MTL wireless connectivity

CROUSE-HINDS
SERIES

Flexible wireless solutions for industrial applications

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In today's process industries there is increasing demand for greater efficiency, higher reliability and lower cost of ownership throughout the lifetime of a project. These demands are placed directly on field equipment and supporting networks. Technological advancement over the past decade has enabled a wide array of wireless devices to be deployed both into safe and hazardous areas, bringing with it the benefits of mobility, ease of installation and diagnostic capability. Communication standards are evolving to satisfy industrial requirements and to enhance the reliability and security of wireless networks. This makes wireless technology a more viable option for monitoring, control and network infrastructure.

Our range of wireless products can be selected and customised for operation in both license and license-free RF bands in many countries.

MTL offers end-to-end or part solutions to meet the requirements of your project. From plant-wide 802.11 network infrastructure in hazardous areas to simple transducer cable replacement, **MTL** brings the experience and the products to offer robust and secure wireless systems. **MTL** wireless technology supports industry standard connections and protocols, maximizing flexibility and reducing inventory costs.

Wireless technology can be used to solve physical problems such as:

- **Cabling repeatedly damaged or EMC issues on site**
- **Mobile data access (personnel, rotating machines, vehicles)**
- **Large communication distances**
- **Harsh or protected environments**

In addition to the above solutions, wireless technology can bring benefits and flexibility to a new or completed project beyond that of a purely cabled solution.

Benefits of wireless systems include:

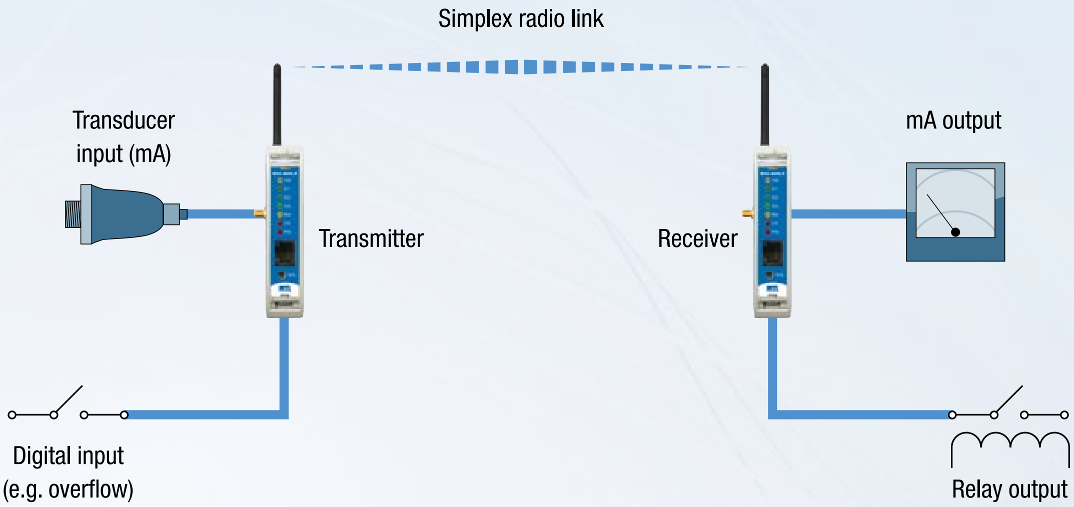
- **Simpler installation options; pulling cable through walls and ceiling can increase complexity**
- **Improved commissioning options; some wireless systems can be tested before installation**
- **Improved scalability; wireless networks are simpler to scale than wired equivalents.**
- **Increased mobility; wireless networks enable personnel to perform diagnostics remotely**

MTL can advise on the usage of wireless in an application and provide advice on different solutions.

MTL Wireless Applications

Cable replacement

Cabling a sensor into a monitoring system can exceed the cost of the measurement equipment. Significant time can also be spent on installation which ultimately affects decisions on whether a variable is monitored or not. MTL wireless networks make it **more cost effective** to deploy a sensor or transducer link. Real cost benefits can be seen for distances over 200 metres and in some cases at even shorter ranges. The MTL cable replacement solution is **easy to install** without configuration, reducing installation and commissioning time scales.



Safe link checking

Link status and signal strength indications are **easily accessible** with the MTL solution to allow monitoring of the wireless communications. Encryption can be enabled to render any data being sent over the wireless link inaccessible to a third party.

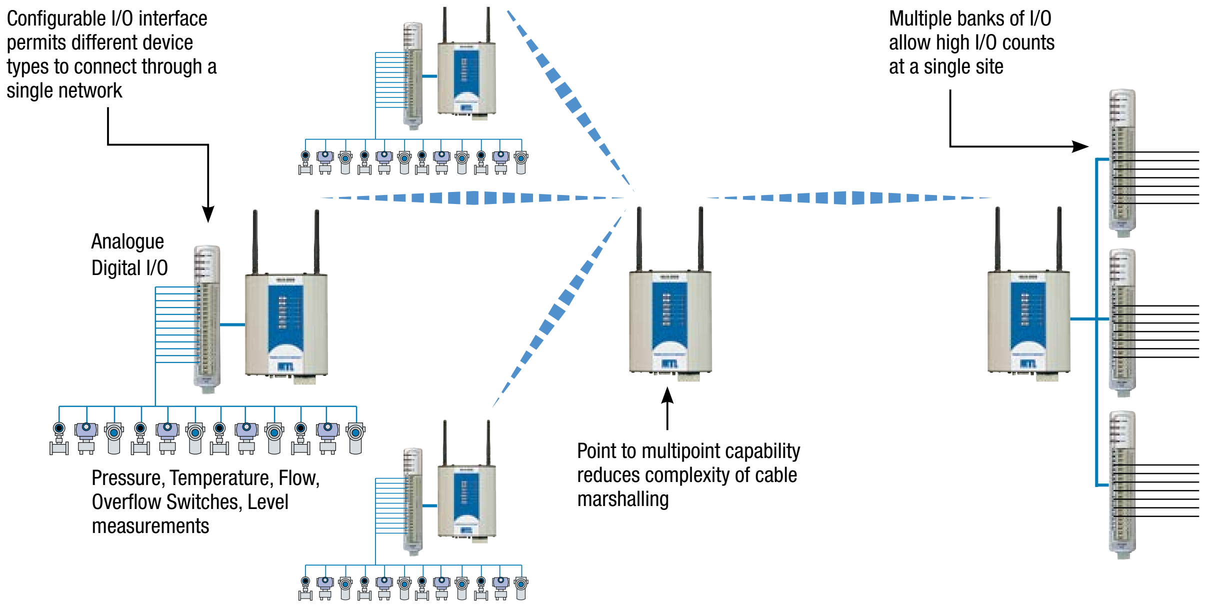
MTL Wireless goes the distance

MTL cable replacement can be deployed to communicate from **several metres to several km.** This ensures that the signal data is available where and when it is needed. License-free operation in lower frequency bands provides communication where line of sight is not possible, for example through a building, structure or factory. Wireless point to point communications can also be deployed to **communicate site information** such as supply voltage and reducing the need for site visits.
The Result? More time is spent on analysing data rather than collecting it.

