MiMOMax Wireless Ltd

SubMux Interface MANUAL

2011

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CONTENTS

1 OVERVIEW

The MiMOMax SubMux Interface is a multiplexer capable of multiplexing RS422, X21, RS232 and C37.94 data for transport across MimoMax NDL links. The SubMux is aimed at utilities that wish to transport for example Differential Line Protection (synchronous) as well as SCADA (RS232) over a single radio link.

1.1 FEATURES

The MiMOMax SubMux featured two RS422/X.21 Synchronous ports, four RS232 ports, one IEEE C37.94 multimode fibre optic port and an alarm port. Configuration is via the web based CCMS used to configure MiMOMax radios. Additionally the SubMux may be configured for use with third party equipment. The MiMOMax SubMux sports low latency real-time modes for use with low latency applications such as Differential Line Protection.

Figure 1: SubMux Interface

1.2 DATA PORTS

The SubMux features the following ports:

1.2.1 IEEE C37.94 Fibre Optic Port

The C37.94 port is aimed at line protection relays. It is multimode at a wavelength of 850nm.

Connection is via ST Connectors (IEC 61754-2).

1.2.2 X.21 / RS422 Ports

The two synchronous ports can be configured to operate in either X.21 or RS422 mode.

Note that clock and termination jumpers need to be set correctly see Section 2.3 for details.

Connection is via shielded RJ-45 connectors.

1.2.3 RS232 Ports

The RS232 ports can operate at BAUD rates ranging from 300 to 115200. The ports also support hardware flow control via RTS / CTS signals. The RS232 ports are usually operated in a buffered mode, but can also be operated in a real-time mode to facilitate “mirrored-bits” type applications.

Connection is via RJ-45 connectors.

1.3 ALARM

The SubMux features a configurable alarm port with both normally open and normally closed relay contacts.

Connection is via a Phoenix Contact MC 1.5/3-G-3.81.

The mating connector for this is a Phoenix Contact MCVR 1,5/3-ST-3.81 (MiMOMax Internal part number 240-02644-00).

1.4 HSSI

The connection between SubMux and MiMOMax Radio units is via the HSSI Port. A shielded cable with RJ-45 connectors is provided for this purpose.

1.5 THIRD PARTY USE AND CONFIGURATION

The SubMux features an additional RS232 port that can be used for configuration for use with third party equipment. A separate PC application is required for use with this port. The HSSI port can also be configured for X.21 mode for use with third party data transport. Please contact MiMOMax for additional details.

1.6 INDICATORS AND PORTS

The MiMOMax SubMux has various ports and indicators which are identified in Figure 2 and Table 1.

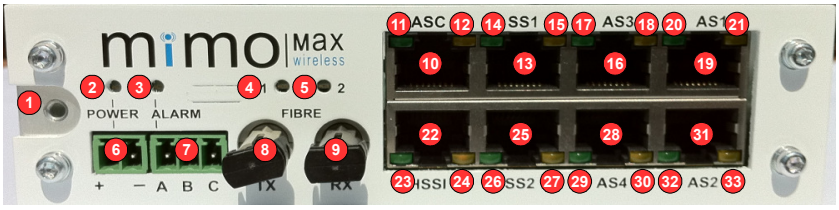

Figure 2: Ports and Indicators

No	Function	No	Function
1	Earth Connection	18	Asynchronous Serial Port 3 alarm LED
2	Power LED	19	Asynchronous Serial Port 1 (RS232)
3	Alarm LED	20	Asynchronous Serial Port 1 enabled LED
4	Fibre Port enabled LED	21	Asynchronous Serial Port 1 alarm LED
5	Fibre Port alarm LED	22	HSSI port or third party X21 port
6	DC power input	23	HSSI port enabled LED
7	Alarm Relay	24	HSSI port alarm LED
8	IEEE C37.94 Fibre Optic Tx (output)	25	Synchronous Serial Port 2 (RS422 / X.21)
9	IEEE C37.94 Fibre Optic Rx (input)	26	Synchronous Serial Port 2 enabled LED
10	Third Party configuration Port (RS232)	27	Synchronous Serial Port 2 alarm LED
11	LED Always on	28	Asynchronous Serial Port 4 (RS232)
12	Not used	29	Asynchronous Serial Port 4 enabled LED
13	Synchronous Serial Port 1 (RS422 / X.21)	30	Asynchronous Serial Port 4 alarm LED
14	Synchronous Serial Port 1 enabled LED	31	Asynchronous Serial Port 2 (RS232)
15	Synchronous Serial Port 1 alarm LED	32	Asynchronous Serial Port 2 enabled LED
16	Asynchronous Serial Port 3 (RS232)	33	Asynchronous Serial Port 2 alarm LED
17	Asynchronous Serial Port 3 enabled LED		

Table 1: Indicators and Ports

2 INTERFACES

2.1 POWER AND EARTHING

The SubMux features an isolated (1500V) DC/DC power supply with input voltage range from 12-48V, power consumption is less than 3.2 watts.

