RACAL

Tracs TDMA

Operators Manual

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This operating manual is issued for guidance and training purposes only and it should not be used as the source of definitive parameters.

The information contained herein was believed to be correct at the time of publication but may not have been updated in line with current manufacturing drawings.

CONTACT INFORMATION

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EQUIPMENT TYPE APPROVAL AND COMPASS SAFE DISTANCE

This equipment has been tested and found to comply with the following standards:

Type Approval to: ETS 300 113 (1996)
"Radio Equipment and Systems (RES);
Land mobile service;
Technical characteristics and test conditions
For radio equipment intended for
The transmission of data (and speech)
And having an antenna connector"

Type Examination to: EN 300 828 (1998)
"Electromagnetic compatibility and Radio spectrum Matters (ERM);
Electromagnetic Compatibility (EMC) for radiotelephone transmitters and receivers for the maritime mobile service operating in the VHF bands"

Compass Safe Distance: 0.3 metres

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1 SYSTEM DESCRIPTION

1.1 OVERVIEW OF TRACS TDMA

Tracs TDMA is a high speed, intelligent network radio datalink which operates in the VHF/UHF band to provide an addressable network datalink with integrated position reporting from an internal or external GPS receiver. It is primarily intended for vehicle and vessel tracking applications although it can be used for general data communication.

Each unit in the network is assigned an unique address so that messages can be specifically addressed to that unit. A broadcast address is provided to allow multiple units to receive, for example, an RTCM correction message. The system manages the data bandwidth by dividing it into timeslots synchronised by means of GPS time.

The units, or groups of units, can be assigned transmission data bandwidth for up to 4 categories of message:

1) Position reports.
2) Transparent data (e.g. RTCM 104 corrections).
3) General data messages including remote set-up commands.
4) Broadcast message repeater.

Every transmitter has its own timeslot set-up. Units in receive mode (i.e. any unit not transmitting) can receive messages in any timeslot irrespective of its own transmission timeslot set-up. Bandwidth can be shared. For example, a master unit can use the general message channel to communicate with a mobile, which can then reply using the same allocation. A network control PC (VTCC) will provide dynamic bandwidth allocation where units only require data bandwidth for short periods or in

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large capacity systems where units transfer between different base station cells.

The system can carry 4 types of message:

a Position reports are compressed binary messages containing Time, Latitude, Longitude, Height, RTCM Age, HDOP, No. of SV's, Velocity and Heading.

b The transparent message type allows the units to communicate without any input and output framing protocol so that existing external systems can use the datalink as a 'virtual wire'. This message type is used to convey RTCM correction messages through the system.

c The general (OPEN) message type allows an external application layer to use the datalink as a general purpose communications network. General messages are input to the unit with a destination address to be sent to any other unit or as a broadcast message. The receiving unit outputs the message with the source address attached.

d Configuration messages can be sent to any unit via the serial input. Messages with the local ID are actioned locally. Messages with another ID are transmitted to that unit for action.

Key units, such as reference stations or base units, can be duplicated with one or more backup units. The backup units will automatically take over the function if the active unit fails. The units are set-up with the same ID but each is given a different backup cycle count. A unit in this mode will operate in receive only mode unless it detects no transmissions from the active unit for the set number of

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backup cycles. The faulty unit can be removed and repaired and will then become the standby unit when turned on.

The coverage achievable on land is very dependant upon the nature of the terrain, since the VHF/UHF signals will not travel around corners, and hills and other obstructions will create shadow areas. In order to extend coverage the system provides two forms of repeater, an automatic system for point to point messages and a store and forward (Broadcast) mode primarily for transparent message repeating. Both modes are built into every unit and any unit can operate both modes simultaneously with its normal reporting and data communications functions.

The automatic mode allows any transceiver unit (including any normal mobile) to repeat a message. The datalink determines when the direct path is blocked and requests another unit, which is in communication with both the source and destination units, to repeat the message. The automatic repeater mode of operation is controlled by routing tables. Every unit builds up a routing table in memory by listening in every timeslot and decoding the transmitter source address of every non-repeated position report packet received. The automatic mode requires position reports to be active in order to operate.

A unit transmits its routing table as part of the position report packet if repeater mode is enabled. The table transmitted is blank if repeater mode is disabled. The allocation of a repeater is completely transparent to the user of the system and changes dynamically as the mobiles move within the covered area.

Broadcast messages cannot be repeated by the automatic mode since it operates between specific source and destination unit addresses and the source unit has no way of determining the addresses of all the listening units. A broadcast repeater mode is intended to be used where a broadcast message is required to be repeated due to known blocking. For example, it would be used to repeat a transparent (RTCM) message around a headland etc. A unit configured to be a broadcast repeater is set-up to repeat all messages, or all messages of a particular type, from a specific source address. The repeater re-transmits the message to be repeated in a set of timeslots pre-allocated to that repeater. The received message will also be subject to the normal receiver processing so that the message can be acted upon by the repeater unit in any other mode of operation, i.e. it may be an RTCM message that the repeater also will use for its own GPS receiver as well as repeating it for other units.

A unit configured in this mode can also provide automatic repeater operation for point to point messages, such as position reports. The datalink automatically removes any duplicate messages received both directly and via a repeater.

It is usual (but not necessary) to designate one unit as the destination for the position report messages (base station). This unit will receive all the position reports and output them via its RS232 serial interface to the logging / display system. If required this unit can also be the source of the DGPS corrections for the system, although the system can be configured to use one or more separate units as DGPS correction sources with the mobile units selecting the reference station to use.

In some large systems a number of base units may be connected to a VTCC controller via a landline or a second radio datalink to achieve the desired coverage. The base stations may be configured on two or more different frequencies, similar to the arrangements used with cellular telephone systems. Mobile units can be configured to find the active frequency automatically in a particular area and

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to switch channel as the mobile moves into the adjacent area. Use of multiple repeaters and bases allows very large areas to be covered by a Tracs TDMA system.

1.2 SYSTEM COMPONENTS

The Tracs TDMA system is available in a number of forms according to the functionality required.

1.2.1 Standard Tracking Unit

A Standard tracking unit comprises a radio datalink integrated with a DGPS receiver. A range of GPS modules are available. The unit may be connected to external processing and/or display systems if required.

1.2.2 Reference Station unit

Locally generated DGPS corrections may be generated in a Reference station unit. The unit is a GPS receiver capable of generating differential corrections.

1.2.3 Base Station Unit

The Base station unit can be either a Standard Tracking unit or a Reference station unit depending upon whether the DGPS corrections are to be generated at the Base station. Systems incorporating mobile base units, such as a seismic tracking system, may use DGPS corrections from another source, which are injected into the Tracs TDMA system at the base station for re-broadcast around the network.

1.3 NETWORK CONTROL SOFTWARE

PC software to provide message scheduling, co-ordinate conversion, system monitoring and network control functions is available for inclusion in either simple, single base station systems or multiple-base/frequency systems. The software can output the tracking data to multiple destinations in a number of formats.

PC software to manage a database of the position reports and a graphical display of mobile locations is available. The software can be partitioned so as to allow multiple displays from the same database.

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2 SYSTEM DESIGN

2.1 INTRODUCTION

The Tracs TDMA system can be configured in many ways to produce Tracking, Data Communications and combined Tracking/Data Communications systems.

Chapter 1 gave an overview of the system and its messaging capabilities. This chapter describes a number of system scenarios and discusses the configuration options.

Due to the flexibility of the system it is not practical to present all possible configurations. However, understanding these basic configurations will allow the system designer to adapt the system to the specific requirements of the project.

2.2 TRACKING SYSTEM DESIGN

A Tracs TDMA network should be treated as a web of equally important units. In a small system there is no central controller although a PC connected to a static unit is usually used to collect position reports from mobile units. Each unit is assigned a unique number (ID), which serves as its address. In larger systems each unit is dynamically assigned a temporary ID by login commands sent from a base station unit connected to a network management computer (VTCC). As a unit moves into the coverage area of an adjacent base station the VTCC will handover control to the adjacent base station and a new temporary ID will be assigned to the mobile unit.

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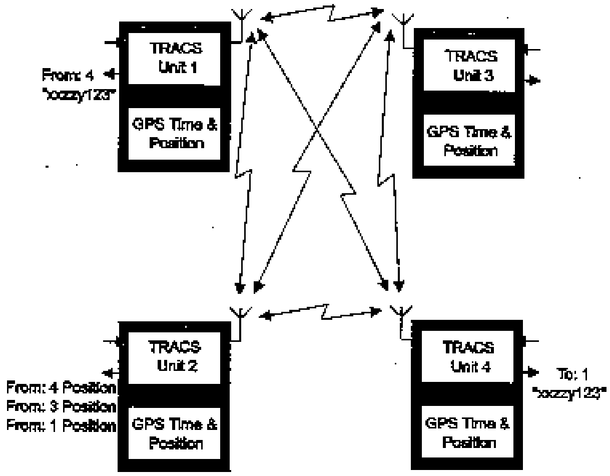

Figure 2.1 - The Tracs TDMA Network

Figure 2.1 shows the concept of the system. In this example the 4 Tracs TDMA units are given the ID numbers 1, 2, 3 and 4. Units 1, 3 and 4 are set-up to send position reports back to unit 2. These reports are received by unit 2 and output through its COMMAND serial port.

In parallel with these reports, unit 4 is set-up with timeslots to allow it to transmit an Open, general data message to unit 1. Unit 1 receives this message and outputs it through its COMMAND serial port with a header that indicates that the message is from unit 4. A number of data message protocols are provided to allow both formatted and unformatted input and output messages.

