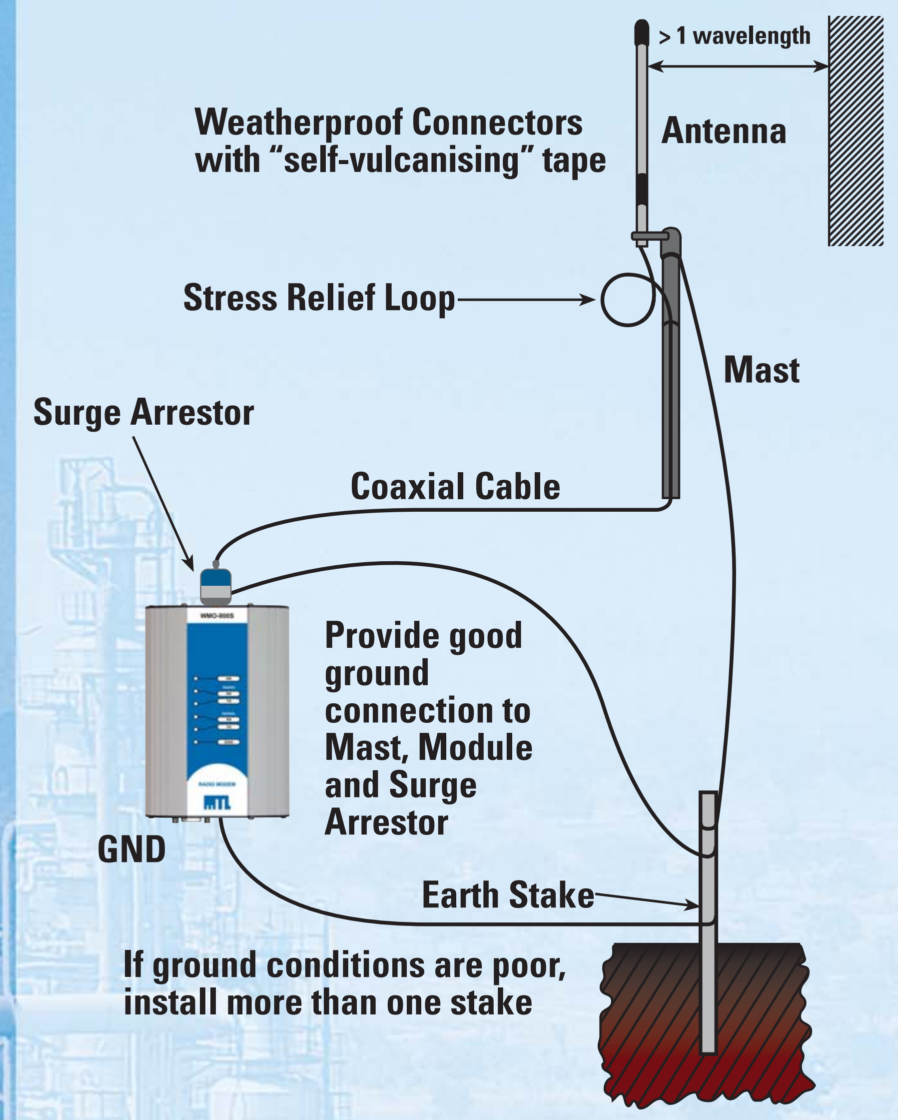
# Working Wireless

MTL Instruments

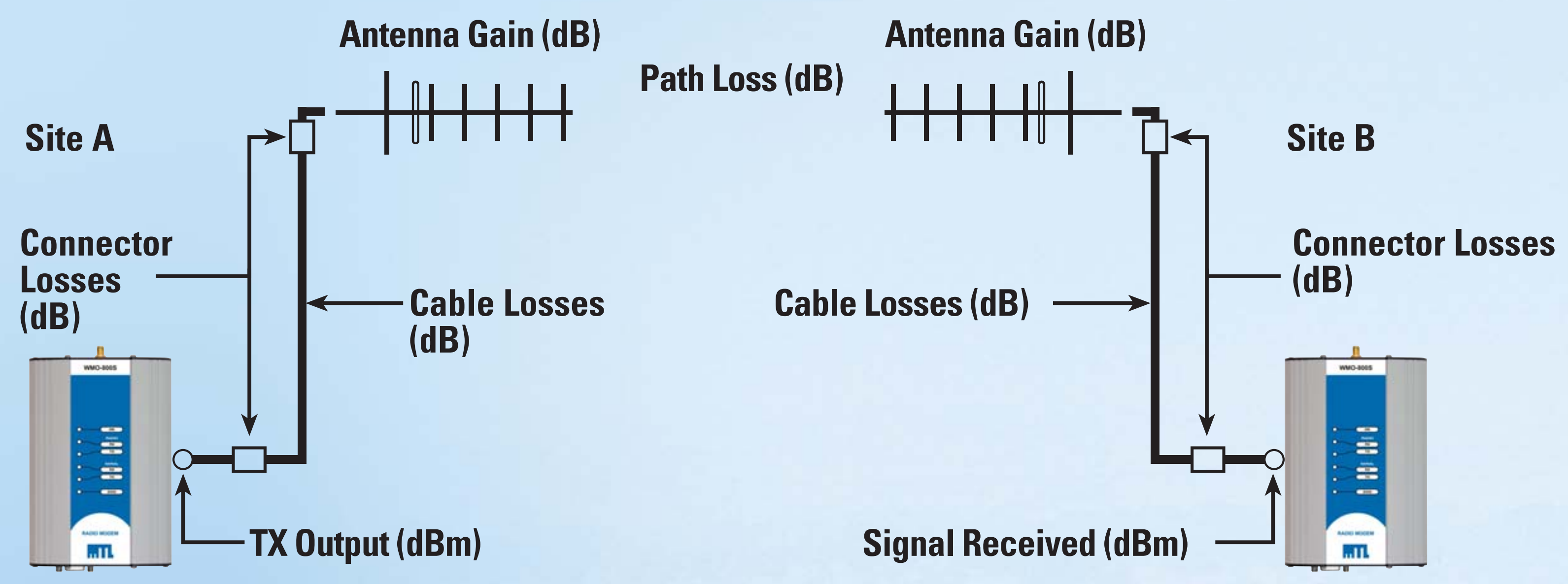
## INSTALLATION GUIDE




## 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 |

## RADIO PATH COMPARISONS




RX Signal Level = TX Output + Total Antenna Gains - Path Loss - Total Cable Losses - Total Connector Losses

## 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 |

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

## 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

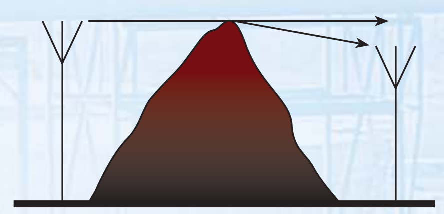
| Antenna | Gain | Gain dBd | Beamwidth 'E' | Beamwidth 'H' |
|---|---|---|---|---|
| 16 Element Yagi | 15dBi | 13dBd | 32° | 35° |
| 9 Element Yagi | 12dBi | 10dBd | 36° | 44° |
| 6 Element Yagi | 9dBi | 7dBd | 46° | 50° |
| 3 Element Yagi | 6dBi | 4dBd | 57° | 76° |
| Collinear 8dB | 8dBi | 6dBd |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