As the power supply is isolated it is advisable to earth the SubMux via the Earth connection on the front of the SubMux. Where the SubMux and radio are co-located, both should be Earthed to the same point.

Pin	Signal	Polarity		Description
-	NEGATIVE	0 volts	- volts	DC Input
+	POSITIVE	+ volts	0 volts	(Polarity must be observed)

Table 2: DC power connector

Connection is via a Phoenix Contact MC 1.5/2-G-3.81.

The mating connector for this is a Phoenix Contact MCVR 1,5/2-ST-3.81 (MiMOMax Internal part number 240-02643-00).

2.2 DATA INTERFACES

The data interfaces are all via shielded RJ-45 connectors. The pinout is defined in Figure 3.

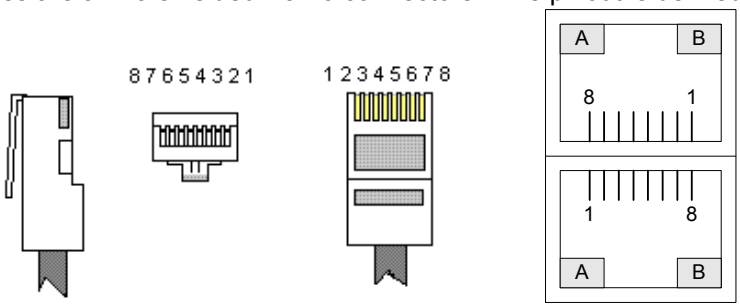

Figure 3: RJ45 pinout

2.2.1 HSSI

The shielded HSSI cable for connection between the radio unit and SubMux is provided with the SubMux. A diagram of the table is provided in Table 3.

SubMux RJ45		Radio Unit RJ45	
Signal	**Pin**	**Pin**	**Signal**
Tx Data B (output)	1	1	Tx Data B (input)
Tx Data A (output)	2	2	Tx Data A (input)
not used	3	3	not used
Rx Data B (input)	4	4	Rx Data B (output)
Rx Data A (input)	5	5	Rx Data A (output)
not used	6	6	not used
not used	7	7	not used
not used	8	8	not used
GND	Body	Body	GND

Table 3: HSSI cable pinout

Note: Unshielded CAT5 cable may be used for this connection but shielded RJ45 plugs **must** be used and the plug shields must be connected with one or more of the unused conductors!

2.2.2 Third Party Configuration Port

The Third Party Configuration port (labelled ASC) on the SubMux is an RS232 port, configured with the following settings:

- 115200 BAUD
- 8 data bits
- No parity bits
- 1 stop bit
- No flow control.

A separate PC application is required to use this port.

A pin out for the RJ-45 connector can be seen in Table 4.

Pin	Signal
1	GND
2	Rx (Input to SubMux)
3	RTS (Output from SubMux)
4	GND
5	Tx (Output from SubMux)
6	GND
7	CTS (Input to SubMux)
8	GND
Body	GND

Table 4: Third party configuration port pinout

2.2.3 Synchronous Ports

The Synchronous ports typically operate at 64000bit/sec. The pinout for the RJ-45 can be seen in Table 5. The Synchronous ports can be configured to operate in both X.21 and RS422 modes (Co and Contra directional clocking is supported). Note that different termination may be required, see Section 2.3.

Pin	Signal
1	Tx-data B (Input to SubMux)
2	Tx-data A (Input to SubMux)
3	Rx-clock B (Output from SubMux)
4	Rx-data B (Output from SubMux)
5	Rx-data A (Output from SubMux)
6	Rx-clock A (Output from SubMux)
7	Tx-clock B (Input or output of the SubMux)
8	Tx-clock A (Input or output of the SubMux)
Body	GND

Table 5: Synchronous port pinout

Note that in X.21 mode, Tx-Clock is not used.

2.2.4 Asynchronous Ports (RS232)

The pin-out for the four asynchronous ports can be seen in Table 6.

Pin	Signal
1	GND
2	Rx (Input to SubMux)
3	RTS (Output from SubMux)
4	GND
5	Tx (Output from SubMux)
6	GND
7	CTS (Input to SubMux)
8	GND
Body	GND

Table 6: RS232 port pinout

2.2.5 Fibre (C37.94)

Connections are via ST connectors (IEC 61754-2).

2.2.6 Alarm

The SubMux has a relay with both normally open and closed alarm contacts. Note that the SubMux is in alarm condition when the power is removed (i.e. pins A & B are shorted).

