A. W. Communication Systems Limited

TR*ip*

IP Gateway for four wire analogue circuits used in the PMR industry

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Summary:

This document contains the specification for a TR*ip* Gateway to connect 4 wire analogue private circuits to an Ethernet 10/100 Mbps LAN connection for the purpose of carrying full duplex 3.4 KHz audio bandwidth information over an IP connection.

Contents

1. References

Reference 1: **RFC 1889 - RTP: A Transport Protocol for Real-Time Applications [Jan 1996]**

Reference 2: **draft-ietf-avt-profile - RTP Profile for Audio and Video Conferences with Minimal Control [March 2003]**

2. Scope

This document describes the product specification for the provision of a VoIP (voice over IP) gateway suitable for interfacing 4 wire analogue private circuits to a 10/100 Mbps Ethernet LAN and also for the transportation of serial data over the LAN connection. The unit name is the TR*ip*.

3. Introduction

For historic reasons the PMR (Private Mobile Radio) market has often used 4 wire analogue circuits provided by the local PTT to carry audio between operators and remotely situated transmitters.

The increasing availability of low cost “always on” IP connections has raised the possibility that these links can be replaced using a packet based connection rather than the direct physical connection provided by the older 4 wire analogue circuits.

The product described in this specification is specifically designed to satisfy the requirements of the industry for a device that can interface between existing operator/transmitter switch equipment that has a 4 wire audio interface and an IP network capable of carrying the audio traffic as packet data.

The device will be referred to as the “TR*ip*” in the remainder of this document.

This document discusses the form, features and functionality of a standalone unit.

4. Technical Specification

4.1 Internet Protocol and Application Features

The TR*ip* provides support for the following IP features and applications to enable the required operation of the unit: -

- IP – Internet Protocol, base network protocol used by all higher-level protocols.
- Diffserv - Differential Services, IP enhancement for QoS support.
- UDP – User Datagram Protocol, unacknowledged transport protocol.
- TCP – Transmission Control Protocol, acknowledged transport protocol.
- RTP – Real Time Protocol, application protocol for the transmission of real time data
- RTCP - Real Time Control Protocol, application protocol for the monitoring of RTP
- ICMP – Internet Control Message Protocol, network management protocol
- TELNET - Terminal Emulation, Application protocol for terminal emulation
- TFTP - Trivial File Transfer Protocol, application protocol for the transfer of files over IP networks

The support for each of the protocols and applications is discussed in each interface section it is used to support.

4.2 Logical Interface Architecture

The TR*ip* has a logical Interface architecture as shown in Figure 1.

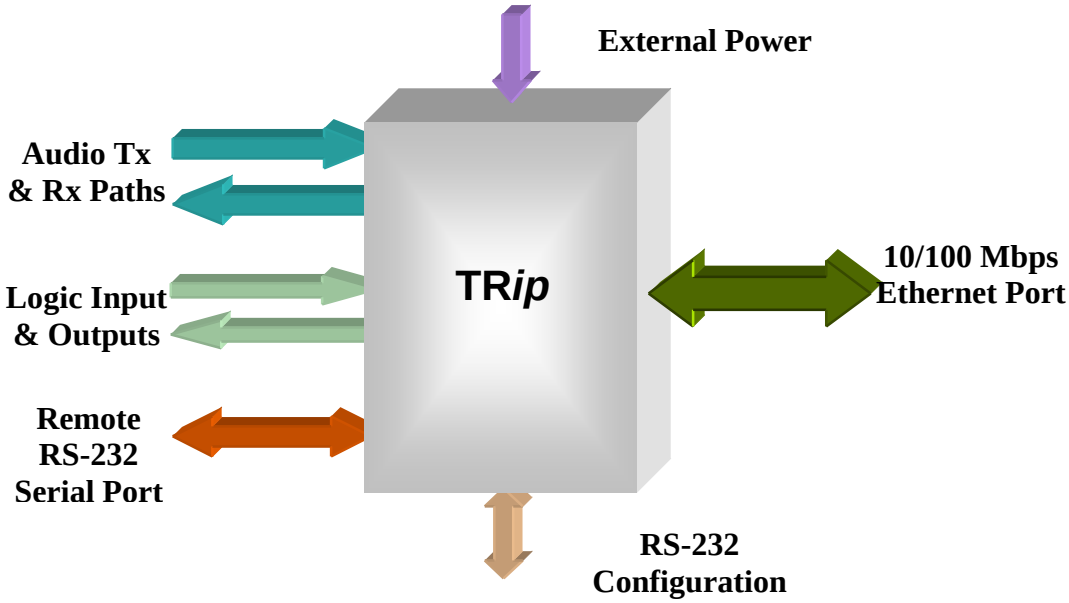

Figure 1 TRip Logical Interface Architecture

The Audio TX and RX paths are designed to imitate the physical interface provided by a 600 Ohm 4 wire interface. The audio will be digitised and compressed and carried across a UDP stream using RTP. Two of the three compression algorithms used are not suitable for the transmission of tones, so an extra serial interface and an extra logic control interface have been added to allow the transmission of transmitter control information through these interfaces rather than over the audio path.

4.3 Operational Scenarios

The unit is deployed in a point-to-point configuration. Within this configuration there would normally be a Master Unit and a Slave Unit. The master unit would normally be associated with the control site, and is capable of having an input pin that is used to control the state of the remote transmitter (transmitting/ Not transmitting). On the remote unit this pin is therefore an output, and defines the unit as a slave unit.