2.3 DIFFERENTIAL GPS CORRECTION

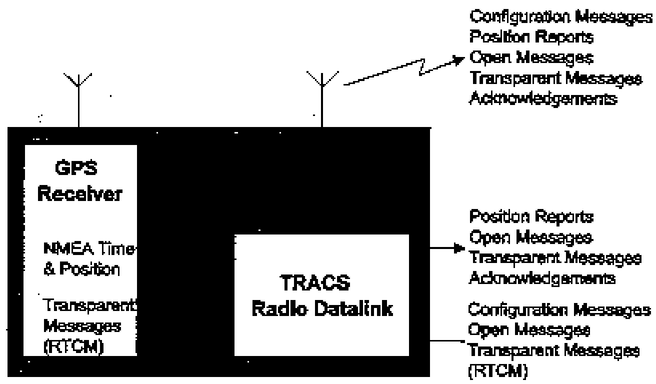

Figure 2.2 – Tracs TDMA Unit Message Connectivity

The Tracs TDMA system is configured around a GPS receiver to measure time and position and so the system provides a data path to transmit RTCM corrections from a base reference unit to all the mobiles.

Figure 2.2 shows the structure of the Tracs TDMA unit and how the various message types are passed through the system. In particular this diagram shows the two paths available for received Transparent messages.

The Transparent message type provides unformatted input and output paths so that it is used for RTCM corrections as well as other unformatted messages passing through the system. The Tracs TDMA units are set-up to receive Transparent messages in two simultaneous ways.

a. BROADCAST Transparent messages from a selected SOURCE ID are output to the GPS

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receiver. RTCM corrections are transmitted as broadcast Transparent messages.

b. Other Transparent messages, ADDRESSED to the receiving unit ID, are output through the COMMAND serial port of the Tracs TDMA unit.

The system allows for several sources of RTCM to be present in the network, so that any broadcast message from an ID other than the selected ID is ignored so that the alternate reference station RTCM transmissions do not appear through the COMMAND serial port.

A consequence of this feature is that **broadcast** Transparent messages **cannot** be used for other message transmission. Specifically addressed Transparent messages can be used from any unit for general data transmission.

2.4 BASIC POSITION REPORTING

Figure 2.3 shows a basic DGPS tracking example involving two Tracking Units, one labelled DGPS Reference/Base (Unit 1) located at a known, fixed point, and the other labelled Mobile (Unit 2). Unit 1 is allocated timeslots for transmission of Transparent messages containing the RTCM corrections. Unit 2 is given timeslots for transmitting a position report back to the base station.

Hence Unit 1 is able to continuously track the position of Unit 2. The position reports from Unit 2 can be displayed and logged on any display system (running suitable software) connected to Unit 1.

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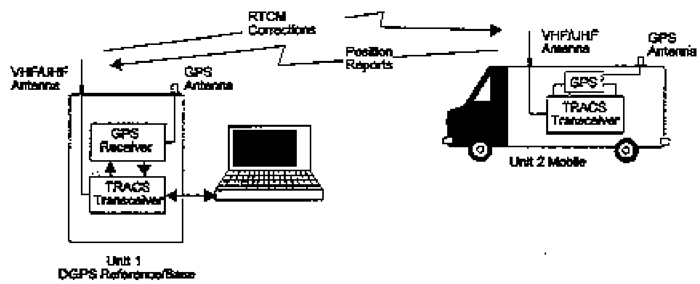

Figure 2.3 - Position Reporting

Position reports received by the base unit are output through the COMMAND port in a format described in Section 8.6. The baud rate set-up for the COMMAND serial port must be sufficient to output the received messages at the maximum link capacity.

2.5 SEPARATE DGPS REFERENCE STATION

In the example in Figure 2.4 the functions of DGPS reference and position report base station are separated. This separation may be because the reference point is at a different location to the base station system.

A third Tracking Unit (Unit 3) is used. Units 2 and 3 both receive RTCM corrections from Unit 1 and transmit their respective positions in their allocated timeslots. It can be seen that this arrangement could equally be set up for Unit 2 to monitor the position of Unit 3.

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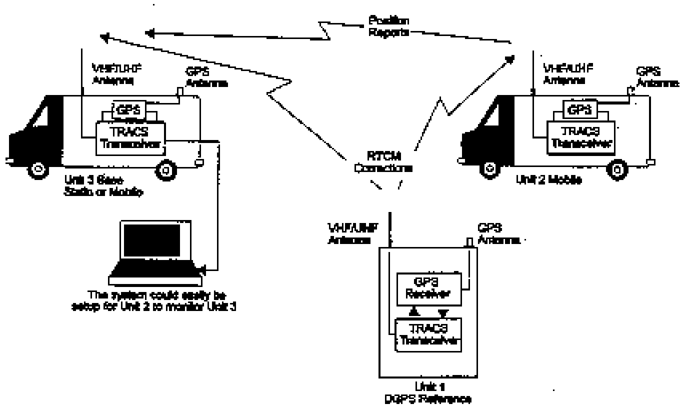

Figure 2.4 - Separate Reference and Base stations

2.6 USING A FIXED REPEATER STATION

In many situations the mobiles will move into areas where they cannot communicate with either the RTCM source unit or the position report base station. In this case Tracs TDMA provides a **STORE AND FORWARD** repeater function. In the example shown in Figure 2.5, mobile 2 can no longer receive the RTCM corrections from unit 1. A fixed repeater is set-up on a suitable position and configured to repeat all the Transparent messages from unit 1. Mobile 2 can then receive corrections from the repeated transmissions when it passes out of the direct reception area. The mobiles automatically ignore any repeated messages if they have already received the direct transmission.

In this example mobile 2 is also unable to communicate with unit 3 which is the position report base station. Tracs TDMA provides another repeater mode, **AUTOMATIC MODE**, which is built into **ALL** units to repeat point to point messages when required.

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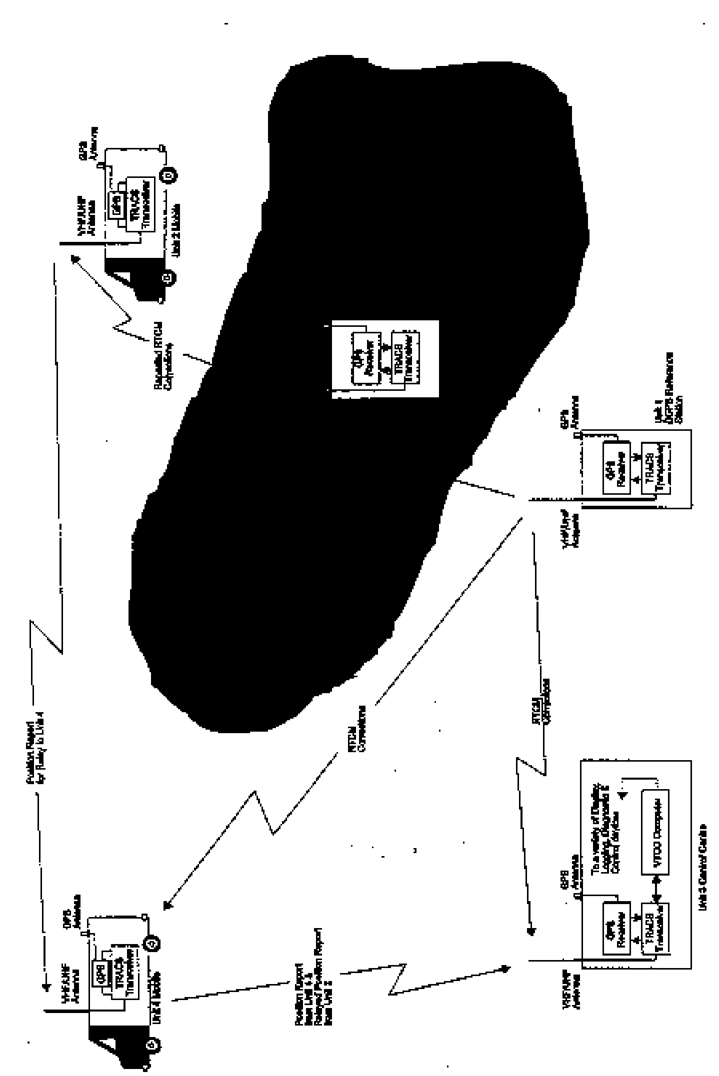

Figure 2.5 - Use of a Fixed Repeater Unit

For example, Unit 2 knows from received position reports that Unit 4 can 'see' the base station Unit 3 and can

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therefore relay its position report to Unit 3 via Unit 4. Alternatively, it could route its report via the fixed repeater station (Unit 5). This feature of automatic repeating is built into all Tracs TDMA units.

2.7 BASE STATION SOFTWARE

The position reports, output from the base station Tracs TDMA unit, can be connected to a number of computer display systems, that accept the report message format (See section 8.6), according to the system requirements. In many cases a Tracs TDMA system will consist of a single base station, but the system can be configured to operate over a very large geographical area by using a number of base stations. In such systems a network management computer (VTCC) manages the mobiles over the multiple base stations and provides a single position report message out to the display device.

The VTCC software can also provide for fault monitoring, automatic configuration and co-ordinate conversion. The software is described in a separate operation manual.

3 GENERAL COMMUNICATION MESSAGES

3.1 DATA MESSAGE TYPES

A Tracs TDMA unit can send 4 different message types:

a. Position Report
Derived from the GPS NMEA GGA and VTG messages

b. Transparent Data
Unformatted In / Out data channel (RTCM etc.)

c. Open Data
Formatted addressable data messages

d. Configuration messages
Remote unit configuration

3.1.1 Position Reports

Position reports are automatically generated from the NMEA GGA and VTG messages input to the radio unit from the GPS receiver. The position report contains: Time, Latitude, Longitude, Height, Course made good, Speed, Reference station ID, HDOP, Age of correction and Number of satellites. The report format is detailed in Section 8.6.

An external device may generate a special position report, overriding the automatic report, by sending a FIXT message into the serial port of the unit.

The unit will also detect an Emergency input signal and generate an Emergency report if it is set Low (Contact closure). The operation of the Emergency button is described in section 5.4.

An NMEA Heading message, from an external gyro or compass, can be input to the unit to override the Course made good (CMG) with the external heading. A flag in the position report indicates whether the message contains CMG or external heading and if it is True (gyro) or Magnetic (compass).

These messages are described in Section 8.