Pin	Signal
A	Closed in Alarm
B	Common
C	Open in Alarm

Table 7: Alarm power connector pinout

2.3 TERMINATION AND CLOCK CONFIGURATION

The synchronous serial ports clocks are hardware configurable as inputs or outputs via jumpers to allow for both contra- direction and co-directional clocking of the synchronous ports.

Figure 4 shows the location of the jumpers on the PCB, the jumpers are shown in their default positions.

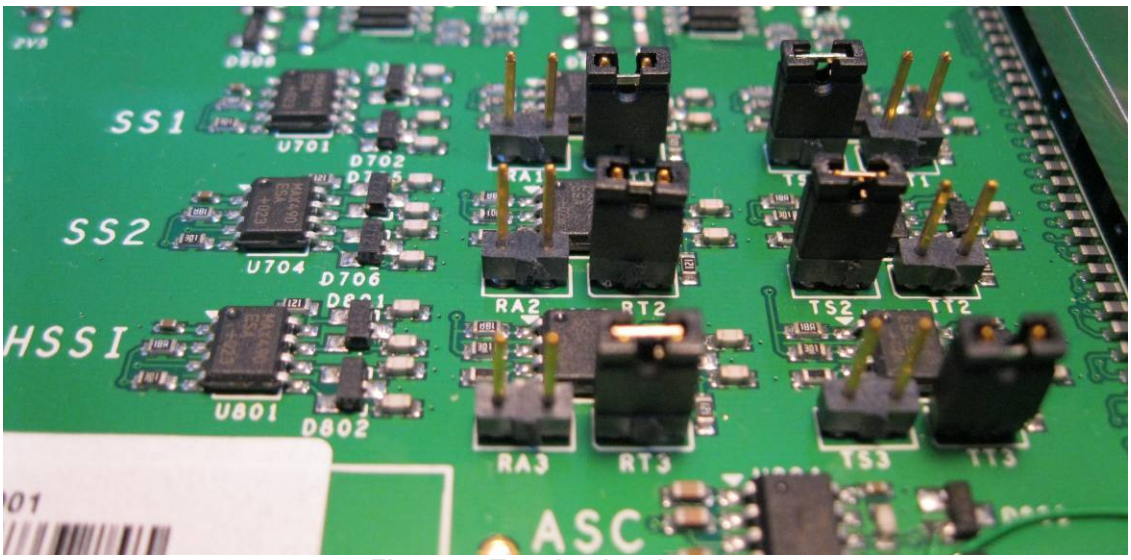

Figure 4: Termination Jumpers

Note: The labelling on the PCB has Tx and Rx swapped when compared to the DCE standard which is followed everywhere in the SubMux documentation and CCMS, please use the jumper positions provided in Table 8 to avoid confusion.

PCB label	Co-directional clocking and X.21	Contra-directional clocking
RA#	Open	Short
RT#	Short	Open
TS#	Short	Short
TT#	Open	Open

Table 8: X.21 Co and Contra directional configurations (note replace the # with the port number 1 or 2)

The factory default position of the jumpers is for Co-directional clocking and X.21 on both sync serial ports; this needs to be changed to operate contra-directional clocking on either synchronous port.

	Chan 1 (SS1)	Chan 2 (SS2)	Chan 3 (HSSI)
RA	Open	Open	Open
RT	Short	Short	Short
TS	Short	Short	Open
TT	Open	Open	Short

Table 9: Factory defaults

Note: Leave the HSSI port as it is set from the factory, which is with the jumpers in positions RT3 and TT3.

3 INSTALLATION

The SubMux can be co-located in the same rack tray as the MiMOMax radio unit. See Figure 5.

Figure 5: Radio Unit and SubMux collocated in 19" rack tray

A SubMux kit contains the SubMux and the required components for connection to the radio unit and attachment to the rack tray. See Table 10.

Description	Qty	MiMOMax Internal Part Number
SubMux	1	INT-NIB-MX1-XXX-01XX
Mounting Bracket	1	302-06015-00
Screw M4x8 Pan Head	4	349-02059-00
Screw M4x10 Counter Sunk	2	349-02060-00
HSSI Cable	1	219-03337-00
Power connector and cable	1	219-03374-00
Alarm connector	1	240-02644-00

Table 10: SubMux kit

The two M4x10 Counter Sunk screws attach the mounting bracket to the rack mount tray. These are visible in Figure 5.

The four M4x8 Pan Head screws are used to attach the SubMux to the mounting bracket and the rack mount tray. The two screws attaching the SubMux to the mounting bracket are visible in Figure 5.

4 SYSTEM

The SubMux is designed to primarily work with MiMOMax Radio units. A typical setup can be seen in Figure 6.

