GEM80 Series Controllers
FIP

Technical Manual

Publication No. T1653En
Issue 2

ALSTOM

SAFETY/HAZARDS WARNINGS

Health and Safety

COMPLIANCE WITH INSTRUCTIONS IN THIS MANUAL

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

For the safety of all personnel permitted to work on or in the vicinity of this equipment, the user should comply with the instructions and information contained in this manual.

In order to preserve the safety of the equipment during installation and operation the user must ensure that personnel are qualified and trained in the operation of the equipment.

The hazards associated with this equipment are predominantly electrical. Voltages up to and exceeding 250 VAC may be present while the equipment is operating and for a period after the sources of energy are removed. These voltages will give severe electrical shock which may kill.

Only trained, qualified personnel should install and maintain the equipment.

The installation and maintenance of the equipment must be carried out in the manner described in this manual. These instructions are designed to provide a safe installation which complies with the international standards listed within this manual.

Any question or doubt concerning the equipment should be referred to ALSTOM T&D Ltd, Power Conversion.

In addition to these instructions, the user should take note of any local or national safety requirements particular to their installation.

The equipment has been designed to operate in an industrial environment. Care must be observed that these conditions are maintained at all times. Your attention is particularly drawn to the electromagnetic emission and susceptibility screening, and the personnel safety protection, provided by the enclosure. Both may be compromised when covers are removed or enclosure doors are open.

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Glossary

The following terms and acronyms are used within the text of this manual:

FIP	Factory Instrumentation Protocol.
FIP network	A network which provides a communication network for up to 256 unique FIP compliant network subscribers. There are 3 FIP compliance standards : SlowFIP, WorldFIP Profile A and FIP.
Network subscriber	Any device connected to the FIP network.
VCOM	Variable of Communication. A group of data transmitted on a FIP network.
VCOM ID	VCOM identifier. Each VCOM transferred on the network has a unique 16-bit identifier in the range 0-65535.
Consumer	A FIP network subscriber which receives a VCOM from the FIP network into its local FIP communication database.
Producer	A FIP network subscriber which transmits a VCOM from its local FIP communication database onto the FIP network.
Consumed VCOM	A VCOM which is read from the FIP network into the local FIP database.
Produced VCOM	A VCOM which is written to the FIP network from the local FIP database.
BA	Bus Arbiter. This is a network subscriber which controls all other network subscriber access to the FIP network. Only one subscriber can be the active Bus Arbiter. There may be several subscribers which have the potential to be Bus Arbiter.
PC	Personal Computer.
@	Used in this manual to indicate a number is hexadecimal.

References

[1] GEM80-400 Series Controllers Technical Manual T1614
[2] GEM80-400 VME Processor Module Technical Manual T1630
[3] FIP NETWORK INSTALLATION AND COMMISSIONING MANUAL DPS 50414 a-en
[4] GEM80-500 Series Controllers Technical Manual T2025En

Table of Contents

1. Introduction

The FIP upgrade for the GEM80-400 series controllers provides the technology required to transfer data on a FIP network. All GEM80-400 controllers with the FIP upgrade will communicate with other network subscribers on a dual redundant 1 Mbit/s FIP network. Details of FIP network compliance standards are provided in the FIP compliance standards section, page 2-3 for the GEM80-400 controller and page 3-1 for the GEM80-400 VME controller.

A GEM80-400 controller is configured to communicate on a FIP network using a GEM80 special function. This is described in section 4 Operation (page 4-1). Examples of the use of this special function are given in section 5 Application examples (page 5-1).

Data is transferred on the FIP network in discrete packets. Each transmitted packet may be read by one or more network subscribers, i.e. data is broadcasted on the network. Data is transferred on the FIP network under control of a Bus Arbiter. The Bus Arbiter is supported by all GEM80-400 controllers, but may only be active on one network subscriber.

If you have a GEM80-400 controller then please read section 2 and then section 4 onwards. If your board is a GEM80-400 VME controller then please skip section 2 and read section 3 onwards.

NOTE

The FIPCFG special function takes up to 10 seconds to execute. Therefore, it is recommended that you call the special function once on a HALT to RUN transition of the controller.

1.1 GEM80-500

Although this manual generally refers to the GEM80-400 series controller, the information is also generally applicable to the GEM80-500 series controller. The GEM80-400 uses P120 to P122, however the GEM80-500 uses P94 to P96. For further information on the GEM80-500 FIP sub-module and its connections, please refer to the [4]GEM80-500 Series Technical Manual (T2025En).

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2. GEM80-400 FIP Technical specification and installation

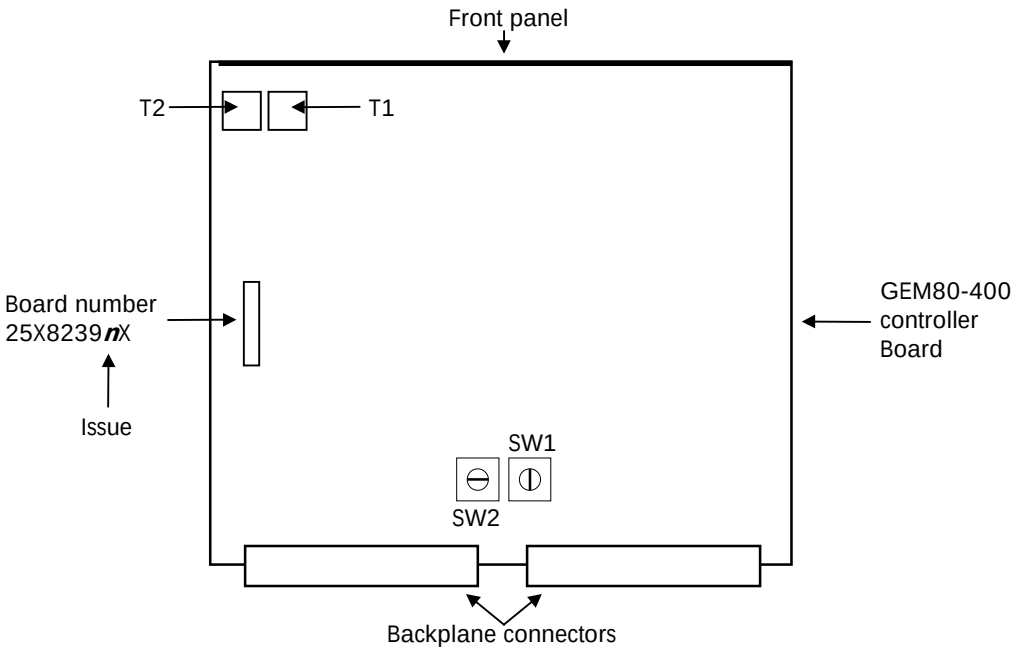
2.1 Technical specification

The firmware required for the GEM80-400 controller is dependent on the version of the controller. If you have ordered a new controller then it will have been supplied with firmware that supports operation on a FIP network.

If you are upgrading the firmware, then you can determine the required version as follows :

- Read the board issue n from the board number which is in the format 25X8239***n***X (see Figure 2-1)
- See if components T1 and T2 are fitted
- Use Table 2-1 (page 2-2) to determine the required version of firmware

Figure 2-1 GEM80-400 board number



If you are unsure about what version of firmware to upgrade to then please contact your local ALSTOM representative.

Table 2-1 GEM80-400 controller firmware versions

Board issue	Order code	Required firmware	T1 & T2 fitted	FIP hardware
C or previous	8239-4001 (Standard) 8239-4002 (Enhanced)	00S015-4002	No	Requires FIP hardware sub-module 25X8609
C or previous	8239-4003 (Standard) 8239-4004 (Enhanced)	00S015-4002	Yes	Fitted on board
D or later	8239-4005 (Standard) 8239-4006 (Enhanced)	00S015-4003	No	Not fitted
D or later	8239-4007 (Standard) 8239-4008 (Enhanced) 8239-4018	00S015-4003	Yes	Fitted on board

NOTE

The FIP hardware sub-module 25X8609 is no longer available.

2.1.1 Electrical

AC Earthing method for FIP cable:	AC earth module	Order code 8892-4300
LED Indication:	FIP "Cd"," Te" Medium A: FIP "Cd"," Te" Medium B:	2 yellow LEDs 2 yellow LEDs
Connections:	FIP Medium A & B:	Male 9 way D-type pin 6 = D+ pin 7 = D-

2.1.2 Physical

Order code	FIP hardware
8239-4001 8239-4002	Sub-module (106 x 82 x 30 mm) - obsolete Plugs in to processor board
8239-4003 8239-4004 8239-4007 8239-4008 8239-4018	FIP hardware on-board FIP hardware on-board FIP hardware on-board FIP hardware on-board FIP hardware on-board

2.1.3 Environmental

Operating temperature:	0° to 60°C
Storage temperature:	-25° to 70°C
Humidity:	5% to 95% RH non-condensing

2.1.4 FIP compliance standards

All GEM80-400 controllers can be configured for compatibility with the following standard:

- SlowFIP
  TXrate = 1Mbit/s, Silence time = 224µs, Return time = 61µs.

GEM80-400 controllers order code 8239-4007, 8239-4008 and 8239-4018 can be configured for compatibility with the following standards:

- WorldFIP Profile A (IEC 1158-2)
  TXrate = 1Mbit/s, Silence time = 110µs, Return time = 10µs.

- FIP (NFC 46-603/4)
  TXrate = 1Mbit/s, Silence time = 110µs, Return time = 10µs.

2.2 Installation

CAUTION
ELECTROSTATIC DAMAGE
This equipment contains solid state devices which may be affected by electrostatic discharge.

When this equipment is handled, static handling precautions in accordance with Protection of Electrostatic Sensitive Devices, Part 1, General Requirements , BS EN 100015 Pt.1 (1990) must be used.

2.2.1 FIP network subscriber address

The GEM80-400 controller FIP network subscriber address is set using the two BCD switches on the processor board. These switches are shown in Figure 2-1. The address is an 8-bit hexadecimal value. SW1 is the low nibble and SW2 is the high nibble. For example, if SW1 is set to 1 and SW2 is set to 2, the FIP network subscriber address will be @21, i.e. hexadecimal value 21.

NOTE

1. Each controller connected to the FIP network must have a unique FIP network subscriber address. To change the subscriber address the controller must be power cycled.

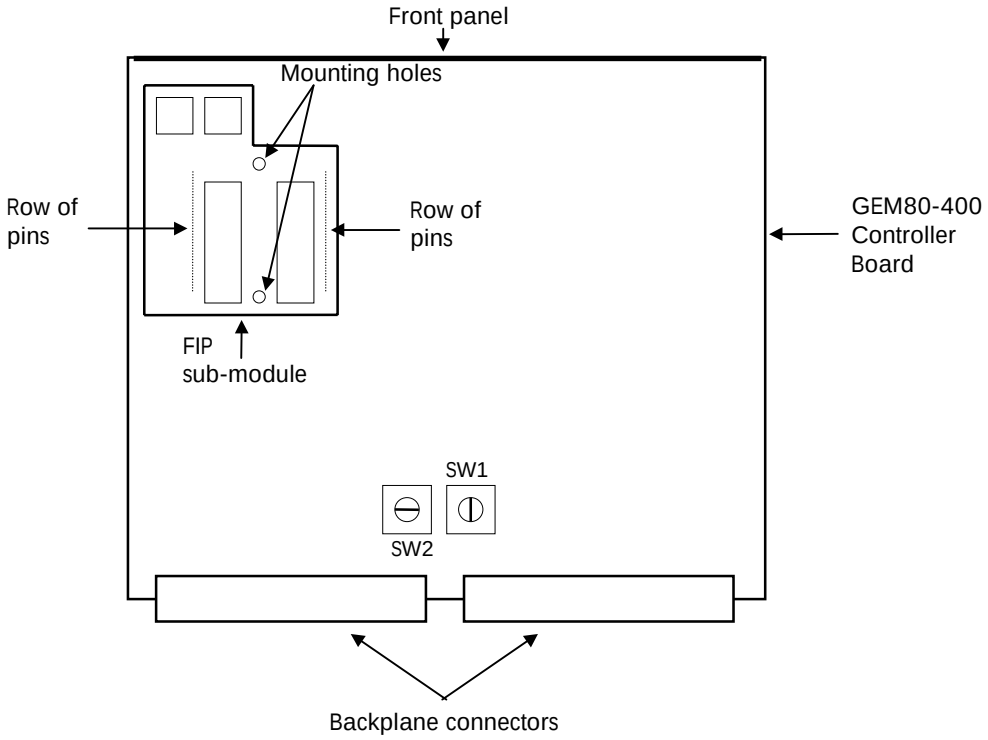
2. The subscriber address is set using BCD switches. Some addresses are not selectable, i.e. @A-@F, @1A-@1F, ... , @9A-@FF.

3. If the GEM80 rack has an enhanced backplane then the subscriber address may be set by the backplane switches or the switches on the controller board, but not both. The set of switches not used for the subscriber address must be set to zero.

2.2.2 Physical installation

As described in section 2.1, page 2-1, GEM80-400 controllers 8239-4001 and 8239-4002 require a FIP hardware sub-module. Table 2-1 describes which controller boards have FIP hardware components already fitted. If your board does not have the necessary FIP hardware then please contact your local ALSTOM representative.

Figure 2-2 Position of GEM80-400 FIP sub-module



If you are fitting the sub-module please remove the power to the GEM80-400 controller. You will be provided with suitable fixings for securing the sub-module in place. The sub-module is located as shown in Figure 2-2. Align the two rows of pins on the sub-module with the two rows of sockets on the controller board. Also check that the sub-module mounting holes are positioned directly above the pillar supports on the controller board. Gently push the sub-module down until the pins are firmly inserted into the processor board sockets. Excessive force must not be used. Check the FIP sub-module alignment and secure in place using the fixings provided.

2.2.3 GEM80-400 FIP connections

Two 9 way male D-type FIP network connectors that conform to the FIP standard are provided on the GEM80-400 front panel. Screw retention for the FIP network connectors is provided on the front panel. See Figure 2-3.

The GEM80-400 controller provides connection to a dual redundant FIP network. The two links are transformer isolated from each other and from 0V. The data transmission rate is fixed at 1 Mbit/second.

FIP network cables and network structure should comply with the FIP standards ([3] FIP NETWORK INSTALLATION AND COMMISSIONING MANUAL DPS 50414 a-en). Cables suitable for connecting the GEM80-400 controller 9 way D-type connectors to the FIP network must be used. For connection to a tap box a shielded 4 core cable is recommended, although two separate shielded 2 core cables are acceptable. For daisy chaining, a shielded 2 core cable is acceptable.

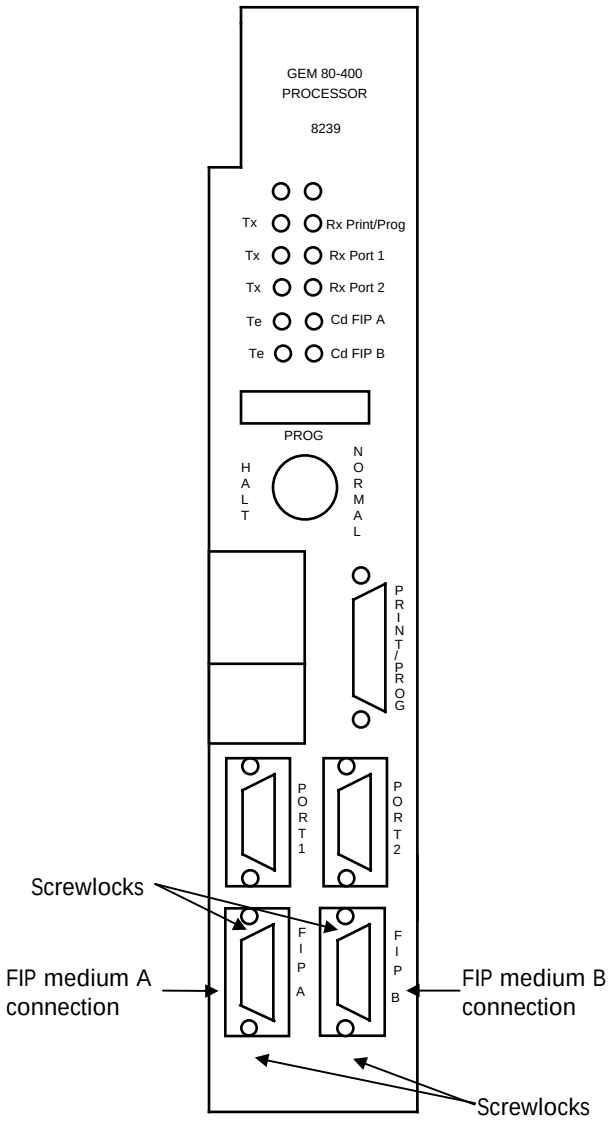


Figure 2-3 GEM80-400 front panel layout

Each FIP network must have a single DC earth near the mid-point of the network. A separate "AC earth" for the FIP cable screen must be provided as close as possible to the unit. An AC earth module order code 8892-4300 is available for this purpose (Please contact your ALSTOM representative for details). The network cable outer insulation is stripped back and the cable clamped to the earth module using the P-clip provided. The module must be mounted directly onto earthed metalwork to provide a good earth path. The screwlocks must be isolated from the screen of the FIP network cable. This is achieved using a plastic cased D-type connector.

Extreme ends of the FIP network cable must be terminated (see [3] FIP NETWORK INSTALLATION AND COMMISSIONING MANUAL DPS 50414 a-en)

For a dual redundant FIP network the earthing and line termination scheme must be applied to each network separately.

Electrical noise and electromagnetic interference can be introduced into a micro-electronics system via the cables and wires connected to it. To avoid this, wiring which could carry noise (i.e. 'dirty' cables) should be kept away from cables which are sensitive to noise, these cables are then kept 'clean' (i.e. free from electrical noise). Wiring that falls into the same group can be run together, while wiring from the different groups should be kept apart, though paths may cross at right angles. All connections to the GEM80-400 controller are considered to be 'clean' except for the earth connection which is considered to be 'dirty'.

2.2.4 Programming tools

The recommended programming tool for configuring a GEM80-400 controller for FIP operation is Advanced GEM80 Programmer (AGP).