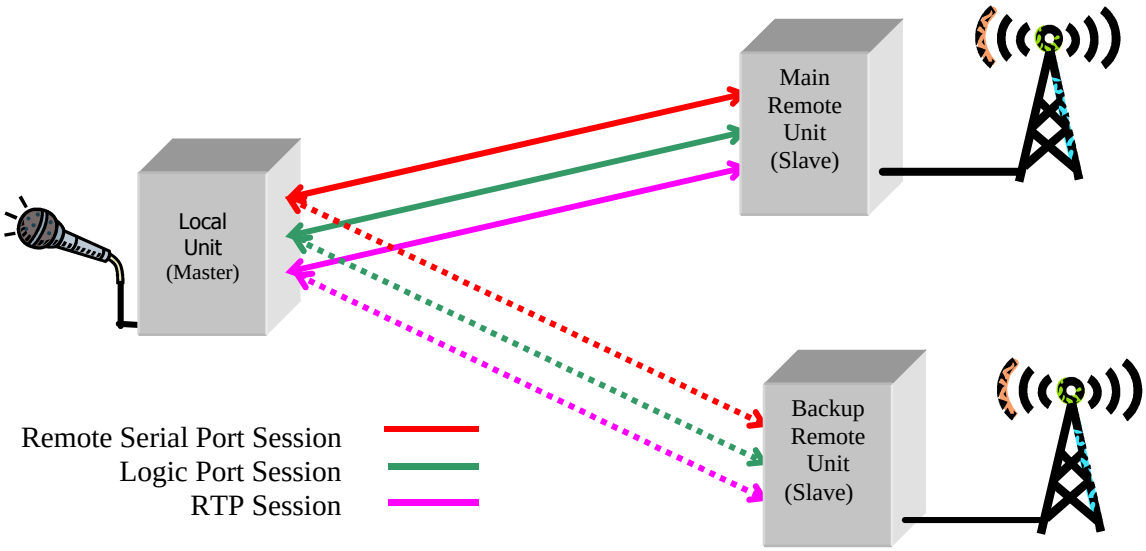

Figure 2 Main/Backup Operation

Each unit can also be configured with main and backup remote unit details.

The master unit can be switched between remote units using one of the logic input pins as a control, or via the command line interface for more permanent selection.

Remote units can also be switched between main and backup master units, but this is only possible using a command line instruction.

A master or slave unit can only receive IP data from one IP address (unit) at a time. All other IP data sources will be ignored, except for ICMP ping and telnet traffic. The accepted source IP address can be either the Main or Backup remote unit IP address, and the choice is based on the current setting provided in the command line parameter or from the logic control port pin in the case of a master unit.

4.4 Interface Descriptions

4.4.1 Audio Interface

4.4.1.1 Functional

4.4.1.1.1 Supported Compression Algorithms

The Audio interface provided by the TR*ip* will take a single analogue transmit and receive audio path with a bandwidth between 300 Hz and 3400Hz and packetise it using its internal Codecs.

The internal DSP supports the following audio compression Codecs: -

Voice Codec	Media only Data Rate	VAD/CNG
G.711 (A-Law)	64 Kbps	No
G.729	8 Kbps	Yes
G.723	6.3 Kbps	Yes
G.723	5.3 Kbps	Yes

Table 1 Supported Codecs, Bit Rates and features

Voice activity detection and comfort noise generation is provided on the low bandwidth Codecs to further reduce the required bit rate when there is no speech in a particular direction. The data rates in both directions must be the same otherwise no audio will be heard.

The bit rate specified above does not include the IP packetisation overhead, which can be further reduced by adding extra delay to the sampling time (placing more audio samples in fewer IP packets). The allowable sample periods are as shown in Table 2.

Codec	Supported Sample Periods(ms)
G.711	10, 20
G.723.1	30
G.729 A/B	10, 20

Table 2 Codec Audio Sample Periods

To prevent issues surrounding IP transmission delays and echo of transmitted audio, the local audio receive path can be disabled

4.4.1.1.2 IP Protocol Support

The digitised and compressed audio data is encapsulated using RTP version 2 as described in RFC 1889 [Reference 1]. The RTP data will be carried using UDP over IP.

The PMR IP Gateway also implements the RTCP (Real Time Control Protocol) to provide feedback on the quality of data path transmission.

Each unit maintains a number of RTP and RTCP alarm status variables.

- **Local RTP Alarm Status** – this variable will be set if there is a period of time in excess of the RTP LOCAL DELAY value (see Table 9) when no RTP packets are received. The setting of this variable can be used to generate a local alarm condition.
- **Local RTCP Alarm Status** - this variable will be set if there is a period of time in excess of the RTCP LOCAL DELAY value (see Table 9) when the jitter and loss averages are held above the values in RTCP JITTER and RTCP LOSS. The setting of this variable can be used to generate a local alarm condition.
- **Remote RTP Alarm Status** - this variable will be set if there is a period of time in excess of the RTP REMOTE DELAY value (see Table 9) when no RTP packets are received. The setting of this variable can be used to generate an alarm condition to a remote entity using SMTP.
- **Remote RTCP Alarm Status** - this variable will be set if there is a period of time in excess of the RTP REMOTE DELAY value (see Table 9) when the jitter and loss averages are held above the values in RTCP JITTER and RTCP LOSS. The setting of this variable can be used to generate an alarm condition to a remote entity using SMTP.

The TR*ip* supports a single UDP over IP connection for the RTP stream. The IP address and Port number used for the UDP connection is specified in an internal configuration table that maintains the following information: -

Transmit Audio Data UDP/IP Parameters		**Receive Audio Data UDP/IP Parameters**	
Main Destination		Main Source	
IP Address	Port Number	IP Address	Port Number
Backup Destination		Backup Source	
IP Address	Port Number	IP Address	Port Number

Table 3 RTP Transport Address Parameters

By default the port numbers used for all RTP and RTCP UDP streams will be 5004 and 5005 respectively but the port numbers can be configurable to any value above 5000. The RTCP port number is always the RTP port number + 1. The RTP port number is always even.

Each unit has the capability to transmit and receive audio streams to and from two different remote endpoints. By default the unit will transmit to the main IP destination socket (IP socket = IP address + Port Number) and receive IP packets from the main IP socket.

The switch between Main and Backup source and destination sockets can be done through a command line action.

The provision of access authorisation security where the correct source for the received audio datastream is an important requirement to prevent unauthorised access to transmitter resources. Within the TR*ip* a simple IP address filter is implemented based on the transport address (IP Address and Port Number). This feature limits the acceptable source transport address to only those provided in the Origination & Destination Table (see section

Unit Module Action Verbs).

The RTP payload format type for G.711 A-law audio will be as specified in [Reference 2] table 4 for PCMA (8).

The provision of a guaranteed quality of service for the audio data path is a feature of the IP network across which the data stream travels. In order to support QoS features within the network, the TR*ip* supports the definition of a transmitted Differential Services Code Point for the RTP stream containing the transmitted audio data.