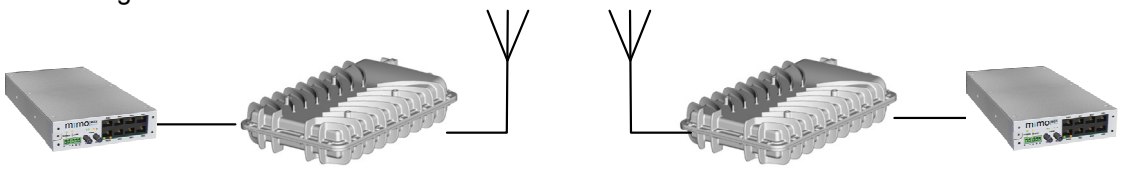

Figure 6: System diagram

When designing a linking solution various parameters need to be considered:

- Required bandwidth
- Required latency
- Channel Priority
- Buffered / Real-time channels

4.1 SubMux Bandwidth Requirements

Table 11 shows the total available user bandwidth for all modes of operation.

Find the radio modulation and bandwidth down the left hand side and the number of channels enabled in your SubMux at the top of the table. The resulting figure is the total bandwidth, in kbits/sec, available for SubMux data ports.

The bandwidth not used by the SubMux data ports is available on the Radio's Ethernet port plus the additional for Ethernet bandwidth shown on the far right of the table.

Num Channels Enabled Radio Mod & BW	1	2	3	4	5	6	Additional Data Rate for Ethernet
12.5kHz QPSK	20	10	5	5	0	0	6
12.5kHz 16QAM	55	45	40	40	35	35	8
12.5kHz 64QAM	85	75	70	70	65	65	15
12.5kHz 256QAM	115	105	100	100	95	95	22
25kHz QPSK	55	45	40	40	35	35	8
25kHz 16QAM	115	105	100	100	95	95	22
25kHz 64QAM	180	170	165	165	160	160	31
25kHz 256QAM	245	235	230	230	225	225	40

Table 11: Available bandwidth (kbits/sec)

4.2 SubMux Latencies

Radio Mod & BW	X.21 and C37.94	RS422 (64 kbps)	RS232(1,2)
12.5 KHz QPSK	N/A	N/A	20 ms(3)
12.5 KHz 16QAM	N/A	N/A	12.8 ms(3)
12.5 KHz 64QAM	10.6 ms	12 ms	11.2 ms
12.5 KHz 256QAM	8.7 ms	9.2 ms	10.5 ms
25 KHz QPSK	N/A	N/A	11 ms(3)
25 KHz 16QAM	7.2 ms	9.2 ms	7.9 ms
25 KHz 64QAM	6.1 ms	8.2 ms	6.6 ms
25 KHz 256QAM	6.0 ms	7.8 ms	6.2 ms

Table 12: SubMux latencies as a function of radio bandwidth and modulation

Notes:

(1) RS232 Latencies are measured at 9600 baud with a concurrent X.21 port.

(2) Baud rate affects the latency.

(3) The RS232 latency measurement for 12.5 kHz QPSK, 12.5 kHz 16QAM and 25 kHz QPSK were at 9600 baud **without** a concurrent X.21 port.

4.3 MULTIPLEXER CHANNELS

The SubMux uses the concept of channels to transport data to and from the various ports. Channels are then mapped onto physical ports during the configuration process. If for example one wants to use one X.21 port and two RS232 ports, then three channels are required. Channel 1 has the highest priority and would usually be used for the synchronous port. Channel priority comes into play when the bandwidth required by the SubMux exceeds that which can be provided by the radio link. This may for example happen if the radio reduced its modulation order to adapt to a fade or interference. Under these conditions the lowest priority channels are either dropped (real-time configuration) or buffered (RS-232 ports configured in buffered mode).

4.4 BUFFERED VS REAL-TIME CHANNELS

Synchronous ports can only be configured for real-time operation. Asynchronous ports (RS232) can be configured for either buffered or real-time operation.

Real-time operation should only be used to support latency critical applications such as SEL mirrored bits.

5 CCMS CONFIGURATION

5.1 RADIO CONFIGURATION

To use a SubMux with the MiMOMax Radio Unit, the radio unit must be fitted with a DIF2 and the Radio Unit must be configured for DIF2 operation (Under "System Configuration in the CCMS), see Figure 7. The Serial Interface on the Radio Unit must also be configured for HSSI2 mode (under Serial Interfaces in the CCMS), see Figure 8.

