Section 6

RF Exposure Information

Radio Frequency Radiation Exposure Evaluation

FCC Rules: 1.1307, 1.1310, 2.1091, 27.52

FCC Requirement: < 1mW/cm^2 General Population / Uncontrolled Exposure

Standard: IEEE Std C95.3 – 2002
FCC OET Bulletin 65

Procedure: The Motorola, Inc. 802.16e WiMAX device operates as a Time Division Duplex (TDD) product with a Time Division Multiplex (TDM) frame structure. The CPE*i*25300 Customer Premise Equipment device is able to transmit a time division duplex (TDD) signal up to a maximum 49.4 % transmit duty cycle. To measure the RF Exposure, the CPE transmitter is enabled in test mode and set to the maximum power level. Measurements are performed at the low, mid, and high channels of each channel bandwidth, using the maximum transmitter duty cycle and both antenna polarizations. Modulation was set to QPSK ¾ rate for 5 MHz channels and QPSK ½ rate for 10 MHz channels.

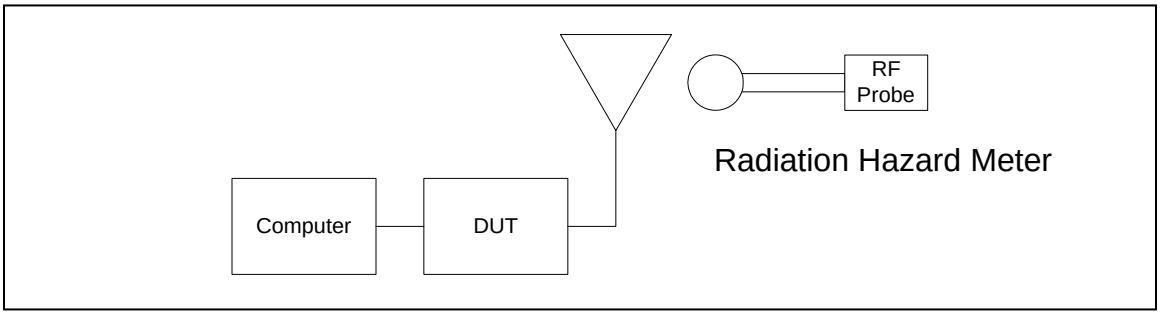
The transmitter power available at each of the internal antenna port connections was measured. To ensure that the spectrum analyzer was properly triggered to capture the transmission during the burst, a low level transmitter signal available on one of the non-selected ports was applied to the input port of the Analog Devices AD8319 log detector. The output signal from the AD8319 Log Detector is used to time gate the spectrum analyzer by triggering on the negative edge of the Vout signal.

Conditions: Frequency = 2499, 2593, 2687 MHz for 5 MHz emissions
2501, 2593 2685 MHz for 10 MHz emissions
Temperature = 25ºC
Supply Voltage = 120 VAC / 60 Hz Nominal to DUT Power Supply

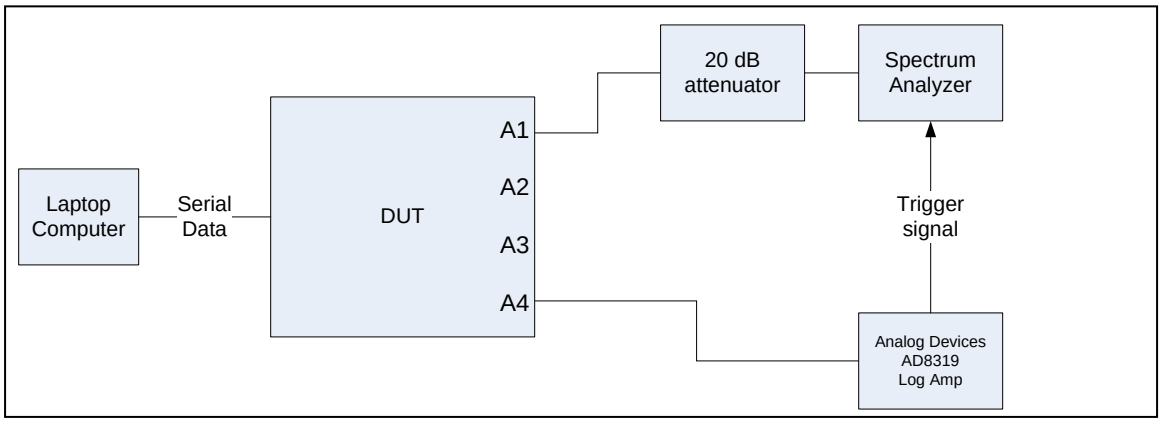
Test Equipment:

