GEM80-500

Series Controllers

Technical Manual

Publication No. T2025En
Issue 3 (08/04)

ALSTOM

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Acknowledgements

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Issue Information

Publication T2025En Issue 3 (08/04)	Addition of GEMCAN I/O Scanner Module and dc power supply versions. New System Status Indications.
Publication T2025En Issue 2 (11/02)	Addition of FIP Module.
Publication T2025En Issue 1 (08/02)	Initial Release.

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SAFETY INSTRUCTIONS

Care has been taken with the design of this product to ensure that it is safe. However, in common with all products of this type, misuse can result in injury or death. Therefore, it is very important that the instructions in this manual and on the product are observed during transportation, commissioning, operation, maintenance and disposal.

This technical manual should be regarded as part of the product. It should be stored with the product and passed on to any subsequent owner or user.

Local safety laws and regulations must always be observed.

Persons working on the product must be suitably skilled and should have been trained in that work for these products.

The product is a component designed for incorporation in installations, apparatus and machines.

The product must not be used as a single item safety system. In applications where maloperation of the product could cause danger, additional means must be used to prevent danger to persons.

Product approvals and certifications will be invalidated if the product is transported, used or stored outside its ratings or if the instructions in this manual are not observed.

In the European Union:
Products within the scope of the Low Voltage Directive, 73/23/EEC as amended are CE marked.

The product complies with the essential protection requirements of the EMC directive 89/336/EEC as amended, when installed and used as described in this manual. The requirements of the EMC Directive should be established before any installation, apparatus or machine which incorporates the product is taken into service.

A machine should not be taken into service until the machine has been declared in conformity with the provisions of the Machinery (Safety) Directive, 98/37/EEC.

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Scope

This publication provides details of the GEM80-500 Series Controller which is a new GEM80 Controller similar in power and flexibility to a GEM80-400 Controller but housed in a much smaller enclosure. An overview of the product and its features and specification are included in this publication as well as details to enable system Configuration, Programming, Installation and Commissioning, Maintenance and Fault Finding to be carried out.

The GEM80-500 Series Controller is designed for upgrading existing GEM80 Systems, and for new applications, and this publication includes guidance for carrying out such upgrades.

Because of the similarity between the GEM80-500 and GEM80-400 Series Controllers, and the commonality of many of their features, this publication will often refer to details which can be found in the GEM80-400 Publication T1614 and should therefore be read in conjunction with it. This publication (T2025En) should be regarded as part of the GEM80-500 product. It should be retained for the life of the product and passed on to any subsequent owner or user.

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1. Introduction

1.1 The GEM80-500 Series Controller

1.1.1 Overview

The GEM80-500 Series Controller is similar in power and flexibility to a GEM80-400 Controller but housed in a much smaller enclosure. It is suitable for new applications and for upgrading existing GEM80 Systems (refer to Section 8 for upgrading information).

The GEM80-500 Controller has many of the facilities of the GEM80-400 Controller including:

(a) Serial Links;

(b) Real Time Clock;

(c) RAM/Flash EPROM Storage;

(d) Basic and Verification I/O.

Section 1 of this manual provides an overview of the product and its features.

Section 2 of this manual includes a System Specification (2.5) which outlines the compatibility with the GEM80 range of products and details those system features particular to the GEM80-500 Controller.

1.1.2 Compatibility with other GEM80 Products

The GEM80-500 Controller is compatible with other GEM80 products including:

(a) All Basic I/O Modules;

(b) All Verification I/O Modules;

(c) Verification I/O Expanders;

(d) Verification Remote I/O;

(e) All variants of ESP;

(f) User Program and GEM80 Ladder Diagram Programming Language.

Notes:

(1) The GEM80-500 Controller does not support GEMSTART CCU, Fast I/O Modules, GEMLAN-D, STARNET, or an IMAGEM Graphics Display Module.

(2) There are also some differences in the GEM80-500 Controller Instruction Set, compared to other GEM80 products, including no support for floating point operation and a reduced range of Maths Functions. Refer to Table 5-2 and Table 5-3 where the full set and the differences are detailed.

1.2 Features

The GEM80-500 Series Controller is shown at Figure 1-1 with its features annotated. Each of the features is described at an appropriate place within the manual. The controller is a compact unit with an integral power supply. It is supplied for either panel mounting or subrack mounting to meet the requirements of new applications and those for upgrading existing GEM80 Systems. The controller also has a facility for optional modules to be added for additional applications. The optional modules are described at 1.3.

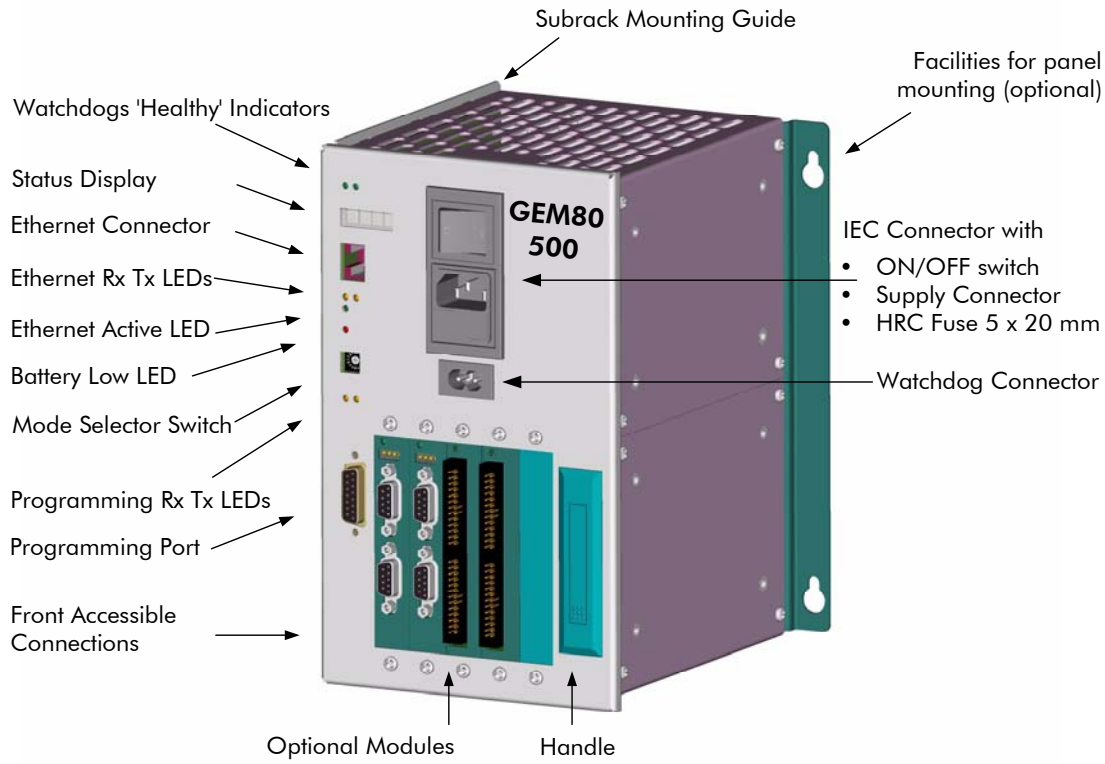


Figure 1-1 Features of a GEM80-500 Controller

1.3 Optional Modules

The GEM80-500 Controller is available with a range of optional modules for connection to I/O Highways and external communications. These optional modules are listed at Table 1-1 and the facilities are now described.

Table 1-1 Optional Modules for GEM80-500 Controller

ALSTOM Reference	Description	Remarks
9713-4020	Basic plus Verification I/O Interface	A maximum of 1 per system
9713-4021	Basic I/O Interface	A maximum of 2 per system
9714-4020	Serial Communications Module (RS232/RS485)	A maximum of 2 per system
9715-4020	FIP Module (1 Mbits/s)	A maximum of 1 per system
9716-4020	TCP/IP Ethernet Module	A maximum of 1 per system
9720-4020	GEMCAN I/O Scanner Module	A maximum of 2 per system

1.3.1 9713-4020 Basic and Verification I/O Interface Module

Figure 1-2 9713-4020 Module for One Basic I/O and One Verification I/O Ribbon Cables

The Module has connection facilities for one Basic I/O Ribbon Cable of 256 bits capacity and one Verification I/O Ribbon Cable of 1024 Words capacity.

1.3.2 9713-4021 Basic I/O Interface Module

Figure 1-3 9713-4021 Module for Two Basic I/O Ribbon Cables

The Module has connection facilities for two Basic I/O Ribbon Cables each of 256 bits capacity.

1.3.3 9715-4020 FIP (Factory Instrumentation Protocol) Module

A FIP Module for use with the GEM80-500 Controller will provide the technology to transfer data on a FIP (Factory Instrumentation Protocol) Network. The module is one of the optional modules for use with the controller. Refer to the T1653 GEM80 Series Controllers FIP Technical Manual for full details about use with the GEM80-500 Controller.

Figure 1-4 9715-4020 FIP Module

1.3.4 9714-4020 Serial Communications Module

Figure 1-5 9714-4020 Serial Communications Module

The Module provides two isolated RS232/RS485 communication ports. Each port can support:

- GEM80 Standard ESP;
- Programming;
- Printer.

1.3.5 9716-4020 TCP/IP Ethernet Module

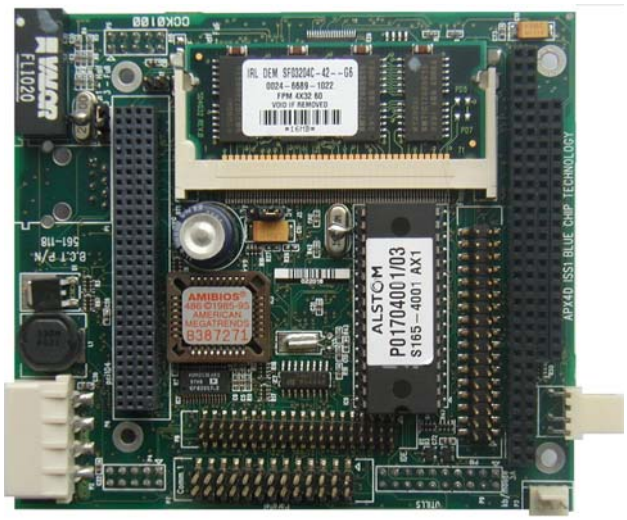


Figure 1-6 TCP/IP Ethernet Module

The Module can support:

- Up to 50 virtual simultaneous connections;
- Programming connection available using AGP (Advanced GEM80 Programmer);
- Peerless Communications;
- Built-in Web Server.

1.3.6 9720-4020 GEMCAN I/O Scanner Module

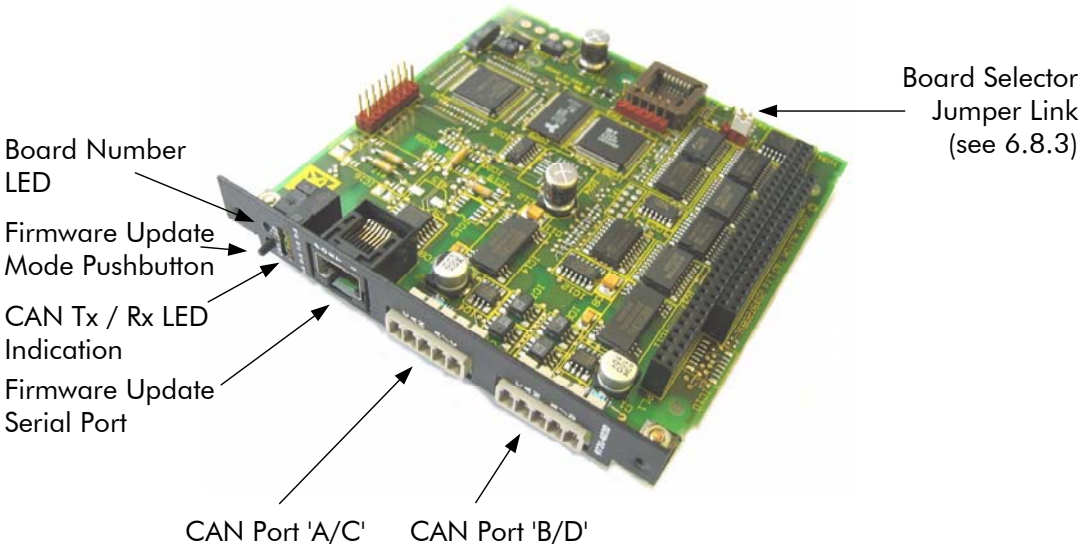


Figure 1-7 GEMCAN I/O Scanner Module

The Module provides two CAN communications ports, CAN 'A' and 'B'. Each port can support:

- Communications to I/O
- Communications to other GEM80 controllers

1.4 Associated Publications

ALSTOM Publications associated with this technical manual are now listed.

T391 GEM80 Ladder Diagram Language Programming Manual

This manual provides a competent user, who is familiar with programming GEM80 controllers, details for all aspects of programming, including the language, the Standard Instruction Set and all the GEM80 Special Functions. It does not include some Additional Instructions which are used for the GEM80-400 and 500 Series Controllers that are described in the GEM80-400 manual.

T1614 GEM80-400 Series Controllers Technical Manual

This manual provides a competent user who is familiar with GEM80 controllers details for the installation, commissioning, operation and maintenance of the GEM80-400 Series Controllers. It includes some software details which are cross-referenced from the GEM80-500 manual.

T1653 GEM80 Series Controllers FIP Technical Manual

This manual provides a competent user who is familiar with GEM80 controllers details for the specification, configuration, installation and operation of a FIP Module for use with a GEM80-400/500 Controller.

Note:

The FIP Module used with the GEM80-500 Controller has some differences from that used for the GEM80-400 Controller (e.g. in the P-tables where P94 to P96 were P120 to P122 for GEM80-400). However, much of the information in the T1653 Manual will be of use with the GEM80-500 Controller.

T2011 GEMLAN-T Technical Manual

This manual provides the information necessary to configure and install the GEMLAN-T Module for communications between networked GEM80 Controllers. The manual covers the module's technical and physical specifications, installation, operation and general use. Examples and application notes are also included.

T457 GEM80 Serial Communications Technical Manual

This manual provides comprehensive technical information about GEM80 serial links. It includes guidance for the construction and operation of serial links between GEM80 Controllers and between GEM80 equipment and other types of equipment.

T2031En GEM80 GEMTEQ I/O Technical Manual

This manual provides a competent user details for the specificaion, configuration, installation and operation of a GEMTEQ I/O system for use with GEM80.

2. Specification

2.1 Introduction

The GEM80-500 Series Controller specification is detailed in this section. There are also application dependent requirements which affect operation of the controller and these are described at Section 6 where full installation instructions are included.

2.2 Environmental Specification

Operating

Temperature	0 to +50°C
Humidity	5 to 95% RH (non-condensing)
Atmospheric contamination	The controller must be totally protected from potentially corrosive atmospheres e.g. benzene, acid fumes, sulphur dioxide, hydrogen sulphide and nitrous oxide

Notes:

(1) Additional protection should be provided to prevent dust ingress when the controller is used in high dust concentration locations (Enclosure is IP20 – see Mechanical Specification).

(3) Rapid temperature changes should be avoided to prevent condensation forming in areas of high humidity.

Storage and Transport

Temperature	-20°to +70°C
Humidity	5 to 95% RH (non-condensing)

2.3 Mechanical Specification

Enclosure Ingress Protection (IP)	IP20 (to IEC 60529)
Size (H x W x D)	235 mm x 141 mm x 173 mm
Size with Panel Mounting Kit	235 mm x 170 mm x 181 mm
Weight	2.5 kg (**without** optional modules)
Weight	3.0 kg (**with** optional modules)
Mounting	Subrack or Panel mountable (see Section 6 for Installation)
Optional Panel Mounting Kit	8890-4900

2.4 Electrical Specification

Supply Voltage	88 to 264 V ac 18 to 36 V dc 36 to 72 V dc	(8870-4979) (8870-4979DC24) (8870-4979DC48)
Supply Frequency	47 to 63 Hz	(8870-4979)
Supply Rating	230 VA maximum at 100% load (AC version) 100W maximum at 100% load (DC versions)	
Supply loss ride through	20 ms minimum with ac suppy 7 ms minimum with dc suppy	
Inrush Current	30 A maximum at 230 V ac and 100% load 35 A maximum at 24/48 V dc and 100% load	
Leakage current	0.5 mA maximum at 240 V ac	
Watchdog contact rating	250 V, 1 A ac	
Earthing/grounding	Via the appropriate terminal in the IEC Mains Connector	
Wire size for Supply Wiring	1.0 mm^2 (equivalent 18 AWG)	
A.C. Supply Connector	Cold Condition IEC Connector (IEC 60320-1/C14) with an integral ON/OFF switch and a protective fuse (3.15 A size 5.0 x 20 mm time delay HRC type to IEC 60127)	
D.C. Supply Connector	Hot Condition IEC Connector (IEC 60320-1/C16) with an integral ON/OFF switch and a protective fuse (5 A size 5.0 x 20 mm time delay HRC type to IEC 60127)	
Watchdog Connector	C7 Style 'Figure of 8' connector plug rated at 2.5 A 250 V	
Internal Power Supply Output Rating	6 A at +5 V, 2.7 A at 15 V, 63W Maximum	
Controller Power Consumption	0.7 A at 5 V, 50 mA at 15 V	
Programmer Load Consumption	40 mA at 15 V	
I/O Interface Module Consumption	0.2 A at 5 V, 50 mA at 15 V	
Serial Comms Module Consumption	0.65 A at 5 V	
TCP/IP Module Consumption	1.3 A at 5 V	
FIP Module Consumption	0.5 A at 5 V	
GEMCAN I/O Scaner	0.3 A at 5 V	

External Power Supply

Output Tolerance	+/- 5% Max over full supply and load range
Ripple and Noise content	+/- 1% peak to peak maximum
Hold up Time	Greater than 20mS
Overvoltage protection on Outputs	Limit to +20% of nominal rail voltage

Note:
The total power consumption for the required controller configuration can be calculated from the above specification. The remaining current capacity on the +15 V output can be used to power GEM80 I/O Modules via the I/O ribbon cables. Any additional +15 V current requirement for I/O Modules, and +5 V current for Verification I/O Modules must be provided by separate power supplies fed to the I/O Module Subracks.

2.5 System Specification

- Standard GEM80 Language
- 20 K user Instructions in RAM or FLASH Memory as standard
- 30 K data tables
- 30 K bytes for user messages
- 4 character status display
- Independent Watchdog
- Real time clock
- Battery-backed data tables, real time clock and user program
- Programming Port
- Firmware easily upgradable by the user
- 100 event system log
- I/O Interface with optional modules including:

  256 bits Basic I/O plus 1024 Words of Verification I/O, or

  1024 bits Basic I/O

- Expansion facilities with optional Modules, including:

  TCP/IP Ethernet compatible with GEMLAN-T

  GEMCAN I/O Scanner

  FIP – WorldFIP (IEC 61158-2), Slow FIP and FIP (NFC 46-603/4)

  Up to 4 Serial Ports RS232/RS485.

3. Configuration of Optional Modules

3.1 Introduction

The GEM80-500 Controller provides a flexible and cost-effective means of replacing previous GEM80 Controllers having differing I/O and Communication facilities. This is achieved by using a range of optional plug-in modules. This flexibility is enhanced by the use of a single jumper link allowing two modules of the same type to be fitted in the system.

The GEM80-500 Controller can support the following I/O combinations:

- One Module 9713-4020 providing one Basic Ribbon and one Verification Ribbon;
- One Module 9713-4021 providing two Basic Ribbons;
- Two Modules 9713-4021 providing four Basic Ribbons;
- One Module 9713-4020 and one Module 9713-4021 providing three Basic Ribbons and one Verification Ribbon.

The Controller can also support up to two plug-in Serial Communications Modules of type 9714-4020. Each module has two serial ports.

The Controller can also be fitted with a TCP/IP Ethernet Module (9716-4020), a FIP module (9715-4020) and upto two GEMCAN I/O Scanner modules (9720-4020).

This section details the configuration of each of the modules and the serial ports.

The selection of optional modules for use in the GEM80-500 Controller is subject to rules which govern the combinations of modules that may be used.

Recommendations are also made for the stacking order in which the modules are fitted into the controller.

3.2 Configuration of Optional Modules in the controller

3.2.1 Configuration Rules

The rules, which have to be followed when selecting optional modules, are:

- Only one FIP Module can be fitted;
- Maximum of two GEMCAN I/O Scanner Modules can be fitted;
- Maximum of two Serial Communications Modules can be fitted;
- Only one Basic/Verification I/O Module can be fitted;
- Maximum of two Basic I/O Modules can be fitted;
- One Basic/Verification I/O Module with one Basic/Basic I/O Module can be fitted;

These rules are embodied at Table 3-1 which shows the various arrangements of optional modules and, in particular, the mandatory arrangements which apply.

To illustrate a mandatory arrangement consider the Basic I/O Module. Each module has two ribbons of I/O. The first module is referred to as Basic 1 and Basic 2 and the second module is referred to as Basic 3 and Basic 4. It is mandatory that if a module with Basic 3 and Basic 4 ribbons is used that there is also a module fitted which has Basic 1 and Basic 2 ribbons fitted.

When I/O Modules, Serial Communications Modules and/or GEMCAN I/O Scanner Modules are to be configured it is important that the module jumper links 1 to 3 on each module are correctly set for each module in the controller. Refer to 6.8.3 for details of this linking arrangement.

3.2.2 Configuration Recommendations

There are also recommendations which should be followed when selecting the positions for the optional modules in the GEM80-500 Controller. These recommendations are made for three reasons, namely:

(a) to keep the modules with the greatest power requirements nearest to the power supply;

(b) to give maximum space for the 15 V power supply cable assembly referenced 41Y8230/10 to be fitted;

(c) to provide an orderly arrangement of cabling to the ribbon connectors and the Serial Link ports at the front of the controller.

3.2.3 Recommended Module Stacking Arrangement

The recommended arrangement for the modules is:

- always fit the communication modules (i.e. FIP, GEMCAN I/O Scanner Modules and Serial Communications Modules) first when building up a stack of optional modules i.e. positioned closest to the controller motherboard;
- fit the I/O modules (i.e. Basic and Basic with Verification) after the communication modules.

In summary, working from left to right when viewing the controller from the front, the module arrangement should be:

Left **Right**

FIP	First GEMCAN I/O Scanner	Second GEMCAN I/O Scaner	First Serial Comms. Module	Second Serial Comms Module	Basic I/O Module	Basic I/O with Verification Module

Example:

If a FIP Module is not being used with the controller all the modules move position to the left i.e. the module nearest the controller motherboard will then be the first GEMCAN I/O Scanner Module.

Table 3-1 Configuration Rules for Optional Modules

		(Can I fit ....?)								
		Basic 1/ Basic 2	**Basic 3/ Basic 4**	**Basic 1/ Verif.**	**Basic 3/ Verif.**	**Serial Port 1/ Port 2**	**Serial Port 3/ Port 4**	**FIP**	**GEM CAN 1**	**GEM CAN 2**
(If I have ....)	**Basic 1/ Basic 2** (1st Module) 9713-4021	X	✓	X	✓	✓	✓	✓	✓	✓
	Basic 3/ Basic 4 (2nd Module) 9713-4021	M	X	X	X	✓	✓	✓	✓	✓
	Basic 1/ Verification (1st Module) 9713-4020	X	X	X	X	✓	✓	✓	✓	✓
	Basic 3/ Verification (2nd Module) 9713-4020	M	X	X	X	✓	✓	✓	✓	✓
	Serial Comms. Port 1/ Port 2 (1st Module) 9714-4020	✓	✓	✓	✓	X	✓	✓	✓	✓
	Serial Comms. Port 3/ Port 4 (2nd Module) 9714-4020	✓	✓	✓	✓	M	X	✓	✓	✓
	FIP 9730-4020	✓	✓	✓	✓	✓	✓	X	✓	✓
	GEMCAN (1st Module) 9720-4020	✓	✓	✓	✓	✓	✓	✓	X	✓
	GEMCAN (2nd Module) 9720-4020	✓	✓	✓	✓	✓	✓	✓	M	X

Notes:

(1) X = an illegal combination;
✓ = a valid combination;
M = a mandatory combination.

(2) The maximum number of plug-in modules is 5.

WARNING

Setting P93 = -1 will disable all Basic I/O ribbons, in which case the Verification Interface scans all 1040 words of I/O.

3.3 Using one 9713-4020 Basic and Verification I/O Interface Module

3.3.1 I/O Access (Capacity and Addressing)

This module allows access to 16 words of Basic I/O, fixed at addresses A/B 0 to 15 and 1024 words of Verification I/O. If required, the Basic I/O may be disabled by selecting P93 = -1, in which case the Verification Interface scans all 1040 words of I/O.

Connection to the 9713-4020 Module is by two 26 way ribbon headers mounted on the front of the module.

Figure 3-1 shows the Jumper Link setting required for this configuration and the addresses covered by each ribbon.

For installation of the 9713-4020 Module see Section 6.

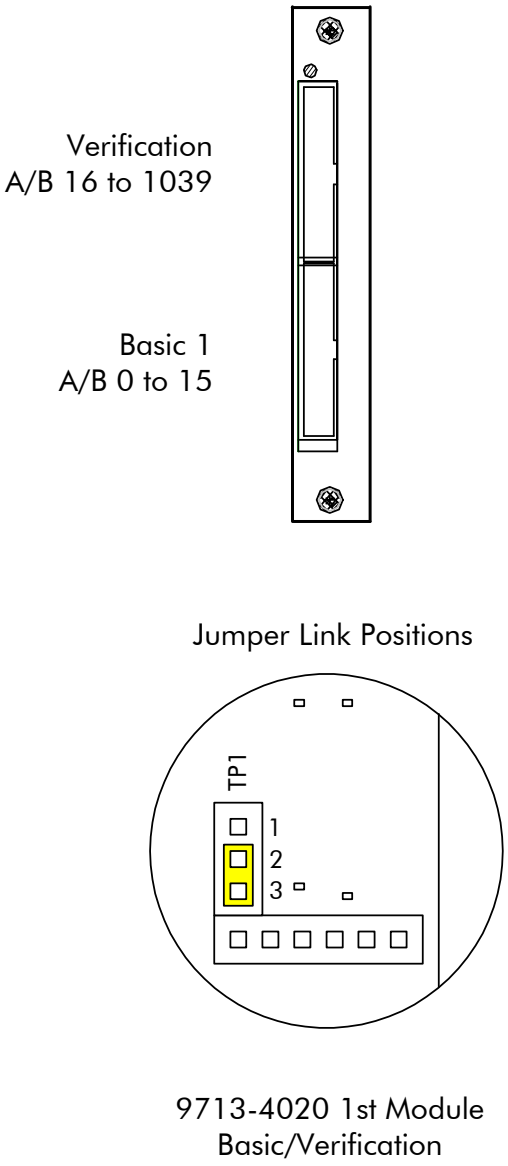


Figure 3-1 9713-4020 1st Module Basic/Verification I/O Addressing and Linking

3.4 Using one 9713-4021 Basic I/O Interface Module

3.4.1 I/O Access (Capacity and Addressing)

This module allows access to 32 words of Basic I/O fixed at addresses A/B 0 to 31.

Connection to the 9713-4021 Module is by two 26 way ribbon headers mounted on the front of the module.

Figure 3-2 shows the Jumper Link setting required for this configuration and the addresses covered by each ribbon.

For installation of the 9713-4021 Module see Section 6.