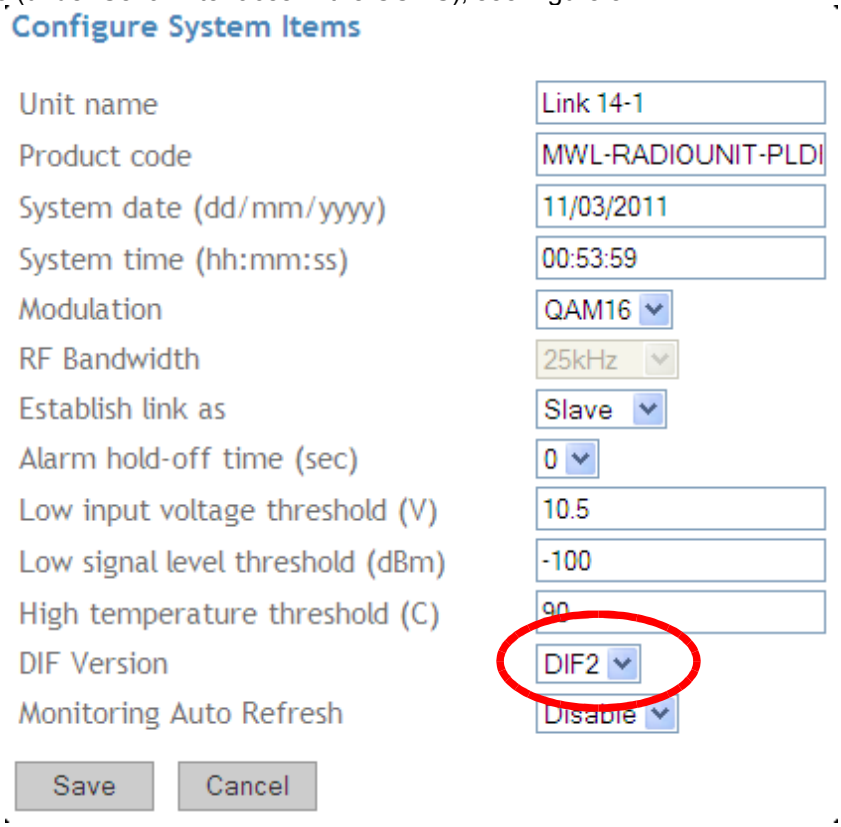

Figure 7: DIF2 selection

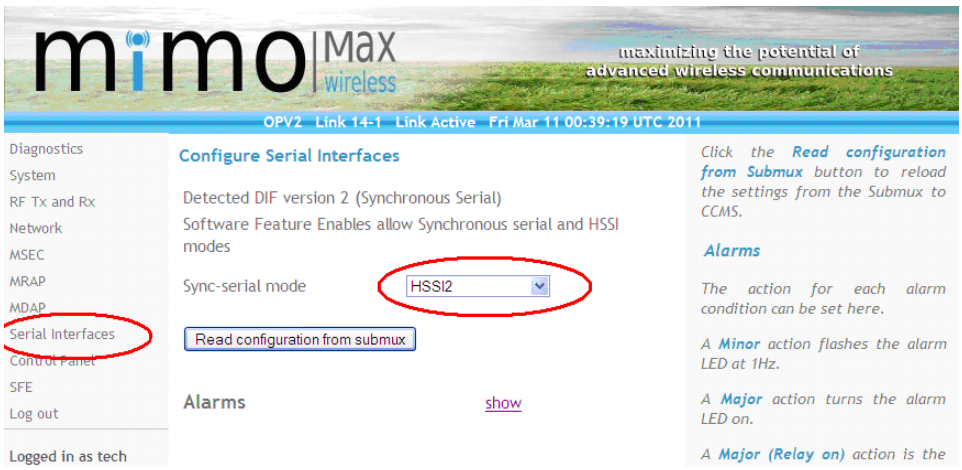

Figure 8: HSSI2 configuration

5.2 SUBMUX CCMS CONFIGURATION

The SubMux is configured via the CCMS under “Serial Interfaces”. The CCMS will report the serial number, product code, hardware revision and software version under “SubMux configuration”, see Figure 9. Additionally the required number of channels is also selected here.

Note: that the configuration of the SubMux must match on both ends of the link for it to function correctly. For more information on channel configuration, see Section 4.3.

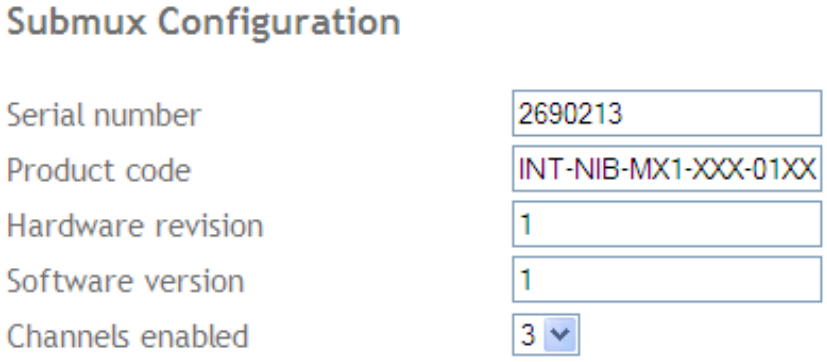

Figure 9: CCMS SubMux Configuration

5.3 SUBMUX CCMS CHANNEL MAPPING

The mapping of ports onto channels is performed on the “Channel Mapping” section. In Figure 10, three channels have been selected. Notice that the X.21 port is automatically in real-time mode and the RS232 ports have been configured for buffered mode.