A far end loop back facility is provided that allows the output of the digital section of the devices AFE to be looped back to the digital input section of the devices AFE. This loop back will be controllable both locally and remotely, and allow the audio received from a remote site to be transmitted back to the remote site.

4.4.1.2 Physical & Electrical

The analogue audio interface is provided on an RJ45 socket that shares functionality with the remote RS-232 Port and a Push to Talk Control pin. The pin connections are as shown in Table 4. The Line In and Line Out directions are as viewed by the TR*ip* equipment.

Pin No:	Purpose
1	RS-232 RXD
2	RS-232 TXD
3	Audio Line Out
4	Audio Line In
5	Audio Line In
6	Audio Line Out
7	PTT I/O
8	Ground

Table 4 RJ45 Audio, Remote Serial and Control Interface connections

The audio connection to the TR*ip* is a four wire balanced 600 ohm circuit with input and output levels set on factory test to be – 10 dBm. The audio levels are mapped directly between master and slave TR*ip* units and a level of – 20 dBm into the Master will produce – 20 dBm at the slave output.

There is an internal limiter within the TR*ip* which is set to 0 dBm when the units leave the factory, all audio levels above this value will be reduced and will produce 0 dBm at the corresponding TR*ip* output.

The electrical characteristics of the remote RS-232 Port are specified in section 4.4.2.3.

The PTT I/O pin is a Push to Talk Control pin whose function is dependent on which end of the link a particular unit is located. The functionality and electrical characteristics of this pin are specified in section 4.4.4.

4.4.2 Remote RS 232 Port

4.4.2.1 Functional

Each TR*ip* unit provides a remote terminal server capability through its remote RS-232 port. The connection between two units will be on a point-to-point basis only, mimicking the connectivity that would have been provided by a dedicated copper connection.

The remote serial port can operate at the data rates shown in Table 5:

Speed Kbps
9600
19200
38400
57600
115200

Table 5 Remote Asynchronous port speeds

The product will by default support 9600 kbps. The speed settings for both transmit and receive data will be identical. The configuration of the interface speed will be performed through the local configuration port, or via the remote telnet.

The unit does not support auto bauding on the remote RS-232 port and all data transmitted by the locally attached terminal equipment on the TXD in, will be transmitted out on the RXD Pin of the remote interface.

The Remote RS-232 Port will support the following asynchronous data frame types. Parity is even.

Data Bits	Parity Bits	Stop Bits
7	1	1
7	None	1
7	1	2
7	None	2
8	None	2
8	None	1
8	1	2
8	1	1

Table 6 Remote RS-232 Port Supported Frame Characteristics

The unit will perform no interpretation of the data stream received on the local TXD pin.

The unit will perform no interpretation of the data stream received from the remote unit for transmission on the local RXD pin.

The TR*ip* unit will perform no character translation or echo. Any echo back requirements must be performed by the attached terminal application.

The remote RS-232 port will not provide hardware based serial data flow control.

The use of software flow control mechanisms (XON/XOFF) by the higher layer applications is possible because of the transparent nature of the data streams, but no support within the unit is provided for this form of flow control.

The settings of the Local and remote units should be the same.

4.4.2.2 IP Protocol Support

On reset, the local unit will attempt to establish a TCP session with the remote unit specified by either the Main or Backup IP Address specified in the "unit" module command line parameters. A remote unit will only accept the establishment of a TCP session from the unit whose IP address is configured in its main or backup IP address configuration parameter.

The choice of which address to use is determined by the current setting of the UNIT SET REMOTE [main/backup] command line parameter, or if the unit is a master unit, by the current state of the main/backup unit input pin.

If the TCP session is not active for whatever reason, the reception of a valid character at the local interface will cause the TCP session to be established.

The default port address for the TCP connection will be 5008, but can be changed to any port number in the range 2048 to 65535. The port address used for transmit and receive directions will be identical and will be stored in the "Remote Terminal Server IP Port" configuration parameter.

4.4.2.3 Physical & Electrical

The Remote RS-232 port is supported using two dedicated pins on the RJ45 Audio interface connector as shown in Table 4.

The electrical characteristics of the remote serial port comply with the EIA/TIA–232-F standard, and are also compatible with the EIA RS-232D standard.

The Remote RS-232 and Local RS-232 Configuration port share the same asynchronous UART device, but have separate RS-232 driver devices and physical ports.

The Local RS-232 Configuration Port utilises the incoming RTS to enable switching within the unit between Remote port operation and Local Configuration port operation. See section 4.4.3.2 for further information.

4.4.3 Local RS-232 Configuration Port

The local RS-232 configuration port is used to facilitate the inspection and change of parameters from a locally connected RS-232 terminal such as a Personal Computer.

The configuration port supports a command line instruction set as specified in section 4.4.3.1.1.

Access to the command line is restricted using a simple User name and Password combination. The user name and password must be provided to use the CLI after a unit reset, and after a switch from remote serial port to local serial port through asserting the local serial port RTS pin.

4.4.3.1 Command Line Interface

The Local RS-232 port supports a command line interface for the configuration and interrogation of the TR*ip* unit.

On reboot the unit will provide direct access to the command line interpreter from the Local serial port.

4.4.3.1.1 Command Syntax

The Command Line interface will provide a Command Line Prompt as shown below:-

[UNIT IDENTIFIER]>>

The unit identifier is a configuration option that provides a user configurable name up to a maximum of 15 characters that can be used to identify the unit. By default the Unit identifier is set to “Slave”.

The command line interface syntax consists of a three parts, a module name, an action verb and a variable set of action parameters. Each command is terminated by a carriage return.

[Module Name] < Action Verb > < Parameter List > [CR]

Although each module name or action verb may consist of several letters, only sufficient letters to uniquely identify the module name or action verb are required. For example to enter the module name **LOCAL**, only three characters LOC are required to differentiate it from the module name **LOGIC.**

If a module name is entered without an action verb to follow, the command line focus enters the module name given, for example the command: -

ALARMS [CR]

Will cause the command line interface focus to enter the Alarms module, and the Command line prompt will change to:-

[UNIT IDENTIFIER]>>ALARMS>>

When the Command line focus is within a specific module, then only the action verbs specific to that module will be effective. To return focus to the highest level, use:

EXIT [CR]

The entry of a carriage return without a module name or action verb will invoke the help text specific to the command line focus at that time.

