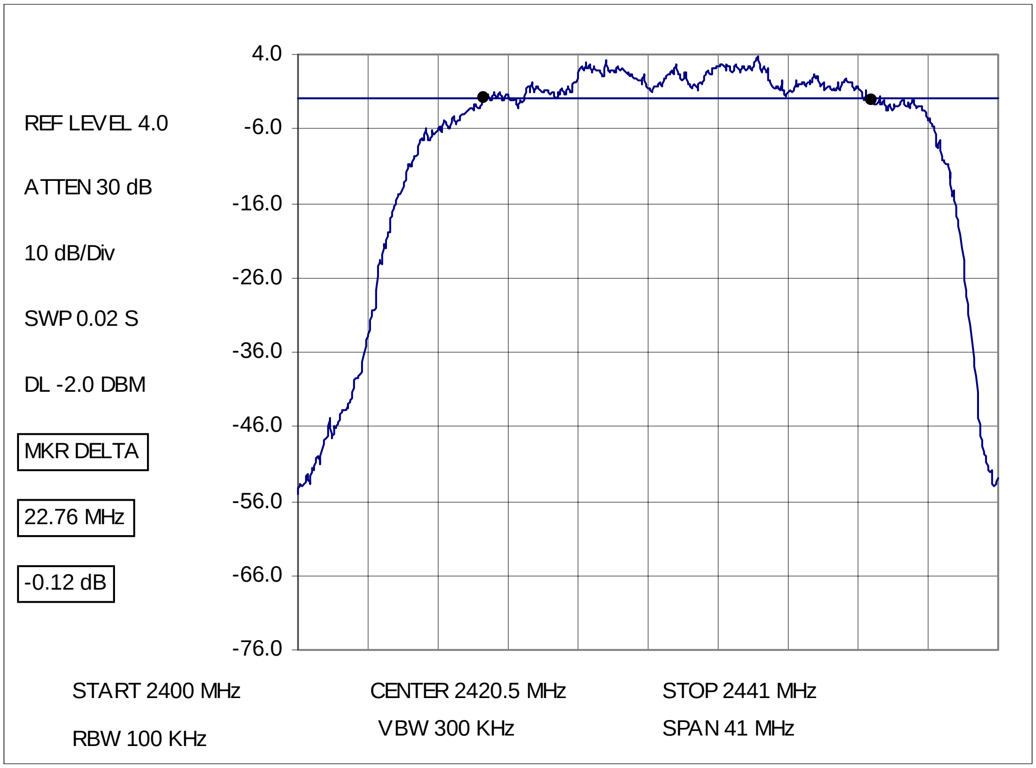


Figure 1 – Plan A Bandwidth Plot

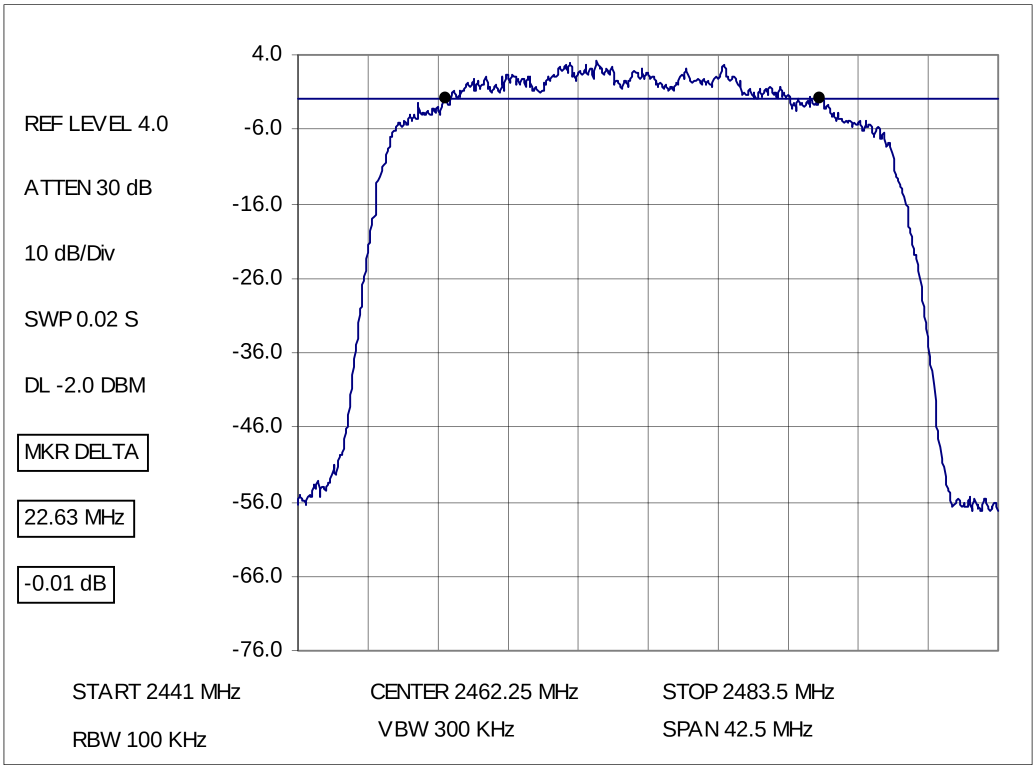


Figure 2 – Plan B Bandwidth Plot

3.2 Power Output

Section 15.247(b)(1) specifies that the maximum peak output power of a direct sequence spread spectrum transmitter shall not exceed one watt. The peak output power was measured with a power meter to be 20.3 dBm (107.2 mW) as measured at the antenna port of the RFC section. This reading was taken with the TRACER set to the highest transmit power.

These measurements were made with a Boonton power meter, Model Number: 4232A-01 in conjunction with a Boonton power sensor, Model Number: 51013.

3.2.1 *Specific Absorption Rate and Maximum Permissible Exposure (MPE)*

The calculations below for maximum transmitted power and the MPE limits are based on OET 65 Edition 97-01, August 1997. The Tracer is designed for a maximum transmit power of 30 dBm (1000 mW). The highest allowable antenna gain for a 1 Watt transmitter as stated in §15.247 (b)(3) is 6 dBi or 3.981. Assuming a worst case scenario, the power density at a distance of 1 meter was calculated as follows:

Using the equation for power density $S=PG/4*\pi*R^2$

Where S = power density in mW/cm^2
P = transmit power in milliwatts
G = numeric gain of transmit antenna
R = distance (cm)

$S = \{(1000)(3.981)\}/\{4*\pi*(100)^2\}$

$S = 31.68\ \mu W/cm^2$ at a distance of 1 meter.

This power density is worst case with maximum beam exposure. This level is below the 1 mW/cm^2 MPE for General Population / Uncontrolled Exposure as stated in OET 65 Edition 97-01, August 1997. This device is designed for telecommunications transmission for distances over 20 miles. As stated in the User's Manual, this device must be installed only by professionals. The following precautions are also outlined in the User's Manual to prevent exposure to high levels of RF energy:

- The installed antenna must not be located in a manner that allows exposure of the general population to the direct beam path of the antenna at a distance of less than 15 feet (4.6 meters). Installation on towers, masts, or rooftops not accessible to the general population is recommended; or
- Mount the antenna in a manner that prevents any personnel from entering the area within 15 feet (4.6 meters) from the front of the antenna.
- It is recommended that the installer place radio frequency hazard warnings signs on the barrier that prevents access to the antenna.
- Prior to installing the antenna to the RFC output, make sure the power is adjusted to the settings specified in section 2 of this manual.
- During antenna installation, be sure that the power to the TRACER equipment is turned *off* in order to prevent any energy presence on the coaxial connector.
- During installation and alignment of the antenna, do not stand in front of the antenna assembly.
- During installation and alignment of the antenna, do not handle or touch the front of the antenna.