Monitoring more with less

Multi-purpose sensor I/O networks

Transferring sensor data back to the control room or for output on a remote location can require complex cabling and marshalling. **MTL's sensor I/O** interfaces can be deployed to send and receive sensor signal data from **multiple devices** using 4-20mA, 0-10V or digital inputs and outputs. Several banks of I/O can be connected to a single radio and then send over a distance through point to point, point to multipoint or meshing repeater networks.



Maximum sensor support

MTL I/O interfaces can be configured to **support 0/4-20mA, 0-10V and digital I/O, all on one device.** This allows different device types to connect through the same network while converting between different signal types.

Need to connect and convert between mA and voltage sensor signals? MTL can provide a reliable and secure way to meet these needs.

Change of state or deterministic system design

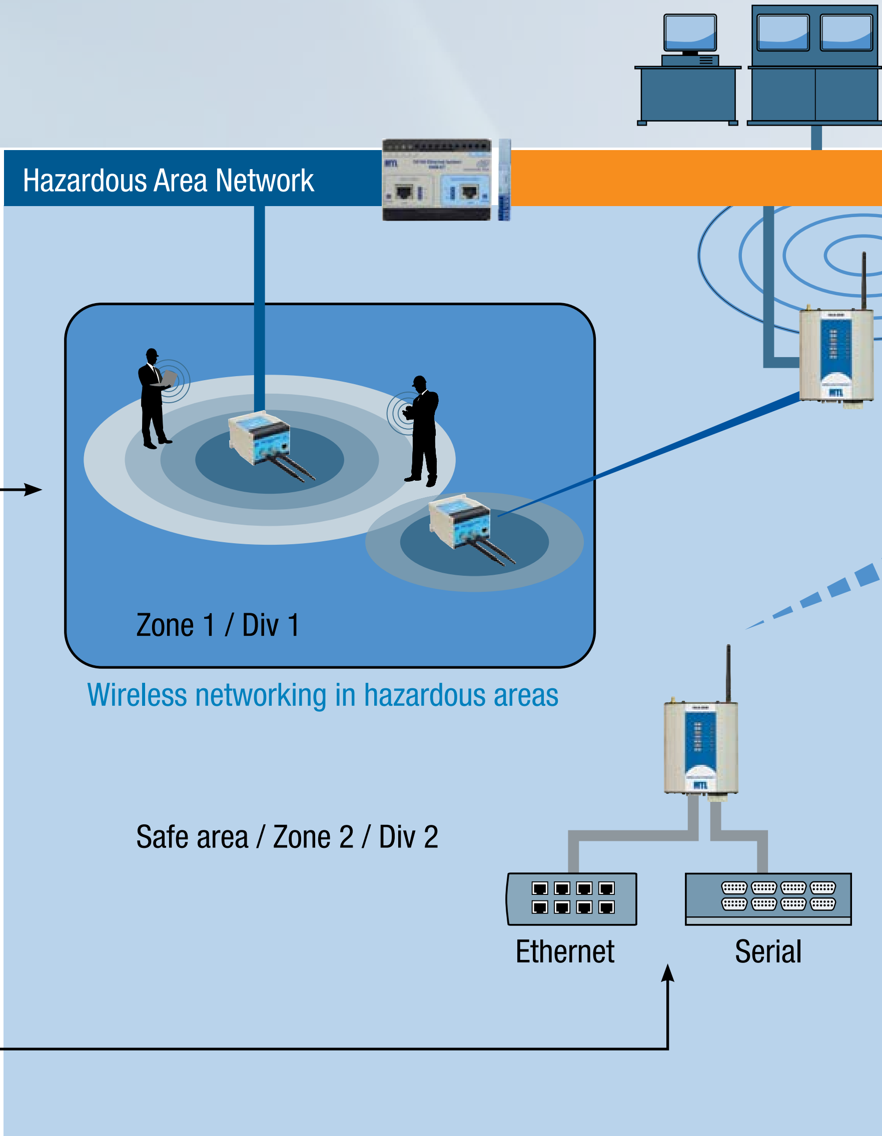
The problem with many polling based systems is that there can be delays in receiving important information. The ability to distinguish between urgent and non-urgent data is necessary in many process networks. On a single site there can be several system requirements. Immediate reporting of alarms, for example, is necessary in most cases. In other cases timed updates are required to ensure that network traffic volumes can be tightly controlled and calculated. MTL recognises these different needs and **MTL sensor I/O networks support both of these network types.** Digital alarm data can be sent immediately while other data can be sent on a timed update to reduce network traffic, fulfilling these requirements.

Wireless Network Infrastructure

MTL offers **complete** robust solutions for wireless network infrastructure both in and out of hazardous areas. MTL can extend the plant network into Zone 1 / Div 1, Zone 2 / Div 2 and safe areas making network and device data easily and securely accessible across a plant.

Intrinsically safe **wireless Ethernet** access points and clients promote safe operation and reduce maintenance costs.

Multiple end devices connected to a single MTL wireless product reduces network interfacing costs