3.1.2 Transparent Messages

Transparent messages are a form of ASCII messages which do not require any input formatting (e.g. RTCM 104 data from a GPS reference receiver) and are output from a receiving unit unformatted. The Tracs TDMA transmitter is pre-configured to route the Transparent messages to the desired destination. When the Transparent message type is used for RTCM, this setting would be to broadcast the message. The incoming message is input through the COMMAND port of the transmitting Tracs TDMA unit.

Any Tracs TDMA unit receiving a Transparent message addressed to its ID will output it through its COMMAND serial port. In addition, the receiving Tracs TDMA unit can be pre-configured to select broadcast Transparent messages from a particular transmitter ID and output them to the unit's GPS receiver. This mechanism allows the RTCM messages to be sent to the correction input port of the GPS receiver. See Section 2.3 concerning restrictions on the use of broadcast Transparent messages for other purposes.

The data rate of the incoming data should be less than the transmission rate set-up by the slot allocation to avoid buffer overflow. For example, with an over the air transmission rate of 9600 a slot per second gives 300 baud effective data rate, so an incoming, continuous, data rate of 1200 baud would require 4 slots / second. An

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internal buffer of 512 bytes is provided to even out incoming data whose average rate is less than the serial bit rate.

3.1.3 Open Messages

Open messages may be used to provide a general purpose data link between any units. An open message is input via the COMMAND serial port with a header describing the destination for the message. Each input message provides a 32 byte (Character) packet and can have a different destination so as to provide a flexible data path. The Open message format provides for data to be input to the Tracs TDMA unit as either an ASCII message or a true binary message. The formats are described in the section 8.7.

The transmitting unit can hold up to 12 messages in its input buffer. An ACK message is sent out to the source device every time a message is transmitted. It is the responsibility of the source device to track when the buffer is empty. A NAK message will be sent out by the transmitting unit if there are no channel 2 timeslots set-up.

Currently Open messages received by a Tracs TDMA unit are processed according to whether they are an ASCII or binary message. The facility to select the message processing will be added in later firmware releases.

The ASCII content of Open ASCII messages are output without any headers or terminators (<CR><LF> etc.) so that the body of the message can be sent directly to some other application software or hardware device. For example, a specific format message can be sent to an external piece of equipment that cannot accept any other message formatting.

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Open binary messages are converted to ASCII hex format and output with headers in the format described in section 8.7.

3.1.4 Configuration Messages

All configuration messages are available for over air set-up. The destination ID specified in the message indicates whether the unit receiving the message through its COMMAND serial port has to act upon the message itself or to transmit the message to the desired destination. The receiving unit will acknowledge the configuration in the timeslot indicated (See below for explanation of reply timeslot allocation) except that timeslot 0 is interpreted as NO acknowledgement.

Broadcast configuration messages cannot be acknowledged, since all the units would have to transmit back an acknowledgement. Broadcast configuration messages can be used EXCEPT that the local unit ignores the configuration (To avoid confusion) and must be set-up explicitly if so required. Thus broadcast settings request messages are illegal and are NAK'd by the transmitting unit if received through the serial port.

The acknowledgement timeslot specified in the configuration message MUST be a timeslot available for use. It can either be allocated by the source of the configuration message or by the transmitting unit. The latter option is more efficient in that it allows the use of a timeslot repeat interval rather than a specific timeslot to be indicated. Thus a reply requiring a repeater will be repeated more rapidly than if a single timeslot were specified.

The timeslot specification is interpreted as follows:

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0000 = No acknowledgement (Illegal setting for Request message)

1 to 1200 = Actual slot number. Reply must be in this slot. A replying unit needing to request a repeater for the reply must indicate this slot number for the repeat so up to 2 cycles may elapse before the reply is received.

9999 = Automatic slot allocation by the transmitter. Recommended option.

The messages are acknowledged by the destination unit with either an acknowledge message to indicate whether the configuration was actioned or, if the message is a settings request message, a message indicating the current settings.

3.2 TIMESLOT MANAGEMENT

All transmissions from a Tracs TDMA unit are in timeslots synchronised to UTC derived from a GPS receiver. Every transmitter has its own timeslot set-up. The operation of the system timeslot planning software is described in the Tracs TDMA Configuration manual and covers the actual setting messages used to configure a Tracs TDMA unit.

Units in receive mode (i.e. any unit not transmitting) can receive messages in any timeslot irrespective of its own transmission timeslot set-up.

3.2.1 Timeslot Configuration

The length of each timeslot and hence the number of timeslots/second is dependent upon the over-air bit rate as follows:

Bit Rate	Slots/sec
16,000	20
14,400	20
12,000	16
9,600	12
8,000	11
7,200	10
6,000	8
4,800	7

Higher bit rates offer greater data throughput but at the cost of a lower maximum operating range.

The network is set-up, at each transmitter, as a number of sets of transmission timeslots, each with a number of equally spaced timeslots specified by first slot number and interval. The system can operate with a timeslot cycle of up to 60 seconds in intervals of 10 seconds. i.e. 960, 840, 720 or 420 slots in total. It is recommended that a cycle length of 60 seconds is always used since an individual unit can be allocated any number of timeslots within that cycle.

Timeslot sets for position reports, transparent data, open/configuration messages and store and forward repeater re-transmissions can be configured. Specific message types will only use the timeslot set allocated for that class of message. Normally a timeslot set will always be allocated to every unit for position reports. Timeslots for other messages may either be allocated permanently or can be allocated temporarily by a central controller.

Network timeslot settings may be set-up for a specific unit either directly or via the radio network. Timeslots are set-up in 4 sets. These allocations allow the transmitter to determine in which timeslots to transmit the appropriate message. For example, position reports are transmitted in the timeslots set-up for set 1. External interface messages received by a unit for a set not set-up will generate a NAK acknowledgement message. For example, an open message input to a unit without set 3 allocated. The set-up message can set-up any unit ID if the source unit is first set-up with a set 3 for that purpose.

Set 1 is used by position reports.
Set 2 is used by transparent messages.
Set 3 is used for open messages or set-up messages.
Set 4 is used for store and forward repeater use.

3.2.2 Shared Use of Timeslots

Timeslots allocated for open and configuration messages may be shared by several units. For example, a unit may send a message to another unit requesting a reply. The receiving unit can be set-up with the same set of timeslots to use for the reply. The first unit must wait for the reply, with a suitable timeout in case of error, before sending out another message to other units.

3.2.3 Dynamic Mode

The system allows for up to 255 units to be configured for a network. Increasing the number of ID's in the system would severely compromise the operation of the repeater function. Applications where there may be 1000,s of units within a network require that the operating ID's of the units be controlled dynamically by a network controller connected to the base stations. The controller divides the operating units into groups of up to 255 units and distributes them between base stations in non-overlapping areas and on different frequencies.

A unit configured in dynamic mode is normally also configured into auto-frequency mode to detect the loss of destination base unit for its position reports. This detection

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will cause the mobile unit to switch frequency until it finds a signal from a unit with the base station ID. (In this system the base stations will all have the same ID).

The dynamic mode will cause the unit to clear the set-ups for transmissions in timeslot sets 1 to 4 and transmit a Control channel message in its Control channel timeslot set 0 to the detected base station. This may involve sending via a repeater if appropriate depending upon whether the base was detected directly or via a routing table setting.

3.2.4 Dynamic Multi-Base/Frequency mode

In situations where the number of mobiles exceeds the capacity of a single base station in an area and or multiple base stations are required to provide coverage, the system must operate in dynamic mode.

The VTCC PC is connected to all base stations forming a network. These will include base stations at the same site, but on different frequencies, to increase coverage in a particular area. The VTCC is given a set of timeslot map files for each base station unit and manages a table of current allocations against each map. The maps are configured at system planning stage so that the VTCC PC only has to manage allocation of resource , not how to achieve it. The VTCC may also have a set of location or function rules to determine the update rate etc. to allocate to each unit.

In addition to the mobile units being configured in auto-frequency mode the units are also in dynamic mode. The unit will operate with the additional function that, when it first powers up or when it looses its base station, the unit in dynamic mode clears all its allocated timeslots in sets 1 to 4 so that it cannot transmit. The unit will then monitor the channel for packets that show a connection to the base station, as in auto-frequency mode, and continue to switch frequency until a base station is detected. The mobile then transmits a service request message using the control timeslot set 0 and waits for a reply from the VTCC. In order to avoid jamming on an incorrect or faulty base station the unit will transmit requests for a period and then continue in auto-frequency mode as before trying all frequencies until the VTCC replies.

3.2.5 Logon Process

In dynamic mode the mobile is initially 'silent' at power up. It then listens to each frequency in its list for a base station, or its repeater, issuing a login broadcast message. This message is effectively a call to mobiles to login. The message contains details of the range of serial numbers allowed, the timeslots to reply in, and a randomising timeout seed to be employed. This gives the power to the VTCC to dynamically control the login processes. The mobile will also enter the login state after it has lost contact with the base station after a predefined period of time.

4 SYSTEM HARDWARE

4.1 INTRODUCTION

The main components of the Tracs TDMA system is the VHF/UHF Tracking Unit as illustrated at Figure 4.1. Footprint dimensions for the unit are given in Figure 6.1, Section 6.10.1

All installations, either permanently sited or mobile, incorporate a tracking unit, combined GPS/Link antenna or separate antennas and a set of interconnection cables as shown in Figures 4.4 and 4.5.

A list of part numbers for the various components of the system is given in Section 4.2, and a Technical Specification is given in Section 6. Details of the Tracking Unit's connectors and installation cables are given in section 7.