The command line interface supports the following configuration module names: -

Module Name	Module Description
ACCESS	This module allows the configuration of the user access name and password
ALARMS	This module allows the configuration of the alarm control parameters
AUDIO	This module facilitates the configuration of the analogue front-end parameters and the treatment of the audio streams.
IP	This module permits the configuration of the IP parameters specific to this unit.
LOCAL	This module controls the configuration and settings of the Local Asynchronous configuration port
LOGIC	This module accesses the configuration and settings of the logic Control port.
REMOTE	This module defines the configuration and settings of the remote asynchronous configuration port
RTP	This module allows the configuration of the RTP and RTCP protocols for the unit
SMTP	This module permits the configurations and settings for the SMTP client
UNIT	This module looks after various other miscellaneous functions and configuration options for the unit

Table 7 Command Line Module Names And Descriptions.

4.4.3.1.1.1 Access Module Action Verbs

Action Verb	Parameters		Comment
	1	2	
SET	NAME	<UserName>	Sets the user name used in local or remote access to be “UserName”. <UserName> can be up to 30 characters long, and contains any printable character.
	PASSWORD	<Password>	Sets the password used in local or remote access to be “Password”. Omitting the second parameter clears the Password parameter to blank. <Password> can be up to 30 characters long, and contains any printable character.
SHOW	ALL		Shows the current access Name and Password

Table 8 Access Module Configuration Commands

4.4.3.1.1.2 Alarms Module Action Verbs

Action Verb	Parameters				Comment
	1	2	3	4	
SET	LAN	LOCAL	DELAY	x	Sets the local alarm generation delay for the LAN Link loss alarm to be x seconds where x is in the range 1 –3600 seconds. A value of 0 disables the generation of the alarm.
	RTP	LOCAL	DELAY	x	Sets the local alarm generation delay for the loss of incoming RTP packets alarm to be x seconds where x is in the range 5 – 3600 seconds. A value of 0 disables the generation of the alarm.
		REMOTE	DELAY	x	Sets the remote alarm generation delay for the RTP packet stream loss alarm to be x seconds where x is in the range 5 – 86,400 seconds. A value of 0 will disable the alarm generation
	RTCP	LOCAL	DELAY	x	Sets the local alarm generation delay for the RTCP statistics alarm to be x seconds where x is in the range 5 –3600 seconds. A value of 0 disables the generation of the alarm.
		REMOTE	DELAY	x	Sets the remote alarm generation delay for the RTCP statistics alarm to be x seconds where x is in the range 5 – 86,400 seconds. A value of 0 will disable the alarm generation
		JITTER	x		Sets the average jitter value in milliseconds that must be exceeded in order to generate the RTCP alarm.
		DELAY	x		Sets the average Delay value in milliseconds that must be exceeded in order to generate the RTCP alarm. ***This setting is not available in the first release.***
		LOSS	x		Sets the average packet loss value that must be exceeded in order to generate the RTCP alarm.
		PERIOD	X		Sets the period in seconds over, which the received RTCP statistics are calculated. The values can range between 60 – 3600 seconds
	LCP	LOCAL	DELAY	x	Sets the local alarm generation delay for the LCP packet loss alarm to be x seconds where x is in the range 5 –3600 seconds. A value of 0 disables the generation of the alarm.
		REMOTE	DELAY	x	Sets the remote alarm generation delay for the LCP packet loss alarm to be x seconds where x is in the range 5 – 86,400 seconds. A value of 0 will disable the alarm generation
CLEAR	ALL				Resets the alarm status to pending of all outstanding alarms. All delay counters are reset. No SMTP messages or SNMP traps will be generated.
	LAN				Resets the alarm status to pending for the LAN alarm. The delay counter is reset. No SMTP message or SNMP trap will be generated.
	RTP				Resets the alarm status to pending for the RTP alarm. The delay counter is reset. No SMTP message or SNMP trap will be generated.
	RTCP				Resets the alarm status to pending for the RTCP alarm. The delay counter is reset. No SMTP message or SNMP trap will be generated.
	LCP				Resets the alarm status to pending for the LCP alarm. The delay counter is reset. No SMTP message or SNMP trap will be generated.
SHOW	ALL				Lists the current alarms that are pending and then set along with the how long ago they were set. Also lists the current Average Jitter, Average Packet Loss, Jitter and Delay values accumulated from the RTCP packets over the given “period”
	SETTINGS				Lists the current settings for the alarm delays, and also the Pin number for an LCP pin used as a Local Alarm Condition indicator.
	HISTORY				List the last 10 alarm generation and clearance events with a time differential from the current system time in minutes and hours.

Table 9 Alarms Module Command Line Syntax

4.4.3.1.1.3 Audio Module Action Verbs

Action Verb	Parameters 1	Parameters 2	Comment
SET	DATARATE	64	Sets the data rate for the audio Codec to be 64Kbps = G.711 A law compression
		8	Sets the data rate for the audio Codec to be 8Kbps = G.729 compression
		6.3	Sets the data rate for the audio Codec to be 6.3Kbps = G.723 low compression
		5.3	Sets the data rate for the audio Codec to be 64Kbps = G.723 high compression
	SAMPLE	10	Sets the audio sample period to be 10 ms, only applicable when DATARATE = 64 (G.711) or 8 = (G.729) (DEFAULT VALUE)
		20	Sets the audio sample period to be 20 ms, only applicable when DATARATE = 64 (G.711) or 8 = (G.729)
		30	Sets the audio sample period to be 30 ms, only applicable when DATARATE = 6.3 or 5.3 = (G.723)
	PTT	INPUT	Sets the PTT (Push To Talk) circuit to be an Input Logic Circuit. This denotes the device as a Control Station device.
		OUTPUT	Sets the PTT circuit to be an Output Logic Circuit. This denotes the device as a Transmitter Station device. (DEFAULT VALUE)
	ECHOBACK	LOCAL	This setting allows the PTT circuit to determine the source of the audio sent on the analogue transmit path. If the PTT parameter is configured as INPUT, this parameter ensures that the analogue receive audio is locally looped back to the analogue transmit audio, each time the PTT circuit is raised. Each time the PTT circuit is lowered, the analogue loop is removed and the received packet audio is played out to the analogue transmit.
		REMOTE	This setting ignores the state of the PTT circuit and always plays the received packet audio to the analogue transmit. This setting of the echo back parameter is the only valid setting if the PTT parameter is set to OUTPUT (DEFAULT VALUE)
		OFF	This setting disconnects the received packet audio path from the analogue transmit path when the PTT circuit is raised. This setting is only valid if the PTT parameter is set to INPUT.
		DELAY	X: This parameter delays the disconnection of the receive analogue path from the transmit analogue path by X ms when the PTT circuit is lowered. X must be in the range 0 – 500 ms and divisible by 50. The Default value is 0.
SHOW	ALL		Lists all the configuration settings for the Audio module