3.3 *Field Strength Calculation*

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG
where FS = Field Strength in dB(uV/m)
RA = Receiver Amplitude (including preamplifier) in dB(uV)
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB(1/m)
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows:

Assume a receiver reading of 52.0 dB(uV) is obtained. The antenna factor of 7.4 dB(1/m) and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dB(uV/m). This value in dB(uV/m) was converted to its corresponding level in V/m.

RA = 52.0 dB(uV)
AF = 7.4 dB
CF = 1.6 dB(1/m)
AG = 29.0 dB

FS = 52.0 + 7.4 + 1.6 - 29.0 = 32 dB(uV/m)

Level in uV/m = Common Antilogarithm [(32 dB(uV/m))/20] = 39.8 uV/m

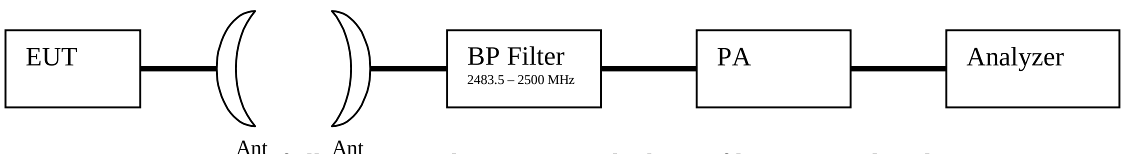
3.4 *Transmitter Conducted Spurious Emissions*

§15.247(c) specifies requirements for spurious emissions from direct sequence spread spectrum transmitters. In any 100 kHz bandwidth outside the frequency bands listed in §15.247, the radio frequency power that is produced by the modulation products of the spreading sequence, the information sequence and the carrier frequency shall be either at least 20 dB below that in any 100 kHz bandwidth within the band that contains the highest level of the desired power or shall not exceed the general levels specified in §15.209(a), whichever results in the lesser attenuation. All other emissions outside these bands shall not exceed the general radiated emission limits specified in §15.209(a).

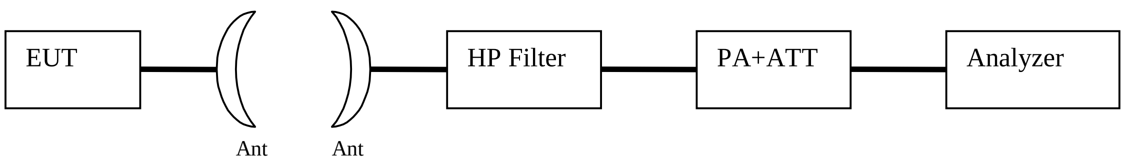
Two separate tests (described below) were performed to determine the spurious emissions from the device:

(1) The first test was performed using a direct connection between the antenna port of the transmitter and the spectrum analyzer. The resolution bandwidth was set to 100 kHz, and the video bandwidth was set greater than the resolution bandwidth. A scan was performed up to the tenth harmonic to ensure that all the harmonics/spurs were at least 20 dB down from the highest emission level within the authorized frequency bands. The results of this test are shown in Table 1.

(2) The second test was a radiated emission test to determine the amplitude of harmonics/spurs which fall within the restricted bands listed in §15.205(a). The limits for emissions in these restricted bands are listed in §15.209. For measurements above 1 GHz, a resolution bandwidth of 1 MHz and a video bandwidth of 1 MHz were used. The results of this test are shown in Table 3.5-2 and 3.5-3. This test was performed with a representative sample of each antenna type that is to be used with this device. For measurements in the restricted band of 2.4835 – 2.5 GHz, a notch filter was employed. The notch filter was designed to pass only frequencies in this restricted band.



For measurements of all emissions above 3 GHz, a high pass filter was employed.



3.4.1 *Transmitter Conducted Spurious Emissions Data: Plan A*

The data shown below lists the significant emission frequencies, the limit and the margin of compliance. Numbers with a minus sign are below the limit.