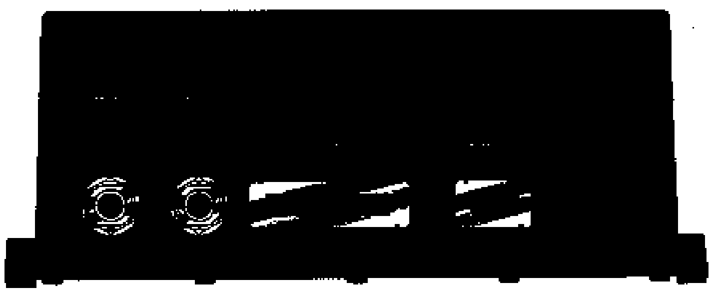

Figure 4.1 – Tracs TDMA VHF/UHF Base Unit 90775/90779 for use with separate antennae

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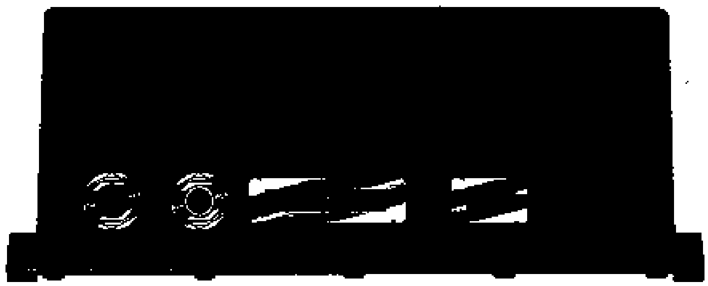

Figure 4.2 – Tracs TDMA VHF/UHF Mobile Unit 90775/90779 for use with combined antenna

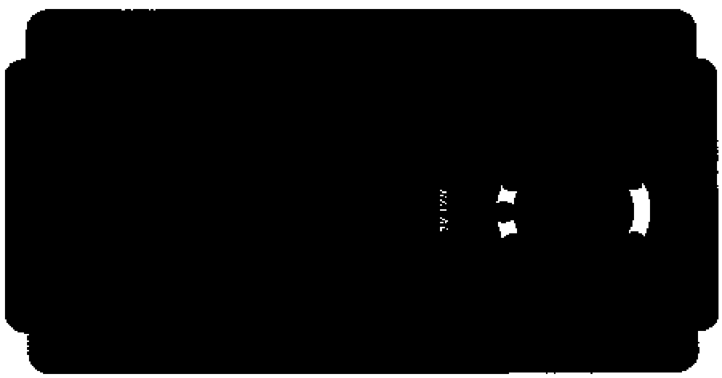

Figure 4.3 – Tracs TDMA VHF/UHF Display Panel

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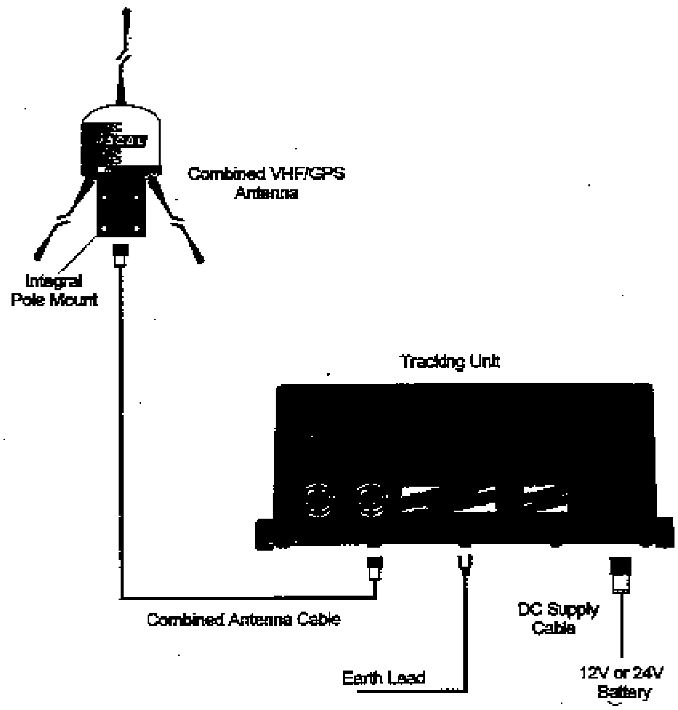

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Figure 4.4 - Mobile Installation Components

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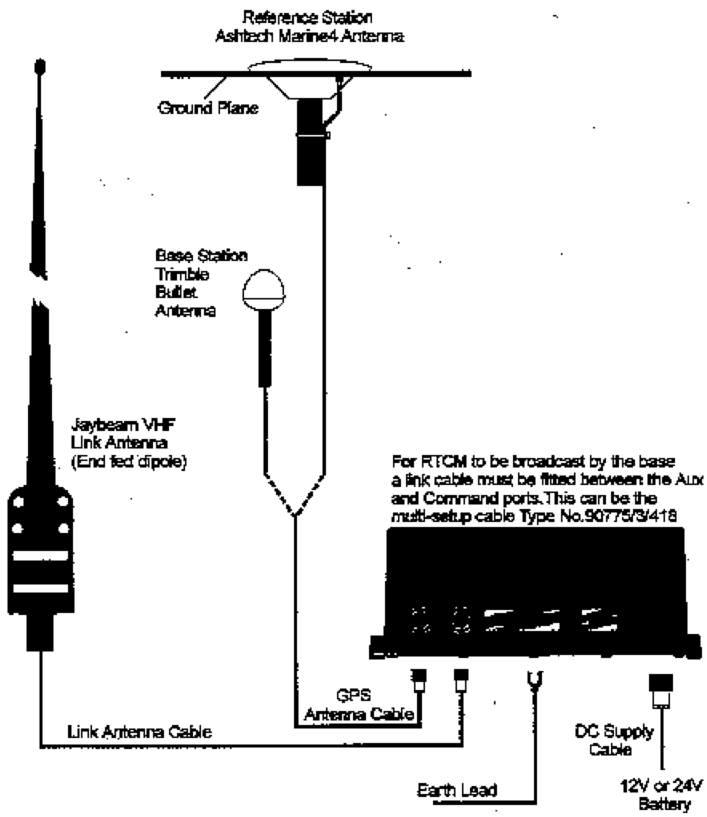

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Figure 4.5 - Base and Base Reference Installation

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4.2 SYSTEM HARDWARE

4.2.1 Tracking Units

4.2.1.1 Differential Reference Stations

Unit	Type Number.
Differential Reference Station (1) VHF Intelligent radio with integrated 10 Watt Power Amplifier, dual antenna system, integrated Ashtech G12B GPS reference receiver. Marine 4 GPS Antenna Antenna Mounting Bracket VHF Dipole Antenna Jaybeam Antenna Cable VHF (10m, N to N) Antenna Cable GPS (10m. N to TNC) DC Power Cable (2.9m)	**90775/3/1-G12BP2**
Differential Reference Station As (1) above except with 2 Watt power output.	**90775/3/1-G12BN2**

4.2.1.2 Base/Mobiles

Unit	Type Number
Base Station/Mobile Tracking Unit (3) VHF Intelligent radio with integrated 10 Watt Power Amplifier, dual antenna system, integrated Trimble SK8 GPS receiver. Bullet GPS Antenna Antenna Mounting Bracket VHF Dipole Antenna Jaybeam. Antenna Cable VHF (10m, N to N) Antenna Cable GPS (10m, F to N) Power Cable (2.9m)	**90775/3/1-SK8P2**
Base Station/Mobile Tracking Unit As (3) above except with 2 Watt power output.	**90775/3/1-SK8N2**
Base Station/Mobile Tracking Unit (4) VHF Intelligent radio with integrated 10 Watt Power Output, combined GPS/VHF antenna system, integrated Trimble SK8 GPS receiver. Combined Antenna Antenna Cable (5m N to TNC) Power Cable (2.9m)	**90775/3/1-SK8P1**
Base Station/Mobile Tracking Unit As (4) above except with 2 Watt power output.	**90775/3/1-SK8N1**

This selection maybe configured and used either as a base or mobile tracking unit.

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Unit	Type Number
Base Station/Mobile Tracking Unit (5) VHF Intelligent radio with integrated 10 Watt Power Amplifier, dual antenna system, integrated Ashtech G12L GPS receiver. Bullet GPS Antenna Antenna Mounting Bracket VHF Dipole Antenna Jaybeam Antenna Cable VHF (10m, N to N) Antenna Cable GPS (10m, F to N) Power Cable (2.9m)	**90775/3/1-G12LP2**
Base Station/Mobile Tracking Unit As (5) above except with 2 Watt power output.	**90775/3/1-G12LN2**
Base Station/Mobile Tracking Unit (6) VHF Intelligent radio with integrated 10 Watt Power Output, combined GPS/VHF antenna system, integrated Ashtech G12L GPS receiver. Combined Antenna Antenna Cable (5m N to TNC) Power Cable (2.9m)	**90775/3/1-G12LP1**
Base Station/Mobile Tracking Unit As (6) above except with 2 Watt power output.	**90775/3/1-G12LN1**

This selection maybe configured and used either as a base or mobile tracking unit.

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4.2.1.3 High Dynamic Mobiles

Unit	Type Number
High Dynamic Mobile Tracking Unit (7) VHF Intelligent radio with integrated 10 Watt Power Amplifier, dual antenna system and integrated Ashtech G12R GPS receiver. Marine 4 GPS Antenna Antenna mounting Bracket VHF Dipole Antenna Jaybeam Antenna Cable (10m N to N) Antenna Cable (10m N to TNC) DC Power Cable (2.9m)	**90775/3/1-G12RP2**
High Dynamic Mobile Tracking Unit As (7) above except with 2 Watt power output.	**90775/3/1-G12RN2**
High Dynamic Mobile Tracking Unit (8) VHF Intelligent radio with integrated 10 Watt Power Amplifier, combined antenna system and integrated Ashtech G12R GPS receiver. Combined Antenna Antenna Cable (10m N to TNC) DC Power Cable (2.9m)	**90775/3/1-G12RP1**
High Dynamic Mobile Tracking Unit As (8) above except with 2 Watt power output.	**90775/3/1-G12RN1**

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4.2.2 Components

Description	Type Number
Marine 4 GPS Antenna *	21055
Bullet GPS Antenna **	25045
VHF Jaybeam Dipole Antenna	7500-5000-14
Combined VHF/GPS Antenna	90776/3/40
Combined UHF/GPS Antenna	TBA
Reduced Antenna GPS only	TBA
Antenna Cable (10m N to N)	90774/3/412A
Antenna Cable (10m N to TNC)	90747/3/412
Antenna Cable (5m N to TNC)	90821/3/401
Antenna Cable (5m N to BNC)	90821/3/408
DC Power Cable (2.9m)	90775/3/411
Antenna Mounting Bracket *	90716/3/100
Earth Cable	90538/3/26
Set-up Cable (9 way)	32044
Multi-set-up Cable	90775/3/418
Operation & Installation Manual	90775/44/1A
Antenna** mounting pole	90821/3/63

Notes - * Parts suitable for the Marine 4 Antenna.
** Parts suitable for the Bullet Antenna.