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3. GEM80-400 VME FIP Technical specification and installation

3.1 Technical Specification

3.1.1 Electrical

FIP sub-module power consumption:	5V DC @ 400mA	
AC Earthing method for FIP cable:	AC earth module	Order code 8892-4300
LED Indication:	FIP "Cd"," Te" Medium A: FIP "Cd"," Te" Medium B:	2 yellow LEDs 2 yellow LEDs
Connections:	FIP Medium A & B:	Male 9 way D-type pin 6 = D+ pin 7 = D-

3.1.2 Physical

Dimensions	FIP sub-module (108 x 116 x 16 mm) Plugs in to processor board

3.1.3 Environmental

Operating temperature:	0° to 60°C
Storage temperature:	-25° to 70°C
Humidity:	5% to 95% RH non-condensing

3.1.4 FIP compliance standards

The GEM80-400 VME controller can be configured for compatibility with the following standards:

- SlowFIP
  TXrate = 1Mbit/s, Silence time = 224µs, Return time = 61µs.
- WorldFIP Profile A (IEC 1158-2)
  TXrate = 1Mbit/s, Silence time = 110µs, Return time = 10µs.
- FIP (NFC 46-603/4)
  TXrate = 1Mbit/s, Silence time = 110µs, Return time = 10µs.

3.2 Installation

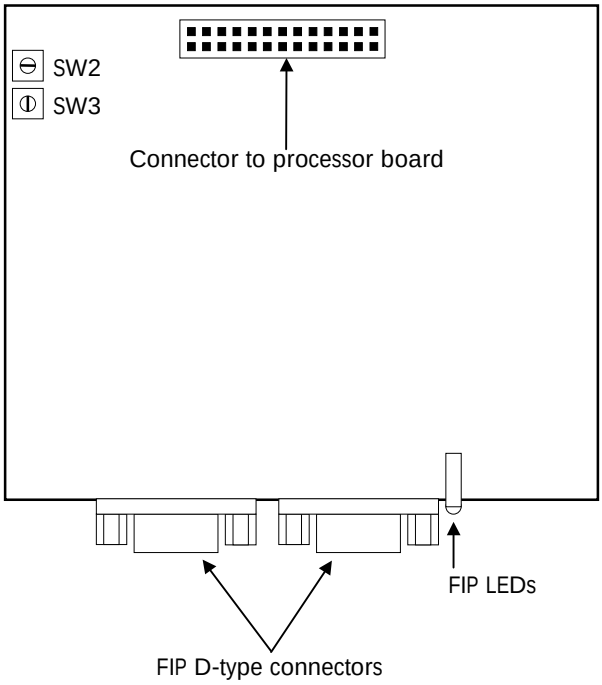
CAUTION
ELECTROSTATIC DAMAGE
This equipment contains solid state devices which may be affected by electrostatic discharge.

When this equipment is handled, static handling precautions in accordance with Protection of Electrostatic Sensitive Devices, Part 1, General Requirements , BS EN 100015 Pt.1 (1990) must be used.

3.2.1 FIP network subscriber address

The GEM80-400 VME controller FIP network subscriber address is set using the two BCD switches on the FIP sub-module. These switches are shown in Figure 3-1. The address is an 8-bit hexadecimal value. SW3 is the low nibble and SW2 is the high nibble. For example, if SW3 is set to 1 and SW2 is set to 2, the FIP network subscriber address will be @21, i.e. hexadecimal value 21.

Figure 3-1 GEM80-400 VME FIP sub-module



NOTE

1. Each controller connected to the FIP network must have a unique FIP network subscriber address. To change the subscriber address the controller must be power cycled.

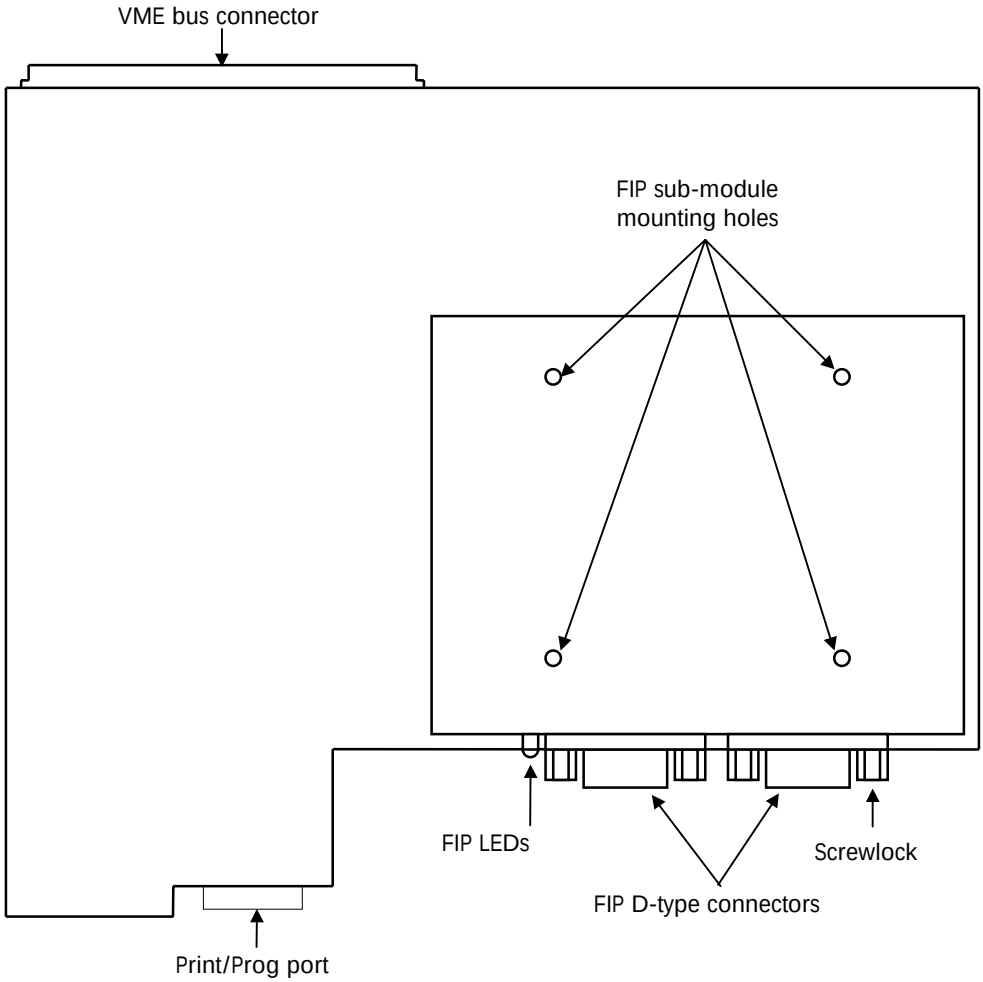
2. The subscriber address is set using BCD switches. Some addresses are not selectable, i.e. @A-@F, @1A-@1F, ... , @9A-@FF.

3.2.2 Physical installation

For the GEM80-400 VME controller, the FIP hardware is supplied as a sub-module which plugs into the processor board. If you do not have this sub-module then please contact your local ALSTOM representative.

Please remove the power to the GEM80-400 VME controller before fitting the FIP sub-module. You will be provided with suitable fixings for securing the sub-module in place. The sub-module is located as shown in Figure 3-2.

Figure 3-2 Position of GEM80-400 VME FIP sub-module



Align the sub-module such that the processor board connector is directly above the pins fitted to the processor board. The switches SW2 and SW3 will be on the opposite side of the printed circuit board. Therefore you must set the subscriber address before fitting the sub-module. Check that the sub-module mounting holes are positioned directly above the pillar supports on the processor board. Gently push the sub-module down until it makes contact with the pillar supports on the processor board. Excessive force must not be used. Check that the processor board connector is pushed down onto the pins protruding from the processor board. Secure the sub-module in place using the fixings provided.

3.2.3 GEM80-400 VME controller FIP connections

A label showing the GEM80-400 VME controller connections is provided. Please stick this label on the inside of the front panel door of the controller. This label will indicate the two 9 way male D-type FIP network connectors and FIP LEDs. These connectors conform to the FIP standard and screw retention for FIP network connectors is provided.

The GEM80-400 VME controller FIP sub-module provides connection to a dual redundant FIP network via two 9 way male D-type plugs. The two links are transformer isolated from each other and from 0V. The data transmission rate is fixed at 1 Mbit/second.

FIP network cables and network structure should comply with the FIP standards ([3] FIP NETWORK INSTALLATION AND COMMISSIONING MANUAL DPS 50414 a-en). Cables suitable for connecting the GEM80-400 controller 9 way D-type connectors to the FIP network must be used. For connection to a tap box a shielded 4 core cable is recommended, although two separate shielded 2 core cables are acceptable. For daisy chaining, a shielded 2 core cable is acceptable.

Each FIP network must have a single DC earth near the mid-point of the network. A separate "AC earth" for the FIP cable screen must be provided as close as possible to the unit. An AC earth module order code 8892-4300 is available for this purpose (Please contact your ALSTOM representative for details). The network cable outer insulation is stripped back and the cable clamped to the earth module using the P-clip provided. The module must be mounted directly onto earthed metalwork to provide a good earth path. The screwlocks must be isolated from the screen of the FIP network cable. This is achieved using a plastic cased D-type connector.

Extreme ends of the FIP network cable must be terminated (see [3] FIP NETWORK INSTALLATION AND COMMISSIONING MANUAL DPS 50414 a-en)

For a dual redundant FIP network the earthing and line termination scheme must be applied to each network separately.

Electrical noise and electromagnetic interference can be introduced into a micro-electronics system via the cables and wires connected to it. To avoid this, wiring which could carry noise (i.e. 'dirty' cables) should be kept away from cables which are sensitive to noise, these cables are then kept 'clean' (i.e. free from electrical noise). Wiring that falls into the same group can be run together, while wiring from the different groups should be kept apart, though paths may cross at right angles. All connections to the GEM80-400 VME controller are considered to be 'clean' except for the earth connection which is considered to be 'dirty'.

3.2.4 Programming tools

The recommended programming tool for configuring a GEM80-400 VME controller for FIP operation is Advanced GEM80 Programmer (AGP).

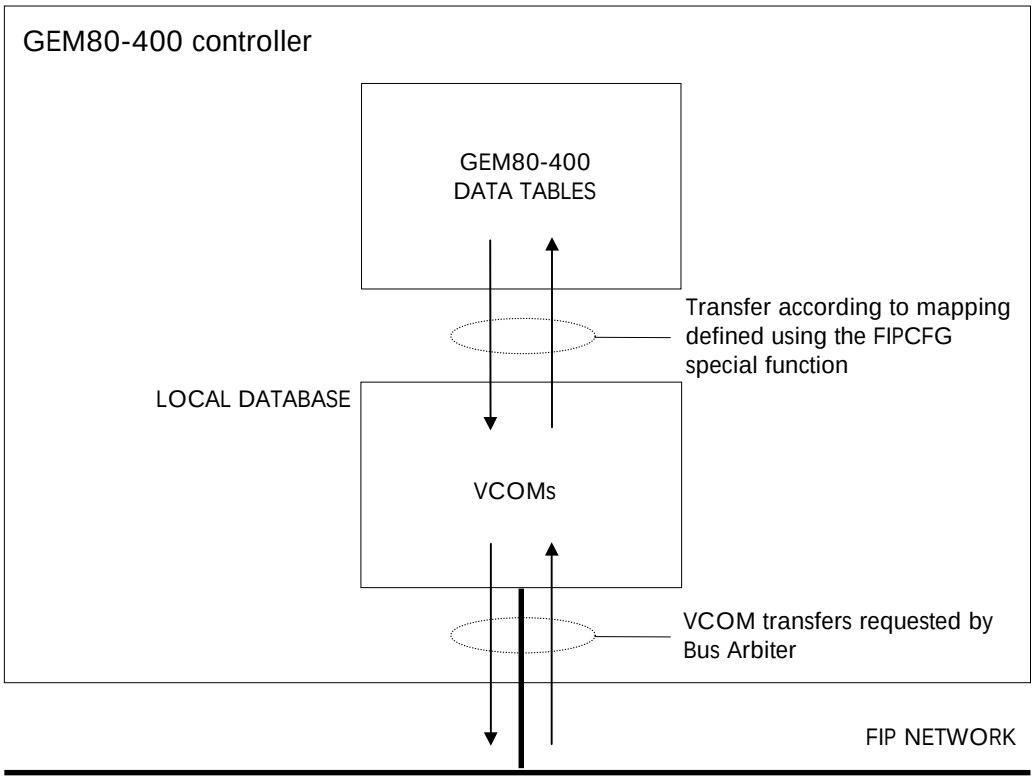
4. Operation

4.1 Introduction

The FIP network provides the means to transfer GEM80-400 data tables from one controller to other FIP network subscribers. The information is transferred over the FIP network using Variables of Communication (VCOMs). The mapping between VCOMs and the data tables is configured using the S145 (FIPCFG) special function. The special function only defines the mapping; it does not transfer any data.

Each GEM80-400 has local copies of the VCOMs as defined by the FIPCFG special function. These local copies are stored in a local database. Data is transferred between data tables and VCOMs between controller scans. The VCOMs are transferred between the local database and the FIP network on request by the Bus Arbiter (BA). This concept is shown in Figure 4-1. The concept of a Bus Arbiter will be explained in 4.4 The Bus Arbiter, page 4-5.

Figure 4-1 Data transfer between data tables and the FIP network



The BA operates asynchronously to the GEM80-400 controller scan. Therefore the transfer of VCOMs on the FIP network is asynchronous to the transfer of data between VCOMs and GEM80-400 data tables. In the event that a VCOM to data table transfer is required whilst that VCOM is being consumed from the FIP network, the VCOM to

data table transfer will use the data from the last complete VCOM consumed. If a data table to VCOM transfer is required whilst that VCOM is being produced on the FIP network, the VCOM transfer on the network will use the last complete VCOM data written to the local database.

4.2 GEM80-400 operation

Data is transferred between data tables and VCOMs between controller scans. When the GEM80-400 controller is in the state running with normal inputs, the sequence of events is as follows:

- Read I/O inputs
- Run ladder program
- Write I/O outputs
- Transfer data between data tables and VCOMs according to mapping defined by FIPCFG special function

Data is not transferred until the first inter-scan period after a FIPCFG special function has been successfully executed in the ladder program. Data transferred between data tables and VCOMs is updated according to Table 4-1. Data received from the FIP network in a VCOM is transferred to the appropriate GEM80-400 data tables provided that the controller is not in one of the shutdown states. Data is transferred from GEM80-400 data tables to the appropriate VCOM if and only if the controller is running with normal inputs. However, this has no bearing on the transfer of such a VCOM on the FIP network since this is under control of the BA. It simply means that the contents of the VCOM will not be updated by the controller, but the VCOM will still be transmitted on the FIP network if requested by the BA.

Table 4-1 Behaviour of GEM80-400 controller data table - VCOM transfer

GEM 80-400 Controller state	Write data table to VCOM	Read from VCOM to data table
Running, normal inputs	✓	✓
Running, test inputs	×	✓
Halted, normal inputs	×	✓
Halted, test inputs	×	✓
Non-fatal shutdown	×	×
Fatal shutdown	×	×
Extremely fatal shutdown	×	×

A warning flag associated with a consumed VCOM can be used to indicate that the VCOM contents have not been updated within a given time-out period. This is explained in more detail in 4.3 Variables of communication (VCOMs), page 4-3 and 4.6 FIPCFG special function, page 4-12.

The FIPCFG special function supports two modes of FIP network configuration. One is a quick configuration which is suitable for GEM80 to GEM80 communication over the FIP network. The other configuration is a flexible one which will allow the GEM80 to communicate with other network subscribers running the same FIP network compliance standard. The quick configuration requires less configuration data than the flexible

approach. The flexible configuration allows greater control in tailoring the use of the FIP network to the application. These configuration modes are described in 4.6 FIPCFG special function, page 4-12. The quick configuration is selected by setting the protocol ID byte in the parameter list header to 0. The flexible configuration is selected by setting the protocol ID byte to 1.

4.3 Variables of communication (VCOMs)

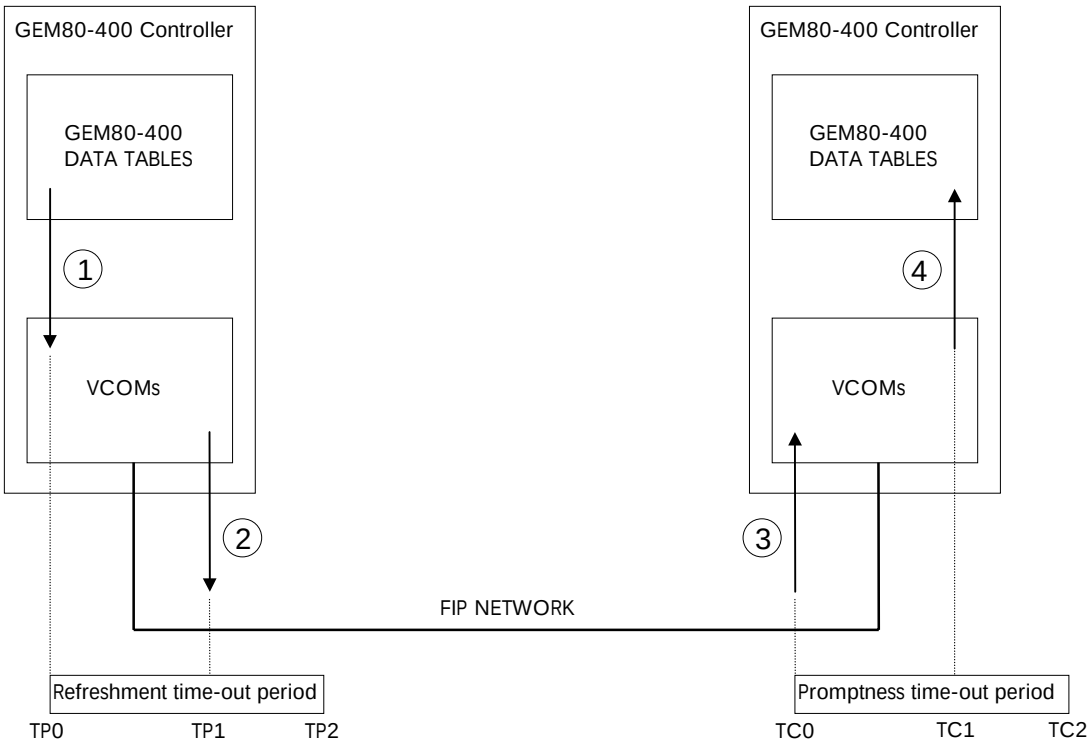
Each network subscriber has its own local FIP communication database which contains local copies of the data for each VCOM. VCOMs can be produced or consumed. A produced VCOM is a VCOM which is written to the FIP network from the local FIP communication database. A consumed VCOM is a VCOM which is read from the FIP network into the local FIP communication database. VCOMs are transmitted on the FIP network when requested by the BA. Each VCOM has a unique 16-bit identifier, known as the VCOM ID. The BA requests transmission of individual VCOMs by transmitting the VCOM ID on the FIP network.

