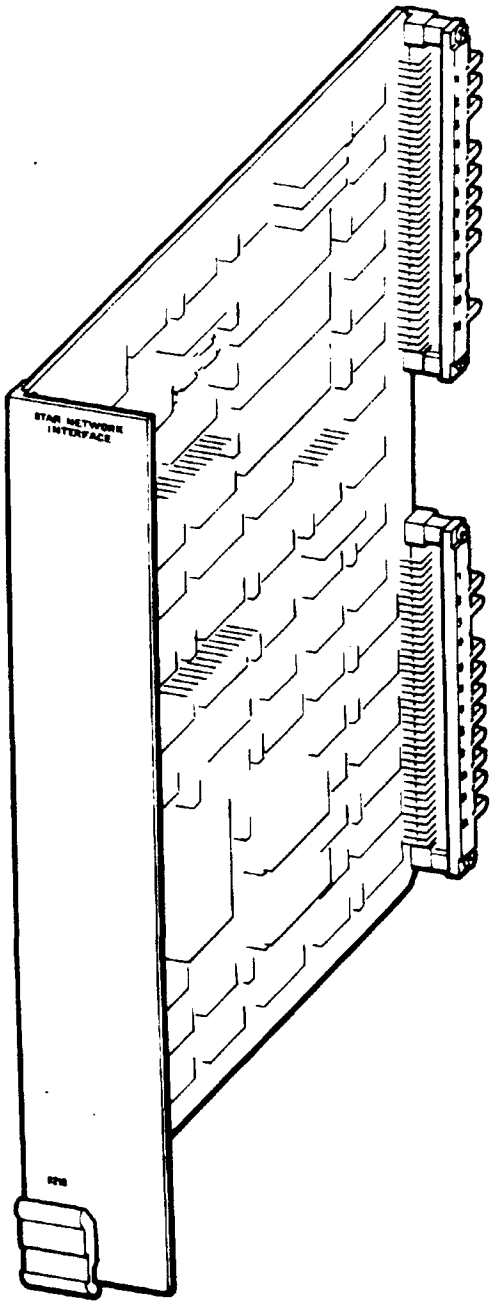
ALSTOM

STARNET 8218



GEM 80 USER INFORMATION

The changes and additions in this addendum should be read in conjunction with the GEM80 STARNET User Information document T464. The page, section and sub section in this document refer to document T464.

Front Title Page

With this addendum the document covers Double Width Modules type 8218 and also Single Width Modules type 8268

1. INTRODUCTION

Page 1

STARNET modules can be fitted to GEM80/400 controllers in addition to the 300 Series, 700 Series and GEM80/165 Controllers.

Single or double width modules provide four communications ports

The point of contact for equipment upgrades is GEM 80 Product Manager, Telephone ++44 (0) 1782 781000

2. SPECIFICATION

Page 3

In figure 1.1 the Starnet modules should be labelled 0 and 1 rather than 1 and 2 and the following key applies

C = ESP Control Port
P = HDLC Primary Port
S = HDLC Secondary Port
T = ESP Tributary Port

3. HARDWARE

Page 4

Changes

In section 3.1 the words 'up to' should appear after 'consists of'

In section 3.2 the paragraph header should be
3.2 Interface Modules

In Section 3.2 the existing paragraph title
3.2 Interface Module 8218-4003/4 should be
3.2.1 Interface Module 8218-4003/4

In section 3.3 the number 8218 should appear before STARNET

Additional Paragraphs

3.2.2 Interface Module 8218-4101

This enhanced Interface Module is used with GEM80/300,310 and 700 series controllers and has four front connected ports in a single width configuration.

3.2.3 Interface Module 8268-4001

This Interface Module is used with GEM80/165 controllers and has four ports The module occupies two slot positions and utilises a 9285-4002 Serial Communications Interface module for its external connections.

3.2.4 Interface Module 8268-4101

This enhanced Interface Module is used with GEM80/400 series controllers and has four front connected ports in a single width configuration.

4. Operation

Page 5

Table 4.2

Address Zm+Y+7n+1. The meaning should read

Number of partners on the link.
(See Note 4)
(1 to 31 for HDLC Primary)
(1 to 15 for ESP Control)
(1 for Secondary/ Tributary) (See note 1)

Page 6

Note 4 should read

These configuration parameters should be set to a value equal to the number of secondaries/ tributaries on the link, with one exception.

This exception is when the STARNET channel is an ESP Control port connected to (a) STARNET secondary channel(s) operating as (an) ESP Tributary port(s). In this case the value must be one greater than the number of secondaries on the link. This is because STARNET tributary addresses start at 1 whereas STARNET Control port addresses start at address 0.

In this exception case for table exchange mode the unused transfers for address 0 should be suppressed by setting the appropriate Ux bits 0-7 to zero so preventing time outs on the link.

Page 11

Section 4.2.4

First sentence should read 'A port on a particular module is addressed using a 16 bit hexadecimal number split into four fields as follows :- '

The sentence preceding Example 1 is deleted.

Page 13

Table 4.10

Meaning for Zm+1 add ' See section 4.3.3.6

Page 19

Section 4.3.3.13

First sentence should read ' A controller is addressed using a 16 bit hexadecimal number split into four fields as follows:-'

The sentence reading 'This is represented by a three field Hex number occupying one data table (16 bits)' is deleted

In example 2 last sentence 'number' should read 'address'

Page 22

Section 4.4.1 Figure 4.2

'GEM/300' should read 'GEM80'

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Section 4.4.5

The note applies to GEM80/400 Series Controllers in addition to those listed.

Page 25

Section 4.4.7

The second sentence of paragraph 1 should begin 'The user must write data to U-Table locations.....'

The last sentence of paragraph 2 should read ..... programming unit directly into the U-tables may be ....

A new paragraph is added after paragraph 4 as follows

The user programme must declare sufficient U-Tables to cater for all four ports of all used modules even though all the ports of all the modules may not be in use.

5. POWER SUPPLIES

No changes

6. INSTALLATION

No changes

7. CONNECTIONS

Page 34

Section 7.1 should be titled
7.1 External Connections to Modules

The existing section 7.1 should be re numbered 7.1.1 and titled
7.1.1 Connection via Backplane 8585 or 9252

A new section is added

7.1.2 Direct connections to modules

Where Interface modules are provided with connectors on the front panel of the module connections to the termination panels may be made directly to the module . The lower connector is for ports 0 and 1, the upper connector is for ports 2 and 3

8. ORDERING CODES

This section is completely changed as follows.

8.1 Main Equipment

Enhanced STARNET Module, single width, 4 ports, front connected.	8268-4101

The use of this module makes all the previous assemblies obsolete so that modules type 8218-4003 & 4004 and their associated backplanes and connectors are obsolete. Similarly STARNET module 8268-4001 and its associated Interface module 9285 are also obsolete.

No other configurations are available as complete assemblies. Only the STARNET modules are available as spares. See below.

8.2 Spares

STARNET module, double width, 4 port, for use with GEM80/300, 310 and 700 series controllers.	8218-4003
STARNET module, single slot, 2 port, for use with GEM80/300, 310 and 700 series controllers.	8218-4004
Enhanced STARNET Module, Single width, 4 port, for use with GEM80/300, 310 and 700 series controllers.	8218-4101
STARNET module double width, 4 port, for use with GEM80/165 series controllers.	8268-4001 *
Enhanced STARNET module single width, 4 port, for use with GEM80/400 series controllers.	8268-4101

* 8268-4101 may be used as a replacement for 8268-4001 by moving the ribbon cable connections from the 9285 Interface module to the connectors on the 8268-4101 front panel.

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LIST OF TABLES

1. INTRODUCTION

GEM80 STARNET modules provide the GEM80/300 and 700 Series Controllers and the GEM80/165 Controller with a fast and flexible communications facility for running a master/slave protocol.

Each STARNET module fits into the Central Highway of a GEM80/300 or 700 series Controller or GEM80/165 to provide either two or four independent serial communications ports. See Figure 1.1 for the hardware layout of a typical configuration.

Individual links can be point-to-point or multi-drop, but must include only one primary (or master) together with its associated secondaries (slaves). The primary device controls all activity on the link, allowing the secondaries to communicate only when given permission.

There are two types of STARNET modules currently available. A single width module providing two communication ports and a double width module providing four communication ports. If there is room on the Central Highway, a single GEM80 Controller may house a combination of single and double width modules up to a total of 5 STARNET modules. Refer to Section 8 for details of their respective ordering codes.

Each STARNET module is software configurable to provide a range of data rates up to 180k bits per second and a choice of two transmission protocols, High Level Data Link Control (HDLC) or Extended Simple Protocol (ESP).

HDLC is an international standard protocol which includes a number of options. STARNET uses what is called the 'normal response mode' (NRM) which allows a master port to communicate along a single link to one or more subsidiaries. In HDLC, the master port is called the PRIMARY and slave ports are called SECONDARIES. As a lower speed alternative to the synchronous link HDLC, STARNET offers an asynchronous link with the standard GEM80 protocol ESP. In ESP, the master port is called a CONTROL and slave ports are called TRIBUTARIES.

The STARNET system offers two methods of data transfer control. Data Table Exchange, where dedicated data tables are used as transmit and receive storage, and the Special Function option where data can be transmitted from and received into any pre-specified write enabled data table locations.

Each STARNET module contains a 35 Kbyte buffer for message buffering. The buffer is shared by all four ports on the module.

For minimum processing overheads and fastest response, moderate quantities of data can be transferred using the table exchange mode. Where fast communication is needed from one controller to many others, the broadcast modes allow a moderate quantity of data to be transmitted simultaneously in a single message. The broadcast options are particularly suitable for supervision of groups of GEMDRIVE-MICRO drives where close synchronisation of reference signals may be needed between many drives.

The choice of operation is up to the user and the options are discussed in the following sections.

Due to progressive development the early versions of STARNET do not contain all the software facilities.

It is expected that firmware changes only will be necessary to upgrade from the early versions. No hardware changes are expected. The EPROMS are labelled with the software issue letter.

STARNET Version 1 (software issue A, released December '86) implements Special Function mode with some restrictions for queue mode, and table exchange mode without broadcast.

STARNET Version 2.0 (software issue B, released December '86) implements enhancements to Special Function queue mode.

STARNET Version 2.2 (software issue D, released February '87) implements an address change at link level to make address values within messages consistent with the address values in the user interface. The effect is to introduce an address offset between software issues A/B/C/D onwards. This lack of direct compatibility is reflected in a change in module order number: 8218-4001 for A/B/C, 8218-4003 for D onwards.

The two module numbers should not be mixed on any installation

STARNET Version 3.0 (software issue E, released March '87) implements broadcast without response.

STARNET Version 3.1 (software issue F, released June '87) implements optional offset to base address used in N-, O- and U-tables for table exchange mode.

STARNET Version 4.0 (software issue H, released January '88) implements broadcast with response.

STARNET Version 5.0 (software issue J, released April '88) implements user control for ESP ports, and allows multiple ports at 180k bits/s in Special Function mode, provided each frame is individually acknowledged.

For any upgrades to your existing equipment, please consult the Customer Services Manager for prices.
Telephone: Stoke-on-Trent (0782) 785311.

2. SPECIFICATIONS

Data link protocols	:	Synchronous High Level Data Link Control (HDLC), ISO 3309, BS 5397.
	:	Asynchronous GEM80 Extended Simple Protocol (ESP)
HDLC option	:	Synchronous signalling.
	:	HDLC protocol.
	:	Normal response mode.
	:	Half duplex.
	:	Basic repertoire of commands and responses.
	:	Frame format 8-bit address field 8-bit control field
ESP option	:	Asynchronous signalling.
	:	ESP protocol.
	:	Frame format - 1 start bit 8 data bits 1 stop bit (No parity implied at protocol level)
	:	Optional user control mode allows ladder program in host GEM80 Controller to 'handshake' data to/from the serial link.
Mixing of options	:	HDLC and ESP can be mixed on the same module except that 180k HDLC cannot be mixed with 4800 and 9600 ESP. 180k and 48k cannot be mixed.
Data transfer	:	The interface to the network is configurable for each port. This provides for a special function interface with full functionality, or a table exchange transfer with limited maximum table sizes or a broadcast table exchange transfer.
Message Buffer	:	35 Kbyte buffer shared all 4 ports.
Number of ports	:	2 or 4 per STARNET module.
Space occupied by module	:	1 or 2 slots in GEM80 Controller subrack.
Status of serial ports	:	All ports are independent On any link, whether point-to-point or multi-drop, two types of port can be identified: primary and secondary. The primary organises all data flow over the link and there can be only one primary on the link. Secondaries are subservient to the primary and each port can be configured as primary or secondary.
Diagnostics	:	Power up diagnostics are performed and errors handled according to GEM80 standard.
Error recovery procedures	:	The serial link is monitored for bit errors and lost data frames. On error detection, automatic recovery is invoked. If an error is not recoverable, the user program is notified through status bits.
	:	Time-out for HDLC link is 0.25 seconds to 0.5 seconds.
	:	If failure occurs on HDLC multi-drop link after communication has been established, the primary immediately steps on to next route. The primary then re-tries the failed route after several cycles of the remaining routes (approximately 0.25 seconds after a first failure), and with progressively greater intervals after successive failures. After 16 successive failures, the fault is reported to the user, and re-tries are made about once every four seconds.
	:	A secondary reports loss of communication, and link re-connect after 30 seconds.
Link statistics	:	A log is kept of link statistics. CRC errors, number of re-tries, time-outs, acknowledgements etc. (See Section 4.2)
HDLC rates	:	48k, 180k bits/s
Encoding methods	:	NRZI is the method normally used on STARNET. FM0 and FM1 are additional methods to provide future flexibility. (These methods are fully described in Section 4.6.)
ESP rates	:	1,200, 2,400, 4,800, 9,600 bits/s. For the GEM80 standard 20mA current loop, there is a trade-off between bit rate, distance, number of tributaries and controller type. The Serial Links User Information gives further details, Publication No.T418.
Secondary devices	:	GEM80 Controllers, GEMDRIVE-MICRO and compatible computers.
	:	Tactile Keypads.

Number of secondaries per link : 15 if the link uses ESP.

This may be subject to reduction depending on the bit rates, distance and controller combination.

: 31 for HDLC.

Cable length. : RS485 2km total per link.