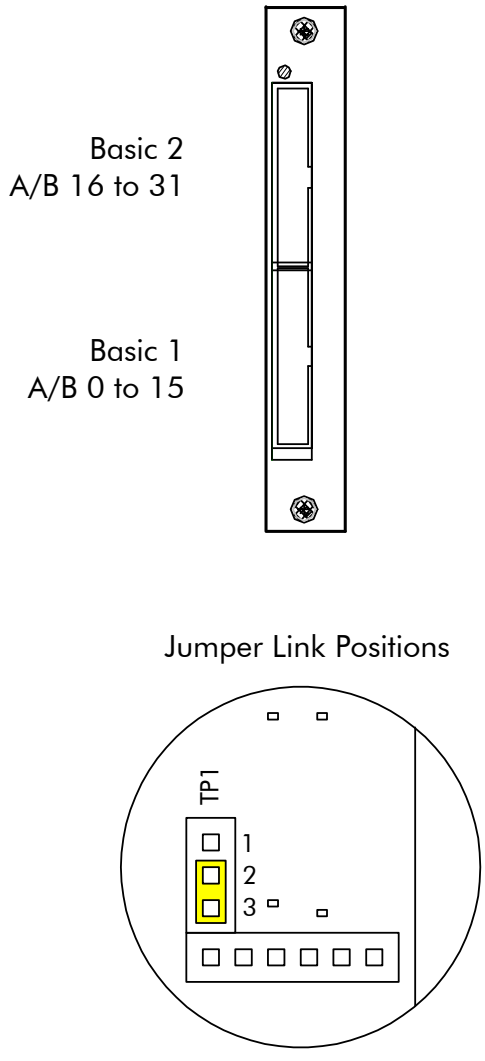


Figure 3-2 9713-4021 1st Module Basic/Basic I/O Addressing and Linking

3.5 Using two 9713-4021 Basic I/O Interface Modules

3.5.1 I/O Access (Capacity and Addressing)

These modules allow access to 64 words of Basic I/O fixed at addresses A/B0 to 63.

Connection to the 9713-4021 Modules is by four 26 way ribbon headers; two per module.

Figure 3-3 shows the Jumper Link setting required for this configuration and the addresses covered by each ribbon.

For installation of the 9713-4021 Module see Section 6.

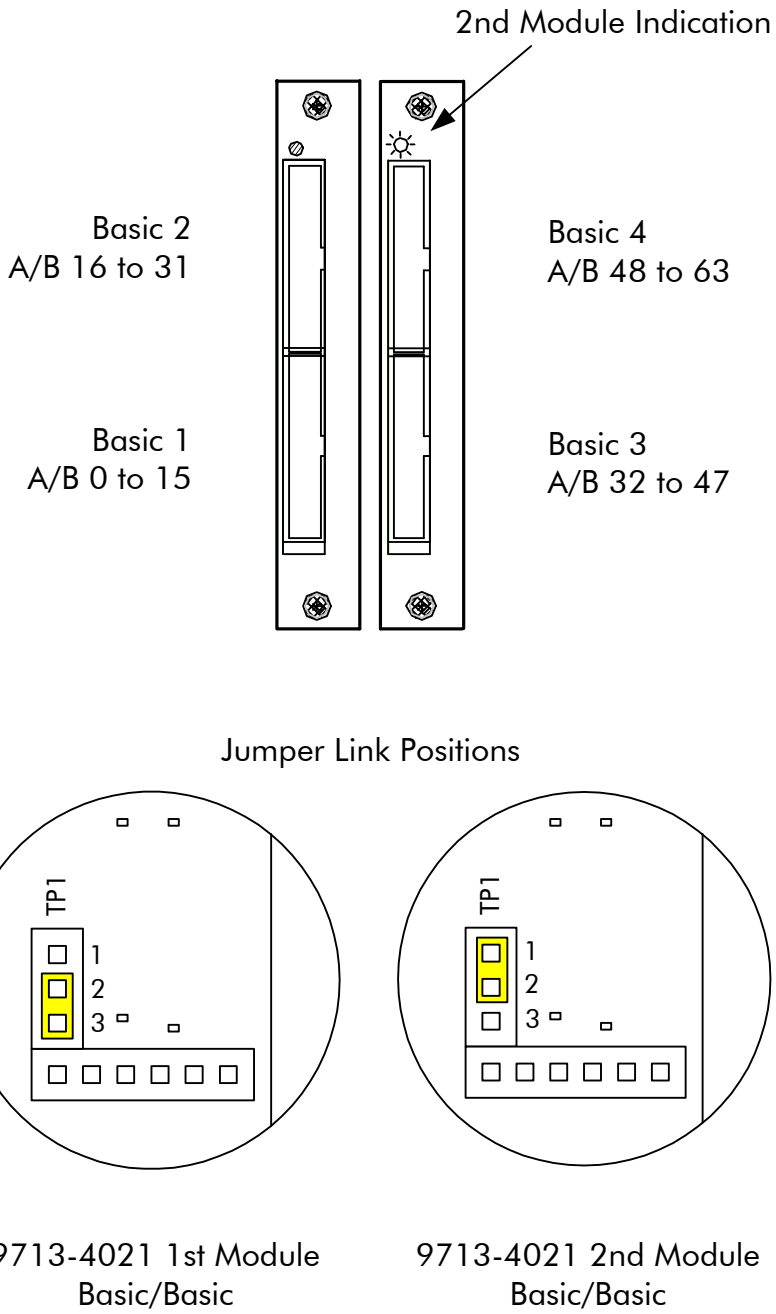


Figure 3-3 9713-4021 1st and 2nd Module Basic/Basic I/O Addressing and Linking

3.6 Using one 9713-4020 and one 9713-4021 I/O Interface Modules

3.6.1 I/O Access (Capacity and Addressing)

This arrangement of modules gives access to 48 words of Basic I/O and 992 words of Verification I/O.

Figure 3-4 shows the Jumper Link setting required for this configuration and the addresses covered by each ribbon.

For installation of the 9713-4020 and 9713-4021 Modules see Section 6.

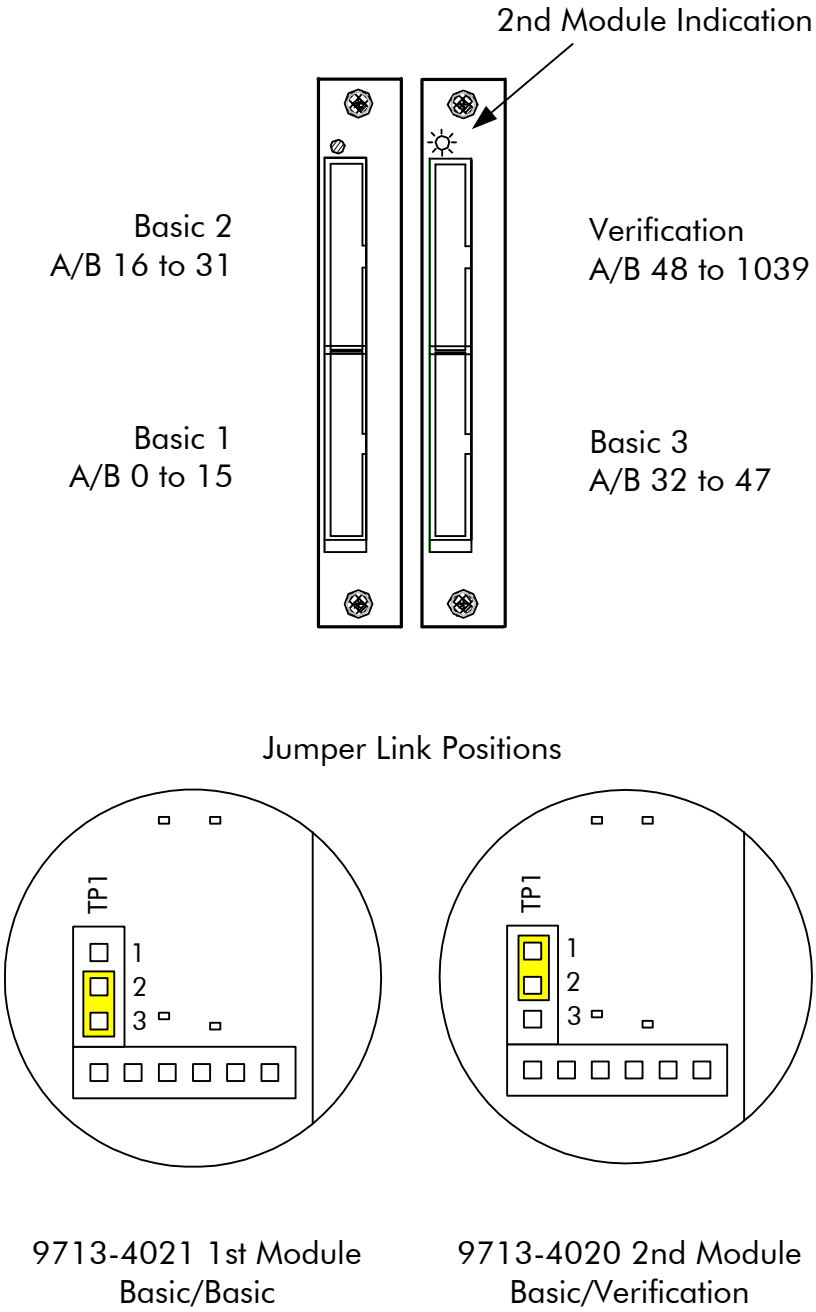


Figure 3-4 **9713-4021 and 9713-4020 1st and 2nd Module Basic/Verification I/O Addressing and Linking**

3.6.2 Basic I/O Expansion

Additional Basic I/O may be addressed by converting Verification I/O to Basic I/O using an 8191-4004 Verification I/O Expander. Each Expander can convert up to 32 words of Verification I/O to Basic I/O. Refer to the T1614 GEM80-400 Controller Manual for more details.

3.7 FIP Module 9715-4020

The GEM80-500 Controller can have a single FIP module fitted; giving a single logical port with media 'A' and media 'B' connections.

Refer to the T1653 GEM80 Series Controllers FIP Technical Manual for full details about use with the GEM80-500 Controller, however please note the reserved P-Tables indicated in Table 3-2

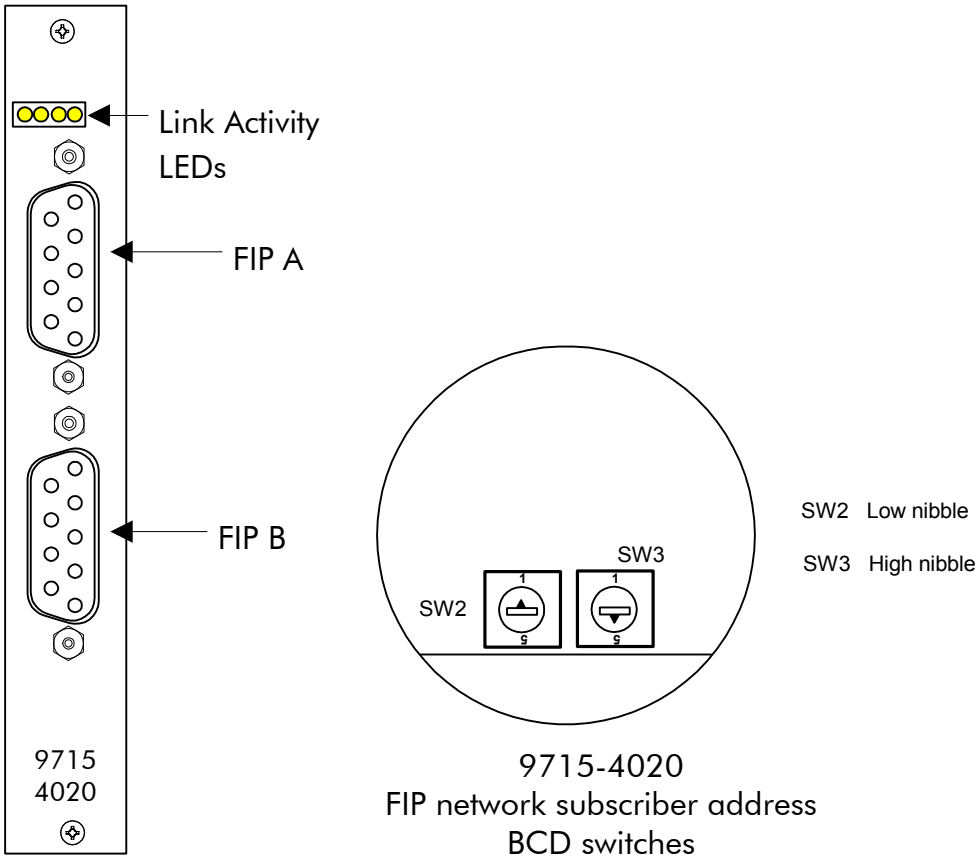


Figure 3-5 9715-4020 FIP Port Identification and Address Configuration

Table 3-2 P-Tables reserved for GEM80-500 FIP

P-Table	Description	Range
P94	FIP network compliance standard	0 = SlowFIP 1 = WorldFIP-A 2 = FIP The controller must be power cycled for a change in this value to take effect.
P95	BA idle frame	@0 - @FFFF @0 gives default value @8000 (@8000 is normally used on SlowFIP networks @9080 is normally used on WorldFIP networks)
P96	Byte ordering	0 = No byte swapping 1 = Bytes of each complete word are swapped on transfer to/from GEM80 data tables

3.7.1 FIP Connection

Connection to the 9715-4020 FIP Module is by the standard FIP Connectors mounted on the front panel of the module, for further information please refer to the T1653 GEM80 Series Controllers FIP Technical Manual.

For installation of the 9715-4020 FIP Module see Section 6.

3.8 Serial Communications Module 9714-4020

The GEM80-500 Controller can have up to four additional serial communication ports; Port 1 to Port 4.

Ports 1 to 4 are contained in optional Serial Communications Modules type 9714-4020, each providing two 9-way 'D' Type connectors. These ports are general purpose RS485/RS232 interfaces which support the following GEM80 serial communication protocols:

(a) Extended Simple Protocol (ESP);

(b) ESP with flexible data tables;

(c) ASCII (Printer/VDU Terminal);

(d) Programming Port.

The signalling rate for Ports 1 to 4 is user selectable between 110 and 19,200 bits per second. These rates are set in the P-tables.

Figure 3-7 shows identification of the serial port connectors at the controller front panel when the 9714-4020 modules are installed.

3.8.1 Serial Ports 1 to 4 Pin Connections

Serial Ports 1 to 4 produce RS232 and RS485 format signals. The connectors are 9-way, female, 'D'-type socket connectors with threaded 4-40 UNC retention pillars. The pinouts are as shown at Figure 3-6.

Pin	Connection
1	RS485 RXA (Rx+)
2	RS232 Rx
3	RS232 Tx
4	RS485 RXB (Rx-)
5	Signal Ground
6	RS485 TXA (Tx+)
7	RTS
8	CTS
9	RS485 TXB (Tx-)

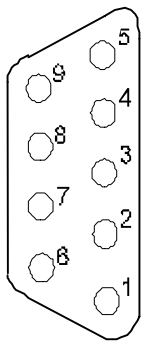


Figure 3-6 Serial Ports (Ports 1 to 4) Pinouts

Ports 1 to 4 may be converted to 20 mA current loop using a suitable active converter.

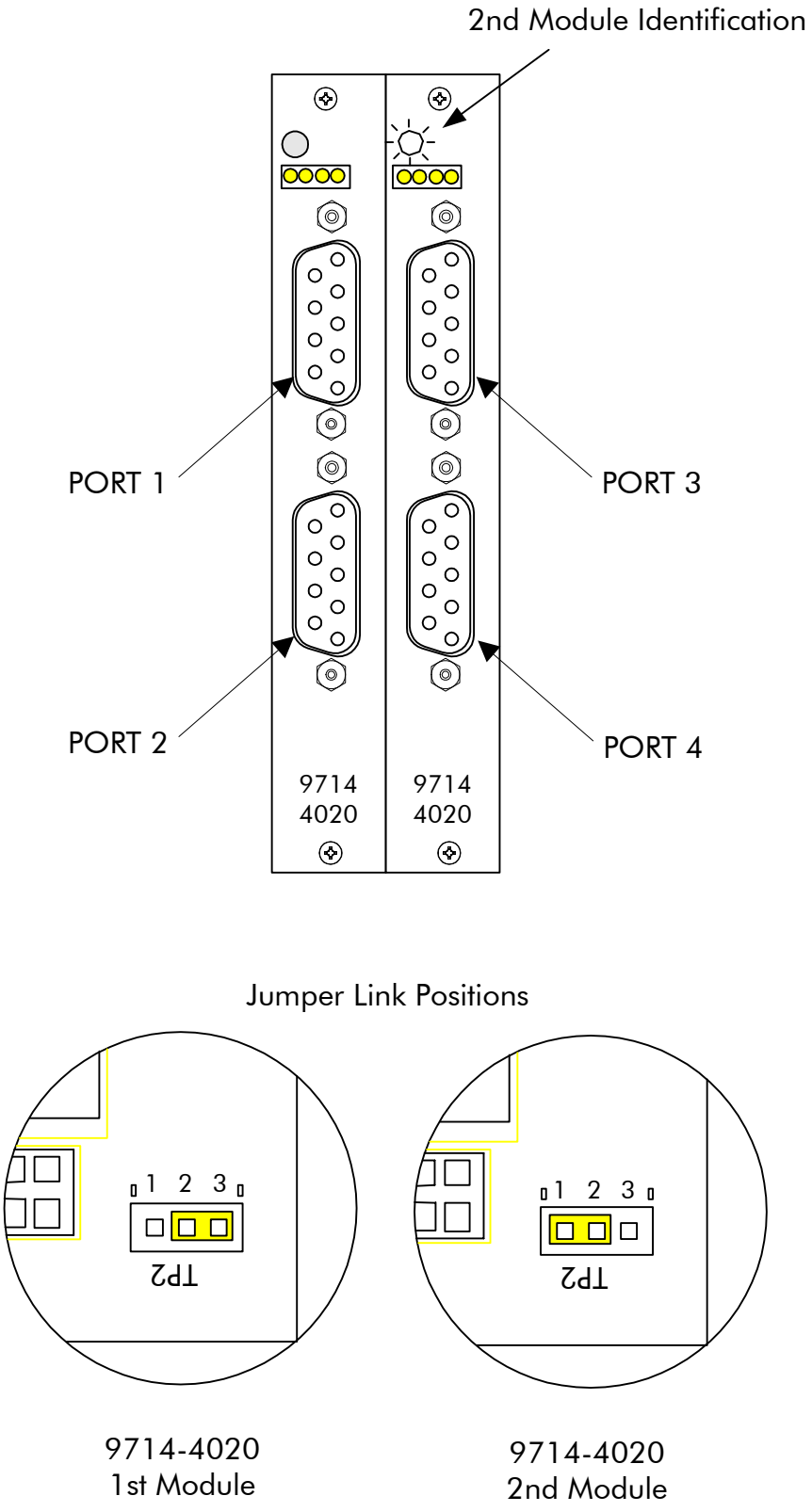


Figure 3-7 9714-4020 Serial Port Identification and Configuration

3.8.2 Configuring the Serial Ports

Ports 1, 2, 3 and 4 are configured by entering data in the P-table, and then performing a RECOMPILE (powering down is not required). The type of serial port is determined by the value entered in P11 for Port 1, P31 for Port 2, P111 for Port 3 or P131 for Port 4. The function of the rest of the P-table locations is dependent upon this value. The baud rate is user defined between 110 and 19,200 bits per second. The rate is selected by entering the baud rate in P10, P30, P110 or P130 for Ports 1, 2, 3 and 4 respectively. The following baud rates are allowed: 110; 300; 600; 1,200; 2,400; 4,800; 9,600 and 19,200.

If a baud rate other than the above is selected then the controller defaults to 9600 baud with a timeout value of 13.75 seconds.

3.8.3 Data Tables

Refer to Table 5-5 for a list of all the data tables applicable to the GEM80-500 Controller. The individual data tables are included at Section 5. The data tables used for Serial Communications are listed at Table 3-3.

Table 3-3 Data Tables for Serial Ports 1 to 4

Data Table	Content		Port 1	Port 2	Port 3	Port 4
J	Holds INPUT data received		J0 to J255	J256 to J511	J512 to J767	J768 to J1023
K	Holds OUTPUT data to be transmitted		K0 to K255	K256 to K511	K512 to K767	K768 to K1023
P	Configuration Data		P10 to P29	P30 to P49	P110 to P129	P130 to P149
I	User-control Data		I0 to I39	I40 to I79	I80 to I119	I120 to I159
F	Fault diagnosis table Link Statistics (see Section 7 for further information)	Diagnostics	F10 to F29	F30 to F49	F50 to F69	F70 to F89
		Statistics	F90 to F109	F110 to F129	F130 to F149	F150 to F169
E	Buffer Filling Flag		E0.8	E0.9	E0.10	E0.11
	Buffer Empty flag		E0.12	E0.13	E0.14	E0.45

Setting up a Printer/Keyboard Port

Table 3-4 shows the P-table addresses and the data the user must write to these addresses to enable the port to operate as a Printer/Keyboard Port. Changes to the P-table are implemented on RECOMPILE (no need to power down).

Table 3-4 P-Tables for Printer/Keyboard Port

Port 1	Port 2	Port 3	Port 4	Contents
P10	P30	P110	P130	Baud rate (110 to 19,200)
P11	P31	P111	P131	0
P12	P32	P112	P132	0 = Printer Mode 1 = Terminal Mode 2 = Free Format Mode
P13	P33	P113	P133	Number of characters per line (1 to 132)
P14	P34	P114	P134	Number of padding characters (1 to 131)
P15	P35	P115	P135	Parity Enable 0 = 8 data bits no parity bit 1 = 7 data bits plus 1 parity bit 2 = 8 data bits plus 1 parity bit
P16	P36	P116	P136	Parity Select 0 = Even parity 1 = Odd parity
P17	P37	P117	P137	Not used

Operation of a Printer/Keyboard Port

The Printer/Keyboard Port can operate in either 'Direct Mode', 'Terminal Mode' or in 'Free Format Mode'.

Note:
This port will operate in all controller operating states, i.e. halted, running, normal input and test inputs.

Full details of each mode of operation are included in the GEM80-400 T1614 Technical Manual.

3.8.4 Installation

Installation of the 9714-4020 Serial Communications Module is described at Section 6.

3.9 TCP/IP Ethernet Module 9716-4020

The Ethernet Module uses standard PC104+ hardware and offers up to 50 virtual simultaneous connections. It has a programming connection available for use with a suitable GEM80 Programming Package.

Refer to the T2011 GEMLAN-T Technical Manual for full details about use with the GEM80-500 Controller.

3.9.1 Ethernet Connection

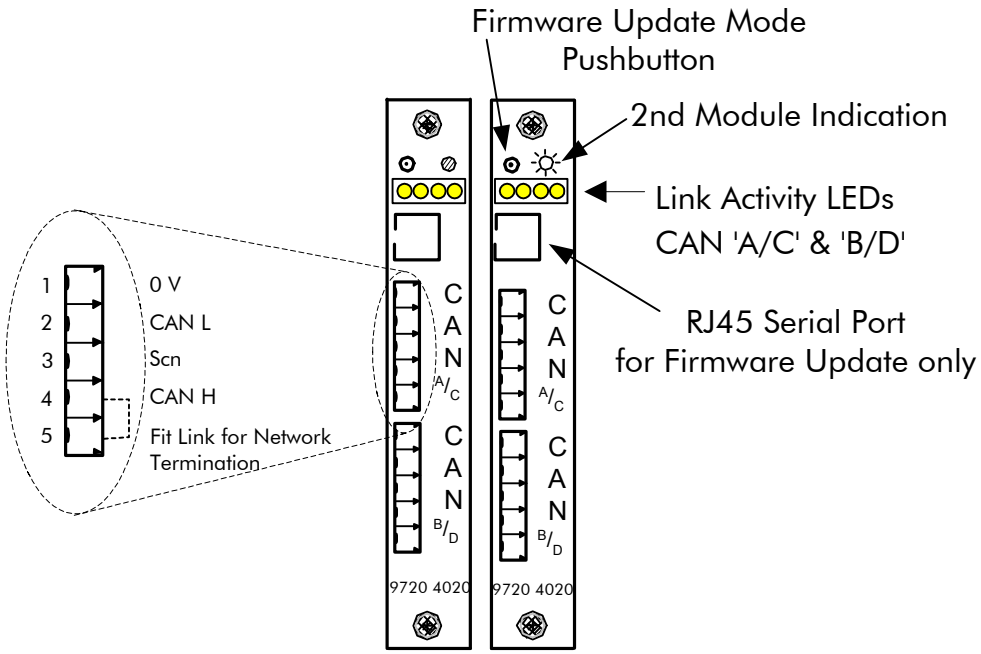
Connection to the 9716-4020 Ethernet Module is by the standard Ethernet Connector mounted on the front panel of the controller. The Ethernet interconnecting cable for the controller should be less than 2 m in length and meet the EMC Requirements outlined in the T2011 GEMLAN-T Technical Manual.

For installation of the 9716-4020 TCP/IP Ethernet Module see Section 6.

3.10 GEMCAN I/O Scanner Module 9720-4020

The GEM80-500 Controller can have up to two GEMCAN I/O Scanner modules fitted; each module providing two ports; CAN 'A' & CAN 'B' on Module 1, CAN 'C' & CAN 'D' on Module 2.

Please refer to T2031En, GEM80 GEMTEQ I/O Technical Manual for full details about use with the GEM80-500 Controller, however please note the reserved P-Table in Table 3-5.



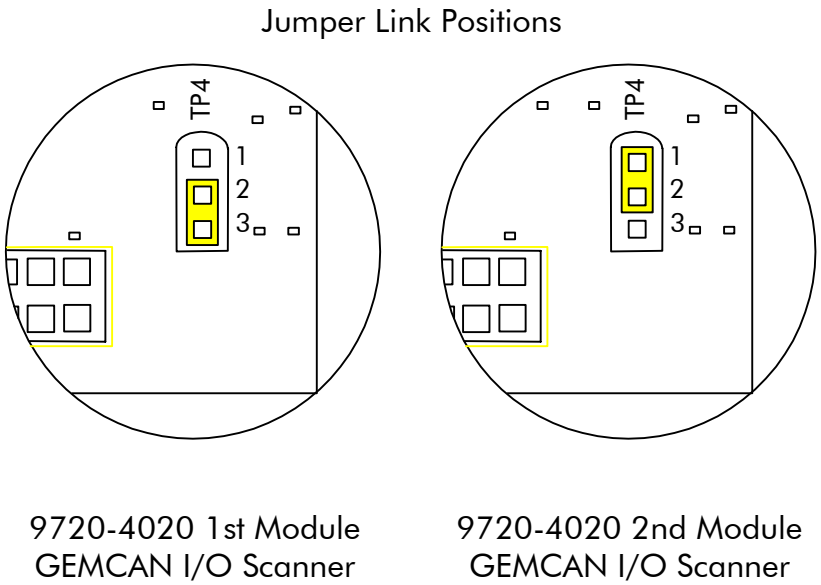


Figure 3-8 9720-4020 GEMCAN I/O Scanner Port Identification and Configuration

Table 3-5 P-Table reserved for GEM80-500 GEMCAN I/O Scanner

P-Table	Description	Comment
P73	Pointer to GEMCAN I/O Scanner Module(s) Configuration Data.	e.g. 500 = parameters start at P500

For installation of the 9720-4020 GEMCAN I/O Scanner Module see Section 6.

For details of the data tables used by the GEMCAN I/O Scanner module for the I/O data, see Table 5-5.

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4. Serial Communications

4.1 Applications of Serial Communication Links

GEM80-500 Controllers may transfer and receive data using serial communications links. The serial ports can be used for the following types of application:

(a) Operating the GEM 80-500 Controller as part of a distributed controller network, i.e. data table exchange with other GEM 80 controllers or other intelligent devices, or supervisory operations or co-ordinated operation of GEM 80 controllers. Details are given in the 'Data Tables' section.

(b) Supplying controller data, i.e. alphanumeric characters for intelligent devices, printers, VDUs or keyboards, to a computer for statistical analysis and data logging. See the 'Communication with a Printer, VDU or Suitable GEM 80 Programming Tool' section for details.

(c) Connecting the controller to a suitable GEM 80 Programming Package, or a printer.

4.2 Data Tables

Refer to Table 5-5 for a list of all the data tables applicable to the GEM80-500 Controller. The individual data tables are included at Section 5. The data tables used for Serial Communications are listed at Table 4-1.