The description on the following page expands upon the description in the introduction (page 4-1).

As mentioned in 4.2 GEM80-400 operation, a consumed VCOM can have a warning flag associated with it in order to indicate its update status. There are two time-out periods governing the state of the warning flag. A produced VCOM has a time-out period known as the refreshment time-out. A consumed VCOM has a time-out period known as the promptness time-out. Refer to Figure 4-2 when reading the following description.

1. The refreshment time-out is a period starting at time TP0 when the VCOM copy in the local FIP communication database is updated. A status byte added at the end of a produced VCOM indicates the update status.
2. VCOM is transmitted on the network at time TP1. If TP1 is greater than TP2 (the refreshment time-out), the status byte indicates 'stale' data to network subscribers consuming that VCOM.
3. The promptness time-out is a period starting at time TC0 when the VCOM is received from the network and written to the local FIP communication database.
4. Data is transferred from the database to GEM80 data tables at time TC1. If TC1 is greater than TC2(the promptness time-out), the data is indicated as 'stale'.

Figure 4-2 VCOM refreshment and promptness status



The warning flag ('stale' data indication bit) will be set by a GEM80-400 controller consuming a VCOM indicated as stale. Stale data indication bits are described in 4.6 FIPCFG special function, page 4-12. All subscribers configured to consume a VCOM will do so at the same point in time. Therefore, if a refreshment time-out has occurred for a particular VCOM, all subscribers consuming that VCOM will see it as stale.

If the stale indication bit is set it may be due to a refreshment time-out, a promptness time-out or both.

For the quick configuration the refreshment and promptness time-out is used for all VCOMs, i.e. the status byte is always transmitted at the end of a produced VCOM. For the flexible configuration use of the refreshment and promptness time-out is optional. If the refreshment and promptness time-out is not used, the status byte is not transmitted at the end of a produced VCOM. In this case an extra byte is available for VCOM data.

NOTE

1. We strongly recommend that you use the stale data indication bits to check the validity of the data transmitted on the FIP network.

2. A consumed VCOM which has never been received from the network will be indicated as stale and the data tables mapped to that VCOM will be set to zero.

3. The stale data indication bits are updated between controller scans. The BA operation is asynchronous to the controller scan. Refreshment/promptness time-out values equal to the periodicity of VCOM requests on the FIP network do not guarantee data will never be stale. Also, a refreshment/promptness time-out smaller than the periodicity of VCOM requests does not guarantee that the stale data indication will always be set.

4.4 The Bus Arbiter

4.4.1 Introduction

All data transfers on a FIP network are controlled by the Bus Arbiter (BA); the BA is completely responsible for the timing and sequencing of data transfers over the FIP network. Without an active BA data can not be transferred.

The BA may be considered as if it were an additional device connected to the FIP network. In practice, the BA is simply another function that a suitably configured subscriber node can provide.

The actual data flow is specified by the BA program or “Macro Cycle”. This program is made up of BA instructions. The user must choose the sequence of BA instructions, to reflect the requirements of the system wide FIP network.

The BA continuously executes the macro cycle, i.e. it automatically restarts at the beginning of the macro cycle when it reaches the end of the macro cycle. The actual repetition rate is controlled by the instructions within the macro cycle.

Only one BA may be active on a FIP network at any one time. There may be many potential BAs connected to a FIP network, one of which will become active should the currently active BA stop. All BAs should be configured with the same macro cycle to prevent the network behaviour becoming dependent on which BA is active; this is normally undesirable.

The BA can also contain a "Test Presence" instruction. This instruction is used by the BA function to compile a list of subscribers which are active on each media. The test presence instruction is also used to ensure that both media are healthy.

4.4.1.1 Types of FIP data transfer

A FIP network may transfer data using two different mechanisms: VCOMs and messages.

4.4.1.2 VCOM data transfer

All VCOMs are transferred using a broadcast mechanism. When the BA requests a VCOM, the node that has been configured to produce that VCOM, transmits its data to the FIP network. Any node that has been configured to consume the data reads the data from the network.

The FIP network has a large but finite data transfer rate or "bandwidth". In most control systems some groups of data are time critical and require transmitting on a regular basis, called "periodic data". Data that is only required on demand may be described as "aperiodic data".

As the exact sequence and timing of all the periodic VCOMs is known in advance, the portion of the macro cycle needed to transfer this type of data can be pre-configured. The individual VCOM references are grouped (by the user) into one or more "VCOM lists", usually on the basis of how often the VCOMs within a list are to be transferred, i.e. a list contains VCOMs that need to be transferred at the same time interval or "period".

Aperiodic VCOM traffic is characterised by being unknown in advance and the VCOMs required cannot therefore be pre-configured. The system designer should however know the level of aperiodic traffic that is required and can therefore specify (in the macro cycle) a suitable amount of time to be reserved for aperiodic transfers.

4.4.1.3 Messaging

The FIP network supports the transfer of messages. Message are typically used for programming and the transfer of large quantities of non time critical data. As the actual messages are not generally known in advance the user must specify (in the macro cycle), the amount of time to be reserved for this type of traffic.

4.4.2 FIP Bus Bandwidth optimisation

Within the data that needs to be sent on a periodic basis , there are normally some data groups, or VCOM lists that need to be sent more often than others. The BA can be

programmed to transfer a particular list of VCOMs at particular times. A macro cycle can therefore be defined that requests some lists more often than others. This technique will increase the efficiency of use of the available bandwidth.

4.4.3 Bus Arbiter timing

The BA function provides a timer that can be used by BA instructions to maintain time synchronisation. This timer is reset to 0 at the beginning of each repetition of the macro cycle. All times are therefore relative to the beginning of the macro cycle.

In order to specify adequate time limits for aperiodic VCOM transfer, message transfer and the maximum macro cycle execution rate, the user needs to know the time taken to transmit the VCOMs. These times can be calculated as shown in Table 4-2. All values are in microseconds. The time is dependent on the actual length of the VCOM and the selected FIP network compliance. Note that if a refreshment/promptness time has been specified for a VCOM (see Variables of communication (VCOMs), page 4-3), then an extra byte of data is transmitted with the VCOM.

Table 4-2 Time taken to transfer VCOMs on the FIP network

SlowFIP	FIP	WorldFIP
382 + (VCOM length x 8)	192 + (VCOM length x 8)	198 + (VCOM length x 8)

ALL VCOM LENGTHS IN BYTES

For example, if four VCOMs each 120 bytes in length are transferred on a FIP network using SlowFIP compliance, the time taken to transmit the VCOMs is 4 x (382 + (120 x 8)) = 5368 µs (5.386ms). This is assuming that refreshment/promptness time-out is zero for each VCOM. If the time-out is non-zero the time would be 4 x (382 + (121 x 8)) = 5400 µs (5.4 ms).

The test presence instruction takes about 10mS to execute.

4.4.4 Bus Arbiter program instructions

4.4.4.1 Send list (SEND_LIST)

This instructs the BA to request the transfer of each of the VCOMs contained in the specified list in the order they appear in this list.

4.4.4.2 Wait Aperiodic (SEND_APER)

This instructs the BA to action as many of the outstanding aperiodic VCOM transfer requests, until the specified time. The time is relative to the start of the macro cycle. If there are no outstanding aperiodic requests, or the time specified has already passed, the instruction terminates and execution passes to the next instruction.

Aperiodic VCOMs cannot be configured on GEM80-400 controllers. However, the BA is a network-wide function and there may be subscribers on the network with aperiodic VCOMs configured. The wait aperiodic instruction allows the BA to process aperiodic VCOM transfer requests.

4.4.4.3 Wait Message (SEND_MSG)

This instructs the BA to action as many of the outstanding message transfer requests as is possible between the current time and the time specified. The time is relative to the start of the macro cycle. If there are no outstanding message requests or the time specified has already passed, the instruction terminates and the next instruction is executed.

4.4.4.4 BA Wait (BA_WAIT)

This instructs the BA to request the idle frame until the specified time. The time is relative to the start of the macro cycle. If the time specified has already passed the next instruction is executed. This instruction should be used to ensure the periodicity of the macro cycle.

An idle frame is requested during this period to avoid a period of silence on the FIP network. There is no response to the idle frame request. The idle frame requests ensure that the active BA maintains control of the FIP network. If there is a period of silence, another potential BA attempts to take over control of the FIP network, i.e. a long period of silence indicates that the last active BA has stopped transmitting.

4.4.4.5 Test Presence

This instruction is not directly available to the user. The BA function in GEM80-400 controllers automatically includes a test presence instruction just before the start of the first wait aperiodic instruction in the macro cycle. The test presence instruction will not be performed if the macro cycle does not contain a wait aperiodic instruction, and as a consequence the presence and network media bits (see sections 4.6.1 and 4.6.2) will be unreliable.

Executing the FIPCFG special function on a GEM80-400 controller clears the presence and network media bits. The removal of the test presence instruction will make the presence and network media bits unreliable on all GEM80-400 controllers that are not the active BA. This information is determined from the last present subscriber list received and the test presence instruction is required to keep this information up-to-date.

4.4.5 Specifying the Macro Cycle

The macro cycle can be made up of any sequence of BA instructions. There are however several conventions that must normally be observed to ensure compatibility with other equipment connected to the FIP network.

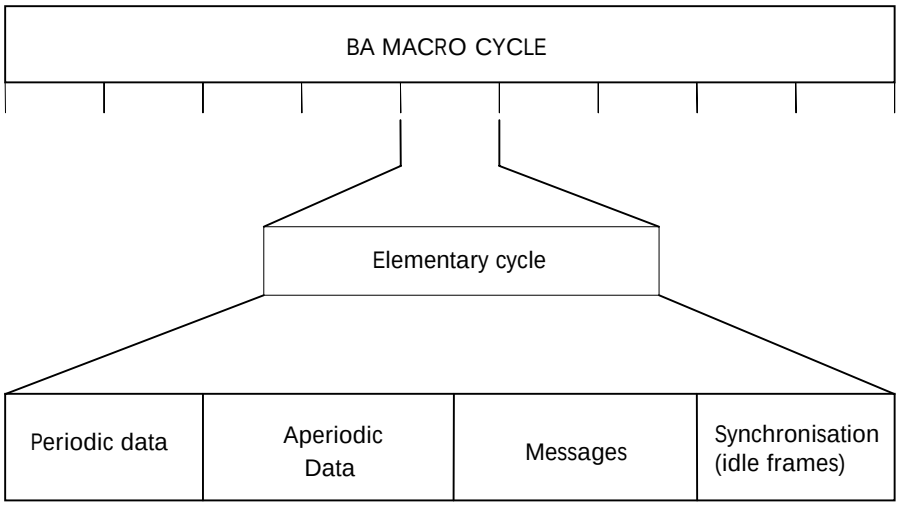
A macro cycle can be made up of one or more program segments each having the same duration. These program segments are called “elementary cycles” (see Figure 4-3, page 4-9).

An elementary cycle is made up of a sequence of :

0 or more send lists instructions,
0 or 1 wait aperiodic instruction,
0 or 1 wait message instruction,
A BA wait instruction.

The list associated with a send list instruction specifies the VCOMs to be transferred. The wait aperiodic instruction will execute any aperiodic requests until the specified time, or if there are not any aperiodic requests, terminate. The wait message will execute any requests for massaging until the time specified or terminate. The BA wait instruction will force the BA to wait until the specified time before either restarting the macro cycle if this elementary cycle is the only or last elementary cycle, or proceed to execute the next elementary cycle.

Figure 4-3 BA macro cycle consisting of elementary cycles



It must be noted that the elementary cycle is only a concept that can be supported by the appropriate use of the BA instructions, and though not mandatory it may well be required for compatibility with other FIP equipment.

The main use of the elementary cycle is to ensure that the data is transmitted in a strictly periodic fashion, a feature that is essential for some control algorithms, and to facilitate the use of the bandwidth optimisation discussed above.

For example, suppose the data contained in VCOMs 1 and 2 are required every 10ms, the data in VCOMs 3 and 4 is required every 30 ms and some aperiodic and messaging transfers are required :

VCOMs 1 and 2 would be combined (by the user) into VCOM list 1
VCOMs 3 and 4 would be combined into VCOM list 2

Table 4-3 shows the corresponding macro cycle. It consists of three 10ms long elementary cycles.

Table 4-3 BA macro cycle example

Real Time	Macro Cycle Time	Elementary Cycle	BA instructions
0, 30, 60, ... ms	0ms	1	SEND_LIST 1
			SEND_LIST 2
			SEND_APER 6ms
			SEND_MSG 9ms
			BA_WAIT 10ms
	10ms	2	SEND_LIST 1
			SEND_APER 6ms
			SEND_MSG 9ms
			BA_WAIT 10ms
	20 ms	3	SEND_LIST 1
			SEND_APER 6ms
			SEND_MSG 9ms
			BA_WAIT 10ms

Sections 5.4.1 and 5.4.2 give examples of BA programs that do and do not make use of the elementary cycle concept.

When a GEM80-400 controller transmits on the FIP network, the data is transmitted on both media. The medium on which data is first received is selected for reading data from the FIP network into the local database. In the case of a contention, the bias is towards medium A.

In the event of severe communication errors the BA will automatically stop transmitting for a period of 1 or more seconds. If communication quality improves then the BA will attempt to start transmitting again.

A medium is considered healthy if there is at least one other subscriber present on the medium and the number of frames received with errors in one second on that medium is below 10.

4.5 How to configure

This section describes the steps required to configure a GEM80-400 controller to exchange data via the FIP network. This section is only a summary and details of the actual configuration data required are provided in 4.6 FIPCFG special function. The steps to configure are as follows :

1. Select the FIP network compliance standard using P-Table P120.(P94 for GEM80-500)
2. Set the idle frame ID in P-Table P121. (P95 for GEM80-500)
3. Choose byte ordering using P122. (P96 for GEM80-500)
4. Decide on the protocol ID (0 for quick configuration, 1 for flexible configuration)
5. Decide which data tables are to be written to the FIP network and which data tables are to updated with data from the FIP network. If FIP communication statistics are required, decide which data tables the statistics will be copied to.
6. Define VCOMs that will be used to transfer each block of data tables. It is common for the low byte of a VCOM ID to be the same as the subscriber address.
7. If you are using the flexible configuration and you want the GEM80-400 controller to be a BA then define the BA lists and BA macro cycle.
8. Enter the configuration data into data tables. P-Tables are recommended.
9. Add the FIPCFG special function S145 to the ladder program.
10. Execute the special function once. It is recommended that the special function is executed once on a halt to run transition of the controller.
11. If an error is reported by the special function correct the configuration data.
12. Configure other FIP network subscribers to exchange data.
13. Check that data tables are transferred correctly.

4.6 FIPCFG special function S145

This special function does not transfer any data; it only configures the data transfer. When the GEM80-400 is powered-up there is no active FIP network configuration. The special function must be executed for a FIP network configuration to become active.

NOTE

The FIPCFG special function takes up to 10 seconds to execute. Therefore, it is recommended that you call the special function once on a HALT to RUN transition of the controller.

The format of the FIPCFG special function is

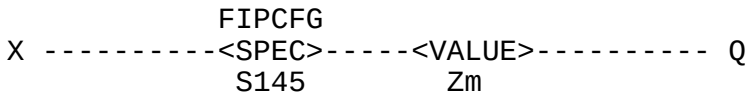


Table 4-4 describes X, Zm and Q.

Table 4-4 Parameters associated with FIPCFG special function

Parameter	Description	Function	Range
X	Rung input	0 = Do not execute < > 0 Update FIP network configuration	@0 - @FFFF
Zm	Value location	Start of parameter list	Any table usable by special functions
Q	Rung output	Report status following execution of special function	@0 - @FFFF

Examples using this special function are in section 5. Application examples. The first entry in the Zm parameter list specifies the protocol ID. The two allowed values are 0 and 1. A value of 0 selects the fixed FIP network configuration format. A value of 1 selects the flexible FIP network configuration format.

The configuration data for the special function must be entered in GEM80-400 data tables. P-Tables are recommended for storing the configuration data. Syntax checking is performed on the configuration data and configuration errors are reported in the Q output of the special function. In addition, F-Table F4 reports the absolute table number that is found to be in error, e.g. If the configuration starts in table P1000 and an error is detected in P1024, then the value in F4 will be 1024. If an insufficient number of data tables exist for the requested configuration then an error is reported by the special

function. Errors for out of range values are listed throughout sections 4.6.1 and 4.6.2. Details of all errors can be found at the end of sections 4.6.1 and 4.6.2. A summary of faults with recommended solutions to clear faults is provided in 6.2 Special function fault diagnosis, page 6-2.

If the FIPCFG special function returns an error then the last successful configuration, if any, is still active and FIP data will continue to be transferred according to the last successful configuration. The special function will not be able to determine if the user has requested an unacceptable FIP network configuration, an example of which would be two or more GEM80-400 controllers configured to produce the same VCOM on the same FIP network. If more than one FIPCFG special function is executed then the last one successfully executed will determine the active configuration.

The ladder scan time will increase linearly with an increase in the number of configured VCOMs. An approximate measure is an increase of 10ms for every 16 maximum length VCOMs that are consumed or produced.

There are three P-Tables which apply to both modes of configuration. These are described in Table 4-5. The values in these tables are not cleared by a 'Clear Store' command.