Table 10 Unit IP Parameter Configuration Commands

IP Module Action Verbs

The IP Module has three actions verbs: -

Action Verb	Parameters		Comment
	1	**2**	
SET	ADDRESS	xxx.xxx.xxx.xxx	Sets the IP Address of this unit to be that given in parameter 2.
	MASK	xxx.xxx.xxx.xxx	Sets the sub-net mask for this unit to be that given in parameter 2.
	GATEWAY	xxx.xxx.xxx.xxx	Sets the default gateway address for this unit to be that given in parameter 2
SHOW	ALL		Lists all the configuration settings for the IP Module
PING	xxx.xxx.xxx.xxx		Sends an ICMP ping to the IP address given in parameter 1

Table 11 Unit IP Parameter Configuration Commands

4.4.3.1.1.4 Local Module Action Verbs

Action Verb	Parameters		Comment
	1	**2**	
SET	DATA	8	Sets the number of Data bits to be 8 (Default)
		7	Sets the number of Data Bits to be 7
	STOP	1	Sets the number of stop bits to be 1 (Default)
		2	Sets the number of stop bits to be 2
	PARITY		Set the Parity bit
	NOPARITY		Unset the Parity Bit (Default)
	SPEED	9K6	Sets the Port speed to be 9.6 Kbps
		19K2	Sets the Port speed to be 19.2 Kbps
		38K4	Sets the Port speed to be 38.4 Kbps
		57K6	Sets the Port speed to be 9.6 Kbps
		115K2	Sets the Port speed to be 115.2 Kbps(Default)
SHOW	ALL		

Table 12 Local Serial Port Configuration Commands

4.4.3.1.1.5 Logic Module Action Verbs

Action Verb	Parameters 1	2	3	Comment
SET	MAIN	PORT	XXX	This command sets the Main IP port number of the remote unit to which Logic control packets will be sent and received to be XXX. The default value is 5006, but can be any value above 5000.
	BACKUP	PORT	XXX	This command sets the Backup IP port number of the remote unit to which Logic control packets will be sent and received to be XXX. The default value is 5006 but can be any value above 5000.
	IN	PIN	X	Sets pin X to be an Input where X has a value between 1 and 9.
	OUT			Sets pin X to be an Output where X has a value between 1 and 9.
	REMOTE	PIN	X	This command selects pin X as the toggle for switching between the main or backup remote unit. X can have a value between 0 and 8. The value 0 disables this function. The default value is 0. This command will only succeed if the unit is currently defined as a Master unit, and the Pin is currently defined as an input. When configured as a toggle switch, the status of this pin sent to the remote units is always OFF.
	ALARM	PIN	X	This command selects pin X as an Alarm output Pin. X can have a value between 0 and 8. The value 0 disables this function. The default value is 0. This command will only succeed if the Pin is currently defined as an output. When configured as an alarm output, the status of the corresponding remote pin is ignored.
	EMAIL	ON	X	This command causes the pin X to send an email when it is toggled.
		OFF	X	This command disables the sending of email when pin X is toggled.
	ON	FAILPIN	X	Sets the no update messages fail state to be ON for pin X. (Only Applicable when Pin X is set be an output). X is in range [1,9].
	OFF			Sets the no update message fail state to be OFF for pin X.(Only Applicable when Pin X is set be an output). X is in range [1,9].
	NOC			Sets the no update message fail state to be NOC (No Change) for pin X. (Only Applicable when Pin X is set be an output). X is in range [1,9]
	POLLRATE	XX		Sets the Logic Port Poll rate to be XX times per second where XX can be between 1 and 10. Detecting a change will cause a Logic Update message to be sent immediately. (Default Value is 10)
	UPDATE	XX		Sets the no change update time to be XX where XX is between 1 and 10 seconds. If no change is detected on the logic port in XX seconds a Logic update message is sent anyway. (Default Value is 2 seconds)
	TIMEOUT	XX		Sets the no logic update message timeout to be XX seconds where XX is between 3 and 30 seconds. If no Logic Update Message is received within the timeout period, the Logic port is set to the pre-configured default value. (Default Value is 6 seconds)

	PROFILE	MASTER		Sets the Logic Port Parameters to be the following values:- POLLRATE = 10 times / second UPDATE TIME = 1 seconds TIMEOUT = 30 seconds PIN 1 = OUTPUT, Fail state = OFF PIN 2 = OUTPUT, Fail state = OFF PIN 3 = OUTPUT, Fail state = OFF PIN 4 = OUTPUT, Fail state = OFF PIN 5 = INPUT PIN 6 = INPUT PIN 7 = INPUT PIN 8 = INPUT PIN 9 = INPUT AUDIO ECHOBACK LOCAL is set
		SLAVE		Sets the Logic Port Parameters to be the Following Values:- POLLRATE = 10 times / second UPDATE TIME = 5 seconds TIMEOUT = 6 seconds PIN 1 = INPUT PIN 2 = INPUT PIN 3 = INPUT PIN 4 = INPUT PIN 5 = OUTPUT, Fail state = OFF PIN 6 = OUTPUT, Fail state = OFF PIN 7 = OUTPUT, Fail state = OFF PIN 8 = OUTPUT, Fail state = OFF PIN 9 = OUTPUT, Fail state = OFF AUDIO ECHOBACK REMOTE is set
SHOW	ALL			