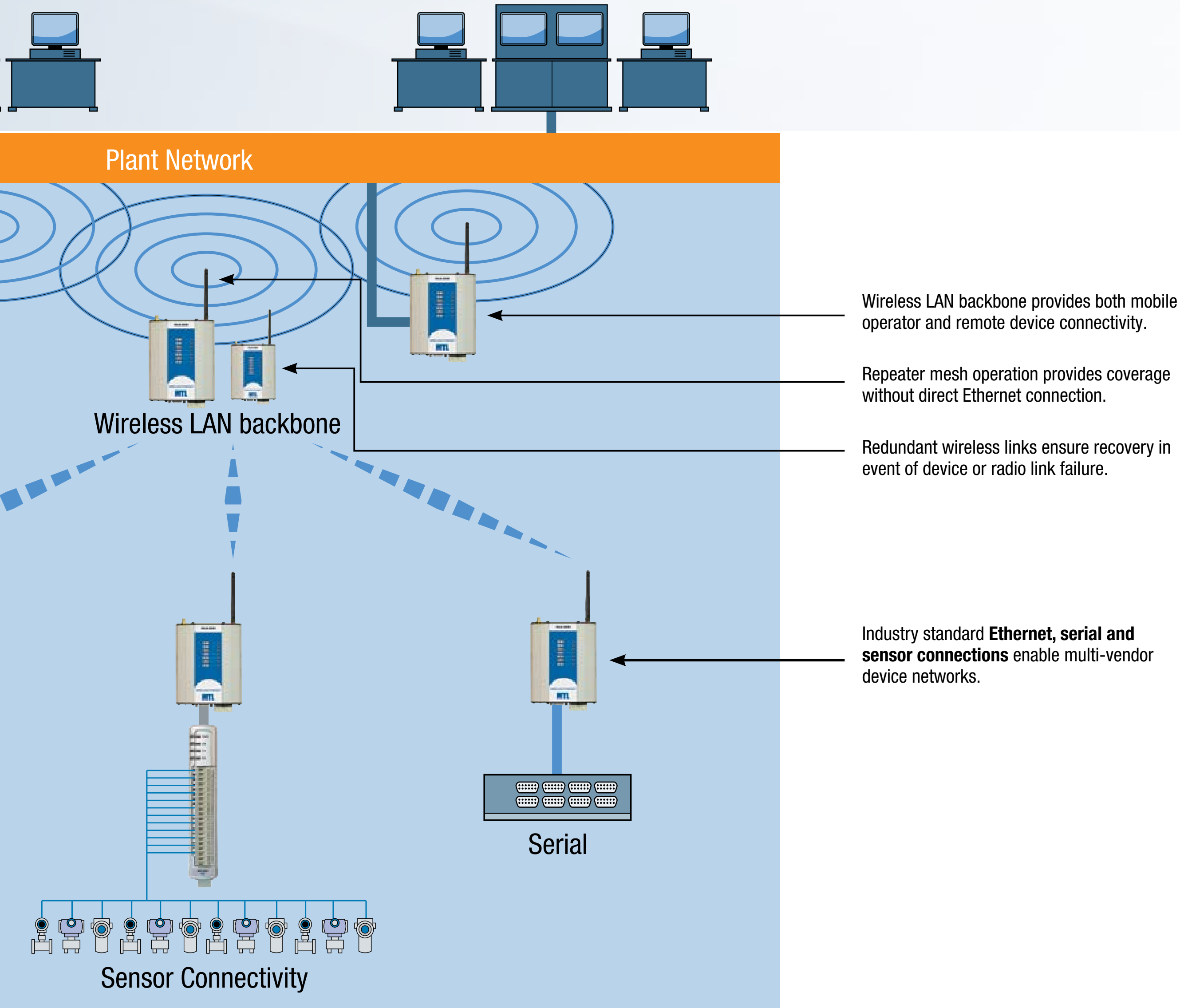


Live maintenance in hazardous areas

Intrinsic safety (I.S.) provides completely **safe operation** in hazardous areas reducing the risks associated with electrical devices in a potentially hazardous area. **Products are live workable,** meaning that in many situations gas clearance certificates are not required to work on the I.S. equipment and can save time when performing maintenance, installing, testing or replacing devices.

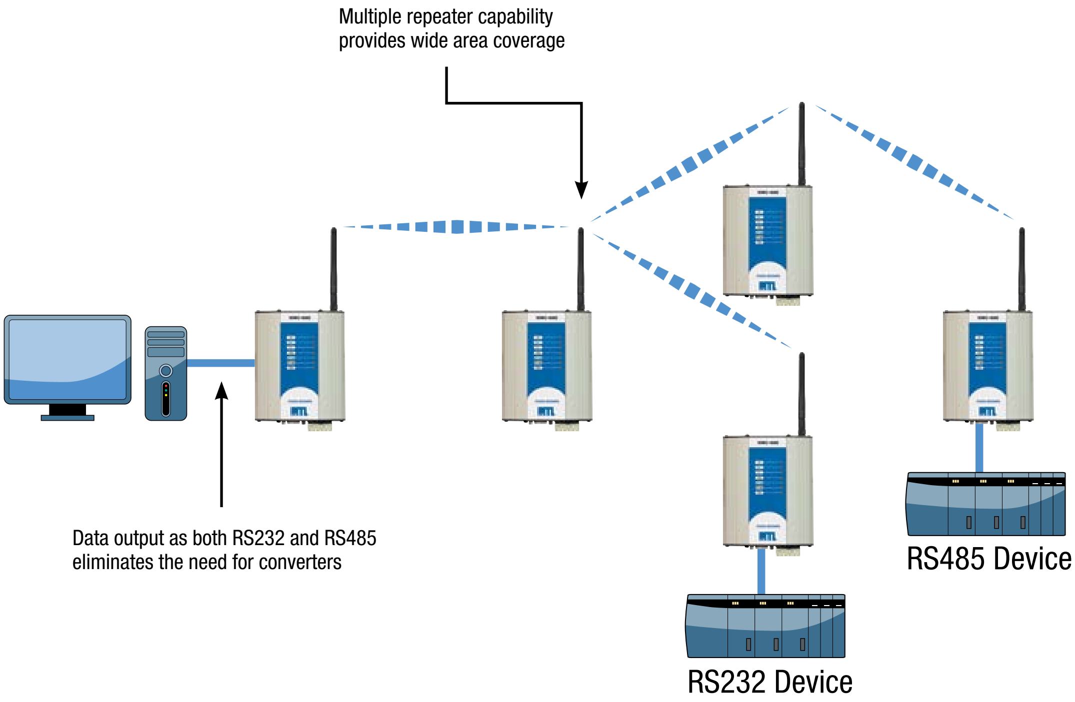
Flexible, secure wireless networks

MTL Wireless LAN's (local area networks) feature 802.11 compliant radio communication to bring Ethernet and sensor device data back to the control room through a combination of wireless access points, clients and interfaces. Featuring **advanced security,** link status notification and redundant wireless link capability, MTL wireless networks ensure easy installation, **robust and secure** deployment plant wide.



Wireless Serial Networks

Serial interfacing is one of the most well supported data transfer methods between industrial devices. MTL provides an **easy to use and secure** serial to wireless interface for industrial devices such as intelligent transducers, PLCs, data loggers and temperature multiplexers. MTL wireless connections provide **superior range** and networking options both in and out of a plant.



Network Topologies

MTL serial modems can transparently multicast (point to multipoint communication) to send the same data across the network to meet the needs of **polling protocols.** Through the use of an added protocol specific path routing feature, the data paths can also be predefined by protocol address to ensure the data only is output where it is needed.