## ANTENNA MATCH

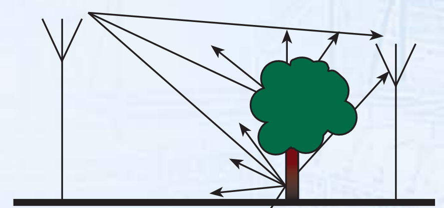
| VSWR | Return Loss | Transmission Loss |
|---|---|---|
| 1.0:1 | Inf. | 0.0 dB |
| 1.2:1 | 20.83 dB | 0.036 dB |
| 1.5:1 | 13.98 dB | 0.177 dB |
| 5.5:1 | 3.19 dB | 2.834 dB |

## PROPAGATION MECHANISMS

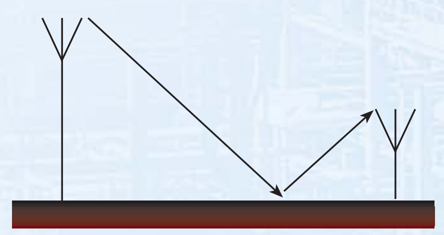
### DIFFRACTION




### SCATTERING




### REFLECTION




## WIRELESS UNITS

dB = decibel , (10 $\log_{10}$ ratio )

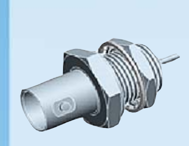
dBi = decibels relative to isotropic antenna
dBd = decibels relative to dipole antenna
dBW = decibels relative to one watt
dBm = decibels relative to one milliwatt
dBV = decibels relative to one volt
dBuV = decibels relative to one microvolt

## WIRELESS PRODUCT SERIES QUICK REFERENCE

| MTL Product | Serial | Ethernet | I/O | Frequency / power |
|---|---|---|---|---|
| WLN-2000 | RS232/RS485 | 10/100 BaseT | 1 DIO | 2.4 & 5GHz / 15-400mW |
| 9469-ET (I.S.) | - | 10/100 BaseT | - | 2.4 & 5 GHz / 100mW |
| WMO-400S | RS232/RS485 | - | 1 DIO | 430-490MHz / 10mW-5W |
| WMO-800S | RS232/RS485 | - | - | 869MHz / 500mW & 5mW |
| WMO-900S | RS232/RS485 | - | - | 900MHz FHSS / 1W |
| WIO-800L | - | - | 2DI/O, 1AI/O, T/C | 869MHz / 500mW & 5mW |
| WIO-900L | - | - | 2DI/O, 1AI/O, T/C | 900MHz FHSS / 1W |
| SIO-100S | RS232/RS485 | - | Up to 16 DIO, 8AI/O | - |

## CONNECTOR TYPES

N-Type



BNC

SMA

## 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 |

## 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

## TYPICAL WIRELESS STANDARDS

| 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 |
| EN 300 220-3 | Unlicensed data <1GHz |
| EN 300 328 | Unlicensed data in 2.4GHz band |
| **USA** | |
| FCC Part 15.247 | Spread spectrum devices |
| FCC Part 15 | EMC |
| FCC Part 90 | Licensed radio |
| **Canada** | |
| RSS210 | Spread spectrum devices |
| RSS119 | Licensed radio |
| **Australia / New Zealand** | |
| 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<br>869 MHz license-free 500mW<br>400-500 MHz license-free channels<br>10mW - 500mW (some countries)<br>370 - 520 MHz licensed channels, to 5W |
| Australia / New Zealand | License-free, up to 1W EIRP | 472 MHz license-free, 100mW<br>370 - 520 MHz licensed channels, to 5W |
| China | | 220 - 235 MHz, licensed, 5W<br>370 - 520 MHz licensed channels, to 5W |
| Japan | | 426 MHz license-free 10mW |
| Asia | License-free in some countries | 370 - 520 MHz licensed channels, to 5W |
| Middle East | License-free in some countries | 370 - 520 MHz licensed channels, to 5W |
| South Africa | | 869 MHz license-free 500mW<br>433 MHz license-free, 100mW<br>370 - 520 MHz licensed channels, to 5W |
| Africa | License-free in some countries | 370 - 520 MHz licensed channels, to 5W |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