Table 4-5 P-Tables reserved for GEM80-400/500 FIP

GEM80-400 P-Table	GEM80-500 P-Table	Description	Range
P120	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.
P121	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) Must not be a reserved ID, see Table 4-20 (page 4-25), with the exception of the idle frame itself.
P122	P96	Byte ordering	0 = No byte swapping 1 = Bytes of each complete word are swapped on transfer to/from GEM80 data tables

NOTE

1. The same FIP network compliance and idle frame must be used for all network subscribers connected to the same FIP network. Each network subscriber must have a unique FIP network subscriber address. If more than one subscriber has the potential be an active BA then all such subscribers should be configured with an identical BA macro cycle. The FIP A network connection on the GEM80-400 controller must be connected to the FIP A connection on all other network subscribers on the same

network. Similarly, all FIP B connections must be connected together.

2. The controller must be power cycled for a change in P120 (P94 for GEM80-500) to take effect.

3. The BA idle frame specified in P121 (P95 for GEM80-500) must not be identical to a VCOM ID on any subscriber on the FIP network. For example, protocol ID 0 uses VCOM IDs in the range 1-128. The BA idle frame specified in P121 should not be in this range.

Some GEM80-400 controllers only support the SlowFIP compliance standards (see 2.1 Technical specification, page 2-1 and 2.1.4 FIP compliance standards, page 2-3). The selection of an unsupported compliance standard produces an error which is displayed by the programming tool.

Changes in P121 and P122 (P95 and P96 in GEM80-500) are taken into account when the FIPCFG special function is next executed.

With the quick configuration up to 128 VCOMs can be defined and each one is fixed in length at 120 bytes, i.e. it is mapped to 60 GEM80-400 data tables. The 60 data tables must be consecutive and available for use. The VCOM ID must be in the range 1-128. Each VCOM has a fixed refreshment/promptness time-out of 500ms. This configuration has a fixed BA macro cycle which periodically requests all VCOMs with IDs 1 to 128.

The flexible configuration allows you to specify the length and refreshment/promptness time-out for each VCOM. You can also define your own BA macro cycle.

NOTE

1. Each data table to VCOM mapping is unique. That is, you cannot map the same VCOM to different sets of data tables. An attempt to do so will result in the special function reporting an error.

2. F-Table F3 bit 0 indicates run-time faults. If data tables mapped to VCOMs become non-existent (i.e. due to a running re-compile with the data tables no longer referenced) then F-Table F3 bit 0 will be ON. F3.0 is also set ON if the data tables to which communication statistics are mapped become non-existent.

3. Executing the FIPCFG special function causes the BA to stop. Another BA will take over which may be running a different macro cycle. The subscriber with the newly active BA will start with media healthy bits and presence detection bits clear.

4. If you are executing the FIPCFG special function in an obey block, do not map consumed data into the table that is used to trigger the obey block.

5. If there is an active FIP network configuration and the controllers store is cleared, then data will no longer be transferred between VCOMs and data tables. However, the VCOMs will still exist in the local communication database and therefore the VCOMs will be transferred on the FIP network if requested by the BA.

6. If a subscriber producing a VCOM has been re-configured using the FIPCFG special function and has not yet entered the running normal mode, then all controllers consuming that VCOM will mark it as stale and the data tables to which it is mapped will be cleared to zero.

4.6.1 Protocol ID 0

This configuration mode has the following features :

- Up to 128 data table to VCOM mappings
- Fixed VCOM length of 120 bytes (60 GEM80-400 data tables)
- VCOM IDs in the range 1 to 128
- VCOM refreshment/promptness time-out is fixed at 500ms
- 1 communication statistics to data table mapping
- Optional BA macro cycle program
- BA macro cycle program is pre-defined and requests VCOMs with VCOM ID 1 to 128 in sequence
- BA macro cycle includes the test presence instruction
- BA macro cycle has a fixed period of 150ms

4.6.1.1 Parameter list

The Zm parameter list takes the form of a header, followed by 0 to 129 configuration elements. The parameter list header requires three data tables. There are three types of configuration element as described in Table 4-6.

Table 4-6 Types of configuration element (protocol ID 0)

Configuration element type	Number of data tables required
A produced VCOM to GEM80-400 data table mapping	3
A consumed VCOM to GEM80-400 data table mapping	3
A statistics to GEM80-400 data table mapping	3

The maximum number of 129 configuration elements caters for 128 data table to VCOM mappings and 1 communication statistics to data table mapping. The number of configuration elements should be kept as short as possible to reduce the execution time of the special function. The Zm parameter header is defined in Table 4-7 and is referred to as configuration element 0. The configuration elements that follow are referred to as configuration element 1 to configuration element 129. The Q output errors are listed at the end of section 4.6.1.

Table 4-7 Zm parameter list header (protocol ID 0)

	High byte	Low byte
Data table N	Reserved for future use	Protocol ID = 0 (0 = quick configuration mode)
Data table N + 1	FIP interface control word Bit 0 : BA inhibit (ON prevents/stops BA macro cycle running) Bits 1-15 : reserved for future use	
Data table N + 2	Number of configuration elements in the following configuration list (0 to 129) 0 = de-configure FIP network configuration. All data table to VCOM mappings and statistics to data table mapping will be removed and the BA will be stopped if it is active.	

An example for the Zm parameter list header is given in Table 4-8.

Table 4-8 Example of Zm parameter list header (protocol ID 0)

	Value	Comments
Data table N	@0	Select protocol 0, i.e. quick configuration format.
Data table N + 1	@0	Allow the controller to be an active BA.
Data table N + 2	@3	There are 3 configuration elements in the following list.

4.6.1.2 VCOM to data table mapping element

A data table to VCOM mapping is defined using a configuration element based on the definition in Table 4-9.

Table 4-9 Data table to produced/consumed VCOM mapping configuration element (protocol ID 0)

	High byte	Low byte
Data table N	Configuration element type identifier “P” or “C” (@50 or @43) Set to "P" if this element refers to data that is to be "Produced" (written) to the network. Set to "C" if this elements refers to data that is to be "Consumed" (read) from the network.	Upper case table letter of source or destination table “A” to “W” (@41 to @57)
Data table N+1	Start table offset (0 to 32000) The source or destination table must have adequate subsequent tables to allow all of the VCOM data to be mapped to.	
Data table N+2	Last VCOM ID (0 to 128) Must be greater than first VCOM ID. If 0 then only one VCOM is defined which has the ID specified by first VCOM ID.	First VCOM ID (1 to 128)

An example of a mapping configuration element is given in Table 4-10.

Table 4-10 Example of mapping configuration element (protocol ID 0)

	Value	Comments
Data table N	@4347	Consumed data. Destination G tables.
Data table N+1	@0	Table start offset 0.
Data table N+2	@401	Map VCOMs with IDs 1-4 to G tables. VCOM 1 is transferred to G0-G59, VCOM 2 to G60-G119, etc.

4.6.1.3 Statistics to data table mapping element

Communication statistics are mapped to data tables using a status configuration element, see Table 4-11. Note that only one of these elements should be defined. If more than one is defined then the last one encountered will provide the active mapping.

Table 4-11 Status mapping configuration element (protocol ID 0)

	High byte	Low byte
Data table N	Configuration element type identifier “S” (@53) Set to "S" if this element refers to Status (communication statistics) to be copied into the data tables.	Upper case table letter of source or destination table “A” to “W” (@41 to @57)
Data table N + 1	Start table offset (0 to 32000) The destination table must have adequate subsequent tables to allow all of the communication statistic data to be mapped to.	
Data table N + 2	Number of FIP communication statistics required (0 to 35) A size of 0 indicates that all of the statistics are to be copied to the data tables. If statistics are not required then this element should not appear in the configuration list.	

An example of a status mapping configuration element is in Table 4-12.

Table 4-12 Example of status mapping configuration element (protocol ID 0)

	Value	Comments
Data table N	@534D	Communication statistics. Destination M tables.
Data table N + 1	@32	Table start offset 50.
Data table N + 2	@0	Map 35 tables of communication statistics to M50-M84

The format of the communication statistics is shown in Table 4-13.

Table 4-13 FIP communication statistics (protocol ID 0)

<table>
<tr><th>Offset from start table</th><th>Description</th></tr>
<tr><td>0</td><td>FIP interface fault bits. 0 = healthy.
<table>
<tr><td>Bit 15</td><td>Bits 14-10</td><td>Bit 9</td><td>Bit 8</td><td>Bits 7-0</td></tr>
<tr><td>ON=warning</td><td>Reserved for future use</td><td>ON=unable to produce. (Cannot read from data tables)</td><td>ON=unable to consume. (Cannot write to data tables)</td><td>Failed VCOM ID (1 to 128)</td></tr>
</table></td></tr>
<tr><td>1</td><td>Media integrity bits.
<table>
<tr><td>Bits 15-8 (BA state)</td><td>Bits 7-3</td><td>Bit 2</td><td>Bit 1</td><td>Bit 0</td></tr>
<tr><td>@00 SENDING
@01 STOPPED
@02 STARTING
@03 IDLE
@04 MSG_W
@05 APER_W
@06 WAIT
@07 PENDING</td><td>Reserved for future use</td><td>ON=BA active</td><td>ON= medium B healthy</td><td>ON=medium A healthy</td></tr>
</table></td></tr>
<tr><td>2-9</td><td>Stale data indication bits. These bits only operate for consumed VCOMs.

128 bits, one for each VCOM as follows :
Offset 2, bit 0 for VCOM ID 1
Offset 2, bit 15 for VCOM ID 16
Offset 3, bit 0 for VCOM ID 17, etc.

ON=VCOM data is stale</td></tr>
<tr><td>10-17</td><td>VCOM configured bits.

128 bits, one for each VCOM as follows :
Offset 2, bit 0 for VCOM ID 1
Offset 2, bit 15 for VCOM ID 16
Offset 3, bit 0 for VCOM ID 17, etc.

ON=VCOM configured . If a bit is ON, data was transferred to or from the corresponding VCOM during the last inter-scan period. These bits can be used as a mask for the stale data indication bits.</td></tr>
<tr><td></td><td>FIP communication network statistics. (NUMBER PER SECOND)</td></tr>
<tr><td>18</td><td>Number of non Echoing transmission errors</td></tr>
<tr><td>19</td><td>Number of underrun errors</td></tr>
<tr><td>20</td><td>Number of driver errors on medium 1</td></tr>
<tr><td>21</td><td>Number of driver errors on medium 2</td></tr>
<tr><td>22</td><td>Number of driver errors on medium 1 and 2</td></tr>
<tr><td>23</td><td>Number of frames received without error</td></tr>
<tr><td>24</td><td>Number of truncated frame errors</td></tr>
<tr><td>25</td><td>Number of inconsistent frame errors</td></tr>
<tr><td>26</td><td>Number of time-out errors</td></tr>
<tr><td>27</td><td>Number of overrun errors.</td></tr>
<tr><td>28</td><td>Number of Manchester encoding errors.</td></tr>
<tr><td>29</td><td>Number of CRC errors.</td></tr>
<tr><td>30</td><td>Number of time-out and bad frame errors.</td></tr>
<tr><td>31</td><td>Number of transactions performed without errors on medium 1</td></tr>
<tr><td>32</td><td>Number of transactions performed without errors on medium 2</td></tr>
<tr><td>33</td><td>Number of frames received with errors on medium 1</td></tr>
<tr><td>34</td><td>Number of frames received with errors on medium 2</td></tr>
</table>

NOTE

1. The FIP communication network statistics are presented as a rate per second.

2. The media healthy bits (media integrity bits 0 and 1) will only be active if there is a test presence instruction in the macro cycle.

The BA state is updated every one second. Therefore the state in the communication statistics does not reflect the BA behaviour during the last second; it is the state at the point in time at which it was last sampled. The BA status bit is set to indicate an active BA if the BA is in any state other than stopped, starting or idle.

The 16-bit Q output of the special function provides fault and status information. It is divided up as shown in Table 4-14.

Table 4-14 Format of special function Q output

Bits	15	14	13 to 12	11 to 8	7 to 0
Usage	Set to 1 if configuration fails in any way	Set to 1 on successful execution of special function. Bits 7-0 set to subscriber address	Reserved for future use	Error Number. See Table 4-15	Diagnostic information related to error number in bits 11-8 if bit 15 is set to 1. Set to subscriber address if bit 14 is set to 1, i.e. successful configuration

When bit 15 indicates a failure, bits 11-8 indicate the type of failure using an error number. The error numbers are listed in Table 4-15. If table F3 bit 0 is OFF, i.e. there is no run-time error, then table F4 will indicate the number of the table which caused the error, see section 6.2 Special function fault diagnosis, page 6-2.

Table 4-15 Q output error numbers (protocol ID 0)

Q output	Description	Q7-0
@40XX	No Error	XX = subscriber address
@8100	Unsupported Protocol Error The protocol ID in the Zm parameter list header is not valid	Set to 0
@82XX	Syntax Error The special function could not understand what the user intended	XX = configuration element number (0-129)
@83XX	Cannot Write to Table Error A read only table has been specified as a destination table	XX = configuration element number (1-129)
@84XX	VCOM Out Of Range Error An unsupported VCOM ID has been requested	XX = configuration element number (1-129)
@85XX	Statistics Size Error A negative number or a number larger than the maximum statistics size has been specified	XX = configuration element number (1-129)
@86XX	Table Out Of Range Error A source or destination table is non-existent or there are not enough tables for the intended mapping	XX = configuration element number (0-129)
@8700	FIP Error An error has occurred during the reconfiguration of the FIP database	Set to 0
@88XX to @8DXX	Not used for protocol ID 0	N/A
@8E00	FIP Hardware Not Present Error An attempt was made to configure the FIP database using the FIPCFG special function when the controller is not fitted with FIP hardware components	Set to 0
@8F00	FIP Compliance Invalid/Changed Error The FIP compliance standard in table P120 (P94 for GEM80-500) is invalid or it has been changed since the last execution of the FIPCFG special function	Set to 0

4.6.2 Protocol ID 1

This configuration mode has the following features :

- Up to 128 data table to VCOM mappings
- Definable VCOM length of 1-125 bytes with refreshment/promptness. VCOM length of 1-126 bytes without refreshment/promptness
- VCOM IDs in the range 0-@FFFF except reserved IDs (see Table 4-20)
- Definable refreshment/promptness time-out up to 2000ms
- 1 communication statistics to data table mapping
- Optional BA macro cycle
- BA macro cycle is user-defined
- Up to 50 BA macro cycle instructions
- Optional use of test presence instruction
- Variable or fixed (up to 500ms) BA macro cycle period
- Up to 240 unique VCOMs can be requested by the user-defined BA macro cycle

4.6.2.1 Parameter list

The Zm parameter list takes the form of a header, followed by 0 to 145 configuration elements. The parameter list header requires five data tables. There are five types of configuration element as described in Table 4-16.

Table 4-16 Types of configuration element (protocol ID 1)

Configuration element type	Number of data tables required
A produced VCOM to GEM80-400 data table mapping	5
A consumed VCOM to GEM80-400 data table mapping	5
A statistics to GEM80-400 data table mapping	5
BA VCOM list definition	18
BA macro cycle definition	3-101 (variable)

The BA macro cycle definition consists of BA macro cycle instructions. There are four instructions available for creating the macro cycle program as follows :

- SEND_LIST
- SEND_APER
- SEND_MSG
- BA_WAIT

VCOMs are transmitted on the FIP network by referencing BA VCOM list definitions using a SEND_LIST instruction in the macro cycle. These BA VCOM lists consist of between 1 to 16 VCOM IDs. Up to 15 BA VCOM lists can be defined allowing up to 15 x 16 (240) unique VCOMs to be requested.

NOTE

The BA lists must be defined in the configuration list before they are referenced in the BA macro cycle

The maximum number of 145 configuration elements caters for 128 data table to VCOM mappings, 1 communication statistics to data table mapping, 15 BA VCOM list definitions and 1 BA macro cycle definition. The number of configuration elements should be kept as short as possible to reduce the execution time of the special function.

The Zm parameter header is defined in Table 4-17 and is referred to as configuration element 0. The configuration elements that follow are referred to as configuration element 1 to configuration element 145. The Q output errors are listed at the end of section 4.6.2.

Table 4-17 Zm parameter list header (protocol ID 1)

	High byte	Low byte
Data table N	Reserved for future use	Protocol ID = 1 (1 = flexible configuration mode)
Data table N+1	Maximum subscriber address for presence detection (0 to 255) Subscribers with addresses above this value should not be scanned for. 0 = do not perform subscriber presence scanning procedure, i.e. do not include a test presence instruction in the macro cycle If a non-zero value is specified then the macro cycle must have an aperiodic data window defined (i.e. contain a SEND_APER instruction) for the scanning process to work. A test presence instruction will be automatically included in the macro cycle program.	FIP interface control byte Bit 0 : BA inhibit (ON prevents/stops BA macro cycle running) Bits 1-7: reserved for future use
Data table N+2	Reserved for future use	
Data table N+3	Reserved for future use	
Data table N+4	Number of configuration elements in the following configuration list (0 to 145) 0 = de-configure FIP network configuration. All data table to VCOM mappings and statistics to data table mapping will be removed and the BA will be stopped if it is active.	

A lower maximum subscriber address will speed up the subscriber scanning process. An example for the Zm parameter list header is given in Table 4-18.

Table 4-18 Example of Zm parameter list header (protocol ID 1)

	Value	Comments
Data table N	@1	Select protocol 1, i.e. flexible configuration format.
Data table N+1	@1	No subscriber presence scanning. Do not allow the controller to be an active BA.
Data table N+2	@0	Reserved for future use.
Data table N+3	@0	Reserved for future use.
Data table N+4	@3	There are 3 configuration elements in the following list.

4.6.2.2 VCOM to data table mapping element

For the flexible configuration, each VCOM has the attributes shown in Table 4-19.

Table 4-19 VCOM attributes

VCOM attribute	Range
VCOM ID	@0 - @FFFF
Refreshment/promptness time-out	0-2000 ms
VCOM length	1-126 bytes (if refreshment/promptness time-out = 0) 1-125 (if refreshment/promptness time-out > 0)

The VCOM ID is a 16-bit value. However, there are some values which are reserved. These are listed in Table 4-20.