Table 4-1 Data Tables for Serial Ports 1 to 4

Data Table	Content		Port 1	Port 2	Port 3	Port 4
J	Holds INPUT data received		J0 to J255	J256 to J511	J512 to J767	J768 to J1023
K	Holds OUTPUT data to be transmitted		K0 to K255	K256 to K511	K512 to K767	K768 to K1023
P	Configuration Data		P10 to P29	P30 to P49	P110 to P129	P130 to P149
I	User-control Data		I0 to I39	I40 to I79	I80 to I119	I120 to I159
F	Fault diagnosis table Link Statistics (see Section 7 for further information)	Diagnostics	F10 to F29	F30 to F49	F50 to F69	F70 to F89
		Statistics	F90 to F109	F110 to F129	F130 to F149	F150 to F169
E	Buffer Filling Flag		E0.8	E0.9	E0.10	E0.11
	Buffer Empty flag		E0.12	E0.13	E0.14	E0.45

4.3 Communication between GEM80 Controllers

Communication arrangements between the GEM80-500 Controller and any other GEM80 Controller, or related equipment, is described in more detail in the GEM80-400 T1614 Technical Manual which also includes details for the following topics:

(a) Communication Protocols (e.g. Extended Simple Protocol – ESP);

(b) Serial communications between two or more GEM80 Controllers (using ESP Protocol);

(c) Point-to-Point Serial Link using RS422 or RS485;

(d) Multi-drop Serial Link Communication using RS485;

(e) Communication with a Printer, VDU or Suitable GEM 80 Programming Tool;

(f) Remote Programming;

(g) Editing of messages (e.g. for alphanumeric displays).

4.4 Operation as a Printer/Keyboard Port

Table 4-2 shows the P-table data used to configure each GEM80-500 Controller Serial Port as a Printer/Keyboard Port.

Table 4-2 Configuring a Printer Port: P-table data

Port 1	Port 2	Port 3	Port 4	Contents
P10	P30	P110	P130	Baud rate (110 to 19,200)
P11	P31	P111	P131	0
P12	P32	P112	P132	0 = Printer Mode 1 = Terminal Mode 2 = Free Format Mode
P13	P33	P113	P133	Number of characters per line (1 to 132)
P14	P34	P114	P134	Number of padding characters (1 to 131)
P15	P35	P115	P135	Parity Enable 0 = 8 data bits no parity bit 1 = 7 data bits plus 1 parity bit 2 = 8 data bits plus 1 parity bit
P16	P36	P116	P136	Parity Select 0 = Even parity 1 = Odd parity
P17	P37	P117	P137	Not used

The Printer/Keyboard Port can operate in either 'Direct Mode', 'Terminal Mode' or in 'Free Format Mode'.

Note... This port will operate in all controller operating states, i.e. halted, running, normal input and test inputs.

4.4.1 Direct Mode

This mode is intended for use with a printer and a separate serial input device, such as a matrix keyboard. The port has two cyclic buffers, one for input and one for output. Data can only be written to the output buffer, and read from the input buffer, by means of GEM80 Special Functions. You cannot otherwise access these buffers from your ladder diagram program. All characters received from the keyboard are directly transferred to the input cyclic buffer as they arrive. The only exception is that, if parity is enabled, any character with a parity error is replaced by @FF. Output data is taken from the output cyclic buffer after the previous output has finished. However, transmission does not commence until an ETX (@03) character or an end-of-line marker is found. An end-of-line marker is transmitted as carriage-return (@0D), line-feed (@0A), plus any user defined quantity of NUL (@00) characters. An ETX character is not itself transmitted, but simply initiates output from the cyclic buffer, allowing partial lines to be output.

Note... Many printers do not print any characters until a carriage-return or line-feed is received.

4.4.2 Terminal Mode

This mode is specifically intended for interactive operator interfacing using a VDU and keyboard terminal or VDU terminal. It performs the functions of auto-echoing and line editing without the need for user programming.

The terminal is expected to have the following characteristics (ASCII character names are shown in parentheses):

(1) Pressing the carriage-return key generates @0D (CR).
(2) Pressing the Delete/Rub out key generates @7F (DEL).
(3) Receipt of @0D, @0A (CR, LF) moves the cursor to the left-hand edge of the screen on the next line, scrolling the display if on the last line of the screen.
(4) Receipt of @00 (NUL) performs no action.
(5) Receipt of @07 (BEL) sounds an audible alarm.
(6) Receipt of @08 (BS) moves the cursor one character position to the left.
(7) Receipt of @20 (SP) blanks out the current display position.
(8) Receipt of @1A (SUB) displays a non-blank character.

As for direct mode, the port has an input cyclic buffer and an output cyclic buffer. Data can be written to the output buffer, and read from the input buffer, by means of GEM 80 Special Functions. This is the only way to access these buffers from the GEM80 Ladder Diagram User Program.

However, the input channel has a separate input line buffer in addition to the input cyclic buffer. All received characters are initially stored in the line buffer. They are only transferred to the input cyclic buffer when a @0D (CR) is received and, until this happens, cannot be read by the controller.

As characters are received into the line buffer, they are echoed back to the VDU via the output channel and are displayed on the VDU screen, with the following exceptions:

1. Any non-printing character other than CR, DEL, XON or XOFF is discarded (not loaded into the line buffer) and echoed as BEL .
2. XOFF is discarded, and causes output (including echoing) to be suspended.
3. XON is discarded, and causes output suspended by XOFF to resume.
4. DEL is discarded, and causes the previous character loaded into the line buffer to be removed. It is normally echoed as BS, SP, BS. However, if the line buffer is already empty, BEL is echoed.
5. CR is echoed as CR, LF, plus the user-defined quantity of NUL characters. It is stored in the line buffer as an end-of-line marker (@0A). Once this has been done, the contents of the line buffer are transferred to the input cyclic buffer and the line buffer is then cleared
6. Any character other than CR which would cause the line buffer to

contain as many characters as the user-programmed line length is discarded and echoed as BEL.

7. When parity is enabled, any character received with a parity error is replaced in the line buffer with @FF and is echoed back to the VDU as SUB. Thus, if the VDU displays an upside-down question mark for SUB (@1A), the operator will be able to back space to any symbol of this type on the line and overkey the character to re-transmit it to the printer/Keyboard Port. However, after the end of the line has been reached, as indicated by CR, any such error cannot subsequently be corrected.

XOFF and XON are generated automatically by some VDUs (e.g. DEC VT101 set up for smooth scroll). They may also usually be generated by keying Ctrl-S and Ctrl-Q respectively.

Output data is taken from the output cyclic buffer after the previous output has finished. However, transmission does not commence until an ETX (@03) character or an end-of-line marker (@0A) is found.

The exception to this is if the program calls for output to commence while the operator is also keying in data on the keyboard. In this case, the output will skip to a new line (by sending CR, LF, and NULs if programmed), then display the output line. Upon completion of the output line, the contents of the line buffer are re-output (preceded by CR-LF plus NULs if the cursor is not already at the left-hand margin), followed by the echo of any characters which were entered during the output.

4.4.3 Free Format Mode

This mode is intended to be used with any serial device. This mode is the same as the direct mode except that all data from 00H to FFH can be transmitted and received and no formatting of the data will take place. The transmit data is sent as soon as it is placed in the transmit buffer by the GEM80 Special Functions. The detection of parity errors is reported by setting an error bit in the CHARIN GEM80 Special Function to indicate a parity error.

Using this mode the user should be able to control serial devices using simple serial link protocols by manipulating the received and transmit data in the ladder program.

4.5 Serial communications between two or more GEM80 Controllers (ESP Protocol)

When communication is required between two or more GEM80 controllers, the serial port of one of the controllers must be used as a control port and the rest as tributaries. The control port can receive data from and transmit data to all the tributaries, and controls the transmission and reception of data within the system. The tributaries can only receive data from and transmit data to the control port, though data can be transferred between tributaries via the control port.

Serial Communication between two or more GEM80 Controllers is described in more detail in the GEM80-400 T1614 Technical Manual.

4.5.1 Operation as an ESP Tributary Port

Table 4-3 shows the P-table data used to configure each GEM80-500 Controller Serial Port as an ESP tributary. Table 4-4 shows the J, K and I-table data associated with ESP Tributaries.

Table 4-3 Configuring an ESP Tributary Port: P-table data

Port 1	Port 2	Port 3	Port 4	Contents
P10	P30	P110	P130	Baud rate (110 to 19,200)
P11	P31	P111	P131	1
P12	P32	P112	P132	0 = Free running 1 = User control
P13	P33	P113	P133	Tributary address (0 to 14)
P14	P34	P114	P134	Number of tables to be transmitted (free running mode only) 0 to 32 for fixed data tables 0 to 128 for flexible data tables
P15 to P29	P35 to P49	P115 to P129	P135 to P149	Unused

Table 4-4 Configuring an ESP Tributary Port: J, K and I-table data

Port 1	Port 2	Port 3	Port 4	Contents
J0 to J255	J256 to J511	J512 to J767	J768 to J1023	J-table (Data received by the controller)
K0 to K255	K256 to K511	K512 to K767	K768 to K1023	K-table (Data to be transmitted by the controller)
I0	I40	I80	I120	Flags – SEND FLAG Bit 0 of the word – RECEIVE FLAG Bit 8 of the word
I1	I41	I81	I121	Quantity of words received or transmitted – Bits 8 to 15 received length – Bits 0 to 7 length to transmit

4.5.2 Operation as an ESP Control Port

Each ESP control port can be used either with fixed J/K data tables, with message length limited to a maximum of 32 words, or with flexible data tables that allow a maximum message length of 128 words per route (subject to a total J/K table allocation of 256 words per port).
Table 4-5 shows the P-table addresses and data used to configure the port. When the port is configured as an ESP control port, data is received and transmitted at the data table addresses shown at Table 4-6. I-table information to operate the serial link in the user control mode is shown at Table 4-7. Recompile to implement any changes to the P-table. Changes to transmission lengths and tributary selections are effective immediately.

Note:

ESP control ports will only operate when the controller is in the following states: Running, Normal Inputs; Running, Tests Inputs. They will not operate when the controller is in any other state.

Table 4-5 Configuring an ESP Control Port

Port 1	Port 2	Port 3	Port 4	Contents
P10	P30	P110	P130	Baud rate (110 to 19,200)
P11	P31	P111	P131	2 (ESP Control Port Mode)
P12	P32	P112	P132	0 = Free running Mode 1 = User control Mode
P13	P33	P113	P133	Bits 0 to 7 enable transmission to addresses 0 to 7
P14	P34	P114	P134	Number of tables to be transmitted to address 0
P15	P35	P115	P135	Number of tables to be transmitted to address 1
P16	P36	P116	P136	Number of tables to be transmitted to address 2
P17	P37	P117	P137	Number of tables to be transmitted to address 3
P18	P38	P118	P138	Number of tables to be transmitted to address 4
P19	P39	P119	P139	Number of tables to be transmitted to address 5
P20	P40	P120	P140	Number of tables to be transmitted to address 6
P21	P41	P121	P141	Number of tables to be transmitted to address 7
P22 to P29	P42 to P49	P122 to P129	P142 to P149	Unused

Table 4-6 J - and K-Tables for an ESP Control Port

Port 1	Port 2	Port 3	Port 4	Function
J/K 0 to 31	J/K 256 to 287	J/K 512 to 543	J/K 768 to 799	Tributary Address 0
J/K 32 to 63	J/K 288 to 319	J/K 544 to 575	J/K 800 to 831	Tributary Address 1
J/K 64 to 95	J/K 320 to 351	J/K 576 to 607	J/K 832 to 863	Tributary Address 2
J/K 96 to 127	J/K 352 to 383	J/K 608 to 639	J/K 864 to 895	Tributary Address 3
J/K 128 to 159	J/K 384 to 415	J/K 640 to 671	J/K 896 to 927	Tributary Address 4
J/K 160 to 191	J/K 416 to 447	J/K 672 to 703	J/K 928 to 959	Tributary Address 5
J/K 192 to 223	J/K 448 to 479	J/K 704 to 735	J/K 960 to 991	Tributary Address 6

J/K 224 to 255	J/K 480 to 511	J/K 736 to 767	J/K 992 to 1023	Tributary Address 7

Table 4-7 I-Table for an ESP Control Port

Port 1	Port 2	Port 3	Port 4	Contents
I0	I40	I80	I120	Transmit and receive flags Bit 0 = Transmit flag tributary address 0 Bit 1 = Transmit flag tributary address 1 Bit 2 = Transmit flag tributary address 2 Bit 3 = Transmit flag tributary address 3 Bit 4 = Transmit flag tributary address 4 Bit 5 = Transmit flag tributary address 5 Bit 6 = Transmit flag tributary address 6 Bit 7 = Transmit flag tributary address 7 Bit 8 = Receive flag tributary address 0 Bit 9 = Receive flag tributary address 1 Bit 10 = Receive flag tributary address 2 Bit 11 = Receive flag tributary address 3 Bit 12 = Receive flag tributary address 4 Bit 13 = Receive flag tributary address 5 Bit 14 = Receive flag tributary address 6 Bit 15 = Receive flag tributary address 7
I1	I41	I81	I121	Tributary 0, Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 32 bits 8 to 15 (Rx) = 0 to 32)
I2	I42	I82	I122	Tributary 1, Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 32 bits 8 to 15 (Rx) = 0 to 32)
I3	I43	I83	I123	Tributary 2, Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 32 bits 8 to 15 (Rx) = 0 to 32)
I4	I44	I84	I124	Tributary 3, Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 32 bits 8 to 15 (Rx) = 0 to 32)
I5	I45	I85	I125	Tributary 4, Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 32 bits 8 to 15 (Rx) = 0 to 32)
I6	I46	I86	I126	Tributary 5, Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 32 bits 8 to 15 (Rx) = 0 to 32)
I7	I47	I87	I127	Tributary 6, Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 32 bits 8 to 15 (Rx) = 0 to 32)
I8	I48	I88	I128	Tributary 7, Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 32 bits 8 to 15 (Rx) = 0 to 32)
I9 to I39	I49 to I79	I89 to I119	I129 to I159	Unused

4.5.3 Operation as an ESP Control Port with Flexible Data Tables

Table 4-8 shows the P-table data for an ESP control port using flexible data tables.

Table 4-8 Configuring an ESP Control Port using Flexible Data Tables

Port 1	Port 2	Port 3	Port 4	Contents
P10	P30	P110	P130	Baud rate (110 to 19,200)
P11	P31	P111	P131	3 (Flexible ESP Control Port Mode)
P12	P32	P112	P132	0 = Free running Mode 1 = User control Mode
P13	P33	P113	P133	Bits 0 to 7 enable transmission to addresses 0 to 7 bits 8 to 15 unused
P14	P34	P114	P134	Number of tables to transmit/assign – Route 0 (Maximum Value 128)
P15	P35	P115	P135	Number of tables to transmit/assign – Route 1 (Maximum Value 128)
P16	P36	P116	P136	Number of tables to transmit/assign – Route 2 (Maximum Value 128)
P17	P37	P117	P137	Number of tables to transmit/assign – Route 3 (Maximum Value 128)
P18	P38	P118	P138	Number of tables to transmit/assign – Route 4 (Maximum Value 128)
P19	P39	P119	P139	Number of tables to transmit/assign – Route 5 (Maximum Value 128)
P20	P40	P120	P140	Number of tables to transmit/assign – Route 6 (Maximum Value 128)
P21	P41	P121	P141	Number of tables to transmit/assign – Route 7 (Maximum Value 128)
P22 to P29	P42 to P49	P122 to P129	P142 to P149	Unused

Note:

The maximum total number of tables to be shared between all the tributaries is 256 per port.

J- and K-Tables for an ESP Control Port with Flexible Data Table Allocation

The following description is for Port 1, but applies equally to ports 2 to 4 if the relevant tables are substituted.

Port 1 is configured as a control port with flexible data table allocation when P11 = 3. The tables are allocated according to the two-byte values set in P14 to P21. The number of tables allocated to a route is the greater of the high and low byte set in each P-table. Each route is assigned consecutively as shown at Table 4-9. See also Table 4-10.

Table 4-9 Route Assignment for J- and K-Tables

P-table	Bits 8 to 15 (J - tables)	Bits 0 to 7 (K-tables)	J/K-tables assigned.
P14 = @0020	0	32_{10}	Assigns 32 tables, J0 to J31 and K0 to K31 to Route 0
P15 = @3420	52_{10}	32_{10}	Assigns the next 52 tables, J32 to J83 and K32 to K83 to Route 1
P16 = @1002	16_{10}	2_{10}	Assigns the next 16 tables, J84 to J99 and K84 to K99 to Route 2
P17 = @0048	0	72_{10}	Assigns the next 72 tables, J100 to J171 and K100 to K171 to Route 3

Table 4-10 I-Table for an ESP Control Port using Flexible Data Tables

Port 1	Port 2	Port 3	Port 4	Contents
I0	I40	I80	I120	Transmit and receive flags Bit 0 = Transmit flag, Route 0 Bit 1 = Transmit flag, Route 1 Bit 2 = Transmit flag, Route 2 Bit 3 = Transmit flag, Route 3 Bit 4 = Transmit flag, Route 4 Bit 5 = Transmit flag, Route 5 Bit 6 = Transmit flag, Route 6 Bit 7 = Transmit flag, Route 7 Bit 8 = Receive flag, Route 0 Bit 9 = Receive flag, Route 1 Bit 10 = Receive flag, Route 2 Bit 11 = Receive flag, Route 3 Bit 12 = Receive flag, Route 4 Bit 13 = Receive flag, Route 5 Bit 14 = Receive flag, Route 6 Bit 15 = Receive flag, Route 7
I1	I41	I81	I121	Route 0, Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 128 bits 8 to 15 (Rx) = 0 to 128)
I2	I42	I82	I122	Route 1, Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 128 bits 8 to 15 (Rx) = 0 to 128)
I3	I43	I83	I123	Route 2, Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 128 bits 8 to 15 (Rx) = 0 to 128)
I4	I44	I84	I124	Route 3, Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 128 bits 8 to 15 (Rx) = 0 to 128)
I5	I45	I85	I125	Route 4, Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 128 bits 8 to 15 (Rx) = 0 to 128)
I6	I46	I86	I126	Route 5, Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 128 bits 8 to 15 (Rx) = 0 to 128)

Port 1	Port 2	Port 3	Port 4	Contents
I7	I47	I87	I127	Route 6, Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 128 bits 8 to 15 (Rx) = 0 to 128)
I8	I48	I88	I128	Route 7, Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 128 bits 8 to 15 (Rx) = 0 to 128)
I9	I49	I89	I129	Route 0, Tx and Rx addresses (bits 0 to 7 (Tx) = 0 to 15 bits 8 to 15 (Rx) = 0 to 14)
I10	I50	I90	I130	Route 1, Tx and Rx addresses (bits 0 to 7 (Tx) = 0 to 15 bits 8 to 15 (Rx) = 0 to 14)
I11	I51	I91	I131	Route 2, Tx and Rx addresses (bits 0 to 7 (Tx) = 0 to 15 bits 8 to 15 (Rx) = 0 to 14)
I12	I52	I92	I132	Route 3, Tx and Rx addresses (bits 0 to 7 (Tx) = 0 to 15 bits 8 to 15 (Rx) = 0 to 14)
I13	I53	I93	I133	Route 4, Tx and Rx addresses (bits 0 to 7 (Tx) = 0 to 15 bits 8 to 15 (Rx) = 0 to 14)
I14	I54	I94	I134	Route 5, Tx and Rx addresses (bits 0 to 7 (Tx) = 0 to 15 bits 8 to 15 (Rx) = 0 to 14)
I15	I55	I95	I135	Route 6, Tx and Rx addresses (bits 0 to 7 (Tx) = 0 to 15 bits 8 to 15 (Rx) = 0 to 14)
I16	I56	I96	I136	Route 7, Tx and Rx addresses (bits 0 to 7 (Tx) = 0 to 15 bits 8 to 15 (Rx) = 0 to 14)
I17 to I39	I57 to I79	I97 to I119	I137 to I159	Unused

4.5.4 Operation as a Control Port

The control port can be operated in a free-running mode or user-control mode. Data table transfers occur only between user program scans, and the I-table is also only examined between scans in user-control mode. If a message is received that is longer than the space allocated, the message is truncated and a fault flag is set; see Section 7 - Maintenance and Fault Finding for further information.

Full details of each mode of operation are included in the GEM80-400 T1614 Technical Manual.

The modes are:

(a) Free-Running Mode;

(b) User-Control Mode;

(c) Extended Time-out Option;

(d) Broadcast Message Facility.

5. Programming

5.1 Introduction

This section includes details for the programming of a GEM80-500 Controller. Many of the features which are common to other GEM80 systems are cross-referenced to other GEM80 documents.

The Instruction Set, and all the data tables, applicable to the GEM80-500 Controller are included in this section of the manual.

5.2 Programming

The GEM80-500 Controller uses the standard GEM80 programming language. Refer to the T391 GEM80 Ladder Diagram Language Programming Manual for comprehensive details.

Those programming details which are special to the GEM80-500 Controller are included in this manual.

5.2.1 Programmer Units and Tools

To obtain the correct display of diagnostic messages and to use the on-line program editing facility a suitable GEM80 Programming Package is required.

5.2.2 Remote Programming

A suitable GEM80 Programming Package can operate on a multi-drop serial link connected to several controllers at whatever signalling rate is selected by the user. The signalling rate which will be satisfactory for the given distance between the controller and a GEM80 Programming Package, can be found by consulting the 'Serial Links User Information Sheet', Publication No.T456, and the 'Serial Communications Manual', Publication No.T457. Also refer to 'Remote Programming' at Section 4 of the T1614 GEM80-400 Technical Manual for further details.

5.2.3 Program and Data Table Capacity

- Program capacity : 20 K instructions
- Data Table capacity : 30 K tables
- User Messages : 30 K characters

The user messages are stored in a separate area to the data tables, and do not take up data table space. However, they do take up half of a P-table address per character and therefore reduce the number of P-table addresses available to the user program.

5.2.4 Message Editing Facility

The controller includes facilities for entering and editing message format definitions and can include literal and replacement characters. The message formats are handled as a single list which the controller automatically manages as the definitions are entered, edited or deleted. A print-out facility lists the message formats in a numbered

and readily understandable form. Text messages, edited in a suitable GEM 80 Programming Package, can be stored in the GEM 80 data tables. The controller can be programmed to output messages to selected serial ports using the GEM 80 Special Functions S38 PRITEXT and T38 PRINT.

5.2.5 Connecting a Suitable GEM 80 Programming Tool

A suitable GEM 80 Programming Package is connected to the Programming Port, Port 0, of the GEM 80-500 Controller, via a lead, appropriate to that programming tool. When a suitable GEM 80 programming tool is connected to Port 0, the GEM 80-500 Controller automatically detects its presence and selects the correct baud rate (either 9,600 or 19,200 baud). Wiring details for the Programming Connection Port are given at 5.2.6.

5.2.6 Programming Port (Port 0) Connections

The Programming port connector is a 15-way, female, 'D'-type socket connector with threaded retention pillars. The pinouts are as shown at Figure 5-1 and the functions for each pin are listed at Table 5-1.

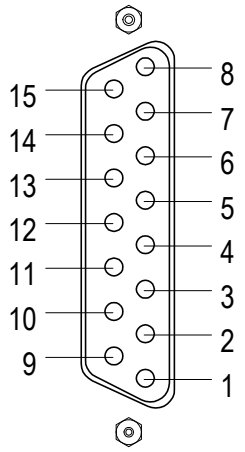


Figure 5-1 Programmer Port (Port 0) Pinouts

Table 5-1 Pin functions for Programmer Port (Port 0)

20 mA Connections			RS232 Connections		
Pin	**Connection**	**Remarks**	**Pin**	**Connection**	**Remarks**
1	Rx+	External current source required Do not use GEM80 current sources except when connecting to a local programming tool otherwise isolation will be compromised	9	RXD	The RS232 port is not isolated from the Controller 0V.
2	Rx-		10	TXD	
3	Tx+		11	CTS	
4	Tx-		12	RTS	
5	ST+		13	-	Make No connection
6	ST-		14	0V	Non-isolated
7	SR+		15	5V	Non-isolated

8	SR-				

If it is to be connected to a suitable GEM80 Programming Package, using RS232 then link the following:

Pin 1 to Pin 7
and
Pin 2 to Pin 8.

5.2.7 Program Compilation

The user program is stored in two forms:

(a) as 'source' code for editing purposes;

and

(b) as 'compiled' form for execution by the processor.

Conversion from source code to compiled code is called 'Compilation' and is carried out under the following conditions:

(1) At power up (automatically).

(2) On halt/run transitions.

(3) When the user issues a RECOMPILE command while the program is running.

(4) On single cycle when the program has been changed since the controller was last running.

Compilation not only converts the program into an executable form but also checks the source program to verify that it can be executed. Any error detected during compilation prevents the program being executed and if the controller was previously running a version of the program it continues to run this 'old' program. The errors are reported by text messages and can be displayed by a suitable GEM 80 Programming Package; a detailed discussion of compilation and associated problems is given at Section 7.

Errors detected during compilation will prevent the program being executed.

5.2.8 On-line Program Changes

There are two versions of the program held in memory, compiled and source. The source program can be edited while the compiled program is running and controlling the plant. This edited version can be printed out or copied to disk without halting the controller. To incorporate the changes made during an editing session, the user can issue a RECOMPILE command from a suitable GEM80 Programming Package. The controller will pause for a short time (typically one millisecond per 1000 instructions) while compilation is in progress and during this time, all outputs are frozen and inputs are ignored. If compilation is successful, the controller will run the modified program. If not, the controller will run the previous compiled program. A message to this effect will be displayed on the alphanumeric display on the controller front panel.

Note:

Any change to P-table data above P149 will affect the running program immediately without recompilation being necessary. Refer to the Data Tables in this section for more information.

The on-line RECOMPILE command does not affect data table contents. After any RECOMPILE command has been successfully executed, flag bit E0.6 is set ON for one program cycle, and then set OFF again. This flag bit can be used to initiate any block of instructions that needs to be executed once only.

Note:

On-line program changes cannot be made on Flash EPROM based systems.

5.2.9 Off-line Program Debugging

Using TEST INPUTS mode, a program can be de-bugged on a system in the office with no I/O present. Program timing is not significantly altered compared with when the I/O is present. When the TEST INPUTS mode is selected from a suitable GEM80 programming tool:

(a) The Watchdog contacts do not close.

(b) Input scanning is executed but the A-tables are not updated.

(c) Output scanning is executed.

(d) All I/O self tests are suspended.

(e) All compilation checks on the presence of both Basic and Verification I/O are suspended.

(f) All Serial Link protocols function normally during TEST INPUTS mode.

5.2.10 Loading Programs

Before loading a program, it is recommended that a CLEAR STORE command is always issued, for the following two reasons:

(a) The area of memory that holds printer messages is not normally write-accessible except via the message editor facility. The CLEAR STORE command allows data to be loaded into the area.

(b) The controller allocates memory space for the data tables according to the content of the ladder program. The CLEAR STORE command sets all data table areas to their minimum size, and ensures that unnecessary space has not been allocated by the previous version of the program.

When a CLEAR STORE command is issued, the whole of the P-table is cleared except for P0 to P149. These table locations include the configuration data for the serial links. These sections of P-table are not cleared because the GEM 80-500 Controller may be programmed either from the front port of the controller, or remotely via one of the serial ports. If the controller lost data about the serial port configurations, it might become impossible for the controller to communicate with a remote programming tool. This data is therefore retained even when the rest of the memory is cleared.

Note:

When the data being loaded includes messages, the message area, made write-accessible by the CLEAR STORE command, becomes write-protected again after compilation, except via the message editor.

5.2.11 Programming the Controller

User programs for operating the GEM 80-500 Controller are written in the GEM 80 Ladder Diagram Programming Language. Full details of how to use this programming language, how to program the controller and the use of the Standard Instruction Set are contained in the 'GEM 80 Programming Manual', Publication No.T391.

Note:

Flash EPROM based systems cannot be programmed, only downloading to a suitable GEM 80 Programming Package is allowed.

5.3 User Program

5.3.1 Introduction

The GEM800-500 Controller User Program uses the GEM80 Ladder Diagram programming and this subject is dealt with, in detail, in the GEM80 Programming Manual Publication No. T391.

5.3.2 GEM80-500 Controller Instruction Set

The GEM80-500 Controller has the same Instruction Set as the GEM80-400 Controller except for the GEM80 Instructions listed at Table 5-3 which are not included.

The comprehensive instruction set includes standard GEM80 Instructions and GEM80 Special Functions. They fall into the following categories:

(a) Relay Replacement Functions;

(b) Logic Functions;

(c) Maths Functions (Integer);

(d) Signal Processing;

(e) Closed Loop Control;

(f) Binary Tests;

(g) Binary Manipulation;

(h) Numerical Tests;

(i) Numerical Manipulation;

(j) Block Instructions;

(k) Data Moving Instructions;

(l) Code Conversion;

(m) Serial Port Alphanumeric Input and Output;

(n) Output Functions;

(o) GEM 80-500 Additional Special Functions.

