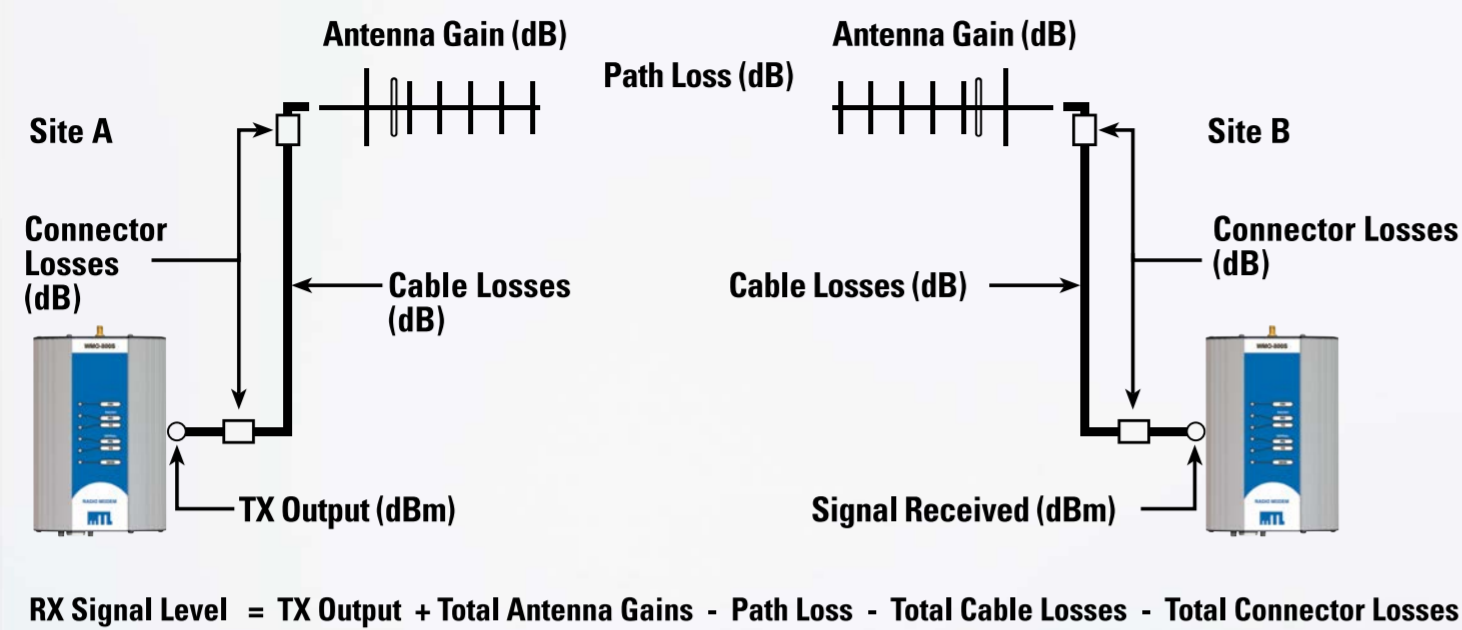


RADIO PATH COMPARISONS

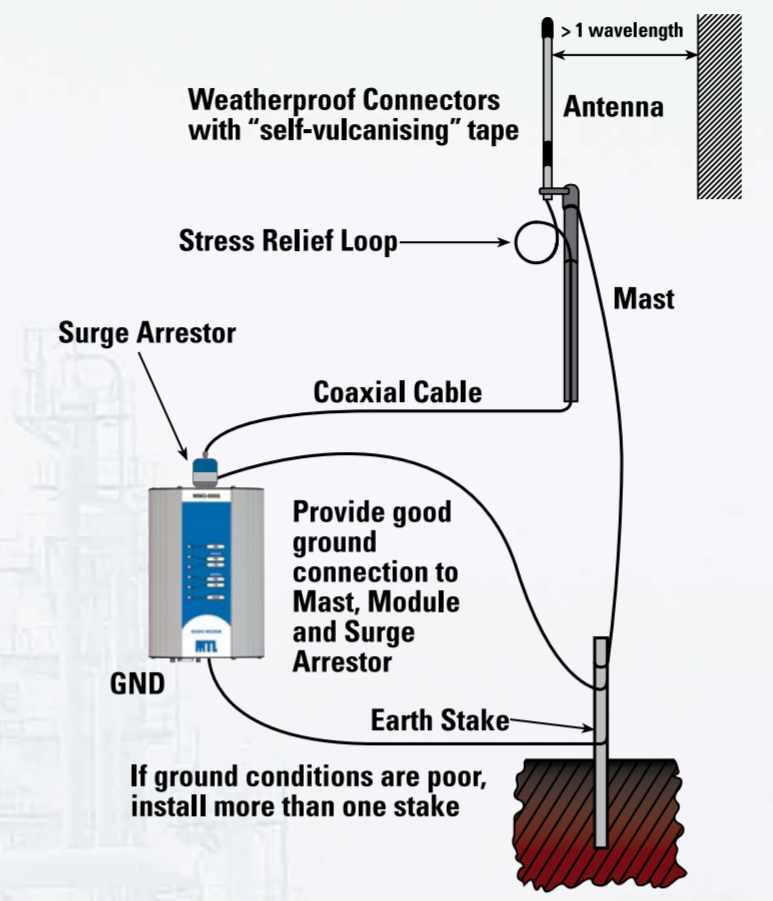


POWER CONVERSION

Power Conversion	
1mW	0 dBm
10mW	10 dBm
32mW	15 dBm
50mW	17 dBm
100mW	20 dBm
200mW	23 dBm
500mW	27 dBm
1W	30 dBm
2W	33 dBm
5W	37 dBm
10W	40 dBm

$\text{dBm} = 10 \log_{10} [\text{RF Power in mW}]$

INSTALLATION GUIDE



TYPICAL LINE-OF-SIGHT DISTANCES

Frequency Band	Km
2.4 GHz 36dBm / 4W EIRP 802.11 (America/Canada)	3 - 8
2.4 GHz 20dBm / 100mW EIRP 802.11 (Europe)	0.5 - 1
2.4 GHz 27dBm / 500mW EIRP 802.11 (Australia)	1 - 3
900 MHz 36dBm / 4W EIRP FHSS (America/Canada)	15 - 30
900 MHz 30dBm / 1W EIRP FHSS (Latin America/Australia)	8 - 15
869 MHz 27dBm / 500mW EIRP Fixed Frequency (Europe)	5 - 10
450 MHz 37dBm / 5W (Licensed frequencies)	35 - 100
433 MHz 27dBm / 500mW EIRP Fixed Frequency (Europe)	5 - 15
433 MHz 10dBm / 10mW EIRP Fixed Frequency (Europe)	1 - 2
472 MHz 20dBm / 100mW EIRP (Australia)	5 - 10

HAZARDOUS AREA RADIO FREQUENCY POWER THRESHOLDS (IEC 60079-0 ED 5.0)

Equipment for	Threshold power W	Thermal initiation time (averaging period) μs