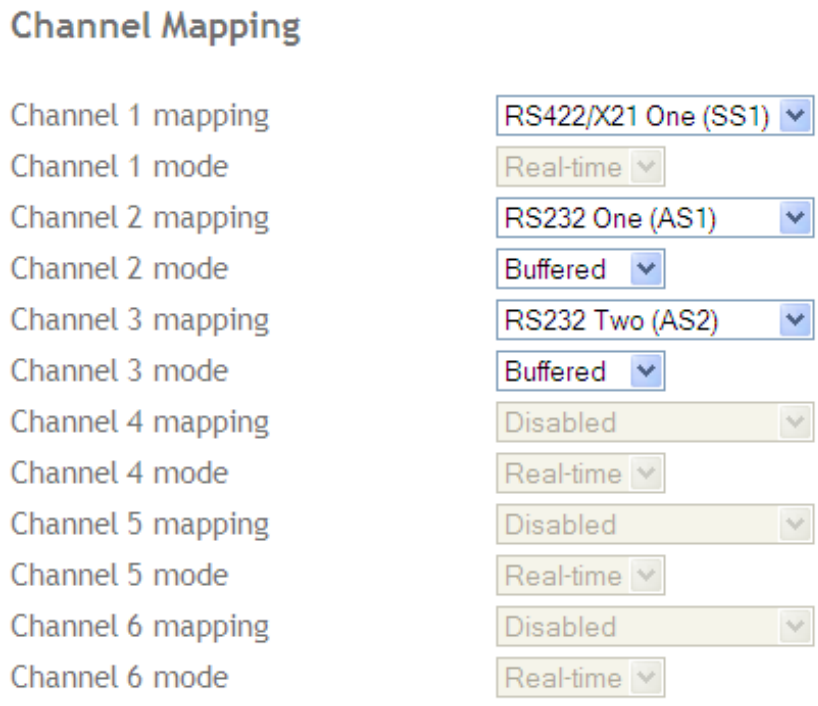

Figure 10: CCMS SubMux Channel Mapping

5.4 SUBMUX CCMS PORT CONFIGURATION

Figure 11 shows the port configurations for RS232 and Synchronous serial.

RS422/X21 ports:

- The Mode setting selects X21 or RS422 mode.
- Bit Rate sets the bit rate of the port (RS422 only).
- Rx clock edge defines which clock edge receive data is valid on.
- Tx clock edge defines which clock edge transmit data will be read on.
- Tx Clock Mode selects clock direction. Co-Directional sets as a clock input, Contra-Directional sets as a clock output (RS422 Only).

Note that when changing from X21, RS422 co-directional clocking and RS422 contra-directional clocking, the jumpers on the PCB may need changing, please refer to section 2.3 of this manual for information on the jumper settings.

RS232 ports

- Baud rate sets the RS232 baud rate.
- The data bits can be set to 7 or 8.
- The stop bits can be set to 1 or 2.
- Hardware flow control using CTS and RTS signals is supported and can be set as disabled or enabled.

C37.94

- There are no configurable parameters for the C37.94 port.

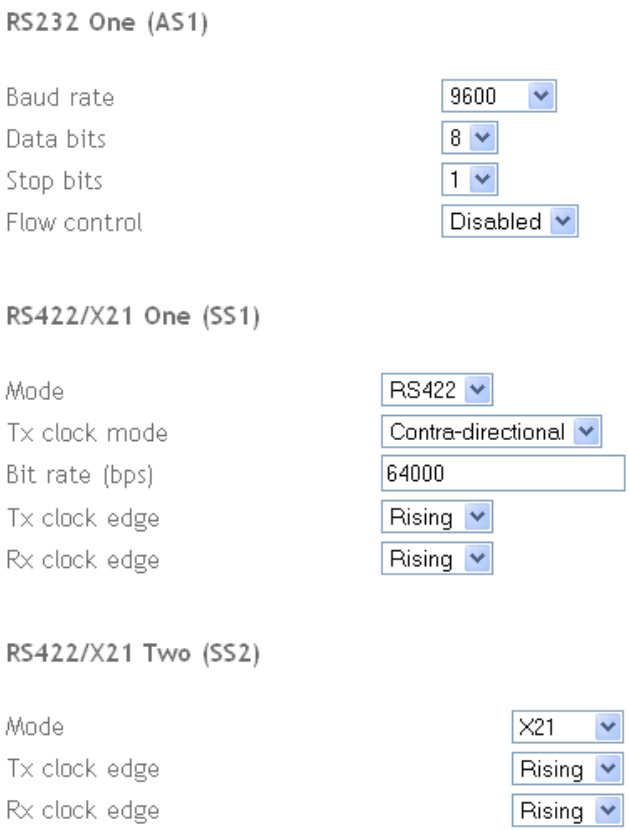

Figure 11: CCMS SubMux Port settings

Note:

- Configuration changes are only written to the SubMux when the “save” button is pressed in CCMS.
- For SubMux configuration items to be applied, one does not need to click on “Apply Changes” in the Control Panel as one does for Radio Unit configuration parameters.

Figure 12: CCMS Save and Cancel buttons

5.5 SUBMUX CCMS ALARM CONFIGURATION

Alarm configuring is covered in the diagnostics section on the next page.

6 DIAGNOSTICS AND TROUBLE SHOOTING

6.1 ALARMS

The SubMux continuously monitors its ports and internal states and reports alarms when ever an error condition occurs. The actions taken when these conditions occur are fully configurable. These can range from turning on the alarm LED to activating the alarm relay.

Alarm actions are:

- A Minor action flashes the alarm LED at 1Hz.
- A Major action turns the alarm LED on.
- A Major (Relay on) action is the same as major but also puts the alarm relay into its alarm state.
- A Critical alarm is non configurable and will flash the LED at a 0.25Hz rate and can only be cleared by power cycling the SubMux, this only occurs with hardware failure.

Note: All alarms are logged (All logs and databases in the Control Panel).

Figure 13 shows the alarm state and configuration in the CCMS. If no alarm is present then the table is hidden. To show the table click "show" next to "alarms". If any alarms are set, the CCMS will display the alarm, the number of occurrences and the action to take.

Note: Save needs to be clicked in order to save changes in the alarm actions.

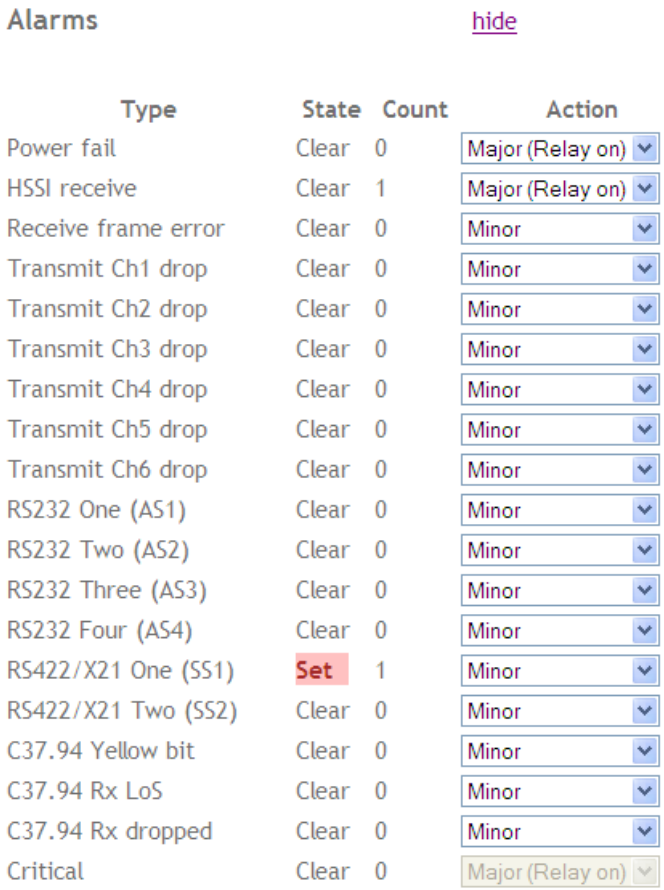

Figure 13: CCMS SubMux Alarm configuration

6.2 LOGS

The Radio Unit logs all alarm transitions to a CSV file that is included in the “All logs and databases” download in the Control Panel of the radio unit, see Figure 14.

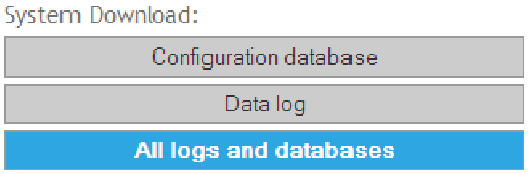

Figure 14: CCMS Download all logs

Note that the timestamp in the log file is in "POSIX time" (seconds since 00:00:00 UTC on 1 January 1970).