Details of the Standard Instruction Set are contained in the 'GEM80 Programming Manual', Publication No.T391. However, GEM80-500 Additional Instructions, namely: Set Coil, Reset Coil, Jump, Label and Seqelem, are not contained in the 'GEM80 Programming Manual', Publication No. T391, but are detailed in the GEM80-400 Technical Manual T1614. Table 5-2 details the GEM80-500 Instruction Set.

Table 5-2 GEM80-500 Controller Instruction Set

	Function	Instruction	GEM 80 Special Function	Remarks	Number of Instructions	Number of Table Locations used by VALUE	Execution Time in μs
1. Relay Replacement Functions	N/O contact	---] [---	-	Functions as a normally open relay contact	1	-	1.35
	N/C contact	---]/[---	-	Functions as a normally closed relay contact	1	-	1.35
	Coil	---( )---	-	Functions as a relay coil	1	-	2.75
	Set coil	---(S)---	-	Set retentive coil	1	-	-
	Reset coil	---(R)---	-	Reset retentive coil	1	-	-
	Output	OUT	-	Outputs 16-bit word to a specified data table location	1	-	1
	Time Delay	DELAY	-	Time range 100ms to 54 minutes	1	-	7
	Counter	COUNT	-	Counter with a capacity of 32,767 (resettable)	1	-	12
	Sequencer	SEQR	-	16-step Sequencer with reset	1	-	7
2. Logic Functions	Logic AND	AND	-	Bit-by-bit ANDing of 2 × 16-bit words	1	-	*0.3/0.85
	Logic AND group of words	ANDGRP	T24	Bit-by-bit ANDing of 2 groups of 16-bit words	2	3	See Note 1
	Logic OR	OR	-	Bit-by-bit ORing of 2 × 16-bit words	1	-	*0.3/0.85
	Logic OR group of words	ORGRP	T25	Bit-by-bit ORing of 2 groups of 16-bit words	2	3	See Note 1
	Logic exclusive OR	XOR	-	Bit-by-bit XORing of 2 × 16-bit words	1	-	*0.3/0.85
	Exclusive OR group of words	XORGRP	T26	Bit-by-bit XORing of 2 groups of 16-bits words	2	3	See Note 1
	Invert	INV	-	Inverts each bit of 16-bit word	1	-	0.2
	Invert group	INVGRP	S25	Inverts each bit of a group of 16-bit word	2	3	See Note 2
	Sequence diagnostics	SEQDIAG	T19	Enables automatic monitoring of any sequence of events	2	11 + N (See also Note 3)	<12
3. Math Functions	Addition	ADD	-	Addition of Floating point/Integer values, limits +32767 to-32768	1	-	*5.7/6.35
	Array addition	ADDARAY	T12	Addition of arrays, limits +32767 to -32768	2	3	See Note 4

	Function	Instruction	GEM 80 Special Function	Remarks	Number of Instructions	Number of Table Locations used by VALUE	Execution Time in μs
	Subtraction	SUB	-	Subtraction of Floating point/Integer values, limits +32767 to -32768	1	-	7
	Array subtraction	SUBARAY	T13	Subtraction of arrays, limits +32767 to -32768	2	3	See Note 4
	Multiply	MULT	T10	Multiplication of Floating point/Integer values, limits +32767 to -32768	1	-	9
	Array multiplication	MULARAY	T14	Multiplication of arrays, integer multiplication limits +32767 to -32768	2	3	See Note 5
	Division	DIV	T11	Division of Floating point and Integer values, integer division limits +32767 to -32768	2	1	14
	Array division	DIVARAY	T15	Integer division limits +32767 to -32768	2	4	See Note 6
	Linear conversion	LINCON	S11	Provides arithmetic calculation	2	4 (See also Note 7)	68
	Array linear conversion	CONARAY	S10	Provides multiplication, division and addition calculations for two arrays of data, i.e. performs LINCON on array	2	3 + 3N (See also Note 9)	See Note 8
	Square root	SQRT	S12	Square root, limits +32767 to -32768	2	1	78
	Checksum	CHKSUM	T9	Calculates the checksum of data table contents	2	1	See Note 10
	Standard Deviation	STDDEV	T18	Calculate mean and standard deviation of a number of values	2	11	See Note 11
4. Signal Processing	Debounce input signal	DBOUNCE	S0	Provides signal conditioning to logic signals prone to spurious or transient problems	2	5 (See also Note 7)	36
	Function generator	FGEN	S30	Approximate continuous function	2	4 + N (See also Note 9)	125
	Dead band	DEDBAND	S31	Deadband offset	2	3 (See also Note 7)	18
	Limiter	LIMIT	S32	Limits input between high and low limits	2	3 (See also Note 7)	28
	Ramp generator	RAMP	S33	Comprehensive ramp generator (includes rounding), variable rate with output limits	2	15 (See also Note 7)	287
	First order time constant	ANALAG	S37	First order digital filter to smooth fluctuating numerical values	2	5 (See also Note 7)	61
	Time constant	TCONST	S60	Digital filter programmable time constant	2 OR 1	- OR 6	≈500
	Ramp generator	RAMPGEN	S61	Time independent ramp generation	2 OR 1	- OR 13	≈900
5. Closed Loop Control	Absolute 3 term controller	PIDABS	S34	Provides absolute proportional, integral and derivative control with absolute output	2	15 (See Note 7)	165
	Incremental 3 term controller	PIDINC	S35	Provides incremental, proportional, integral and derivative control with incremental output	2	9 (See Note 7)	144

	Function	Instruction	GEM 80 Special Function	Remarks	Number of Instructions	Number of Table Locations used by VALUE	Execution Time in μs
	Incremental output	INCOUT	S36	Incremental output with limits and deadband	2	5 (See Note 7)	94
6. Binary Tests	High state	HISTATE	S3	Reports bit number of highest bit of 16-bit word set on (1)	1	-	16
	Bits ON	BITSON	S26	Reports number of bits set on (1) in a group of 16-bit words	2	2	See Note 12
	Compare group	CMPGRP	T21	Compares two groups of 16 bits and reports details of the first difference	2	3	See Note 13
	Get bit	GETBIT	T22	Performs a test of on state individual bits in group of words	2	2	50
7. Binary Manipulation	Swaps 1/2 locations	SWAP	S4	Swap 1/2 locations	1	-	1
	Shift	SHIFT	S27	Left and right shift on a group of 16-bit words	2	3	See Note 14
	Rotate	ROTATE	S28	Left and right rotation on a group of 16-bit words	2	3	See Note 14
	Put bit	PUTBIT	T23	Allows setting and resetting of individual bits in groups of words	2	3	See Note 15
	Shifts bits in words	QSHIFT	T27	Shifts bits of words left or right	1	0	7-10
	Rotate bits in words	QROTATE	T28	Rotates bits of words left or right	1	0	8-24
8. Numerical Tests	Compare	COMPARE	T0	Compares two inputs and shows whether they are equal, unequal, etc. These GEM 80 Special Functions report if:	2	1	11
	Comparison	EQ	T1	(a) X=Y, Test for equality	1	0	3
	-	NE	T2	(b) X≠Y, Test for inequality	1	0	3
	-	GT	T3	(c) X greater than Y	1	0	3
	-	LT	T4	(d) X less than Y	1	0	3
	-	GE	T5	(e) X greater than/= Y	1	0	3
	-	LE	T6	(f) X less than/= Y	1	0	3
	Select maximum in array	MAXARAY	S13	Finds maximum value in array	2	3	See Note 16
	Select minimum in array	MINARAY	S14	Finds minimum value in array	2	3	See Note 16
	Select maximum	MAX	T7	Finds maximum of two inputs	1	0	15
	Select minimum	MIN	T8	Finds minimum of two inputs	1	0	15
	Compare Array	CMPARAY	T16	Array comparison	2	4	See Note 17
	Delay Array	DELARAY	S15	Multiple delay array	-	-	See Note 18
	Negate	NEGATE	S5	Changes the sign of a number	1	0	1.5
	Absolute	ABS	S6	Makes a number positive	1	0	1.5
	Non-zero	NONZERO	S7	Convert non-zero input into integer -1	1	0	1.5
9. Block Instructions	Enclose conditionally executed rungs	START OF BLOCK	-	Conditionally executed block of ladder diagram instructions can be nested to a depth of 16	1	-	1.5

	Function	Instruction	GEM 80 Special Function	Remarks	Number of Instructions	Number of Table Locations used by VALUE	Execution Time in μs
	-	END OF BLOCK	-	-	1	-	-
	-	JUMP	-	JUMP forward to LABEL	-	-	-
	-	LABEL	-	LABEL associated with JUMP	-	-	-
	-	SEQELEM	-	Sequence element	-	-	-
10. Data Moving	Locate data table address	LOCATE	S20	These two GEM 80 Special Functions, S20 and T20, are usually used together for moving groups of data from one area of memory to another. May be used for locating an internal address required by various GEM 80 Special Functions. Provides pointer to data table	2	1	100
	Move data between data table addresses	MOVE	T20	Commonly used in conjunction with S20, moves blocks of data tables	2	0 or 1	See Note 19
	Cyclic store	STORE	T30	First in first out store	2	4 + N (See Note 20)	130
	Get word	GETWORD	S19	Indirect data access	2	1	96
	Fill array	FILL	T17	Fill array with value	2	0 or 1	See Note 21
	Put word	PUTWORD	T29	Indirect output of word	2	1	96
	Collate	COLLATE	T37	Collates random bits or words into a group of adjacent data table locations	1	0	See Note 22
11. Code Conversion	BCD input conversion	BCDIN	S1	Converts up to 4 decades of BCD to binary	1	0	36
	BCD output conversion	BCDOUT	S2	Converts binary to up to 4 decades of binary coded decimal	1	0	32
	Convert gray code to binary	GRAYBIN	S9	Converts gray code input to binary	2	1	29
12. Serial Port Alpha-numeric Input and Output	Print text	PRITEXT	S38	Enables messages stored in controller memory to be output to serial port/printer	2	(C + 1)/2 (See Note 23)	144
	Print	PRINT	T38	Enables user definable messages to be output on a serial port/printer	2	N (See Note 25)	See Note 24
	Character input	CHARIN	T39	Read input from serial port	2	(C + 1)/2 (See Note 23)	115
	Message store OR retrieval	GETTEXT	S21	Store message strings	2 OR 1	2	-
13. Output Functions	Output	OUTPUT	S8	Intermediate output from rung	2	1	1.5
14. GEMLAN-T	Opens a communication channel	LOPEN	T62	See GEMLAN-T Manual T2011	2	2	See Note 27
	Requests Data	LREAD	T64	See GEMLAN-T Manual	2	6	See Note 27
	Sends Data	LWRITE	T63	See GEMLAN-T Manual	2	6	See Note 27
	Closes Communication channel	LCLOSE	S62	See GEMLAN T Manual	2	2	See Note 27
	History record of status changes	LSTATUS	S63	See GEMLAN T Manual	2	4	See Note 27
15	Time Delay	TON	S125	Timer with ON Delay	2	1	7

	Function	Instruction	GEM 80 Special Function	Remarks	Number of Instructions	Number of Table Locations used by VALUE	Execution Time in μs
GEM 80-500 Additional Special Functions	Time Delay	TOFF	S126	Timer with OFF Delay	2	1	7
	Time Delay	TP	S127	Timer with Pulse Output	2	1	7
		TOGGLE	S128	Toggle Flip-flop	2	1	7
		ONESHOT	S129	One-shot, ON for one scan	2	1	7
		SEQGRP	T111	Sequence Group	2	See Note 28	
		SR	T112	SR Flip-flop	1	-	2.75
		RS	T113	RS Flip-flop	1	-	2.75
		CLOCK	S55	Real time clock	2	6	68
		FIPCFG	S145	FIP configuration (FIP interface module required)	2	See Note 26	See Note 27

Notes on Table 5-2:

* Constant/Table

(1) 100 + (6 x Qty) - Array with array; 75 + (5 x Qty) - Array with constant

(2) 63 + (3 x Qty)

(3) N = 2 × Number of transitions

(4) 115 + (10 x Qty) - Array with array; 95 + (9.5 x Qty) - Array with constant

(5) 115 + (8 x Qty) - Array with array; 95 + (8 x Qty) - Array with constant

(6) 120 + (14 x Qty) - Array with array; 100 + (13 x Qty) - Array with constant

(7) Typically uses stated number of locations in both preset and working tables

(8) 62 + (40 × Qty) - Array with array; 55 + (38 × Qty) - Array with constant

(9) N = number of tabulated points or array length

(10) 36 + (13.5 × Qty)

(11) Acquire 540μs, Reset 250μs, Calculate 14,500, Acquire + Calculate 18,000

(12) Simple 43, Group 43 + (38 × Qty)

(13) 72 + (8 x Qty)

(14) 80 + (8 + (0.5 × shift) × Qty)

(15) Simple 22, Group 54

(16) 43 + (6 × Qty)

(17) 136 + (10 x Qty) - Array with array; 100 + (8.5 x Qty)

(18) Reset 194, Run 136 + (13 × qty) + (7 × qty while running) + (17 × qty when reset)

(19) 72 + (0.7 × qty)

(20) 4 + store length

(21) 94 + Qty

(22) 360 + (11 x message number) + (110 x number of words) + (120 x number of bits)

(23) (message length)/2

(24) For text (4 × message number) + 190, for text and numbers (4 × message number) + (260 to 575)

(25) N = quantity of numbers to be output

(26) Number of table locations used is variable. See FIP Manual T1653.

(27) Time of execution is dependent on a number of factors and is impossible to predict.

(28) See later in chapter for examples of this function.

(29) 5800+ 600 per channel

(30) 700 + 800 per block of 111 words + (7 * Qty. of locations)

(31) 900 + 500 per block of 111 words + (7 * Qty. of locations)

5.4 Differences between the GEM80-400 and GEM80-500 Instruction Sets

Table 5-3 lists the GEM80 Instructions which are included in the GEM80-400 Controller but not in the GEM80-500 Controller.

5.5 Programming Procedures

5.5.1 Declare Highest Address

Since data table sizes are computed by the controller from the user program (see 5.7.4) in some cases where addresses are not specifically stated in the user program, problems can occur. If the user wishes to access and use any P-table he must explicitly declare the highest table in the program, so securing the address range. Refer to the GEM80-400 T1614 Technical Manual for examples.

Some GEM80 Special Functions use groups of addresses which are not specifically written in the user program (LOCATE, MOVE, etc.) and the user must declare the highest address in each table where this occurs. Refer to the GEM80-400 T1614 Technical Manual for examples.

5.5.2 Storing Programs

As programming proceeds and especially when complete, copies of the program should be saved onto suitable media even if they are untested, so that at each stage as the program is developed, a nearly up to date copy of the program is available. This enables the programmer to back track quickly if necessary, by clearing store and re-loading, and gives back up should unforeseen problems occur. Both program instructions and P-table can be stored onto suitable media and, in fact, two records should be maintained by alternately storing the program first onto one media then the other at each stage of development. On completion, you should store two identical final programs which should be filed separately in two secure locations.

Table 5-3 GEM80 Instructions NOT IN the GEM80-500 Controller

Function	Instruction	GEM80 Special Function	Remarks
Maths Functions			
Sine	SIN	S70	Provides the sine of an angle, FP
Cosine	COSINE	S71	Provides the cosine of an angle, FP
Tangent	TANGENT	S72	Provides the tangent of an angle, FP
Arc sine	ASIN	S80	Provides the angle of a sine function, FP
Arcosine	ACOS	S81	Provides the angle of a cosine function, FP
Arc tangent	ARCTAN	S82	Provides the angle of a tangent function, FP
Degrees to radians	DEGRAD	S75	Converts degrees to radians
Radians to degrees	RADDEG	S85	Converts radians to degrees
Log to the base 10	LOG10	S73	Provides the logarithm to the base 10 of a value, FP
Log to the base e	LOGE	S74	Provides the logarithm to the base e of a value, FP
Pi	PI	S77	Provides 'Pi' in FP
Exponential	EXP	S84	Raises 'e' to a specified power, e^x, FP
Standard Deviation	STDDEV	T18	Mean/Standard deviation calculation
Power	POWER	T70	Raises a value to a specified power, x^y, FP
Floating point scale	FSCALE	T73	Multiplies a value to a specified power of 10, $X \times 10^y$, FP
Closed Loop Control			
PID control	PIDCON	T60	Mode selectable time independent PID control
Programmable PID control	PIDSIM	T61	Programmable PID control
Numerical Manipulation			
Floating point to integer conversion	FPTOINT	S76	Floating point to integer
Error flag	FPFLAGS	S78	Floating point maths error
Integer conversion	FIX	S79	Convert floating point to BCD
Off Line Data Manipulation			
Clear Off Line Data	CLEAR	S29	Resets off line data
Put Off Line data	GET	T31	
Get off line data	PUT	T32	
Configure Ports	CONFIG	T33	Used to configure STARNET ports
Send Message	SEND	T34	Transmit outgoing data
Receive Message	RECEIVE	T35	Receive incoming data
Log Statistics	STATS	T36	Report STARNET errors and statistics

5.5.3 Storing Program and Presets in Flash EPROM

The user program, user messages and P-tables (presets) may be transferred to Flash EPROM for more permanent storage.

The Flash EPROM is integral to the GEM80-500 Controller.

The integral Flash EPROM may be erased and reprogrammed, in situ, by the GEM80-500 Processor. The contents of the Flash EPROM may be protected from modification by selecting Position 1 on the front panel Mode Switch.

When the system is "running in EPROM" the data is stored in the locations shown at Table 5-4.

Table 5-4 Storage Locations when the system is running in EPROM

Function	Flash Memory	RAM
Source for User Program	YES	NO
Compiled User Program	NO	YES (see Note 1)
User Text Messages	YES	YES (see Note 2)
P-Tables	YES	YES (see Note 2)
Other Data Tables	NO	YES

Notes:

(1) Generated by the compiler at power up using the User Program source.

(2) Copied from the Flash EPROM at power up. The controller cannot write to these areas.

5.5.4 Transferring Program and Presets to Flash EPROM

The system is transferred to and from Flash EPROM by writing commands in the form of values into the S0 table location. Please refer to the relevant programming tool manual for details.

Valid S0 commands are as follows:

0 Run from RAM

1 Run from Flash EPROM

2 Program Flash EPROM

Note:

S0 may only be changed when the controller is halted. When the controller is running S0 is write protected.

5.5.5 Programming Flash EPROM

To transfer the program into Flash EPROM, halt the controller and set S0 to 2. This causes the following sequence of events to occur:

(a) Stop scanning I/O

(b) Check Flash EPROM areas:

- The user Flash EPROM is checked to ensure that it is programmable.
- The Flash EPROM is erased. During this process “S/E” alternating with “BUSY” is written to the front panel display.
- The user’s program is copied to the Flash EPROM. During this process “PROG” alternating with “BUSY” is written to the front panel display.

If the check on the onboard Flash EPROM is unsuccessful, the transfer operation is aborted:

(1) Error messages are sent to the System Event Log and programming tool, and the corresponding error code is displayed.

(2) The controller remains halted.

(3) S0 remains unchanged. The controller cannot be run until S0 is set to 0.

Switch to Flash EPROM:

(i) The "EPROMS Successfully Programmed" message is sent to the System Event Log and programming tool.

(ii) The S0 table is set to 1.

(iii) The controller remains halted.

(iv) The word "Halt" is written to the alphanumeric display.

If the controller has been running from Flash EPROM but you wish to return to RAM operation, the controller must be halted and the S0 location set to a value of 0. This causes the contents of the Flash EPROM to be copied to RAM. When copying has finished a message is displayed on the programming tool screen, 'NOW READY TO RUN IN RAM'.

If the controller has been running in RAM, but you wish to run from Flash EPROM, halt the controller and set the S0 location to a value of 1. Provided the Flash EPROM is valid, this causes the controller to destroy the contents of RAM and switch to the program in Flash EPROM.

A message is displayed on the programming tool screen,

'NOW READY TO RUN IN EPROM'.

WARNING

The controller will automatically enter the RUN state when power is applied if ALL of the following are true:

- **The Flash EPROM contains a valid User Program.**
- **The front panel Mode Switch is set to 'Flash EPROM Protect' Position 1.**
- **The on-board battery has been unable to maintain the RAM content during power down.**

The consequences of above happening are:

- **The controller will use the ladder program and P Tables contained in the Flash EPROM and the watchdogs will close.**
- **All other data tables including R and W tables will be set to zero**
- **The fault log will be cleared.**
- **The Real Time Clock will be set to 01/01/93 12:00:00**

When the front panel Mode Switch is set to Position 0, the controller will not enter the RUN state if the RAM content is corrupt.

5.6 Watchdog Trip Initiated by User Program

Watchdog trips initiated by the user program may be achieved by writing a non-zero value into F1 and holding this non-zero code for at least one ladder scan. This is achieved by enclosing the instruction to write to F1 in an obey block.

Refer to the GEM80-400 T1614 Technical Manual for more details and a ladder rung diagram.

5.7 Data Tables

The data tables consist of 16-bit binary words of data stored in the memory and accessed by their address.

Each data table location may hold:

(a) 16 ON/OFF bits;

(b) A numerical value in the range -32,768 to +32,767.

5.7.1 Data Table Addressing

The data tables are addressed using the initial letter of the table followed by a number e.g. G41 points to the word 41 in the G-table. If, for example, we were to look at the content of data table address G1 it may be:

BIT NUMBER	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ACTUAL VALUE	0	0	0	0	0	0	0	0	1	0	1	1	0	0	1	0

To address individual bits in the G-table a decimal value is used, e.g. G41.2 points to bit 2 in word 41 of the G-table. If we were only interested in the content of one bit of G1, for example, bit 4, we would examine the data table address G1.4 and find that G1.4 = 1.

5.7.2 Data Storage Formats

The data table content can be interpreted as:

(a) An equivalent decimal number.

(b) 16 individual bits each of value 1 or 0.

(c) An equivalent hexadecimal number.

For example, address G2 may contain:

BIT NUMBER	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ACTUAL VALUE	1	0	1	0	1	1	0	0	0	0	1	1	0	1	0	1

which can be interpreted as:

BINARY	1	0	1	0	1	1	0	0	0	0	1	1	0	1	0	1
DECIMAL	-21451															
HEXADECIMAL	@AC35															

Decimal

As shown in the above example, when converting from binary to decimal, 2s-complement notation is used. Bit 15 is taken as the sign bit and the number displayed will be a signed integer within the range +32,767 to -32,768. When bit 15 = 1, a negative number is represented and when bit 15 = 0, a positive number or zero is represented.

Hexadecimal

The numbers are to base 16 and are denoted by a preceding '@'. The range of numbers covered is from @0000 to @FFFF.

Text

Text strings are stored using the ASCII format for use as messages.

5.7.3 Data Table Content and Addresses

Table 5-5 shows the addresses for the controller and also the information which is to be found in the memory locations.

5.7.4 Data Table Sizes

Data table sizes are calculated by the controller from the user program so that if, for example, the highest G-table address in the user program is G345 then G0 to G345 will be reserved.

Where addresses are implied (e.g. when using LOCATE and MOVE GEM 80 Special Functions) the user must include a dummy rung or rungs to declare the highest address (see 5.5.1 for full details).

When constructing the user program it should be borne in mind that memory wastage will occur if large gaps of unused data tables are left with only high numbered and low numbered tables used. Also, even if only one or two bits of a word are used, (e.g. G104.1) the whole word G104 is reserved by the controller.

A GEM80 Programming Package cannot work with bit addresses above 999.15. This restriction means for example, G999.15 can be used, but address G1000.1 cannot be used, as individual bits cannot be accessed. However, word G1000 can be used and words up to 30,000 can be used where access to individual bits is not required. The limitation is on the programming tool itself where there is space only for 7 characters on the screen.

5.7.5 Action of Clear Store on Data Tables

The CLEAR STORE command has the following effects:

(a) Removes the ladder diagram program from memory.

(b) Resets all data tables to zero except the E, F, V tables and P-table numbers 0 to 149, which have to be retained so that serial link configurations can be maintained. This is essential for remote programming.

(c) Removes all user defined messages.

Table 5-5 GEM80-500 Data Tables

Subject	Function	Data Table	Content	Min. Table Size	Maximum Table Size	Cleared to Zero at Halt/Run Transition	Cleared to Zero at Power Off/On	Cleared to Zero (by Clear Store Command)
I/O	Basic and Verification I/O Highway Data	**A**	These tables store the states of INPUT transducers connected to the Basic and Verification I/O Highways	0	The maximum A/B table size is dependent on which 'plug-in' modules are present e.g. with one 9713-4020 module present the maximum size is 1040 (16 + 1024) words (each 16 bits).	YES Except if R0.0 set	YES	YES
		B	These tables store the OUTPUT states (derived from the execution of the user program for output to the Basic and Verification I/O Highways	0		YES Except if R0.0 set	YES	YES
		C	These tables store data RECEIVED by the GEMCAN I/O Scaner module(s).	0	The maximum C/D table size is dependent on which 'plug-in' modules are present e.g. with one 9720-4020 module present the maximum size is 125 x 16 = 2000 words. With two modules present 4000 words.	YES Except if R0.0 set	YES	YES
		D	These tables store data derived by execution of the user program for TRANSMISSION by the GEMCAN I/O Scanner module(s).	0		YES Except if R0.0 set	YES	YES
	Serial Communication Links Data	**J**	These tables store data RECEIVED by the controller through the serial communication links	0	256 J and K tables are required for each of the serial ports 1 to 4.	YES Except if R0.0 set	YES	YES
		K	These tables store data derived by execution of the user program for TRANSMISSION on the serial communication links	0	The number of tables allocated is 256 J and 256 K tables multiplied by the number of the highest port configured e.g. for port 4 configured the maximum size is 1024 words (each 16 bits)	YES Except if R0.0 set	YES	YES

Subject	Function	Data Table	Content	Min. Table Size	Maximum Table Size	Cleared to Zero at Halt/Run Transition	Cleared to Zero at Power Off/On	Cleared to Zero (by Clear Store Command)
	Serial Link Control	**I**	This table enables the user program to control serial link exchanges, ESP control	160	40 tables are pre-allocated for each of the serial ports 1 to 4 and the maximum table size is 160	YES	YES	YES
PRESET DATA		**P0 to P149**	Controls Program Repetition Interval, System Identification Codes, Serial Link operational data (signalling rate, printer data, etc.), Verification I/O data and FIP	150	-	NO	NO	NO
		P150 on	Available for use in the user program for GEM 80 Special Functions, printer text messages and storing text messages	-	-	NO	NO	YES
GENERAL WORK SPACE	-	**R**	These retained workspace tables are available for the user program to use for storing counter values, sequencers and general data	1	-	NO	NO	YES (Except for R0)
		W	Retained workspace. Note...Tables only cleared when power first applied to system or by clear store command	0	-	NO	NO	YES
		G, H, L	These tables are available for the user program to use for storing counter values, sequencers and general data	0	-	YES Except if R0.0 set	YES	YES
		N, O, U	These tables are available for the user program to use for storing counter values, sequencers and general data	0	-	YES	YES	YES
TIMING AND FLAGS	-	**E**	These tables indicate overflow, time, date and timing flags.	9	9	NO	NO	NO
FAULT CODES	-	**F**	These tables contain fault codes, which are written by the controller as a result of the built-in self-test routines or as a result of execution of the user program. (Some tables are available for the user to use as desired.)	400	-	NO	YES	NO

Subject	Function	Data Table	Content	Min. Table Size	Maximum Table Size	Cleared to Zero at Halt/Run Transition	Cleared to Zero at Power Off/On	Cleared to Zero (by Clear Store Command)
MAINTAINER	-	**M**	Available for user programmed test. Write access from programmer with key removed. Accessible in data list mode only.	0	-	YES	YES	YES
EPROM	-	**S**	Available to the user for RAM/FLASH EPROM control (only values 0,1 and 2 used)	1	1	NO	NO	YES
MEMORY USAGE	-	**V**	Available to the user for READ only and internal system use. These tables contain internal controller statistics.	71	71	NO	NO	NO

5.7.6 P-Tables

Data written to the P(Preset)-table falls into the following categories:

(a) Data entered by the user to control the program scan (repetition time) and serial link operational data.

(b) Preset data values entered by the user for use in the program, and addresses P150 upwards.

(c) Storage of Printer Text Messages. The user should access printer text messages through the editor system.

(d) Configuration of Verification I/O tables.

(e) GEMCAN I/O Scanner configuration, where GEMCAN is fitted, uses P73.