: 20mA length depends on number of tributaries and signal rates. See the GEM80 Serial Communications Manual, Publication No.T457.

Note... RS485 length applies to all encoding methods except FM0 and FM1 for which link distance drops to 900m.

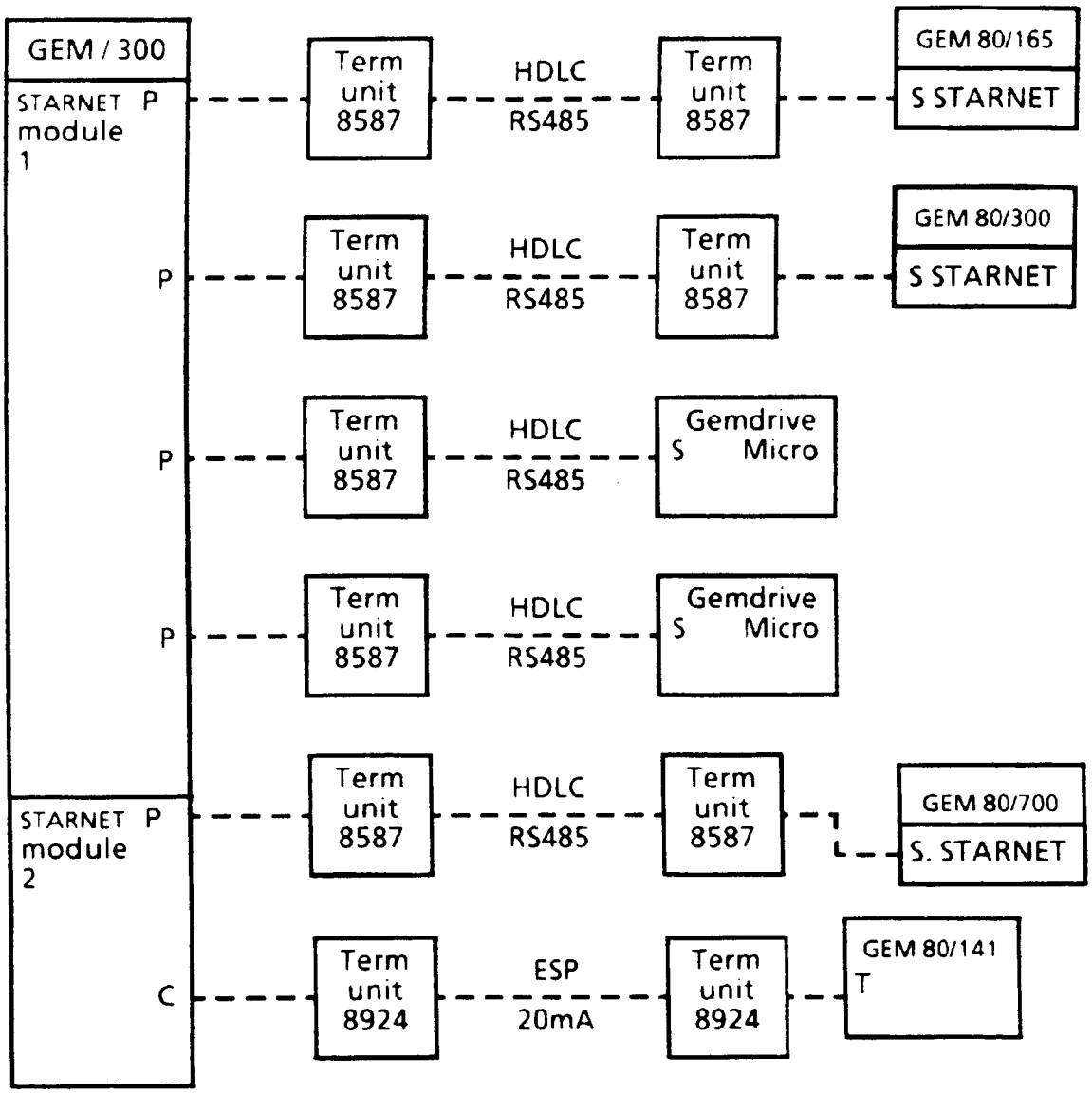


Figure 1.1 Typical STARNET Configuration

3. HARDWARE

3.1 Introduction

The STARNET hardware consists of three main parts, an interface module, a backplane and a termination panel or unit for each port used.

3.2 Interface module. 8218-4003/4

The interface module plugs into the central highway of the controller and contains all the necessary firmware for the ESP and HDLC protocols. Two types of module are offered, a double width module with four communication ports (8218-4003), and a single width module with two communication ports (8218-4004). Although occupying two slots in the Controller subrack, the double width module is in fact a single width board. Two slots are required to accommodate the two connectors on the backplane.

3.3. Backplanes.

The backplanes provide the external connections from the STARNET module.

3.3.1 Type 8585. (Double Width)

This backplane consists of two connectors, each connector carrying two communications ports plus their associated control lines.

3.3.2 Type 9252. (Single Width)

This backplane consists of one connector carrying two communication ports plus their associated control lines.

3.4. Termination Units

A termination unit is required for each of the fitted channels. All termination units are electrically isolated (greater than 1.5kV) from the controller and provide line driving flexibility. The user information sheets on serial links give further details on termination panels and units, including dimensions and fixing details. See Publication No.T456. Additional information is provided in the GEM80 Serial Communications Manual, Publication No.T457, with details of the connections and protocols used with GEM80 Serial Links and Local Area Networks.

Figure 1.1 illustrates the position and function of these units in the network.

4. OPERATION

The STARNET module is capable of providing an extremely versatile and flexible communication system. Within the rules described later, each of the channels can operate at different data rates, encoding modes and protocols. On the same module, 48k bits/s and 180k bits/s cannot be mixed. HDLC and ESP can be mixed but not 4,800 bits/s or 9,600 bits/s ESP with 180k bits/s HDLC.

Two main methods of data exchange are offered - Special Function Mode and Table Exchange Mode and within these methods the user can choose the speed and protocols best suited for the application.

There are four Special Functions specifically designed for use with STARNET. T33 CONFIG, T34 SEND, T35 RECEIVE and T36 STATS.

T33 CONFIG is used to initialise or configure the STARNET module irrespective of the mode of data exchange chosen.

T34 SEND and T35 RECEIVE are used only when the STARNET module has been configured by T33 CONFIG to exchange data in the Special Function mode.

T36 STATS may be used in either mode of data exchange to provide detailed statistics.

The following paragraphs describe in detail the way in which the Special Functions are set up and used.

4.1. T33 CONFIG - Configure STARNET

4.1.1. Description

The CONFIG Special Function provides the mechanism for configuring the STAR network. Re-configuration while running is supported, but care should be exercised as this causes a re-set and all data and pending messages are lost.

4.1.2. Specification

Control Language for CONFIG:-

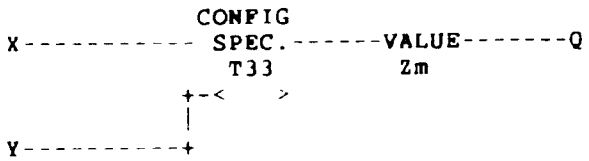


Table 4.1. CONFIG. Program Rung Data.

Sym	Location	Use	Range
X	Upper rung input	Module Number	0 to 4
Y	Lower rung input	Offset	0 to 9999
Zm	Value	Address for start of configuration data block. Effective address = Zm + Y (see Note)	Any table usable by Special Functions
Q	Rung output	Fault (non zero)	See Table 4.4.

Note... Each port requires a block of seven (7) words for configuration data. Each STARNET module therefore requires a total of 28 words to configure all four ports.(or 14 if 8218-4004). The first block of seven is for port 0, the next for port 1 etc., see Table 4.2.

Table 4.2. Configuration Data

Address	Meaning
n = Port number (range 0 - 3). Zm + Y + 7n	Defines primary/secondary (HDLC) or control/tributary.(ESP) Defines link address if secondary/tributary/ 0 = Primary or Control 1 to 31 = Secondary address 1 to 14 = Tributary address Trib address 0 is not available for STARNET but is available on other products.
Zm + Y + 7n + 1	Number of partners on the link (1 to 31 for primary) (1 to 15 for control) (1 for secondary/tributary) (see Note 1)
Zm + Y + 7n + 2	Channel Type (see Table 4.3.)
Zm + Y + 7n + 3	Transmit mode >= 0 : queue mode <0 : overwrite mode (see Note 2)
Zm + Y + 7n + 4	Receive mode >= 0 : queue mode <0 : overwrite mode (See Note 2)
Zm + Y + 7n + 5	Interface mode = +3 : Special Function mode 180k bits/s HDLC with individual frame acknowledge. Can be used for multiple ports. = +2 : Broadcast with response. (HDLC only) = +1 : Broadcast without response. (HDLC only) = 0 : Special Function mode. HDLC up to 777 word messages or ESP up to 111 word messages. One port only at 180k bits/s. = -1 : Table exchange free run mode (HDLC or ESP). = -2 : Table exchange user control mode, (ESP only). For control port, selects doubled timeout. (see Note 3 and application notes for configuration mixes).
Zm + Y + 7n + 6	Number of partners to be updated per inter-scan period if configured as table exchange. (0 ....to maximum configured)

'Primary' and 'Secondary' refer to HDLC links. 'Control' and 'Tributary' refer to ESP links.

Notes...

1. : If the link address is non-zero, i.e. a secondary, the number of partners is automatically set to 1.

2 : In the queue mode all data accepted for transmission is presented at the other end of the link. In the queue mode for received data, messages tend to form a queue. In the overwrite mode for transmission and reception, only the most recent data is available.

3. : Broadcast without response is implemented ONLY in STARNET firmware Issue E onwards. Broadcast with response is implemented ONLY in STARNET firmware Issue H onwards. In STARNET firmware Issue A and B, the Zm + Y + 7n + 5 Interface mode is interpreted as >= 0 for Special Function mode, and <0 for table exchange mode.

4. : A STARNET port cannot be a tributary 0 because the CONFIG. table used to set the address is also used to define the port as a Master if the value is zero. Because a STARNET tributary CANNOT be address 0 and a STARNET Master can only specify the number of partners NOT their addresses, the P-table and the CONFIG. table specifying the number of blocks and partners must be one more than the actual number required. For example,this means that Port 1 as Master communicating with 5 (five) STARNET tributaries, MUST have P61 set to 6 (six) and the value in the CONFIG table for Port 1 number of partners also set to 6 (six).

Table 4.3. Channel Types

Value	Meaning
0	Channel not in use
1	HDLC 48k bits/s NRZI coding
2	HDLC 48k bits/s FM0 coding
3	HDLC 48k bits/s FM1 coding
4	HDLC 180k bits/s NRZI coding
5	HDLC 180k bits/s FM0 coding
6	HDLC 180k bits/s FM1 coding
7	ESP 1.2k bits/s
8	ESP 2.4k bits/s
9	ESP 4.8k bits/s
10	ESP 9.6k bits/s
11	Reserved for special types

For standard STARNET module 8218-4003/4, type 11 is HDLC 48k bits/s NRZI with link level address increased by 1. As an alternative, type 11 is available to suit special user requirements.

See Section 4.5 (Protocol) for details of HDLC and ESP conventions.

When using ESP, Tributary address 0 cannot be used. Note 4 in Section 4.1.2 details this restriction.

Table 4.4. Fault Codes

Condition	Rung Output Bits 'ON'
Error. (any of bits 1-15 ON) (see Note)	0
Invalid link address	1
Invalid port type	2
Invalid number of partners (only set if port is a primary)	3
Invalid configuration mix	4
Invalid interface mode	0 and 5
Not used	6,7,8
STARNET module failed/not present	9
Not used	10
Invalid effective address	11
Not used	12
Invalid module number	13
Internal error	14
Not used	15

Note... If the 'Invalid Configuration Mix', or 'Invalid Interface Mode' errors are reported, the relevant ports will not run as configured. The other ports operate with their new configuration.

If any other error is reported, all the ports remain in the same state that they were in before the CONFIG was executed.

4.1.3 Application Data.

4.1.3.1 Restrictions

The limitations described apply SEPARATELY to each STARNET module on a GEM80 controller. There are no limitations if different modules are used.

a. HDLC and ESP can be mixed on the same STARNET module but there are signalling rate limitations.

b. Special Function, table exchange and broadcast mode can be mixed on the same module.

c. For STARNET versions 1 to 4 (software Issue A to H), if one port is used at 180k bits/s in Special Function mode 0, the other ports on that module can be used ONLY for 1,200 or 2,400 bits/s ESP. STARNET version 5.0 (software Issue J) onwards allows any mix of Special Function mode 3 and 1,200/2,400 bits/s ESP, plus a maximum of one port at 180k bits/s with Interface mode 0. (Special Function mode).

d. Different signalling rates can be selected for the 4 ports on a STARNET module, but the following combinations are not allowed:-

e. 180k bits/s and 48k bits/s CANNOT be mixed on the same module. In table exchange and broadcast modes all four ports can be 48k bits/s in any mix of modes.

f. 180k bits/s CANNOT be mixed with 9,600 or 4,800 bits/s on the same module.

g. To use broadcast mode, HDLC must be selected. ESP cannot be used.

4.1.3.2 Partners per scan

The Zm + Y + 7n + 6 field allows the user to specify how many secondaries are up-dated every scan. With a long scan it may be desirable to try and transfer data for as many secondaries as is possible instead of only one per scan. It also allows outputs for a secondary to be performed a scan ahead of the inputs, thus reducing the response time to/from a particular secondary.

If this value is 0, one secondary is updated per interscan for both output (from O-table) and input (from N-table). If this value is 1, one secondary is updated per interscan for output and the previous secondary (up-dated for output the previous interscan) is up-dated for input.

If this value is >1, the number of secondaries is up-dated for output and input, the output for a particular secondary being one scan ahead of the input.

This field is significant when a port is configured as a primary multi-drop. For point-to-point or secondaries, setting this location to a non-zero value does not affect the operation of the STARNET module.

4.1.3.3 Results of configuration

On power up, a GEM80 STARNET system is not configured and none of the ports will operate.

If the CONFIG Special Function is successfully executed, the STARNET ports commence operation. A primary port starts sending messages to the quantity of secondaries as defined in the Zm + Y + 7n + 1 field (number of partners on the link). A secondary waits for valid messages. An error condition is indicated if none are received after a time-out period of 30 seconds and the secondary continues to wait for messages.