Table 1: Antenna Conducted Emissions – Plan A

Company:	**ADTRAN, Inc.**	Tested by:	Jeremy O. Pickens
Model:	**TRACER 10BaseT Rackmount**	Location:	Duluth
Job No.:	**J20033434**	Detector:	HP8595E
Date:	01/04/01	Antenna:	NA
Standard:	FCC Part 15	PreAmp:	None
Class:	A	Cable(s):	HS1700N-N
Notes:	**Plan A**	Distance:	**NA**

Frequency GHz	Reading dB(uV)	Cable Loss dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB
Highest point of the fundamental					
2.427	105.0	1.0	106.0	NA	NA
All Measurements below are noise floor readings					
4.854	46.0	1.2	47.2	86.0	-38.8
7.281	52.9	1.0	53.9	86.0	-32.1
9.708	54.1	1.5	55.6	86.0	-30.4
12.135	54.8	2.0	56.8	86.0	-29.2
14.562	58.8	2.1	60.9	86.0	-25.1
16.989	59.9	2.9	62.8	86.0	-23.2
19.416	61.1	3.1	64.2	86.0	-21.8
21.843	64.6	4.3	68.9	86.0	-17.1
24.270	64.7	5.5	70.2	86.0	-15.8

TEST PERSONNEL:

Tester Signature

Jeremy O. Pickens / Senior Project Engineer
Typed/Printed Name

2/20/01
Date

3.4.2 Transmitter Conducted Spurious Emissions Data: Plan B

The data shown below lists the significant emission frequencies, the limit and the margin of compliance. Numbers with a minus sign are below the limit.

Table 2: Antenna Conducted Emissions – Plan B

Company:	**ADTRAN, Inc.**	Tested by:	Jeremy O. Pickens
Model:	**TRACER 10BaseT Rackmount**	Location:	Duluth
Job No.:	**J20033434**	Detector:	HP8595E
Date:	01/04/01	Antenna:	NA
Standard:	FCC Part 15	PreAmp:	None
Class:	A	Cable(s):	HS1700N-N
Notes:	**Plan B**	Distance:	**NA**

Frequency GHz	Reading dB(uV)	Cable Loss dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB
Highest point of the fundamental					
2.459	104.8	1.0	105.8	NA	NA
All Measurements below are noise floor readings					
4.918	46.0	1.2	47.2	85.8	-38.6
7.377	53.1	1.0	54.1	85.8	-31.7
9.836	54.1	1.5	55.6	85.8	-30.2
12.295	54.9	2.0	56.9	85.8	-28.9
14.754	59.3	2.1	61.4	85.8	-24.4
17.213	59.8	2.9	62.7	85.8	-23.1
19.672	64.6	3.1	67.7	85.8	-18.1
22.131	64.7	4.3	69.0	85.8	-16.8
24.590	65.4	5.5	70.9	85.8	-14.9

TEST PERSONNEL:

Tester Signature

Jeremy O. Pickens / Senior Project Engineer
Typed/Printed Name

2/20/01
Date

3.5 Radiated Emissions

The data shown below lists the significant emission frequencies, the limit and the margin of compliance. Numbers with a minus sign are below the limit.

The TRACER was terminated into a 50 ohm load at the end of a 1.5 meter coaxial cable installed on the antenna port of the transmitter section.

Table 3: Radiated Spurious Emissions, 30 - 1000 MHz

Company: **ADTRAN, Inc.**
Model: **TRACER 10BaseT**
Job No.: **J20033434**
Date: 11/08/00
Standard: FCC15
Class: A Group: None
Notes: Antenna Port terminated into 50 Ohms

Tested by: Shawn McGuinness
Location: Duluth
Detector: HP8546
Antenna: EMCO3141
PreAmp: None
Cable(s): CABLETW2 CABLEN2
Distance: **10**

Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB
V	50.400	22.0	5.1	1.1	0.0	0.0	28.2	39.1	-10.9
V	210.420	16.4	11.2	2.1	0.0	0.0	29.8	43.5	-13.7
V	303.500	18.8	14.2	2.7	0.0	0.0	35.7	46.4	-10.7
V	353.000	16.7	16.2	2.9	0.0	0.0	35.8	46.4	-10.6
H	454.300	17.6	17.7	3.4	0.0	0.0	38.7	46.4	-7.7
V	656.350	14.0	21.0	4.2	0.0	0.0	39.2	46.4	-7.2

Tester Signature

Shawn K. McGuinness / Project Engineer
Typed/Printed Name

Feb 20, 2001
Date

The data shown below lists the significant emission frequencies, the limit and the margin of compliance. Numbers with a minus sign are below the limit.

The TRACER was terminated into a 50 ohm load at the end of a 1.5 meter coaxial cable installed on the antenna port of the transmitter section.

Table 4: Radiated Spurious Emissions, 1000 - 22000 MHz

Company: **ADTRAN, Inc.**
Model: **TRACER 10BaseT**
Job No.: **J20033434**
Date: 11/08/00
Standard: FCC15
Class: A Group: None
Notes: Cushcraft Yagi Antenna

Tested by: Shawn McGuinness
Location: Duluth
Detector: HP8546
Antenna: EMCO3115
PreAmp: Hp1-26g
Cable(s): HS1700N-SMA HS7000N-SMA
Distance: **3**

Ant. Pol. (V/H)	Frequency MHz	Avg Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Avg Limit dB(uV/m)	Margin dB
V	2461.000	92.3	30.3	4.3	36.9	0.0	90.0	NA	NA
V	4923.000	47.5	34.9	6.0	36.4	0.0	52.0	60.0	-8.0
V	7385.000	44.5	37.5	6.6	36.4	0.0	52.2	60.0	-7.8
V	9845.000	44.6	38.6	8.1	37.3	0.0	54.0	60.0	-6.0

Tester Signature

Shawn K. McGuinness / Project Engineer
Typed/Printed Name

Feb 20, 2001
Date

3.6 AC Power Line-Conducted Emissions

For AC powered devices, line-conducted emissions testing is performed based on the requirements in §15.207.

* The TRACER was DC powered, and therefore, no line conducted testing was required.

3.7 *Power Spectral Density*

For direct sequence systems, the peak power spectral density conducted from the intentional radiator shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

Figure 3 and Figure 4 show the power spectral density for Plans A and B. These measurements were made with the antenna port of the TRACER directly connected to the spectrum analyzer.

For these measurements, the resolution bandwidth was set to 3 kHz, the span was set to 300 kHz, and the sweep time was 100 seconds. The highest peak reading for Plan A was 0.743 dBm, and the highest peak reading for Plan B was 0.202 dBm.