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4.3 INSTALLATION NOTES

4.3.1 Antennas

There are currently three types of antenna for the Link,

- Combined
- End fed dipole
- Portable whip

The end fed dipole is typically used for installations at base stations while the combined link and GPS antenna is used on all sea-borne vessels.

The whip antenna is more suitable for installation on smaller vehicles. Its 180° adjustable-pivot construction enables fitting to virtually any flat or inclined plane.

[redacted]

4.3.2 Equipment Location

4.3.2.1 Tracking Units

In mobile installations, the operator of the vehicle or vessel will have little or no recourse to the unit once it is set up and working correctly. It should, therefore, be mounted in a position that provides easy access to the emergency button. At permanent, fixed installations, like reference stations and control centres, the unit can be mounted in any convenient position. Tracking units should be mounted away from potential sources of interference like radar transmitters or other VHF/UHF transmitters. It is good practice that units be connected to a good earth point or vehicle ground. Any one of the base plate screws is suitable for use as an earthing point.

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4.3.2.2 Combined Antenna

The combined antenna is supplied with detachable radial sections these are pre-cut precisely to length and match the systems frequency of operation. The radials should be fully fitted by hand then tightened approximately 1/8th of a turn with a spanner, avoid over tightening and damaging the threads. The top radial is marked with a rubber sleeve and is the shortest in length. The base of the antenna incorporates an integral pole mount fitting which accepts pole sizes of 25 to 35 mm in diameter. The pole mount U-bolts should not be over tightened.

Where possible the antenna should be mounted to give a clear 360° view of the sky down to the horizon. On sea-borne vessels, the antenna should be mounted above the vessel's superstructure and be sited away from any source of interference. In the event of limited space availability, vertical separation is preferable to avoid other antennae. The vertical radial in the top of the antenna should be a minimum of 2 metres from a metallic object while the four downward radials require to be in free space. The ideal installation is shown below.

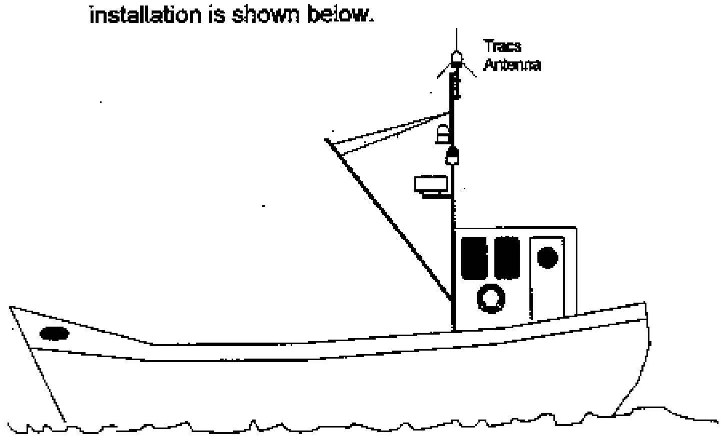

Figure 4.6 - **Ideal vessel antenna location**

4.3.2.3 Separate Link and GPS Antennae

At fixed installations, where a good antenna site is essential, the link antenna and separate GPS antenna are usually pole-mounted. GPS performance can suffer from effects caused by multipath so ensure that there are no objects/structures around the antenna which could cause signal reflections. GPS antenna used at a reference station (namely the Ashtech Marine 4 antenna) can be fitted with a ground plane to minimise multipath.

For best performance, the VHF/UHF link antenna should be mounted at such a height and position to give a clear, all round line of sight to as much of the local area as possible.

The length of the antenna signal cable must not exceed 10m (thin RG58 cable) or 30m (thick RG213 cable). Where possible the correct connectors should be used to avoid the use of adapters or conversion cables as this introduces unnecessary losses. All external connections should be protected with self amalgamating tape.

Note that the maximum attainable range between two tracking units is affected by the height at which both antennas are mounted. In the line of sight system,

$$R = 4.1(\sqrt{h_1} + \sqrt{h_2})$$

Where R = attainable range (km)
h_1 = transmitting antenna height (m)
h_2 = receiving antenna height (m)

Note that this is the maximum line of sight range achievable and in practice the maximum range is limited by the antenna gains, receiver sensitivity, transmitter power, feeder cable losses, data link bit rate, type of terrain and local noise environment.

A radio propagation range modelling program should be used to obtain an estimation of the achievable range of a system.

Installations with long cables should select a higher gain antenna if permitted to compensate for the feeder cable losses. A 10m length of RG58 cable, or a 30m length of RG213 cable, is equivalent to approximately 3dB of loss at VHF frequencies. Assuming that the range is not limited by line of sight, then it will be approximately halved for every 6dB of feeder loss and doubled for every 6dB of antenna gain.

4.3.3 DC Supplies

Installations can be powered from either a 12V or 24V battery supply. Power cables are supplied in a standard length of 2.9m.

5 SYSTEM DIAGNOSTICS

5.1 GENERAL INFORMATION

Racal's Tracs TDMA equipment is designed and manufactured to exacting standards and, once installed and operating correctly, should give prolonged trouble-free service.

The fault diagnosis and troubleshooting assistance given in this short chapter is divided into two levels.

- Unit Diagnostics (checks on individual Tracking Units)
- System Diagnostics (using diagnostic software)

Facilities provided by the VTCC network control software are described in the operating manual for that software.

There are no user-adjustable controls or user-replaceable items within a tracking unit. Suspect or faulty units should be returned to the manufacturer for repair.

To expedite repairs, the following information should be included with the returned unit:

- Detailed fault description and operating conditions
- Contact name and telephone/fax numbers

Note - The unit is protected against current overload by an internally mounted thermal fuse. This fuse is not accessible to the user and will reset shortly after the overload or reverse polarity is removed.

5.2 UNIT DIAGNOSTICS

If a tracking unit appears to malfunction, or fails to operate at all, the cause can usually be traced to a installation fault or an incorrect unit set-up. The mobile unit can indicate certain faults by sequences of flashes from the System Health LED on the top panel, these are for use by service personnel and should be included in any fault report.

As with any transmitting and receiving equipment the importance of correct installation, in particular the integrity of the antennas and earthing arrangements, cannot be over stressed. So often the equipment can be functioning perfectly well but system performance is degraded because of poor earthing and antenna connections. These connections should be checked as a matter of course when dealing with any apparent faults, especially those connected with poor signal and noise levels.

Note - The unit will cease to transmit (But will still receive signals) if its GPS timing is lost for any reason. This could be caused by a defective GPS antenna installation or poor GPS reception (a bad location, radio interference or multi-path GPS signal reflections).

5.2.1 Physical Checks

Check the physical installation paying particular attention to the following,

- Correct installation of equipment
- All plug and socket connections
- Security of antenna mountings
- Cable runs
- Installation earths

Check the battery supply at the unit end of the power cable.

5.2.2 Set-up Checks

The unit may be set-up, using the set-up software, from a PC connected to its COMMAND port using a serial data cable as shown in Section 7.2.6.

With reference to Control Software Manual, run the Set-up Program and check that the unit's functional settings, ID and timeslot allocations (for all sets) are correct. Pay particular attention to source and destination unit IDs.

5.2.3 GPS Receiver Checks

If the unit is receiving but not able to transmit any signals it may not be receiving correct GPS timing signals from the GPS receiver.

If an external GPS receiver is being used, first check that the 1pps and serial data connections between the GPS receiver and the Tracs TDMA radio unit are correct and that the GPS antenna is connected with a clear view of the sky.

If no obvious faults are found, the operation of the GPS receiver can then be monitored using a suitable terminal program on the PC. Connect the PC to the Serial I/O port which has been mapped for NMEA Output by the set-up software. The port connections are shown in Section 7.1.6.

Monitor that the GGA and VTG NMEA messages displayed by the Terminal software are correct. The unit should acquire satellites within approximately 2 minutes. This will be longer for units not previously used in your current location.

If the unit does not appear to operate correctly, the GPS receiver should be set-up again to ensure that it is correctly configured. With reference to the Control Software Manual, use the system set-up software to set-up the GPS receiver. The port used for configuring the GPS receiver is also configurable by the set-up software. Check the port assignments with your system administrator.

5.3 FAULT REPORTING

The above checks should identify whether the fault is in the GPS receiver or the radio datalink module Replace the tracking unit with a serviceable replacement before returning a unit for repair to ensure that some other local effect is not causing the failure.

If the failure is confirmed, the suspect unit should be returned for repair with the following information.

- Description of the observed fault.
- Result of local diagnostic tests(LED indications)
- Frequency settings for unit
- Operational settings for unit
- Geographical location of system
- Description of the Tracs TDMA system configuration

5.4 EMERGENCY FIX INPUT

The system will generate an emergency fix if the Emergency Fix Button is pressed. This report is then transmitted. The control centre unit receiving the emergency fix will pass it out of its Command Serial Output for action. Any other unit receiving this emergency fix will display it by flashing the emergency LED red.

In the event of an emergency the emergency button should be **pressed and held** (more than 2 seconds) until the emergency LED stops flashing red/green and illuminates steady red. This indicates that the emergency button has been latched and will generate the necessary position report. The emergency LED will then flash green once the emergency position report has been transmitted to the control centre. Upon receipt of an acknowledgement from the control centre the emergency LED will illuminate steady green.