Gather, Send, Repeat

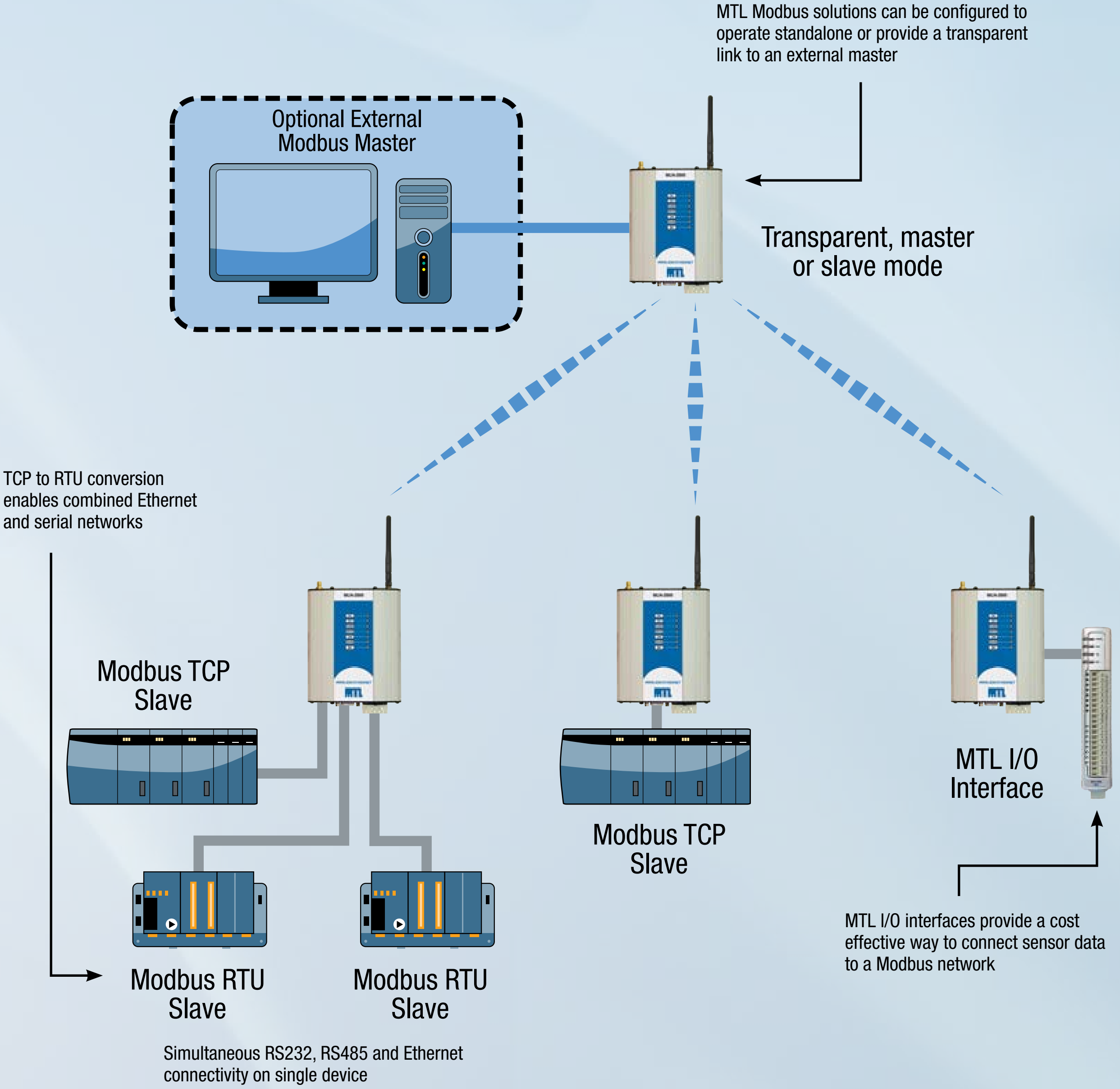
Each MTL wireless modem in a network can buffer messages, report radio parameters and serve as a repeater. This allows reliable operation beyond the normal coverage range of a single wireless modem. A network backbone is not necessary in every case as a simple point to point system can be deployed in a cable replacement type arrangement.

Compatibility

With configurable serial and radio interfaces, MTL wireless serial solutions ensure that the specific requirements of different networks can be met. Operating on a **wide range of frequencies,** MTL wireless serial can be deployed in both licensed and license-free applications.

Wireless Modbus systems

MTL offers **high level flexibility** when wirelessly enabling hosted networks such as supervisory control & data acquisition (SCADA) and distributed control systems (DCS). **Modbus TCP and RTU** protocols are supported by MTL wireless networks, offering communications used by a wide range of devices such as Ethernet/serial PLCs, data loggers and I/O.



Device gateway mode

Internal registers located within the MTL wireless devices can store data from several external slaves. This collected data can provide a single point of data access for a control system or transfer the stored data between slave devices. Registers indicating communication timeout status can be used to indicate the health of individual Modbus communications. A Modbus TCP to RTU conversion feature can be also enabled to transfer data between Ethernet and serial Modbus devices.

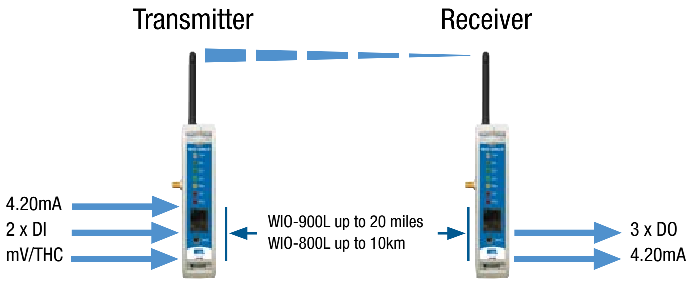
The Products

Our range of wireless products can be deployed to communicate mA, voltage, digital, pulsed, Ethernet and serial data over wireless connections. Products can be selected for a wide range of licensed or license-free frequencies for operation in many different countries. MTL wireless products contain high quality radios to ensure that wireless signals are reliably received where and when they are required.

WIO-900L and WIO-800L Easy wireless I/O

The WIO-900L and 800L simply and reliably communicate transducer and switch data by providing a 4-20mA, mV and digital interface in a small footprint radio. The sensor data is transmitted to a remote output as digital and 4-20mA effectively replacing the cable. Line of sight distances of up to 10km for the WIO-800L and 20 miles for the WIO-900L are achievable making this product useful for short or long range communication.

- Simple setup – out of the box solution
- 4-20mA, digital and mV thermocouple signal transfer
- Communication status indication via digital output
- Radio signal strength indicated via LEDs for easy link tests
- Live adjustable analogue set point alarm
- Hazardous area mountable



WIO-900L/800L

WLN-2000 Access point, client and device server

The WLN-2000 enables Ethernet and serial device connectivity over an 802.11 wireless connection for network access or standalone data transfer. Full networking solutions can be deployed to manage data between fixed and mobile devices on 2.4GHz and 5GHz license-free bands. Remote configuration over webpage and security are both features of the WLN-2000 series with diagnostic data available from each module.

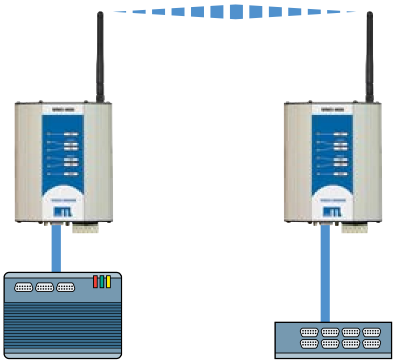
- Highly flexible wireless device server for increased networking options
- 802.11a/b/g access point or client bridge and router configurable
- 10/100 baseT Ethernet device support
- WEP and WPA2/AES encryption for secure networking
- Simultaneous RS232 and RS485 serial port connectivity
- Simultaneous Modbus TCP master and slave configurable
- Redundant meshing connectivity
- Hazardous area mountable

WLN-2000

WMO-900S and WMO-800S Serial Modems

The WMO-900S and 800S serial modems provide remote serial connectivity. Possessing both RS232 and RS485 ports for communication, this device is configurable for a variety of network topologies.