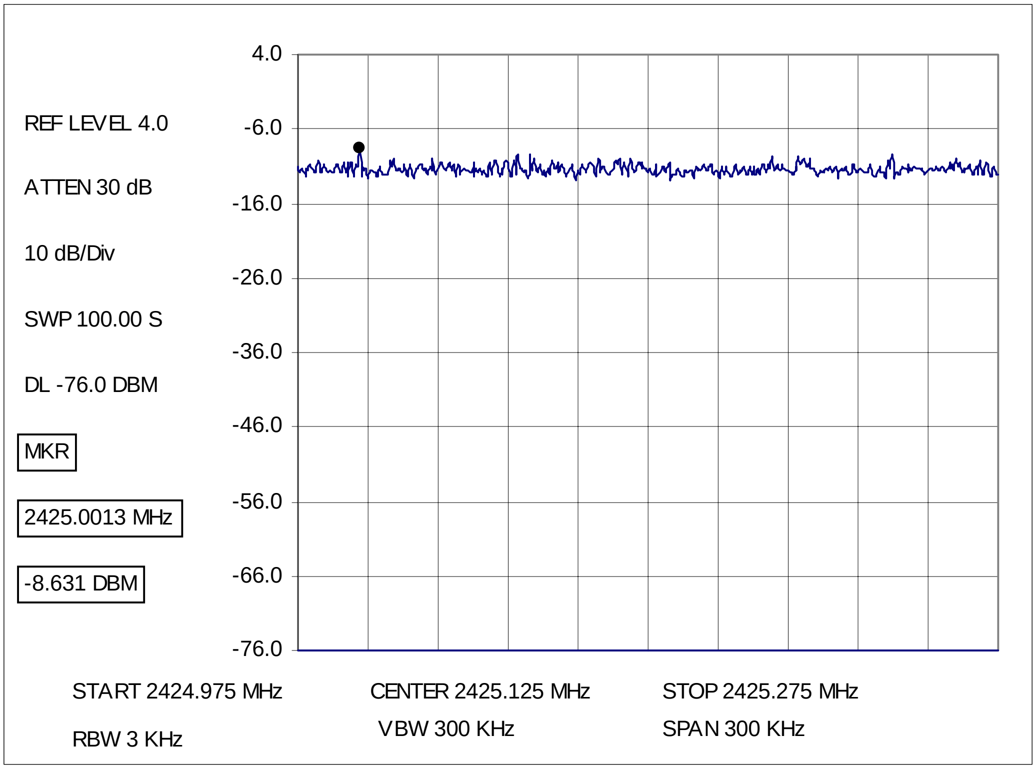


Figure 3: Power Spectral Density - Plan A

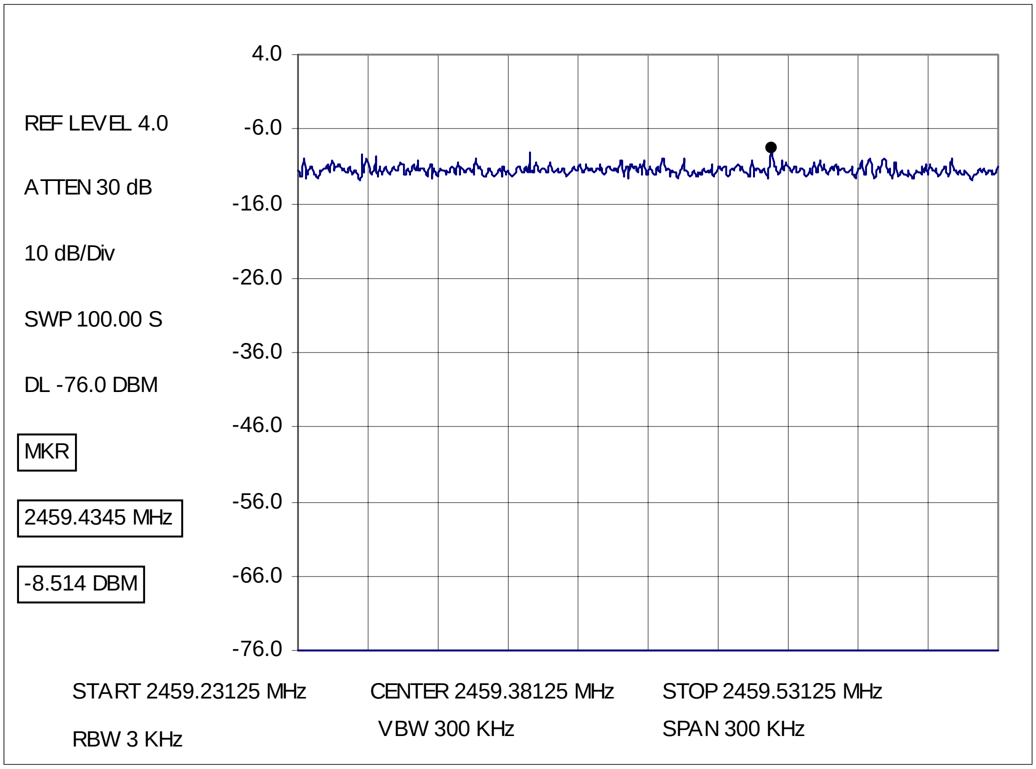


Figure 4: Power Spectral Density – Plan B

4.0 Miscellaneous Information

This miscellaneous information includes details of the measured bandwidth, the test procedure and calculation of factors such as pulse desensitization and averaging factor.