If the CONFIG Special Function is executed with invalid configuration data, the CONFIG Special Function returns an error code which can be used to diagnose the fault. Under these conditions, the STARNET module remains in the same state as before the execution of the CONFIG Special Function. It continues operating if previously configured with valid data.

4.2. T36 STATS. - Report STARNET Statistics and Errors

4.2.1 Description

GEM80 STARNET includes automatic error detection and recovery from data corruption. The STARNET system maintains a count of all error-free messages and a count of errors in various categories.

The STATS Special Function extracts the performance statistics which have been accumulated for a particular port, and places the results in a group of data table locations.

If a GEM80 Controller uses several STARNET ports, the STATS Special Function can be executed to extract the statistics for all the ports.

4.2.2 Specification

Control language for STATS:-

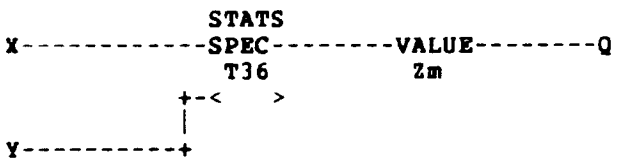


Table 4.5. STATS Program Rung Data

Sym	Location	Use	Range
X	Upper rung input	Module, port and link number, re-set if bit 7 set. (See Note 1)	see 4.2.4
Y	Lower rung input	Offset	0 to 9,999
Zm	Value	Address for start of data block. Effective address = Zm + Y (See Note 2)	Any write enabled table usable by Special Functions
Q	Rung output	Fault (non-zero)	See Table 4.7.

Notes...

1. If bit 7 is set in the module/port number the cumulative statistics are re-set to zero after the function call. Statistics are read on an ESP control port only.

2. The statistics for the addressed module are placed in 12 table locations starting at Zm + Y.

4.2.3 Statistics

The start address of the block of table locations which will contain the link statistics is Zm + Y. The 'offset' in Table 4.6 represents the location number relative to that start address.

Care is needed in using a GEM80 programming unit to read the values of any statistic which exceed 32,767 because STATS uses an unsigned notation. The standard representation assumes a range 0 to 32,767 and -32,768 to -1 for hex values 0000 to FFFF. The statistics use 0000 to FFFF to mean 0 to 65,535 decimal in each location. 'Double length' numbers use two adjacent table locations to contain a single value. The contents of the upper location should be multiplied by 65,536 and added to the lower location to obtain the correct total.

Table 4.6 shows the statistic fields.

Note... The fields have different meanings dependent on whether the link is configured for HDLC or ESP.

Table 4.6. Errors and Statistics

HDLC Operation Statistics

Offset	Meaning	Comment
0 1	Number of frames acknowledged (double length)	This is the total number of FRAMES which have been transmitted by the STARNET module and acknowledged by the addressed partner.
2 3	Number of message acknowledgements (double length)	Total number of MESSAGES which have been transmitted by the STARNET module and acknowledged by the addressed partner.
4	No. of CRC failures	Total number of CRC failures encountered in frames received from the addressed partner.
5	No. of receives aborted	Total number of receives aborted by the STARNET module during communication with the addressed partner. The receive is interpreted as aborted when the length of the data field of the incoming data is incorrect.
6	No. of sequence failures	Total number of frames received out of sequence from the addressed partner. These frames are discarded.
7	No. of time-outs (primary only)	Total number of time-outs which have occurred on the STARNET module during communication with the addressed partner.
8	No. of Rx queue full conditions	Total number of times the STARNET module has been unable to accept a message from the addressed partner because the receiver queue was full.
9	No. of resource failures	Total number of resource failures which have occurred on the STARNET module during communications with the addressed partner. A resource failure occurs when all message buffers have been used.
10	No. of data re-transmissions	Total number of times a frame has been re-transmitted.
11	No. of times link re-connected	Total number of times the link with the addressed partner has been re-connected by receipt or transmission of an SNRM (Set Normal Response Mode) frame.

Table 4.6 Errors and Statistics (Cont.)

ESP Operation Statistics

Offset	Meaning
0	Number of control port attempts
1	(double length)
2	Number of control port requests
3	(double length)
4	No. of CRC failures
5	No. of hardware errors
6	No. of data errors
7	No. of time-outs
8	No. of Rx queue full conditions
9	No. of terminator errors
10	No. of NAK replies
11	No. of times connections lost

Statistics are provided for tributary ports, the number of requests, attempts and NAK replies always being 0.

Table 4.7. Fault Codes

Condition	Rung Output Bits 'ON'
Error (any of bits 1-15 ON)	0
not used	1-6
no space on STARNET module	7
not used	8
STARNET module failed/not present	9
port not configured	10
invalid effective address	11
not used	12
invalid module/port number	13
internal error	14
not used	15

4.2.3.1 Application Notes

1. Meaning of individual statistics

The importance of serial link statistics is in assessing the reliability of a link. The statistics indicate totals for successful transfers and totals for failures under various categories.

Failures due to a random effect are not relevant. However, a new STARNET implementation may give rise to errors because of the implementation itself. The pattern of failures could, under those circumstances, be a pointer to the cause of the fault.

2. Causes of link failures.

Failures may arise because of hard faults such as power being switched off arbitrarily, severed cables or electronic component failure. Transient errors may occur because of noise pick-up or marginal operating conditions.

3. Implications of failures

The user can expect a low level of failures during normal operation.

If a failure occurs, there is a time overhead in detecting and recovering, so there may be extra data transmission delays occurring. If response times are important to an application, it is necessary to ensure that error rates are very low.

Although the error detection algorithms give an extremely high statistical chance of detecting any corruption, there is a remote possibility of a valid message being corrupted by a pattern of errors into an equally valid but erroneous message. If errors are allowed to occur continuously, say many times a second, the statistical chance of an undetected error could rise to an unacceptable level. For this reason, equipment should not be allowed to run with very high levels of errors occurring.

4. Recommendations

a. Commissioning

If moderate levels of failures are detected during commissioning, it could be a warning of improper installation. For example, inadequate cable segregation, improper earthing of cable screens or excessive cable lengths. The statistics should be checked when the installation is complete or when significant modifications have been made.

b. Normal Operation

If moderate levels of failures are detected after a period of acceptable operation, it may be a warning of incipient failure. For example, a degraded opto-isolator might give a prior warning of complete failure by requiring a level of re-tries. The user should inspect the link statistics at intervals and flag up a warning if the level is above a threshold of, say 1 in 1,000.

4.2.4. Module/port address

A port on a particular module is addressed through a number of the following form:-

x y R a

Where x = 4 bits (one hex digit) for the STARNET module number (0 to 4)

y = 4 bits (one hex digit) for the port number within the selected module (0 to 3).

R = 1 bit for the reset flag. ON to re-set statistics AFTER this interrogation of statistics.

a = 7 bits for the link address. (0 to 31 decimal).

This is represented by a three field Hex number occupying one data table. (16 bits).

Example 1. The Hex number @0102 would be represented in the data table as the binary number 0000 0001 0000 0010. This would be interpreted as:

STARNET module 0, port number 1 and link address 2.

Example 2. The Hex number @3281 would be represented in the data table as the binary number 0011 0010 1000 0001. This would be interpreted as:

STARNET module 3, port number 2, and link address 1.

Bit 7 in both examples is the reset flag.

In example 1, there is no reset of the cumulative statistics.

In example 2 the statistics are re-set after the Special Function.

4.3. Special Function Mode

The Special Functions T33 CONFIG, T34 SEND and T35 RECEIVE provide the user with comprehensive control of the communications between controllers. Along with Special Function T36, STATS, they allow the user to:

a. specify the block of data table locations to be used for configuration data.

b. specify the block of table locations for transmission which can be varied in size under program control.

c. specify which address the data is to be sent to or received from.

d. read status information which indicates when data has been received and the quantity received.

In this mode of operation the user controls the message transfer by the SEND and RECEIVE Special Functions in the GEM80 ladder diagram program. Up to 777 data table locations can be transferred in each direction using the HDLC protocol, reducing to 111 data table locations for ESP.

STARNET can transmit data either in direct mode or in multi-component mode. Direct mode means that the data table locations containing the message to be transmitted are consecutive. Multi-component mode allows the user to transmit disjointed data table locations but restricts the length of the message to 776 locations.

The following paragraphs describe in detail the operation of the Special Functions used in transmitting and receiving data.

4.3.1. T34 SEND Transmit Outgoing Data
T35 RECEIVE Receive Incoming Data

The SEND Special Function effects the transmission of user defined data tables from one GEM80 Controller or GEMDRIVE micro to another on a STARNET link.

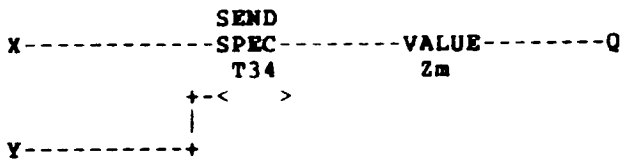
The RECEIVE Special Function accepts data sent from another controller.

The two Special Functions allow the user to:

1. initiate transmission/acceptance of data.
2. pre-program the maximum length permitted for receive data.
3. automatically identify messages
4. collect data into one message from several locations within one controller.
5. distribute data in one message to several locations within the controller.
6. report all data (queue mode), or report only the most recent data (overwrite mode)

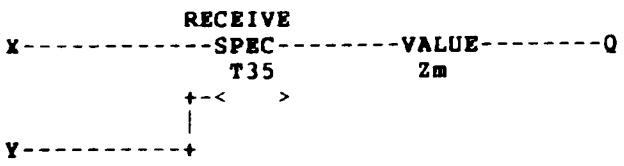
4.3.2 Specification.

Control language for SEND:-



See Table 4.8.

Control language for RECEIVE:-



See Table 4.9.

The functions may be operated in two different modes - Direct or Multi-Component. The selection is made in the controller address parameter X.

In Direct mode, parameter Y points at the data to be sent or the location where received data is to be stored; the length is specified in the VALUE list.

In Multi-Component mode, parameter Y points to a list of blocks which specify the table locations to be used to construct or decode messages (see Application Data 4.3.3.13)

Table 4.8 SEND Program rung data

Sym	Location	Use	Range
X	Upper rung input	Destination link address (See Application Data 4.3.3.13)	According to config.
Y	Lower rung input	Data to be sent (See Application Data 4.3.3.1)	Address of data table. (given by LOCATE Special Function)
Zm	Value	Start of parameter list (2 locations) See Table 4.10	Any write enabled table usable by Special Functions
Q	Rung output	Status/Fault indication	0 for no error. See Table 4.12.

Table 4.9 RECEIVE Program rung data

Sym	Location	Use	Range
X	Upper rung input	Source link address (See Application Data 4.3.3.13)	According to CONFIG.
Y	Lower rung input	Destination for Received Data (See Application Data 4.3.3.1)	Address of data table. (given by LOCATE Special Function)
Zm	Value	Start of parameter list (3 locations) See Table 4.11.	Any write enabled table usable by Special Functions
Q	Rung output	Status/Fault indication	0 for no error. See Table 4.12

Table 4.10. SEND parameter list

Location	Meaning	Range
Zm	Message length in direct mode or the maximum total length of all the separate components in the block list in multi-component mode	0 to 777 direct 0 to 776 multi-component
Zm + 1	Message identification code (ignored in Direct mode)	0 to 9,999

Table 4.11. RECEIVE parameter list

Location	Meaning	Range
Zm	Length of received message	0 to 777
Zm + 1	Maximum acceptable length for received message	0 to 777
Zm + 2	Identification code of message received by this call (-1 if no message received or in Direct mode)	-1 to 9,999

Table 4.12 Status/Fault codes

Condition	Rung Output bits 'ON'
Fatal error (see Note 1) (any of bits 5-15 ON)	0
Destination/source not ready (temporary exhaustion of resources on the addressed Controller)	1
Link re-connected after failure (see Application Data)	2
Not used	3
Previous SEND unacknowledged/no data received	4
Link failed	0, 5
Message pending transmission (SEND only)	0, 6
Not ready for send/receive (See Note 2)	0, 7
Port not configured	0, 8
STARNET module failed/not present	0, 9
RECEIVE length exceeds limit specified in Zm + 1, or in multi-component mode, an invalid identification code. OR RECEIVE in multi-component mode message length exceeds length specified by block list. (See Note 3)	0, 10
Invalid address from LOCATE or in block list or block list extends into non-accessible region	0, 11
Direct mode: length of message >777	0,12
Multi-Component mode: Invalid number of components in the block list, or length specified for a component is <0, or RECEIVE length >777, or SEND length >maximum specified in Zm.	
Invalid destination/source address 'x'	0, 13
Internal error	0, 14
Not used	15

Notes to Table 4.12...

1. : Bits 1 - 4 are non-fatal errors. For SEND, data is held pending transmission. For RECEIVE, data may have been transferred depending on the status of bit 4. If any of bits 5 to 15 are set for SEND or RECEIVE, data has not been transferred to or from the STARNET module.

2. : Bit 7 is used to report total buffer full. This may occur in the multi-drop case with large messages to a large number of secondaries. Section 4.3.3.2 and Section 4.5 give more detail.

3. : In Multi-Component mode data is not transferred under this condition but the received length and message identification fields are updated.

A more detailed error report of link statistics, protocol exceptions etc. may be obtained by using Special Function T36, STATS. See Section 4.2.

4.3.3. Application Data

4.3.3.1. Address of data

The address of data table locations must be obtained by using the LOCATE Special Function. (See Software Data Sheets for details) The address points either directly to the data area for transmission or reception or to the start of a list of blocks to be used in Multi-Component mode.

4.3.3.2. Queue/Overwrite modes

SEND Special Function

According to the configuration of the links, data may be either queued or overwritten on the STARNET module from the SEND Special Function. In the queue mode, all data passed by the SEND Special Function is transmitted. In the overwrite mode the current message overwrites any current whole messages pending transmission on the STARNET module. If SEND Special Functions are allowed to free-run in the queue mode, without any conditional blocks to provide message exchange, only one message may be buffered, an error bit being returned on subsequent SENDS, bit 6.

RECEIVE Special Function

In the queue mode, all data received is held by the STARNET module pending acceptance by a RECEIVE Special Function. In overwrite mode only the most recent whole message is passed to a RECEIVE Special Function, any other messages are lost by being overwritten. More detail is contained in Section 4.5.

