

MiMOMax Radio Installation and Operation Guide



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1 INTRODUCTION

This manual is intended for use by experienced technicians familiar with installation and operation of radio frequency linking equipment. It includes a description of the equipment, general recommendations for site engineering, and instructions for installing and configuring the MiMOMax radio. A basic maintenance and troubleshooting guide is also included in the last section of this manual.

2 OVERVIEW OF THE MIMOMAX RADIO UNIT

The MiMOMax radio products are a family of software flexible, ultra low latency, digital radio links designed for mission critical data linking and backhaul applications. The product family includes the Network Digital Link (NDL), Optimised Protection Variant (OPV), Multipoint Digital Link (MDL) and Rural Digital Link (RDL).

The radios utilise licensed narrow band radio channels and MIMO technology to provide industry leading spectral efficiencies of up to 12.8 bits/Hz/s or greater, enabling raw data rates of up to 320kb/s including link overhead (160kb/s in the OPV version) in 25kHz licensed channels.

Utilising licensed spectrum ensures that the link operates in an interference-free environment and is capable under the right conditions of providing a reliable low-error data transport service ($<1 \times 10^{-7}$ bit error rate).

For data linking applications the radio provides a number of industry standard data interfaces at link end points.

Supply Voltage	10.5V to 32V DC	
Maximum Power	<92W at 13.8V	
Consumption		
Ambient Temperature Range	-25°C to +60°C	
Mounting	2U high rack mount	
_	Also available as wall mount or pole mount unit	
Dimensions (W x L x D)	262 x 393 x 86.5mm, Base Radio Unit	
Weight 6.8kg (pole mount excluding mounting brack		
Gross Data Rate	Up to 320kbps	

2.1 MIMO DIGITAL LINK GENERAL SPECIFICATIONS



2.2.1 Base Radio Unit











2.2.2 Rack mount option



2.2.3 Pole mount option



2.2.4 Wall mount option



3 INSTALLATION ON SITE

3.1 SITE ENGINEERING AND RECOMMENDATIONS

Prior to commissioning any fixed radio link of this nature, a full evaluation of the site and link path characteristics **must** be carried out to ensure reliable operation of the radio link under all environmental conditions. Important factors to consider and allow for include the following:

- expected path loss and link budget;
- multipath propagation and fading effects, including those caused by moving objects such as vehicles and aircraft in or near the link path;
- obstructions (high ground, trees, buildings and structures etc.) in or near the link path (note that weather conditions can significantly affect losses caused by trees and other foliage);
- potential interference from nearby radio frequency sources (these include both narrowband sources such as other radio transmitters, and wideband sources such as noise generated by other electrical equipment in the vicinity);
- potential interference to other nearby radio receiving equipment as a result of normal transmitted emissions from the radio link being commissioned.

A comprehensive source of information and guidance on general site engineering issues has been published by ETSI: EG 200 053 v1.5.1, 2004/06 "Electromagnetic compatibility and Radio spectrum Matters (ERM); Radio site engineering for radio equipment and systems". It is highly recommended that this freely available ETSI document be studied in detail, in conjunction with this manual.

3.2 INSTALLING ANTENNA

3.2.1 Bi Quad Diversity Directional – Loop Yagi Antenna

Antenna overview:

The loop Yagi is a directional dual-polarised antenna containing both vertical and horizontal radiating elements in the same structure. The antenna is made of aluminium and fibreglass with stainless steel mounting brackets and bolts. It is weather resistant and designed for use in outdoor situations. Mounting brackets are included to fit poles from 20mm to 50mm in diameter. The antenna is equipped with two 2m coax "tails" and connectors for interfacing to the radio equipment or intermediate coaxial feeders.



Technical specification:

Polarisation	Horizontal and vertical with separate
	feeds
Antenna gain	>10dBi (typically 11.5dBi)
Beamwidth, -3dB (parallel to polarisation plane)	50° nominal
(perpendicular to polarisation plane)	50° nominal
Front-to-back ratio	>15dB
Frequency bandwidth (>15dB return loss)	>20MHz
Connector arrangement	2 x female type N connector on 1.5m tails of RG214 coaxial cable
Mounting (pole)	Twin vertically spaced clamps for
	attachment to 20-50 mm mounting pipe
Dimensions W x H x L (direction of propagation)	250 x 250 x 850 mm
Weight	2.5 kg, including coax tails and mounting
	brackets

Package contents:

1x loop Yagi antenna with 2 mounting brackets and 2x 2m coax 2x removable mounting brackets 4x stainless steel mounting bolts

Installation guidelines:

Mounting location: The antenna is designed to create a directional radiation pattern. To achieve the expected pattern and gain it should be mounted clear of any local obstructions to the front or close to the sides. Generally the higher an antenna is above

the ground the better it performs. A minimum of 2m above the roof line and away from all power lines and obstructions is a good general rule.

Pole installation: The antenna is designed to mount on a pole of 20–50mm diameter. The pole must be weatherproof and strong enough to support the antenna during wind gusts. Generally, the antenna and pole should be located as close to the radio equipment as possible - long cable runs increase the signal loss. If the radio equipment is located indoors, extension coax cables will be required for the cable run from the radio equipment to the antenna.

Orientation: The Yagi antenna is directional. To achieve best performance, it must be oriented such that the central axis points directly towards the antenna at the other end of the radio link path.



Antenna installation:

Tools and equipment required

- 10mm spanner or socket
- self vulcanising rubber tape
- Step 1 Remove the 4x mounting bolts and 2x removable brackets from the antenna.
- **Step 2** Place antenna on pole and reattach mounting brackets and bolts. Note the "this side down" label this is to ensure the drain holes are located downwards and the coax cables exit at the bottom of the antenna.
- Step 3 Move the antenna to the correct height on the pole so that it has line of sight to the antenna at the other end of the link, and with its central axis aligned to the other antenna preferably to within ±5°. if the other antenna isn't visible use a map & compass (note: be aware that nearby large ferrous objects such as antenna towers can cause erroneous compass readings) or find a landmark in the foreground that is on the signal path and point it towards that. Tighten mounting bolts equally so the mounting bracket clamps evenly.
- **Step 4** Once the connections to the cable feeds have been made it is highly recommended that they are waterproofed using self-vulcanising rubber tape or similar. Follow the manufacturer's instructions for applying the tape.
- **Note: Do not** cut the cable ties holding the coax to the antenna frame it is required for cable strain relief.