Group I	6	200
Group IIA	6	100
Group IIB	3.5	80
Group IIC	2	20
Group III	6	200

ANTENNA SPECIFICATIONS

Antenna	Gain	Gain dBd	Beamwidth 'E'	Beamwidth 'H'
16 Element Yagi	15dBi	13dBd	32°	35°
9 Element Yagi	12dBi	10dBd	36°	44°
6 Element Yagi	9dBi	7dBd	46°	50°
3 Element Yagi	6dBi	4dBd	57°	76°
Collinear 8dB	8dBi	6dBd	13°	-
Collinear 5dB	5dBi	3dBd	30°	-
Dipole	2dBi	0dBd	78°	-
1/4 Wave Whip	-3 to 0 dBi	-	-	-

ANTENNA MATCH

VSWR	Return Loss	Transmission Loss
1.0:1	Inf.	0.0 dB
1.2:1	20.83 dB	0.036 dB
1.5:1	13.98 dB	0.177 dB
5.5:1	3.19 dB	2.834 dB

CONNECTOR TYPES



FREQUENCY SPECIFICATIONS

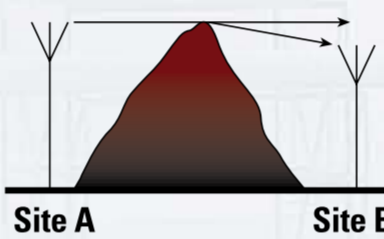
Designation	Abbreviation	Frequencies	Free-Space Wavelengths
Very Low Frequency	VLF	9kHz - 30kHz	33 km - 10 km
Low Frequency	LF	30kHz - 300kHz	10 km - 1 km
Medium Frequency	MF	300kHz - 3MHz	1 km - 100 m
High Frequency	HF	3MHz - 30MHz	100 m - 10 m
Very High Frequency	VHF	30MHz - 300MHz	10 m - 1 m
Ultra High Frequency	UHF	300MHz - 3GHz	1 m - 100 mm
Super High Frequency	SHF	3GHz - 30GHz	100 mm - 10 mm
Extremely High Frequency	EHF	30GHz - 300GHz	10 mm - 1mm