4.3.3.3. Secondary-to-secondary communication

Direct secondary-to-secondary communication is not possible. The primary controller for that link has to provide an intermediate transfer in the user program.

4.3.3.4. Message Lengths

Messages are separated into packets of 111 words. The maximum total message length allowed is 777 words in direct mode or 776 in multi-component mode. In multi-component mode, one word is used for the identification code, limiting the maximum size to 776 words and the capacity of the first packet to 110 words.

Each unit implies an extra overhead affecting execution time of the Special Functions, so care must be taken to ensure that long messages do not adversely affect the user program. For an ESP channel the maximum length is 111 words.

4.3.3.5. Message Exchange

Message exchange between controllers on the link may be provided by using a pair of corresponding SEND and RECEIVE Special Functions in each controller user program, the SEND Special Functions being in conditional blocks. Either the primary or the secondary can initiate the exchange. The primary could initiate the exchange by executing the SEND Special Function. The secondary receives the data using the RECEIVE Special Function. On receipt of the data the secondary can form the reply and send it by enabling the SEND Special Function. The primary would accept the reply and another message exchange may be initiated.

Messages can be exchanged between a primary and more than one secondary simultaneously.

4.3.3.6. Multi-Component Messages

Both SEND and RECEIVE Special Functions may be directed to a 'Block-List' of data table addresses and lengths. The SEND Special Function constructs messages by linking together the blocks of data tables specified in a section of the list. The section to be used is determined by the message identification code supplied by the user. The identification code is added as a prefix to the message before transmission. This message identification code may then be used by the RECEIVE Special Function to distribute the message data to the data tables specified in the Block-List of the receiving controller.

Note... The received message does not need to be broken down into the same blocks as those from which it was constructed.

Structure of each section of the Block-List:

Word	0	=	n - number of components in this message
Word	1	=	address of component 1
Word	2	=	length of component 1
Word	3	=	address of component 2
Word	4	=	length of component 2
Word	2n-1	=	address of component n
Word	2n	=	length of component n

If message identification codes up to 3 were to be used, there would be four such blocks at consecutive locations starting at the data table identified by parameter Y of the Special Functions. The end of the Block-List is indicated by a word containing the value -1.

If the user chooses to SEND in multi-component mode, and RECEIVE the same data in direct mode, it should be noted that the first word of received data will contain the identification code of the message.
Below is a typical Block-List for message identification codes 0-2 located at G100:

G100	=	2 (2 components in message 0)
G101	=	address of G200
G102	=	20 (access G200 - G219)
G103	=	address of G300
G104	=	30 (access G300 - G329)
G105	=	3 (3 components in message 1)
G106	=	address of G150
G107	=	10 (access G150 - G159)
G108	=	address of P500
G109	=	10 (access P500 - P509)
G110	=	address of H100
G111	=	10 (access H100 - H109)
G112	=	1 (1 component in message 2)
G113	=	address of G200
G114	=	50 (access G200 - G249)
G115	=	-1 end of list

Note... Message 1 contains a reference to a P-table location and can therefore only be used by SEND.

4.3.3.7. Program example

Message exchange using Direct Mode.

Figure 4.1 shows a ladder diagram program with two controllers exchanging messages. A hand-shaking mechanism is used so that a new message is sent only when a reply has been received.

When G99.4 is set OFF, the primary sends a block of data of length G11, starting at G100, from its STARNET module 0, via port 1, to the controller at link address 1. The link needs to be configured prior to any data being sent/received, so G99.4 should be set to 1 prior to configuration and set to zero after configuration is complete.

Thereafter G99.4 is set to zero only when a reply has been received. The length of data received is G21, the data starting in G200. Data is not transferred if it has a length of more than 100 words.

The secondary utilises a similar mechanism, and replies from its STARNET module 0, port 3, to the controller at link address 0. (Primary) Each end of the link is in the overwrite mode.

A simple form of error handling is included. If the link fails, G99.5 is set ON by the RECEIVE function at the primary. The primary repeatedly attempts to send a message until the link is established. Thereafter, the hand-shaking mechanism takes over.

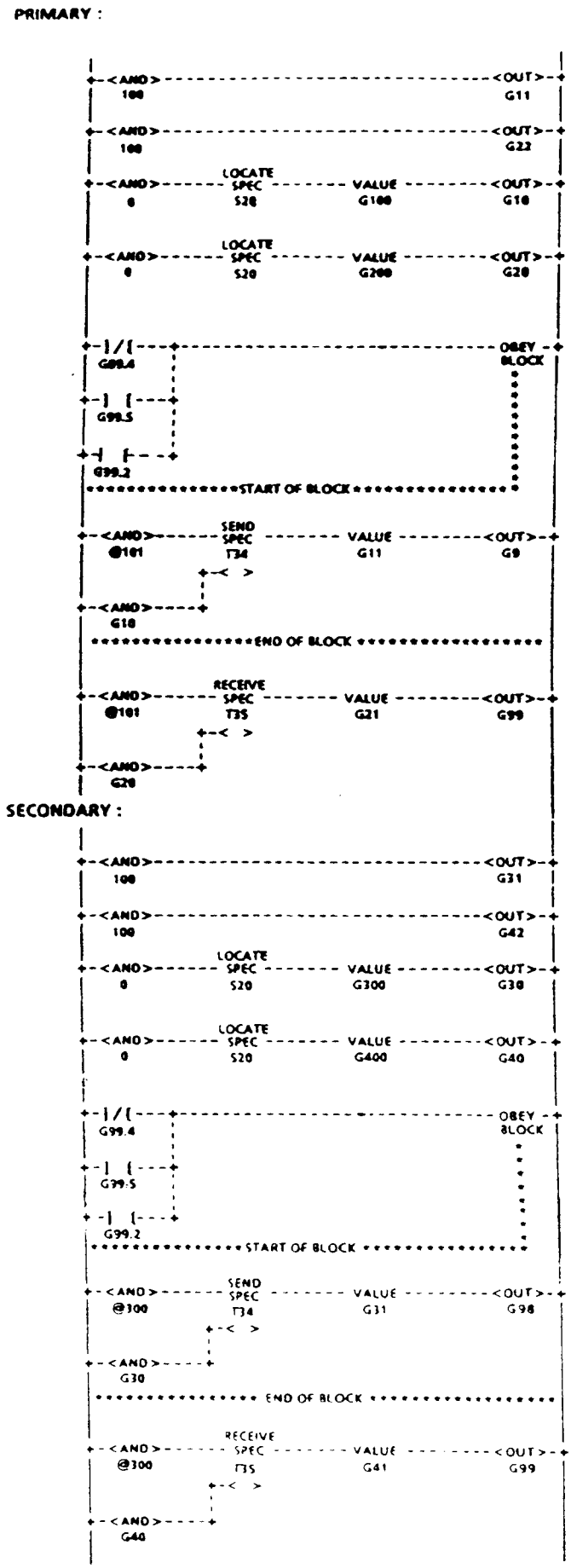


Figure 4.1 Message Exchange

4.3.3.8. ESP Option

The operation for the ESP configuration option is the same as the HDLC operation except that the maximum length for the ESP message is 111 words. The link re-connection bit (bit 2) and the not ready bit (bit 1) in the output from the Special Functions are never set. The previous SEND un-acknowledged bit in the output from SEND (bit 4) is always set.

4.3.3.9. Message Pending Bit

This bit prevents excessive queuing of messages by the SEND Special Function if the link is in the process of failing or if the destination is not accepting the data fast enough.

This bit is only reported from a SEND Special Function call. It is set if a complete message is pending transmission and the data is not accepted for transmission.

4.3.3.10. Link Failed Bit

If this bit is set, the logical connection is not present to the destination/source. This bit is set after a SEND/RECEIVE call after CONFIG called but before link established. Once the link has become established the bit is cleared on return from SEND/RECEIVE calls and transient faults requiring a few re-tries are not treated as link failure.

For a primary link, the bit is set if 16 successive unsuccessful re-tries are attempted (4+ seconds). For a secondary link, the bit is set if there is no activity on the link for 30+ seconds.

The bit is cleared if SEND/RECEIVE is executed after the link is re-established.

At the point of link failure, as defined for primary or secondary above, any data pending transmission is discarded.

The link failed bit (bit 5) is reported from the RECEIVE Special Function after all pending messages have been accepted.

4.3.3.11. Link Re-connection

The link re-connected bit (bit 2) is used to report link re-connection, i.e. the link failed for a period when no SEND/RECEIVE Special Function was called. This allows detection of possible loss of data due to link re-connection.

Link re-connection may be due to the following reasons:-

a) The primary exceeds its retry limit and re-sets the link to that secondary.
b) The primary receives a re-connection request from a secondary.
c) A secondary receives a re-connection request from the primary.

If the re-connection bit(bit 2) is set and the previous data not acknowledged bit(bit 4) is also set in the output from a SEND Special Function call, the unacknowledged data may not have been accepted by the destination.

4.3.3.12. Programming for Error Conditions

To ensure error-free data transmission and to detect any loss of communication, the ladder program should include rungs to check the fault codes in the rung output of the SEND and RECEIVE Special Functions.

Some of the possible fault codes tend to arise during commissioning, when there may be errors in the user programs of the various controllers on the STAR network. If a simple rung is included to detect bit 0, which is set ON for all the error conditions, the more unusual error conditions may be diagnosed by using a GEM80 Programming Unit in rung monitor mode.

It is recommended that the ladder program should include rungs to detect specifically the failure of the link (bit 5 of rung output), and the non-acceptance of data by the STARNET module (bit 6 of rung output).

When link failure is detected (bit 5 ON), appropriate action should be initiated to reflect the loss of communication to that particular address.

When bit 6 (message pending) is ON, there is an indication that the data which the user was attempting to send has not been accepted for transmission. If it is important that the particular data should get through to the destination, the user must arrange the ladder program to retain the data and try again later. If the link is merely sending updates to the SAME data, it may not matter that a particular message does not get through. The user should note that there are processing overheads in trying to send data which cannot be accepted, and it is good programming practice to ensure that such failures do not occur to an excessive level.

The STARNET system copes automatically with occasional failures without any loss of data, and automatically re-connects a link after a hard failure. If a link failure is of short duration, perhaps power switched off for a moment, or a cable briefly disconnected, it is possible for a hard link failure to exist during a period in which the user does not execute a SEND or RECEIVE Special Function. For example; a STARNET module may lose power momentarily with a loss of data which has already been accepted for transmission. If the loss of power is of short duration, the SEND and RECEIVE Special Functions execute without error. If it is important to guarantee no loss of data, the user program should include checks on bit 2 (link re-connected), and re-SEND the last two messages if bit 2 ever goes ON.

4.3.3.13. Source/destination address

A Controller is addressed through a number of the following form:-

x y M a

Where x = 4 bits (1 hex digit) for the STARNET module number (0 to 4)

y = 4 bits (1 hex digit) for the port number within the selected module (0 to 3)

M = 1 bit to select multi-component or direct mode. (bit 7)

a = 7 bits for the link address. (0 to 31 decimal)

This is represented by a three field Hex number occupying one data table. (16 bits).

In the following examples, bit 7 determines whether the transfer is in the direct mode or the multi-component mode. Bit 7 OFF (reset) for direct mode, ON (set) for multi-component mode:-

Example 1. The Hex. number @210A would be represented in the data tables as the binary number 0010 0001 0000 1010. This would be interpreted as :

STARNET module 2, port number 1, link address 10 in the direct mode.

Example 2. The Hex. number @0290 would be represented in the data tables as the binary number 0000 0010 1001 0000. This would be interpreted as :

STARNET module 0, port number 2, link number 16 in the multi-component mode.

4.3.4. Timing Details

The following timing details for STARNET assume error-free communications and are in units of microseconds. If errors do occur, times could be significantly longer.

4.3.4.1. CONFIG Special Function

Execution time in the ladder

CONFIG Special Function, in normal operation, is run only once in an initialisation routine and its time varies with the number of ports used. All times in microseconds.

1 port	13,000 +/- 300
2 ports	14,200 +/- 300
3 ports	15,400 +/- 300
4 ports	16,600 +/- 300

4.3.4.2. STATS Special Function

Execution time in the ladder - 2,900 +/- 300 microseconds

4.3.4.3. SEND/RECEIVE Special Function

The time from a SEND Special Function being executed in one controller to data being present in another controller after the execution of a RECEIVE Special Function is as follows, all times in microseconds:-

SEND EXECUTION

Time taken in ladder

a)	Direct mode	(1,300 ±300) + (1,600 x no. of frames) + (7 x no. of words)
b)	Multi-component mode	(1,500 ±300) + (1,600 x no. of frames) + (7 x no. of words) + (75 x no. of cmpts) + (25 x id code no.)

These times correspond to the execution times of the Special Function, although there will be some variation in times depending on activity. The times quoted above are slightly greater than the average.

LATENCY AT TRANSMIT END: 6,000 average per secondary on link

This delay is a function of the time it takes the primary to poll around the secondary and where it happens to be in the poll cycle. On average it will be halfway round the poll, taking 12 milliseconds per secondary. The poll time may be extended if activity at the partner delays the response.

PROCESSING AT TRANSMIT END: 1,300

TRANSMISSION TIME:

a) 48k bits/s	333x(5 + no. of words) + 2,000x(no. of packets-1)
b) 180k bits/s	89x(5 + no. of words) + 2,000x(no. of packets-1)

LATENCY AT RECEIVE END: 5,000 typical

The delay is a function of the level of activity at the receive end and the channel number being used. If another channel with a higher channel number is processing some transmit or receive data, or if any Function is being executed, there is a wait until completion. The quoted time allows for a reasonable amount of activity.

PROCESSING AT RECEIVE END: 1,300

WAIT FOR LADDER SCAN: Average half a scan. Worst case, one scan. Best case, zero.