6.3 LOOP-BACK TESTING

To loop-back the HSSI port at either the radio or the SubMux, a RJ45 plug needs to be made which connects pin 1 to pin 4 and pin 2 to pin 5. If this is used on the radio, simply plug it in and it can be used immediately. To loop-back the HSSI at the SubMux, plug the loop-back connector in and power cycle the SubMux. The power cycle is needed as without it the SubMux will attempt to lock its HSSI, X.21 and C37.94 clock to itself and the clock frequencies will be incorrect on these ports.

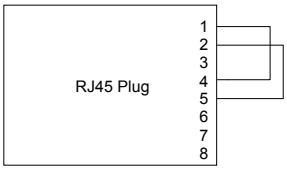

Figure 15: HSSI Loop-back

To loop-back any of the other ports a suitable loop-back connector must be made that matches the pin out of the port. For looping back RS422 ports, co-directional Tx clocking is needed and the clock signal must be looped back.

6.4 SUBMUX BACK-TO-BACK TESTING

Two SubMuxes can be connected back-to-back for testing purposes, see Figure 16 and Figure 17 for details on the required cable.

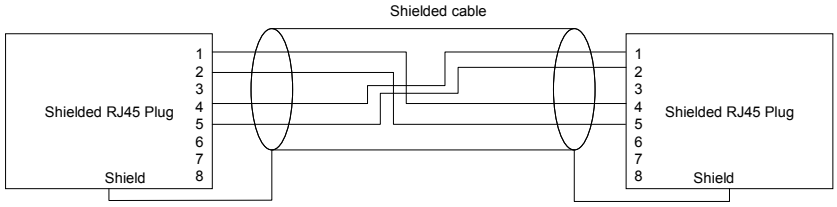

Figure 16: HSSI Cross over cable (For back-to-back SubMux Connection)

Figure 17: HSSI Cross over cable pinout

Pin number RJ45 (primary end)	Pin number RJ45 (secondary end)
1	4
2	5
4	1
5	2
shield	shield

Pins 3, 6, 7 and 8 can be connected or left unconnected.

6.5 RESET TO FACTORY DEFAULTS

The SubMux can have its configuration reset to factory defaults by the following procedure:

1) Remove the 6 screws holding the lid on the SubMux.
2) Locate the selector switch and set to position “F”. See Figure 18.
3) Locate the reset button and press reset
4) Set the selector switch back in position “0”
5) Replace the lid and screws

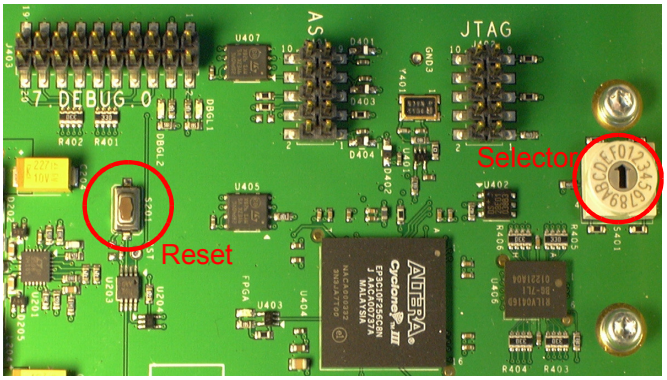

Figure 18: SubMux Reset button and Selector Switch

Factory default settings is with all ports disabled, number of channels set to 1 and the HSSI connection set on HSSI2 mode ready for use with a MiMOMax radio. All alarms except the power fail and HSSI receive alarm are set to the minor action. Power fail and HSSI receive alarm are set to the major (relay on) action.

7 SPECIFICATIONS

Asynchronous Serial Interface	
Interface type	RS232 (V.35)
Number of Channels	Up to 4
Connector	RJ45
Baud Rate	300 to 115 200
Synchronous Serial Interface	
Interface type	X.21 / RS422
Number of Channels	Up to 2
Connector	RJ45
Data Rate	64 000 bps
Fibre IEEEC37.94 Interface	
Number of Channels	Up to 1
Connector	ST (IEC 61754-2)
Data Rate	64 000 bps
Wavelength	850nm (Multimode)
Alarm	
Connector	Detachable screw terminal
Physical	Voltage free changeover contacts
Power	
Connector	Detachable screw terminal
Type	Isolated DC/DC converter
Isolation	1500 volts
Nominal Input Voltage	12 to 48 V DC
Power Consumption	< 3.2W
Mechanical Dimension	
Mechanical Dimension (H x W x D)	38mm x 140mm x 258mm (ST connectors protrude from this)
Environmental	
Temperature (Operational)	- 25 ºC to 60 ºC
Relative Humidity (Operational)	4% to 100% (per EN 300 019 sec. 3.3 & 4.2H)
Altitude (Operational)	0 to 3000m