Table 4-20 Reserved VCOM IDs

VCOM ID	Description
@1000 - @10FF	Identification variables
@1100 - @11FF	Report variables
@1400 - @14FF	Presence variables
@9001	Synchronisation ID
@9002	Present subscriber list
(Idle frame ID)	Not reserved by FIP standard, but it must not be used as a VCOM ID. The idle frame is set using a P-Table, see Table 4-5.

For the flexible configuration refreshment/promptness time-out is optional. A time-out value of 0 means it is not used and the VCOM length can be anything from 1 to 126 bytes. If the time-out is non-zero then the VCOM length can be anything from 1 to 125 bytes (1 byte less than before since the last byte of the VCOM conveys status information regarding the time-out).

A data table to VCOM mapping is defined using a configuration element based on the definition in Table 4-21.

Table 4-21 Data table to VCOM mapping configuration element (protocol ID 1)

	High byte	Low byte
Data table N	Configuration element type identifier “P” or “C” (@50 or @43) Set to "P" if this element refers to data that is to be "Produced" (written) to the network. Set to "C" if this elements refers to data that is to be "Consumed" (read) from the network.	Upper case table letter of source or destination table “A” to “W” (@41 to @57)
Data table N+1	Start table offset (0 to 32000) The source or destination table must have adequate subsequent tables to allow all of the VCOM data to be mapped to.	
Data table N+2	VCOM ID (@0 - @FFFF) Do not use the FIP network idle frame ID specified in table P121 (default is @8000 if P121=0) or IDs reserved for variable identification/ report/presence (@10xx, @11xx, @14xx, @9001 and @9002). See Table 4-20 for reserved VCOM IDs.	
Data table N+3	Reserved for future use	Length of VCOM (1 to 125 bytes) when refreshment/promptness time-out required (1 to 126 bytes) when refreshment/promptness time-out not required
Data table N+4	Refreshment/Promptness time-out in ms (0 to 2000) A value of zero indicates that refreshment/promptness time-out status is not required	

An example of a mapping configuration element is given in Table 4-22.

Table 4-22 Example of mapping configuration element (protocol ID 1)

	Value	Comments
Data table N	@4347	Consumed data. Destination G tables.
Data table N+1	@7D0	Table start offset 2000.
Data table N+2	@2000	VCOM ID = @2000
Data table N+3	@78	VCOM length = 120 bytes, i.e. map VCOM @2000 to G2000-G2059.
Data table N+4	@3E8	Promptness time-out = 1000ms.

4.6.2.3 Statistics to data table mapping element

Communication statistics are mapped to data tables using a status configuration element, see Table 4-23, page 4-27. Note that only one of these elements should be defined. If more than one is defined then the last one encountered will provide the active mapping.

Table 4-23 Status mapping configuration element (protocol ID 1)

	High byte	Low byte
Data table N	Configuration element type identifier “S” (@53) Set to "S" if this element refers to Status (communication statistics) to be copied into the data tables.	Upper case table letter of source or destination table “A” to “W” (@41 to @57)
Data table N + 1	Start table offset (0 to 32000) The destination table must have adequate subsequent tables to allow all of the communication statistic data to be mapped to.	
Data table N + 2	Number of FIP communication statistics required (0 to 47) A size of 0 indicates that all of the statistics are to be copied to the data tables. If statistics are not required then this element should not appear in the configuration list.	
Data table N + 3	Reserved for future use	
Data table N + 4	Reserved for future use	

An example of a status mapping configuration element is in Table 4-24.

Table 4-24 Example of status mapping configuration element (protocol ID 1)

	Value	Comments
Data table N	@534D	Communication statistics. Destination M tables.
Data table N + 1	@0	Table start offset 0
Data table N + 2	@F	Map 15 tables of communication statistics to M0-M14
Data table N + 3	@0	Reserved for future use
Data table N + 4	@0	Reserved for future use

The format of the communication statistics is shown in Table 4-25.

Table 4-25 FIP communication statistics (protocol ID 1)

<table>
<tr><th>Offset from start table</th><th>Description</th></tr>
<tr><td>0</td><td>FIP interface fault bits. 0 = healthy.
Run-time error information is in F-Table F4.
<table>
<tr><td>Bit 15</td><td>Bits 14-10</td><td>Bit 9</td><td>Bit 8</td><td>Bit 7-0</td></tr>
<tr><td>ON=warning</td><td>Reserved for future use</td><td>Unable to produce. (Cannot read from data tables)</td><td>Unable to consume. (Cannot write to data tables)</td><td>Reserved</td></tr>
</table></td></tr>
<tr><td>1</td><td>Media integrity bits.
<table>
<tr><td>Bits 15-8 (BA state)</td><td>Bits 7-3</td><td>Bit 2</td><td>Bit 1</td><td>Bit 0</td></tr>
<tr><td>@00 SENDING
@01 STOPPED
@02 STARTING
@03 IDLE
@04 MSG_W
@05 APER_W
@06 WAIT
@07 PENDING</td><td>Reserved for future use</td><td>ON=BA active</td><td>ON=medium B healthy</td><td>ON=medium A healthy</td></tr>
</table></td></tr>
<tr><td>2-9</td><td>Stale data indication bits. These bits only operate for consumed VCOMs.

128 bits, one for each defined VCOM as follows :
Offset 2, bit 0 for 1st VCOM in configuration list
Offset 2, bit 15 for 16th VCOM in configuration list
Offset 3, bit 0 for 17th VCOM in configuration list, etc.

ON=VCOM data is stale</td></tr>
<tr><td>
10
11
12
13
14</td><td>FIP communication network statistics. (NUMBER PER SECOND)
Number of non Echoing transmission errors
Number of transactions performed without errors on medium A
Number of transactions performed without errors on medium B
Number of frames received with errors on medium A
Number of frames received with errors on medium B</td></tr>
<tr><td>15-30</td><td>Medium A presence detection bits.

256 bits, one for each of the possible FIP network subscribers on medium A :
Offset 15, bit 0=FIP network subscriber address 0 on medium A
Offset 15, bit 15=FIP network subscriber address 15 on medium A
Offset 16, bit 0=FIP network subscriber address 16 on medium A, etc.

ON=subscriber is present.
OFF=either the subscriber is not present or presence checking for that subscriber address is disabled by maximum subscriber address in the parameter header.</td></tr>
<tr><td>31-46</td><td>Medium B presence detection bits.

256 bits, one for each of the possible FIP network subscribers on medium B :
Offset 31, bit 0=FIP network subscriber address 0 on medium B
Offset 31, bit 15=FIP network subscriber address 15 on medium B
Offset 32, bit 0=FIP network subscriber address 16 on medium B, etc.

ON=subscriber is present.
OFF=either the subscriber is not present or presence checking for that subscriber address is disabled by maximum subscriber address in the parameter header.</td></tr>
</table>

NOTE

1. The FIP communication network statistics are presented as a rate per second.

2. In addition to reporting errors from the FIPCFG special function, F4 reports the absolute table number of the location in configuration list causing a run-time error, e.g. Consider a configuration starting at P1000. The Zm parameter list header is in P1000 to P1004. If two data table to VCOM mappings are defined they are in P1005 to P1009 and P1010 to P1014 respectively. If the data tables to which the second VCOM is mapped are removed, then F4 will contain a value of 1010 indicating that the VCOM defined by the configuration element starting at P1010 cannot be mapped to data tables.

3. The presence detection bits are part of the reserved present subscriber list VCOM which has ID @9002. The contents of this VCOM are updated by the BA. For all subscribers which are not running the BA macro cycle, a copy is obtained from the BA each time the BA has finished its subscriber presence scanning. It is therefore possible for a subscriber not running the BA macro cycle to have an out of date subscriber list should connection to the FIP network be lost. You are strongly advised to make use of 'stale' data indications wherever possible.

4. The media healthy bits (media integrity bits 0 and 1) will only be active if there is a test presence instruction in the macro cycle. Also, the presence detection bits will only be active if there is a test presence instruction in the macro cycle.

5. The macro cycle must contain a SEND_APER instruction for a test presence instruction to be included.

The BA state is updated every one second. Therefore the state in the communication statistics does not reflect the BA behaviour during the last second; it is the state at the point in time at which it was last sampled. The BA status bit is set to indicate an active BA if the BA is in any state other than stopped, starting or idle.

4.6.2.4 BA VCOM list definition element

A BA VCOM list configuration element is based on the definition in Table 4-26. This is a list of VCOM IDs which can be sent on the FIP network by the BA to request transmission of the VCOMs which have IDs stated in the list.

Table 4-26 BA list configuration element (protocol ID 1)

	High byte	Low byte
Data table N	Configuration element type identifier "L" (@4C)	BA List element number (1-15)
Data table N+1	Periodic window type Must be 0 to indicate this list is for periodic data VCOMs	Number of VCOM IDs (1-16) If less than 16, then remaining VCOM IDs are ignored
Data table N+2	VCOM ID (@0-@FFFF)	
Data table N+3	VCOM ID (@0-@FFFF)	
Data table N+4	VCOM ID (@0-@FFFF)	
Data table N+5	VCOM ID (@0-@FFFF)	
Data table N+6	VCOM ID (@0-@FFFF)	
Data table N+7	VCOM ID (@0-@FFFF)	
Data table N+8	VCOM ID (@0-@FFFF)	
Data table N+9	VCOM ID (@0-@FFFF)	
Data table N+10	VCOM ID (@0-@FFFF)	
Data table N+11	VCOM ID (@0-@FFFF)	
Data table N+12	VCOM ID (@0-@FFFF)	
Data table N+13	VCOM ID (@0-@FFFF)	
Data table N+14	VCOM ID (@0-@FFFF)	
Data table N+15	VCOM ID (@0-@FFFF)	
Data table N+16	VCOM ID (@0-@FFFF)	
Data table N+17	VCOM ID (@0-@FFFF)	

There is no restriction on the choice of VCOM IDs in these lists. A VCOM ID can appear in a list more than once and can be in more than one list. An example of a VCOM ID list configuration element is given in Table 4-27. If the same VCOM list is defined more than once in the configuration list then the duplicated VCOM list nearest the end of the configuration list will be used.

Table 4-27 Example of VCOM ID list configuration element (protocol ID 1)

	Value	Comments
Data table N	@4C01	Defining list 1.
Data table N+1	@8	List will contain 8 VCOM IDs.
Data table N+2	@40	Request VCOM with ID @40
Data table N+3	@41	Request VCOM with ID @41
Data table N+4	@140	Request VCOM with ID @140
Data table N+5	@141	Request VCOM with ID @141
Data table N+6	@8001	Request VCOM with ID @8001
Data table N+7	@8002	Request VCOM with ID @8002
Data table N+8	@8040	Request VCOM with ID @8040
Data table N+9	@8041	Request VCOM with ID @8041
Data table N+10	@0	Not used
Data table N+11	@0	Not used
Data table N+12	@0	Not used
Data table N+13	@0	Not used
Data table N+14	@0	Not used
Data table N+15	@0	Not used
Data table N+16	@0	Not used
Data table N+17	@0	Not used

4.6.2.5 BA macro cycle definition element

The BA macro cycle program is defined using a BA macro cycle configuration element as shown in Table 4-28. You can specify as many as 50 macro cycle instructions. The test presence instruction is optional. Its inclusion is controlled by the maximum subscriber address in the parameter list header and it is not counted as one of the 50 instructions. The macro cycle can have a fixed period of up to 500ms. However, it is possible to define a macro cycle which has a varying period in order to optimise the use of the FIP network.

Table 4-28 BA macro cycle configuration element (protocol ID 1)

	High byte	Low byte
Data table N	Configuration element type identifier "B" (@42)	Number of instructions to include in BA macro cycle (1 to 50). (Each instruction requires two data tables: one for the instruction and one for an associated parameter)
Data table N + 1	Reserved for future use	BA macro cycle instruction type : "L" (@4C) = SEND_LIST (20 max.) "W" (@57) = BA_WAIT "A" (@41) = SEND_APER "M" (@4D) = SEND_MSG
Data table N + 2	Associated parameter for BA macro cycle instruction : **Instruction type** — **Associated parameter** SEND_LIST — List No (1 to 15) BA_WAIT — Idle frame time limit in ms (0 to 500) SEND_APER — Aperiodic data transfer window time limit in ms (0 to 500) SEND_MSG — Aperiodic message transfer window time limit in ms (0 to 500)	
	. 1 to n instructions (n = 1 to 50) .	
Data table (n x 2) + N - 1	Reserved for future use	BA macro cycle instruction type : "L" (@4C) = SEND_LIST (20 max.) "W" (@57) = BA_WAIT "A" (@41) = SEND_APER "M" (@4D) = SEND_MSG
Data table (n x 2) + N	Associated parameter for BA macro cycle instruction : **Instruction type** — **Associated parameter** SEND_LIST — List No (1 to 15) BA_WAIT — Idle frame time limit in ms (0 to 500) SEND_APER — Aperiodic data transfer window time limit in ms (0 to 500) SEND_MSG — Aperiodic message transfer window time limit in ms (0 to 500)	

There should be only one macro cycle definition. If more than one is defined, then the one nearest the end of the configuration list will be the one used. The sequence of the overall BA macro cycle program is determined by the order in which the BA macro cycle

instructions are defined. The BA macro cycle execution time depends on the instructions contained in the BA macro cycle (see Note below).

A test presence instruction, if requested, will be inserted before the first SEND_APER macro cycle instruction. If a SEND_APER instruction is not included in the BA macro cycle then subscriber presence scanning will not work. If subscriber presence scanning is not required it can be de-selected by setting the maximum subscriber address for presence detection to zero. A LABEL instruction will be automatically added at the start of the macro cycle. This indicates the start of a macro cycle definition. A NEXT_MACRO_2 and END_BA instruction will automatically be added at the end of the macro cycle. The NEXT_MACRO_2 instruction informs the BA to repeat the current macro cycle. The END_BA instruction indicates the end of a macro cycle definition.

NOTE

The overall BA Macro Cycle execution time is the sum of the time to process send list instructions, aperiodic data, aperiodic message and the overhead associated with a test presence instruction if it is included. Time limits specified for BA_WAIT, SEND_APER and SEND_MSG instructions are relative to the start of the BA macro cycle.

An example of a BA macro cycle program is given in Table 4-29. This example defines a BA macro cycle which requests a list of VCOMs to be transmitted on the FIP network. The BA then transmits idle frames for any remaining time up to 50ms since the macro cycle began. If the contents of BA list no. 1 are those in the example in Table 4-27, then the VCOMs requested are those with IDs @40, @41, @140, @141, @8001, @8002, @8040 and @8041.

Table 4-29 Example of a BA macro cycle (protocol ID 1)

	Value	Comments
Data table N	@4202	2 macro cycle instructions.
Data table N+1	@4C	SEND_LIST instruction.
Data table N+2	@1	Send list of VCOM IDs in BA list no. 1. See Table 4-27 for list of VCOM IDs.
Data table N+3	@57	BA_WAIT instruction
Data table N+4	@32	Send idle frames from now until 50ms have elapsed since the macro cycle started. If more than 50ms have already elapsed then the BA will not send any idle frames and will go back to the first instruction in the macro cycle,

Finally, the 16-bit Q output of the special function provides fault and status information. It is divided up as shown in Table 4-30.

Table 4-30 Format of special function Q output (protocol ID 1)

Bits	15	14	13 to 12	11 to 8	7 to 0
Usage	Set to 1 if configuration fails in any way	Set to 1 on successful execution of special function. Bits 7-0 set to subscriber address	Reserved for future use	Error Number. See Table 4-31	Diagnostic information related to error number in bits 11-8 if bit 15 is set to 1. Set to subscriber address if bit 14 is set to 1, i.e. successful configuration

When bit 15 indicates a failure, bits 11-8 indicate the type of failure using an error number. The error numbers are listed in Table 4-31. Table F4 will indicate the number of the table which caused the error, see section 6.2 Special function fault diagnosis, page 6-2.

Table 4-31 Q output error numbers (protocol ID 1)

Q output	Description	Q7-0
@40XX	No Error	XX = subscriber address
@8100	Unsupported Protocol Error The protocol ID in the Zm parameter list header is not valid	Set to 0
@82XX	Syntax Error The special function could not understand what the user intended	XX = configuration element number (0-145)
@83XX	Cannot Write to Table Error A read only table has been specified as a destination table	XX = configuration element number (1-145)
@84XX	Reserved VCOM ID Error A reserved VCOM ID has been requested	XX = configuration element number (1-145)
@85XX	Statistics Size Error A negative number or a number larger than the maximum statistics size has been specified	XX = configuration element number (1-145)
@86XX	Table Out Of Range Error A source or destination table is non-existent or there are not enough tables for the intended mapping	XX = configuration element number (0-145)
@8700	FIP Error An error has occurred during the reconfiguration of the FIP data base	Set to 0
@88XX	Refreshment/Promptness Size Error A negative number, or a number larger than the maximum size has been specified	XX = configuration element number (1-145)
@89XX	Aperiodic Window Size Error A negative number, or a number larger than the maximum size has been specified	XX = configuration element number (1-145)

Q output	Description	Q7-0
@8AXX	Messaging Window Size Error A negative number, or a number larger than the maximum size has been specified	XX = configuration element number (1-145)
@8BXX	BA Macro Cycle Wait Time Error A negative number, or a number larger than the maximum size has been specified	XX = configuration element number (1-145)
@8CXX	VCOM Length Error The number of bytes specified for the VCOM length is outside the range (1-125 or 1-126)	XX = configuration element number (1-145)
@8DXX	BA List No Out Of Range Error A List No outside the range 1-15 was specified	XX = configuration element number (1-145)
@8E00	FIP Hardware Not Present Error An attempt was made to configure the FIP database using the FIPCFG special function when the controller is not fitted with FIP hardware components	Set to 0
@8F00	FIP Compliance Invalid/Changed Error The FIP compliance standard in table P120 (P94 for GEM80-500) is invalid or it has been changed since the last execution of the FIPCFG special function	Set to 0

5. Application examples

5.1 Introduction

This section provides examples of complete GEM80 FIP network configurations using protocol ID 0 and protocol ID 1. An example user ladder program is provided in 5.5 Example ladder program, page 5-14. This program can be used for all the FIP network configuration examples. We recommend performing a HALT to RUN transition to perform a FIP network re-configuration so that the special function is only executed once following this transition.