3.3 ENVIRONMENTAL AND SAFETY

3.3.1 Grounding

On site ground networks must be created in accordance with ITU-T recommendation K.27: Protection against Interference; Bonding Configuration and Earthing inside a telecommunications building.

3.3.2 Lightning protection

This aspect is very important to assure the protection of the tower, antennae and the radio equipment hardware.

The following diagrams show the techniques recommended for tower protection, antennae, feeder and RF hardware protection.

Adequate lightning protection is dependent on the effectiveness of the station earth point.



This diagram shows a typical tower protection arrangement. The site earth point is wired to the tower base with a conductor of no less than 16mm square area. This conductor then is taken to the tower top and bonded to the tower and a lightning conductor rod. The rod is typically about 2 metres long. The 45-degree cone of protection profile then defines where protected plant can be mounted.



This example shows where the top antenna serves a dual role as receive antenna and lightning rod. Most collinear style antennae are designed to have the active elements placed at ground potential such that this dual role is possible.

When this example is used it is important that the heliax feeder sheath is also bonded to the tower adjacent to the antenna connection.



This diagram shows a recommended feeder earthing and discharge protection scenario. Feeder earthing kits are placed at the antenna adjacent to the feeder connector, where the feeder leaves the base if the tower and where the feeder enters the building structure. This is a 3 point earthing concept. If earthing kits supplies are limited or connection to an earth point is difficult, the order of importance of the earthing locations is:



For a top mounted antenna acting for lightning protection.

- 1. At antenna connection point.
- 2. At the tower base.
- 3. At the entry to the building.

For a general mounted antenna.

- 1. At the entry to the building.
- 2. At the tower base.
- 3. At the antenna connector.

The polyphaser discharge unit is very important to release high voltage charges developed between the cable inner and outer. There are two types supplied, a transmitting and a receiving variant. The transmitting is the larger. It is very important that these function do no become confused because the lower discharge potential rating for the receiver unit will be triggered by transmitting voltages. This will cause a high VSWR and poor coverage.

3.3.3 Equipment ventilation

The radio (rack mount option) should be installed preferably in a dry, dust-free room. It is recommended that a thermal study be carried out for each site to check and ensure that thermal conditions within the cabinets do not raise the ambient temperature of the radio above its operating limit. If the temperature of the site can range beyond the operating limits, the site enclosure must have air conditioning or a forced air system installed to stabilise these excursions.

Note: Equipment cooling in the rack mount configuration relies on the front panel cooling fan. It is important to ensure that the panel fan inlet is unobstructed and that the fan is operating correctly.



3.4 CONNECTING UP THE RADIO

3.4.1 Connecting the Data Cables and Termination





Radio Unit Connector and LED layout

Ethernet

A single shielded RJ45 socket provides connectivity. Shielded cable is not normally required. The green LED of the connector indicates Ethernet traffic while the yellow LED is NOT used.

Synchronous serial

The Synchronous Serial sub system as provided by the 'DIF version 2' PCB supports two main standards RS422 and G.703 (64 kbps only). For best performance in noisy environments, these interfaces are optically isolated. The RS422 implementation also supports connection to compatible standards such as X.21 (64 kbps only) and V.35. Connection to RS323 is also possible under certain circumstances.

Connection to the Radio Unit is through a single shielded RJ45 socket. The yellow LED of the connector is a status indicator while the green LED is NOT used.

All signals are named with respect to connected equipment. Transmit data is an input to the Radio Unit while receive data is an output.

Except for X.21 clocking for transmit and receive paths is independent and for RS422 codirectional and contra-directional transmit clocking is supported.

The G.703 implementation is of the 64 kbps co-directional (4 wire) version and as such utilizes a symbol rate of 256 kHz where bit and byte timing are embedded.

Synchronous Serial Signal Characteristics

Standard	Output Signal Voltage	Input Threshold
G.703	Mark: 1V ±0.1V	NA
	Space: 0V ±0.1V	
RS-422	±5 V	±200 mV

RS-422 compatible standards			
Standard Output Signal Voltage		Input Threshold	
V-35	±500 mV	±200 mV	
V-11	±5 V	±300 mV	
X-21	±5 V	±300 mV	



Synchronous serial Cabling

The recommended cable is shielded twisted pair similar to Belden 1868E fitted with a shielded RJ-45 plug as shown in the following images.



Shielded RJ-45 plug

Termination

Although operation will not normally be prevented if the connecting cable is incorrectly terminated at the user equipment, proper termination is strongly advised. As well as ensuring maximum signal integrity over longer cables, correct termination is necessary to ensure that compliance with CISPR22/EN55022 EMC standards is maintained.



Differential Signal Path Overview (T indicates point of termination)

RS422 / X.21 / V.11

Termination is generally a single resistor across the inputs of the receiver of a value no less than 100 ohms and generally between 100 and 150 ohms. Multiple receivers may be connected to a single driver in which case only the receiver furthest from the generator shall be terminated.



V.35

Termination is a resistor network providing a load of 100 \pm 10 ohms and a path to ground of 150 \pm 15 ohms.

Note: The Radio Unit provides RS422 type termination only.



G.703

The nominal impedance for termination is 120 ohm.

Grounding

The Synchronous Serial drive circuitry and corresponding ground are isolated from chassis ground (to 1500 VRMS). Isolation is provided to prevent the possibility of ground loops. There is therefore the need to ground any shield at the user equipment (DTE) to prevent the shield/ground from floating.



Alternatively provision has been made to place a shorting link between the Synchronous Serial and chassis grounds. Under NO circumstances should there be grounding at both ends (ie. The shorting link placed and a ground connection at the connected equipment).



Synchronous Serial Physical

RS422

The following table outlines the OPV SII Synchronous Serial RS422 signals that are provided on the RJ45 connector.

