

### Multipath Effects

Refer to Figure 4. The μLink digital radio operates at a frequency of 2.4 GHz. It is likely that it will be influenced by the effects of multipath. Understanding these effects will help to install the μLink digital radio link and maximise the reliability of the link.

Multipath fade occurs when the receiving antenna receives not only the direct signal from the transmitting antenna but also a signal from the transmitting antenna that has reflected off the ground or nearby obstacles. The reflected signal takes a longer path to reach the receiver and acts as an interferer since it is not in phase with the direct signal. The amplitude of this interferer can be almost equal to that of the direct path, thus degrading the link.

Multipath is dependent on transmit frequency and the specific geometry of the link such as antenna heights, distance between the antennas and the local terrain. To counteract multipath, the installer can change the frequency at which the link operates (a change by 1 channel should be sufficient) or slightly adjust the height of one or both of the antennas (a change of 0.5m is typical, but this depends on the geometry of the link).

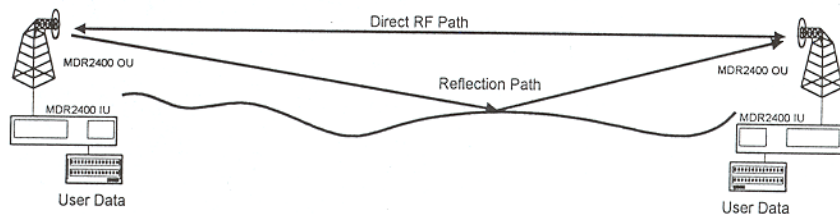


Figure 4. Multipath Effects.

### Installation Information

#### General Information

This section contains only general information and installation guidelines for the μLink. Specific installation instructions for the Indoor Unit (IU), Outdoor Unit (OU), Antenna and Interconnection Cable are provided in Chapter 2 of this manual.

#### Indoor Unit

The IU is designed for mounting in the DIN 41494 (19") racking standard. It is 1U in height, 390 mm in depth and has a mass of < 6 kg. Optional table-top mounting is possible by fitting rubber feet.

The IUs main data, wayside data, power and alarm interfaces are located on the rear panel, suitable for rack installations. For commissioning and testing, the Monitor connector (used for the Craft Terminal) is located on the IU front panel.

#### Outdoor Unit and Antenna

The OU is fastened to the antenna. The OU / Antenna combination is then mounted to a pole (50 mm to 102 mm in diameter) using mounting brackets. Once installed, this allows for replacement of the OU without the need to realign the antenna.



## Operational Capabilities

The user can view equipment status and configuration data of all MDR equipment attached in a multiple hop link from the IU to which the Craft Terminal is attached. The μLink has the following capabilities:

**Upload Indoor Unit Software.** Allows you to transfer a file of executable code from the Craft Terminal to the IU Microprocessor non-volatile memory.

**View Equipment Data.** Allows you to view the following:

- Equipment Status
- Alarms and Alarm History
- Equipment Configuration and Settings
- Data Transmission Performance Characteristics
- Data Channel Options
- Equipment Date and Time

**Control Equipment.** Allows you to configure and/or set system parameters such as; channel selection, RF power level, transmitter on/off, data options, plant alarm options, etc.

**Built-in Testing.** Performs the following built-in tests:

- Start-up BIT (SBIT)
- Continuous BIT (CBIT)

**Real Time Clock Interface.** Used to time stamp the command and error log with the current time.

**History Logging.** Logs all CBIT, SBIT commands and responses issued and received by the Indoor Unit.

## Maintenance Features

- a. No routine maintenance required.
- b. Mean time to repair after arrival on site is less than 30 minutes, provided that the units to be repaired are reasonably accessible.
- c. Extensive self-diagnostics with software-based fault localisation.
- d. Craft Terminal diagnostics, control and management functions are able to access any local or remote station equipment linked by radio.
- e. IU alarm display allows for simple fault diagnostics.
- f. IU common to all OUs.
- g. All panels and covers can be removed with one tool.
- h. No special external test equipment is required to maintain the system.
- i. OU can be replaced without having to re-align the antenna.

## Built-in Test Features

The μLink has the following built-in test features:

- LED alarm and status indicators on IU Front Panel.
- Remote unit alarms indicated similar to the local unit's alarms.
- Historic alarm logging (last 1000 events) - future upgrade.
- CRC-4 error detection on user data.
- Loss of Data Input Detection.
- Loss of Frame Detection on Radio Frames.
- Automatic AIS Insertion.
- Input Data Loopback.
- Output Data Loopback.
- Payload data Output Enable/Disable function.
- Real Time Clock for time-stamping of alarm and other events (Y2K compatible).

## System Specifications

The μLink has the following specifications:

## Performance Characteristics

### Link Range:

**Low Power.** Up to 10 km. Provides a link margin of 18 dB based on a  $10E^{-6}$  BER for an E1 link.

**High Power.** Up to 30km. Provides a link margin of 22 dB based on a  $10E^{-5}$  BER for an E1 link.

**High Power Duplexer option.** Up to 40 km using a 22 dBi antenna. Provides a link margin of 22 dB based on a  $10E^{-5}$  BER for an E1 link.

