

UPLINK EIRP

One of the more important rules for communicating with satellites is to use the proper power (Effective Isotropically Radiated Power or EIRP) when transmitting to the satellite. Uplink EIRP is a combination of power transmitted by a transmitter and gain added to the transmitter by an antenna minus any cable losses. Uplink EIRP is referenced after the antenna contribution before any free space loss is encountered. First, a quick review of a decibel is in order.

Decibel (as referenced to 50 ohm systems for satellite transmitters)

A decibel (as applied to system gain or loss) is defined by the equation:

$$dB = 10 * \text{Log}_{10} \left(\frac{P_{out}}{P_{in}} \right)$$

(Pin and Pout represent the power into and out of a system.)

A dBm is a decibel relative to a milliWatt. It is defined by the decibel equation with Pin set at $1 * 10^{-3}$ (1 milliwatt) or

$$dB = 10 * \text{Log}_{10} \left(\frac{P_{out}}{1 * 10^{-3}} \right)$$

The dBm equation is used to convert a power in watts to dBm as shown in the following chart:

Power Output in Watts	Power Output in dBm
0.001	0.00
0.01	10.00
0.1	20.00
1.00	30.00
2.00	33.01
3.00	34.77
4.00	36.02
5.00	36.99
6.00	37.78
7.00	38.45
8.00	39.03
8.50	39.29
9.00	39.54
10.00	40.00
12.00	40.79
15.00	41.76
18.00	42.55
20.00	43.01
25.00	43.98

To calculate the EIRP of a system, use the following equation: (This is considered the uplink EIRP and is not necessarily the power received by the satellite.)

$$\text{EIRP(dBm)} = \text{Transmit Power(dBm)} + \text{Antenna Gain(dB)} - \text{Cable Loss(dB)} - \text{Connector Loss(dB)}$$

EXAMPLE: A transmitter outputs 8.5 watts with an 11 dB gain antenna, cable loss is 1.2 dB, and connector losses are 0.25 dB.

Assume that the antenna is directly pointed at the satellite. The uplink EIRP is : $\text{EIRP} = 39.29 \text{ dBm} + 11.0 \text{ dB} - 1.2 \text{ dB} - .25 \text{ dB} = 48.84 \text{ dBm EIRP}$

WARNING: NESDIS requires that under all service conditions, with any platform directed to the GOES series satellite that the uplink EIRP never exceed +50 dBm.

THE DECIBEL AS APPLIED TO 600 OHM APPLICATIONS

Telephone, private line or twisted pair applications, are standardized on 600 Ohm impedance. Telephone companies supply line signal level information typically in terms of dB and dBm and the customer may at times have the need to measure the level of the signals in or out of his modem with a voltmeter or oscilloscope. The following equation from above is:

$$dB = 10 * \text{Log}_{10} \left\{ \frac{\text{Power}}{1 * 10^{-3}} \right\}$$

Using the following substitution:

$$\text{Power} = \left\{ \frac{V_{rms}^2}{R} \right\} = \frac{(V_p * .707)^2}{600}$$

Then:

$$dBm = 10 * \text{Log}_{10} \left\{ \frac{(V_p * .707)^2}{1 * 10^{-3} * 600} \right\} = \frac{(V_p * .707)^2}{.6}$$

And, finally, since

$$V_p = \frac{V_{p/p}}{2}$$

then:

$$dB = 10 * \text{Log}_{10} \left\{ \frac{(V_p * .707)^2}{2.4} \right\}$$