Connecte	d Equipment Interface		OPV SII	
Termination	Signal	Pin –	Signal	In / Out
(ohm)		RJ45		
		(male)		
2020	Tx Data (non inverted)	2	Tx Data A	т
none	Tx Data (inverted)	1	Tx Data B	I
100 150	Rx Timing (non inverted)	6	Rx Clock A	
100 - 130	Rx Timing (inverted)	3	Rx Clock B	0
100 150	Rx Data (non inverted)	5	Rx Data A	0
100 - 130	Rx Data (inverted)	4	Rx Data B	0
100 - 150	Tx Timing (non inverted)	8	Tx Clock A	I/O
(1)	Tx Timing (inverted)	7	Tx Clock B	1/0
N/A	Shield	Body	Shield / GND	N/A

NOTE (1): Termination is for co-directional mode only. NOTE (2): GND is isolated from chassis ground.

Circuit Overview

The opposite diagram (RS422 circuit outline) shows the basic functional blocks that form the RS422 sub system and corresponding data paths.

Transmit and receive paths including their clocks are totally independent of each other.

The transmit clock is internally selectable as co-directional or contra-directional. The receive clock driver may be

disabled such that a static state exists on it's outputs.



RS422 circuit outline



Cable Termination



Either the connected equipment shall provide internal termination or external termination at the locations shown in 'RS422 Connections and Termination'. The termination shall be within the 100 to 150 ohm range.

RS422 Connections and Termination

V.35 Considerations

Signal Levels: Although the generator drive levels (\pm 5 volts for RS-422 and \pm 0.5 volts for V.35) are different the receiver decision levels (\pm 0.2 volts for RS-422 and V.35) are the same meaning the two standards are compatible.

Termination for RS-422 and V.35 is somewhat different however this alone will not prevent operation.

As with RS-422, connection of the cables shield to ground is required and should be made at the connected equipment.





X.21

The following table outlines the OPV SII Synchronous Serial signals that are provided on a RJ45 connector.

Connected Equipment Interface			OPV SII	
Termination (ohm)	Signal	Pin – RJ45 (male)	Signal	In / Out
none	Tx Data (non inverted)	2	Tx Data A	I

	Tx Data (inverted)	1	Tx Data B	
100 150	Timing (non inverted)	6	Rx Clock A	0
100 - 150	Timing (inverted)	3	Rx Clock B	0
100 150	Rx Data (non inverted)	5	Rx Data A	0
100 - 130	Rx Data (inverted)	4	Rx Data B	0
		8	N/U	т
N/A		7	N/U	1
N/A	Shield	Body	Shield / GND	N/A

NOTE (1): GND is isolated from chassis ground and is accessible through the shield of the socket.

Circuit overview



The opposite diagram (X.21 circuit outline) shows the basic functional blocks that form the X.21 sub system and corresponding data paths.

X.21 circuit outline

Cable Termination

Either the connected equipment shall provide internal termination or external termination shall be provided at the locations shown in the opposite diagram (X.21 Connections and Termination). The termination shall be within the 100 to 150 ohm range.



X.21 Connections and Termination

G.703

The following table outlines the OPV SII Synchronous Serial connections and the corresponding for connected equipment.

Connected	d Equipment Interface		OPV SII	
Termination	Signal	Pin –	Signal	In / Out
(ohm)		RJ45		
		(male)		
nono	Tx Data (non inverted)	2	Tx Data A	т
none	Tx Data (inverted)	1	Tx Data B	1
	GND 6 GND ⁽¹⁾		GND ⁽¹⁾	
N/A	GND	3	GND ⁽¹⁾	N/A
nono	Rx Data (non inverted)	5	Rx Data A	0
none	Rx Data (inverted)	4	Rx Data B	0
		8	NO CONNECT	
N/A	NO CONNECT	7	NO CONNECT	N/A
N/A	Shield	Body	Shield / GND ⁽¹⁾	N/A

NOTE (1): GND is isolated from chassis ground.

Cabling

Some installations may require an alternate cable with individually screened twisted pairs. In which case pins 3 and 6 of the RJ45 socket provide for the connection of the individual screens to the Radio Unit.

Circuit overview



G.703 circuit outline

The opposite diagram (G.703 circuit outline) shows the basic functional blocks that form the G.703 sub system.

Termination and Grounding

It is expected that equipment requiring a G.703 interface will have internal termination. It is the responsibility of the installer to ensure the correct termination is provided. Termination is expected to have a nominal value of 120 ohms. In the event that cable with individually screened pairs is used, connection of those shields to ground is possible through the connector as shown. A connection of the cables shield to ground is required and should be made at the connected equipment.



G.703 Connections and Termination

4 RADIO CONFIGURATION

4.1 CCMS SETUP

MiMOMax radios use a built in web configuration package called CCMS. To access the CCMS, point a web browser to the radio's IP address (see Figure 1). MiMOMax radios are often preconfigured with an IP address specified by the customer when the radio is ordered. If no IP address has been assigned, the default is 192.168.0.1/24. Additionally MiMOMax radios will broadcast 3 gratuitous ARPs to advertise the IP address when the radio boots up.



Figure 1: MiMOMax logon



To logon to the radio, press the "log into System" button. MiMOMax radios have two levels of access (user and tech). The default login credentials are:

	Username	Default password		
	user	user		
	tech	tech		
F	Figure 2: Default login credentials			

See section 4.7 on changing the default passwords.

4.2 SYSTEM INFORMATION AND CONFIGURATION

The System configuration page (see Figure 3) is where one can set the system related items. Most of these will have been set in the factory prior to shipping.

mi	mo Max		maximizing the government of advenced wireless communications
Hanitar System Transmitter Reserver Network Sync Genal Control Panel SPE Log out Log out	Configure System Rems Configure System Rems Unit name Maximum modulation Adaptive modulation Link retry time out Establish Ink as Low input votage threshold (V) Low signal level threshold (dBm) High temperature threshold (dBm) High temperature threshold (dBm) Save Cancel	55 test radio 1 QAMLS • Disabled • 200 Slave • 10.5 -100 55 Disable •	System System Mill name can be assigned to the unit for uses of referance. Machine modulation refers to the controlution same that the code of attenut to use that imp only be reacted if ugnal quality parents Link retry time code should be dift for a master and if for a slave and Low require will for the should to all the compare the send should be dift for a master and if for a slave and Low signal level threshold - signal Side true Make the send to send the signal for Side true Make the send to send the send to be Side true
	Convelopt a 200	8 Marcula - William	Providenzyda uder - Kettesh enablezyda uder - Autor - Autor - Autor levely few seconds: This can increase levely few seconds: This can increase leveling an the rates of

Figure 3: System configuration page

To configure a radio, one should set the following items:

1. Give the system a descriptive name that can be used to identify the radio for example, "SS test radio 1" in Figure 3.

2. Set the desired modulation order and whether adaptive modulation (MCAM) is enabled or not. Note that the M-CAM and QAM256 features are software add-ons, see Software Feature Enable (section 5.5).