- Wirelessly enables RS232 and RS485 devices
- Repeater functionality for extended range
- Transparent mode for easy data transfer
- Controlled mode with link checking
- License free operation
- Hazardous area mountable

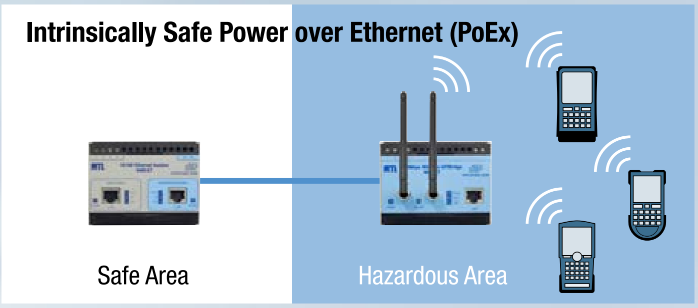


WMO-900S

9469-ET - Hazardous area wireless access point

The 9469-ET provides a low maintenance 802.11 compliant secure network in hazardous areas. The wireless network can support mobile operators and third party devices such as CCTV cameras and I.S PDAs. Through the use of the 9469-ET's WDS configuration, it is possible to connect remote access points wirelessly providing area coverage with minimal equipment. An intrinsically safe power over Ethernet connection provides a single cable for both power and signal.

- Live workable in Zone 1 or Zone 2 Hazardous area (Zone 1 / Div 1 certified)
- 802.11a/b/g access point or client
- WEP and WPA/AES encryption
- 10/100 Ethernet connectivity
- 100mW transmit power
- Intrinsically safe power over Ethernet (PoEx)



9469-ET

WMO-400S Wireless Serial Modem

The WMO-400S serial modem is ideal for long range SCADA applications. Providing serial communication for devices such as PLCs, intelligent transducers and data loggers the WMO-400S operates on the 400MHz frequency range for licensed and license-free applications. Features of the WMO-400S include configurable radio power, frequency, network topology and data pathing features.

- Enables RS232 and RS485 devices to communicate over a wireless link
- User-configurable frequency and RF power
- Remote configuration and diagnostics
- Supports wide range of network topologies
- Distances of 35km (20miles) achievable
- Hot redundant standby radio for maximum uptime
- Repeater capability

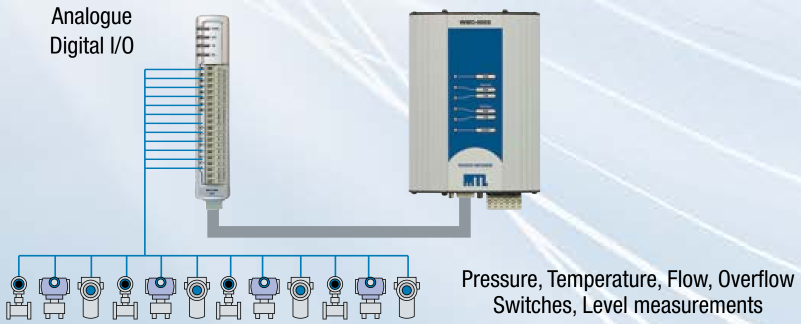
WMO-400S

SIO-100S I/O interface for wireless devices

The SIO-100S series of wireless I/O multiplexers provide an interface to MTL wireless networks for sensors, transducers and switches. The SIO-100 can communicate via Modbus RTU or a point to point exception reporting protocol. The SIO-100S possesses configurable input types and supports a wide range of end devices.

- Industry standard RS232 and RS485 communication ports
- Modbus RTU slave or exception reporting protocol selectable
- 0/4-20mA and 0-10V I/O with configurable scaling (version dependant)
- Digital and pulsed I/O
- Loop supply available to provide sensor and transducer power
- Hazardous area mountable

SIO-100S



Wireless Fundamentals

In its simplest form, wireless communication is the process of transferring information from one location to another via a radio path. There are several aspects to consider when designing a wireless system. General rules are commonly used to provide an indication of what radio parameters, antenna types, network topology and equipment is required prior to purchasing and testing a wireless system.

Glossary

Transmission power – The power output of the radio, typically measured in, Watts (W), milliWatts (mW) or decibel milliWatts (dBm). Transmission power directly affects the achievable distance. Power limits are commonly regulated by standards.

RSSI – Received Signal Strength Indication. This represents the signal power received from a remote radio and is typically measured in dBm. A typical value for RSSI is -70dBm.

Wavelength (λ) – The wavelength is considered as the distance between successive peaks or troughs in the electric field of the radio signal. Wavelength is related to the frequency and the speed of light. It can be roughly calculated by the formula **wavelength (in meters) =300 / f** where f is frequency in MHz. For wavelength in feet, use 1000/f.

Channel bandwidth – The difference between the upper frequency limit and lower frequency limit of a radio channel that is used for communication. Channel width tends to be measured in kHz or MHz and this value directly determines data rate. Narrowband operation in the 400MHz frequency range commonly uses a channel bandwidth of 12.5kHz whereas 802.11g channel widths are typically 20MHz.

Receiver sensitivity – A parameter of a radio which indicates the minimum power level a signal must be above in order for the radio to correctly receive the data without any external noise sources applied. A typical value for sensitivity is -110dBm but varies between device types.