(f) FIP configuration, where FIP is fitted, uses P94 to P96

Note:

The FIP Module used with the GEM80-500 Controller has some differences from that used for the GEM80-400 Controller (e.g. in the P-tables where P94 to P96 were P120 to P122 for GEM80-400).

The P-tables are not cleared at power-off or at halt/run transition, although a clear store command will clear (P150 upwards). The content of the other P-tables can be altered by over-writing. Like other data tables, the size of the P-table is derived by the controller as described at 5.7.4 and Table 5-5.

The P-tables' contents are detailed at Table 5-6.

Table 5-6 P-Table Contents

Address	Content	Remarks
P0	Available for user's system identification code	-
P1	Program repetition interval (scan rate) Range 0 OR 10 to 2000 (ms), zero for free-running	Resolution 1ms. Maximum scan time is 2000 ms. If negative numbers are inserted the sign is ignored and if numbers greater than 2000 are inserted the scan time limits to the maximum.
P2	Length of preset message area in bytes. Note...This effectively limits the message length	Should not be written to by user. Automatically updated by message editor.
P3-P9	Reserved	-
P10-P29	Serial link configuration data for Serial Port 1	See Section 3.
P30-P49	Serial link configuration data for Serial Port 2	See Section 3.
P50-P58	Reserved	-
P59	Offset of configuration data for GEMLAN-T module within P-Tables.	See relevant documentation for details (T2011En).
P60 – P72	Reserved	-
P73	Offset of configuration data for GEMCAN I/O Scanner within P-Tables.	See relevant documentation for details (T2031En).
P74 – P91	Reserved	-
P92	Offset of configuration data for Verification I/O configuration data, within P-tables.	See relevant Data Sheets for Verification I/O Modules
P93	Basic I/O Defeat 0 Basic I/O is scanned -1 Basic I/O is not scanned	Up to 4 ribbons of Basic I/O are declared depending on the mix of plug-in modules. A value of –1 defeats all Basic I/O. The corresponding A/B tables are then included in the Verification I/O scan (if present).
P94	FIP Network Compliance	See Table 3-2.
P95	FIP BA Idle Frame	See Table 3-2.
P96	FIP Byte Ordering	See Table 3-2.
P97 – P109	Reserved	-
P110 – P129	Port 3 Serial Link	See Section 3.
P130 – P149	Port 4 Serial Link	See Section 3.

5.7.7 E-Tables

The E-tables contain timing markers, flags and duration of previous program scan. The table is available for the user program to read. The information contained in the E-tables is shown at Table 5-7.

Table 5-7 E-Table Contents

Address	Content			Remarks
E0.0	0.1 second timing marker			Set ON for one program cycle at 0.1 second intervals
E0.1	1 second timing marker			Set ON for one program cycle at 1 second intervals
E0.2-E0.5	Reserved			-
E0.6	Recompile flag marker			Set ON for one program cycle after a recompile
E0.7	Limit flag set ON or OFF after each ADD or SUB instruction			Can be used more than once in program. Set ON if result in Error due to + or - 32767 limits.
E0.8	1st Plug-in	Buffer filling flags	Port 1	For use when a 9714-4020 Serial Communications Module is fitted.
E0.9			Port 2	
E0.10	2nd Plug-in		Port 3	
E0.11			Port 4	
E0.12	1st Plug-in	Buffer empty flags	Port 1	For use when a 9714-4020 Serial Communications Module is fitted.
E0.13			Port 2	
E0.14	2nd Plug-in		Port 3	
E0.15			Port 4	
E1	Seconds (0 - 59)			
E2	Minutes (0 - 59)			Time
E3	Hours (0 - 24)			
E4	Days (1 - 31, as appropriate to the month)			
E5	Months (1 - 12)			Date
E6	Years 1991 - 2090			
E7	Duration of previous program scan			In 1ms units. On a run to halt transition, or on a single cycle, this is set to 100.
E8	Running clock OR Cumulative total of cycle times (0 to @FFFF)			In 1ms units. This has a resolution of 1ms. It is a 16-bit unsigned value. On halt-to-run transition, or on a single cycle, it is updated by 100ms. Resets to zero at @FFFF.

5.7.8 F-Tables

The F-Tables are allocated as shown at Table 5-8.

Table 5-8 F-Table Contents

Address	Content	Remarks
F0	Reserved	-
F1	User required watchdog trip	Any non-zero value placed in F1 by user program trips the watchdog, terminates program execution and displays a fixed diagnosis message on a suitable GEM 80 programming tool screen.
F2	System fault bits	See Below.
F2.0	-	Set to 1 if previous program cycle exceeds preset scan time.
F2.1	-	Set to 1 for one scan if recompile successful.
F2.2	-	Set to 1 if recompilation will occur on the current scan.
F2.3	-	Reserved.
F2.4	Battery condition. Onboard battery low warning bit	Set to 1 if battery power low.
F2.5	Reserved	-
F2.6 to F2.15	Reserved	-
F3	FIP Run Time Fault Flag	-
F4	FIP Configuration Fault Information	-
F5- to F9	Reserved	-
F10 to F89	Serial link diagnostics	See 7.15.
F10 to F29	Serial link diagnostics for Serial Port 1	See 7.15.
F30 to F49	Serial link diagnostics for Serial Port 2	See 7.15.
F50 to F69	Serial link diagnostics for Serial Port 3	See 7.15.
F70 to F89	Serial link diagnostics for Serial Port 4	See 7.15.
F90 to F109	Serial Link statistics for Port 1	See 7.16.
F110 to F129	Serial Link statistics for Port 2	See 7.16.
F130 to F149	Serial Link statistics for Port 3	See 7.16.
F150 to F169	Serial Link statistics for Port 4	See 7.16.
F170 to F199	Reserved	-
F200 to F329	Basic and Verification I/O status bits	2 bits per I/O address, bit 0 = fault/fail, bit 1 = warning. For Basic I/O both bits are set if an error is detected.
F330 to F371	GEMCAN I/O Scanner status data.	See relevant documentation for details (T2031En).
F372 to F499	Reserved	-
F500 upwards	-	These tables are available to the user program.

5.8 Fault Reporting and Detection

> **WARNING**
>
> **Earlier models of GEM80 Controllers would trip the watchdogs if any faults were detected on Basic or Verification I/O. The GEM80-500 Controller will not trip automatically under these circumstances. This allows the user to determine which I/O addresses are necessary for the correct operation of the plant.**
>
> **In the event of F-tables being set, the associated inputs drop to zero and the associated outputs freeze. It is the user's responsibility to take any necessary action within the program to ensure safe plant operation under these conditions.**

The GEM80-500 Controller checks transfers on the Basic I/O Highway by reading back the data patterns it writes onto the highway. If the controller detects any faults, it sets an F-table bit corresponding to the address of the I/O module addressed. The F-table bits for Basic I/O are reported in two tables per ribbon starting at F200. Two bits are used per I/O address. If the controller detects any failures when data is being transferred, the corresponding F-table bit is set to 1 (producing patterns such as @0005, @0050, @5005 in F200 and F201).

In addition, the controller tests the Basic I/O Highway by writing out test patterns and reading back the results. If any of these test patterns are incorrect, all the odd bits in F200 and F201 are set to 1 (producing the data pattern @AAAA in both tables).

If both tests fail, combinations of the two patterns are seen.

If failures are detected when critical inputs or outputs are being addressed (refer to Fault Finding at Section 7) the user program could use F-table bits to trip the controller watchdogs by setting F1 to any non-zero value.

The Verification I/O Highway provides greater security against the transfer of corrupted data between the controller and the GEM80 I/O Modules. The Verification I/O transfer provides 'address/data checkwords' and 'data confirm words' during the I/O transfer. Outputs are not written to the plant by the I/O module unless the address/data checkword sent by the controller is mathematically verified. Inputs are not written into the A-tables unless the checkword received by the controller is correct. If the data is not successfully transferred after two retries, an F-table is set for that address and the value read or written remains at the last value transferred correctly.

The F-table bits for Verification I/O start at F200 assuming that the Basic I/O is disabled. If the Basic I/O is enabled, then the Verification Fault Report starts at F202, 204 or 206 depending upon the number of Basic I/O ribbons present. There are 2 bits per address. The odd numbered bit indicates warning, this results in patterns such as @5555; the even numbered bit indicates fault/fail.

For details of the fault reporting for GEMTEQ I/O via the GEMCAN I/O Scanner Module, please refer to the GEMTEQ I/O Technical Manual T2031En.

5.8.1 I-Tables

The I-tables are allocated as shown at Table 5-9.

Table 5-9 I-Table Content

Address	Content	Remarks
I0 to I39	User control mode for serial port 1	-
I40 to I79	User control mode for serial port 2	-
I80 to I119	User control mode for serial port 3	-
I120 to I159	User control mode for serial port 4	-

5.8.2 J/K-Tables

The J- and K-tables are allocated when serial communications ports are configured in the P-Tables. The allocations depend upon the communications protocols in operation (refer to Section 3) and are shown at Table 5-10.

Table 5-10 J/K-Table Content

Address	Content	Remarks
J/K0 to J/K255	Serial port 1	-
J/K256 to J/K511	Serial port 2	-
J/K512 to J/K767	Serial port 3	-
J/K768 to J/K1024	Serial port 4	-

5.8.3 R-Tables

There is one R-table permanently declared in the system which has the function of selecting whether or not certain data tables are retained. R0.0 is set to retain tables.

5.8.4 V-Tables

The V-tables are used by system software and may be read but not written to by the user. The details allocated are shown at Table 5-11. The V-table is not part of the user allocation.

Table 5-11 V-Table Content

Address	Content	Remarks
V0	Not used	-
V1	Compilation count, moving flag.	Low byte contents are incremented after each successful compilation V1.8 =1 Moving (See note 1)
V2 to V47	Used by system software for data table offsets and lengths	-
V48 to V51	Reserved for system usage	-
V52	Length of the message area in bytes	-
V53 to V57	Reserved for system usage	-
V58	V-table checksum	-
V59	User program checksum	-
V60	P-table checksum	-
V61	FIP network subscriber address (if present)	-
V62	Front Panel Switch setting	This is read once when the controller is powered up.
V63	Always 0	No off-line support
V64	Firmware issue	This is copied from the firmware issue in the format A_
V65 to V66	Reserved for System Usage	-
V67 to V71	Plug-in Module Identifiers	V67 to V71 do not give any indication of the slot positions of the modules. The first module found is reported in V67, the second in V68 etc. If less than 5 modules are present, then the unused entries contain 0. **@0711** 1st Basic I/O Module (Basic Ribbons 1 and 2) **@0715** 2nd Basic I/O Module (Basic Ribbons 3 and 4) **@0710** 1st Basic/Verification I/O Module (Basic Ribbon 1 / Verification Ribbon 1) **@0714** 2nd Basic/Verification I/O Module (Basic Ribbon 3 / Verification Ribbon 1) **@0628** 1st Serial Communication Module Ports 1 and 2 **@052C** 2nd Serial Communication Module Ports 3 and 4 **@1318** FIP Module **@2720** 1st GEMCAN I/O Scanner Module **@2724** 2nd GEMCAN I/O Scanner Module

Note 1 at Table 5-11:

V1 bit 8 is set just before compilation and reset when compilation is complete.

6. Installation and Commissioning

WARNING

- **Radio Transmitters**

  Do not use mobile phones or walkie talkies within 2 metres (6 feet) of the equipment.

CAUTION

This equipment contains solid state devices which may be affected by electrostatic discharge. Observe static handling precautions.

6.1 Introduction

This section describes the receipt of the GEM80-500 Controller at a site and provides instructions for its installation and commissioning.

When the GEM80-500 Controller is to be used with an existing GEM80 System refer to Section 8 and check that:

(a) Compatibility is being maintained between the existing GEM80 System and the new GEM80-500 Controller;

(b) All the parts identified at Section 8 for the upgrade of a particular system are available for installation and commissioning to proceed.

6.2 Receipt of a GEM80-500 Controller

6.2.1 Unpacking and Checking the Consignment

When the equipment arrives on site it should be carefully unpacked and inspected for any sign of damage. Handling precautions for equipment containing Electrostatic Sensitive Devices (ESD) should be followed.

The complete consignment should be checked against the delivery note for any loss in transit. Check that all the loose items have been included, in particular:

(a) Watchdog cable assembly, reference 56940/138.

(b) Re-wirable Cold Condition IEC Mains Socket with side entry, for connection of ac mains supply wiring to the controller, reference 80720/223; or Hot Condition IEC Main Socket for connection of dc supply wiring , reference 80720/224.

(c) Optional Panel Mounting kit (when requested), reference 8890-4900 – check that this kit includes all the M5 size screws and washers as detailed at 6.6.

(d) When an Optional Module type 9713-4020 or 9713-4021 has been received check that a 15 V Power Supply Cable Assembly reference 41Y8230/10 has been included.

6.2.2 What to do if something is missing or damaged

If any damage has occurred, or any parts are missing, ALSTOM Kidsgrove, should be contacted immediately and the following details quoted:

(1) List of damaged or missing items;

(2) Description of any damage;

(3) Package numbers;

(4) Delivery/Advice Note numbers, dates and any other reference numbers such as order and item numbers.

Note:

Failure to inform ALSTOM Kidsgrove, of damage to goods or shortages within three days from receipt of equipment will be held to free ALSTOM from liability.

6.3 Storing a GEM80-500 Controller before Installation

6.3.1 Environmental Conditions and Protection

Equipment which is not required for immediate installation should be stored in a clean, dry atmosphere at a reasonably constant temperature (-20 to +70°C). To minimise the ingress of fine dust, the equipment should be kept in the original packing, which should be re-sealed after the delivery inspection.

Where equipment is unavoidably subjected to high humidity (e.g. for short pre-commissioning periods during installation in a humid location) it is recommended that any enclosure, into which the controller is to be mounted, should be fitted with anti-condensation heaters and the equipment be thoroughly dried out prior to the first application of power. Such heaters should then be automatically switched on whenever the GEM80 equipment is subsequently shut down.

6.3.2 Capacitor Reforming

The controller contains electrolytic capacitors which degrade if the system is not powered up. Where inactive storage times are expected to be in excess of 2 years, the shelf life of electrolytic capacitors may be exceeded, it is essential that the controller is powered up every 2 years.

6.4 Site Requirements

The area in which the GEM80-500 Controller is to be installed must meet the following conditions:

(a) Comply with the Environmental Specification at 2.2;

(b) Have adequate access for installation, commissioning and maintenance.

6.5 Methods of Mounting

The GEM80-500 Controller may be mounted in an existing, or new, GEM80 Subrack or it may be mounted directly onto a panel, or it may be mounted onto a panel using

an Optional Panel Mounting Kit type 8890-4900 available from ALSTOM. Each method of mounting is now described. Whichever method of mounting is used ensure that:

(a) The selected mounting position will have a gap above and below the controller of at least 50 mm for the free flow convection cooling air.

(b) The selected mounting position provides sufficient space at the front of the controller for cabling access and viewing of the controller status LEDs.

6.6 Panel Mounting the Controller

6.6.1 Direct Mounting (without using a Panel Mounting Kit)

The GEM80-500 Controller has four M5 size tapped inserts in its rear face that allow it to be panel mounted. This method of mounting is suitable for locations where access is available to the front and rear of the panel on which the controller is to be mounted. Figure 6-1 shows the fixing hole dimensions for this type of mounting.

The controller is mounted with four M5 screws (of maximum length 10 mm) through the panel, from the rear, into the tapped inserts in the controller rear face.

6.6.2 Using a 8890-4900 Panel Mounting Kit

If access can only be gained to the front face of the panel on which the controller is to be mounted, then use of an Optional Panel Mounting Kit 8890-4900 is recommended. This kit consists of a metal Mounting Panel, four M5 x 10 mm screws and spring washers, and four M5 Taptite screws. The Mounting Panel includes four keyhole slots for fixing the Mounting Panel, with controller attached, in its preferred position.

Refer to Figure 6-2 and use the Mounting Kit 8890-4900 as follows:

(a) Drill the panel as shown at Figure 6-2 and fit the four M5 Taptite screws to approximately half their thread depth.

(b) Fix the metal Mounting Panel to the rear face of the controller with the four M5 x 10 mm size screws and spring washers. The screws fit into tapped inserts on the rear face of the controller.

Note:

Ensure that the keyhole slots are in the correct vertical orientation.

(c) Locate the keyhole slots in the Mounting Panel over the heads of the four M5 Taptite screws. Now fully tighten the four Taptite screws.

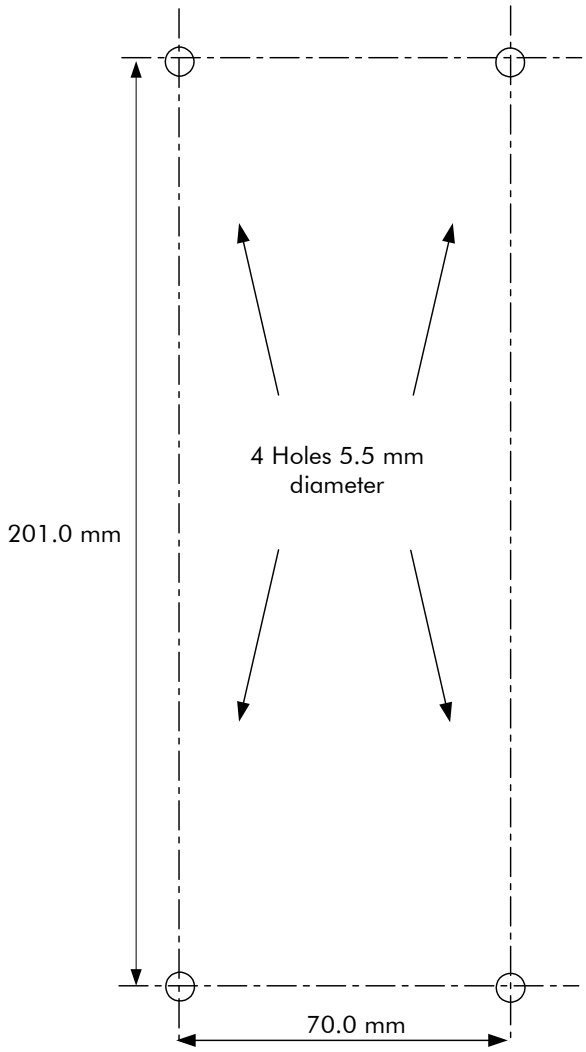


Figure 6-1 Fixing Hole Dimensions for Direct Panel Mounting of a Controller

6.7 Mounting the Controller in a Subrack

The GEM80-500 Controller may be mounted in an existing, or new, GEM80 Subrack.

When the controller is to be mounted in an existing GEM80 System refer to Section 8 to ensure that all parts are available for the controller to be mounted in a safe and compatible manner.

In upgrade applications where the GEM80-500 Controller is to replace an earlier controller type, the power supply should be removed and the GEM80-500 Controller fitted in the space vacated in the subrack. See also Section 8 for further details.

The controller will be retained by the integral slide bars at the top and bottom front edges of a moulded subrack.

The GEM80-500 Controller can also be fitted to the earlier metal GEM80 subracks but these have no suitable means of providing controller retention. This use should therefore be avoided in applications where any level of shock or vibration could be encountered, unless some form of restraint is provided.

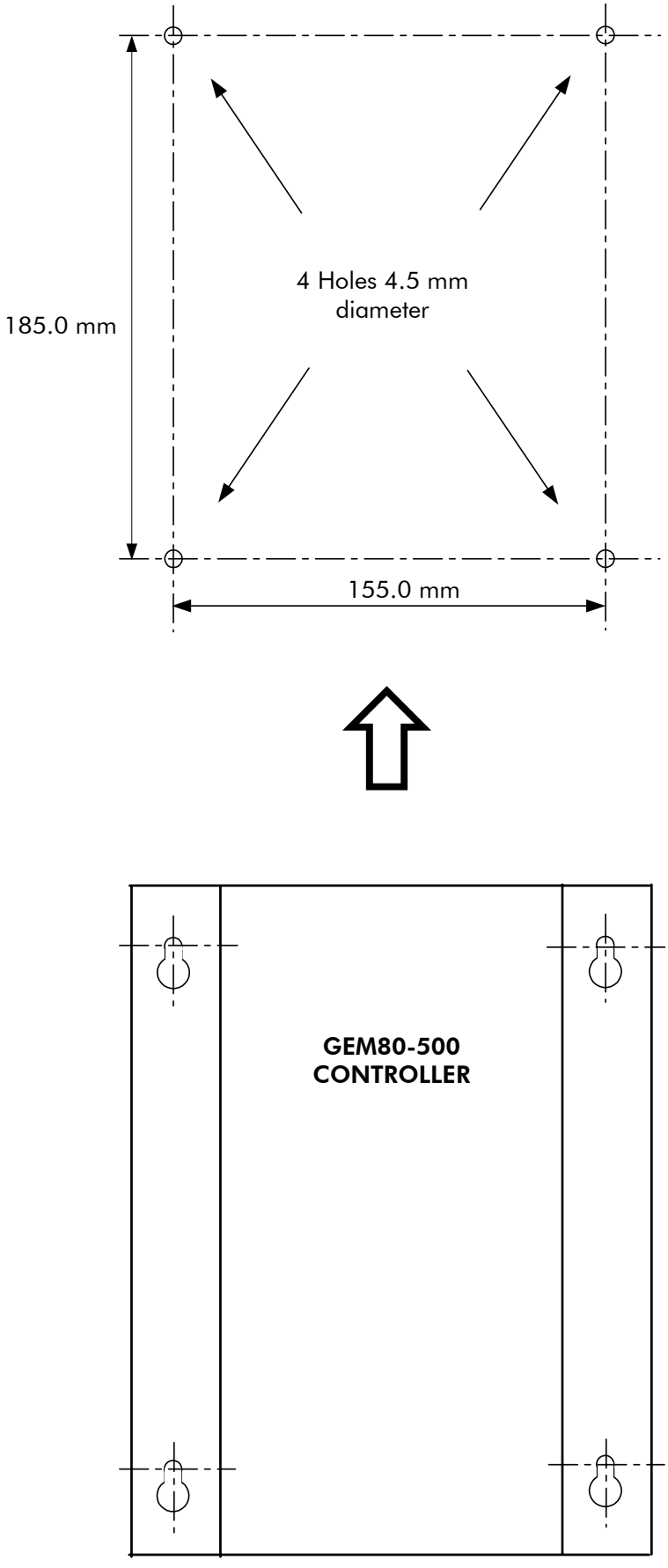


Figure 6-2 Fixing Hole Dimensions for Panel Mounting of a Controller using the 8890-4900 Mounting Kit

6.8 Installation of Optional Modules

6.8.1 Introduction

The GEM80-500 Controller may be fitted with up to five optional modules. These provide additional features such as a Basic I/O Interface, Verification I/O Interface, Serial Communications Ports, FIP Comunications and GEMCAN I/O Scanner. Installation instructions for these modules are included at 0.

An optional Ethernet Interface Module can also be added to the controller assembly and this has a separate position allocated on the controller motherboard. Separate installation instructions are included at 6.8.7.

If any of these modules are to be fitted after initial installation of the controller, the controller must first be powered down and removed. It is recommended that the installation procedures in this section are carried out with the controller at a workstation that provides the necessary clean and static handling conditions.

> **WARNING**
>
> **The supply and Watchdog signal circuit to the controller must be disconnected by removing both incoming cable sockets.**

6.8.2 Protection of Equipment from Static Damage

Protective measures are required when handling any of the optional modules to prevent damage to Electrostatic Sensitive Devices (ESDs). The following rules must be observed:

(a) Personnel handling the modules should NOT wear outer clothing which will generate a static charge, e.g. synthetic materials like nylon, cotton is preferable.

(b) All personnel handling the modules should put themselves in contact with a grounded surface before removing any modules from their protective packing or from equipment. The antistatic equipment should be kept on during all module handling.

(c) Avoid finger contact with devices on the modules and with its connectors

(d) If it is necessary to place any module down 'unprotected', place on a static shielding bag, or other equivalent material

(e) Modules should be protected by a static-shielding bag when out of the equipment.

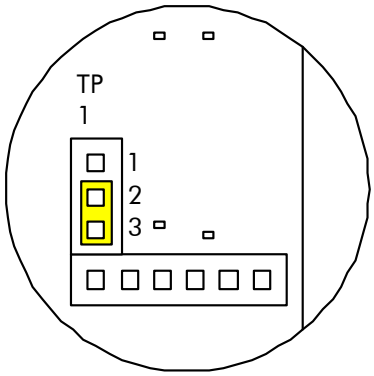
6.8.3 Setting I/O, Serial Communications and GEMCAN I/O Module Jumper Links

The I/O Interface Modules 9713-4020 and 9713-4021, the Serial Communications Module 9714-4020, and the GEMCAN I/O Scanner Module 9720-4020, each have a 2-position jumper link arrangement. A jumper link has to be set depending upon the module function and its use in the controller i.e. the first or second module of a particular type – refer to Table 3-1 for more details about configuration of modules.

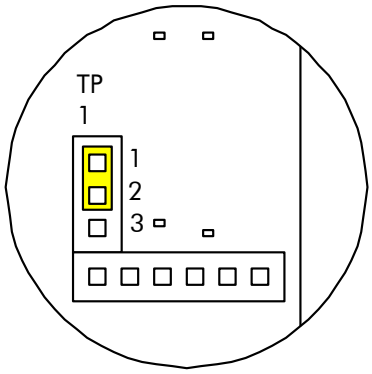
Table 6-1 lists the link settings for each Module and
Figure 6-3 shows the linking positions on a module.

Table 6-1 I/O and Serial Communications Module Jumper Links

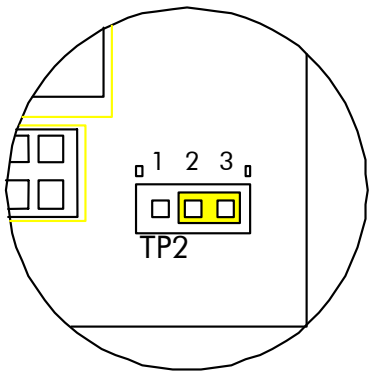
Jumper Link between Positions		Module Function	Module Reference
TP1	2 to 3	1st Module Basic 1/Basic 2	9713-4021
TP1	1 to 2	2nd Module Basic 3/Basic 4	9713-4021
TP1	2 to 3	1st Module Basic 1/Verification	9713-4020
TP1	1 to 2	2nd Module Basic 3/Verification	9713-4020
TP2	2 to 3	1st Serial Communications Module Ports 1 & 2	9714-4020
TP2	1 to 2	2nd Serial Communications Module Ports 3 & 4	9714-4020
TP4	2 to 3	1st GEMCAN I/O Scanner Module	9720-4020
TP4	1 to 2	2nd GEMCAN I/O Scanner Module	9720-4020



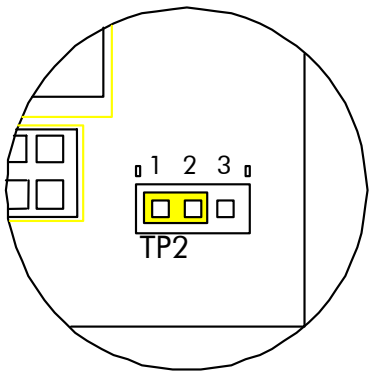
9713-4020 or 9713-4021
1st Module



9713-4020 or 9713-4021
2nd Module

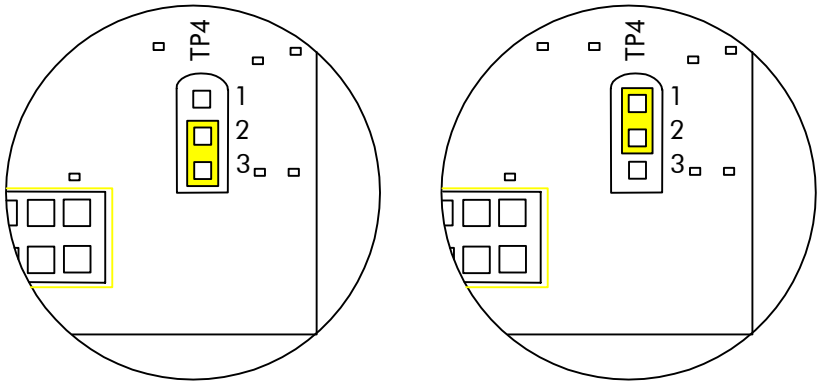


9714-4020
1st Serial Module



9714-4020
2nd Serial Module

Figure 6-3 I/O and Serial Communications Modules showing Jumper Link Positions



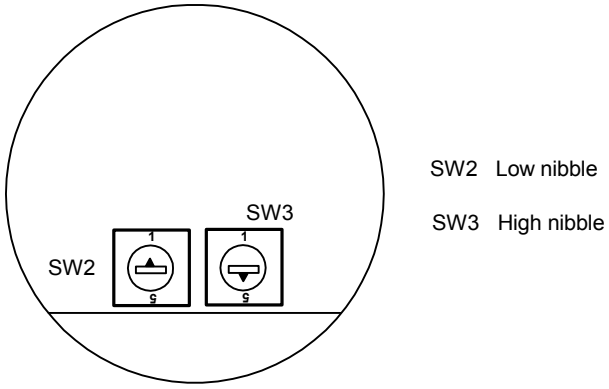
9720-4020 1st Module
GEMCAN I/O Scanner

9720-4020 2nd Module
GEMCAN I/O Scanner

Figure 6-4 GEMCAN I/O Scanner Module showing Jumper Link Positions

6.8.4 Setting FIP Module Subscriber Address

The GEM80-500 Controller FIP network subscriber address is set using two BCD switches on the FIP Module 9715-4020. These switches are shown in Figure 6-5. The address is an 8-bit hexadecimal value. SW2 is the low nibble and SW3 is the high nibble. For example, if SW3 is set to 5 and SW2 is set to 1, the FIP network subscriber address will be @51, i.e. hexadecimal value 51.