**System Start-up Time.** Less than ten (10) seconds (at 25 °C). If ambient temperature is < -15 °C, it takes 10 mins. before system operates to full specification.

## Data Transmission Characteristics

Description	Characteristics
a. Frequency Band	2.400 GHz to 2.4835 GHz
b. Go/Return spacing	42 MHz (E1, T1)
c. Data Rate Options	2048, 1544 (T1) kbit/s.
d. Interface Standards	ITU-T G.703, G.704, G.706, G.823
e. Jitter and Wander	ITU-T G.823
f. Modulation	QPSK
g. Error Detection Code	CRC-4
h. Background BER	$< 10^{-11}$

## Transmitter Characteristics

Description	Characteristic
a. Carrier Frequency Band	2.400 to 2.442 GHz (LB) 2.442 to 2.4835 GHz (HB)
b. Modulation B/width (max)	22 MHz
c. Link Data Rate (max)	2142 kbit/s
d. Tx Power, max. oper.	+2 dBm (Low Power) +24 dBm (High Power) +30 dBm (Duplexer)
e. Tx Power, min. oper.	+12 dBm (HP + DU) +2 dBm (Low Power)
f. Frequency Stability	±7ppm
g. Tuning method	Microprocessor-controlled PLLs
h. Transmitter disable under software control	
i. Spurious Emissions comply fully with FCC 15.247, FCC 15.201 and ETSI 300-328	

## Receiver Characteristics

Description
a. Sensitivity measured at radio module input connector (typical):
<b>Data Rate (kbit/s)</b> <b>BER=<math>10^{-6}</math> (dBm)</b>
2048      -90
b. Spurious Response Rejection complies with ETS 300-328
c. Spurious Emissions-see <i>Transmitter Characteristics</i>
d. Equipment Background BER $< 10^{-11}$ (Receive level between 9 and 34 dB above threshold).



## Wayside Service Channel

### Description

- One (1) wayside service channel of RS-232 serial data up to a baud rate of 19200 is provided.
- The serial data channel provides simultaneous, full duplex serial data transfer between stations. Data rates range from 300 to 19200 baud. The RS-232 standard is provided, with the following signals : TxD, RxD and Signal Ground.
- The interface provides a DCE (Data Communications Equipment) interface mode.

## Auxiliary/Alarm Interfaces

### Description

- a. Two (2) inputs (for sensing contact closure or opening) are provided to sense site alarm inputs. The states of these alarm inputs are shown on connected management equipment, eg. µLink Management Information System, as well as from the IU Front Panel Site Alarm LED.
- b. Two (2) relays are used to indicate alarm / auxiliary outputs. Each relay has normally open (N.O.) Common (C) and normally closed (N.C.) contact outputs. Output states are software controlled. The outputs are used to indicate alarm or other states selected by the operator.

## Power Supply Characteristics

### Description

- a. Input supply voltage (DC) 21.5 to 56 VDC
- b. Input supply voltage (AC) 100 to 240 VAC
- c. Power Consumption < 20 W
- d. Selection of a single DC supply or an AC supply to the IU. The OU is supplied by an isolated single DC supply fed from the IU via the interconnecting cable.
- e. Reverse voltage protection for equipment and supply (DC option only).

## Controls and Displays

### Description

- a. The µLink IU has a nine LED *alarm* and *status* display. All control functions are accessed via the Craft Terminal.
- b. The operator can perform all essential control and management functions of both the near and far end station equipment in the link using the Craft Terminal.

## Antenna Characteristics

Description	Characteristic
a. Size	550 mm x 550 mm x 25 mm flat panel sealed construction
b. Frequency	2.400 GHz to 2.4835 GHz
c. Gain Tx	18 dBi $\pm$ 0.2 dB
d. Gain Rx	18 dBi $\pm$ 0.4 dB
e. Connection	non-ohmic coupling to the OU
f. VSWR	< 1.5 : 1
g. Isolation Tx/Rx	> 40 dB
h. Polarisation	Tx / Rx Orthogonal

## Equipment Status Monitoring

- | Description   |
|---|
| a. <b>Indoor Unit Status.</b> The IU logs the state of the baseband signals in the Management Information Base (MIB) and informs the State and Mode Control function of any problems or failures.   |
| b. <b>Outdoor Unit Status.</b> The OU transmits a periodic status message to the IU containing the status of the OU. The Fault and Status Manager in the IU monitors this, updates the MIB and informs its State and Mode Control function of any problems.   |
| c. <b>Far-end Radio Station Status.</b> The near end IU transmits a periodic status message to the remote IU. The Fault and Status Manager in the remote IU determines if the transmitting IU is functioning normally then updates its MIB and informs its State and Mode Control function of any problems. |
| d. <b>Health Monitoring.</b> A background process continuously checks the health of the system hardware and software and reports any anomalies to the Management Information Base (MIB) of the appropriate IU. The Fault Manager responds to this information.  |