The adaptive modulation (M-CAM) feature, when enabled, allows the RF modulation logic to step up or down depending on the quality of the received signal. It traverses from QPSK through to the maximum modulation order and visa versa depending on RF channel conditions.

If this feature is disabled, the RF modulation logic will stay on the set maximum modulation independent of signal quality. M-CAM typically allows for better utilisation of the channel as the modulation order is adapted as channel conditions change. In some circumstances this may not be desirable (e.g. differential line protection, where fixed bandwidth and latency is required).

QPSK will provide 64kbit/sec, QAM16 128kbit/sec, QAM64 197kbit/sec and QAM256 256kbit/sec user data rates in 25kHz licensed channels.

- 3. The link retry timeout is set to 6 for a slave unit or 200 for a master unit. It does not matter which end of a link is slave or master as long as each end is different this is usually set in the factory.
- 4. Set the low voltage notification level. An SNMP trap can be sent if the input voltage dips below this value. MiMOMax radios can operate down to 10.5V DC. A value of 11V for a 12V system or 22V for a 24V system may be appropriate. Note that the SNMP features are software add-ons; see Software Feature Enable (section 5.5).
- 5. Set the low signal threshold which can be used to trigger an SNMP trap to be sent.
- 6. Set the high temperature level which can be used to trigger an SNMP trap to be sent.
- 7. The "Auto refresh" feature refers to web pages in the CCMS auto refreshing. For example, the monitoring page can refresh every few seconds if enabled. On low bandwidth links or busy networks, this option is best disabled.
- 8. Press the "Save" button to save the changes. "Cancel" will revert to the original settings. Once the settings are saved, they can be activated by clicking on "Apply changes" on the Control Panel page.

4.3 SYSTEM INFORMATION

The system information page (see Figure 4) shows various version numbers of software and hardware. The most notable items are the software version and the backup (Inactive partition) software version.

mi	mo Max wireless	in curen	eximiting the petendial or ced wireless communications
	0992 1722615.85	Link Active The Feb 24 22:14:07	OTC 2001/
Harritte	System Information		System information
Bystein	Manufacture date	15/12/2008	lawner companient crater, service
Tearandter.	Product code	MWL-RADIOUNIT-OH	numbers and relation numbers.
Feceiver	Product serial number	23000098	The radie has two banks for sufficient mapper. The version of cofficient
Hebyork.	DPS IPN	XMWL-DPS-AAAA	currently running is shown in Software
Sync Serial	DP5 revision	P008	is shown in inactive partition
Cantrol Panel	DPS serial number	2600250	sofferare version
life	Theremitter IPN	XMWL-TX-AAAA	The ademate optivore mage can be activated by sisting Rollback
Log out	Transmitter revision	P003	software" in the Control Panel
	Transmitter serial number	2600283	
Logged in as tech	Hecewerthy	XMWL-HX-AAAA	
	Receiver newsion	P004	
	Software version	2000035	
	Bootloader version	16	
	Kemel version	Feb 4 16:26:54 NZDT 2009	
	FPGA version	Unknown 0-10	
	Rootfs version	Feb 04 17:03:08 NZDT 2009	
	Database version	OPv2 0-03	
	Nactive partition software version	OPv2-1.2	

Figure 4: System information

4.4 NETWORKING

MiMOMax linking radios can run in two network configurations:

- Layer II Ethernet bridge
- Layer III router

Layer II networking makes for easy network setup, but can be problematic in larger networks where broadcast traffic needs to be isolated.

To setup IP networking, click on "Network" (see Figure 5). Firstly setup the desired IP address, subnet mask and default gateway. Be sure to note the IP address down if it is changed. All MiMOMax radios broadcast 3 gratuitous ARPs when booting up to

advertise the IP address, this can be used in conjunction with a packet capturing program to find the IP address should it be unknown.

MiMOMax radios have a real-time clock that can be synchronised with a Network Time Protocol (NTP) server. Time is used for logging purposes only. To use an NTP server, enter the NTP server's IP address in the NTP server field.

Next, select if the radio should function as a layer II bridge or layer III router. To enable layer III router mode, disable "Network bridge" (see Figure 5). When running in router mode, an IP address for the air interface needs to be specified. The air IP addresses should be on completely different subnet (for example 192.168.x.x). If running in layer III mode, the default gateway address could be the air interface of the remote radio.

MiMOMax radios have an optional built in SNMPv3 service that can allow various parameters to be read from the radio. For details of what can be read from your radio, click on "SNMP base MIB" and "SNMP MIB" in the control panel. Note that the SNMP service is an optional "software feature enable" (SFE), to enable this feature see Section 5.5.

The following traps (notifications) can be sent by the radio if SNMP is enabled.

1. Low input voltage notification

This notification is sent if the system detects that the input voltage goes below a set threshold.

2. Low signal level notification

This notification is sent if the system detects that the RSSI (Received Signal Strength Indicator) has gone below a set level.

3. High temperature notification

This notification is sent if the system detects that the temperature on the radio has exceeded a set threshold.

The thresholds for these traps are set on the System configuration page, see section 4.2.

The SNMP service can be enabled by selecting "Enabled" from the drop down menu. A username and password also needs to be provided that will be used for authenticating SNMP clients connecting to the radio. The various traps can also be enabled / disabled.