Test Equipment	Description
DUT	Motorola Customer Premise Equipment Model No. CPEi25300 S/N: TQ097W00PW
Spectrum Analyzer	Agilent E4440A S/N: MY44022791 Calibrated: 05/21/2007 Calibration due: 05/21/2009
Attenuator	20 dB, 1W Attenuator Pasternak Model PE7005-20 Calibrated by user
Trigger Signal	Log Detector Board, Analog Devices AD8319 (provides analyzer external trigger signal)
Laptop Computer (NN1303)	Dell Precision M65 S/N: CRFK 381 Calibration not required
Ethernet Switch	D-Link Model: DSS-5+ 5-port 10/100Mbps S/N: DT8615B009993 Calibration not required
CPE Power Supply	Delta Electronics, Inc. Model: EADP-24KB 12V, 2A, Rev. Level S4 S/N: HYW0728001507
Voltmeter	Fluke 87 V True RMS Multimeter S/N: 87180024 Measurement level verified with meter listed below
Digital Voltmeter	HP 34401A S/N: MY45001201 Calibrated: 5-4-2007 / Calibration due: 5-4-2009
Radiation Hazard Meter	General Microwave Corporation RAHAM Model 3 Calibrated: 12-21-2007 Calibration Due: 12-21-2009

Test Set-Ups:



Radiation Hazard Test Setup Diagram



Transmit Power Verification Test Setup Diagram

ANALOG DEVICES

1 MHz to 10 GHz, 40 dB Log Detector/Controller

AD8319

FEATURES

Wide bandwidth: 1 MHz to 10 GHz
High accuracy: ±1.0 dB over temperature
>40 dB dynamic range up to 8 GHz
Stability over temperature ±0.5 dB
Low noise measurement/controller output VOUT
Pulse response time: 8/10 ns (fall/rise)
Small footprint 2 mm x 3 mm CSP package
Supply operation: 3.0V to 5.5V @ 22 mA
Fabricated using high speed SiGe process

APPLICATIONS

RF transmitter PA setpoint control and level monitoring
Power monitoring in radiolink transmitters
RSSI measurement in base stations, WLAN, WiMAX, radar

FUNCTIONAL BLOCK DIAGRAM

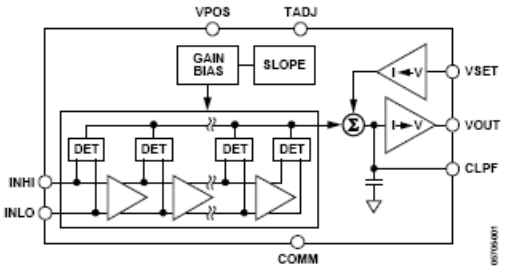


Figure 1.

GENERAL DESCRIPTION

The AD8319 is a demodulating logarithmic amplifier, capable of accurately converting an RF input signal to a corresponding decibel-scaled output. It employs the progressive compression technique over a cascaded amplifier chain, each stage of which is equipped with a detector cell. The device can be used in either measurement or controller modes. The AD8319 maintains accurate log conformance for signals of 1 MHz to 8 GHz and provides useful operation to 10 GHz. The input dynamic range is typically 40 dB (re: 50 Ω) with error less than ±1 dB. The AD8319 has 8/10 ns response time (fall time/rise time) that enables RF burst detection to a pulse rate of beyond 50 MHz. The device provides unprecedented logarithmic intercept stability vs. ambient temperature conditions. A supply of 3.0 V to 5.5 V is required to power the device. Current consumption is typically 22 mA, and it decreases to 200 μA when the device is disabled.