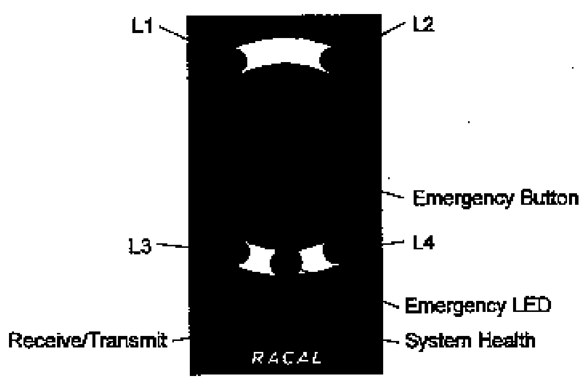

Figure 5.1 – Tracs TDMA Mobile Display Panel

An alarm may be cancelled by re-pressing the emergency button. A momentary press of the emergency button (less than 2 seconds) will test the button and LED operation causing the LED to flash red and green for the duration of the test.

6 TECHNICAL SPECIFICATION

6.1 GPS RECEIVER OPTIONS

The TRACS TDMA system is currently available with 4 GPS receiver options:

Ashtech G12B (Base Reference Station)
Ashtech G12R (High Dynamic Mobiles)
Ashtech G12L (Mobile and Base Station)
Trimble SK8 (Mobile and Base Station)

The system can be used with other external GPS receivers and may be offered with additional integral options.

6.2 POWER CONSUMPTION

Input Voltage : 9 – 36 volts

Input Current (@ 24V DC input):-

Mode	2 Watt PA	10 Watt PA
Receive only	0.2A	0.2A
Low duty cycle	0.3A	0.4A
High duty cycle	0.6A	1.7A

6.3 RANGE

Typical range achievable between two Tracs TDMA units set at 2W power and using standard (0dB) antennae installed at heights of 100m and 10m with a link bit rate of 12,000 bps is approximately 40km.

Note - The operating range will also be affected by local noise conditions and terrain and will be limited to radio line-of-sight if antennae heights are low. The range will be increased if higher gain antennae are used and reduced if long antenna cables are required. The overall antenna/cable gain should be considered for range calculations.

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6.4 FREQUENCY BANDS

VHF : 136 - 174MHz
UHF : 430 – 512MHz

6.5 NUMBER OF CHANNELS

The unit is set up (using the Tracs TDMA set-up software) with up to 10 operational channels.

6.6 BANDWIDTH

The unit will operate in a 12.5 kHz or 25 kHz radio channel dependent upon the over-air data rate.

6.7 TRANSMITTED POWER OUTPUT

High : 10W (Power Amplifier Option)
Medium : 2W (Standard setting)
Low : 0.5W

6.8 CCIR EMISSION DESIGNATOR

25K0F1D

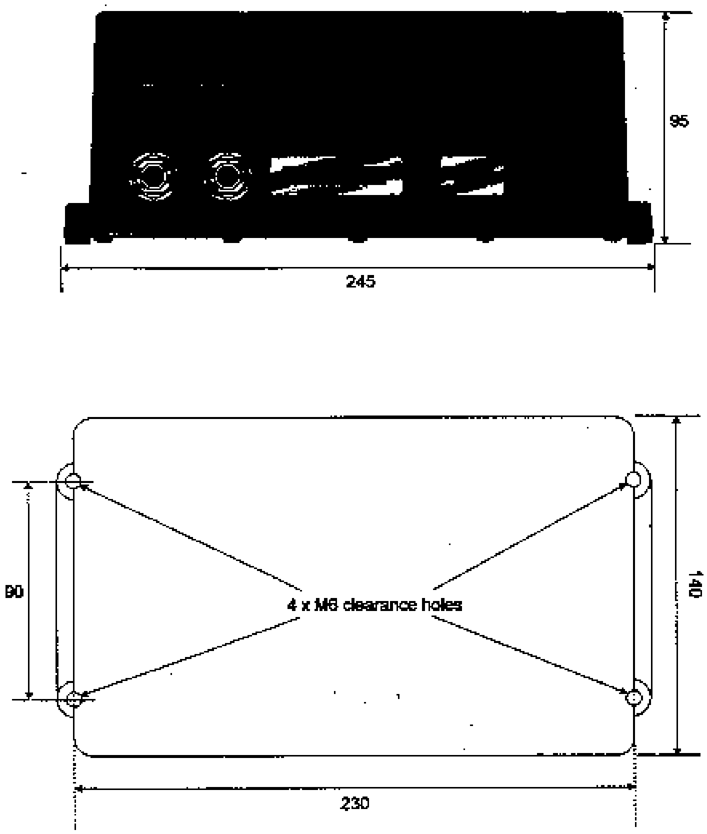
6.9 ENVIRONMENTAL SPECIFICATION

Operating Temperature : -30°C to +60°C
Storage Temperature : -40°C to +70°C
IP Rating : IP67
Compass Safe Distance : 0.3m

6.10 DIMENSIONS AND WEIGHTS

6.10.1 Tracs TDMA 90775/90779 (VHF/UHF)

Height : 95mm
Width : 245mm
Depth : 140mm
Weight : 2.17kg (Typical)



Dimensions in millimetres

Figure 6.1 – Tracs TDMA dimensions

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6.10.2 Combined Antenna Type 90776/3/40

Height : 180mm (excluding radials)
Width : 110mm diameter
Mounting holes: 46mm sq pitch. Hole diameter 7mm.
Weight : 0.8kg (excluding U-bolts)
Radial Lengths: Cut to length depending upon required system frequency. Contact Racal Tracs for further information.

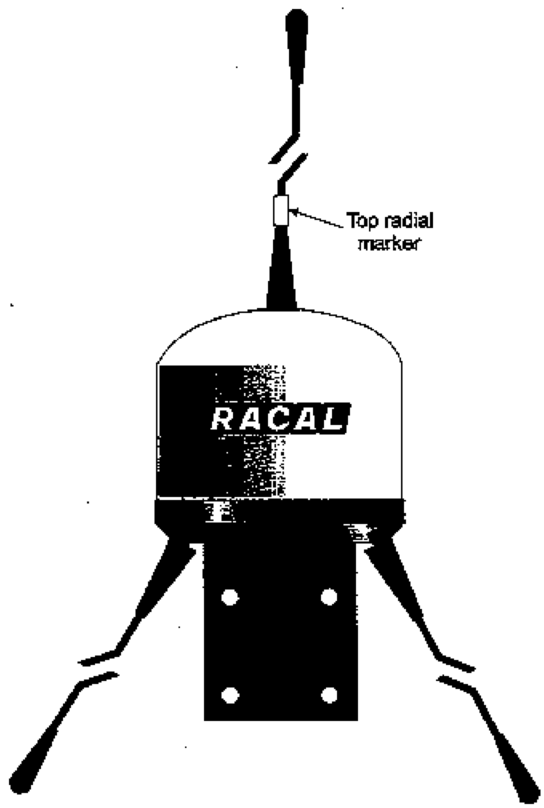

Figure 6.2 - Combined VHF/GPS Antenna

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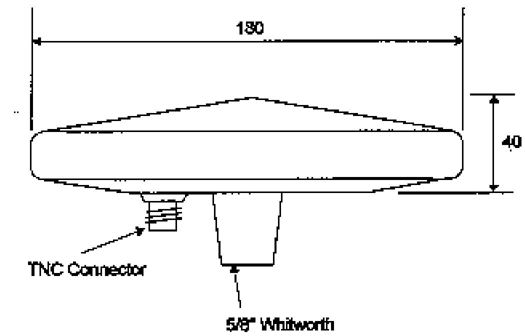
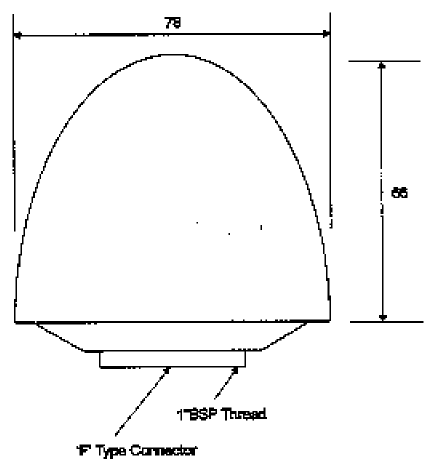
6.10.3 Marine 4 GPS Antenna



6.10.4 Bullet GPS Antenna



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7 INTERFACING

7.1 CONNECTORS

7.1.1 Link Antenna Socket

N Type Chassis Socket

Pin	**Function**
Inner	Signal
Outer	Ground

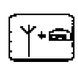
7.1.2 GPS Antenna Socket

N Type Chassis Socket

Pin	**Function**
Inner	Signal & +5VDC
Outer	Ground

Note - This connection supplies power for the GPS antenna and must not be short circuited. Take care not to accidentally connect a Link antenna to this socket.

7.1.3 Combined Antenna Socket



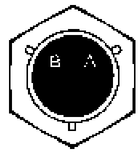
N Type Chassis Socket

Pin	**Function**
Inner	Signal & +5VDC
Outer	Ground

Note - This connector should not be used to plug in a separate VHF or UHF antenna as this will short out the unit.