Once the networking options have been entered, click "Save", this will save the options to the radio's internal database. To activate the changes, click on "Apply changes" in the control panel. If the radio's IP address has been changed, you may need to change you computer's IP address to match the radio's new subnet.

TIT		11 5 (2) 3	accimizing the periodial of need wireless communications
-	I I I VIIciess		
	00002-0122-04-01-01-0100	Active Sun Feb 22 20(38)	12 DTC 2009
Monitor	Configure Network and SNMP		Network
System	191		IP address is the M address of th
Transmitter	Ethernet		Galerine IV address is the Ut adver-
le ceiver	IP address	172.26.19.85	of the idotream router Sphered)
Tebalark.	Subnet mask	255.255.255.0	DNS 6 NTP metwork Time Protoco
tync Serial	Gateway IP	172.26.19.126	and optional
Control Panel	Wired MAC address	00:00:0dica(01:1e	dence can be configured as a Lajar
1HE	Primary DNS	0.0.0.0	Bridge or as a Layer 7 router. When th bridge or alloadshed, a unit Air 1
log out	Secondary DNS	0.0.0.0	address must be provided in order for the day to both a word
Logged in as tech	NTP server	172.26.19.118	The SHAP service can be esabled as
	Air MAC Address	00:00:0d:ca:01:1f	shambed Traps are sent to the Shift
	Network bridge	Enabled +	interioger in address. Indoi will be ser
	Air P address	(tang)	Rats will also be part when the leve gues below the threatist after here
	SNMP		the thresholds for these frame are a
	SNMP service	Enabled +	Note that for 5004 traps to be used.
	SNMP Manager		the W eddress service an gassword need to be entered
	P address	172.26.19.119	
	Usemame	EMPTY	
	Password		
	Confirm password	(j	
	SNMP Traps		
	Low input voltage notification	Enabled -	
	Low signal level notification	Enabled +	
	High temperature notification	Enabled -	
	Save Cancel		

Figure 5: Network configuration page

Static routes can be added to the radio should the radio need to communicate with routers other than the default gateway. These can be added on the static routes configuration page (See Figure 6). Enter the destination network, netmask and gateway address and then click "Save". To delete a route, check the "Del" checkbox and then click "Save". To activate the route changes, click on "Apply changes" in the control panel.

mi	mo	Max lireless	mestintet advanced wi	ne the potential of reless communications
Maratar	Static Routes Confi	guration		
System	Network	Netmask	Gateway	Del
Transmitter	192.168.2.0	255.255.255.0	172.26.19.126	(D)
Paratver	Canal Canal	add		
Network.	-pave Caute	- And		
Sync Seriel				
Control Pariel				
sire.				
tur pai				
Lopped in as tech				
		Copyright & 2000 Minish	an Wirelaw M.E.	

Figure 6: Static routing page

4.5 RF SETTINGS

MiMOMax radios feature internal duplexers for full duplex low latency communication on a frequency pair. The duplexers are factory tuned for a specific frequency range, therefore the transmit and receive frequencies are factory set. These frequencies can be viewed on the transmit (see Figure 7) and receive (see Figure 8) pages. Additionally the receive page also allows for internal 20dB receive attenuators to be enabled should they be needed due to very high receive levels or for interference trouble shooting. As with all options, to save changes press the "Save" button and then to activate the changes, click "Apply changes" in the control panel.

m		masinizing the poter payment with ess comm	tial of infections
Hantiar	Configure Transmitter	Transmitter	
System	Transmitter frequency (MHz)	447.86874 This nade has	z XIND instantiant
Transmitter		speraling on the	save frequency
Remainer	and the second s	Transmittiv fres	powercy is the carrier
Network.			
Spro: Satial			
Control Farvel			
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Figure 7: Transmitter configuration page

m		Los Active Sectors	urbaliniting the potential of elvented wholess communications
Hentor Bystem Transmitter Receiver Networti Sync Serial Control Panel SPE Cog out Logged in as tech	Configure Receiver Receive frequency (MHz) Rx 1 20dB attenuator Rx 2 20dB attenuator Save Cancel	442.86250 Disabled (* Disabled (*	Rocolvor This radio has 2 MMO receivent spenning on the same frequency: 2000 attenuators can be used to reduce the receiver agric/ kinel when spendforms
	Copyright	© 2000 HEROMAN WE	refess Ltd.

Figure 8: Receiver configuration page

4.6 SYNCHRONOUS SERIAL SETTINGS (OPV)

OPV (Optimised Protection Variant) versions of the NDL (Network Digital Link) family of products contain a synchronous serial port that supports the following standards:

- RS422
- X.21
- V.35
- G.703

The desired serial standard is usually specified when the radio is ordered and set in the hardware and software in the factory

Should any changes need to be made to the synchronous serial setting, click on "Sync Serial" (See Figure 10). The signals listed on this page are defined from the perspective of the connected equipment, see Figure 9.

Signal	Direction
Transmit data	input
Transmit clock	input/output
Receive data	output
Receive clock	output
Timing (X-21)	output

Figure 9: Synchronous serial signals

1. Synch Serial Mode

Selects the desired mode for the interface. Note: G-703 requires a hardware change. Selecting "Disabled" will disable the synchronous serial hardware and allow the full bandwidth to be used for Ethernet traffic.

2. Desired Bit Rate

User defined bit rate.

3. Actual Bit Rate

Actual achieved bit rate. Note: Desired and actual values my differ. Only exact multiples of the internal clock will result in a one to one relationship.

4. Configuration

Pre-defined settings (remaining fields are inaccessible) or manual (all fields are accessible)

5. Rx Clock Mode

When disabled no receive clock signal will be available.

6. Rx Phase

Defines which clock edge receive data is valid on.

7. Tx Clock Mode

Selects clock direction. Co-Directional sets as an input, Contra-Directional sets as an output.

8. Tx Phase

Defines which clock edge transmit data will be read on.

It is advised to consult the MiMOMax application notes for details on interfacing various synchronous serial products to the OPV radios.