The AD8319 can be configured to provide a control voltage to a power amplifier or a measurement output from the VOUT pin. Because the output can be used for controller applications, special attention has been paid to minimize wideband noise. In this mode, the setpoint control voltage is applied to the VSET pin.

The feedback loop through an RF amplifier is closed via VOUT, the output of which regulates the amplifier's output to a magnitude corresponding to V_{SET}. The AD8319 provides 0 V to (V_{POS} − 0.1 V) output capability at the VOUT pin, suitable for controller applications. As a measurement device, VOUT is externally connected to VSET to produce an output voltage V_{OUT} that is a decreasing linear-in-dB function of the RF input signal amplitude.

The logarithmic slope is −22 mV/dB, determined by the VSET interface. The intercept is +15 dBm (re: 50 Ω, CW input) using the INHI input. These parameters are very stable against supply and temperature variations.

The AD8319 is fabricated on a SiGe bipolar IC process and is available in a 2 mm × 3 mm, 8-lead LFCSP_VD package for an operating temperature range of −40°C to +85°C.

The General Microwave RAHAM Model 3 isotropic broadband electromagnetic radiation hazard meter consists of a model 83A probe and model 481B meter. The model 83A probe employs three orthogonally-oriented thin-film thermoelectric arrays. This type of probe exhibits extremely good adherence to square-law characteristics such that the dc output from the thermocouple is proportional to the square of the electric field strength. The recorder output from the RAHAM meter is applied to the Fluke DVM. The dc level of the Recorder Output is recorded and then converted to the corresponding maximum permissible exposure value. The recorder output at a full scale reading is 124 mV. The measurements performed for this report utilize the 2 mW/cm^2 setting of the RAHAM instrument.

General Information:

The Motorola, Inc. CPE*i*25300 transmitter can apply up to 0.551 watts (27.41 dBm) of RF power, within a channel, to any one of the 4 internal antennas in the 2496-2690 MHz band. Only one antenna is selected during a transmit burst. The maximum power available at each antenna port is measured and the corresponding MPE of each antenna will be measured. The CPE*i*25300 has a maximum transmit duty cycle of 49.4 % and is based on a TDM frame (see test information at end of this report).

Each antenna has a maximum gain of 7.81 dBi. The maximum transmitter power of 27.41 dBm as reported in the 4Ba_FCC_Part27_Test_Report will be used for calculations. Therefore, the maximum radiated transmit power would be:

Burst Transmitter Power:
Pmax = Ptx(dBm) + G(antenna(dBi))
Pmax = 27.41 + 7.81 = 35.22 dBim
Pmax = 35.22 dBm EIRP = 3.3266 Watts EIRP

The equivalent transmitter power can be adjusted for sourced based transmitter duty cycles per 47CFR2.1091
Equivalent Transmitter Power for MPE calculations:
Pmax-eq = Ptx(dBm) + G(antenna(dBi)) – 10*log(duty cycle)
Pmax-eq = 27.41 + 7.81 + 10*log(0.494)
Pmax-eq = 27.41 + 7.81 – 3 = 32.22 dBm EIRP
Pmax-eq = 1.6672 Watts EIRP = 1667.2 mWatts EIRP

Calculations:

The following calculations can be used to determine the distance from the transmitting antenna that must be maintained to ensure that the exposure limit as defined in Table 1 of part 1.1310 (B) Limits for General Population / Uncontrolled Exposure. The formula for the following calculations are found in the OET Bulletin 65, edition 97-01 August 1997, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields".

The maximum equivalent power level from the previous calculations will be used.

$S = EIRP/4\pi R^2$
or
$R = (EIRP/4\pi S)^{0.5}$

2496-2690 MHz Band:

$S=1\ mW/cm^2$	$R=20\ cm$
$EIRP = 1.6672\ W$	$EIRP = 1.6672\ W$
$EIRP = 1667.2\ mW$	$EIRP = 1667.2\ mW$
$S = 1\ mW/cm^2$	$R = 20\ cm$
$R = (1667.2/(4*\pi*1))^{0.5}$	$S = 1667.2/(4*pi*20^2)$
$R = 11.52\ cm$	$S = 0.3317\ mW/cm^2$

Calculated safe distance from the transmitting antenna is 11.52 cm for a point source radiation element, or the maximum field strength for a point source radiation element at 20 cm would be 0.3317 mW/cm^2. A measurement of the signal strength at 20 cm from the antenna is detailed below. The measured values of S have been adjusted to include the current calibration factor of the radiation hazard meter.