RECEIVE EXECUTION

Time taken in ladder

a)	Direct mode	(1,600 ±300) + (1,100 x no. of frames) + (7 x no. of words)
b)	Multi-component mode	(1,900 ±300) + (1,100 x no. of frames) + (7 x no. of words) + (75 x no. of cmpts) + (25 x id code no.)
c)	No message received	1,900 ±300

TIME TO TRANSMIT 20 ITEMS OF INFORMATION

All times in milliseconds (ms).
Transmitting GEM80 (GEM 1) has 100ms scan time
Receiving GEM80 (GEM 2) has 30ms scan time

Time from input changing to data being available in GEM 1, 2 scans	200.000
Assume the SEND instruction is 10ms into the ladder prog.	010.000
Execution of SEND = (1.6 + 1.6) + (0.007 x 20)	003.340
Latency within STARNET (max)	012.000
Processing at Transmit end	001.300
Transmission time = (20 + 5) x (16/48k)	008.333
Latency at Receive end	05.000
Processing time at Receive end	001.300
Max time for data to be present in ladder is one scan	030.000
RECEIVE execution = (1.9 + 1.1) + (0.007 x 20)	003.140
Total time to update GEM 2	274.413
Average time	203.000

4.4. Table Exchange Mode

The essential difference between this mode of operation and the Special Function mode is that in Table Exchange, the data to be transmitted or received is contained in dedicated data tables (N and O), while in Special Function mode the data can be in any table usable by Special Functions. The maximum quantity of data to be transferred is defined in the P-table and can be up to 111 table locations. Within this mode of operation, three sub-modes are available.

4.4.1. Multi-drop Table Exchange

This mode of working allows fast but simple communication to up to 31 secondaries. Secondaries are polled in a cyclic manner and therefore do not receive data at precisely the same moment. It is possible however that they may all be up-dated within one scan.

4.4.2. Broadcast Without Response

This mode of operation is only available with STARNET Firmware Issue E onwards.

Table exchange mode is used with the primary transmitting up to 111 table locations to all secondaries. Replies are not expected from the secondaries and because of this,the data transfer is the fastest in operation. The lack of feedback means that no re-tries are made in the event of corrupted messages, neither does the primary detect a secondary going off-line. Although error detection is not available at the primary, corrupt data is not accepted at the secondary. To overcome this lack of monitoring it is recommended that an a dditional channel is used to provide feedback. Figure 4.2 shows how this additional channel may be connected.

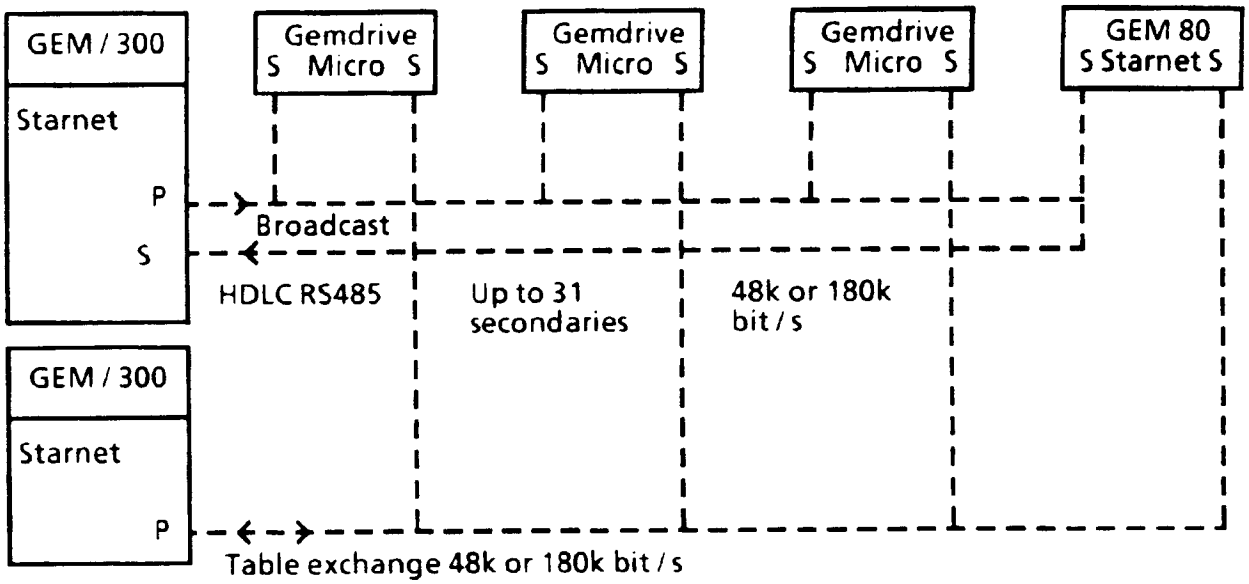


Figure 4.2 Broadcast Without Response.

4.4.3. Broadcast With Response

This mode is similar to broadcast without response except that the STARNET module designates one secondary per broadcast to respond with information.

The out-going broadcast message contains the address of the secondary to respond. The selection of the respondent may be defined by data in a U-table (see 4.4.7) or may be in automatic cyclic form. Figure 4.3 shows a STARNET module connected to 4 secondaries.

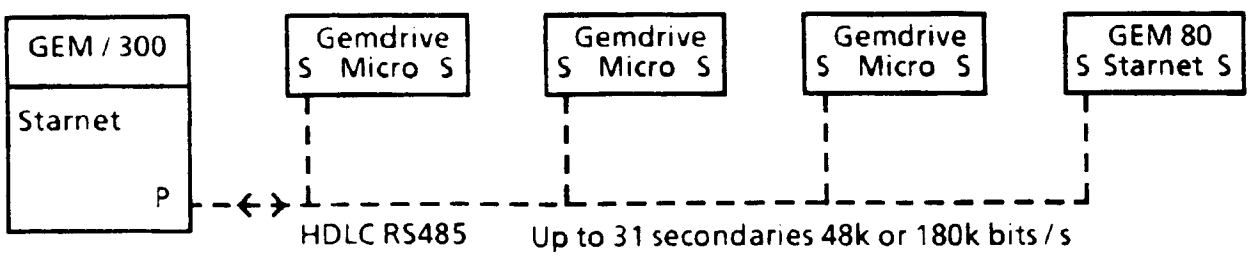


Figure 4.3 Broadcast With Response

4.4.4. N-Table Locations

Data is received INTO these tables.

4.4.5. O-Table Locations

Data is sent FROM these tables.

Note... In the GEM80/300 and 700 series controllers and GEM80/165 controller, the N-, O- and U-tables are not automatically created and must have the highest location required specified in the user program. That is, all table locations for a module must be created even if some ports are not being used.

4.4.6. P-table Allocation

The CONFIG Special Function defines the mode in which each port will operate. If defined for Special Function mode, none of the N-, O- and U-table locations for that port are used. If defined as table exchange, with or without broadcast option, some of the locations are used but not necessarily all. It is essential that the P-table configuration data sets up enough blocks of sufficient size, but it is immaterial if a particular port does not use all the allocated locations.

Two P-table words per module are used for configuration. The configuration data defines the layout of N-, O- and U-table locations, and allocates blocks of locations for each port. The configuration data does not create the data tables itself, but determines which locations are available to each port.

The configuration data starts at P60, see Table 4.13. The data which repeats for each STARNET module is designated Px and Px + 1.

The 1st word, Px, defines the quantity of N- and O-tables (block size) to be used for each partner on that port. It must be set to the largest quantity of locations which is to be used for input or output from any of the ports on that module. The available range is 1 to 111.

The 2nd word, Px + 1, defines the maximum number of secondaries to which any port on that module is to multi-drop. The available range is 1 to 31. One block of any N-, O- and U-table locations is allocated for each route on a multi-drop link. If any port on the module acts as the primary on a multi-drop link, multiple blocks of table locations are allocated for ALL the ports.

Px (N- and O-table size)

Bits 15 to 8	Not used
Bits 7 to 0	No.of words allocated for N- and O-tables.

Px + 1 (Secondary allocation)

Bits 15 to 8	Not used
Bits 7 to 0	Maximum No. of secondaries for U-table allocation.

A set of P-table locations is used to define an offset for the base address to be used by STARNET for each of the N-, O- and U-tables. This offset is COMMON to all STARNET modules in the controller, and is available only in STARNET software Issue F onwards.

The base address offset defines the lowest location to be used by STARNET. The available range is zero or a positive number up to a maximum determined by the table size in the host GEM80 Controller. If the application allows these data tables to be reserved for STARNET, an offset of zero is recommended. The offset for N-, O- and U-table locations is set up in P70, P71 and P72 respectively.

Section 4.4.6.1 gives three examples of systems with differing requirements.

Table 4.13 Assignment of the P-tables

STARNET module No.	0	1	2	3	4
P-table location.	P60 & P61	P62 & P63	P64 & P65	P66 & P67	P68 & P69

4.4.6.1 Examples of Table Allocation.

Example 1.

System with one module fitted, exchanging 100 words of data with one partner.

P-table	Value	Meaning
P60	100	100 locations per N/O block for module 0.
P61	@1	Table space allocated for one partner for each port of module 0
P70	0	Zero offset for N-table
P71	0	Zero offset for O-table
P72	0	Zero offset for U-table

Table Allocation

Module 0 Port 0	Module 0 Port 1	Module 0 Port 2	Module 0 Port 3
N0-99	N100-199	N200-299	N300-399
O0-99	O100-199	O200-299	O300-399
U0-3	U4-7	U8-11	U12-15

Example 2.

System with one module fitted, exchanging 100 words of data with one partner, and using offset of 500 for base addresses in N- and O-tables.

P-table	Value	Meaning
P60	100	Locations per N/O block for module 0.
P61	@1	Table space allocated for one partner for each port of module 0
P70	500	500 offset for N-table
P71	500	500 offset for O-table
P72	0	Zero offset for U-table

Table Allocation

Module 0 Port 0	Module 0 Port 1	Module 0 Port 2	Module 0 Port 3
N500-599	N600-699	N700-799	N800-899
O500-599	O600-699	O700-799	O800-899
U0-3	U4-7	U8-11	U12-15

Example 3.

System with two modules fitted. The first exchanging 100 words of data with one partner, the second exchanging 20 words with each of two partners.

P-table	Value	Meaning
P60	100	100 locations per N/O block for module 0.
P61	@1	Table space allocated for 1 partner for each port of module 0.
P62	20	20 locations per N/O block for module 1.
P63	@2	Table space allocated for two partners for each port of module 1.
P70	0	Zero offset for N-table
P71	0	Zero offset for O-table
P72	0	Zero offset for U-table

Table Allocation

Module 0 Port 0	Module 0 Port 1	Module 0 Port 2	Module 0 Port 3
N0-99	N100-199	N200-299	N300-399
O0-99	O100-199	O200-299	O300-399
U0-3	U4-7	U8-11	U12-15
Module 1 Port 0	**Module 1 Port 1**	**Module 1 Port 2**	**Module 1 Port 3**
N400-419	N440-459	N480-499	N520-539
N420-439	N460-479	N500-519	N540-559
O400-419	O440-459	O480-499	O520-539
O420-439	O460-479	O500-519	O540-559
U16-19	U24-27	U32-35	U40-43
U20-23	U28-31	U36-39	U44-47

4.4.7. U-tables

The U-table provides a means for the user to control and monitor the STARNET links. Normally the user writes data to U-table locations using the ladder program. During test and commissioning it may be desirable to enter test patterns. The user should take particular note that a programming unit should NOT be used to write directly to the U-table.

Between scans of the GEM80 ladder program. GEM80 STARNET reads a block of U-table locations, operates on the block of data, then reads it back to the U-table. Data entered by the programming unit may be overwritten by the data written back from the STARNET module.

If necessary, dummy rungs should be entered to copy general work space locations (G-table for example) to the U-table locations, and write test data into those locations using the programming unit.

There are 4 words for each partner on each port, designated Ux, Ux + 1, Ux + 2 and Ux + 3, with each word having the following structure:-

Ux (HDLC Option)

Bit 15. Poll bit. If the poll bit is set, but there is no data to be sent, a zero length message is sent by the STARNET module to extract the most recent data from partner, this being performed during a user scan.

Bit 14. Synch. bit. If the synch. bit is set, transmission on that port is synchronised with other ports which have their synch. bits set. To synchronise transmissions accross STARNET modules, pin PLUC4 of each synchronised module must be connected together. This means that data transmission is delayed until all the appropriate ports are ready, then all start simultaneously. This minimises the time differences in receiving data sent via different ports.

Bit 13. Interlock. If the interlock bit is set, the data is transmitted as soon as possible after the end of the controller scan. This prevents the secondaries being polled between data transmissions. Once the interlock bit is set, the interlock condition can only be cleared by re-configuring the STARNET module.

Bits 12 to 8. Not used.

Bits 7 to 0. Set by the user program to determine the number of words to be transmitted. This can be any number, from zero to the maximum N/O-table location size already allocated.

Ux (ESP Option)

At an ESP control port, zero length in Ux bits 0 to 7 suppresses all link activity to that particular address. If the application requires an ESP control port to 'poll' a particular tributary for data, the control port must send a minimum of one word of data.

At an ESP tributary port, zero data length in Ux bits 0 to 7 causes the tributary to reply to incoming messages with an 'ACK' message.

Ux + 1

Bits 15 to 8. This Byte is used in broadcast with response ONLY. The bits are set by the STARNET module to indicate the address of the secondary from which the data in the N-table has been obtained, and for which the diagnostic information in Ux + 3 applies.

Bits 7 to 0. The receive data length is set by the STARNET module to the number of words of data received from a partner and is in the range zero to the maximum N/O-table location size already allocated.

Ux + 2 (HDLC Option)

Bits 15 to 8. Not Used.

Bits 7 to 0. For broadcast with response ONLY, the user program defines which secondary is to reply to the next message by entering the address of the required secondary. A value of zero specifies an automatic 'round robin' whereby the primary performs a repetitive cycle, addressing each secondary one at a time in ascending address order, from one to the total specified in the 'number of partners' field of the CONFIG. Special Function. (T33)

Ux + 2 (ESP Option)

For ESP ports configured for table exchange user-control mode:

Bit 0 This bit is set ON by user program to initiate message transmission and is set OFF by the STARNET module to acknowledge data copied from the O-table ready for transmission.

Bit 8 This bit is set ON by the STARNET module to indicate message received, and received data available in N-table.

A port configured for user-control mode transmits only if Ux + 2 bit 8 is OFF and Ux + 2 bit 0 is ON.

Ux + 3

Bits 15 to 8. These bits are used as a status check on a partner. The status bits are only relevant when STARNET has exchanged data with that partner the previous interscan period, this is indicated by two bits (Bits 8 and 9). The transmit update and receive update for a partner are staggered by one scan. The U-table statistics are updated in both cases. If the link is point-to-point, the partner is up-dated for input and output once per interscan period.