1111		A State of the	mediatizing the potential at varied wireless communications
Munitur System Transpritter Receiver Network Sync Senal Control Panel SFE Log out Logged in as tech	Configure Sync Serial Sync serial mode Desired bit rate (bps) Actual bit rate (bps) Configuration Rix clock mode Rix phase Tix dock mode Tix phase Save Cancel	X-21 + 64000 Rising + Rising +	Synchronous Serial Synchronous Serial Synchronous Serial Synchronous Serial Synchronous defeed Rom th Despactor of the connects ensure ensure the connects Transmit sheck musticular decover data august Review sheck august Review sheck august Transmit sheck musticular decover data august Review sheck august Review sheck august Connect Bit Refer Review shecks the teste ACTE Destend and Actors address Connects Bit Refer Review address Review data audites Review data audites Conference and review on a set to an content of Review Review and the teste ACTE Destend and Actors address Review data audites Review data Review address Review data

Figure 10: Synchronous serial page

4.7 CHANGING PASSWORDS

Passwords are used to secure access for the "user" and "tech" logins. In addition to "tech" being able to change the "tech" password, "tech" may also change the "user" password.

To change a password, click on "Change Passwords" under System and then do the following (see Figure 11):

- 1. Type the intended password into the column labelled "Password" and retype the password into the column labelled "Retype Password".
- 2. Click "Save" to save the changes
- 3. Click on "Apply Changes" in the Control Panel to activate the new passwords.

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Monttor	Change User Password(s)		Change Passwords
Tythom		257 32 - W	This railly has various invests of log-st
Transinitar	User Name Password	Retype Password	The same allows the channe of
Felever	tech		addamardfal for the surrently logged in
Mebro(rit			The state of the second second
Sync Serial	Save Cancel		password in both bases and click
Control Panel	Characterist Concernants		See
11FE			
Log out			
Logged in as tech			
	Capyright C	2998 MINTON AN WITCHESS	tie.

Figure 11: Password page

5 ADVANCED TOPICS

5.1 MONITORING AND DIAGNOSTICS

This section is aimed at diagnosing poor radio link performance on a link that was previously known to be good. A radio link may perform badly due to poor signal or a fault. The following set of steps will endeavour to discover and solve the source of the problem.

Step 1

The first thing to check is if one can logon to the radio:

Point a web browser to the radio's IP address. This can be done remotely or locally with a laptop (ensure that the laptop has an IP address on the same subnet as the radio). If the radio is online, one should be presented with a logon screen (See Figure 12).

mim	
SS te	st radio 1 Login
User ID:	
Password:	
	Submit
IP: 172.26.19.85 Link st	atus: Not Active

- Figure 12: Logon page
- Logon as user "tech" (The default password is "tech").
- If one can't logon to the radio then:
 - Ensure that power is on and verifying that the power LED is on.
 - Verify that the Ethernet LED flashes in the presence of network traffic.
 - Ensure that there is IP connectivity to the previous router in the network or logon to the radio locally.
 - The status LED will be on if there is an RF link to the remote end of the link.
 - If one can't login locally then please contact MiMOMax for service.

5.1.1 Step 2

• Click on the monitoring menu item. One should see a screen similar to the one in Figure 13.

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Months

0442 - 172,24, 19,85 - Link Artilive - Sun Pelb 22 20:25:58 07C 2009

	system manufalling		Landiand
Bystem Towardtar	Date	2009-02-22	This page gives an overview of the radio performance
Receiver	Frequency offset estimate	20:26:01 3,70455 Hz	Erequency offset estimate a an estimate of the difference of cystem
Hebvort.	Air interface bytes sent	100739462 Bytes	clocks on both ends of the Tek. This is
Sync Serial	Air interface bytes received	362909415 Bytes	Load average as a measure of work
Central Panel	Air interface frame received	628180	that the CPU is being usind to perform
II/FE	Air interface frame received in error	2	1 is the maximum loading, greater than 1 indicates investigating
Log out	Wired interface bytes sent	504367979 Bytes	input voltage should be greater than
Logged in as tech	Wired interface bytas received Free memory Load average Uptime	229166514 Bytes 46912 kB 0.18 2 days 18 hrs 01 mina	Transmitter temperatures should not go over 83 degrees Celcus. Signal quality is a measure of hose much noise is on the channel. A 205 signal quality will not usually result in
	Piput voltage Transmitter 1 temperature	23.488 V 54.1 C	E is purely a measure of channer performance. A very four signal quality is usually an independent interference.
	Signal quality 1 Signal quality 1 Signal quality 2	54.2 C 96.31 % 96.39 %	RSSI (Received Signal Strength multiplicator) a measure of the reseived signal strength
	R×1 RSS Rx2 RSS	-87.91 dBm -87.27 dBm	Autoreeliesh hidrates if this page will referab. This is set on the System configuration page.
	Auto-refresh	Disabled	

Figure 13: System monitoring page

- Items to check are:
 - Link state (in the banner at the top of the page). "Not active", indicates that there is no communication with the radio on the other end of the link.

t & 2999 All All Max Wireless to

- **Signal Quality** (Should be higher than 50%). Signal quality is a measure of how much noise is on the channel. A 70% signal quality will not usually result in any more bit errors than a 90% signal. It is purely a measure of channel performance. A very low signal quality is usually an indication of interference.
- RSSI (Should not be below -97dBm). For OPV or greater (see product data sheet)
- Errors on the air interface (Errors are to be expected on a radio channel, but a high error rate indicates a problem, probably related to poor RF conditions).
- Uptime (A unexpectedly short uptime indicates an unexpected reboot).
- High transmitter temperature (90°C+)
- Low input voltage (less than 10.5VDC)

If signal levels are bad on one end only, it either indicates a faulty transmitter at the far end or a faulty receiver at the near end. If the signal levels are bad at both ends, check the antennas and antenna feeds.

Errors on a synchronous serial connection with good signal level, good signal quality and few air interface errors could be a result of noise on the synchronous serial cable or missing terminators on the connected equipment on long cable runs.

5.2 LONG TERM MONITORING

MiMOMax radios store various engineering parameters for 48 hours at a 1 minute sample resolution. These can be downloaded in CSV format from the control panel, by clicking on "Data log".

5.3 SOFTWARE UPGRADE

A software upgrade is usually done locally via the wired Ethernet connection to the radio device. However, if the optional Over-The-Air Programming (OTAP) feature is enabled, the process can also be done remotely via the MiMOMax link.