Measurement calculations:

dc voltage recorded	$= 15.3\ mV$
Convert dc level to	$Sdc = (15.3\ mV * 2\ mW/cm^2) / 124\ mV$
	$= 30.6\ mVmW/cm^2 / 124\ mV$
	$= 0.247\ mW/cm^2$
Apply the calibration factor	$S = Sdc*CF$
	$= 0.247\ mW/cm^2 * 1.21$
S (MPE level)	$= 0.299\ mW/cm^2$

Test Results:

RSU*i25300* Antenna 1 20 cm from antenna surface (4 QAM)					
Channel	Bandwidth	Pmax (dBm)	Max Meter Voltage	Max S (mw/cm^2)	Corrected Max S (mw/cm^2)
2499.0	5 MHz	26.83	12.50	0.202	0.244
2593.0	5 MHz	26.55	12.40	0.200	0.242
2687.0	5 MHz	26.77	15.30	0.247	0.299
2501.0	10 MHz	26.44	12.70	0.205	0.248
2593.0	10 MHz	26.39	14.40	0.232	0.281
2685.0	10 MHz	26.25	13.00	0.210	0.254

RSU*i25300* Antenna 2 20 cm From CPE Antenna (QPSK)					
Channel	Bandwidth	Pmax (dBm)	Max Meter Voltage	Max S (mw/cm^2)	Corrected Max S (mw/cm^2)
2499.0	5 MHz	26.99	12.20	0.197	0.238
2593.0	5 MHz	26.72	11.00	0.177	0.215
2687.0	5 MHz	26.98	14.40	0.232	0.281
2501.0	10 MHz	26.62	11.90	0.192	0.232
2593.0	10 MHz	26.38	12.50	0.202	0.244
2685.0	10 MHz	26.44	11.90	0.192	0.232

RSU*i25300* Antenna 3 20 cm From CPE Antenna (QPSK)					
Channel	Bandwidth	Pmax (dBm)	Max Meter Voltage	Max S (mw/cm^2)	Corrected Max S (mw/cm^2)
2499.0	5 MHz	27.01	11.00	0.177	0.215
2593.0	5 MHz	26.66	12.50	0.202	0.244
2687.0	5 MHz	27.38	12.20	0.197	0.238
2501.0	10 MHz	26.37	9.90	0.160	0.193
2593.0	10 MHz	26.45	13.60	0.219	0.265
2685.0	10 MHz	26.43	12.30	0.198	0.240