Bit 9 is set the scan after that partner was selected for the transmission of O-tables. Bit 9 does not necessarily indicate that a message was sent. If the channel is configured as ESP User Control, the O-tables are transmitted only if 'request to send' (Ux + 2, bit 0) was set and 'message received' (Ux + 2, bit 8) was cleared.

An attempt to transmit a message may fail when the transmit channel is in the queue mode. The attempt fails when there is already a message in the queue, pending transmission. This failure to transmit the data is indicated by bit 12.

Bit 8 is set the first scan after that partner was selected for the update of N-tables. If a message for that partner was not on the receive queue, the N-tables will not have been updated. Bit 10 indicates when a message was received.

Bit 15 Invalid length. Length outside range 0 to 111, or less than 'BLOCK SIZE' declared in P-table, or N- or O-table too small for message.

Bit 14 Retry limit exceeded (data lost). Applies only to an HDLC primary port in Broadcast with Response mode. It is recommended that this bit be used as an interlock in the ladder program to take appropriate action if the link fails or is not established

Note... The interlock facility does not apply in the Broadcast Without Response mode because bit 14 is always On.

Bit 13 Not configured or configuration data in error or broadcast message received when not configured for broadcast mode.

Bit 12 Previous data not transmitted (data not loaded from O-table)

Bit 11 Previous data not acknowledged. Bit not defined for ESP operation.

Bit 10 Data loaded into N-table

Bit 9 Set if this is the current partner for output

Bit 8 Set if this is the current partner for input

Bits 7 to 0 Not used.

The status bits are only relevant when the STARNET module has attempted to exchange data with that partner the previous inter-scan period. This is indicated by bits 8 and 9.

For further link statistics, the Special Function STATS may be used.

4.4.8. Timing

4.4.8.1. Ladder Scan Overhead

This is the processing time required between scans of the user's ladder program. If more than one STARNET is used, the one with the largest overhead determines the overall ladder overhead. This is due to all the STARNET modules being up-dated in parallel.

A rough estimate of times is 4ms per channel, up to a total of 12ms for all four channels.

The following gives precise details:-

LET

a = No. of blocks present in Px + 1.

b = No. of secondaries to be updated per interscan (see T33 CONFIG).

c = No. of channels on a module configured as a primary multi-drop.

d = No. of channels configured as secondaries or point-to-point primaries.

e = Total No. of data tables transferred in and out per interscan period.

f = No. of blocks of data to be transferred to N-table per interscan period. This is (bc + d), but less any routes which receive zero length data.

g = No. of blocks of input data which are overwritten (i.e a 2nd lot of data received before 1st lot is put into N-tables).

h = Quantity of blocks of data to be transferred from O-tables per interscan period. This is (bc + d) but less any routes which send zero length data.

i = No. of blocks of output data from O-tables which have to overwrite untransmitted data.

j = Grand total of No. of N- and O-tables to be transferred per interscan period..

Interscan overhead for ONE STARNET module in microseconds is:

$$1{,}720 + 125a + c(18 + 874b + 33a) + 274d +$$

$$480f + 150g + 546h + 220i + 4j.$$

Each additional STARNET module increases the total interscan overhead by 500 microseconds.

4.4.8.2. Throughput Times for Table Exchange

The ladder overhead should be calculated and added to the overall ladder scan time before the following calculations are performed.

Table exchange mode is interlocked with the ladder scan so that all data exchanges occur between program scans. Thus at the end of each ladder scan, data is transmitted. The delay incurred by the presence of the STARNET link may be considered as the time from the end of the scan in one controller to the beginning of the scan in the other controller.

An option is available in table exchange mode to synchronise the transmission on several STARNET modules, see Section 4.4.7. This option minimises the time spread of messages to different destinations but, due to the overheads incurred, increases the overall delays.

Total throughput delays for table exchange mode, from end of ladder scan at transmit end to start of ladder scan at receive end, is the sum of the following times in microseconds:-

a. Get Ready Time

This depends on whether the options of synchronisation and interlocking are selected and the priority of the port.

Sync.	Interlock	Get ready time (microseconds)
No	No	1,000 + 1,300 x m.
No	Yes	1,200 + 1,500 x m.
Yes	No	1,900 + 2,200 x m.
Yes	Yes	2,100 + 2,400 x m.

Where m. = the priority of the port (0 to 3).

b. Latency at Transmit End

This varies from zero to a maximum value, dependent upon the number of secondaries on a multi-drop link. Multiply quoted delay by the number of secondaries on the serial link.

Rate	Latency time (microseconds)		
	Min.	Typ.	Max.
48k	0	4,600	9,200
180k	0	2,900	5,800

Processing at transmit end = 1,300 microseconds.

c. Transmission Time

This is a function of signalling rate and quantity of data. In addition to the user data, 'bit stuffing' is performed to allow for flag characters and this extends the transmission time, see Paragraph 4.5.1.1. Allowing for 'bit stuffing' at half the worst case :

Rate	Transmission time (microseconds)
48k	367 x (5 + No of words)
180k	98 x (5 + No of words)

Processing at receive end = 900 microseconds.

Wait for ladder scan = Zero to one scan of ladder. Typically half a scan.

4.5 Message Buffers

4.5.1 Buffer Size

The STARNET module contains a 35 Kbyte buffer which is used for message buffering. The buffer is shared for incoming and outgoing messages, and is shared by all 4 ports on the module.

For many applications, the size of the buffer is such that only a small proportion is ever used, and there is no risk of the buffer becoming full. If a complex application uses several ports, includes primary ports multi-dropping to many secondaries and uses long messages, there is a possibility of the buffer becoming full. The information which follows explains how the buffer is used, in order that users of complex applications can design their system to avoid over-filling the buffer and include detection logic to recover from a transient buffer full condition.

4.5.2 Buffer Usage

Part of the buffer is pre-allocated according to the configuration of the module. The remainder is allocated and de-allocated dynamically as messages are transmitted and received.

100 bytes are pre-allocated from the available 35 Kbytes for each route from each port, as defined by the CONFIG Special Function. A port configured as a secondary uses 100 bytes; a port configured as a primary multi-dropping to 'n' secondaries uses n times 100 bytes.

The remaining part of the buffer is used in 256 byte blocks to store incoming and outgoing messages, with each block containing a maximum of 111 words of data to or from the data tables of the GEM80 Controller. An integral number of blocks is used for any message. There is a completely free trade-off between ports and between incoming and outgoing messages.

On transmissiion, the buffer is allocated when the data is copied from the data tables of the host GEM80 Controller. In Special Function mode this occurs on execution of SEND; in table exchange mode it occurs in an inter-scan period. The buffer is de-allocated when the other end of the link acknowledges receipt by means of the sequence variables automatically included in the STARNET messages. The acknowledgement does not require intervention by the ladder program at the other end of the STARNET link, and should be very shortly after message transmission, provided the buffer at the other end is not full.

When a message has commenced transmission, the buffer space is retained in case an error is detected and re-transmission is required. A second message can be initiated and buffered while the first is being sent, but only one complete pending message is allowed.

On reception, the buffer is allocated when the data is received from the serial link, and is de-allocated when it has been copied into the data tables of the host controller. In the Special Function mode, the data is copied into the data tables on execution of RECEIVE. In the table exchange mode it occurs in an inter-scan period.

On reception there is a fixed queue limit for each route of 10 blocks of 256 bytes. If the other end of the link keeps sending data, and the queue reaches the limit, flow control over the link slows the data flow from the far end.

If a route has failed because, for example, the controller at the other end of the link is powered off, STARNET returns an error code and does not buffer the message.

If the host GEM80 Controller is halted, STARNET keeps working. In the table exchange mode, the controller at the remote end of the link may be unaware that the controller is halted. In the Special Function queue mode, the received messages are queued and eventually flow control stops messages from the other end of the link. On the halt to run transition, all the queued messages are discarded if the CONFIG Special Function is executed (which is normally the case).

4.5.3 Example of Buffer Usage

If a STARNET module has 4 primary ports each multi-dropping to 8 secondaries, the message buffer space is (35k - 3,200) bytes, or 127 blocks of 256 bytes. If all messages are 111 words or less there is capacity for a total of 127 messages; very nearly 2 outgoing and 2 incoming messages for each route. In this example, the buffer can become full if the worst case queue is allowed to build up for all routes. There is ample space for one message in each direction simultaneously on all routes.

4.5.4 Behaviour when Buffer Full

If a SEND Special Function in executed which would over-fill the buffer, the whole message is discarded, and bit 7 is set in the SEND Special Function fault code. The serial link statistics for that route are up-dated with a resource failure. If it is an application requirement that loss of data does not occur, it is important that the ladder program should include rungs to detect transmission failure, so that the same data can be re-presented for transmission.

If a RECEIVE Special Function is executed when the buffer is full, any valid data already received is copied into the data tables, relinquishing some buffer space. If the other end of the link tries to send to a full buffer, the message is not acknowledged and the RECEIVE Special Function indicates no data available.

4.5.5 Queue and Overwrite Mode

In the queue mode, the execution of SEND buffers a message ready for transmission. If a complete message is already pending, the SEND Special Function returns an error code; the previously stored message is left intact but the new message is discarded.

In the overwrite mode, any message pending transmission is overwritten by any new request, so an error code does not arise, and the latest data is ready for transmission.

The buffer space for transmission for queue and overwrite modes are the same; the data content of consecutive messages may be different.

In queue mode for receive, messages tend to form a queue. In overwrite mode, only one message is stored, regardless of how many messages are received. Thus, overwrite mode on receive tends to minimise the buffer requirements.

4.5.6 Application Considerations

The user is recommended to calculate the maximum quantity of data which could ever be buffered on a STARNET module. This is 2 outgoing messages per route, plus 10 blocks per route for RECEIVE in queue mode, or 1 incoming message per route for RECEIVE in overwrite mode. If this total is less than the buffer available, special precautions are not needed to guard against buffer full conditions. If this total does exceed the available buffer space, there is a possibility of buffer full errors occurring.

To minimise buffer usage on receive, it is necessary for the user to consider the timing of message transmission from the other end of the link. If the application can be sure that RECEIVE is executed at a faster rate than SEND at the other end of the link, there is no risk of a queue building up, but there is a risk of buffer full occuring if it happens simultaneously on several routes.

A particular pitfall to avoid is a situation where a central station, with multi-drop primary ports and a slow program scan, has messages initiated simultaneously from many outstations, or consecutive messages are initiated from an outstation with a faster program scan. The user should arrange either that each outstation cannot transmit messages faster than the central station can deal with them, or arrange that it is not possible for many outstations to be transmitting messages simultaneously.

To minimise buffer usage on transmission, it is necessary to consider how the timing of message initiation should be organised. If a very large number of messages are to be sent to many secondaries, it is wise to spread the initiation over a period, so that buffer space is being progressively relinquished while new messages are being initiated.

4.6. Protocol

In the context of communications, a protocol is an agreed convention governing data exchange between two units. Two protocols are used in STARNET, High Level Data Link Control (HDLC) and Extended Simple Protocol (ESP).

4.6.1. HDLC

HDLC is a bit-orientated synchronous protocol, i.e. the receiver clock is synchronised by the incoming signal. One RS422 to RS485 Termination Unit, Type 8587, is used per channel and may be connected to 31 other similar units, see Section 7 for connection details. STARNET uses the normal response mode (NRM) which allows a master port to communicate along a single link to many slave ports.

The 8587 Termination Unit is intended for communication between STARNET modules and other RS485 compatible interfaces. Although RS485 is a balanced 2-wire communication standard, provision is made on the 8587 for 4-wire communications to GEM80 Controllers and GEMDRIVE MICRO.

Three methods of data encoding are offered within the STARNET module, NRZI as standard, with FM0 and FM1 as alternatives. Figure 4.4 illustrates the three methods.

1. Non-return to Zero Inverse (NRZI)
This is the normal form of data encoding used in STARNET. A logic '0' is said to have been transmitted when a change in logic level occurs at the bit cell boundaries.

2. Bi-phase Space - FM0
A transition in logic level always occurs at the start of every bit cell.
A logic '0' is said to have been transmitted if a further transition occurs within a bit cell.
A logic '1' is said to have to been transmitted if no further transition occurs within a bit cell.

3. Bi-phase Mark - FM1
The reverse of FM0. A transition in logic level always occurs at the start of every bit cell.
A logic '0' is said to have been transmitted if no further transition occurs within a bit cell.
A logic '1' is said to have been transmitted if a further transition occurs within a bit cell.

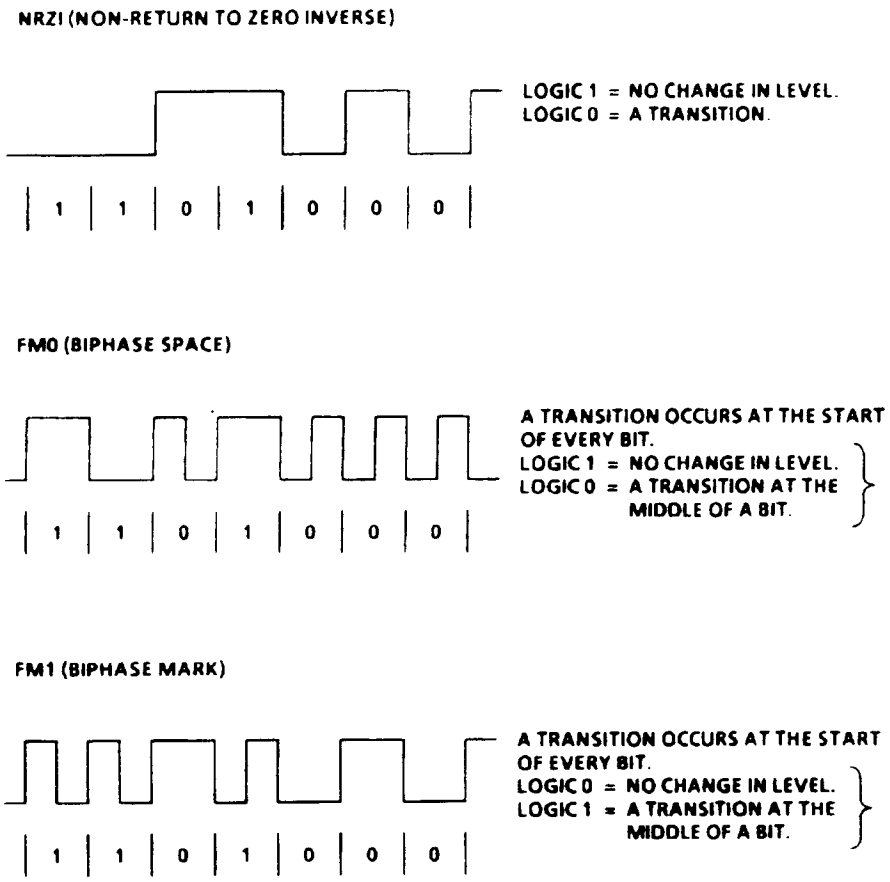


Figure 4.4 Data encoding methods.