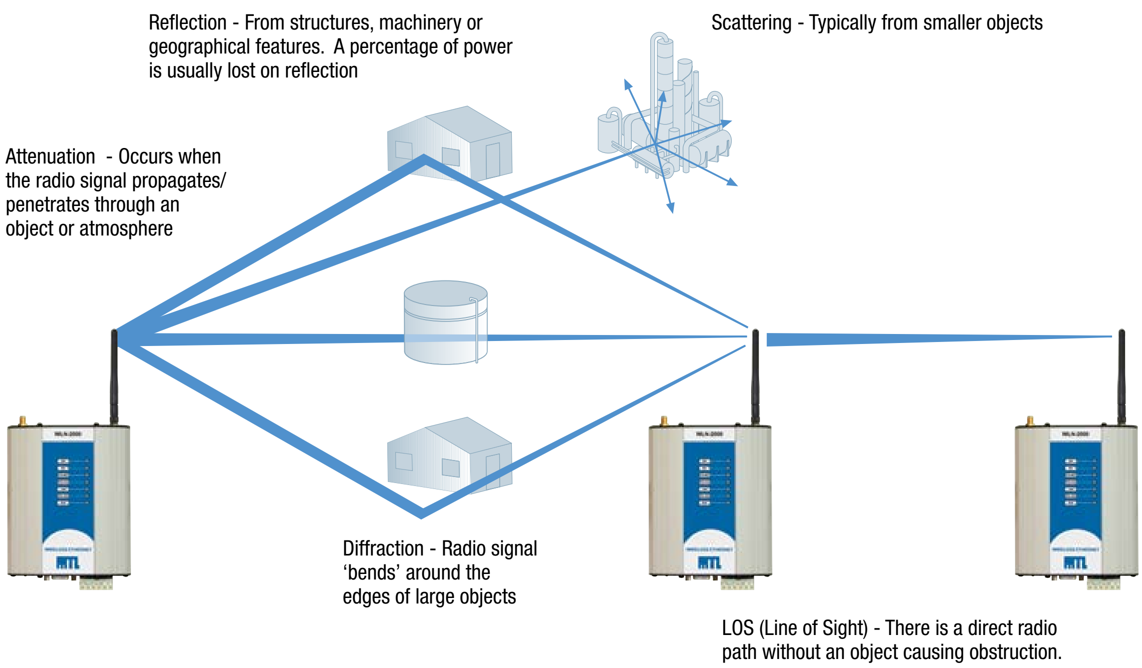
Fade Margin – The difference between the RSSI and the background noise. This number is given in dB and gives an indication of the system's robustness and ability to cope with interference and signal fluctuation. Systems are usually designed with a fade margin in mind where 10dB to 30dB is regarded as a good fade margin.

Antenna gain – The relative increase in signal radiation at the point of maximum signal as transmitted by the antenna. This number is usually expressed in dBi (gain compared to a theoretical omni directional antenna) or dBd (compared to a dipole). A high value indicates a longer range is possible but is likely to result in a more directional antenna.

FHSS – Frequency Hopping Spread Spectrum. This refers to the radio transmitter changing frequency over time to avoid interference with other systems. Typically the radio 'hops' through a number of predefined channels changing on each transmission. These hops appear random, reducing the probability of interference for FHSS enabled equipment.

Propagation

When a radio signal propagates through the atmosphere it is subject to a variety of effects that can alter the maximum range and / or the data rate of communication. The effects that have the most bearing on the signal level at frequencies of above 100MHz are given by the diagram below



Each of these effects can occur simultaneously resulting in the same signal taking different paths to reach the receiving device. These time-delayed signals add together at the receiving unit and can cause destructive or constructive interference. This effect is known as Multipath and is responsible for variations in signal level over relatively short distances. To overcome fade, the system should be designed and tested such that fade tolerant signal levels are achieved. In most cases, line of sight provides the best range, particularly for long range communications.

Regulations

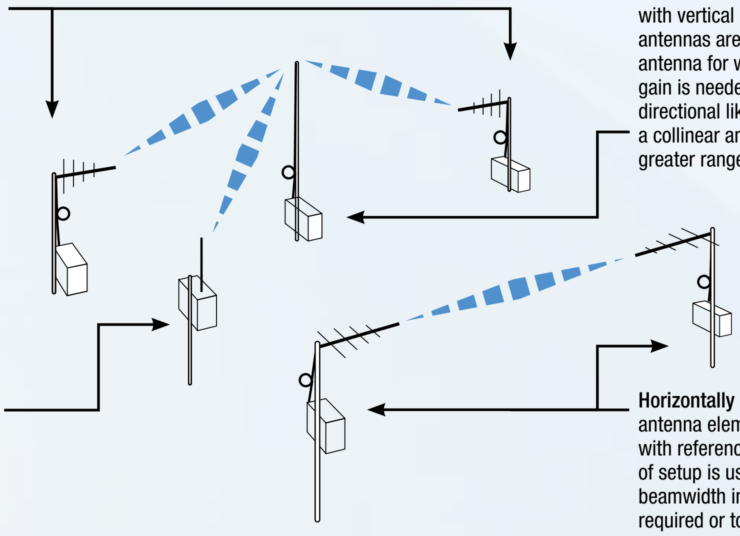
Radio regulations define the frequencies, bandwidths and power levels that a radio transceiver must comply with for permitted use in a given country. In most cases, there are license-free frequencies available that do not require an application be lodged for specific usage of the spectrum. Examples of these are within the 2.4GHz (generally globally accepted), 5GHz, 900MHz (USA, Canada, Australia, New Zealand) and 800MHz (most of Europe) frequency ranges. In some countries, select bands in the 400MHz range are also permitted for license exempt use. **Regulations can also have an impact on the type of antennas permitted for use.** Please check with your local MTL distributor or communications authority for more detailed information on licensed / license-free frequencies and their usage.

Antennas

Choosing an antenna requires consideration as it is the simplest passive way to boost a signal and has a direct impact on the radio range. A well installed antenna can result in maximum possible coverage which can reduce the need for repeaters and contributes to the tolerance of fade. There are a few types of antennas that are most commonly used in industrial applications. These include dipole, Yagi, collinear and quarter wave antennas.

Yagi antennas provide higher gain, longer distance directional communication. Usually installed with vertical polarisation with the smaller elements pointing in the direction of propagation. The elements of the antenna point to the 'floor' for vertical polarisation.

Dipole antenna provides omni-directional communications installed with vertical polarisation. Dipole antennas are commonly the default antenna for wireless systems. If more gain is needed while retaining omni-directional like communications then a collinear antenna can be chosen for greater range.

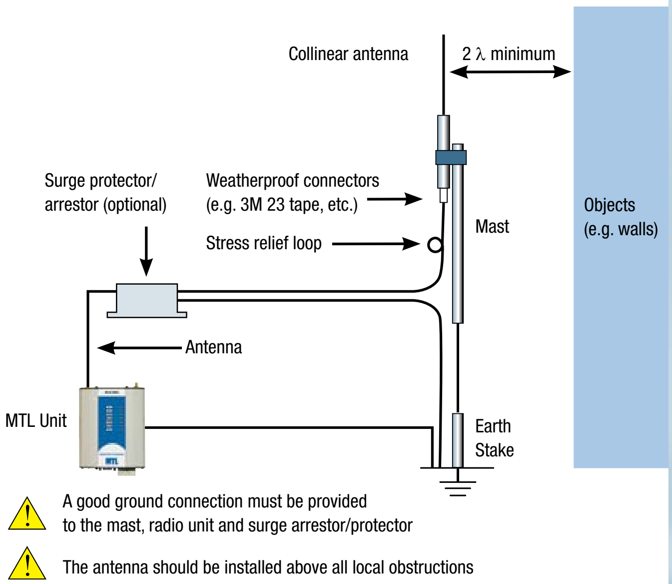


Quarter wave whip (or stub) antennas are physically smaller than their dipole equivalents and usually require a conductive ground plane directly underneath (e.g. metal cabinet) to operate to specification.