7.1.4 DC Power connector

62GB-57A-10-02-P 2-Pin Chassis Plug



Pin	Function
A	+ve 12V or 24V (Red)
B	0V (Blue)

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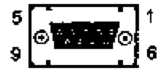
7.1.5 Serial I/O Command Socket



Pin	Name	Function	Level
2	Command Tx	Commands transmitted to external unit	RS232
3	Command Rx	Commands received from external unit	RS232
5	GND	Ground	0V

7.1.6 Serial I/O Auxiliary Socket

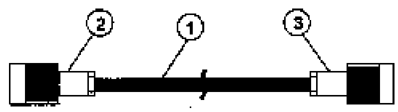
Pin	Name	Function	Level
1	GND	Ground	0V
2	Rx (data)	Data received from external unit	RS232
3	Tx (data)	Data transmitted to external unit	RS232
4	CTS (data)	CTS received from external unit	RS232
5	RTS (data)	RTS transmitted to external unit	RS232
6	TTL_0_OUT	TTL output bit 0	TTL +
7	GND	Ground	0V
8	Tx (port 2)	Port 2 data transmitted to external unit	RS232
9	Rx (port 2)	Port 2data received from external unit	RS232
10	TTL_1_OUT	TTL output bit 1 (Nominally PTT out)	TTL +
11	Analogue I/P	Analogue input monitor	0 to 4.5 volts *
12	OPTO_OUT+	Opto isolator +ve output	0 to 12V +
13	OPTO_OUT-	Opto isolator –ve output	0 to 12V +
14	TTL_2_IN	TTL input bit 2 (Nominally 1pps input bit)	TTL *
15	EMG_IN	Emergency input bit (Pull low)	TTL
16	TTL_1_IN	TTL input bit 1 (Nominally Fix input bit)	TTL *
17	TTL_0_IN	TTL input bit 0	TTL *
18	GND	Ground	0V
19	LED_EMG1	Emergency LED driver 1	TTL
20	Rx (Port 1)	Port 1 data received from external unit	RS232
21	LED_EMG2	Emergency LED driver 2	TTL
22	Tx (Port 1)	Port 1 data transmitted to external unit	RS 232
23	OPTO_IN+	Opto isolator +ve input	0 to 12 V *
24	OPTO_IN-	Opto isolator –ve input	0 to 12 V
25	GND	Ground	0V

Note – Port 1 and Port 2 can be assigned by the Configuration Software. The units are supplied pre-configured with default settings loaded. Port settings are an advanced user option and their assignment is described in the Tracs TDMA Configuration manual.

7.2 CABLES

7.2.1 Antenna Cable N to N, 90774/3/412

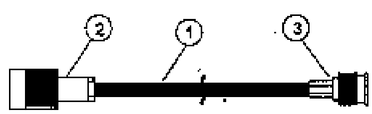
For connecting a Datalink UHF or VHF antenna to any tracking unit.



Item	Description	Part No.
1	Coaxial Cable	RG58/CU
2	Connector N Type Free Plug	N15A55E010X99
3	Connector N Type Free Plug	N15A55E010X99

7.2.2 Antenna Cable N to TNC, 90747/3/412

For connecting a Combined antenna or GPS Marine 4 antenna to any tracking unit.



Item	Description	Part No.
1	Coaxial cable	RG58CU
2	Connector N type free plug	N15A55E010X99
3	Connector TNC type free plug	T35A70E010X99

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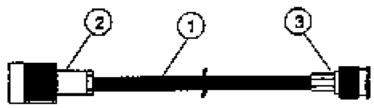
7.2.3 Antenna Cable N to BNC, 90821/3/408

For connecting the GPS Bullet antenna to any tracking unit with separate antenna sockets fitted with the Trimble SK8.



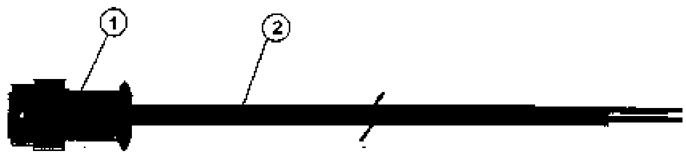
Item	Description	Part No.
1	Coaxial Cable	RG58CU
2	Connector N Type Free Plug	N15A55E010X99
3	Connector BNC Type Free Plug	
4	BNC to F Type Adapter	

GPS antenna cable (SK8)
This is the only cable where the use of an adapter is recommended to convert the bullet antennas 'F' type connector to a BNC. This is due to the poor selection of 'F' type connectors commercially available.

7.2.4 DC Power Cable 90774/3/408

For connecting an external 12V or 24V battery to any TDMA unit. Length 2.9m.

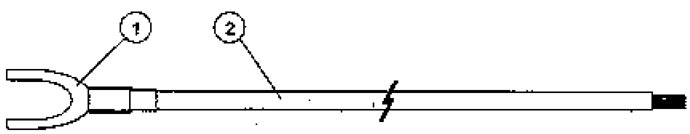
Red:	+ve
Blue:	-ve
Green/yellow:	screen



Item	Description	Part No.
1	Circular 2 Way Socket	62GB-16F-10-02-S
2	Cable 2 Cored Screened Black	16-2-2-C

7.2.5 Earth Lead 90538/1/3/26

For linking the case of TDMA units to ground.



Item	Description	Part No.
1	Solder tag spade end	2352397
2	Cable single core	3222063

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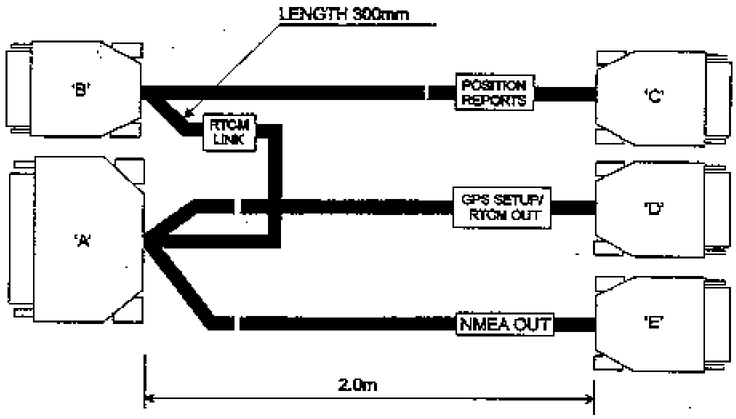
7.2.6 Multi Set-up Cable 90775/3/418

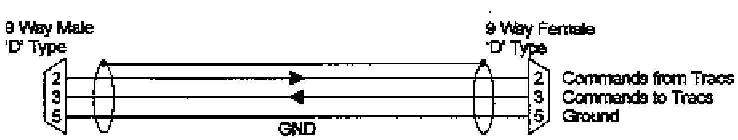
This multi-functional cable allows test and monitoring of the system once it has been configured.



CONNECTOR 'A' IS A 25 WAY D-TYPE PLUG.
CONNECTOR 'B' IS A 9 WAY D-TYPE PLUG.
CONNECTORS 'C','D' & 'E' ARE 9 WAY D-TYPE SOCKETS.

CONNECTOR 'A'	COLOUR	FUNCTION	CONNECTOR 'B'	CONNECTOR 'C'	CONNECTOR 'D'	CONNECTOR 'E'
PIN 9	BLACK	DATA (PORT 2)			PIN 3	
PIN 7	DRAIN	GND/SCREEN	PIN 5	PIN 5		
PIN 8	BLACK	RTCM LINK	PIN 3			
	RED	DATA (PORT 2)			PIN 2	
	RED	POSITION REPORTS	PIN 2	PIN 2		
PIN 22	RED	NMEA (PORT 1)				PIN 2
PIN 20	BLACK	DATA (PORT 1)				PIN 3
PIN 18	DRAIN	GND/SCREEN				PIN 5
	DRAIN	GND/SCREEN			PIN 5	

7.2.7 Command Port Cable 32044



This is a standard cable for connection of the Tracs TDMA Command Port to a PC and is used to configure any tracking unit.

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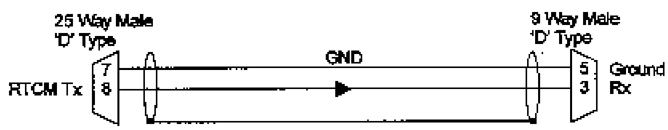
7.2.8 Auxiliary Port Cable

As the internal connections of port 1 and port 2 on the Auxiliary connector are user configurable by the Tracs TDMA Configuration program, the connection diagram given below applies to the normal internal connection of port 2 for control of the GPS receiver.

7.2.9 RTCM Link Cable

For a base reference unit to broadcast RTCM a link cable must be fitted between the 25 way Aux port and the 9 way Command Port.



8 MESSAGE FORMATS AND TIME SYNCHRONISATION

The Tracs TDMA unit normally obtains its position and time information and 1pps timing pulse from the internal GPS receiver. Alternatively, this information can be supplied by an external GPS receiver by altering the I/O port mapping. More detailed information on this is contained in the Tracs TDMA Configuration manual. The message formats and 1pps timing pulse requirements are described below.

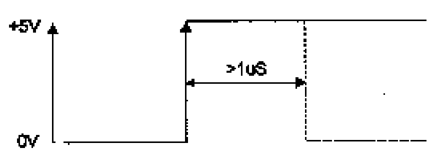
8.1 TIMING PULSE

Tracs TDMA requires a precise time signal to allow it to transmit in timeslot mode. This input is normally derived from the internal GPS receiver connected via the port mapping to Port B of the Tracs TDMA board

The GPS timing input to the TRACS TDMA comprises two signals:

a) A 0 to 5VDC 1pps pulse
b) An RS232 serial data time message

The 1pps pulse is used for precise timing of the transmitter. Either the rising or falling edge of the 1pps can be used as selected by the Tracs TDMA Configuration program. Note that all units in a system should use the same rising or falling edge selection. The (0 $\rightarrow$ 5V) pulse width should be greater than 1us as shown below.



For GPS receivers which have the option to advance or delay the 1pps signal, this **MUST** be set for 0 (zero) delay/advance for correct operation.

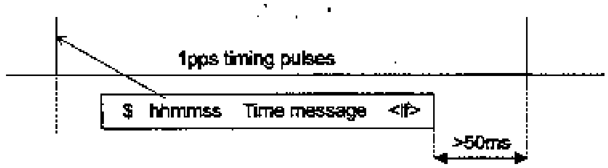
The RS232 serial data is used for position reports and to identify the whole number of seconds to which the 1pps relates. The RS232 serial data from the internal GPS receiver is normally routed via the port mapping out from GPS 2 and into Port B. Note that the same serial port (Port B) is used if RTCM 104 corrections are output by the Tracs TDMA unit, so the corrections will be output at the same baud rate as is configured for the input (the default is 9600 baud).

The unit will accept 4 types of message for timing and/or positioning. NMEA format GGA and VTG messages are required if the unit is to generate a position report.

A non-reporting unit, such as a base or reference station may optionally use an NMEA ZDA message or a Trimble TSIP type '7D' message if the GPS unit cannot generate a GGA message. The timing of all 3 messages (GGA, ZDA or TSIP) relative to the 1pps signal is very important to ensure correct identification of the whole second number.