Note... When transmitting at high speeds with fast edges, a large number of frequencies are present and in order to maintain signal integrity, the transmission medium must be treated as a transmission line. To avoid reflections on the line, termination resistors are used. The value of these resistors matches the nominal impedance of the transmission line. Typically for an RS485 cable they would be 100 to 180 ohms. Due to their low value, they provide a considerable amount of attenuation and care must be used when setting up the link.

4.6.1.1. Message Frame

The HDLC message is sent within a frame de-limited by unique codes called flags.

Figure 4.5 illustrates the full HDLC frame format. To ensure flag integrity, i.e. to prevent confusion between flag and data, the transmitter inserts a '0'(called 'bit stuffing') whenever five contiguous '1's appear outside the flags. This '0' is then removed by the receiver.

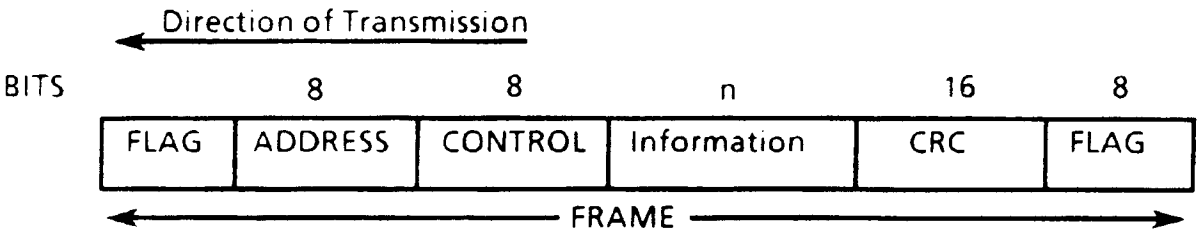


Figure 4.5 HDLC Message Frame Format

4.6.1.2. Polling

The primary or control station must give permission for secondaries or tributaries to transmit. This is done by the primary polling the secondaries in a cyclic order, allowing each secondary in turn to transmit any messages. Where the secondary does not have a message to transmit, an acknowledge signal must be returned.

When the primary wishes to transmit data to a specified secondary, the polling sequence continues and the message is transmitted when the specified secondary has its turn. The secondary then responds with an acknowledgement indicating correct receipt of the message.

4.6.2. Extended Simple Protocol (ESP)

ESP is the standard GEM80 protocol, commonly used with current loop signalling. The protocol uses asynchronous communication with 1 start bit, 8 data bits and 1 stop bit. All communication is between a control station and one or more tributaries. All transmissions are initiated by the control station and a tributary may not transmit except by invitation of the control station.

The protocol provides high confidence that data transmission errors are detected at the receiving end and that detected errors are corrected by automatic re-transmission.

5. POWER SUPPLIES

The STARNET module plugs directly into the GEM80 Central Highway and draws power from the GEM80 Controller Power Module. External power supply connections are not necessary. Each module draws 2.4A at +5V from the GEM80 Controller Power Module.

When calculating the power requirements of the STAR network, provision must be made for the Termination Units used.

For Termination Unit 8587, allow 170mA at +5V; 120mA at +15V.

For Termination Unit 8924, allow 220mA at +5V and 10mA at +15V. For each current source, 20mA at ±15V.

6. INSTALLATION

Special procedures are not necessary when installing the STARNET module which plugs into the Central Highway and its own backplane. Care must be taken to ensure that the top and bottom edges of the module are aligned correctly in the subrack guide rails before pushing the module home. To prevent the possibility of making a mistake and putting a module into the wrong slot, coding strips are provided both on the module and on the mating backplane which allows only the correct orientation. Excessive force should never be used. If you have difficulty in fitting the module, start again. Check the alignment, check the coding strips and try again.

7. CONNECTIONS

7.1. Backplane 8585 or 9252

Two plugs, (one on the single width backplane 9252), are provided on the backplane to connect to the relevant termination panels.

Data is transmitted across these plugs using the RS422 standard. Ribbon cables up to 3 metres long can be fitted to connect whichever termination units are being used.

Two plugs are used for the four ports:

PL1 for ports 0 and 1 (8585 and 9252)
PL2 for ports 2 and 3 (8585 only)

Table 7.1 shows the connections for the 8585 (non-modem option). A future option will allow working with a modem but it will require extra hand-shaking signals. These signals are brought out on PL1 and the pin-out is shown in Table 7.2.

Table 7.1 Backplane Connections. (Non-modem option)

PL1	Pin No.	PL2 (8585 only)
DIR0B	1	DIR2B
DIR0A	2	DIR2A
TXD0B	3	TXD2B
TXD0A	4	TXD2A
not used	5	not used
not used	6	not used
RXD0B	7	RXD2B
RXD0A	8	RXD2A
not used	9	not used
INTERLOCK	10	INTERLOCK
0V	11	0V
0V	12	0V
DIR1B	13	DIR3B
DIR1A	14	DIR3A
TXD1B	15	TXD3B
TXD1A	16	TXD3A
not used	17	not used
not used	18	not used
RXD1B	19	RXD3B
RXD1A	20	RXD3A
not used	21	not used
5V	22	5V
-15V	23	-15V
+15V	24	+15V
+5V	25	+5V
0V	26	0V

Table 7.2 Backplane Connections (Modem Option).

Signal	Pin No.	Signal	Pin No.
RTXCB	1	Interlock	18
RTXCA	2	0V	19
TRXCB	3	0V	20
TRXCA	4	DIR1B	21
DIR0B	5	DIR1A	22
DIR0A	6	TXD1B	23
RTSB	7	TXD1A	24
RTSA	8	DSRB	25
CDB	9	DSRA	26
CDA	10	RXD1B	27
TXD0B	11	RXD1A	28
TXD0A	12	+15V	29
CTSB	13	+5V	30
CTSA	14	-15V	31
RXD0B	15	+15V	32
RXD0A	16	+5V	33
not used	17	0V	34

7.2.1. Termination Unit 8587 (RS422 to RS485)

Each of the terminals on the 8587 termination panel is a screw clamp type, suitable for cables 0.5 to 2.5 sq mm.

Each module has three sets of terminal blocks, the pin-outs of which are shown in Table 7.3.

TB1 has a link 'LINK FOR CHANNEL 2'. On the RS422 ribbon cable coming from the 8585 or 9252 backplane, there are two ports (0 and 1, or 2 and 3). This link selects the second port, i.e. port 1 or port 3 depending upon which ribbon is being used.

Although RS485 is a 2-wire standard, the termination units allow 4-wire working for compatibility with the GEMDRIVE MICRO, and also allow point-to-point working with a partner which uses the RS422 standard. If 2-wire working or 4-wire multi-drop working is required, the termination blocks marked '2 WIRE' must be linked. This enables the termination unit to tri-state the line when not transmitting and so allow other units to use it.

Notes...

1. The GEMDRIVE MICRO is a microprocessor based d.c. drive unit. Comprehensive details can be found in Publication No.TM78219.

2. When communicating to two or more tributaries over a link distance greater than 1km, R6 and R13 should be removed from all units except for the primary/control port.

Figure 7.1 shows the details of the 8587 Termination Unit in diagrammatic form. Figures 7.2 and 7.3 show the 8587 Termination Unit connected for 2- and 4-wire working respectively.

Table 7.3 Termination Unit 8587. Terminal Block Connections

TB1	TB2	TB3	FUNCTION
1 LINK FOR		1 RZO	RECEIVER TERMINATION
2 CHANNEL		2 SCREEN	CABLE SCREEN
2			
		3 SCREEN	CABLE SCREEN
		4 SCREEN	CABLE SCREEN
		5 SYSTEM EARTH	
		6 2-WIRE)	(LINK FOR
		7 2-WIRE)	(2 WIRES
		8 TZO	TRANSMIT TERMINATION
	1 RXA RECEIVE DATA	9 TXA	TRANSMIT DATA
	2 RXA RECEIVE DATA	10 TXA	TRANSMIT DATA
	3 RXA RECEIVE DATA	11 TXA	TRANSMIT DATA
	4 RXB RECEIVE DATA	12 TXB	TRANSMIT DATA
	5 RXB RECEIVE DATA	13 TXB	TRANSMIT DATA
	6 RXB RECEIVE DATA	14 TXB	TRANSMIT DATA
		15 DIRA	DIRECTION OF DATA FLOW
		16 DIRB	DIRECTION OF DATA FLOW