Horizontally polarised Yagi - the antenna elements run horizontally with reference to the 'floor'. This type of setup is used where either a wider beamwidth in the horizontal plane is required or to minimise interference from an adjacent vertically polarised system

General rules to follow for antenna installations:

- Install dipole and Yagi antennas at least 2 wavelengths away from an obstructing object e.g. wall/cabinet
- For long range communications, the higher the antennas the better the distance achieved.
- Ensure that any outdoor connections are waterproof to prevent water ingress into cabling.
- Antennas in a system should be installed with the same orientation, vertically polarized in most cases.



Converting Requirements into Systems

Requirements can come in different forms and there can be several solutions for the same application. Preliminary selection of an optimum wireless technology requires some project specific knowledge of:

- Communication distances
- Country of operation (for regulatory compliance)
- Bandwidth requirements
- Supported interfaces required (e.g. I/O, Serial, Ethernet)
- Radio path condition (e.g. obstructions or line of sight)
- Fault condition responses and security

Typical Communication Distances and bandwidths

Radio communication distances vary with the environment, power, frequency and interference. Using the below guide can give an approximate indication of which frequencies, bandwidths and therefore products may be suitable for a system. In the event that there are several monitoring points throughout the world or if the distance required is over 35km, a GPRS/GSM solution may be the best option. The below frequencies may require licensing. License-free frequencies vary with the country of operation.

Frequency	Throughput (typ)	Distance (LOS) /Power	Distance (in factory) /Power
450MHz	9.6kbps	35km (22mi)/5W; 5km (3mi)/100mW	1km(0.6mi)/5W; 300m(1000ft)/100mW
869MHz	33.6kbps	5km (3mi)/500mW; 500m (1600ft)/5mW	300m(1000ft)/500mW; 100m(300ft)/5mW
900MHz	115.2kbps – 22Mbps	25km(15mi)/4W; 10km(6mi)/1W	1km(0.6mi)/4W; 500m(1600ft)/1W
2.4GHz	250kbps - 22Mbps	800m(2600ft)/100mW; 5km(3mi)/4W	50m(150ft)/100mW; 150m(450ft)/4W;
5.4GHz	22Mbps – 100Mbps	450m(1500ft)/100mW; 1km(0.6mi)/1W	40m(120ft)/100mW; 80m(240ft)/1W

The above frequencies and power levels are subject to local regulation. Distances can vary and are to be used as a guide only, site tests are recommended to confirm communications link.

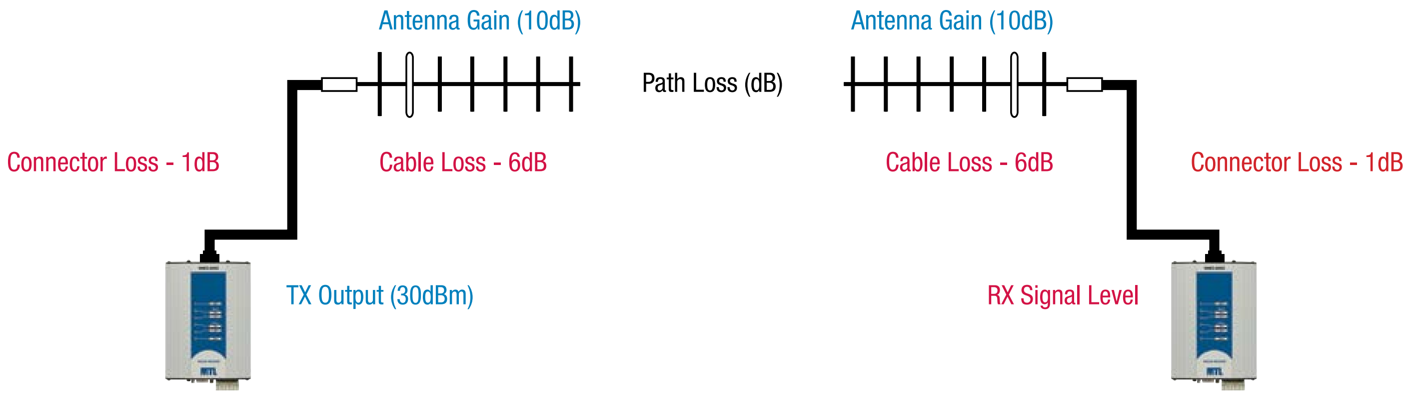
Radio site test vs. Site Survey

Conducting a site test or survey to measure signal strength and background noise is an important process in establishing a reliable wireless link, particularly over long distances. For a site test, ideally similar or identical equipment should be used to take the measurement. The data collected should include the RSSI (received signal strength), and background noise at each site from a data throughput test. The difference between these two values is called fade margin and should be at least 10-40dB, given the signal strength does not exceed the receiver saturation level. Additionally an error rate test should be performed to monitor message or bit error rate, to ensure a reliable data throughput.

A site survey is a more detailed analysis of the radio conditions on site to determine co-channel, adjacent channel and radio path parameters between all nodes on a network.

Estimating Signal Levels

Prior to selecting a product and accessories, an approximate calculation should be made to include the losses and gains of cabling, connections, antennas and path loss. When done in dB, the calculations are simpler in that the values can be added and subtracted from eachother.



The below example shows how to add the appropriate values:

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

The losses vary between systems but a first approximation is possible using the path loss formula:

Path Loss (dB) = 10 x n x log(d) - 20 x log(300/f) + 22

Where n is an exponent which varies between 1.6 and 6 for different radio paths. For most LOS calculations 2.1 can be used. For non line of sight, 4 can be used; d is the distance in meters and f is the frequency in MHz.

The approximated formula for distance in feet is:

Path Loss (dB) = 10 x n x log(d) - 20 x log(300/f) – 5.2 x n + 22

Where d is in feet, f is frequency in MHz and n is a value between 1.8 and 6 as per the meter version.

So for the above system, distance of 1000ft (~300m) in a building with no line of sight (n=4) at 900MHz, the calculation looks like: RX Signal Level = 30dBm + 20dB - 130dB - 12dB – 2dB = -94dBm

This indicates that a link may be possible as the Rx signal level is above the sensitivity however it may require higher gain antennas or lower loss cable to be included in the site test if radio regulations permit.

Cable Type	2.4GHz dB loss / 100ft (30m)	800- 900MHz dB loss / 100ft (30m)	400MHz dB loss / 100ft (30m)
RG58 Cellfoil	-18	-9	-7.2
RG213	-14.5	-8	-5.2
LMR400	-6.8	-3.9	-2.7
LDF2-50	-5.7	-3.3	-2.3

The above table can be used to estimate cable losses in a system. Please note that if surge protection or antenna isolation is added, there will be additional losses in the component which should be taken into account when estimating signal levels.