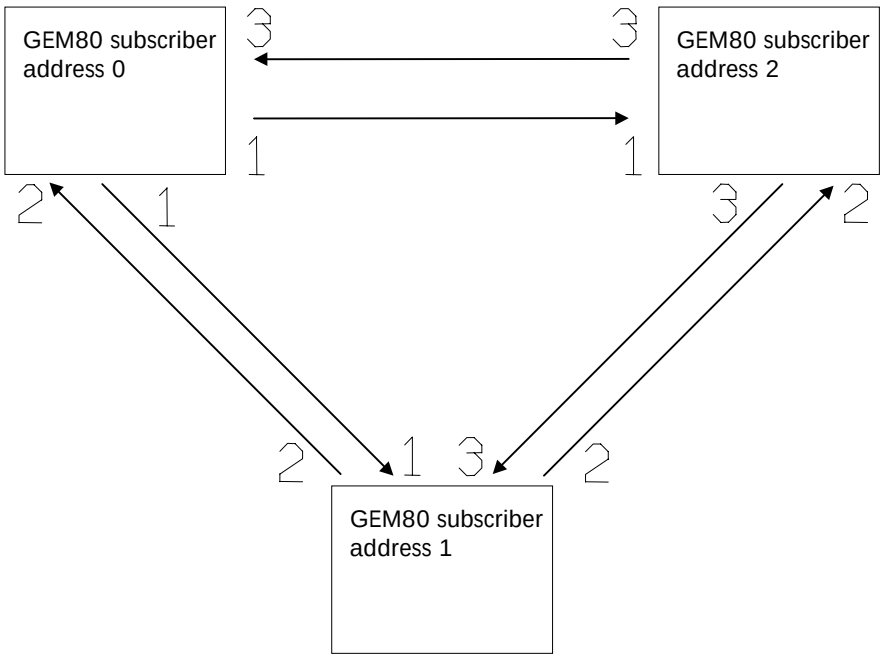
5.2 Configuration methods

Using the programming tool described in Programming tools section you can configure the GEM80 controller by entering configuration data in GEM80 data tables. Summary sheets are provided at the end of this manual as an aid to entering configuration data.

5.3 Protocol ID 0 example

Consider a system with 3 GEM80 controllers connected together using a FIP network. Each GEM80 controller is required to transfer data to the other two controllers using VCOMs. The diagram in Figure 5-1 shows such a system. The numbers 1, 2 and 3 indicate individual VCOMs and the direction of data transfer on the FIP network. The GEM80 controller which has subscriber address 0 produces a VCOM which has a VCOM ID equal to 1. This is consumed by subscribers 1 and 2. Similarly, subscriber 1 produces a VCOM which has a VCOM ID equal to 2 and this is consumed by subscribers 0 and 2. Finally, subscriber 2 produces a VCOM which has a VCOM ID equal to 3 and this is consumed by subscribers 0 and 1.

Figure 5-1 Communication between 3 GEM80 controllers using a FIP network



Following the steps given in section 4.5 How to configure this system is configured as follows:

1. Select the FIP network compliance standard P120 = 0 (SlowFIP). (P94 for GEM80-500)
2. Set the idle frame ID P121 = 0 (defaults to @8000). (P95 for GEM80-500)
3. Choose byte ordering P122 = 0 (byte swapping disabled). (P96 for GEM80-500)
4. Use protocol ID 0 (quick configuration).
5. Consume data into N-tables. Produce data from O-tables. Copy statistics to M-tables.
6. Define VCOMs 1, 2 and 3 on all controllers.
7. No need to define BA macro cycle.
8. Enter the configuration data into P-tables (see Table 5-1).
9. Add the FIPCFG special function S145 to the ladder program.
10. Execute the special function once.
11. If an error is reported by the special function correct the configuration data.
12. Configure other FIP network subscribers to exchange data.
13. Check that data tables are transferred correctly.

Table 5-1 provides the configuration data for this system. The FIPCFG special function is executed once during a HALT to RUN transition using the ladder program in section 5.5, page 5-14.

Table 5-1 Example configuration for protocol ID 0

Table	GEM80 subscriber address 0	GEM80 subscriber address 1	GEM80 subscriber address 2	Comments	Configurat-ion element
P1000	@0	@0	@0	Protocol ID = 0	Parameter list header
P1001	@0	@0	@1	Inhibit BA on subscriber address 2	
P1002	@3	@4	@4	No of configuration elements	
P1003	@534D	@534D	@534D	Statistics copied to M-Tables	Element 1: Status
P1004	@0	@0	@0	Start at table 0	
P1005	@0	@0	@0	Copy all of statistics (35 tables)	
P1006	@434E	@434E	@434E	Consume data into N-Tables	Element 2: VCOM
P1007	@0	@0	@0	Start consuming in table 0	
P1008	@302	@1	@1	Consume VCOM IDs 2 & 3 on subscriber 0. Consume VCOM ID 1 on subscribers 1 and 2.	
P1009	@504F	@434E	@434E	Produce data from O-Tables on subscriber 0. Consume data into N-Tables on subscribers 1 and 2.	Element 3: VCOM
P1010	@0	@3C	@3C	Start producing from table 0 on subscriber 0. Start consuming in table 60 on subscribers 1 and 2.	
P1011	@1	@3	@2	Produce VCOM ID 1 on subscriber 0. Consume VCOM ID 3 on subscriber 1.	

Table	GEM80 subscriber address 0	GEM80 subscriber address 1	GEM80 subscriber address 2	Comments	Configurat-ion element
				Consume VCOM ID 2 on subscriber 2.	
P1012		@504F	@504F	Produce data from O-Tables	Element 4: VCOM
P1013		@0	@0	Start producing from table 0	
P1014		@2	@3	Produce VCOM 2 on subscriber 1. Produce VCOM 3 on subscriber 2.	

All the following data transfers take place between ladder program scans:

- All subscribers copy communication statistics to tables M0-M34
- Subscriber 0 consumes VCOM ID 2 to data tables N0-N59. It consumes VCOM ID 3 to data tables N60-N119. It produces data from data tables O0-O59 to VCOM ID 1.
- Subscriber 1 consumes VCOM ID 1 to data tables N0-N59. It consumes VCOM ID 3 to data tables N60-N119. It produces data from data tables O0-O59 to VCOM ID 2.
- Subscriber 2 consumes VCOM ID 1 to data tables N0-N59. It consumes VCOM ID 2 to data tables N60-N119. It produces data from data tables O0-O59 to VCOM ID 3. This subscriber does not have the potential to be the BA.

The stale indication bits in the statistics tables will show the status of consumed VCOMs as follows

- Subscriber 0 uses M2.1 and M2.2 for VCOM IDs 2 and 3 respectively
- Subscriber 1 uses M2.0 and M2.2 for VCOM IDs 1 and 3 respectively
- Subscriber 2 uses M2.0 and M2.1 for VCOM IDs 1 and 2 respectively

Subscriber 0 or subscriber 1 will be the active BA. During a BA election procedure, subscriber 0 has priority because it has the lowest subscriber address.

5.4 Protocol ID 1 examples

5.4.1 Protocol ID 1 example 1

In this example three GEM80s are connected together using a FIP network. The GEM80s have subscriber addresses 0, 1 and 2. Only subscriber 0 will be configured with a macro cycle and allowed to be the active BA. Subscriber 0 is considered to be controlling the process. Subscribers 1 and 2 will have VCOMs configured which have the VCOM IDs shown in Table 5-2. It is quite common for the low byte of a VCOM ID to be the same as the subscriber address. Subscriber 0 will have all of these VCOMs configured since it is responsible for sending the input VCOMs to the other two subscribers and receiving the corresponding output and status VCOMs.

Table 5-2 VCOMs configured on subscribers 1 and 2

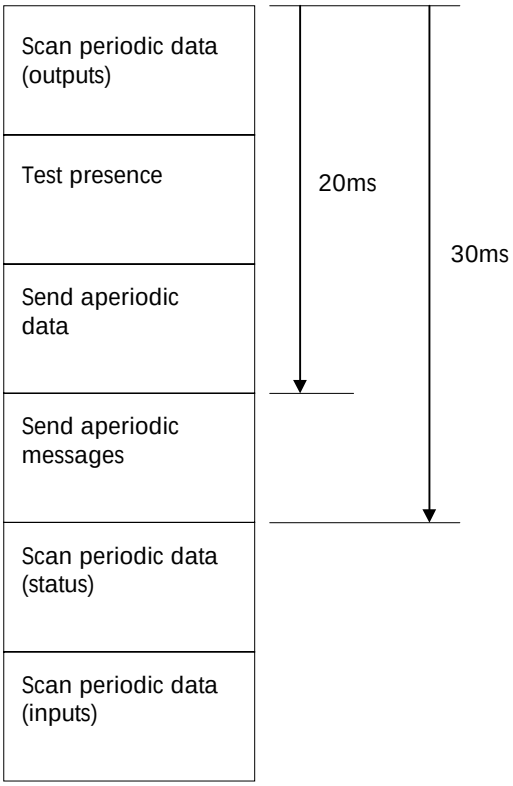
	GEM80 subscriber address 1	GEM80 subscriber address 2
Status VCOM ID	@1	@2
Input VCOM ID	@101	@102
Output VCOM ID	@201	@202

The steps for configuration are as follows :

1. Select the FIP network compliance standard P120 = 1 (WorldFIP). (P94 for GEM80-500)
2. Set the idle frame ID P121 = @9080. (P95 for GEM80-500)
3. Choose byte ordering P122 = 1 (byte swapping enabled). (P96 for GEM80-500)
4. Use protocol ID 1 (flexible configuration).
5. Consume data into N-tables. Produce data from O-tables. Copy statistics to M-tables.
6. Define VCOMs (see Table 5-2).
7. Define BA macro cycle on subscriber address 0.
8. Enter the configuration data into P-tables (see Table 5-3, Table 5-4 and Table 5-5).
9. Add the FIPCFG special function S145 to the ladder program.
10. Execute the special function once.
11. If an error is reported by the special function correct the configuration data.
12. Configure other FIP network subscribers to exchange data.
13. Check that data tables are transferred correctly.

The macro cycle will define an aperiodic data window which will allow the test presence to be automatically inserted in the macro cycle just before the aperiodic data window. However, the test presence instruction is only inserted if the maximum subscriber address for presence scanning is non-zero. The macro cycle will also include an aperiodic message window. Although no messaging takes place between the GEM80s the window is included for illustration. Remember that other subscribers on the FIP network may use messaging. The format of the macro cycle is shown in Figure 5-2, page 5-5.

Figure 5-2 BA macro cycle



The output periodic data will be requested first. The two output VCOMs are 32 bytes in length (see configuration in Table 5-3, Table 5-4 and Table 5-5). The time to allow for these VCOMs to be transmitted on a WorldFIP network is 2 x (198 + (33 x 8)) = 924µs (0.924ms). Remember that an extra byte is allowed for the refreshment/promptness status. When the send aperiodic data instruction is encountered, aperiodic data can be transmitted on the FIP network provided that 20ms has not elapsed since the macro cycle began. We have already calculated that the first part of this macro cycle requires 0.924 ms so 20ms will not have elapsed at the start of the aperiodic data window. If all aperiodic data has been processed before the end of this 20ms period then the aperiodic message instruction is executed. Aperiodic messages are processed up to a time limit of 30ms from the start of the macro cycle. If all aperiodic messages are processed before the end of this 30ms period then the next instruction is executed, i.e. request status VCOMs. This means that the execution time of the macro cycle is variable due to the variable amount of aperiodic data and messages to be transferred on the network. It is possible for the BA macro cycle to have a fixed execution time and this will be demonstrated in 5.4.2. Protocol ID 1 example 2, page 5-9.

The configuration for subscriber 0 is in Table 5-3.

Table 5-3 Configuration for GEM80 subscriber address 0

Table	Value	Comments	Configurat-ion element
P1000	@1	Protocol ID = 1	Parameter list header
P1001	@200	Allow the controller to be an active BA and perform presence scanning up to subscriber address 2	
P1002	@0	Reserved for future use	
P1003	@0	Reserved for future use	
P1004	@B	11 configuration elements to follow	
P1005	@504F	Produce VCOM from O-Tables	Element 1: VCOM
P1006	@0	Start at table 0	
P1007	@101	VCOM ID = @101	
P1008	@14	VCOM length = 20 bytes	
P1009	@1F4	Refreshment time-out = 500ms	
P1010	@504F	Produce VCOM from O-Tables	Element 2: VCOM
P1011	@64	Start at table 100	
P1012	@102	VCOM ID = @102	
P1013	@14	VCOM length = 20 bytes	
P1014	@1F4	Refreshment time-out = 500ms	
P1015	@434E	Consume VCOM into N-Tables	Element 3: VCOM
P1016	@0	Start at table 0	
P1017	@1	VCOM ID = @1	
P1018	@A	VCOM length = 10 bytes	
P1019	@1F4	Promptness time-out = 500ms	
P1020	@434E	Consume VCOM into N-Tables	Element 4: VCOM
P1021	@64	Start at table 100	
P1022	@2	VCOM ID = @2	
P1023	@A	VCOM length = 10 bytes	
P1024	@1F4	Promptness time-out = 500ms	
P1025	@434E	Consume VCOM into N-Tables	Element 5: VCOM
P1026	@3E8	Start at table 1000	
P1027	@201	VCOM ID = @201	
P1028	@20	VCOM length = 32 bytes	
P1029	@1F4	Promptness time-out = 500ms	
P1030	@434E	Consume VCOM into N-Tables	Element 6: VCOM
P1031	@44C	Start at table 1100	
P1032	@202	VCOM ID = @202	
P1033	@20	VCOM length = 32 bytes	
P1034	@1F4	Promptness time-out = 500ms	
P1035	@534D	Statistics copied to M-Tables	Element 7: Status
P1036	@0	Start at table 0	
P1037	@0	Copy all statistics (47 tables)	
P1038	@0	Reserved for future use	
P1039	@0	Reserved for future use	
P1040	@4C01	BA list number 1	Element 8: BA List
P1041	@2	2 VCOM IDs	
P1042	@201	Output VCOM for subscriber 1	
P1043	@202	Output VCOM for subscriber 2	
P1045	@0	Not used	
P1046	@0	Not used	
P1047	@0	Not used	
P1048	@0	Not used	
P1049	@0	Not used	
P1050	@0	Not used	
P1051	@0	Not used	
P1052	@0	Not used	
P1053	@0	Not used	
P1054	@0	Not used	

Table	Value	Comments	Configurat-ion element
P1055	@0	Not used	
P1056	@0	Not used	
P1057	@0	Not used	
P1058	@0	Not used	
P1059	@4C02	BA list number 2	Element 9: BA List
P1060	@2	2 VCOM IDs	
P1061	@1	Status VCOM for subscriber 1	
P1062	@2	Status VCOM for subscriber 2	
P1063	@0	Not used	
P1064	@0	Not used	
P1065	@0	Not used	
P1066	@0	Not used	
P1067	@0	Not used	
P1068	@0	Not used	
P1069	@0	Not used	
P1070	@0	Not used	
P1071	@0	Not used	
P1072	@0	Not used	
P1073	@0	Not used	
P1074	@0	Not used	
P1075	@0	Not used	
P1076	@0	Not used	
P1077	@4C03	BA list number 3	Element 10: BA List
P1078	@2	2 VCOM IDs	
P1079	@101	Input VCOM for subscriber 1	
P1080	@102	Input VCOM for subscriber 2	
P1081	@0	Not used	
P1082	@0	Not used	
P1083	@0	Not used	
P1084	@0	Not used	
P1085	@0	Not used	
P1086	@0	Not used	
P1087	@0	Not used	
P1088	@0	Not used	
P1089	@0	Not used	
P1090	@0	Not used	
P1091	@0	Not used	
P1092	@0	Not used	
P1093	@0	Not used	
P1094	@0	Not used	
P1095	@4205	BA macro cycle with 5 instructions	Element 11: BA macro cycle
P1096	@4C	SEND_LIST	
P1097	@1	Send BA list number 1	
P1098	@41	SEND_APER	
P1099	@14	Aperiodic data window until 20ms elapsed	
P1100	@4D	SEND_MSG	
P1101	@1E	Aperiodic message window until 30ms elapsed	
P1102	@4C	SEND_LIST	
P1103	@2	Send BA list number 2	
P1104	@4C	SEND_LIST	
P1105	@3	Send BA list number 3	

The configuration for subscribers 1 and 2 is in Table 5-4 and Table 5-5 respectively.

Table 5-4 Configuration for GEM80 subscriber address 1

Table	Value	Comments	Configuration element
P1000	@1	Protocol ID = 1	Parameter list header
P1001	@1	Inhibit the BA	
P1002	@0	Reserved for future use	
P1003	@0	Reserved for future use	
P1004	@4	4 configuration elements to follow	
P1005	@504F	Produce VCOM from O-Tables	Element 1: VCOM
P1006	@0	Start at table 0	
P1007	@1	VCOM ID = 1	
P1008	@A	VCOM length = 10 bytes	
P1009	@1F4	Refreshment time-out = 500ms	
P1010	@434E	Consume VCOM into N-Tables	Element 2: VCOM
P1011	@0	Start at table 0	
P1012	@101	VCOM ID = @101	
P1013	@14	VCOM length = 20 bytes	
P1014	@1F4	Promptness time-out = 500ms	
P1015	@504F	Produce VCOM from O-Tables	Element 3: VCOM
P1016	@64	Start at table 100	
P1017	@201	VCOM ID = @201	
P1018	@20	VCOM length = 32 bytes	
P1019	@1F4	Refreshment time-out = 500ms	
P1020	@534D	Statistics copied to M-Tables	Element 4: Status
P1021	@0	Start at table 0	
P1022	@0	Copy all statistics (47 tables)	
P1023	@0	Reserved for future use	
P1024	@0	Reserved for future use	

Table 5-5 Configuration for GEM80 subscriber address 2

Table	Value	Comments	Configuration element
P1000	@1	Protocol ID = 1	Parameter list header
P1001	@1	Inhibit the BA	
P1002	@0	Reserved for future use	
P1003	@0	Reserved for future use	
P1004	@4	4 configuration elements to follow	
P1005	@504F	Produce VCOM from O-Tables	Element 1: VCOM
P1006	@0	Start at table 0	
P1007	@2	VCOM ID = 2	
P1008	@A	VCOM length = 10 bytes	
P1009	@1F4	Refreshment time-out = 500ms	
P1010	@434E	Consume VCOM into N-Tables	Element 2: VCOM
P1011	@0	Start at table 0	
P1012	@102	VCOM ID = @102	
P1013	@14	VCOM length = 20 bytes	
P1014	@1F4	Promptness time-out = 500ms	
P1015	@504F	Produce VCOM from O-Tables	Element 3: VCOM
P1016	@64	Start at table 100	
P1017	@202	VCOM ID = @202	
P1018	@20	VCOM length = 32 bytes	
P1019	@1F4	Refreshment time-out = 500ms	
P1020	@534D	Statistics copied to M-Tables	Element 4: Status
P1021	@0	Start at table 0	
P1022	@0	Copy all statistics (47 tables)	
P1023	@0	Reserved for future use	
P1024	@0	Reserved for future use	

The BA can be configured on subscribers 1 and 2 in exactly the same way as it is on subscriber 0. Remember to clear the BA inhibit bit.