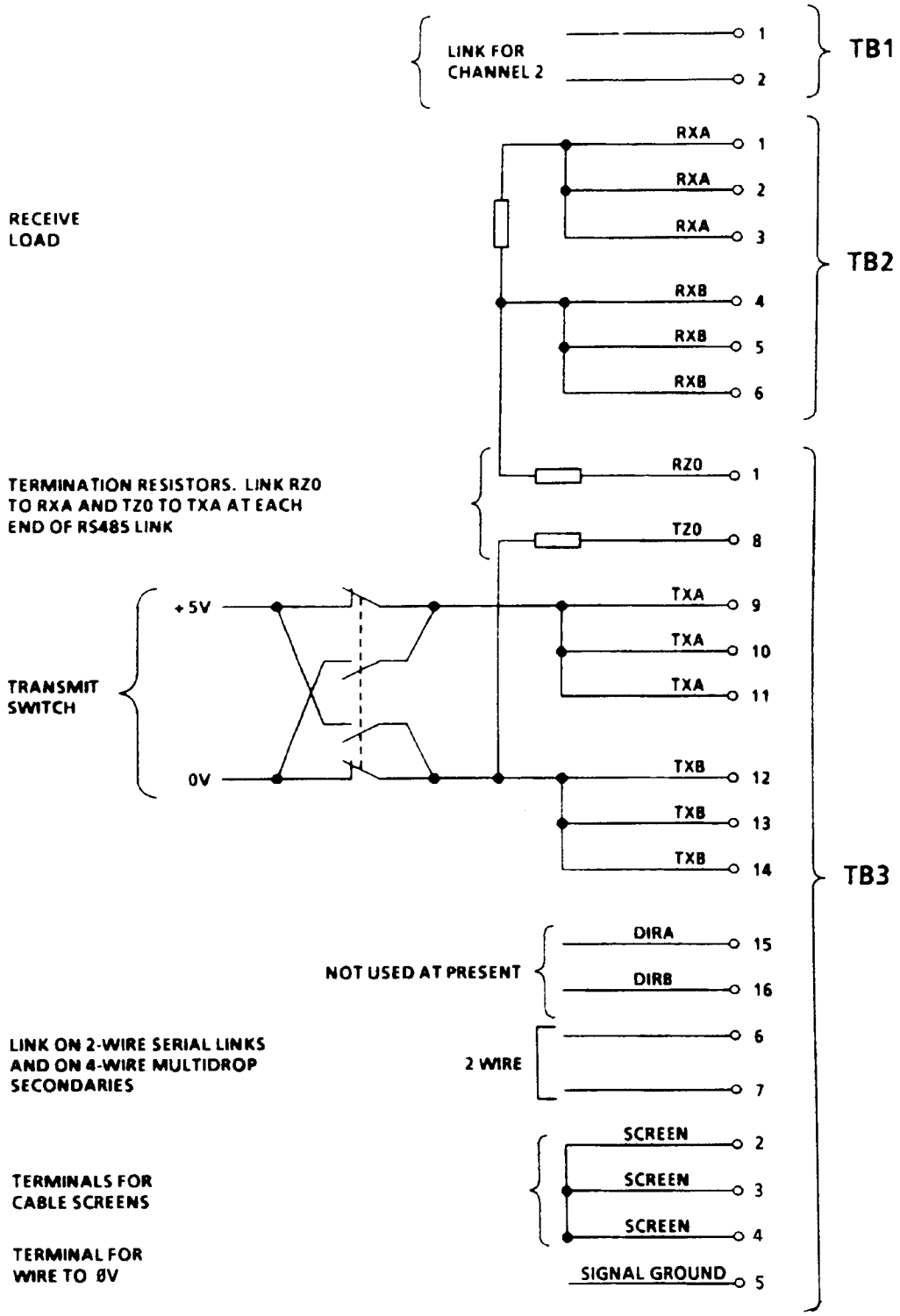


Figure 7.1 Termination Unit 8587. Internal Connections

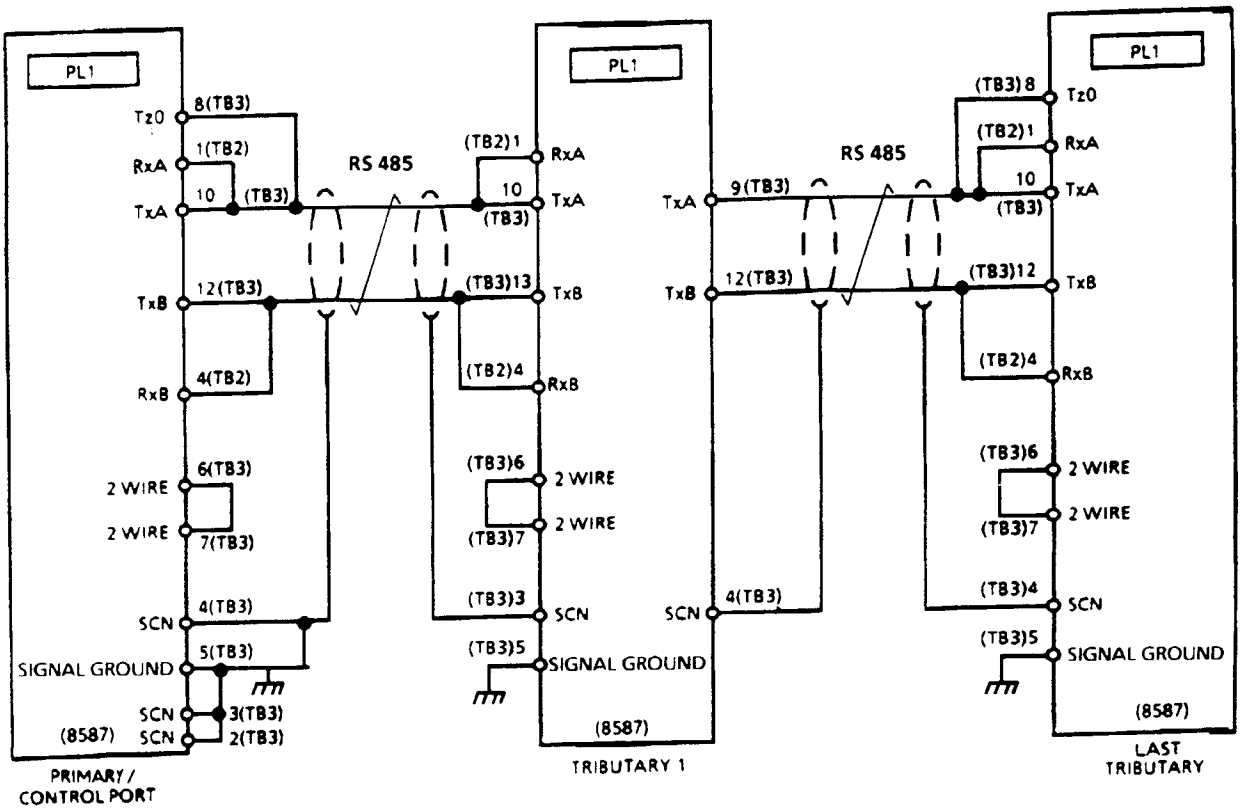


Figure 7.2 Termination Unit 8587. 2-Wire Connection Details

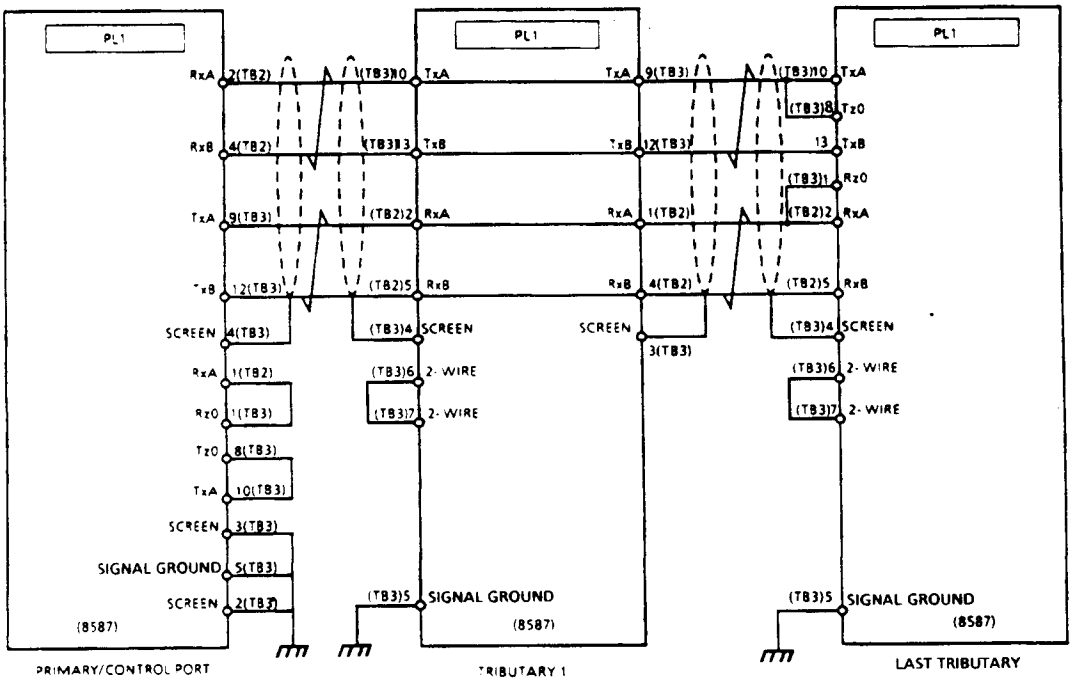


Figure 7.3 Termination Unit 8587. 4-Wire Connection Details

7.2.2. Termination Unit 8924 (RS422 to 20mA Current Loop)

This unit is for use with ESP. It provides conversion for the RS422 from the STARNET module backplane to 2- or 4-wire 20mA current loop. It may be used for signalling rates up to 9.6k bits/s. Specific information on termination panels and termination units is in Publication No.T456.

See Figure 7.4 for connection details and Figures 7.5 and 7.6 which show typical single pair and twin pair wiring respectively.

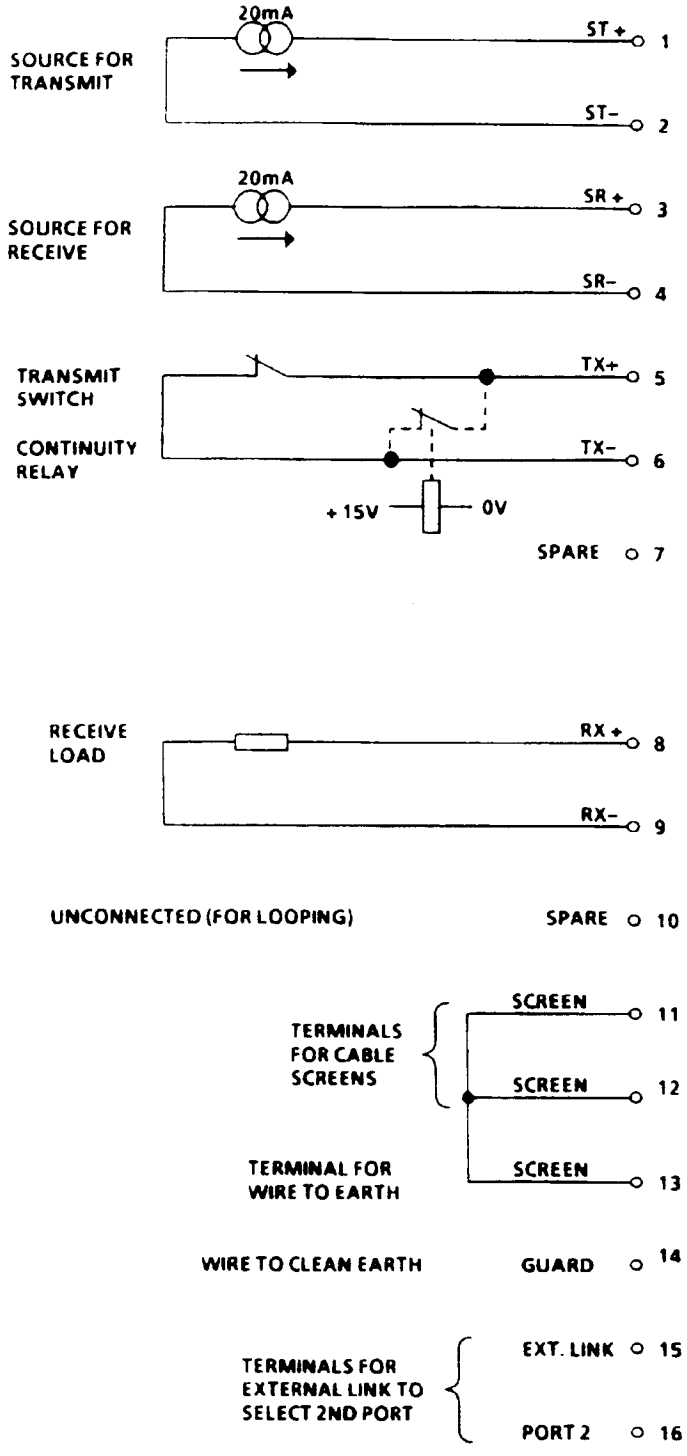


Figure 7.4 Termination Unit 8924 Connection Details

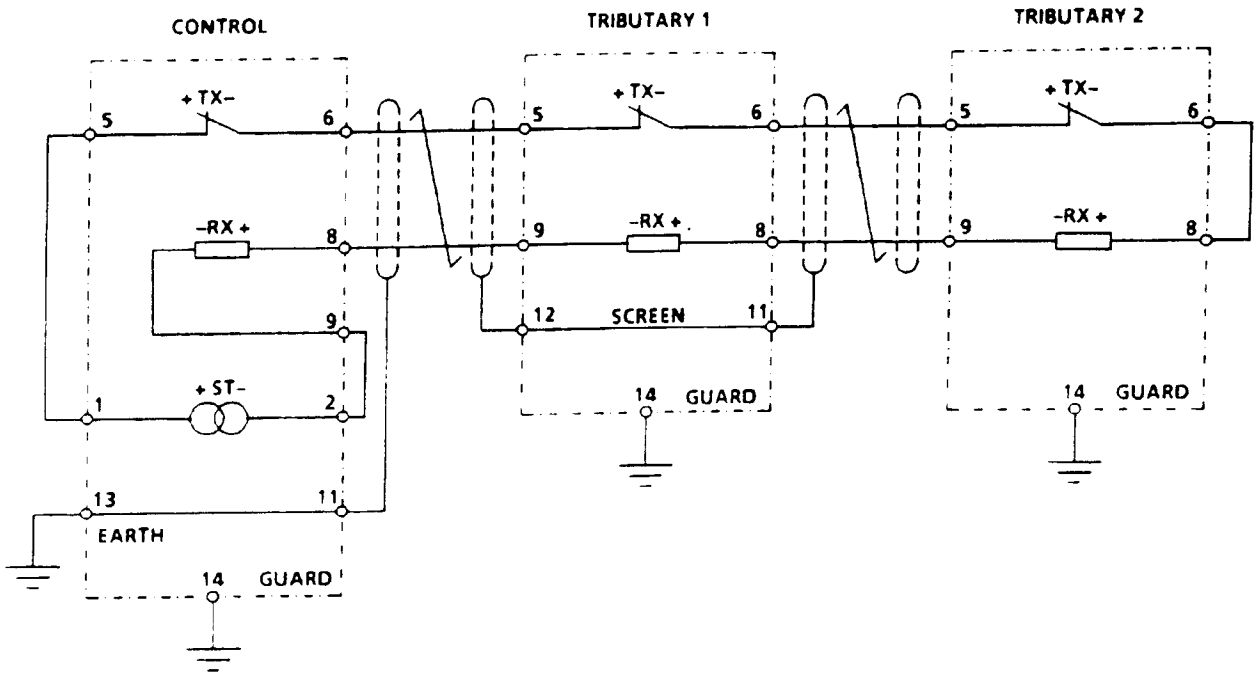


Figure 7.5 Termination Unit 8924. 2-Wire Connection Details

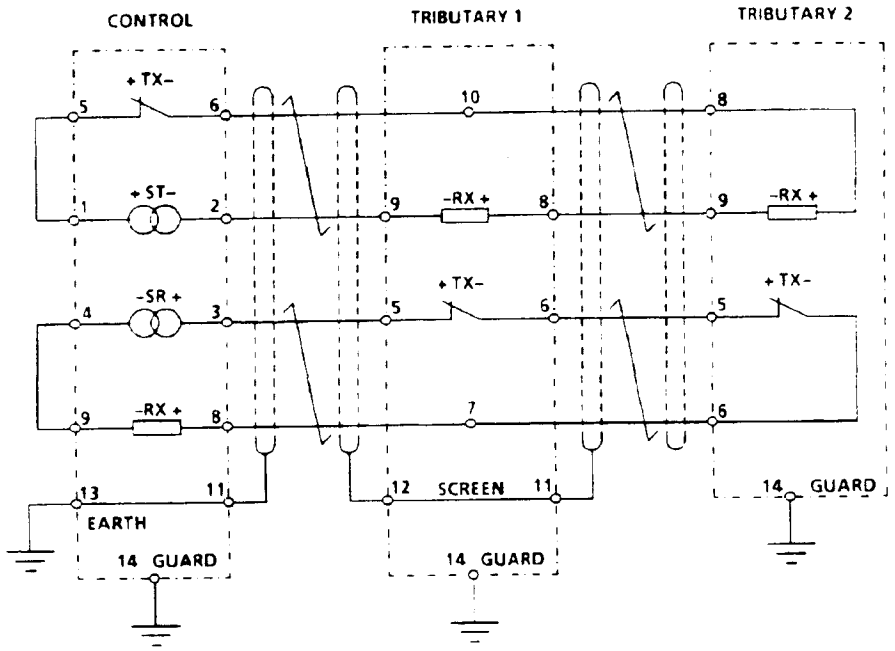


Figure 7.6 Termination Unit 8924. 4-Wire Connection Details

7.3. Cable

The serial link cable should be a screened twisted pair. Various types are available which are suitable for both RS485 or RS422 working. A typical cable would have a characteristic impedance of 100 to 150 ohms, a capacitance $\leq$41pF/m and a resistance not greater than 78.7 ohms per km, e.g. Belden 9729 for 4-wire working, or Belden 9182 for 2-wire working.

The total cable length for RS485(HDLC) running 48K Baud or 180K Baud, NRZI, is 2km maximum, provided that attenuation does not exceed 8dB/km. FM0 and FM1 coding may be used over a cable length of 1Km. The length for 20mA depends on the number of tributaries and the signalling rate.

Cables having values greater than those specified may be used if the distance transmitted is short and there are few secondaries.

7.4. Earthing

An earth connection is available from a screw clamp terminal for optional connection of a cable shield. Connect only one end of the shield to earth, see Figure 7.5.

8. ORDERING CODES

8.1. Main Equipment

STARNET Module and Backplane (double width)	8816-4001
STARNET Module and Backplane (single width)	8816-4003
HDLC serial link termination unit. (provides terminals for one port)	8587-4003
20mA serial link termination panel. (provides terminals for one port)	8924-0000
Ribbon cable for connecting the above. (includes facilities for two ports)	8891-4077

8.2. Spares

STARNET Module (double width)	8218-4003
STARNET Module (single width)	8218-4004

8.3. Subrack Preparation

Adding central modules to a processor after delivery can be a difficult and time consuming job which may involve the subrack having to be returned to the factory. It is recommended that future module additions be considered at the ordering stage.

For double width modules.	8899-4224
For single width modules.	8891-4231

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