4.1 Discussion of Pulse Desensitization

The determination of pulse desensitivity was made in accordance with Hewlett Packard Application Note 150-2, *Spectrum Analysis ... Pulsed RF.*

4.2 Calculation of Average Factor

The detector functions for radiated emission measurements are peak and quasi-peak mode. Average readings, when required, were taken by measuring the duty cycle of the equipment under test and subtracting the corresponding amount in dB from the measured peak readings according to the following formula:

Average Factor in dB = 20 LOG (duty cycle)

The time over which the duty cycle was measured: 100 msec. The worst-case (highest percentage on) duty cycle was used and described specifically in the calculation contained in this section. A plot of the worst case duty cycle, if applicable, is also provided in this report.

Note: This EUT has a 100% duty cycle, and therefore, no correction applies.

4.3 Emissions Test Procedures

The following is a description of the test procedure used by Intertek Testing Services in the measurements of transmitters operating under Part 15, Subpart C rules. The test set-up and procedures described below are designed to meet the requirements of ANSI C63.4:1992.

The transmitting antenna under test was placed on a non-metallic antenna mast. The Baseband Processor (BBP) and Radio Frequency Convertor (RFC) were mounted in a 19” metal telecom rack. During the radiated emissions test, the turntable was rotated and any cables leaving the EUT were manipulated to find the configuration resulting in maximum emissions. The antenna height and polarization were also varied during the testing to search for maximum signal levels. The height of the antenna was varied from one to four meters.

The detector function for radiated emissions was quasi-peak mode. Average readings, when required (above 1 GHz), were taken with an average detector. The method of measurement is indicated in the data tables.

The frequency range scanned was from the lowest radio frequency signal generated in the device, which was greater than 9 kHz, to the tenth harmonic of the highest fundamental frequency or 40 GHz, whichever was lower. For line conducted emissions, the range scanned was 450 kHz to 30 MHz.

Conducted measurements were made as described in ANSI C63.4:1992. An IF bandwidth of 9 kHz was used, and quasi-peak detection was employed. The TRACER was DC powered from DC power supply, and therefore, no AC conducted emissions testing was performed.

The IF bandwidth used for measurement of radiated signal strength was 120 kHz or below 1000 MHz. Above 1000 MHz, a resolution bandwidth of 1 MHz was used.

All radiated measurements were taken at an EUT to antenna distance of three meters. Because the TRACER is a Class A device, a distance factor of 10.5 dB was employed.

5.0 Test Equipment

Located below is a table outlining the test equipment used in this evaluation.

Description	Make	Model	Serial #
EMI Receiver	HP	85462A	3650A00362
RF Filter Selector	HP	85460A	3704A00331
Spectrum Analyzer	HP	8566B	2134A01032
RF Preselector	HP	85685A	2602A00241
Q.P. Adapter	HP	85650A	2412A00382
PreAmp	HP	8449B	3008A0089
PreAmp	CDI	P950	PA2
BiLog Antenna	Chase	2245	CBL6112A
BiLog Antenna	Chase	2622	CBL6112B
Horn Antenna	EMCO	3115	9208-3919
Horn Antenna	AH Systems	SAS200/571	246
Antenna	EMCO	3141	9508-4166
Antenna	CDI	B100	685
Active Loop Antenna	EMCO	6507	9204-1283
Absorbing Clamp	Fischer	F-201	161
Cable	Huber-Suhner	HS1700N-SMA	NA
Cable	Huber-Suhner	HS7000N-SMA	NA

EXHIBIT 1: RF Block Diagram

EXHIBIT 2: Equipment Setup Photographs