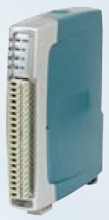
Ordering Information

	Product Codes	Description
WLN-2000	WLN-2400ES-US	Serial, Ethernet and 802.11b/g 2.4GHz 400mW for U.S.
	WLN-2400ES-EU	Serial, Ethernet and 802.11b/g 2.4GHz 100mW for Europe
	WLN-2400ES-AU	Serial, Ethernet and 802.11b/g 2.4GHz 400mW for AU
	WLN-2400ES-NZ	Serial, Ethernet and 802.11b/g 2.4GHz 400mW for NZ
	WLN-2500ES-US	Serial, Ethernet and 802.11a 5GHz 400mW for U.S.
	WLN-2500ES-EU	Serial, Ethernet and 802.11a 5GHz 100mW for Europe
	WLN-2500ES-AU	Serial, Ethernet and 802.11a 5GHz 400mW for AU
	WLN-2500ES-NZ	Serial, Ethernet and 802.11a 5GHz 400mW for NZ

	Product Codes	Description
WMO-400S	WMO-460S-LN	450-470MHz serial modem, 500mW Narrowband (12.5kHz)
	WMO-440S-LN	430-450MHz serial modem, 500mW Narrowband (12.5kHz)
	WMO-480S-LN	470-490MHz serial modem, 500mW Narrowband (12.5kHz)

*** For 5W high power versions, replace the 'L' with 'H'*

*** For Wideband (25kHz) equivalents replace the 'N' with 'W'*



	Product Codes	Description
SIO-100S	SIO-110DX	Digital I/O interface, 16 channels either input or output
	SIO-120AI	8 Digital I/O, 4 x differential or 8 single ended mA or V inputs
	SIO-130AO	8 Digital I/O, 8 x mA or voltage outputs

	Product Codes	Description
WIO-900L WIO-800L	WIO-900LT-US	902-928MHz 1W Transmitter, 1x AI, 2xDI, 1xTHC input
	WIO-900LT-AU	915-928MHz 1W Transmitter, 1x AI, 2xDI, 1xTHC input
	WIO-900LT-NZ	921-928MHz 1W Transmitter, 1x AI, 2xDI, 1xTHC input
	WIO-900LR-US	902-928MHz Receiver, 1x AO, 3xDO, Comms status
	WIO-900LR-AU	915-928MHz Receiver, 1x AO, 3xDO, Comms status
	WIO-900LR-NZ	921-928MHz Receiver, 1x AO, 3xDO, Comms status
	WIO-900LP-US	902-928MHz Radio Pair with ANTCFD890EL antennas
	WIO-900LP-AU	915-928MHz Radio Pair with ANTCFD890EL antennas
	WIO-900LP-NZ	921-928MHz Radio Pair with ANTCFD890EL antennas
	WIO-800LT-EU	869.525MHz 500mW Transmitter, 1x AI, 2xDI, 1xTHC input
	WIO-800LT-EU-L	869.875MHz 5mW Transmitter, 1x AI, 2xDI, 1xTHC input
	WIO-800LR-EU	869.525MHz Receiver, 1x AO, 3xDO, Comms status
	WIO-800LR-EU-L	869.875MHz Receiver, 1x AO, 3xDO, Comms status
	WIO-800LP-EU	869.525MHz Radio Pair with ANTCFD890EL antennas
	WIO-800LP-EU-L	869.875MHz Radio Pair with ANTCFD890EL antennas

	Product Codes	Description
WMO-800S WMO-900S	WMO-900S-US	902-928MHz 1W FHSS serial modem
	WMO-900S-AU	915-928MHz 1W FHSS serial modem
	WMO-900S-NZ	921-928MHz 1W FHSS serial modem
	WMO-869S	869.525MHz 500mW serial modem
	WMO-869S-L	869.875MHz 5mW serial modem
9469-ET	9469-ET	Zone 1 / Div 1 802.11a/b/g access point

Antennas and Accessories

MTL provides high quality antennas, surge protection, cables, mounting brackets, power supplies and data cables to meet a wide range of site requirements.

	Product Codes	Description
Antennas 2.4GHz	ANTWH2400-SMA	Whip, SMA-M connector, 2dBi
	ANTMD2400-EL	Dipole with 5m RG58 cable, 0dBi gain, SMA-M
	ANTSG2400EL	Collinear, 5dBi gain, N-type F
	ANTZ2400EL	Collinear, 8dBi gain, N-type F
	ANTY2400-18EL	Yagi, 18dBi gain, N-type F
Antennas 900MHz / 869MHz	ANTWH900-SMA	Demo Whip, SMA (M) connector
	ANTDG800-1	Whip , 1m RG174 cable, -2dBi gain, SMA-M (869MHz)
	ANTDG900-1	Whip , 1m RG174 cable, -2dBi gain, SMA-M (900MHz)
	ANTCFD890EL	Dipole, 5m RG58 cable, 0dBi gain, SMA-M
	ANTSG900EL	Collinear, 5dBi gain, N-type F
	ANTSG900-6	Collinear, 8dBi gain, N-type F (900MHz)
	ANTYU6-870	Yagi, 10dB gain, N-type F (869MHz)
	ANTYU6-900	Yagi, 10dB gain, N-type F (900MHz)
	ANTYU16-870	Yagi, 15dB gain, N-type F (869MHz)
	ANTYU16-900	Yagi, 15dB gain, N-type F (900MHz)
Antennas 400MHz	ANTUDP400-C	Dipole, 2dBi gain, N-type F (specify frequency on order)
	ANTYU3-400	Yagi, 7dBi gain, N-type F (specify frequency on order)
	ANTYU6-400	Yagi, 10dB gain, N-type F (specify frequency on order)
RF / Data Cables	CC3-SMA	Coaxial cable kit, 3m RG58 cellfoil, N-type M to SMA-M
	CC10-SMA	Coaxial cable kit, 10m RG58 cellfoil, N-type M to SMA-M
	CC20-SMA	Coaxial cable kit, 20m RG58 cellfoil, N-type M to SMA-M
	CCTAIL-SMA-F	Coaxial tail, 600mm, SMA-M to N-type F
	CCTAIL-SMA-M	Coaxial tail, 600mm, SMA-M to N-type M
	ANT-BR-YAG-KIT	Mounting bracket kit for Yagi antenna
	ANT-BR-COL-KIT	Mounting bracket kit for collinear antenna
	CBLSER-DB9	RS232 DB9 serial cable
	CBLETH-C5X	Ethernet cable, crossover, RJ45, 2m
	CBLETH-C5A	Ethernet cable, RJ45, 2m
	CBLSER-RJ45	RS232 cable, DB9 to RJ45
Surge and supply	SURCSD-SMA-2500	Coaxial surge diverter, SMA-M to SMA-F
	SURCSD-N-6000	Coaxial surge diverter, N-type F to N-type F, Bulkhead
	IOP32D	2 x 2 wire I/O surge protection device
	MTL5991	110-240VAC to 24VDC 1.7A supply, DIN rail mount

Please contact MTL for advice on the best accessories to select for a specific application or product.

Note - check frequency ranges of equipment and antennas prior to purchase.

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ZL-B-WLESS-EN-0916
September 2016

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