The following steps described here are common to the following products: OPV, LRU, BRU and RRU. The screen-shots were taken during an RRU software upgrade.

1. MiMOMax will have provided the user with a file whose filename resembles: mdl_rru_software_5.bz2. This file is for an RRU product and is version 5 of the software. The file is securely compressed and encrypted and can not be used on any other products other than an RRU.

2. The user needs to login to CCMS as Technician (username "tech") and navigate to the Control Panel page (see Figure 14).

m	mo Max	elven	edualiting the potential of convertigese communications
	Remate Radio Unit 172.28.19,91 Link in.	intive Tax Feb 27.2	BUILDE ALCONDUC
Moinber	Control Panel		Program Device
System	File to be uploaded:	1641	Chil Configuration Database to
Traingmitter		1 10.001	dawnawe the realid's configuration database
Receiver	Upload_File		Ches SHAD! Dake MD at SHAP MD
Network			to download the MB files to be used with an SNMP Manaper application with SNMPV8 manurer The Base MB is
Control Panel			
set	System Download:		products Chik on SaMP MIR to
ingoit	Configuration database		drenined the LR2-specific MIT file
Logged in as tech	Date log		Citic Apply Changes to action any changes saved on other pages.
120	ShiMP Base MB		Citit Upgrade Software to oppose
	SNMP MIE		Gatern etmeane
	System Upgrade Operations:		Cicl Rollback settmare to rel back to the provision authories version
	Apply changes		Software versions can be seen in the System Information page
	Reset system		Chil Restore database from factory
	Upgrade software		configuration note that this will also
	Rolback software		defould
	Figure 14: Cont	trol Panel	

3. The user clicks on the browse button \boxed{e} next to the "File to be uploaded: " text box to find the software image (see Figure 15).

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Desktop Come Folder Come Folder Come Folder Come Folder Come Folder	Konqueror Main Schwarz Main Schwarz <	
	<pre>mdl_rru_software_dev_2.18r.bz2 Release-Notes.html</pre>	
	Location: mdl_rru_software_dev_2.18.bz2 ▼ ✓ OK <u>F</u> ilter: All Files ▼ Cancel	

Figure 15: Selection of file to upload

4. Once the file is selected, a confirmation box will popup prompting the user to continue the process or not.



Figure 16: Send confirmation



5. Click the "Upload File" button to upload the file. A pop-up message window (see Figure 17) will then inform the user whether the upload was successful or not.



Figure 17: File upload confirmation

6. The user will need to scroll down to the "System Upgrade Operations" section of the Control Panel page and click on the "Upgrade Software" button (see Figure 18).

SPE .	System Download:	products Click on SAIAP MILL br	
Ling aut	Configuration database	drawnioust the Lifth specific shift the	
Logged in as tech	Datalog	Diel Apply Changes to active any changes saved in other pages.	
122	Bouring table	City Upgrade Softwate to upgrade	
	SNMP Base MB	Chel Rollback and many to rol back to	
	SNMP MB	the probabilities pathware version	
	System Upgrade Operations:	System information pape	
	Apply changes	Citri Restore database from factory	
	Reset system	configuration Acts that this will also	
	Upgrade software	charge the in address to the factory default	
	Rollback software	CRCR Packup database to copy the	
	Update SPE	database memory	
	Database Operations:	Click Restare database in cosy if	
	Restore database from factory default	In the action cody:	
	Backup database	Citol Reset radio to reset the radio	
	Restore database from backup	. arter	
	Upgrade database		
	Overwrite database		

Figure 18: Control Panel

7. Once the upgrade process is started, the user will be redirected to a self-reloading page that shows the process status. It reloads every 5 seconds. See Figure 19.

mi		manufalling the potential of
	Remote Badis test 172,26,29,93 Links	matthys Tax Fill 17,23-1453 010 2468
Mender	Upgrade progress	
System	Reference increase and	
Transmitter	Verifying software file	
Releven	- Verification Passed. Decompressing software, please weit.	
Network	WARNENG: Upgrading kernel, this will caus WARNENG: Upgrading reatfs, this will caus	e a reboot a a reboot
Control Panel	WARNONG) Upgrading database, this will ca	use a reboot.
SPE	MARNING: System restarting.	
ing old		
Logged in as tech		
	Copyright © 2000 Ho	NOMAA Witeless Ltd.

Figure 19: Software update progress page

8. The system will automatically reboot when the upgrade is done and the system should be back up in about 1.5 minutes.

The upgrade process takes about 3 minutes to complete plus 1.5 minutes for reboot for a total of 4.5 minutes downtime.

This same process can be used to downgrade the running software. Use the software image with the older version and follow the steps as outlined above.

5.4 SOFTWARE ROLLBACK

The system stores two independent copies of the software image. When the software is upgraded, the new software is copied to the inactive memory partition. In other words, the currently running software is kept intact. After the software upgrade process, the memory banks are swapped such that the previous active partition becomes the inactive partition and vice versa.

If the user needs to go back to the previously running version of the software, the button called "Rollback software" under the Control Panel page is used for this purpose.

When the "Rollback software" button is pressed, the radio immediately shuts down and reboots using the other memory bank.



Figure 20: Software Feature Enable (SFE) page

5.5.1 Software Feature Enablers

The SFE page (see Figure 20) shows the features enabled or disabled in the currently running software. The following features can be found:

1. Adaptive Modulation (M-CAM, MiMOMax Cognitive Adaptive Modulation)

This feature, when enabled, allows the RF modulation logic to step up or down depending on the quality of the received signal. It traverses from QPSK through to the maximum modulation order and visa versa depending on RF channel conditions.

If this feature is disabled, the RF modulation logic will stay on the set maximum modulation independent of signal quality. M-CAM typically allows for better utilisation of the channel as the modulation order is adapted as channel conditions change. In some circumstances this may be not be desirable (e.g. differential line protection, where fixed bandwidth and latency is required).

2. Nitro QAM Boost

This feature allows the RF modulation logic to go up to the full QAM256 giving a boost in data throughput, to reach a user data rate of up to 256kbit/sec (320kbit/sec air speed).