Table 13 Logic Control Port Configuration Commands

4.4.3.1.1.6 Remote Module Action Verbs

Action Verb	Parameters 1	2	3	Comment
SET	DATA	8		Sets the number of Data bits to be 8 (Default)
		7		Sets the number of Data Bits to be 7
	STOP	1		Sets the number of stop bits to be 1 (Default)
		2		Sets the number of stop bits to be 2
	PARITY			Set the Parity bit
	NOPARITY			Unset the Parity Bit (Default)
	SPEED	9K6		Sets the Port speed to be 9.6 Kbps (Default)
		19K2		Sets the Port speed to be 19.2 Kbps
		38K4		Sets the Port speed to be 38.4 Kbps
		57K6		Sets the Port speed to be 9.6 Kbps
		115K2		Sets the Port speed to be 115.2 Kbps
	MAIN	PORT	XXX	This command sets the Main IP port number of the remote unit to which remote serial port packets will be sent to and received from to be XXX. The Default Value will be 5008, and must be in the range 2048 – 6555 (inclusive)
	BACKUP	PORT	XXX	This command sets the Backup IP port number of the remote unit to which RTP packets will be sent to and received from to be XXX. The Default Value will be 5008, and must be in the range 2048 – 6555 (inclusive)
	DSCP	XX		This command sets the 6-bit DIFFSERV Code point for the remote serial port packet stream to be XX. (Default value = 7). This field is saved as <DSCP> <00>, 8 bits in all.
SHOW	ALL			

Table 14 Remote Serial Port Configuration Commands

4.4.3.1.1.7 RTP Module Action Verbs

Action Verb	Parameters 1	2	3	Comment
SET	MAIN	PORT	XXXX	This command sets the Main IP port number of the remote unit to which RTP packets be sent to and received from to be XXXX. The Default Value will be 5004, and must always be even and above the value 5000. The port used for RTCP is always RTP+1. The default RTCP port is 5005.
	BACKUP	PORT	XXX	This command sets the Backup IP port number of the remote unit to which RTP packets will be sent to and received from to be XXX. The Default Value will be 5004, and must always be even, and above the value 5000. The port used for RTCP is always RTP+1. The default RTCP port is 5005.
	DSCP	XX		This command sets the 6-bit DIFFSERV Code point for the RTP packet stream to be XX. (Default value = 3) This field is saved as <DSCP> <00>, 8 bits in all.
SHOW	ALL			

Table 15 RTP Module Configuration Commands

4.4.3.1.1.8 SMTP Module Action Verbs

Action Verb	Parameters			Comment
	1	**2**	**3**	
SET	SERVER	1	xxx.xxx.xxx.xxx	Sets the IP address of primary SMTP server to be xxx.xxx.xxx.xxx (Note the use of DNS is not supported for server name resolution). E-mail will be sent on assertion of an alarm condition via the primary server if configured.
		2	xxx.xxx.xxx.xxx	Sets the IP address of secondary SMTP server to be xxx.xxx.xxx.xxx (Note the use of DNS is not supported for server name resolution). E-mail will be sent on assertion of an alarm condition via the secondary server if configured.
	TOADDRESS		abc@hij.com	Sets the To: Address
	CCADDRESS			Sets the CC: Address
	FROMADDRESS			Sets the FROM: Address
	SUBJECT		SubjectText	Set the contents of the subject field to be "SubjectText". No spaces are allowed in the SubjectText field.
	PINHIGH	X	A message	Set the email message to send when pin X [1,9] goes high. If the message is blank then no message will be sent.
	PINLOW	X	A message	Set the email message to send when pin X [1,9] goes low. If the message is blank then no message will be sent.
DISABLE				This command disables the sending of SMTP alerts (Default)
ENABLE				This command enables the sending of SMTP alerts if the above
SHOW	ALL			

Table 16 SMTP Module Configuration Commands

4.4.3.1.1.9 Unit Module Action Verbs

Action Verb	Parameters			Comment
	1	**2**	3	
SET	MAIN	ADDRESS	xxx.xxx.xxx.xxx	Sets the IP address for the Main remote unit linked to this unit. This IP address is used for the RTP over UDP connection, the Logic Port over TCP session and the Serial Port over UDP session.
	BACKUP	ADDRESS	xxx.xxx.xxx.xxx	Sets the IP address for the Backup remote unit linked to this unit
	NAME	XXXXXXXXXXXX		Sets the unit name for this unit to be XXXXXXXXXXXX where X is any alphanumeric character. Maximum of 12 characters. Default Value is
	REMOTE	MAIN		Sets the primary remote unit to communicate to as the unit defined by the MAIN IP address and Port values.
		BACKUP		Sets the primary remote unit to communicate to as the unit defined by the BACKUP IP address and Port values.
	UPDATE	SERVER	xxx.xxx.xxx.xxx	Sets the IP address of the machine running a TFTP server containing the update file(s).
		FILE	FileName	The name of the file on the update server. This name may contain the symbols %m, %h and %i. These symbols are expanded to the MAC address, host name and IP address respectively. When a macro is used the unit will fetch two files (as opposed to one), the first with the macros removed, the second with the macros expanded.
	TIME	SERVERX	xxx.xxx.xxx.xxx	Where X= [1,3] and Xxx.xxx.xxx.xxx is a NTP server used to retrieve the time. Upon the box starting it will try and get the time from one of these NTP servers. They will also be used with the command 'unit time synchronise'.
UPDATE	NOW			Fetches updates immediately. The updates will be used until the unit is rebooted.
REBOOT	NOW			Reboot unit. This is required after updates.
TIME	SYNCHRONISE			Synchronise unit time with remote NTP servers.
SHOW	ALL			Lists all the current settings and information for the Unit module. (This includes unit name, Mac Address, Firmware version, and status of RTP and Remote Serial Port and input output logical circuits)

Table 17 Unit Module Configuration Commands

4.4.3.2 Physical & Electrical

The Local RS-232 port is supported using an RJ11 connector supporting five circuits as shown in Table . This table also shows the connections for a suitable serial cable terminating in a 9 way Female D-Type suitable for connection to a standard Personal computer COM port.