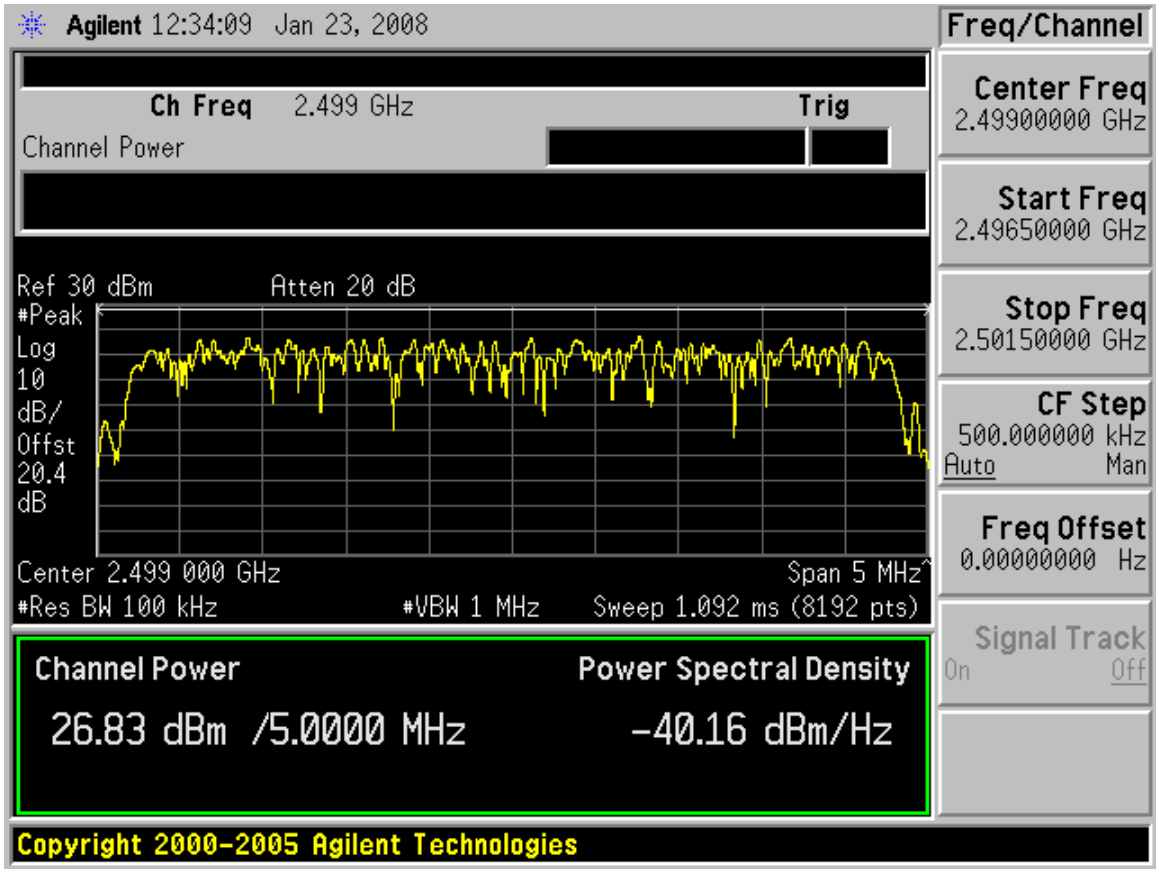
RSU*i25300* Antenna 4 20 cm From CPE Antenna (QPSK)					
Channel	Bandwidth	Pmax (dBm)	Max Meter Voltage	Max S (mw/cm^2)	Corrected Max S (mw/cm^2)
2499.0	5 MHz	26.87	10.70	0.173	0.209
2593.0	5 MHz	26.11	10.80	0.174	0.211
2687.0	5 MHz	26.83	12.30	0.198	0.240
2501.0	10 MHz	26.49	11.20	0.181	0.219
2593.0	10 MHz	26.40	12.40	0.200	0.242
2685.0	10 MHz	26.47	12.30	0.198	0.240

Test Conclusion:

The Motorola, Inc. CPEi25300 product is below the limit for RF Exposure as detailed in the FCC 47CFR1.1310 requirement for General Population / Uncontrolled Exposure.