3. Over-The-Air Configuration (OTAC)

Normally the CCMS web application is only accessible via the local Ethernet port of the radio and not via the link over the air. With this feature enabled, CCMS can then be

accessible via both the local Ethernet port and over the air link, thus allowing remote configuration.

4. Over-The-Air Programming

This feature allows the user to perform software and database updates or upgrades remotely via the RF link. Without this feature, the software and database on the radio can only be updated or upgraded locally via the wired Ethernet port.

5. SNMP Support

MiMOMax radios can be accessed via SNMP (Simple Network Management Protocol) for network monitoring purposes. The radio can also send various traps or notifications via SNMP to a configured SNMP manager on the network.

6. Data Logging

This feature can be used for monitoring the system performance over the previous 48hour period. With this feature, a CSV (Comma-Separated Values) data file will be available for download on the Control Panel page that can be downloaded for a more detailed performance monitoring.

5.5.2 Software Feature Request

The SFE page allows the user to request that additional features are enabled. See Figure 21. This process is described below:

1. The user clicks on the drop-down selection menu opposite to a particular feature or features and sets it to "Enabled".

2. The user then clicks the "Submit" button in order to create a file containing the request. The SFE page will reload and will then display a message that the process is complete and an instruction to the user about what to do next.

3. A new button called "Download SFE" also appears at the bottom of the page. The user must click this button in order to download the generated file and then send it to the nearest MiMOMax Business Center.

4. Once the features are purchased, MiMOMax Wireless will send the customer an SFE update file in order to enable the features on the radio. Please see the next section (5.5.3 SFE Update) for details on how to do this.

IIII	IIIO wireless	advanced wireless communications	1
Manigor	Software Features Enable	nactive Tue Feb 10 00:40:40 VTC 2009	
System	Nitro Boost	Enabled \$	
transmitter.	Over-The-Air Configuration	Enabled \$	
Receiver	Over-The-Air Programming	Enabled \$	
Syric Surial	SNMP Support	Enabled \$	
Control Panel	Data Logging	Enabled \$	
SFE	(Cancel) (Submit)		
Log out			
Logged in as tech	SFE Click on Download ordering completed support centre.	I SFE for the send it to business	
	Download SFE		

Figure 21: Software feature request page

5.5.3 SFE Update

When a customer is given an SFE update file from MiMOMax Wireless, an SFE update process needs to be done in order to apply the SFE changes. This process is described below:

1. The SFE file needs to be uploaded to the specific radio it is meant for. This SFE file can not be used on other radio units. The file upload facility is found on the Control Panel page.

2. Once the file is uploaded, the user needs to click on "Update SFE" button on the Control Panel page in order to apply the SFE changes. The process takes a few seconds to complete and once done, the features requested should then be "Enabled" as shown on the SFE page. See Figure 22.

mi	mo	measimizing the povertial of advanced wireless communications
Monitor	Upgrade progress	N TUN Feb 10 00:35:51 UTC 2005
System	and descharge and and	
Transmitter	bre database updated. Done	
Receiver		
Network		
Sync Sanal		
Control Panel		
SFE		
Log out		
Logged in as tech		
	Copyright 6 2000 M	MGHas Wireless Ltd.

Figure 22: Software feature update status page

5.6 DATABASE OPERATIONS

The database on a MiMOMax radio stores all configuration parameters for the radio. The database is separated from the software so that configuration settings will survive a software upgrade. In other words, even if the radio's software is upgraded or changed multiple times, the configuration settings remain intact.

The user can also download the database file for backup purposes. Additionally, the radio can also keep a backup of the database internally.

The usual time when the user will need to upgrade the database is when a previous software upgrade requires it. It is important for the software and the database to be synchronized for correct operation.

A Technician can choose from among the different database operation options:

1. Restore database from factory default

This operation will reload the factory-set configuration and reboot the radio.

2. Backup database

This operation signals the radio to create a backup of the current configuration internally. The backup database is stored in non-volatile memory and is persistent when the radio is rebooted or powered down.

3. Restore database from backup

This operation will reload the configuration from the backup stored internally in the radio. This also causes the radio to reboot so that the new settings are applied.

4. Upgrade database

This operation will upgrade the current database. It is important to note that a database upgrade does not necessarily affect the current configuration settings. It only means that the database version or schema is upgraded and the relevant values are retained.

5. Overwrite database

This operation will overwrite the database on the radio which means that all the values are overwritten with new ones. The database file used in this operation should be a database file that is specific to the radio, otherwise the operation will fail. This file is usually the result of downloading the database file from the radio by clicking on the "Configuration database" button under the "System Download" section of the "Control Panel" page.

5.6.1 Upgrading the database

The database upgrade process is similar to the software upgrade process.

- 1. MiMOMax will have provided the user with the appropriate database upgrade file where the filename resembles: ndl_opv2_db_1.3.bz2. It is a securely compressed and encrypted file and can only be used for the appropriate product range. In this case, this applies to any OPV series 2 (OPV2) product.
- 2. Login as Technician (username "tech") in CCMS and navigate to the "Control Panel" page.
- 3. Upload the file by clicking on the browse button next to the "File to be uploaded:" text box. Select the file provided (See Figure 23).

5	Konqueror	? – ×
 O C C C O C C C C C O C C C C C O C C C C O C C C C O C C C C C O C C C C O C C C C	 Multiple interval interval	
	Location: ndl_opv2_db_1.3.bz2	✓ <u>0</u> K X <u>C</u> ancel

Figure 23: Database file selection

4. Click on the "Upload file" button. Once the upload is complete, a message prompt will pop-up with the appropriate message (see Figure 24).

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•	File Uploaded.
	<u>мо</u> к

Figure 24: File upload confirmation message

5. Scroll down to the "Database operations" section of the "Control Panel" page and then click on "Upgrade database". Once the radio has verified the file it will then apply the upgrade and reboot the radio. This process is a very quick process such that the browser may not have the chance to load the upgrade status page. This is normal and any HTML errors on the page as a result of a sudden loss of connection to the radio can be safely ignored. The radio should be back up after 1.5 minutes.