9715-4020
FIP network subscriber address
BCD switches

Figure 6-5 FIP Port Subscriber Address Configuration

6.8.5 Installation of Optional Modules

The first Module plugs into the Expansion Bus Connector located at the lower edge of the controller motherboard designated PL2. Additional modules are plugged one on top of the other using built in stack-through connectors.

When the controller has been powered down and removed from its location proceed to install stackable optional modules as follows, noting that all references to left and right apply to the controller when viewed from the front:

(a) Remove the lower right hand side cover from the controller by releasing the four M3 Pozi-pan head earthing/grounding screws. Retain the screws for re-assembly.

(b) Remove the blanking panel(s) at the location where the modules are to be installed. These are secured by two M3 Pozi-pan head earthing/grounding screws. Assembly is simplified if the next blanking panel to the right is also removed.

(c) On the Interface Module, remove the protective moulding from the connector pins and check that all the interface connector pins on the module to be installed are correctly aligned.

(d) Position the module front panel in the space vacated by the blanking panel. Locate the connector pins loosely into the Expansion Bus socket, ensuring that pins and sockets line up.

(e) Gently push the two connector halves together until the module sits flat on the four mounting pillars already fitted to the controller motherboard.

(f) The module is supplied with four M3 spring washers and four more mounting pillars. Fit an M3 spring washer and a mounting pillar to each of the existing mounting pillars to retain the module.

(g) Secure the module front panel to the controller using the two M3 earthing/grounding screws originally in the blanking panel.

(h) Refer to 6.8.6 for connection details for the 15 V Cable Assembly 41Y8230/10 when it is supplied with the module which is being fitted;

(i) When all required modules have been fitted, replace the lower side cover and blanking panels where required.

(j) Ensure that all four earthing/grounding screws are refitted and tightened.

(k) Refer to Commissioning Instructions to bring the controller into its operational state with the additional features.

6.8.6 Connection of the 15 V Cable Assembly Referenced 41Y8230/10

Each of the I/O Modules 9713-4020 and 9713-4021 are supplied with a loose Cable Assembly referenced 41Y8230/10. This cable assembly is used to connect each I/O module to the 15 V power supply at the controller motherboard. The cable assembly comprises three 4-way in-line pcb connectors, one connector for each of two I/O modules and one connector for the motherboard connection. Figure 1-2 and Figure 1-3 show the position of the power supply connector on each I/O module.

Figure 6-6 shows the relative positions of the connectors on the I/O modules and the controller motherboard.

Connect the 15 V Cable Assembly 41Y8230/10 as follows:

(a) At 0 item (h) connect one socket of the 15 V Cable Assembly 41Y8230/10 to the 15 V power supply connector on the controller motherboard;

(b) Connect the other two sockets in the cable assembly to corresponding connectors on each of two I/O modules;

(c) When only one I/O module is fitted in the controller the unused socket and trailing cable should be restrained within the controller;

(d) When two I/O modules have been fitted there will be one cable assembly surplus to requirements and it is recommended that this be retained as a spare.

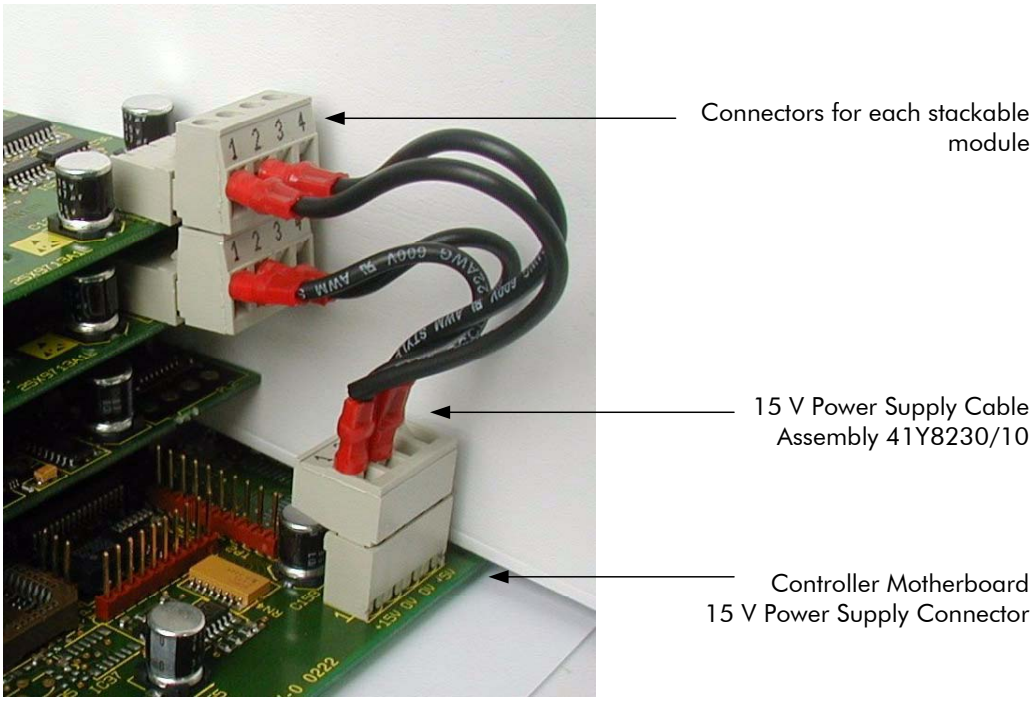


Figure 6-6 Positions of 15 V Power Supply Connectors on I/O Modules and Controller Motherboard for the 41Y8230/10 Cable Assembly

6.8.7 Installation of an Optional Ethernet Module

In addition to the five optional module positions described at 6.8.1 the GEM80-500 Controller has provision for an optional Ethernet Interface module to be fitted.

When the controller has been powered down and removed from its location proceed to install the Ethernet Interface Module as follows, noting that all references to left and right apply to the controller when viewed from the front:

(a) Lay the controller down on its left-hand side.

(b) Release the upper right hand side cover and power supply assembly, by removing the four M3 Pozi-pan head earthing/grounding screws . Retain screws for re-assembly.

(c) Lift the side cover slightly so that the louvered side can be slid under the controller.

(d) Access to the Ethernet Interface Module mounting location on the motherboard should now be possible.

(e) Check that all the interface connector pins on the underside of the Ethernet Interface Module are correctly aligned. Note the position of the corresponding socket connector on the controller motherboard, and locate the two connector parts loosely together.

(f) Check for correct alignment.

(g) Gently push the two connector halves together until the module sits flat on its mounting pillars.

(h) The module should be retained by fitting four M3 x 6 mm screws and spring washers to the four mounting pillars.

(i) Replace the upper side cover and power supply assembly.

(j) Ensure that all four earthing/grounding screws are refitted and tightened.

(k) Refer to Commissioning Instructions to bring the controller into its operational state with the additional features.

6.9 Supply and Earth/Ground Connections

WARNING

The GEM80-500 Controller MUST be earthed/grounded via the appropriate terminal in the IEC Socket Connector.

The GEM80-500 Controller operates from the following supply voltages :-

8870-4979 8870C4979	88 to 264 V ac, 50 or 60 Hz
8870-4979DC24 8870C4969DC24	18 to 36 V dc
8870-4979DC48 8870C4979DC48	36 to 72 V dc

The AC Mains Supply and Earth/Ground Connection is made via an IEC Plug Connector with integral ON/OFF switch, and protective fuse (mounted on the front of the Controller). A compatible rewireable IEC Socket Connector is provided with the Controller for connection of the plant mains supply wiring.

For DC supplied controllers, the IEC Plug Connector is a Hot Condition type and these are supplied with the appropriate rewirable Hot Condition Socket Connector. The

polarising in the Hot Condition plug prevents insertion of a Cold Condition socket carrying 110/230 V ac which would damage DC supply type controllers.

Proceed to wire up the supply and earth/ground connections as follows:

(a) The wires used for the Live, Neutral, DC+, DC- and earth connections should be 1.0 mm^2, (18 AWG) and must be of a type to meet local installation regulations;

(b) Remove the cover on the rewireable IEC Socket Connector;

(c) Slide the supply wires through the cable gland and connect the live, neutral and earth/ground wires to screw terminals marked L, N and E respectively. For DC supply applications connect DC+ to terminal marked L and DC- to terminal marked N;

(d) Fit the cable clamp to provide strain relief for the supply wires, and replace the cover.

(e) Fit the IEC Socket Connector to the IEC Plug Connector which is mounted on the front of the controller;

(f) Restrain the supply cable as close as possible to the controller to prevent the IEC Socket Connector from being inadvertently disconnected;

(g) Connect the free ends of the supply wiring to a supply suitable for the controller type (AC or DC);

(h) Connect the earth/ground lead to a dedicated Safety Earth point ensuring that this is not confused with any Signal Ground bars which are present in the enclosure – these Signal Ground bars may be disconnected from earth during commissioning.

6.10 Watchdog Relay Connections

WARNING

DO NOT apply a supply voltage directly across the pins of the Watchdog Connector, or exceed the rated 1A load, otherwise the Watchdog Relay contacts will be severely damaged.

As a safety measure, the GEM80-500 Controller contains two Watchdog Relays with normally open contacts.

These normally open contacts are wired in series and connected to the Watchdog Socket Connector on the Controller front panel. A typical Watchdog Circuit is shown at Figure 6-7.

When the system is running normally and in a healthy condition, the Watchdog Relays are energised and the contacts closed.

When the system is tripped, either by the user program, or the self-testing detecting a fault, the Watchdog Relays are de-energised and the contacts open.

The relays are also de-energised if the controller is Halted.

The Watchdog Relay contacts can therefore be used, usually in conjunction with a follower relay, to interrupt the plant supplies in the event of the controller being halted or tripped when a fault condition is detected.

The Watchdog Connector simply provides either an open or short circuit connection between its pins depending on the controller condition.

Proceed to wire up the Watchdog connections as follows:

(a) Use the 2 metre long, two core cable rated at 250V, 1A, fitted with a moulded "Figure of 8" socket supplied with the controller (referenced 56940/138) to mate with the Watchdog Connector plug on the controller front panel;

(b) The free end of the cable may be connected into the system safety circuit as required;

(c) Restrain the Watchdog cable as close as possible to the controller to prevent the Watchdog Connector from being inadvertently disconnected.

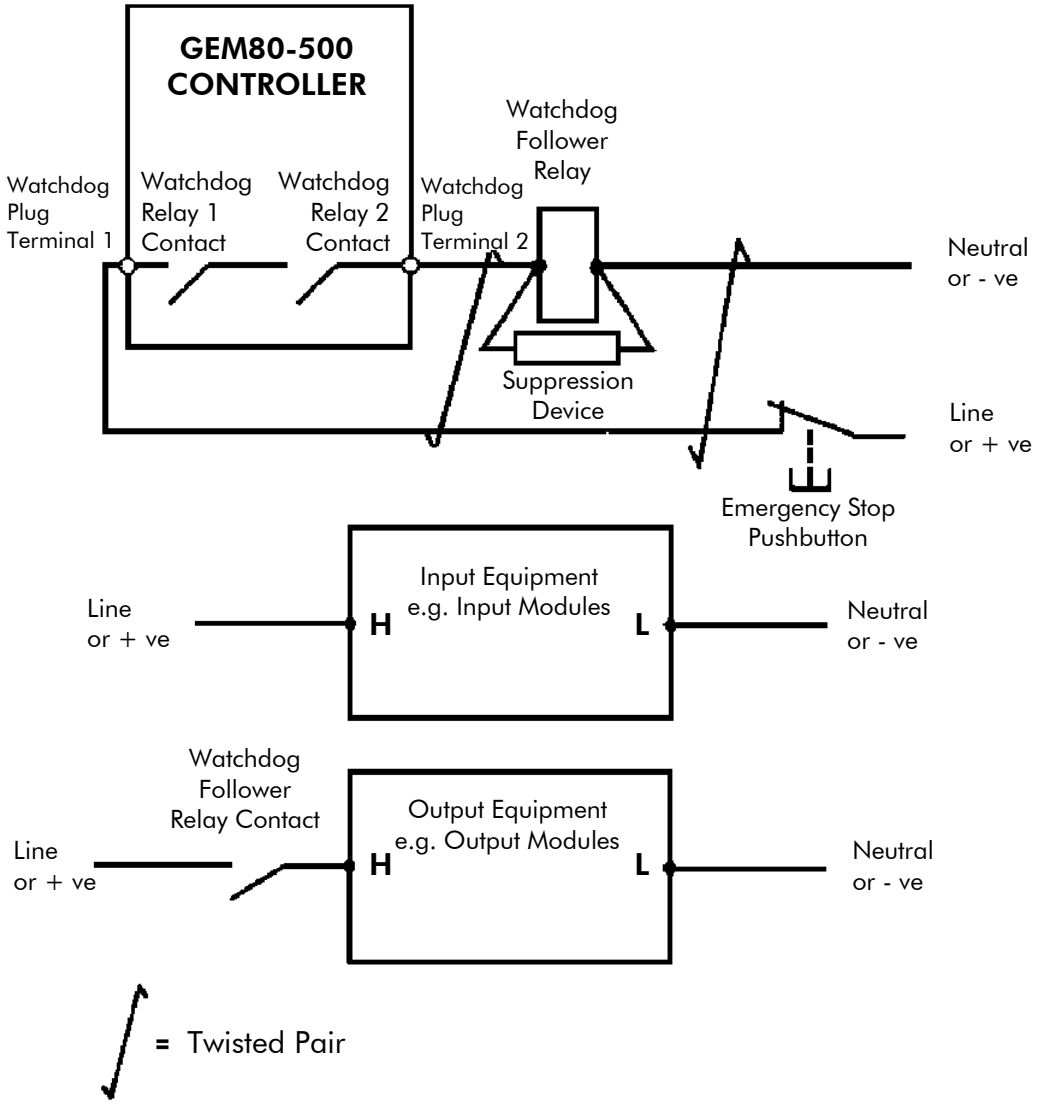


Figure 6-7 Typical Watchdog Circuit

6.11 Connections for I/O Modules 9713-4020 and 9713-4021

Connections from the I/O modules to the Basic and Verification I/O are made by 26-way ribbon connectors. The length of ribbon cables required depends upon each application and these should be made to suit. Refer to a GEM80-400 Technical Manual T1614 if information is required to make up ribbon cables.

6.12 Connections for Serial Communications Module 9714-4020

Connections to the Serial Communications Module are made by 9-way, male, 'D' type socket connectors with threaded retention pillars. The length of cables required depends upon each application and these should be ordered from a proprietary supplier or separately from ALSTOM to suit the application.

6.13 Termination of Serial Links

6.13.1 Termination of Serial Link when using RS485

For successful communication when using RS485 communication links, it is important that the serial link cable is correctly terminated. This is achieved by fitting a 220Ω, 0.25W resistor across each pair of Rx and Tx wires.

Note:

The termination resistors should be placed at each end of the link.

6.13.2 Maximum Length of Serial Links

The maximum length of cable associated with RS485 and RS232 is 3 km and approximately 15 m, respectively. A discussion of this topic is available in Serial Links Technical Publications such as the 'Serial Communications Manual', Publication T457.

6.13.3 Cable

RS485: For a 4-wire serial link, use two twisted pairs with an overall screen having a maximum capacitance of 180nF/km and a maximum resistance of 40Ω/km.

A recommended cable type is: BELDON 9729

6.13.4 Connectors

The connectors on the controller and the Serial Communications Module type 9714-4020 are of the following types for which mating connectors will be required:

Port 0 : 15-way 'D'-type connector on the controller;

Ports 1, 2, 3 and 4 : 9-way 'D'-type connectors on the modules.

6.13.5 Segregation

Ensure that 600 mm (2 feet) exists between the serial link cabling and electrically 'dirty' wiring.

6.14 Commissioning Guidance

The GEM80-500 Controller and I/O will have to be configured to meet particular application requirements. Because these requirements vary for each GEM80 application this section of the manual only includes general commissioning guidance about the method to be followed. The instructions required for each application should be discussed with ALSTOM or an approved System Builder.

6.14.1 Preparation

Before starting to commission a GEM80 system, you should already have:

(a) Installed the equipment and cabled it up, including all earth (ground) connections as given in this section;

(b) Cabled up the watchdog and safety circuits in accordance with the guidelines given in this section and checked their operation;

(c) Fitted all required optional modules in accordance with the instructions in this section;

(d) A suitable GEM80 Programming Package with a stock of suitable storage media;

(e) Ensured that all pertinent regulations for earthing/grounding of the equipment have been adhered to.

6.14.2 Documents Required

During commissioning the following documents will be required in addition to this manual:

(a) A User/Technical Manual for the particular GEM 80 Programming Package in use;

(b) 'GEM 80 Ladder Diagram Programming Manual', Publication No.T300;

These documents will enable test programs to be written to check out the equipment.

6.14.3 Handling Precautions During Setting Up of Equipment

The following precautions must be taken during testing/setting up operations on equipment containing printed circuit boards (PCBs) with Electrostatic Sensitive Devices (ESDs):

(a) All test equipment must be grounded to a common earth point;

(b) The system power and test equipment must be switched OFF before making or breaking any connections;

(c) When possible, power supply voltages should be applied before signal inputs, and should be maintained until signal inputs are removed;

(d) Dielectric strength and insulation resistance tests should not be carried out with the PCBs installed in the equipment;

(e) Do not use audible continuity tests on PCBs;

(f) Do not use 'Freeze' Aerosols on PCBs.

6.14.4 Radio Frequency Interference (RFI)

This clause is intended as a guide for users who wish to operate GEM80 equipment in the vicinity of a radio transmitter. The transmitter may be of the static or the hand-held portable type. Unrestricted use of a transmitting device could result in a malfunction of the equipment. This in turn could cause a breakdown of plant equipment and injury to personnel. GEM80 equipment is designed to function satisfactorily within a RFI field strength of 10V/m over a frequency range of 30 MHz to 1 GHz.

6.15 Use and Setting of the Mode Switch

> **WARNING**
>
> **DO NOT alter the Mode Switch position when the controller is in a powered state. Some positions will cause the controller to trip and the user's program may be erased.**

A Switch, for selection of the mode of operation, is mounted on the front panel of the GEM80-500 Controller (see Figure 1-1). The switch governs the controller's mode of operation when power has been applied. The Mode Switch is labelled with numbers 0 to 9 and can be adjusted with the use of a small flat bladed screwdriver.

Each of the Mode Switch positions is now described.

6.15.1 Mode Switch Position 0 - Normal (A)

When power is applied, the controller returns to the state prior to power removal e.g. running from RAM, running from Flash EPROM, Halted etc.

If the RAM content has become corrupt during power down the controller will not enter the RUNNING state.

With the switch in this position the user's Flash EPROM memory is write **enabled**, allowing storage of the user's program, if required.

6.15.2 Mode Switch Position 1 - Normal (B)

When power is applied, the controller returns to the state prior to power removal e.g. running from RAM, running from Flash EPROM, Halted etc.

If the RAM content has become corrupt during power down the controller examines the content of the user's Flash EPROM. If this contains a valid program the controller will compile and run this program.

With the switch is this position the user's Flash EPROM memory is write **disabled** preventing alteration of the user's program.

6.15.3 Mode Switch Position 2 – HALT

Regardless of the state prior to power removal the controller will be in a HALTED state when power is applied.

6.15.4 Mode Switch Position 3 – Clear Store New System

When power is applied, the controller will be halted with the contents of RAM memory completely cleared of all program and data.

> **WARNING**
>
> **DO NOT select this switch position unless a complete program and data backup has been made.**

6.15.5 Mode Switch Position 4 – Firmware Update (FUP)

When power is applied, the System Status Display will flash between showing F/W and the firmware release i.e. A; the controller will be halted. The GEM80-500 Controller is then awaiting a Firmware upgrade from a PC connected to the Programming Port.

6.15.6 Mode Switch Positions 5, 6, 7, 8 and 9 - Reserved

WARNING

DO NOT select these switch positions unless instructed to do so by ALSTOM Customer Support. There is no control of I/O in these modes. Using these modes will corrupt the user's program in RAM or Flash EPROM.

6.16 Overview of the Commissioning Procedure

To commission a GEM80 system, everything needs to be checked to eliminate errors. The larger the system, the more things there are to check. If a thorough check is not carried out operation of the system might cause serious machinery damage by switching on wrong outputs. So, commissioning requires a methodical, painstaking approach. Don't try to speed up the procedure by cutting corners, or there will be problems. The basic principle is to start off with a small amount of equipment, check it out thoroughly, and then, when you're 100% certain that it all works, add a bit more equipment, check that, and so on. The recommended sequence for commissioning is as follows:

(a) Check the hardwired safety circuits into which the watchdog operates;

(b) Check the power supply;

(c) Check the processor;

(d) Add the Basic I/O, inputs first, then outputs;

(e) Add the Verification I/O, inputs first, then outputs;

(f) Add the GEMCAN I/O, inputs first, then outputs;

(g) Add the serial links to other controllers, printers or VDUs;

(h) Load an initial User Program;

(i) Check the Basic and Verification I/O Logic Inputs;

(j) Check the Basic and Verification I/O Outputs;

(k) Check the GEMCAN I/O Inputs;

(l) Check the GEMCAN I/O Outputs;

(m) Connect the Output Equipment;

(n) Load the User Program;

(o) Run the User Program without any Serial Links connected and check out the program;

(p) When OK run the User Program with the Serial Links connected and test again until the system is working efficiently.

If additional information is required for any of the commissioning stages refer to the appropriate sections of the GEM80-400 T1614 Manual and the GEM80 GEMTEQ I/O Technical Manual T2031En.

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7. Maintenance and Fault Finding

7.1 General Guidance for Maintenance

This section includes general guidance for the upkeep and maintenance of a GEM80-500 Controller, and includes fault finding information which can be used in the event of either an in-service fault or faults which occur because of ladder program development.

GEM80 equipment requires very little maintenance. Flash EPROM memory is used and the battery has a 10 year life expectancy.

This section also includes recommendations at 7.25 for the disposal of a GEM80-500 Controller at the end of its useful life.

7.2 Safety and Handling Information

7.2.1 Earthing/Grounding

The equipment must be properly earthed/grounded in accordance with the instructions given at Section 6.

7.2.2 High Voltages

Dangerous voltages arising from the mains supply and feedback from the plant wiring may be present within the controller.

7.2.3 Power Down before Removing Modules or Connectors

To allow safe access, the GEM 80 power and, where applicable, plant-side power should be switched off before removing or making connections to the controller.

7.2.4 Power Down Safety Procedure

When maintaining or working on plant controlled by a GEM 80-500 Controller, the controller and the plant-side power supplies should be 'locked off' using a padlock, or similar mechanical locking mechanism, to prevent the system being inadvertently powered up. The ON/OFF switch on the controller must NOT be relied on to immobilise the controller.

7.2.5 On-line Programming

Controllers which are executing, accept on-line program changes, but the controller will freeze all outputs and ignore all inputs for approximately 1 millisecond per 1000 instructions on recompilation with large programs.

Notes:

(1) The controller cannot tell whether the program change is safe; it simply carries out the instructions given.

(2) Recompilation can cause problems when modules such as counters are incorporated in a system. It is the user's responsibility to ensure the safe operation of plant equipment when this facility is utilised.

7.2.6 Testing a GEM80 System

In test modes, GEM 80 output signals must be disconnected or in some way deactivated to prevent accidental mobilisation of plant and machinery, or other possible hazards.

7.2.7 Watchdog and Safety Circuits

The requirements for watchdog and safety circuits at Section 6 must be designed into the system.

7.2.8 System Status Indication

The GEM80-500 Controller includes LEDs and an alphanumeric status display on the front panel as shown at Figure 1-1.

It is most important that the status of the GEM80 system is known before any action is taken with the controller – see 7.6.3 for full details.

7.3 Spare Modules

The only spare modules recommended for use with the GEM80-500 Controller are the optional modules for Basic and Verification I/O, Serial Communications and the Ethernet Module. These modules are listed at Table 1-1. If a spare controller is stored for future use be aware of its 10 year battery shelf life limitation.

If it is necessary to return any modules to ALSTOM for repair they must be enclosed in a static shielding bag, and suitably protected by wrapping in foam plastic, and packed in a box labelled 'Caution Static Sensitive PCBs'.

7.4 Cleaning and Visual Inspection

CAUTION

When cleaning the product, never blow, always use suction to avoid damage.

The GEM80-500 Controller requires minimum maintenance but cleaning and visual inspection should be carried out at time intervals determined by the user (dependent upon application and environmental conditions).

The equipment must be isolated from its main supplies and associated equipment before any cleaning or maintenance work is carried out.

Carry out the following:

(a) Periodically, remove dust and dirt from the controller using a vacuum cleaner, brushes and soft cloths.

(b) Visual checks should be made for signs of wiring or component damage and any damaged wiring or components should be renewed.

(c) Check all terminations within enclosures for security

7.5 Batteries

The battery used with the GEM80-500 Controller is a Lithium Thionyl Chloride type. It has a minimum life of 10 years and is not a user serviceable part. The controller has an integral Flash EPROM and therefore many applications will not require a charged battery. The controller will provide a warning about low battery power in the F-Table (F2.4) and by LED on the front panel of the controller.

It is recommended that the controller be included on any scheduled plant maintenance programme and returned to ALSTOM for battery renewal after 10 years operating life.

Please also note that any GEM80-500 Controllers held in storage for spares purposes will also be subject to the 10 year lifetime for the battery.

7.6 Use of LED and Display Indicators

7.6.1 Controller Front Panel Indications

The front panel of the GEM80-500 Controller has various LEDs and displays, shown at Figure 7-1. Where a fault is evident, a quick guide to the state of the system can be obtained from the front panel indications.

The LEDs and displays are:

(a) Alphanumeric Status Display;

(b) Watchdog LEDs;

(c) Rx, Tx and Active LEDs for Ethernet;

(d) Rx, Tx and Active LEDs for the Programming Port;

(e) Battery Low LED.

The front panels of each of the optional modules also include LED displays to identify:

(1) The Basic or Verification I/O Ribbons for 9713-4020 and 9713-4021 Modules;

(2) The Module Numbers, Rx and Tx activity for the 9714-4020 Serial Communications Module.

(3) The Module Number, Rx and Tx activity for the 9720-4020 GEMCAN I/O Scanner Module.

(4) The Cd and Te activity for the 9730-4020 FIP Module.

The indication lamps give an idea of which parts of the system are faulty. Other messages, via the alphanumeric status display, provide an indication of the state of the system.

7.6.2 Alphanumeric Status Display

The four-character alphanumeric status display mounted on the front panel of the controller (see Figure 7-1) is used to provide a local visual indication of the state of the controller and reduces the need to use a programming tool for routine maintenance.

The use of the "!" and "#" prefixes to identify user program detected errors and system errors respectively, and the use of TEXT messages to identify the system state should make it easy to rapidly identify the source of a particular problem without needing to find and connect a GEM80 Programming Package. This should both reduce plant downtime and improve fault reporting.