Subscriber 0 has 4 consumed VCOMs configured. They are configuration elements 3 to 6. The promptness time-out is non-zero so the stale indication bits are in M2.2 for VCOM ID @1, M2.3 for VCOM ID @2, etc. Subscribers 1 and 2 have one consumed VCOM configured. In each case it is the second VCOM element in the configuration list. The promptness time-out is non-zero so the stale indication bit is in M2.1.

5.4.2 Protocol ID 1 example 2

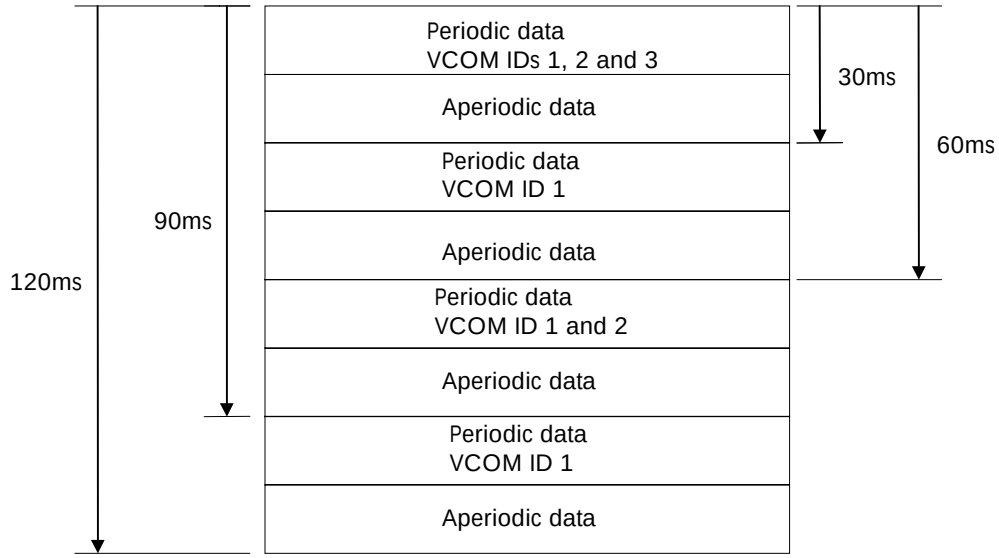
Three GEM80s are connected together using a FIP network in this example. The GEM80s have subscriber addresses 0, 1 and 2. Only subscriber 0 will be configured with a macro cycle and allowed to be the active BA. Subscriber 0 is considered to be controlling the process. Subscriber 0 produces VCOM with VCOM ID 1 and consumes VCOMs with VCOM IDs 2 and 3. Subscriber 1 produces VCOM with VCOM ID 2 and consumes VCOM with VCOM ID 1. Subscriber 2 produces VCOM with VCOM ID 3 and consumes VCOM with VCOM ID 1.

The steps for configuration are as follows :

1. Select the FIP network compliance standard P120 = 0 (SlowFIP). (P94 for GEM80-500)
2. Set the idle frame ID P121 = 0 (defaults to @8000). (P95 for GEM80-500)
3. Choose byte ordering P122 = 0 (byte swapping disabled). (P96 for GEM80-500)
4. Use protocol ID 1 (flexible configuration).
5. Consume data into N-tables. Produce data from O-tables. Copy statistics to M-tables.
6. Define VCOMs 1, 2 and 3
7. Define BA macro cycle on subscriber address 0.
8. Enter the configuration data into P-tables (see Table 5-6, Table 5-7 and Table 5-8).
9. Add the FIPCFG special function S145 to the ladder program.
10. Execute the special function once.
11. If an error is reported by the special function correct the configuration data.
12. Configure other FIP network subscribers to exchange data.
13. Check that data tables are transferred correctly.

The BA macro cycle will consist of 4 elementary cycles each of which has a fixed period. Subscriber presence scanning is allowed. Each elementary cycle period is 30ms and the total macro cycle period is 120ms. VCOM ID 1 has a period of 30ms and is therefore requested in every elementary cycle. VCOM ID 2 has a period of 60ms and VCOM ID has a period of 120ms. Figure 5-3 shows the format of the macro cycle.

Figure 5-3 Fixed period BA macro cycle



If there is no aperiodic data to send in an aperiodic data window or all aperiodic data has been processed before the end of the elementary cycle, then idle frames are transmitted for the remainder of the elementary cycle.

The configuration for subscribers 0, 1 and 2 is in Table 5-6, Table 5-7 and Table 5-8 respectively. In the first elementary cycle, VCOMs with IDs 1, 2 and 3 are requested. On a SlowFIP network this requires 382 + (21 x 8) + 2 x (382 + (101 x 8)) = 2930µs (2.93ms). The remainder of the time in the first elementary cycle is available for processing aperiodic data.

Table 5-6 Configuration for GEM80 subscriber address 0

Table	Value	Comments	Configurat-ion element
P1000	@1	Protocol ID = 1	Parameter list header
P1001	@200	Allow the controller to be an active BA and perform presence scanning up to subscriber address 2	
P1002	@0	Reserved for future use	
P1003	@0	Reserved for future use	
P1004	@8	8 configuration elements to follow	
P1005	@504F	Produce VCOM from O-Tables	Element 1: VCOM
P1006	@0	Start at table 0	
P1007	@1	VCOM ID = @1	
P1008	@14	VCOM length = 20 bytes	
P1009	@3C	Refreshment time-out = 60ms	
P1010	@434E	Consume VCOM into N-Tables	Element 2: VCOM
P1011	@0	Start at table 0	
P1012	@2	VCOM ID = @2	
P1013	@64	VCOM length = 100 bytes	
P1014	@78	Promptness time-out = 120ms	
P1015	@434E	Consume VCOM into N-Tables	Element 3: VCOM
P1016	@64	Start at table 100	
P1017	@3	VCOM ID = @3	

Table	Value	Comments	Configurat-ion element
P1018	@64	VCOM length = 100 bytes	
P1019	@F0	Promptness time-out = 240ms	
P1020	@534D	Statistics copied to M-Tables	Element 4: Status
P1021	@0	Start at table 0	
P1022	@0	Copy all statistics (47 tables)	
P1023	@0	Reserved for future use	
P1024	@0	Reserved for future use	
P1025	@4C01	BA list number 1	Element 5: BA List
P1026	@3	3 VCOM IDs	
P1027	@1	VCOM produced by subscriber 0	
P1028	@2	VCOM produced by subscriber 1	
P1029	@3	VCOM produced by subscriber 2	
P1030	@0	Not used	
P1031	@0	Not used	
P1032	@0	Not used	
P1033	@0	Not used	
P1034	@0	Not used	
P1035	@0	Not used	
P1036	@0	Not used	
P1037	@0	Not used	
P1038	@0	Not used	
P1039	@0	Not used	
P1040	@0	Not used	
P1041	@0	Not used	
P1042	@0	Not used	
P1043	@4C02	BA list number 2	Element 6: BA List
P1045	@1	1 VCOM ID	
P1046	@1	VCOM produced by subscriber 0	
P1047	@0	Not used	
P1048	@0	Not used	
P1049	@0	Not used	
P1050	@0	Not used	
P1051	@0	Not used	
P1052	@0	Not used	
P1053	@0	Not used	
P1054	@0	Not used	
P1055	@0	Not used	
P1056	@0	Not used	
P1057	@0	Not used	
P1058	@0	Not used	
P1059	@0	Not used	
P1060	@0	Not used	
P1061	@0	Not used	
P1062	@4C03	BA list number 3	Element 7: BA List
P1063	@2	2 VCOM IDs	
P1064	@1	VCOM produced by subscriber 0	
P1065	@2	VCOM produced by subscriber 1	
P1066	@0	Not used	
P1067	@0	Not used	
P1068	@0	Not used	
P1069	@0	Not used	
P1070	@0	Not used	
P1071	@0	Not used	
P1072	@0	Not used	
P1073	@0	Not used	
P1074	@0	Not used	
P1075	@0	Not used	
P1076	@0	Not used	
P1077	@0	Not used	

Table	Value	Comments	Configurat-ion element
P1078	@0	Not used	
P1079	@0	Not used	
P1080	@420C	BA macro cycle with 12 instructions	Element 8: BA macro cycle
P1081	@4C	SEND_LIST	
P1082	@1	Send BA list number 1	
P1083	@41	SEND_APER	
P1084	@1E	Aperiodic data window until 30ms elapsed	
P1085	@57	BA_WAIT	
P1086	@1E	Send idle frames until 30ms elapsed	
P1087	@4C	SEND_LIST	
P1088	@2	Send BA list number 2	
P1089	@41	SEND_APER	
P1090	@3C	Aperiodic data window until 60ms elapsed	
P1091	@57	BA_WAIT	
P1092	@3C	Send idle frames until 60ms elapsed	
P1093	@4C	SEND_LIST	
P1094	@3	Send BA list number 3	
P1095	@41	SEND_APER	
P1096	@5A	Aperiodic data window until 90ms elapsed	
P1097	@57	BA_WAIT	
P1098	@5A	Send idle frames until 90ms elapsed	
P1099	@4C	SEND_LIST	
P1100	@2	Send BA list number 2	
P1101	@41	SEND_APER	
P1102	@78	Aperiodic data window until 120ms elapsed	
P1103	@57	BA_WAIT	
P1104	@78	Send idle frames until 120ms elapsed	

Table 5-7 Configuration for GEM80 subscriber address 1

Table	Value	Comments	Configuration element
P1000	@1	Protocol ID = 1	Parameter list header
P1001	@1	Inhibit the BA	
P1002	@0	Reserved for future use	
P1003	@0	Reserved for future use	
P1004	@3	3 configuration elements to follow	
P1005	@504F	Produce VCOM from O-Tables	Element 1: VCOM
P1006	@0	Start at table 0	
P1007	@2	VCOM ID = 2	
P1008	@64	VCOM length = 100 bytes	
P1009	@78	Refreshment time-out = 120ms	
P1010	@434E	Consume VCOM into N-Tables	Element 2: VCOM
P1011	@0	Start at table 0	
P1012	@1	VCOM ID = @1	
P1013	@14	VCOM length = 20 bytes	
P1014	@3C	Promptness time-out = 60ms	
P1015	@534D	Statistics copied to M-Tables	Element 3: Status
P1016	@0	Start at table 0	
P1017	@0	Copy all statistics (47 tables)	
P1018	@0	Reserved for future use	
P1019	@0	Reserved for future use	

Table 5-8 Configuration for GEM80 subscriber address 2

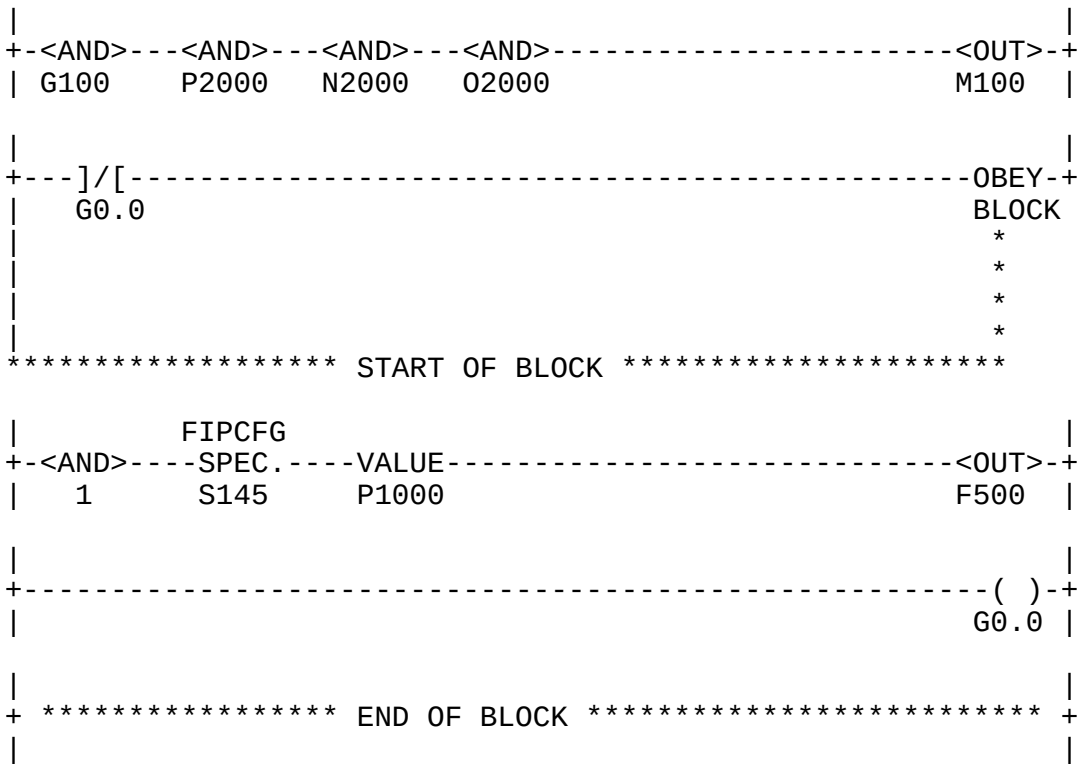
Table	Value	Comments	Configuration element
P1000	@1	Protocol ID = 1	Parameter list header
P1001	@1	Inhibit the BA	
P1002	@0	Reserved for future use	
P1003	@0	Reserved for future use	
P1004	@3	3 configuration elements to follow	
P1005	@504F	Produce VCOM from O-Tables	Element 1: VCOM
P1006	@0	Start at table 0	
P1007	@3	VCOM ID = 3	
P1008	@64	VCOM length = 100 bytes	
P1009	@78	Refreshment time-out = 120ms	
P1010	@434E	Consume VCOM into N-Tables	Element 2: VCOM
P1011	@0	Start at table 0	
P1012	@1	VCOM ID = @1	
P1013	@14	VCOM length = 20 bytes	
P1014	@3C	Promptness time-out = 60ms	
P1015	@534D	Statistics copied to M-Tables	Element 3: Status
P1016	@0	Start at table 0	
P1017	@0	Copy all statistics (47 tables)	
P1018	@0	Reserved for future use	
P1019	@0	Reserved for future use	

The BA can be configured on subscribers 1 and 2 in exactly the same way as it is on subscriber 0. Remember to clear the BA inhibit bit.
Subscriber 0 has 2 consumed VCOMs configured. They are configuration elements 2 and 3. The promptness time-out is non-zero so the stale indication bits are in M2.1 for VCOM ID @2, M2.2 for VCOM ID @3, etc. Subscribers 1 and 2 have one consumed

VCOM configured. In each case it is the second VCOM element in the configuration list. The promptness time-out is non-zero so the stale indication bit is in M2.1.

5.5 Example ladder program

The ladder program below shows how the FIPCFG special function can be used to create a FIP network configuration for any of the examples in sections 5.3 and 5.4. If any of the configuration data in the P-Tables is changed then the FIP network configuration should be modified by performing a HALT to RUN transition.



6. Maintenance and fault finding

6.1 Faults

Faults detected by the system are represented by a three digit error code and an English language text message. This information is displayed when a suitable programming tool is connected. For example :

#970 FIP network initialisation failure.

The errors fall into two groups as shown in Table 6-1.

Table 6-1 Error message types

Error message number	Type of error message
#500 to #699	System status errors
#900 to #999	System errors

6.1.1 System status at power up (#500 to #699)

If during the power-up self-test cycle, one of these fault conditions is detected, the controller will remain in the HALT condition and return the fault message until the fault is cleared. Unless otherwise stated in Table 6-2, if one of these errors occurs, power cycle the controller. If the problem persists it should be reported to your local ALSTOM representative.

Table 6-2 System status error messages

Code	Fault message	Possible causes	Recommended recovery
#643	FIP generated warning no. %x	Internal error	Power cycle and report warning value to Customer Support
#644	FIP Compliance error, invalid value at P%d	Incorrect value entered in table P120. (P94 for GEM80-500)	Correct the value, recompile and power cycle

If the value in table P120 (P94 for GEM80-500) is invalid at power up, the controller will display error #644 and enter the halted state. If the controller is run and the FIPCFG special function executed with an invalid value in P120 (P94 for GEM80-500), then the Q output will be @8F00. The value in P120 (P94 for GEM80-500)must be corrected and the controller power cycled.

6.1.2 System errors (error messages #900 to #999)

These errors relate to internal maloperation of the executive software. They cannot be cleared with a HALT to RUN transition. It may be possible to clear the fault be power

cycling the controller, but if the fault persists it should be reported to your local ALSTOM representative. Table 6-3 details the system errors.

Table 6-3 System errors error messages

Code	Fault message
#970	FIP error during initialisation %d
#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

6.2 Special function fault diagnosis

The special function Q output reports errors during FIP network re-configuration. Table 6-4 (page 6-2) and Table 6-5 (page 6-4) show Q output errors with the corresponding type of configuration data that Table-F4 is pointing at. Table 6-4 is for protocol ID 0 and Table 6-5 is for protocol ID 1. In each case the exact nature of the fault is described and solutions recommended to clear the fault. Note that if Q output error number 7 (FIP error) occurs then the controller should be power cycled. If the fault persists it should be reported to your local ALSTOM representative.