RJ11 Pin No:	9 Way Female D-type Pin No:	Circuit Description
6	No Connect	Not Used
5	2	RXD
4	8	CTS
3	3	TXD
2	7	RTS
1	5	GND

Table 18 Remote RS-232 Port Cable Pin Assignments

The electrical characteristics of the remote serial port comply with the EIA/TIA–232-F standard, and are also compatible with the EIA RS-232D standard.

The Remote RS-232 and Local RS-232 Configuration port share the same internal asynchronous UART device, but have separate RS-232 driver devices and physical ports.

The Local RS-232 Configuration Port utilises the incoming RTS to enable switching within the unit between Remote port operation and Local Configuration port operation. The TR*ip* provides an output CTS signal which can be looped to RTS to indicate that the local port should be made active. The presence of an RTS signal from an attached PC COM Port or terminal will also have the same effect.

4.4.4 Logic Control Port

The TR*ip* also provides logic Control port that can provide remote monitoring and control of input/output pins on a TR*ip* unit at the remote end of a logical link. Each local TR*ip* will periodically examine the state of its input pins and send updates on the status to the corresponding remote TR*ip* unit.

These updates are sent whenever a change on a pin is detected, and also periodic updates are sent to maintain the state of the corresponding output pins. If a periodic update is not received on the remote TR*ip* within a configurable time limit the output pins will adopt their default setting.

The failure of a TR*ip* to receive an update message within the configured time will set the Missing LCP Packets Alarm Status variable (see section 4.8.4)

Pin changes will be detected by polling, and the default poll period is 100 milliseconds.

The periodic update timeout is configurable between 3 and 30 seconds.

The periodic update refreshment rate is configurable between 1 and 10 seconds.

The logic control port provides a total of 9 input/output pins that are configurable between input and output functionality.

One of the eight-input/output pins can be used to control the selection of Main/Backup slave unit. This functionality is only available to a master unit and only when the relevant pin is configured as an input. The pin is used as a toggle input. When low, the pin selects the remote unit set by the UNIT SET REMOTE [MAIN/BACKUP] command. When asserted it toggles to the other unit.

All of the logic pins (including the PTT pin) can be configured to send an email when toggled high/low. The messages to be sent are configured and are sent to the server selected within SMTP module. Emails are only sent when a pin is set as input and there is a message to be sent.

Eight of the nine-input/output pins are provided on a dedicated 9-way D-Type connector. The ninth pin is provided as a Push to Talk control pin on the Audio interface RJ45 Connector.

Logic Control Port Pin 1 on the local TR*ip* will map directly to Logic Control Port Pin 1 on the remote TR*ip* and so on. The settings for each pin are configured within each unit, and it is the responsibility of the installer to ensure that inputs at the local TR*ip* correspond to outputs at the remote TR*ip*. The PTT control pin is Logic Control Port Pin 9.

By default, a newly shipped unit is a SLAVE unit with the PINs set as per the table below.

When configured as an output pin, each output can be set to have one of three default states:

- Link Fail On – With this setting the failure to receive a periodic logic control port refresh message within the periodic update timeout will cause the output pin to go to the On state
- Link Fail Off – With this setting the failure to receive a periodic logic control port refresh message within the periodic update timeout will cause the output pin to go to the OFF state
- Link Fail No Change – With this setting the failure to receive a periodic logic control port refresh message within the periodic update timeout will cause the output pin to remain in its current state, no change will occur.

To help ease the configuration issues arising from these requirements, each TR*ip* can be set up to use a preconfigured setup profile.

Currently only two profiles are specified, "Master" and "Slave", and the LCP settings for each are as shown in Table

	Profile			
Parameter	**"Master"**		**"Slave"**	
	Value	**Fail State**	**Value**	**Fail State**
Pin No: 1	Output	Off	Input	N/A
Pin No: 2	Output	Off	Input	N/A
Pin No: 3	Output	Off	Input	N/A
Pin No: 4	Output	Off	Input	N/A
Pin No: 5	Input	N/A	Output	Off
Pin No: 6	Input	N/A	Output	Off
Pin No: 7	Input	N/A	Output	Off
Pin No: 8	Input	N/A	Output	Off
Pin No:9 (PTT)	Input & Local Audio Loop back	N/A	Output	Off
Poll Rate	10/sec		10/sec	
Update Refresh	1 s	-	5 s	-
Refresh Timeout	30 s	-	6 s	-

Table 19 Default Profile Settings for Logic Control Port pins

Logic Control Port pin 9 also has a secondary configurable control function. It can be configured to implement a Local Audio Loop back feature. This feature disables the output of the received audio stream and loops the transmitted audio back to the user when placed in the ON state by the locally attached terminal. This feature can be used to prevent echo of transmitted audio from the local user due to delays within the audio compression and IP transmission process.

4.4.5 10/100 Mbps Ethernet Port

The Ethernet port operates with auto negotiation to allow configuration of the port for speed and duplex operation.

The pins assignments on the RJ45 connector used will be as shown in Table

Pin No:	Signal
1	**Transmit +**
2	**Transmit -**
3	**Receive +**
4	**Not Used**
5	**Not Used**
6	**Receive -**
7	**Not Used**
8	**Not Used**

Table 20 Ethernet Port Pin Assignments

The Ethernet port also has two LED indicators: -

- Link Active Indicator – will be illuminated when a link up status is detected on the Ethernet port.
- Data present Indicator - will be illuminated on reception or transmission of packets on the Ethernet interface.

4.4.5.1 MAC Address

Each Ethernet port requires a globally unique MAC (Media Access Controller) address.

Programming of the MAC address into the unit will be done prior to production testing at manufacturing time.

4.5 Remote Configuration & Management

The TR*ip* includes a TELNET interface that allows remote access to the unit's command line interface. The command structure of the remote configuration access is identical to that seen through the Local RS-232 configuration port.

4.6 Operating Firmware Upgrade

The operating firmware can be upgraded both locally and remotely by using the LAN port. The update mechanism is designed to allow upgrading of groups of units and then individual units within that group. This is achieved by choosing a group of units, and selecting a filename for them, say 'update.cfg'. Then by inserting the predefined

macros %h (hostname), %i (IP address) or %m (MAC address) or any combination of them into the group string, possibly ‘update.cfg%m’ then the units with this string will first fetch the update list ‘update.cfg’, process the file, fetch ‘update.cfg0001df123456’ (for a MAC address of 0001df123456) and process that file. The server and update file names may be configured in the unit module.