Errors detected by the user program may be output to the display by writing a user supplied three digit decimal error code to F1 which will also cause a user requested watchdog trip. Values greater than 999 will be displayed as "!???".

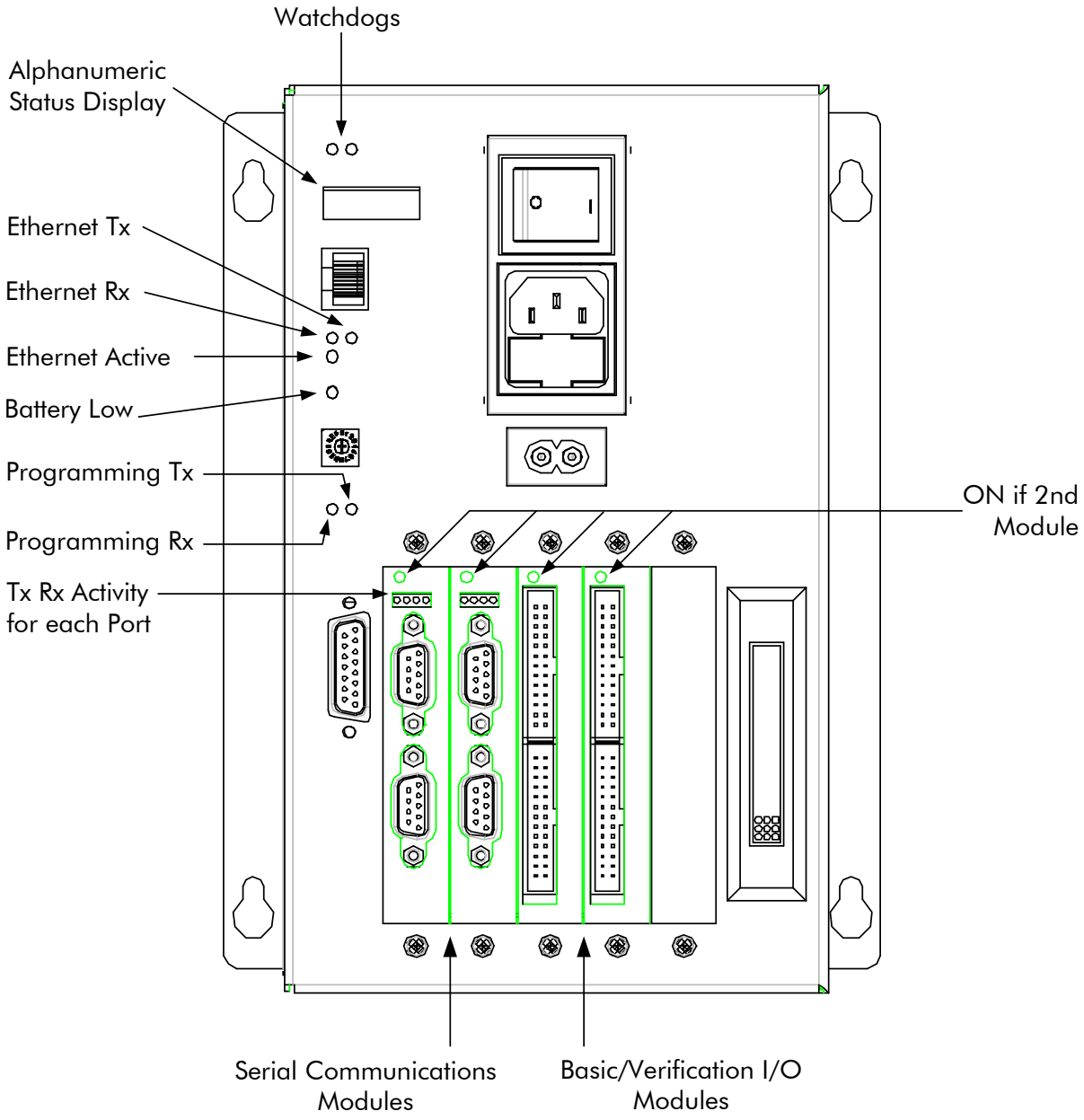

Figure 7-1 Functions for GEM80-500 Controller Front Panel LED and Display Indicators

7.6.3 System Status Indication

When the green LEDs labelled Watchdogs are illuminated, and RUN is displayed on the controller front panel alphanumeric status display, the controller is running the user program and may be controlling moving machinery.

The four-character alphanumeric status display provides the user with the following indications:

Run - System running, Normal Inputs (EPROM or RAM memory)

eRun - System running from EPROM memory, Normal Inputs (Only available on later releases of the GEM80-500)

rRun - System running from RAM memory, Normal Inputs (Only available on later releases of the GEM80-500)

Halt - System halted, Normal Inputs

#nnn - Fault shutdown (nnn = error number)

!nnn - User watchdog trip (nnn = user error code)

Test - Full system self test

TRun - Run, Test Inputs

THlt - Halted, Test Inputs

BATT - Battery low warning

BOOT - System checks that main code is present and correct.

F/W - Controller is in Firmware update mode; all GEM80 functions are suspended.

7.7 Guidance for Fault Finding

7.7.1 Introduction

When a fault occurs in a system, it will be indicated initially by an error message number (error code) on the alphanumeric status display of the controller. The GEM80 has built-in comprehensive fault finding facilities to indicate possible causes of the fault, not only throughout the plant but also within the GEM80 itself and these can be accessed by connecting a suitable GEM80 Programming Package to the controller.

If a fault is detected which does not allow the controller to continue running, watchdogs are tripped, the controller halts, and the fault is reported at a suitable GEM80 Programming Package by a three-digit error code and an English language text message. This message is displayed when the programming tool is connected. For example:

#601 CRC NOT STORED, PROGRAM MAY HAVE CHANGED

Not all error messages halt the controller. Error messages fall into five specific groups as shown at Table 7-1.

Table 7-1 Error Messages

Error Message Number	Type of Error Message
#100 to #199	Compilation Errors
#400 to #499	Boot Code Test Errors
#500 to #699	System Status Errors
#700 to #799	Self-test Errors
#800 to #899	Interprocessor Communications Errors
#900 to #999	System Errors

In addition to the error messages, there are data tables which contain additional data for fault analysis and an area of memory which the user can program and document for fault analysis of problems in the plant. This data table, called the F-table, is detailed at Section 5, and later in this section. Controller front panel LED indications and alphanumeric displays are detailed at 7.6.1 and 7.6.2 respectively. Monitoring and test facilities are also available and these are detailed at 7.7.2.

7.7.2 Monitoring and Test Facilities

It is possible to monitor program execution while the GEM80 is running, subject to observing the safety precautions detailed in this section.

With a suitable GEM80 Programming Package connected, and the appropriate option of the initial screen selected, either specific rungs of ladder diagram or data table locations can be monitored. When monitoring a rung of ladder diagram program, contacts and coils are displayed as shown at Figure 7-2 to indicate their state (energised, de-energised, open or closed) and word mnemonics are replaced by the content of the element's data table.

...] [... Contact open

—] [— Contact closed

...( )... Coil de-energised

—( )— Coil energised

Figure 7-2 Symbols Displayed in Monitor Mode

7.8 User Program Checksum Calculations

All GEM80 controllers protect the user instructions running program and preset data from unnoticed corruption by calculating a checksum on the memory containing them. This is checked at start-up and also as part of the background self-test. When a change is made to the user program or preset data, the checksum is recalculated immediately.

7.9 Compilation and Compiler Error Messages (#100 to #199)

7.9.1 Compilation Error Messages

If a compilation error is detected, the compiler issues an error message number, in the range #100 to #199, and an error message. Compilation errors do not halt the controller, and the old program continues to run. Table 7-2 details the compilation error messages.

Table 7-2 Compilation Error Messages

Code	Fault Message	Possible Causes	Recommended Recovery
#101	Source corruption. Error near instruction X, rung Y.	Could be caused by loading corrupt program. Could occur while programming, i.e. if lead becomes disconnected while inserting a complex rung.	Use back-up copy. Re-edit program with lead connected.
#102	Object RAM full.	Program too large for store.	Reduce program size
#103	Blocks over nested. Error near instruction X, rung Y.	Maximum depth of nesting is 16. End-of-block command overlooked.	Reduce nesting of blocks. Insert missing end-of-block command, if applicable.
#104	Data table RAM full.	Data tables are greater than 32,000 words (approximately). Use of large table location reference possibly accidental.	Reduce number of data table references in program.
#105	Basic I/O ref. Error at instruction data.	Same word referred to as both input and output, e.g. cannot refer to A0 and B0 in same program. Reference over table limit.	Words must be either input or output, not both. Change program to be within limits or Fit additional I/O modules.
#107	Special not included. Error at instruction X, rung Y, Special SZ or TZ.	The specified Special Function, 'SZ' or 'TZ' is not available in the controller. Special reference number entered wrongly.	Change for defined special, if possible. Edit program.
#108	Value missing or type incorrect. Error near instr. X, rung Y.	The user did not supply a required parameter or the correct type of parameter for a function.	Add/correct type of parameter required.
#109	Invalid address in value near instruction X, rung Y.	Non-existent address specified for VALUE. Writing to a write-protected data table. Insufficient tables after that in VALUE table for parameter.	Change to valid address. Change to a write-enabled table. Ensure highest table reference creates sufficient space.

Code	Fault Message	Possible Causes	Recommended Recovery
#110	Write protect violation. Error near instruction X, rung Y.	Cannot output to P- or V-tables.	Alter address to write-enabled data table.
#111	Illegal J/K reference. Error at instruction X, rung Y.	Attempting to access a J/K-table associated with a non-configured port, or one configured as a printer, or a reference over the table limit.	Configure port correctly, or change address to a different table. If port configured as a printer, then J/K-tables corresponding to that port cannot be used. If referencing outside the table limit, alter to be within the limits.
#112	Illegal S/T reference. Error at instruction X, rung Y.	S- or T- tables used other than in Special Function call.	Except for S0, S- and T-tables can only be used in Special Function calls.
#113	Reference over table limit. Error at instruction X, rung Y.	Attempt to read/write from non-existent location in a fixed sized table.	Alter instruction to be within the limits.
#117	Illegal L reference. Error at instruction X, rung Y.	Reference over limit.	Edit program.
#120	Value instr. present - not required. Error near instr. X, rung Y.	Value instruction is present, after Special Function, which is not needed.	Delete value instruction.
#121	No floating point variant possible. Error near instr. X, rung Y.	Instruction cannot use floating point data.	Convert to integer before input to Special Function.
#122	Instr. can't accept floating point. Error near instr. X, rung Y.	AND instruction which is not at the start of the rung, uses floating point.	
#123	Instruction can't accept integer. Error near instr. X, rung Y.	Floating point Special Function cannot use integer data.	Convert to floating point
#124	Invalid Instruction encountered. Error at instr. X, rung Y.	User program has become corrupted.	Replace the specified instruction.
#125	Special Function without "S" or "T". Error at instr. X, rung Y.	A Special Function with a table letter other than 'S' or 'T' has been encountered.	Modify the Special Function.
#127	Instruction has invalid letter. Error at instruction X, rung Y.	The associated table letter is outside the 'A-W' range.	Modify the instruction.
#128	Instruction needs a table location value. Error at instr. X, rung Y.	VALUE is not present, or is a constant where a table location is required.	Change to a required type of VALUE.

Code	Fault Message	Possible Causes	Recommended Recovery
#129	Instruction needs a data value. Error at instruction X, rung Y.	The preceding Special Function requires a VALUE (either constant or table reference) to follow it.	Insert the appropriate VALUE.
#130	No value at end of instruction. Error near instruction X, rung Y.	The last instruction has been reached before the VALUE for a Special Function has been found.	Insert the appropriate VALUE.
#131	Rung stack underflow. Error near instruction X, rung Y.	User program has become corrupted.	Replace the specified instruction.
#132	Rung stack overflow. Error near instruction X, rung Y.	User program has become corrupted.	Replace the specified instruction.
#133	Rung imbalanced. Error near instruction X, rung Y.	Last rung not complete. Usually caused by halting transfer from the programming tool before transfer is complete.	Modify last rung.
#136	Invalid source of instructions.	The compiler is attempting to fetch instructions from an incorrect area of memory.	Power off/on and retry compilation. If problem persists replace controller.
#137	Invalid object region.	The compiler is storing object code to an incorrect area of memory.	Power off/on and retry. If problem persists replace processor module.
#139	P-table limit exceeded for system. Error near instr. X, rung Y.	Reference to P-table higher than allowed by system.	Optimise program.
#140	Unmatched JUMP (data) at instruction number X, rung Y.	A JUMP was specified but no corresponding LABEL to which to jump was specified.	Add LABEL at appropriate place or remove JUMP if unintended.
#141	Duplicate LABEL (data) at instruction X, rung Y.	A LABEL number was specified in more than one place.	Change LABEL number or remove LABEL if unintended.
#142	Reverse JUMP (data) at instruction X, rung Y.	An attempt to JUMP backwards in the ladder program was found.	JUMPs can only be forwards.
#143	LABEL number (data) exceeds maximum at instruction X, rung Y.	Maximum LABEL number is 15.	Reduce LABEL number.
#144	JUMP number (data) exceeds maximum at instruction X, rung Y.	Maximum JUMP number is maximum LABEL number i.e. 15.	Reduce JUMP number.
#145	Insufficient space for message editor strings	Too many user messages have been defined.	Reduce number of messages or shorten them.
#146	FIP configuration error at PX	Incorrect FIP P-Table configuration data.	Edit program
#147	FIP database creation error No.% X	Incorrect FIPCFG Special Function value data.	Edit program

Code	Fault Message	Possible Causes	Recommended Recovery
#148	Serial link configuration error at P%d.	Incorrect Serial Link P-Table configuration data.	Edit program
#149	GEMCAN module %d error %d	Incorrect GEMCAN P-Table configuration data.	Edit program
#150	GEMCAN module %d error %d, see P%d	Incorrect GEMCAN P-Table configuration data.	Edit program
#151	GEMCAN module %d error %d, see P%d and P%d	Incorrect GEMCAN P-Table configuration data.	Edit program

7.9.2 Compilation Checks

On compilation, the controller performs the following checks:

(a) Matching data table sizes to program requirements by searching for the highest specified location in each table.

Notes:

(1) This does not take into account blocks of data used by GEM80 Special Functions where only the first location is specified. If such a block of data is at the end of a table, a specific reference must be included to create a large enough table.

(2) Also note that existing data table locations will be removed if they are no longer required by a program that has been modified. This can create confusion in the case of the P-table since they may be created simply by attempting to access them through a suitable GEM80 Programming Package. Consider the situation where an address list containing P1000 has been created and the value 21 written to it. The program (which contains no reference above P500) is then re-compiled. On re-entering the data list mode, the message INVALID ADDRESS is displayed. If the list is cleared and P1000 re-entered, it will be found to contain 0 and not 21. This is because P1000 had been deleted on recompilation, but then recreated when the data list was renewed.

(b) Generating and checking the I/O configuration data for Basic and Verification I/O.

(c) Checking the legality of data table accesses, e.g. OUT to a P-table is not allowed.

(d) Checks the structure of the user program, e.g. depth of nesting of Obey Blocks.

(e) Checking the correctness of VALUE instructions with COUNT and DELAY GEM80 Special Functions. This checking ensures that if a VALUE is required, it is present and of an acceptable type (e.g. write-enabled data table).

(f) Checking that there is a START OF BLOCK instruction for every END OF BLOCK instruction and vice versa, and checking LABEL and JUMP GEM80 Special Functions.

7.9.3 Error Message #105 and I/O Scanning

I/O Scanning

In a similar way to computing the sizes of data tables, so also, a GEM80-500 Controller computes what I/O ought to be present from the addresses appearing in the user program. The controller only attempts to read input data from, and send output data to those I/O devices whose addresses appear in the program. Refer also to the F-tables, F200 to F329, for further details.

Basic and Verification I/O

Only those Basic and Verification I/O words appearing in the program are included in the I/O scan. For instance, if the program contains a contact referenced A1.0, the whole word A1 will be read from the input modules and units. If a module is fitted and set to an address that is not referred to in the program, this module will not be scanned; no data will be read from or written to it.

When compilation is attempted the program will not run if any forbidden addresses have been used in the program, and the programming tool will display a diagnostic message.

Forbidden addresses are where A-table and B-table addresses have the same number (e.g. A4 and B4) or where addresses have a number greater than the maximum imposed by the hardware.

7.9.4 Programming Routine for Correction of Compilation Errors

To correct a program with several errors, the user should use the 'Search' facility to display and modify the first faulty rung. A recompilation gives information about the next error. This procedure may be repeated until the program compiles successfully.

Note:

A single error may cause several to be reported, e.g. an incorrect I/O reference.

If the compilation is successful, the following message is displayed on the programming tool screen for 10/15 seconds, and held on the System Event Log:

'Compiled. Instructions available xxx. Data tables available yyy.'

Each compile error is reported as shown:

'#1xx <compile_error> at rung xxx: yyy, (instruction zzz).'

where xxx is the rung number, yyy is the number of the instruction within the rung, zzz is the instruction number within the program.

7.9.5 Compilation Errors and the Controller

Compilation errors cause the controller to continue executing the previous successfully compiled version of the user program, and give a fault report from the failed compilation. The System Event Log, available with a suitable GEM80 Programming Package, can display up to 50 compiler error messages (out of 100 System Event Log locations).

When the controller is running and the user makes changes to the source version of the program, the status is displayed on the programming tool as CHANGED instead of RUNNING until such time as the user recompiles. If the controller is running with status CHANGED and there is a power interruption, the controller will go into halt mode after power-up and give a fault report:

"PROGRAM DIFFERENT FROM RUNNING VERSION",

or

"POWER REMOVED WHILE PROGRAM IN A CHANGED STATE".

As part of the self-test procedures which the controller undertakes, there is a check that there has not been any alteration to program instructions and data in the P-table. Each time the user makes changes to his program or P-table data, the controller has to recalculate a CRC value. If power is interrupted before this calculation is complete, the warning message:

"CRC NOT STORED, PROGRAM MAY HAVE CHANGED"

is displayed on power up, and the controller goes into halt mode. The user may, however, run the program if desired.

7.10 System Status at Power Up (#500 to #699)

If, during the power-up self-test cycle, one of these fault conditions is detected, the GEM80-500 Controller will remain in the 'halt' condition and return the fault message until the fault is cleared. The fault messages are detailed at Table 7-3.

Table 7-3 System Status Error Messages

Code	Fault Message	Possible Causes	Recommended Recovery
#501	Monitor Firmware CRC Test Fail.	Firmware has been corrupted.	Power off/on. If this does not work the board is permanently damaged.
#502	System Firmware CRC Test Fail.	Firmware has been corrupted.	Power off/on. Update firmware. If this does not work the board is permanently damaged.
#503	No Valid System Code Found.	Firmware has been corrupted.	Power off/on. Update firmware. If this does not work the board is permanently damaged.
#504	Invalid Monitor Mode Selected.	Front Panel Mode Switch in a Reserved Position.	Correct the Mode Switch setting.
#505	Workspace Ram Test Failed.	Faulty/static damaged RAM chips.	Power off/on. If this does not work the board is permanently damaged.

Code	Fault Message	Possible Causes	Recommended Recovery
#602	Power removed while User Program in a Changed State.	The user program has been edited and the controller powered down before the program was recompiled. The controller will be halted on power up.	Recompile program.
#603	V-table corrupted program store cleared.	Memory corruption of important data occurred, treated as a new system. Could be caused by turning power off during compilation, or faulty processor module. It may be a flat battery, but battery warning should occur first.	Power off/on and reload. If problem persists, suspect processor module, and substitute spare. Check for flat battery and arrange to have battery changed.
#604	New System program store cleared.	Front Panel Mode Switch in a Reserved Position or battery failure.	Correct the Mode Switch setting or arrange to have battery changed.
#606	Unable to switch to RAM.	Failed to copy program to RAM when the S0 location was set to 0.	The processor module is probably faulty and should be replaced.
#607	Unable to switch to EPROM.	Failed to switch to EPROM when the S0 location was set to 1. EPROM is either blank or invalid.	Retry to program EPROM
#626	Write protect switch set, FLASH EPROM cannot be written to.	Front Panel Mode Switch in a Protect Position	Correct the Mode Switch setting.
#630	FLASH EPROMs are empty.	User has requested that the controller runs the user program stored in EEPROM, but the EEPROM is empty.	Program the Flash EPROM.
#636	System Event Log cleared	The user requested Log clear has been executed.	(Information message only)
#637	System Power up.		(Information message only)
#638	System Store Cleared.	The user requested Store clear has been executed.	(Information message only)
#640	Failed to Erase EPROM memory.	FLASH EPROM memory cannot be erased.	Retry to program the Flash EPROM. Failure indicates a faulty processor module.
#641	Failed to Program EPROM memory.	FLASH EPROM memory cannot be programmed.	Retry to program the Flash EPROM. Failure indicates a faulty processor module.

7.11 Self-test and Self-test Failure Error Messages (#700 to #799)

7.11.1 Self-test Error Messages (#700 to #799)

On the occurrence of self-test failure, the controller halts and it will not restart unless the fault is cleared and power switched off and back on again. Table 7-4 details these error messages. The CRC system referred to at Table 7-4 is discussed at 7.8.

Table 7-4 Self-test Error Messages

Code	Fault Message	Possible Causes	Recommended Recovery
#702	Object RAM checksum failure.	On-line corruption	Power off/on to re-initialise the RAM. If the problem persists suspect the processor module
#703	User program checksum failure.	Source code corrupted.	Try clear store, power off/on and reload. If the problem persists suspect the processor module.
#704	V-table checksum test failure.	On-line RAM failure.	Power off/on (will give #603), then reload. If the problem persists suspect the processor module.
#705	Processor local RAM failure	Failed processor module.	Substitute spare processor module.
#706	FLASH checksum error.	Faulty data table/source code.	Substitute spare processor module.
#707	Bit logic test failure.	Failed processor module.	Substitute spare processor module.
#708	Watchdog test failure. Status %d, State %d	Suspect failed processor module.	Substitute spare if the problem persists Note the %d figures when returning the faulty items.
#710	Battery failure.	Flat or disconnected battery. Note...Watchdogs do not trip.	Save program and arrange for the battery to be changed.
#716	User requested watchdog trip F1 = data.	F1 set to non-zero value by user program.	Check user program software for reason. Power off/on to restart.
#718	Program corrupted during power down store cleared.	Only occurs on power-up. P-tables or instructions corrupted.	Clear store, power off/on and reload, check battery warning indication. If the problem persists, Substitute spare processor module and sub board if fitted.
#719	Watchdog self trip. Error No. %d	Watchdog detected error, contacts open. Faulty processor module.	Substitute processor module.
		Error No / Watchdog Tripped	

Code	Fault Message	Possible Causes		Recommended Recovery
		1 2 3 4	0 1 FIP No apparent cause	
#729	Basic I/O test failure.	Faulty connection, cable short, faulty I/O module or faulty processor.		Investigate connections and referenced I/O device. If problem persists, substitute spare processor module and lastly, spare subrack.
#730	User program RAM test failure.	Faulty RAM on processor module.		Substitute spare processor module.
#731	Data table RAM test failure.	Faulty RAM on processor module.		Substitute spare processor module.
#732	Object RAM test failure.	Faulty RAM on processor module.		Substitute spare processor module.
#733	Firmware checksum failure.	EPROMs have failed.		Substitute spare processor module.
#734	Battery failure and power removed when in a changed state.	Battery has failed and changes to user program have been lost by power off/on.		Change Battery. Re-load user program and re-edit.
#735	Failed P Message area RAM test.			Re-load backup program/P-tables/messages. If problem persists Substitute spare processor module.
#737	P-table checksum failure.			Re-load backup program/P-tables/messages.. If problem persists substitute spare processor module.
#738	Message editor checksum failure.			Re-load backup program/P-tables/messages and re-edit message. If problem persists substitute spare processor module.

Note:

Wherever % is shown the number displayed when the fault occurs should be noted and Customer Support contacted.

7.11.2 Self-test System

The self-test system operates as shown:

Execution

(a) One full cycle of start-up tests at power up.

(b) I/O tests repeated every scan.

(c) Regular on-line repetition of running tests.

Faults which immediately trip the watchdog

(a) AC supply break longer than the minimum 20 ms ride-through period.

(b) Power supply module failure.

(c) Failure of processor module.

Faults which trip the watchdog when detected by running tests

(a) Alteration detected in the contents of the read only memory.

(b) Failure of any part of the read/write memory to store and recall data.

Faults from which recovery is automatic

(a) AC supply reapplied after a break.

(b) Corrupt message received on the serial link.

Faults which the user may program to trip the watchdog

There is no restriction on the user programmable watchdog trips. Any ladder rung which writes a non zero value into F1 will cause a watchdog trip. It is recommended that the values chosen are different from the internally generated trip codes to ease fault finding.

7.12 Interprocessor Communications (Error Messages #800 to #899)

Table 7-5 details the Interprocessor Communications Error Messages.

Table 7-5 Interprocessor Communications Error Messages

Code	Fault Message	Possible Causes	Recommended Recovery
#806	IPC timeout to data.	Faulty GEMLAN-T or Faulty Motherboard	If any of these faults occur, contact ALSTOM with the following information: a) the controller ordering code; b) the firmware issue number c) the circumstances in which the fault occurred d) the specific fault code
#807	Task %i IPC error data.		
#808	Processor timeout data.		
#809	Chics error data while creating a message. Task %i		
#810	Chics error data while waiting for message. Task %i		
#811	Chics error data while sending a message. Task %i		
#813	Pmes error. Wrong reply received.		
#814	Invalid processor reply data		
#815	Reply received from unknown processor data		
#816	Region access error data, task %i		
#818	GEMCAN module %d heartbeat timeout	Faulty GEMCAN I/O Scanner module	Replace GEMCAN I/O Scanner module. If problem persists replace host controller. This fault does not trip the host controller.

7.13 System Errors (Error Messages #900 to #999)

These errors concern internal maloperation of the executive software. Try power off/on; if the problem persists, it should be reported immediately with details of the fault message (they contain variable fields), user program and I/O configuration. Table 7-6 details the System Errors.

Table 7-6 System Error Messages

Code	Fault Message
#900	Unknown error data.
#901	%i task. Illegal task number used.
#902	%i task. Too many messages sent.
#903	%i task. No messages available.
#904	%i task. No messages to return.
#905	%i task. Message not received.
#906	%i task. Illegal interrupt number used.
#907	No room in region queue.
#908	Not in region when executing EXIT_PLC_REGION.
#909	Insufficient memory for organiser tables.
#910	Interrupt already defined.
#911	Insufficient memory for organiser tables.
#912	Insufficient memory for organiser tables.
#913	%i task performed return.
#914	Pascal error.
#915	Divide overflow.
#916	Range check overflow.
#917	Trap interrupt.
#919	%i task stack overflow.
#920	User Program not compiled.
#921	Transmit timeout on serial link data.
#922	Software watchdog trip.
#923	Too many interrupt levels defined.
#924	Organiser interrupt timeout (inter processor).
#926	%I task. Timeout in Start-up. %I task
#928	Unused interrupt @cs:ip = %x:%x
#929	Unused Opcode. @cs:ip = %x:%x
#931	Error message data is too long.
#932	Error message data has insufficient number of parameters.
#933	Error message data has excess parameters.
#934	Error message data ended prematurely.
#935	Error message data has invalid character.
#936	Error message data has invalid format specified.

Code	Fault Message
#937	Error message data generated invalid hex character.
#938	Error message data invalid task number.
#939	Error message data included string too long.
#940	Could not switch state in Error Handler.
#941	Invalid state transition. State data, transition data.
#942	Invalid state data.
#943	Source pointer not in region.
#944	Source pointer beyond region.
#947	Invalid processor Id. data.
#948	Invalid call.
#949	Invalid return.
#950	Invalid switch.
#957	Power failure.
#958	DMA 1 interrupt.
#959	DMA 0 interrupt.
#960	Single step error.
#961	INT0 interrupt.
#962	Escape Opcode error.
#963	Array bounds error.
#964	Invalid timer interrupt.
#965	FIP interrupt.
#966	Invalid key switch position.
#967	Invalid serial link interrupt.
#968	Unexpected Watchdog Interrupt.
#969	Unexpected Central Highway Interrupt.
#970	FIP error during initialisation data.
#971	CHICS memory RAM test failure.
#973	Int1 Interrupt FIP Error
#974	FIP Generated Fatal Error no. %x
#975	FIP Network Initialisation failure
#976	FIP Medium invalid, error %x
#977	FIP RAM Test failure, error %x
#978	FIP BA Start error no %x
#979	FIP BA Stop error no. %x
#980	FIP Hardware/ Software incompatibility
#981	FIP Delete BA macro cycle error no %x
#982	FIP Create BA macro cycle error no. %x

Note:

%x value should be available when contacting ALSTOM Customer Support for assistance.