Table 6-4 Errors, causes and solutions (protocol ID 0)

Q error no (bits 11-8)	Q output (bits 7-0)	Table pointed to by F4	Reason for fault	Recommended solution
@E	0	0	Controller is not fitted with FIP hardware components	Contact Customer Support
@F	0	0	FIP compliance standard in table P120 (P94 for GEM80-500) is invalid or has been changed	Set to a valid value and power cycle the controller
@6	0	0	Table specified for start of configuration list does not exist	Choose an existing range of tables for Zm value location and re-configure
@1	0	First word in parameter list header	Unsupported protocol specified	Choose protocol ID 0 or 1
@2	0	No. of config elements word in parameter list header	No of config elements not allowed	Choose value in range 0-129
@6	Configuration element no 1-129	No. of config elements word in parameter list	Not enough data tables available for the expected configuration	Ensure enough tables exist for the number of specified configuration

Q error no (bits 11-8)	Q output (bits 7-0)	Table pointed to by F4	Reason for fault	Recommended solution
		header	list	elements
@6	Configuration element no 1-129	First word of a VCOM configuration element	Specified data table does not exist	Select another data table or ensure data tables exist in ladder program
@3	Configuration element no 1-129	First word of a VCOM configuration element	Cannot consume data into specified data tables; read-only	Select writable data tables
@6	Configuration element no 1-129	Second word of a VCOM configuration element	Not enough data tables available for requested mapping	Increase number of tables or select a lower start table offset
@4	Configuration element no 1-129	Third word of a VCOM configuration element	First/last VCOM ID out of range or last VCOM ID is smaller than the first	Ensure first VCOM ID is in range 1-128 and last is either 0 or in range 1-128 and larger than the first
@2	Configuration element no 1-129	Third word of a VCOM configuration element	VCOM ID or one or more of the VCOM IDs in a range has already been defined	Select a unique ID/ range of IDs for each mapping
@6	Configuration element no 1-129	First word of a status configuration element	Specified data table does not exist	Select another data table or ensure data tables exist in ladder program
@3	Configuration element no 1-129	First word of a status configuration element	Cannot copy statistics to specified data tables; read-only	Select writable data tables
@6	Configuration element no 1-129	Second word of a status configuration element	Not enough data tables available for requested mapping	Increase number of tables or select a lower start table offset
@5	Configuration element no 1-129	Third word of a status configuration element	Number of tables of statistics to copy is too large	Select a number in range 0-35
@2	Configuration element no 1-129	First word of a configuration element	Cannot understand type of configuration element	Select type “P”, “C” or “S”

Table 6-5 Errors, causes and solutions (protocol ID 1)

Q error no (bits 11-8)	Q output (bits 7-0)	Table pointed to by F4	Reason for fault	Recommended solution
@E	0	0	Controller is not fitted with FIP hardware components	Contact Customer Support
@F	0	0	FIP compliance standard in table P120 (P94 for GEM80-500) is invalid or has been changed	Set to a valid value and power cycle the controller
@6	0	0	Table specified for start of configuration list does not exist	Choose an existing range of tables for Zm value location and re-configure
@1	0	First word in parameter list header	Unsupported protocol specified	Choose protocol ID 0 or 1
@2	0	No. of config elements word in parameter list header	No of config elements not allowed	Choose value in range 0-145
@2	0	Second word in parameter list header	BA not inhibited but there is no BA macro cycle definition	Either inhibit BA or define a BA macro cycle
@2	0	Third word of a VCOM configuration element	VCOM ID has already been defined	Select a VCOM ID which has not already been defined
@6	Configuration element no 1-145	No. of config elements word in parameter list header	Not enough data tables available for the expected configuration list	Ensure enough tables exist for the number of specified configuration elements
@6	Configuration element no 1-145	First word of a VCOM configuration element	Specified data table does not exist	Select another data table or ensure data tables exist in ladder program
@3	Configuration element no 1-145	First word of a VCOM configuration element	Cannot consume data into specified data tables; read-only	Select writable data tables
@6	Configuration element no 1-145	Second word of a VCOM configuration element	Not enough data tables available for requested mapping	Increase number of tables or select a lower start table offset
@4	Configuration element no 1-145	Third word of a VCOM configuration element	Reserved VCOM ID has been specified	Select a VCOM ID not specified in Table 4-20
@C	Configuration element no 1-145	Fourth word of a VCOM configuration element	VCOM length out of range	Select one in range 1-125 if refreshment/ promptness non zero else select a value in range 1-126
@8	Configuration element no 1-145	Fifth word of a VCOM configuration element	Refreshment/promptness time-out value out of range	Select a value in range 0-2000
@6	Configuration element no 1-145	First word of a status configuration element	Specified data table does not exist	Select another data table or ensure data tables exist in ladder program

Q error no (bits 11-8)	Q output (bits 7-0)	Table pointed to by F4	Reason for fault	Recommended solution
@3	Configuration element no 1-145	First word of a status configuration element	Cannot copy statistics to specified data tables; read-only	Select writable data tables
@6	Configuration element no 1-145	Second word of a status configuration element	Not enough data tables available for requested mapping	Increase number of tables or select a lower start table offset
@5	Configuration element no 1-145	Third word of a status configuration element	Number of tables of statistics to copy is too large	Select a number in range 0-47
@D	Configuration element no 1-145	First word of a BA list configuration element	List number out of range	Select a value in range 1-15
@2	Configuration element no 1-145	Second word of a BA list configuration element	Periodic window type non-zero or number of VCOM IDs out of range	Periodic window type must be 0 and number of VCOM IDs must be in range 1-16
@2	Configuration element no 1-145	First word of macro cycle configuration element	Number of instructions out of range	Select a value in range 1-50
@D	Configuration element no 1-145	Parameter for SEND_LIST instruction in BA macro cycle	BA list number out of range	Select a value in range 1-15
@2	Configuration element no 1-145	SEND_LIST instruction in macro cycle	More than 20 SEND_LIST instructions in macro cycle	Ensure that no more than 20 SEND_LIST instructions are defined in the macro cycle
@2	Configuration element no 1-145	Parameter for SEND_LIST instruction in macro cycle	BA list number not defined	Ensure BA list is defined before referencing in a SEND_LIST instruction
@B	Configuration element no 1-145	Parameter for BA_WAIT instruction in macro cycle	Time limit out of range	Select a value in range 0-500
@9	Configuration element no 1-145	Parameter for SEND_APER instruction in macro cycle	Time limit out of range	Select a value in range 0-500
@A	Configuration element no 1-145	Parameter for SEND_MSG instruction in macro cycle	Time limit out of range	Select a value in range 0-500
@2	Configuration element no 1-145	Instruction in macro cycle	Cannot understand type of instruction	Select type “L”, “A”, “M” or “W”
@2	Configuration element no 1-145	First word of a configuration element	Cannot understand type of configuration element	Select type “P”, “C”, “S”, “L” or “B”

Table 6-6 describes the F-tables used to report FIP failures.

Table 6-6 FIP F-table usage

F-table	Description	
F3	Run-time fault flags	
	Bits 15-1	Bit 0
	Reserved	ON = Unable to read from or write to data tables mapped to VCOMs and/or FIP statistics
F4	Protocol ID 0 : Extra fault information following execution of FIPCFG special function (see Table 6-4). Not used for reporting run-time faults. Protocol ID 1 : Extra fault information following execution of FIPCFG special function (see Table 6-5). If a run-time fault occurs, this table contains the data table number of the start of the configuration element with which the fault is associated.	

6.3 Run-time failures

6.3.1 Stale data indications

For protocol ID 0, consumed data which has not been received from the FIP network within the previous 500ms will be produce a promptness time-out reflected in the stale data indication bits in the communication statistics. If data has not produced on the network within the previous 500ms a refreshment time-out occurs. This will also be reflected in the stale data indication bits by consumers of that data.

The stale data indications will also work in the same manner for protocol ID 1 provided that you configure non-zero refreshment/promptness time-out values.

6.3.2 Loss of data tables

Some or all of the data tables to which VCOMs are mapped may become non-existent, e.g. a running re-compile with tables no longer referenced. In these circumstances table F3 bit 0 will be set.

When using protocol ID 0, if the data tables reporting communication statistics are still available, then bits 7-0 of the first table of statistics indicate the VCOM ID for which data tables have been lost. This problem may exist for more than one VCOM, but only the ID of the first such VCOM encountered will be reported. If the data tables reporting statistics are not available, then this will also cause F3.0 to be set. Table F4 is not used for reporting run-time faults for protocol ID 0.

Under protocol ID 1 the same type of problem is indicated by F3.0. Table F4 reports a table number in the configuration list which will contain the VCOM ID for which some or all of the data tables are non-existent. If F4 is zero and F3.0 is set, then the data tables to which statistics are mapped are not available.

6.3.3 Media integrity

A medium is indicated as healthy by a GEM80 controller provided that it can detect at least one other network subscriber apart from itself on the same medium and the number of frames received with errors per second on that medium is less than 10.

Media integrity bit reaction time is governed by the operation of the BA and it may take several seconds before being updated. Provided that at least one of the two media are healthy, data will continue to be transferred on the FIP network. If both media are not healthy then data transfer may cease. In this case the stale data indication bits can be used to detect a loss of data transfer before the media integrity bits are updated.

6.3.4 BA status

The BA status is reported in the second word of the communication statistics. A GEM80 controller that is allowed to be an active BA will become the active BA provided that there is not already an active BA on the same network. When two or more subscribers attempt to become active bus arbiters at the same time, a BA election procedure takes place. During this procedure, these subscribers will wait for a length of time determined by the subscriber address before attempting to transmit again. The subscriber with the lowest address will be the first to start transmitting. Once a BA is active on a subscriber, the other subscribers will be on 'stand-by' should the active BA fail.

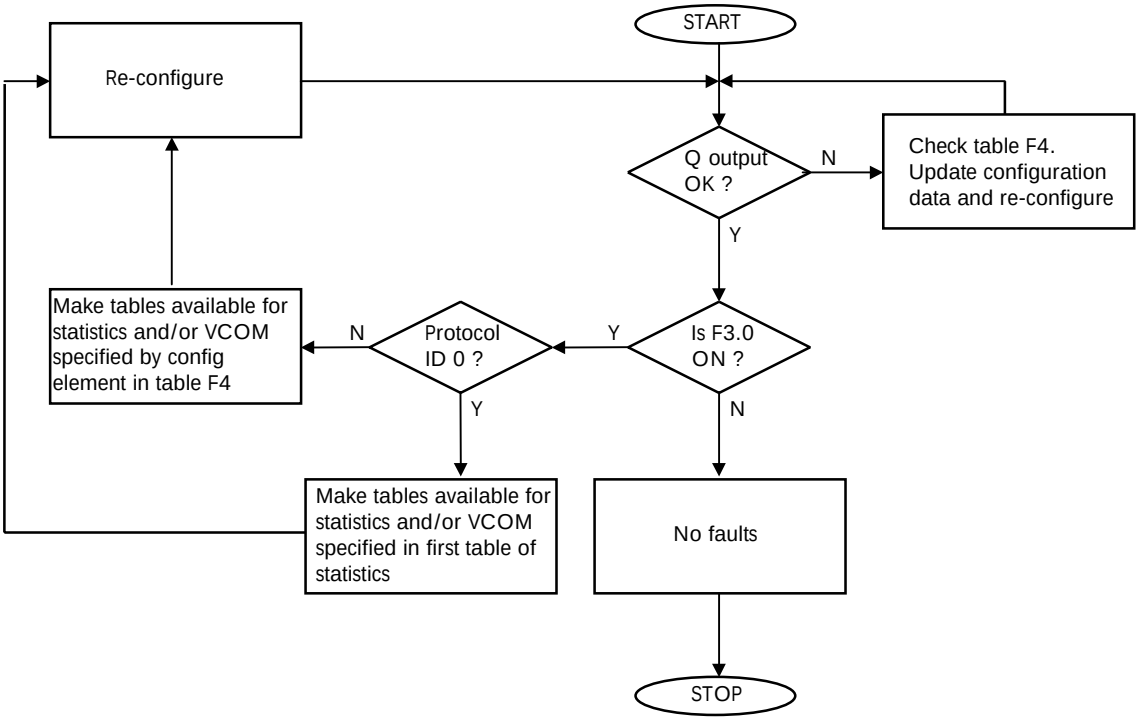
If the number of frames received with error per second on any medium is greater than 10 in four successive seconds, then the BA will stop transmitting. The BA election procedure will then be started.

Note that the communication statistics which indicate the number of transactions performed without error on a medium may be different on individual subscribers. If no errors are indicated in the statistics and data is not indicated as stale then the FIP network is operating correctly.

6.4 Fault diagnosis summary

The flowchart in Figure 6-1 can be used to decide what course of action to take in the event of FIP related failures.

Figure 6-1 Fault diagnosis flowchart



6.5 Self-test system

The GEM80 controller performs a full cycle of tests at power up including a RAM test on the private memory used for the local communication database.

'On-line' tests are performed at regular intervals during normal running. In addition to the two controller watchdogs a separate watchdog is provided to prevent transmission on the FIP network should the controller fail due to failure of processor circuitry.

7. Spares and re-order information

7.1 Spares

The interface does not contain any user replaceable parts and must be returned to the manufacturer for repair.

The executive firmware can be upgraded by the user if necessary.

Please contact your local ALSTOM representative for details.

7.2 Re-order information

Table 7-1 Re-order codes

Description	Order code	Comment
WorldFIP Fieldbus Enhancement module for GEM80-400 VME	4475-4001	FIP sub-module
GEM80-400 Standard Processor with WorldFIP Fieldbus Interface	8239-4018	
GEM80-400 Enhanced Processor with WorldFIP Fieldbus Interface	8239-4018	
WorldFIP Fieldbus Enhancement module for GEM80-500	9715-4020	FIP sub-module
Advanced GEM80 Programmer	GEM80-AGP-ST-P GEM80-AGP-ST-U GEM80-AGP-PF-P GEM80-AGP-PF-U	A programming package for the Microsoft™ Windows™ 98/NT/2000 environment.
AC earth module	8892-4300	

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8. Configuration summary

8.1 Protocol ID 0

Table 8-1 P-tables reserved for FIP

GEM80-400 P-Table	GEM80-500 P-Table	Description	Range
P120	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.
P121	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)
P122	P96	Byte ordering	0 = No byte swapping 1 = Bytes of each complete word are swapped on transfer to/from GEM80 data tables

Table 8-2 Parameter list header

Reserved for future use	Protocol ID = 0
Interface control word (Bit 0 = 1 to inhibit the BA)	
Number of configuration elements (0-129)	

Table 8-3 Data table to VCOM mapping

"P" or "C" (@50 or @43)	Table letter "A" - "W" (@41 - @57)
Start table offset (0-32000)	
Last VCOM ID (1-128) or 0 for single VCOM ID	First VCOM ID (1-128)

Table 8-4 Status mapping

"S" (@53)	Table letter "A" - "W" (@41 - @57)
Start table offset (0-32000)	
Number of FIP communication statistic tables to copy to data tables (0-35)	

Table 8-5 FIP communication statistics

Table offset	Description
0	FIP interface fault bits
1	Media integrity bits
2-9	Stale data indication bits
10-17	VCOM configured bits
18-34	FIP communication network statistics

8.2 Protocol ID 1

Table 8-6 P-tables reserved for FIP

GEM80-400 P-Table	GEM80-500 P-Table	Description	Range
P120	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.
P121	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)
P122	P96	Byte ordering	0 = No byte swapping 1 = Bytes of each complete word are swapped on transfer to/from GEM80 data tables

Table 8-7 Parameter list header

Reserved for future use	Protocol ID = 1
Max. address for subscriber presence detection	FIP interface control byte (Bit 0 = 1 inhibit BA)
Reserved for future use	
Reserved for future use	
Number of configuration elements (0-145)	

Table 8-8 Data table to VCOM mapping

“P” or “C” (@50 or @43)	Table letter “A” - “W” (@41 - @57)
Start table offset (0-32000)	
VCOM ID (@0-@FFFF)	
Reserved for future use	VCOM length (1-125 or 1-126)
Refreshment/promptness time-out (0-2000)	

Table 8-9 Status mapping

"S" (@53)	Table letter "A" - "W" (@41 - @57)
Start table offset	
Number of FIP communication statistic tables to copy to data tables (0-47)	
Reserved for future use	
Reserved for future use	

Table 8-10 BA List definition

"L" (@4C)	List number (1-15)
Periodic window type = 0	Number of VCOM IDs (1-16)
VCOM ID (@0-@FFFF)	
VCOM ID (@0-@FFFF)	
VCOM ID (@0-@FFFF)	
VCOM ID (@0-@FFFF)	
VCOM ID (@0-@FFFF)	
VCOM ID (@0-@FFFF)	
VCOM ID (@0-@FFFF)	
VCOM ID (@0-@FFFF)	
VCOM ID (@0-@FFFF)	
VCOM ID (@0-@FFFF)	
VCOM ID (@0-@FFFF)	
VCOM ID (@0-@FFFF)	
VCOM ID (@0-@FFFF)	
VCOM ID (@0-@FFFF)	
VCOM ID (@0-@FFFF)	
VCOM ID (@0-@FFFF)	

Table 8-11 BA macro cycle definition

"B" (@42)	Number of BA macro cycle instructions (n = 1-50)
Reserved for future use	Instruction 1 "L", "W", "A" or "M" (@4C, @57, @41 or @4D)
Parameter for above instruction (list number 1-15 for "L" or time limit 0-500 for "W", "A" or "M")	
. . .	
Reserved for future use	Instruction n "L", "W", "A" or "M" (@4C, @57, @41 or @4D)
Parameter for above instruction (list number 1-15 for "L" or time limit 0-500 for "W", "A" or "M")	

Table 8-12 FIP communication statistics

Table offset	Description
0	FIP interface fault bits
1	Media integrity bits
2-9	Stale data indication bits
10-14	FIP communication network statistics
15-30	Medium A presence detection bits
31-46	Medium B presence detection bits

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