Mechanical  
Characteristics

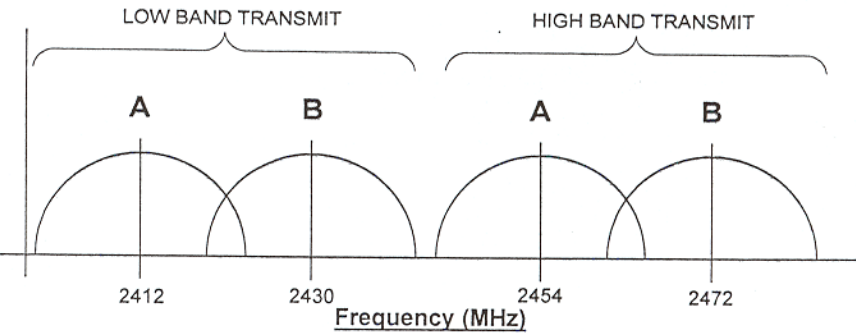
Description	Characteristic
a. Mass	
OU (no antenna)	< 4 kg
IU	< 6 kg
b. IU Racking	19" DIN 41494, 1U
Standard	
c. OU Mounting	Pole mount brackets.
Standard	50 to 102 mm pole diameter.

Environmental  
Characteristics

Description	Characteristic
a. Temp. Range	
• Indoor Unit	0 to +50°C (operating) -40 to +70°C (survival)
• Outdoor Unit	-20 to +70°C (operating) -40 to +70°C (survival)
b. Humidity	
• Indoor Unit	5 to >90% (weather protected locations)
• Outdoor Unit	8 to 100% (all weather)
c. Wind Speed (Outdoor Equipment)	up to 160 km/h (functional)
d. Operating Atmospheric Pressure	70 to 106 kPa
e. Lightning Protection	ITU-T K.20 for: PSU, Payload Data and Interconnection Cable

Frequency  
Band Plan

Refer to Figure 5. The μLink Digital Radio operates in the 2.4 GHz to 2.4835 GHz ISM frequency band. The μLink has predefined channels allocated within this band (Channels A and B). The channel spacing between transmit and receive frequencies is 42 MHz. This is based on the bandwidth occupied by the spread spectrum signal and is used to maximise link performance.



The recommended frequency pairs for the channel plan are :  
A : 2412 & 2454 MHz  
B : 2430 & 2472 MHz

Figure 5. Frequency Band Plan.

## Chapter 2: Installation

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### Introduction to Chapter 2

Chapter 2 provides the installation personnel with the information required to assemble, install and commission the μLink System.

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### Site Requirements

Before installing the μLink, ensure that the installation site meets the following requirements:

- Site characteristics are satisfactory (see *Planning Information* on page 7).
- Suitable mast (pole) used for Antenna and Outdoor Unit (OU) installation is firmly in position. Pole diameter may be between 50 and 102 mm.



#### CAUTION

**THE POLE AND THE EQUIPMENT ROOM, WHICH HOUSES THE INDOOR UNIT (IU) MUST BE EARTHED FOR LIGHTNING PROTECTION ACCORDING TO STANDARD LOCAL PRACTICES.**

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## Parts and Accessories Supplied for Installation

The following parts and accessories are supplied by Tellumat for the installation of the μLink System. Note that this list relates to the parts supplied for a system at a DRS, ie. one end of a DRL.

Description	Qty	Remarks
Antenna	1	The antenna is shipped with a complete installation kit including mounting hardware.
Outdoor Unit (OU)	1	Ensure OU is compatible with the antenna provided.
Indoor Unit (IU)	1	
Data Interface Card	1	E1 or T1.
Interconnection Cable	1	10 m, 20 m, 50 m or 75 m in length as ordered. Used to connect the IU to the OU.

## Customer Furnished Tools and Equipment

The following table lists all tools and equipment required to install the μLink System. Note that these items must be supplied by the customer.

Description	Qty	Remarks
13 mm Spanner	1	Used to secure the Antenna to the Pole.
8 mm Spanner	1	Used to secure the Antenna Mounting Bracket to the Antenna.
Large Flat Screwdriver	1	As above.
Earth Cable or Strap with 5 mm earth lug	1	For earthing the IU. Braided tube, copper tinned. Gauge 4 mm CSA. 8 x 1 mm thick, 45 A, 24/12/0,16.
Cable Ties	A/R	Used to secure the cable to the mast at regular intervals.
AC Supply Cable	1	Standard 3-pin IEC AC plug. For AC supply connection to the rear panel of the IU.
OR DC Supply Cable	OR 1	Minimum 2.5 mm square conductor, rated for 10 A. For connection between the power supply and the IU DC connector on the rear panel.
Binoculars (optional)	1	Used for locating the far end site. This will assist in the antenna alignment operation.