ANTENNA CABLE SPECIFICATIONS

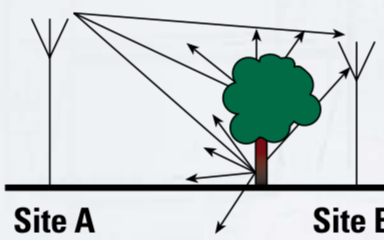
Cable Type	Min Bend (mm)	Outer Dia (mm)	@ 2.4 GHz dB per 100 ft (30m)	@ 800-900 MHz dB per 100 ft (30m)	@ 400 MHz dB per 100 ft (30m)
RG58	51	5	-34.2	-16.5	-10.6
RG58 Cellfoil	51	5	-18	-9	-7.2
RG213	127	10	-14.5	-8	-5.2
LMR400	26	11	-6.8	-3.9	-2.7
LMR600	38	13	-4.4	-2.5	-1.7
LDF2-50	95	11	-5.7	-3.3	-2.3
LDF4-50	125	16	-3.7	-2.2	-1.6

PROPAGATION MECHANISMS

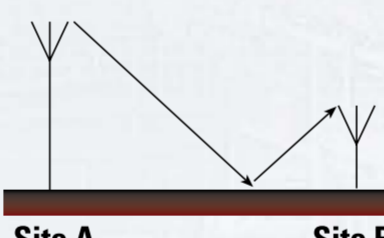
DIFFRACTION



SCATTERING



REFLECTION



GENERAL GUIDELINES

$$\text{Wavelength (m)} = \frac{300}{\text{Frequency (MHz)}}$$

EFFECT OF CHANGING FREQUENCY
4 times the frequency gives half the distance

EFFECT OF CHANGING POWER
4 times the power (6dB) gives twice the distance

When installing Antennas - Height increases range

WIRELESS UNITS

dB = decibel, (10 Log₁₀ ratio)

- dBi = decibels relative to isotropic antenna
- dBd = decibels relative to dipole antenna
- dBW = decibels relative to one watt
- dBm = decibels relative to one milliwatt
- dBV = decibels relative to one volt
- dBuV = decibels relative to one microvolt

TYPICAL WIRELESS STANDARDS

Region	Standard	Device Type
Europe	R&TTE Directive 1999/5/EC	CE Mark
	EN 60950	Safety
	EN 301 489-3	EMC - unlicensed
	EN 301 489-5	EMC - licensed
	EN 300 086	Licensed analogue radio
	EN 300 113-2	Licensed data radio
USA	EN 300 220-3	Unlicensed data <1GHz
	EN 300 328	Unlicensed data in 2.4GHz band
	FCC Part 15.247	Spread spectrum devices
Canada	FCC Part 15	EMC
	FCC Part 90	Licensed radio
Australia / New Zealand	RSS210	Spread spectrum devices
	RSS119	Licensed radio
Japan	AS NZS 4295	Licensed analogue radio
	AS NZS CISPR22	EMC

FREQUENCY BANDS

Country	Spread Spectrum	Fixed Frequency
USA / Canada	License-free, up to 4W EIRP	450 MHz band licensed, to 5W
Mexico & Latin America	License-free, up to 1W EIRP	400 MHz band licensed, to 5W
Europe	2.4GHz only - License-free up to 100mW	869 MHz license-free 5mW
		869 MHz license-free 500mW
		400-500 MHz license-free channels 10mW - 500mW (some countries)
Australia / New Zealand	License-free, up to 1W EIRP	370 - 520 MHz licensed channels, to 5W
China		472 MHz license-free, 100mW
Japan		370 - 520 MHz licensed channels, to 5W
Asia	License-free in some countries	426 MHz license-free 10mW
Middle East	License-free in some countries	370 - 520 MHz licensed channels, to 5W
South Africa		869 MHz license-free 500mW
Africa	License-free in some countries	433 MHz license-free, 100mW
		370 - 520 MHz licensed channels, to 5W