7.14 F-Table Usage

Data in the F-table provides further information on fault diagnosis. The contents of the F-table are detailed at Table 7-7.

The Serial Link Diagnostics are shown at Table 7-8 and Table 7-9.

The F-tables are used by the system to store fault codes and Serial Link Statistics and are allocated as shown at Table 7-10 and Table 7-11.

Table 7-7 F-Table Contents

Address	Content	Remarks
F0	Reserved	-
F1	User required watchdog trip	Any non-zero value placed in F1 by user program trips the watchdog, terminates program execution and displays a fixed diagnosis message on a suitable GEM 80 programming tool screen
F2	System fault bits	See below
F2.0	-	Set to 1 if previous program cycle exceeds preset scan time
F2.1	-	Set to 1 for one scan if recompile successful.
F2.2	-	Set to 1 if recompilation will occur on the current scan
F2.3	-	Reserved
F2.4	Battery condition. Onboard battery low warning bit	Set to 1 if battery power low
F2.5	Reserved	
F2.6 to F2.15	Reserved	-
F3	FIP Run Time Fault Flag	-
F4	FIP Configuration Fault Information	
F5 to F9	Reserved	-
F10 to F89	Serial link diagnostics	See 7.15.
F10 to F29	Serial link diagnostics for Serial Port 1	See 7.15.
F30 to F49	Serial link diagnostics for Serial Port 2	See 7.15.
F50 to F69	Serial link diagnostics for Serial Port 3	See 7.15.
F70 to F89	Serial link diagnostics for Serial Port 4	See 7.15.
F90 to F109	Serial Link statistics for Port 1	See 7.16.
F110 to F129	Serial Link statistics for Port 2	See 7.16.
F130 to F149	Serial Link statistics for Port 3	See 7.16.
F150 to F169	Serial Link statistics for Port 4	See 7.16.

Address	Content	Remarks
F170 to F199	Reserved	-
F200 to F329	Basic and Verification I/O Fault Indication bits	2 bits per I/O address, bit 0 = fault/fail, bit 1 = warning. For Basic I/O both bits are set if an error is detected
F330 to F371	GEMCAN I/O Scanner	See GEMTEQ I/O Technical Manual T2031En for further details
F372 to F499	Reserved	-
F500 upwards	-	These tables are available to the user program.

7.15 Serial Communications Diagnostics F-Tables

Ports 1 to 4 are each allocated 20 F-tables as follows:

Port 1 - F10 to F29

Port 2 - F30 to F49

Port 3 - F50 to F69

Port 4 – F70 to F89

The meaning of the data stored depends upon the working mode of the serial port, e.g. Printer, ESP Tributary, etc.

7.15.1 Printer Port

No fault diagnostics are available when any of the ports are used as a printer port.

7.15.2 ESP Tributary Port

Table 7-8 ESP Tributary Port F-Tables

Port 1	Port 2	Port 3	Port 4	Remarks
F10.0	F30.0	F50.0	F70.0	Tributary failed (set when tributary has not been polled for at least 30 seconds).
F10.8	F30.8	F50.8	F70.8	Last message received was truncated.

7.15.3 ESP Control Port

Table 7-9 ESP Control Port F-Tables

Port 1	Port 2	Port 3	Port 4	Remarks
F10.0	F30.0	F50.0	F70.0	Route 0 failed
F10.1	F30.1	F50.1	F70.1	Route 1 failed
F10.2	F30.2	F50.2	F70.2	Route 2 failed
F10.3	F30.3	F50.3	F70.3	Route 3 failed
F10.4	F30.4	F50.4	F70.4	Route 4 failed
F10.5	F30.5	F50.5	F70.5	Route 5 failed
F10.6	F30.6	F50.6	F70.6	Route 6 failed
F10.7	F30.7	F50.7	F70.7	Route 7 failed
F10.8	F30.8	F50.8	F70.8	Last message on route 0 was truncated
F10.9	F30.9	F50.9	F70.9	Last message on route 1 was truncated
F10.10	F30.10	F50.10	F70.10	Last message on route 2 was truncated
F10.11	F30.11	F50.11	F70.11	Last message on route 3 was truncated
F10.12	F30.12	F50.12	F70.12	Last message on route 4 was truncated
F10.13	F30.13	F50.13	F70.13	Last message on route 5 was truncated
F10.14	F30.14	F50.14	F70.14	Last message on route 6 was truncated
F10.15	F30.15	F50.15	F70.15	Last message on route 7 was truncated
F11	F31	F51	F71	Route 0 diagnostics
F12	F32	F52	F72	Route 1 diagnostics
F13	F33	F53	F73	Route 2 diagnostics
F14	F34	F54	F74	Route 3 diagnostics
F15	F35	F55	F75	Route 4 diagnostics
F16	F36	F56	F76	Route 5 diagnostics
F17	F37	F57	F77	Route 6 diagnostics
F18	F38	F58	F78	Route 7 diagnostics
F19 - F29	F39 - F49	F59 – F69	F79 – F89	Not used

Diagnostic Words

The diagnostics words are defined as follows:

bits 0 to 7	Address of last responding tributary
bits 8 to 11	Fault code
bits 12 and 13	Not used
bit 14	Set when transfer failed
bit 15	Set when transfer successful

Fault codes

0	Successful transfer
3	Transmission failed
4	Hardware error
5	NAK received
6	CRC of received message failed
7	Wrong terminator received
8	Received message too long
9	Data error (incorrect data format)
10	No tables assigned to this route

7.16 Serial Communications Statistics F-Tables

Ports 1 to 4 are each allocated 20 F-tables as follows:

Port 1 - F90 to F109

Port 2 - F110 to F129

Port 3 - F130 to F149

Port 4 - F170 to F199

The first two statistics for each port are in two locations and can be interpreted as follows:

= (65,536 x Value in higher location number) + Value in lower location number

The other statistics are stored in a single location and have a maximum value of 65,535 (@FFFF). The meaning of the data stored depends upon the working mode of the port, as shown at Table 7-10 and Table 7-11.

7.16.1 Printer Ports

Link statistics are not available for any of the ports used as a printer port.

7.16.2 ESP Tributary Ports

Table 7-10 ESP Tributary Port Link Statistics

Port 1	Port 2	Port 3	Port 4	Contents
F90 and F91	F110 and F111	F130 and F131	F150 and F151	Number of messages received
F92 and F93	F112 and F113	F132 and F133	F152 and F153	Number of replies sent to control port
F94	F114	F134	F154	Number of hardware errors (Framing errors)
F95	F115	F135	F155	Number of time-outs
F96	F116	F136	F156	Number of CRC errors in received data
F97	F117	F137	F157	Number of data errors. Incoming message too large for buffer
F98	F118	F138	F158	Number of transmit data errors
F99	F119	F139	F159	Number of stuffing errors
F100	F120	F140	F160	Number of ENQs received. Requests for a resend
F101	F121	F141	F161	Mode error
F102	F122	F142	F162	Transmission time-outs
F103	F123	F143	F163	Overrun error
F104	F124	F144	F164	Break error
F105 to F109	F125 to F129	F145 to F149	F165 to F169	Not used

7.16.3 ESP Control Ports

Table 7-11 ESP Control Port Link Statistics

Port 1	Port 2	Port 3	Port 4	Contents
F90 and F91	F110 and F111	F130 and F131	F150 and F151	Number of message requests
F92 and F93	F112 and F113	F132 and F133	F152 and F153	Number of attempted transmissions (including retries)
F94	F114	F134	F154	Number of hardware errors
F95	F115	F135	F155	Number of time-outs. on receive
F96	F116	F136	F156	Number of CRC errors in incoming message
F97	F117	F137	F157	Number of NAK replies. Short messages received
F98	F118	F138	F158	Number of terminator errors
F99	F119	F139	F159	Number of data errors. message to big for buffer
F100	F120	F140	F160	Transmit time-outs
F101	F121	F141	F161	Overrun error
F102	F122	F142	F162	Break error
F103 to F109	F123 to F129	F143 to F149	F163 to F169	Not used

7.17 Verification & Basic I/O Statistics

There are 2 bits of statistics per I/O address, starting with F200.0 and F200.1 for I/O address 0.

7.18 V-Data Tables

The majority of the locations in the V-table are for system internal functions and have no significance for the user. However, a few are useful and these are described at Table 7-12.

Table 7-12 V-Table

Address	Content	Remarks
V0	Not used	-
V1	Compilation count, moving flag.	Low byte contents are incremented after each successful compilation. V1.8 =1 Moving (See note 1).
V2 to V47	Used by system software for data table offsets and lengths	-
V48 to V51	Reserved for system usage	-
V52	Length of the message area in bytes	-
V53 to V57	Reserved for system usage	-
V58	V-table checksum	-
V59	User program checksum	-
V60	P-table checksum	-
V61	FIP network subscriber address (if present)	-
V62	Front Panel Switch setting	This is read once when the controller is powered up.
V63	Always 0	No off-line support
V64	Firmware issue	This is copied from the firmware issue in the format A etc.
V65 to V66	Reserved for System Usage	

Address	Content	Remarks
V67 to V71	Plug-in Module Identifiers	V67 to V71 do not give any indication of the slot positions of the modules. The first module found is reported in V67, the second in V68 etc. If less than 5 modules are present, then the unused entries contain 0. **@0711** 1st Basic I/O Module (Basic Ribbons 1 and 2) **@0715** 2nd Basic I/O Module (Basic Ribbons 3 and 4) **@0710** 1st Basic/Verification I/O Module (Basic Ribbon 1 / Verification Ribbon 1) **@0714** 2nd Basic/Verification I/O Module (Basic Ribbon 3 / Verification Ribbon 1) **@0628** 1st Serial Communication Module Ports 1 and 2 **@052C** 2nd Serial Communication Module Ports 3 and 4 **@1318** FIP Module **@2720** 1st GEMCAN I/O Scanner Module **@2724** 2nd GEMCAN I/O Scanner Module

Note 1 at Table 7-12:

V1 bit 8 is set just before compilation and reset when compilation is complete.

7.19 Clear Store Command

If the user issues a CLEAR command, part of the P-table is not cleared. This part (P0 to P149) is used to hold configuration data for serial links.

The reason for not clearing this section of P-table is that GEM80-500 Controllers may be programmed either from the front port of the processor, or remotely via one of the serial ports. Loss of data about the serial port configurations could make it impossible for the controller to communicate with a remote programmer, and so this data is retained even when the rest of the memory store is cleared.

Before loading a program, always issue a CLEAR STORE command, for the following two reasons:

(a) The area of P-table that holds printer messages is not normally write-accessible, except via the message editor facility. The CLEAR STORE command allows data to be loaded to the whole of the P-table.

(b) The controller allocates memory space for the data tables according to the content of your program. The CLEAR STORE command sets all data table areas to their minimum size, and ensures that unnecessary space has not been allocated by the previous version of program.

Where the controller is programmed remotely via one of the serial ports, the configuration data must be the same for this port as the values already in store, otherwise you will lose communication after a recompilation or power off/on.

Note:

When the data being loaded includes messages, the message area, made write-accessible by the CLEAR STORE command, becomes write-protected again, except via the message editor, after recompilation.

7.20 System Event Log

The GEM80-500 Controller maintains a battery backed and time stamped log of the last 100 system events. Programming errors detected by the compiler, during an attempted compilation of a user program, are also recorded in the System Event Log.

The System Event Log is of assistance during the program development and modification phases and during normal operation of the system as it provides the opportunity to maximise the plant run time without losing vital diagnostic information that can be investigated at a more convenient time.

System events include:

(a) power on;

(b) power off;

(c) resetting of the real time clock;

(d) clearing of the fault log;

(e) system error messages;

(f) system information messages;

(g) compilation error messages.

The contents of the System Event Log may be displayed, saved to a file, printed and cleared by issuing a simple command from a suitable GEM80 Programming Package. With the use of such a Programming Package the errors may be displayed at the same time as the user program as an aid to fault finding. Each compilation error contains a rung and instruction reference.

7.21 Intermittent Tripping Problems

GEM80 equipment is normally reliable in operation, provided that it is installed in accordance with the guidance given at Section 6.

If the equipment does trip out, note the cause where possible and consequent remedial action. If repeated tripping occurs, keep a log of all trips detailing the fault code, possible explanation and the circumstances under which tripping occurred.

Possible causes of equipment tripping are discussed here:

7.21.1 Electrical Noise or Electromagnetic Interference

GEM80 equipment has been tested against noise immunity from RFI and EMC. However, high levels of RFI noise in close proximity to GEM80 equipment can trip out the system. Hand-held radio transceivers ('walkie-talkies') should not be used within

2 metres of the controller. Segregation requirements and signal ground arrangements should be installed as detailed at Section 6.

7.21.2 Connector/Termination Problems

All connections should be checked. Suspect connections, e.g. mechanically damaged or corroded, should be re-terminated.

7.21.3 Overheating

The installation should conform to the environmental conditions detailed at Section 2. The I/O should be installed as described at Section 6.

7.22 Firmware Update

The executive code or 'Firmware ' that provides the GEM80-500 Controller with its characteristic functionality is stored in Flash EPROM. This may be updated on site using a Windows based PC compatible firmware update utility (FUP32). The firmware update utility communicates with the controller front panel Programming Port in the same way as a PC based programming tool and will normally be able to use the same serial link connection lead.

The instructions given in the README.TXT file, supplied with the firmware update programme, should be followed in order to complete a successful firmware update.

The firmware update mode is selected when the controller is powered up with the front panel Mode Selector Switch in Position 4.

7.23 Repairs to GEM 80 Equipment

GEM 80 equipment is repaired by replacement of faulty modules and units. GEM 80 modules are not considered to be user repairable and any attempt to carry out repairs to modules will invalidate all warranties and guarantees. ALSTOM cannot accept responsibility for GEM 80 equipment that has been repaired, other than by ALSTOM Customer Support Department.

7.24 Fault Finding Back-up and Module Repair Service

To assist the user in the diagnosis and rectification of faults to GEM 80 equipment, the following services are available from ALSTOM:

(a) Product Service Centre Customer Support - available to any GEM 80 user.

(b) A 'service contract' scheme for complete GEM 80 systems.

(c) A Normal and Priority Repair Service - available for repair of GEM 80 equipment.

For Customer Support on any aspect of GEM 80 applications, please call:

Product Service Centre Customer Support

Telephone: +44 (0) 1782 781000

Fax: +44 (0) 1782 781133

e-mail: psc_kidsgrove@powerconv.alstom.com

Any faulty modules should be returned for repair to:

Product Service Centre – Spares and Repairs Dept,

ALSTOM Power Conversion Ltd.,

West Avenue,

Kidsgrove,

Stoke-on-Trent,

Staffs.,

ST7 1TW

England.

Tel: +44 (0) 1782 781128

Fax: +44 (0) 1782 781133

e-mail: psc_kidsgrove@powerconv.alstom.com

Faulty modules or units for repair, should be returned in packing which includes antistatic bags next to the electronic circuitry. Where possible the original packing should be used.

7.25 Disposal

The GEM80-500 Controller should be disposed of in accordance with the laws of the country of use.

Modern high technology materials have been used in the manufacture of the controller to ensure optimum performance. Care has been taken with the selection of these materials to minimise risks to health and safety. However, some materials require special consideration during disposal e.g. the battery which is a Lithium Thionyl Chloride type.

It is recommended that the controller be returned to ALSTOM for safe disposal. Prior arrangements should be made for return to the address at 7.24. Alternatively the controller may be returned to the nearest ALSTOM service centre.

8. Upgrading GEM80 Systems

8.1 Upgrade Philosophy

The philosophy for the use of GEM80-500 to upgrade existing GEM80 systems is to enable:

- existing I/O plant wiring to be retained;
- most of the original user program to be retained;
- communications networks to be retained;
- replacement of processor, power supply unit and/or central modules.

The GEM80-500 Controller will offer:

- better performance;
- improved diagnostics;
- reduced spares holding;
- short project implementation timescales with the use of proven software and plant interfacing.

8.2 List of previous GEM80 systems which can be replaced by GEM80-500

Table 8-1 lists a range of previous GEM80 systems which can be replaced by the GEM80-500 Controller. This list may not be fully comprehensive. If the user has a GEM80 system installed which is not listed in the table contact the ALSTOM Product Service Centre Customer Support for advice (see 7.24 for contact details).

8.3 GEM80-500 Host Subrack Interface Module (9717-4020)

When upgrading controllers such as the GEM80-141, 142, 160, 163, 164, 165, 166, a Host Subrack Interface Module (9717-4020) may be required. In this type of controller, the I/O highways were created on the I/O Processor and interfaced directly with the host subrack via the I/O Processor backplane connector. Once the I/O Processor has been removed, user connection to the I/O highway is no longer possible. The GEM80-500 Host Subrack Interface Module (9717-4020) once again allows I/O Ribbon Cables to be interfaced to the host GEM80 subrack I/O highway. For further details please refer to T1959En GEM80-500 Host Subrack Interface Module (9717-4020) Instruction Sheet.

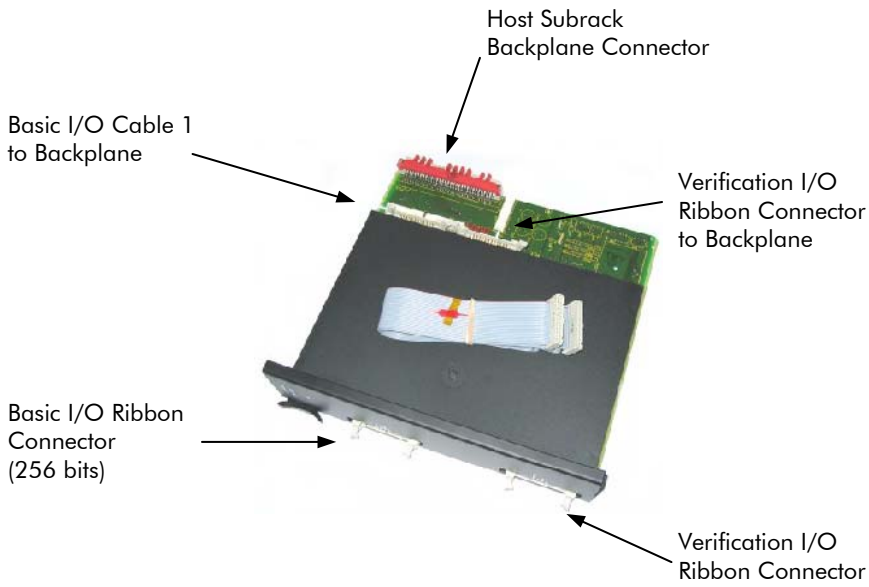

Figure 8-1 Host Subrack Interface Module 9717-4020

8.4 Guidance for upgrading an existing GEM80 System

The recommendations given at Table 8-1 apply to users with standard GEM80 systems i.e. those with standard firmware included. However, when special GEM80 Project firmware has been fitted to a GEM80 system using 3xxx or 6xxx numbered code then functions may have been included which are not in the GEM80-500 Controller. If this applies to the system to be upgraded contact the ALSTOM Product Service Centre Customer Support for advice (see 7.24 for contact details).

There are some GEM80 systems which may require a new I/O subrack when a GEM80-500 Controller is used and these systems are identified in the table. On these systems the Basic I/O ribbon connector is not easily accessible by the user therefore it is likely that a new I/O subrack will be required. Contact the ALSTOM Product Service Centre Customer Support for advice (see 7.24 for contact details).

There are also some items in the table which apply to the upgrading of every GEM80 system and these are identified with notes to the table.

For completeness they are:

- P-tables will have to be moved;
- J and K tables may have to be moved;

WARNING

GEM80-500 Systems do not automatically trip the Watchdog if a BASIC or VERIFICATION I/O fault flag occurs. Suitable rungs must be added to the ladder diagram if a trip is required from selected flags.

Table 8-1 GEM80 Upgrading Recommendations

Type of GEM80 system to be replaced	I/O Hardware	Communications Ports	Declaration of tables	Notes on Special Functions
GEM80-100	9713-4021 Two Basic I/O ribbons	9714-4020 may be required also RS232 to 20mA conversion	Table Declaration rung will be required	All Supported
GEM80-130	9713-4021 Two Basic I/O ribbons	9714-4020 may be required also RS232 to 20mA conversion	Table Declaration rung will be required	WRINUM & WRITEXT are not supported would have to change to PRITEXT or PRINT
GEM80-140	These controllers had two concentrated I/O expanders. These could be replaced by two 9713-4021. *** New I/O Rack could be required**	9714-4020 may be required also RS232 to 20mA conversion	Table Declaration rung should be in existing ladder	All Supported
GEM80-141	9713-4021 Two Basic I/O ribbons *** New I/O Rack could be required**	9714-4020 may be required also RS232 to 20mA conversion	Table Declaration rung should be in existing ladder	All Supported
GEM80-142	These controllers had one or more concentrated I/O expanders. These could be replaced by two 9713-4021. Take care these could be expanded above 64 words of I/O and could even have remote I/O. In these cases a change for verification I/O would be required *** New I/O Rack could be required**	9714-4020 may be required also RS232 to 20mA conversion	Table Declaration rung should be in existing ladder	All Supported
GEM80-150	These controllers had two I/O processors. These could be replaced by two 9713-4021.	These controllers had two I/O processors. These could be replaced by two 9714-4020. RS232 to 20mA may be required.	Table Declaration rung should be in existing ladder	All Supported
GEM80-160	These controllers had one or more verification I/O expanders. These could be replaced by 9713-4021 and/or 9713-4020 cards. Take care these could have more than 20,000 user instructions *** New I/O Rack could be required**	9714-4020 may be required also RS232 to 20mA conversion	Table Declaration rung should be in existing ladder	All Supported except Floating Point

Type of GEM80 system to be replaced	I/O Hardware	Communications Ports	Declaration of tables	Notes on Special Functions
GEM80-163	These controllers had one or more verification I/O expanders. These could be replaced by 9713-4021 and/or 9713-4020 cards. Take care these could have more than 20,000 user instructions *** New I/O Rack could be required**	9714-4020 may be required also RS232 to 20mA conversion	Table Declaration rung should be in existing ladder	All Supported except Floating Point
GEM80-164	These controllers had one or more verification I/O expanders. These could be replaced by 9713-4021 and/or 9713-4020 cards. The Imagem is not supported and would have to be changed to SCADA. ALSPA P1200 will interface via either serial port or Ethernet. Take care these could have more than 20,000 user instructions. *** New I/O Rack could be required**	9714-4020 may be required also RS232 to 20mA conversion	Table Declaration rung should be in existing ladder	All Supported except Floating Point
GEM80-165	These controllers had one or more verification I/O expanders. These could be replaced by 9713-4021 and/or 9713-4020 cards. The STARNET is not supported on a GEM80-500. This may require upgrading to a GEM80-400. Take care these could have more than 20,000 user instructions. *** New I/O Rack could be required**	9714-4020 may be required also RS232 to 20mA conversion	Table Declaration rung should be in existing ladder	All Supported except Floating Point
GEM80-166	These controllers had one or more verification I/O expanders. These could be replaced by 9713-4021 and/or 9713-4020 cards. The GEMLAN-D is not supported on a GEM80-500. This may require upgrading to a GEM80-400. Take care these could have more than 20,000 user instructions. *** New I/O Rack could be required**	9714-4020 may be required also RS232 to 20mA conversion	Table Declaration rung should be in existing ladder	All Supported except Floating Point

Type of GEM80 system to be replaced	I/O Hardware	Communications Ports	Declaration of tables	Notes on Special Functions
GEM80-200 Series e.g. 210/220/225/ 235/245	These controllers could have paged video and/or fast I/O. These are not supported. Video could be replaced by SCADA. ALSPA P1200 can interface via serial port or Ethernet. It may be possible to change the fast I/O modules for verification modules.	9714-4020 may be required also RS232 to 20mA conversion	Table Declaration rung will be required	WRINUM & WRITEXT are not supported would have to change to PRITEXT or PRINT
GEM80-250 e.g. 251/252	These controllers could have paged video and/or fast I/O. These are not supported. Video could be replaced by SCADA. ALSPA P1200 can interface via serial port or Ethernet. It may be possible to change the fast I/O modules for verification modules.	9714-4020 may be required also RS232 to 20mA conversion	Table Declaration rung should be in existing ladder	All Supported
GEM80-350 Series e.g. 351/352/353	These controllers could have paged video and/or fast I/O. These are not supported. Video could be replaced by SCADA. ALSPA P1200 can interface via serial port or Ethernet. It may be possible to change the fast I/O modules for verification modules. These could also have remote I/O which would have to be changed to verification.	9714-4020 may be required also RS232 to 20mA conversion	Table Declaration rung should be in existing ladder	All Supported
GEM80-300 Series e.g. 301/302/303	These controllers could have Starnet, video and/or fast I/O. These are not supported. Video could be replaced by SCADA. ALSPA P1200 can interface via serial port or Ethernet. It may be possible to change the fast I/O modules for verification modules. These could also have remote I/O which would have to be changed to verification. Take care these could have more than 20,000 user instructions.	9714-4020 may be required also RS232 to 20mA conversion	Table Declaration rung should be in existing ladder	All Supported

Type of GEM80 system to be replaced	I/O Hardware	Communications Ports	Declaration of tables	Notes on Special Functions
GEM80-310 Series e.g. 311/312/313	These controllers could have Starnet, video and/or fast I/O. These are not supported. Video could be replaced by SCADA. ALSPA P1200 can interface via serial port or Ethernet. It may be possible to change the fast I/O modules for verification modules. Take care these could have more than 20,000 user instructions.	9714-4020 may be required also RS232 to 20mA conversion	Table Declaration rung should be in existing ladder	All Supported

Notes:

(1) The recommendations at Table 8-1 are for guidance when users have a standard GEM80 system. However, when special GEM80 Project firmware has been fitted to a GEM80 system using 3xxx or 6xxx numbered code then functions may have been included which are not in the GEM80-500 Controller. If this applies to the system to be upgraded contact the Product Service Centre Customer Support at ALSTOM at Kidsgrove for advice (see 7.24 for contact details).

(2) For every GEM80 system listed at Table 8-1 the **P-tables will have to be moved** and the **J and K tables may have to be moved**.

(3) For every GEM80 system listed at Table 8-1 be aware that the GEM80-500 systems do not automatically trip the watchdog if a BASIC or VERIFICATION I/O fault flag occurs. Suitable rungs must be added to the ladder diagram if a trip is required from selected flags.

(4) Some GEM80 systems, identified by *, may require a new I/O Subrack. On these systems the Basic I/O ribbon connector is not easily accessible by the user therefore it is likely that a new I/O subrack will be required. Contact the Product Service Centre Customer Support at ALSTOM at Kidsgrove for advice (see 7.24 for contact details).

9. Re-Order Codes

Description	Order Code
GEM80-500 Controller, 20k User Instructions - 110/220 V A.C. Power Supply	8870-4979
GEM80-500 Controller, 20k User Instructions - 110/220 V A.C. Power Supply - Configured with option modules	8870C4979
GEM80-500 Controller, 20k User Instructions - 24 V D.C. Power Supply	8870-4979DC24
GEM80-500 Controller, 20k User Instructions - 24 V D.C. Power Supply - Configured with option modules	8870C4979DC24
GEM80-500 Controller, 20k User Instructions - 48 V D.C. Power Supply	8870-4979DC48
GEM80-500 Controller, 20k User Instructions - 48 V D.C. Power Supply - Configured with option modules	8870C4979DC48
GEM80-500 Backplate mounting kit (cubicle)	8890-4900
Basic plus Verification I/O Sub-module	9713-4020
Basic I/O Sub-module	9713-4021
Serial Communications Sub-module	9714-4020
FIP Sub-module	9715-4020
TCP/IP Ethernet module	9716-4020
Host Subrack Interface Module	9717-4020
GEMCAN I/O Scanner Sub-module	9720-4020
GEM80 Basic I/O Auxiliary Power Termination Panel	9721-4001

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