The format of the two files fetched is identical. Each update within the file is specified on one line. The information in the line is separated by a space, hence spaces are forbidden in the filenames. The information is as follows md5 hash, imagename, TFTP server upon which image is located and the remote path of image. The md5 hash is used to identify images and prevent unnecessary transfer of images.

The firmware that is updated will not become active until the unit is rebooted. If the updated firmware is unable to execute upon reboot then the previous firmware will be used instead.

4.7 Configuration Access Security

Access to the local or remote configuration session is controlled using an Access Name and Access Password combination.

Each time the Local/Remote RS-232 switch is enabled for remote RS-232 Port operation, the user access is reset and the access name and access password must be re-entered before local access through the local RS-232 Port will be allowed again.

Similarly each time a new TELNET session is connected to the unit the access name and password must be entered prior to any configuration commands.

When the units leave the factory the access name is set to “default” and no password is required.

4.8 Alarms

The TR*ip* will maintain a number of internal alarm status variables. These variables will be set or unset based upon operating conditions encountered by the unit.
Each alarm variable will have an associated local and remote delay parameter. These delays will be used to minimise false alarm signalling to local or remotely based alarm-monitoring systems. If an alarm status variable is unset during the delay period, no alarm condition is signalled. A delay setting of 0 indicates that the alarm is not to be used.

Each alarm status variable can be used to control the local Alarm LED indicator and/or a physical output pin and or the transmission of an alarm condition to a remote monitoring station via SMTP.

4.8.1 LAN link Status Alarm

The LAN Link status alarm is used to indicate that the LAN connection has failed and the unit can no longer send data across the link. For obvious reasons this alarm condition can only be signalled locally, but it is likely that the corresponding remote unit will generate an RTP and /or LCP alarm to a remote monitoring host.

4.8.2 RTP Audio Activity Alarm

Even when there is no audio to pass across the link, the units will be exchanging periodic silence insertion descriptor packets. The failure to receive any RTP packets within a period should be signalled as an alarm condition as it may result in the failure of audio transfer when required.

4.8.3 RTCP Audio Issues Alarm

The RTCP audio issues alarm will be activated if one or more of the statistics provided by the RTCP protocol exceeds given parameters. For example, an increase in the average packet loss may result in poor quality audio. The statistics are calculated on information passed back from the peer. So if the IP connection to the remote unit is broken then these statistics will not be generated until the connection is re-established.

4.8.4 LCP Missing Updates Alarm

The Logic Control Port

Alarm Status Variable Name	Alarm ID	Local		Remote	
		Delay Range (Seconds)	Default Delay	Delay Range (Seconds)	Default Delay
LAN Link Status	1	1 - 3600	1	N/A	N/A
RTP Audio Activity	2	5 - 3600	5	5 - 86400	60
RTCP Audio Issue	3	5 - 3600	5	5 - 86400	0
Missing LCP Update	4	5 - 3600	5	5 - 86400	60

Table 21 Alarm Status Variables

Any pin except Pin 9 of the Logic Control port can be configured as an Alarm Indicator Output. In this scenario the Pin will not reflect the status of its opposite number, but will instead be used to indicate that an internal Alarm status variable has been set and the local delay has expired.

4.8.5 SMTP Alarm Transmission

The TR*ip* also includes an SMTP client for the purpose of transmitting Alarm Status messages via e-mail.

Most parameters of the e-mail message are configurable, to allow maximum flexibility but the text and/or the subject line of the alarm set message will contain the string:-

“[Unit Identifier] Alarm Condition [X] Set”

Where [Unit Identifier] will be replaced with the units configured name and
[X] Is the Alarm ID value

The text and/or the subject line of the alarm Clear Message will contain the string

“[Unit Identifier] Alarm Condition [X] Cleared”

An Alarm Cleared message will be sent immediately an alarm condition has been cleared, but will only be sent if an Alarm Set message was previously sent.

The use of a suitable E-mail to SMS gateway application (such as SMS Gateway) will allow the signalling of alarm conditions to Mobile telephones via SMS messages.

4.9 Time Synchronisation

There is no internal hardware clock on the TR*ip* unit. The time is received via connection to an NTP server upon boot-up. Should none of the configured NTP servers (maximum of 3) be reachable then further attempts will be made at intervals of 30 seconds until successful. In the unlikely instance that this fails even though the NTP servers are set correctly then the command ‘unit time synchronise’ will perform a single attempt to set the time.

There are many publicly available NTP servers on the internet. A list can be found on http://www.ntp.org. If the TR*ip* unit is installed on a private LAN with no internet connection then a server with the ntpd program can be configured to provide a clock source.

4.10 External Power

External regulated +7V DC power will be provided to the TR*ip* by means of a 2.1 mm centre positive jack socket. The power will be proved by an external switched mode power supply.

A green LED indicator is provided that is directly powered from the internally generated 3.3V power supply. Absence of the external +5V or failure of the internal 3.3V power supply will be indicated by non – illumination of this LED.

4.11 Physical Format

The initial TR*ip* product is a standalone unit designed to be either wall mounted or desktop mounted, and provided with an external regulated plug top style mains power supply.

The mechanical design of the PCB will also allow multiple cards to be mounted in a rack mount unit.

4.12 LED Indicators

The TR*ip* will have the following LED Indicators: -

LED Name	Colour	Function
Power	Green	This LED is used to indicate the presence of the internal +3.3V power supply.
LAN Link	Green	This LED is used to indicate the status of the Ethernet connection. On indicates link up status.
LAN Data	Green	This LED is used to indicate the reception of data on the Ethernet port.
Alarm	Red	This LED is used to signal a problem with transmission of audio data over RTP to the remote TR*ip*.

Table 22 LED Indicators

4.13 Enclosure

The TR*ip* unit is mounted in an aluminium extrusion measuring 115mm (width) by 34mm (height) and 125mm (depth).

The rear panel holds the power connector and the LAN connector whilst the front panel holds the Line/remote port, the Logic I/O port and the configuration port.

Using TRip units with routers on a Wide Area Network