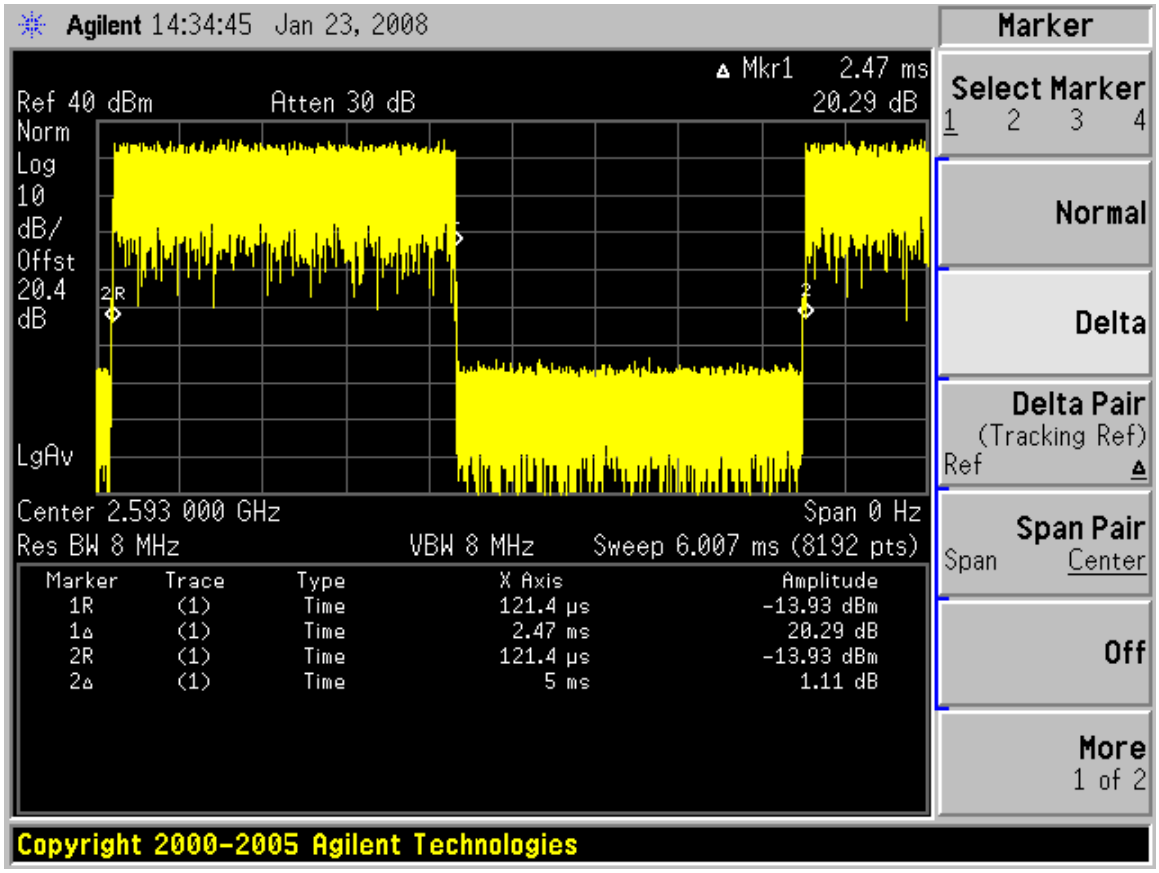
An appropriate RF exposure compliance statement is included in the user's manual.

Transmitter Power Measurement Plot Example:



Antenna Port 1 / Channel BW = 5 MHz

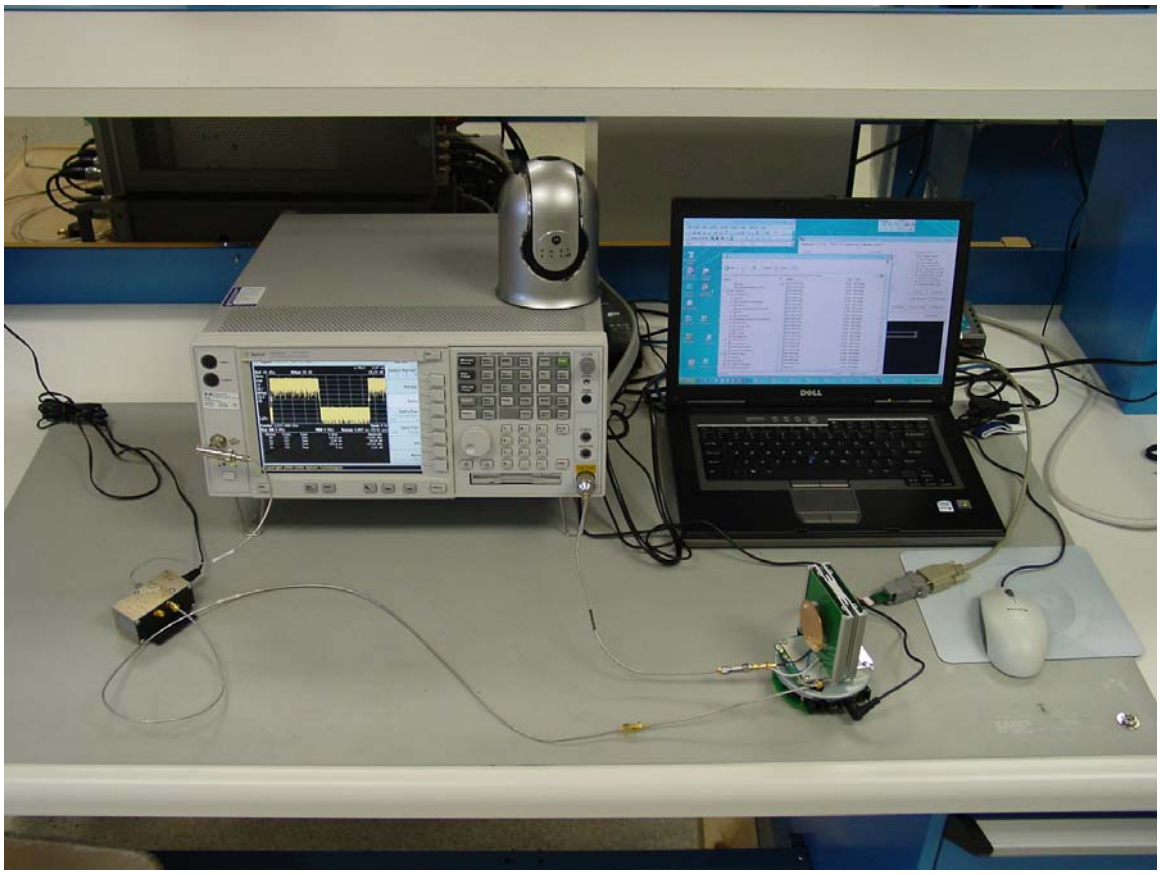
Verification of the Maximum Transmit Duty Cycle is Shown Below:



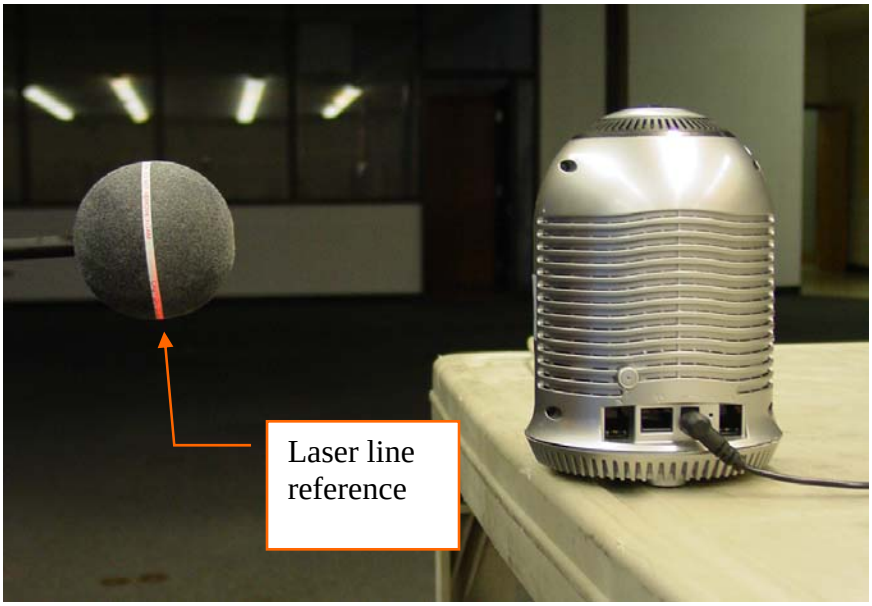
Time for one complete transmit cycle is 5 msec

Transmit on time is 2.47 msec
Transmit duty cycle = transmit time / time between repetition
Transmit duty cycle = 2.47 msec / 5 msec = .494 or 49.4 %

Test Setup Photos:



Transmitter power verification



Radiation Hazard Setup

Setting Laser Level for 20 cm

Radiation Hazard Test Setup