The time message must be received during the second following the 1pps signal to which the time in the time message relates.

The diagram below indicates the timing requirements.



Any erratic timing of the time message from the GPS receiver, where the message continues past the next 1pps signal, will cause incorrect operation of TRACS TDMA

Note - A GPS receiver MUST be configured to output ONLY ONE timing message in NMEA mode. If

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the receiver outputs a GGA and a ZDA message the system may exhibit erratic operation depending upon the timing of the messages.

8.2 GGA MESSAGE

NMEA GGA messages are used internally to provide the information needed for the regular position reports and to give the 'time' to allow timeslot synchronisation. They are also output on pin 22 of the Auxilliary connector for use by external devices (e.g. a Track Plotter).

The GGA message includes time, position and fix related data for the GPS receiver.

$GPGGA,hhmmss.ss,ddmm.mmmm,N,dddmm.mmmm,W,
q,nn,hh.h,±zzzz.z,M,±gggg.g,M,ttt,iiii*hh<cr><lf>

Where:

Field 1 – UTC of Position hhmmss.ss
2 – Latitude ddmm.mmmm
3 – Latitude N (North) or S (South)
4 – Longitude dddmm.mmmm
5 – Longitude W (West) or E (East)
6 – GPS Quality q 0 = No GPS fix
1 = Uncorrected GPS fix
2 = Differential GPS fix
7 – Number of SVs used nn
8 – HDOP hh.h
9,10 – Mean-sea-level height (in metres) ±zzzz.z
11,12 – Geoidal separation (in metres) ±gggg.g
13 – Age of DGPS data ttt
14 – DGPS ref stn ID iiii
15 – Checksum

8.3 VTG MESSAGE

VTG messages must also be enabled to allow a unit to generate position reports.

$GPVTG,hhh.h,T,hhh.hh,M,vvv.v,N,vvv.vv,K*hh<cr><lf>

Where:

Field 1,2 – Track made good in deg true hhh.h
3,4 – Track made good in deg magnetic hhh.h
5,6 – Speed over ground in knots vvv.v
7,8 – Speed over ground in kilometers/hr vvv.v
9 – Checksum

8.4 ZDA MESSAGE

Some reference GPS receivers (e.g. Trimble 4000RS) do not output valid GGA messages when in base mode so the unit can also accept ZDA messages to provide the timeslot synchronisation in this mode. The position report from a reference station in this mode will be null.

$GPZDA,hhmmss.ss,dd,mm,yyyy,oo,oo*hh<cr><lf>

Only the following fields will be decoded; all others are ignored and can be null:

Field 1 – UTC ss
7 – Checksum

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8.5 TRIMBLE TSIP '7D' MESSAGE

<DLE><7D><08><Data String><DLE><ETX>

Databyte	Item	Type	Units
0	Flag	BYTE	Bit 0=0, Bit 1=1 UTC time Good
1	Hours	BYTE	Hours (0 - 23)
2	Minutes	BYTE	Minutes (0 - 59)
3	Seconds	BYTE	Seconds (0 - 59)
4	Day	BYTE	Day (1 - 31)
5	Month	BYTE	Month (1 - 12)
6-7	Year	INTEGER	Year (e.g. 1996)

The Flag byte MUST be xxxxxx10 as indicated for the time to be correct UTC rather than GPS time. <DLE> character in data string byte stuffing as per normal TSIP protocol (Data <DLE> bytes are doubled in the transmission so that any <DLE><DLE> pair is decoded as <DLE>.

TSIP data input is NOT acknowledged.

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8.6 POSITION REPORT OUTPUT

Position reports received by the unit (either addressed to the unit or broadcast reports or emergency reports to any destination) are output through the COMMAND port in Long, Normal or Short formats in NMEA style messages as described below.

Long format ....extra slot and route details, 109 chars inc crlf

$PRPS,POSL,sss,ddd,rrr,ssss,y,cc,hhmmss,ddmm.mmmm,N,dddmm.
mmmm,E,±hhhh.h,vvv.v,bbb.b,x,m,d,aa,hh,ss,rrr *hh <cr><lf>

example ...

$PRPS,POSL,002,050,000,0060,P,01,104404,5123.9412,N,00014.763
3,W,+0101.0,000.0,000.0,0,1,N,02,01,07,0000*3C

Normal format ....   96 chars inc crlf

$PRPS,POSN,sss,y,cc,hhmmss,ddmm.mmmm,N,dddmm.mmmm,E,±h
hhh.h,vvv.v,bbb.b,x,m,d,aa,hh,ss,rrr *hh <cr><lf>

example ...

$PRPS,POSN,002,P,00,104508,5123.9403,N,00014.7630,W,+0100.0,
000.0,000.0,0,1,N,02,01,07,0000*1F

Short format .... No GPS details, count or heading flags
75 chars inc crlf

$PRPS,POSS,sss,y,hhmmss,ddmm.mmmm,N,dddmm.mmmm,E,±hhh
h.h,vvv.v,bbb.b,d *hh <cr><lf>

example ....

$PRPS,POSS,002,P,105458,5123.9417,N,00014.7612,W,+0100.0,000
.0,000.0,N*2B

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The following table defines the field contents, limits and other details.

Long	Norm	Short	element details
y	y	y	sss = source ID
y			ddd = destination ID
y			rrr = repeater ID
y			ssss = slot number position received in
y	y	y	y = message type character "E" to "P"
y	y		cc = message serial number (0 to 15)
y	y	y	hhmmss = time of report (000000 to 235959)
y	y	y	ddmm.mmmm = Latitude (0000.0000 to 8959.99999)
y	y	y	N = Latitude sign "N" or "S"
y	y	y	dddmm.mmmm = Longitude (00000.0000 to 17959.9999)
y	y	y	E = Longitude sign "E" or "W"
y	y	y	±hhhh.h = spheriodal height metres (-300 to 1338.3m)
y	y	y	vvv.v = velocity knots (000.0 to 409.5)
y	y	y	bbb.b = heading degrees (000 to 359.9)
y	y		x = heading source 0 = COG, 1 = external
y	y		m = heading type 0 = magnetic, 1 = true
y	y	y	d = differential flag, N = non-diff, D = diff
y	y		aa = Age of DGPS corrections used for fix (00 to 59)
y	y		hh = HDOP of fix (00 to 15)
y	y		ss = No of satellites in fix (00 to 15)
y	y		rrrr = DGPS reference station used (1023 = non DGPS)
y	y	y	*hh = Checksum (see below)

The checksum field is the last field in the message and follows the checksum delimiter "*". The checksum is the 8-bit exclusive OR (No start or stop bits) of all characters in the message, including "," delimiters, between but not including the "$" and "*" delimiters. The hexadecimal value of the most significant and least significant 4-bits of the result are converted to two ASCII characters (0-9, A-F) for transmission. The most significant character is transmitted first.

8.7 OPEN MESSAGE INPUT

An open (unformatted by the datalink) message is input via the COMMAND port in the following formats. Open ascii messages are sent unmodified, open binary messages are converted to binary from ascii hex and then sent.

Binary format:

The input message is of the form.

$PRPS,OPNB,ddd< binary bytes as ascii hex chars data>*hh<cr><lf>

ddd = destination ID (000 if a broadcast message)
<data> = 1 to 482 bytes as 2 to 964 hex chars
each char must be '0' to '9' or 'A' to 'F' only
*hh = Checksum (See 8.6)

Ascii format:

The input message is of the form.

$PRPS,OPNA,ddd< ascii data>*hh<cr><lf>

ddd = destination ID (000 if a broadcast message)
<data> = 1 to 482 characters
each char must be in the range 20H to FFH with the exception that the following control characters can be used. STX (02H) is converted to CR (0DH) for transmission, ETX (03H) is converted to LF (0AH) for transmission. This is to allow CRLF to be added to strings sent over the air.
*hh = Checksum (See 8.6)

All messages should contain up to 32 + N * 18 bytes according to the super packet length and settings, see table at end of section. The input process should check that the string contains no more data characters than can be sent in one transmission. There must also be space in the OPEN message circular buffer to hold the transmit stream. Any incoming message failing these tests will be ignored and NAKed. A NAK message will also be sent out by the transmitting unit if there are no channel 3 timeslots set-up.

Short messages are padded for transmission and the padding is stripped at the receiver.

The message is acknowledged with the standard acknowledge message when the message is transmitted. Up to 12 messages may be stored in the internal buffer awaiting transmission before the waiting message will be overwritten. The sending device must track the ACK messages to determine the messages leaving the buffer.

The receiving unit does NOT acknowledge the message. The external application using this message is responsible for this level of protocol.

Open messaging max char lengths (data content only)

Slots	14400 packets	14400 data	12300 packets	12300 data	9600 packets	9600 data	4800 packets	4800 data
1	2	32	2	32	2	32	2	32
2	5	86	5	86	5	86	4	68
3	9	158	9	158	8	140	7	122
4	12	212	12	212	11	194	10	176
5	16	284	16	284	14	248	13	230
6	20	356	20	356	18	320	16	284
7	23	410	23	410	21	374	18	320
8	27	482	27	482	24	428	21	374

Open messaging max char lengths header + data + chksum + crlf

Slots	14400 packets	14400 data	12300 packets	12300 data	9600 packets	9600 data	4800 packets	4800 data
1	2	51	2	51	2	51	2	51
2	5	105	5	105	5	105	4	87
3	9	177	9	177	8	159	7	141
4	12	231	12	231	11	213	10	195
5	16	303	16	303	14	267	13	249
6	20	375	20	375	18	339	16	303
7	23	429	23	429	21	393	18	339
8	27	501	27	501	24	447	21	393

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9 APPENDIX

9.1 ADDITIONAL CABLING

These cables are application specific and are used during normal system operation once the units have been configured.

9.1.1 Base Reference Cable

This cable provides the necessary link for the RTCM messages generated by the GPS receiver to be broadcast by the Base Reference unit. In addition it gives access to the position report outputs from the command port and will allow set-up communication with the GPS receiver via the Aux port.