GEM80-131 Series Controllers

Technical Manual

ALSTOM

GEM80/131 Series

Technical Manual

Publication No. T478

CEGELEC INDUSTRIAL CONTROLS Ltd, Kidsgrove, Stoke-on-Trent, Staffordshire, ST7 1TW, England.
Telephone Stoke-on-Trent (0782) 783511 Telex 36293
Facsimile (Group 3) 0782 776329

T478 Issue 3 09.92

1. Compliance with Instructions in this manual

The purchaser should comply with the instructions and information in this manual and all personnel to be associated with the apparatus under this contract should be made familiar with the information contained herein. The user should note that the requirements of this Foreword apply only to the apparatus supplied for installation and use in the United Kingdom (U.K.) and which are therefore subject to the U.K. Health and Safety at Work Act, 1974 and Amendments of 1987, but provide prudent safety guidelines for users outside the U.K.

The user should note any local or national safety precautions that are to be taken.

The equipment has been designed to operate in an industrial environment, the details of which are given within this manual. Care must be observed that these conditions are maintained at all times and your attention is particularly drawn to the electromagnetic emission and susceptibility conditions, and the protection of the enclosure, which will be changed when covers are removed and enclosure doors are open.

2. Guidance Notes for Users on the Safety of Personnel using Electrical Apparatus.

The above Act stipulates that electrical apparatus shall be designed, tested and installed to be safe and without risk to health when properly used and that information is provided on the conditions necessary for safety and on any hazards which could arise during normal use and how these are to be avoided...See Section 6 of HSAWA.

The above Act stipulates that the User, on his part, shall ensure that his employees are informed, trained and supervised and use proper working procedures to ensure their safety. He is advised to comply with the information provided in order to maintain the plant in a safe condition...See Section 2 of HSAWA.

Compliance with these two basic requirements ensures that under normal healthy plant operating conditions, the apparatus will be safe for use by electrically unskilled operators.

With certain categories of apparatus as identified later in this Section, safety hazards may arise when it is necessary to gain access by opening enclosures, removing covers, etc., in order to carry out maintenance work, testing, setting-up, etc. This is especially the case when the apparatus cannot be completely isolated before working on it, as, for example, where circuits must be energised for the purpose of carrying out electrical tests.

As it is often impracticable or impossible to achieve hazard free conditions when working with energised circuits, the main burden of responsibility for the safe conduct of those carrying out the work rests on those under whose authority they act...See Section 2 of HSAWA.

3. Installation, Operation and Maintenance.

The Purchaser is advised to ensure that the apparatus supplied by the Company to the purchaser's order is correctly installed, in a suitable location, by technically qualified and competent persons experienced in the class of work involved.

The rules for ensuring the safety of personnel can be summarised under the following headings.

3.1 During Normal Use

Ensure that the plant operators:-

Are fully conversant with all controls, particularly those for emergency shut down.

Comply with safety warning notices and keep all enclosures shut.

Are trained to recognise signs of maloperation and know what action to take in the event of trouble or difficulty.

3.2 During Maintenance and Testing or Other Work involving Electrical Competence.

Ensure that only suitably skilled persons are permitted to carry out work and that they:-

Isolate the apparatus completely, wherever possible, before opening enclosures and starting work.

Comply with safe working procedures.

Are conversant with the information provided, particularly on measures relating to their safety.

Recognise the hazards which can arise when working on energised apparatus and take all the necessary precautions.

4. Voltages greater than 650V.

The purchaser's attention is drawn to the Electricity Regulations (Factories Act 1961) Ref.18d, in relation to work done on any apparatus of nominal voltage greater than 650V.

5. Access to the apparatus described in this Manual.

The apparatus is allocated:-

GRADE REFERENCE : 3a (Cubicle Mounted) : 5 (Loose Items)

referring to the GRADE/TASK/SKILL GRADE Schedule of this Foreword.

Note

The grade reference applies only to that apparatus covered by this manual and not access to other products/apparatus which may be linked to it as part of a comprehensive installation.

Table (i) describes SKILL GRADES of the Jobs referred to in the GRADE/TASK SKILL SCHEDULE.

6. Apparatus supplied as loose items, chassis, etc.

The apparatus supplied has been designed in accordance with the relevant Standards to operate at its designed rating and under normal accepted good practice; however, where the apparatus is supplied as "loose items" and energised, it could constitute a safety hazard. Since the customer will be arranging for the mounting, wiring and assembly of the apparatus into a structure or enclosure, the ultimate responsibility to conform with the HSAWA will rest with the Customer or associated sub-contractor.

Table (i) Skill Grades

SKILL GRADE	JOB DESCRIPTIONS	
	Proposed by	
	Supplier	Customer
A	Operating and Maintenance Staff with NO Electrical Knowledge.	
B	Operating and Maintenance Staff (Electrical Fitter, Wireman) with some electrical knowledge: not permitted to work on live apparatus.	
C	Authorised and Competent Staff (Electrician, Commissioning Engineer) with high degree of expertise: Trained to work on live apparatus: Fully conversant with apparatus.	

GRADE/TASK/SKILL SCHEDULE FOR ELECTRICAL APPARATUS.

Table (ii) shows the operator skill grade required to carry out a specified task, on apparatus described in this manual.

Table (ii) Operator Skill Grade.

Ref.	APPARATUS GRADE	ISOLATION	NO POWER	REQUIRES POWER	
	Description	Carried out by	Setting, Cleaning, Adjusting, Routine Maintenance & Servicing	Setting, Adjusting, Routine Testing	Troubleshooting, Special Testing, Commissioning
1	Simple 100% isolation. Requires no electrical knowledge to isolate.	A, B, C	B, C	C	C
2	Simple 100% isolation. Requires some electrical knowledge to isolate.	B, C	B, C	C	C
3a 3b	100% isolation possible. Requires Expertise, Training, etc. and knowledge of the apparatus.	C C	B, C C	C C	C C
4	100% isolation not possible because:- Impracticable, Unreasonable, Undesirable	C	C	C	C
5	Apparatus supplied as loose items, chassis, etc., for which the customer is responsible for wiring, assembly, etc., (see Para.6).	Grade of skill cannot be defined by supplier.			

CONTENTS PAGE

CONTENTS

This page left intentionally blank

1.1 Manual Overview

This manual is intended for use by technical personnel and describes the operation, installation and maintenance of the GEM80/131 Controller.

The subjects covered by sections of this manual are detailed below.

1) Introduction

This section gives a description of the Controller. All the components are described and a typical system layout is given. Also included are handling, storage and environmental requirements and the Controller Specification.

2) Architecture and Program Operation

This section gives brief details of the internal architecture and operation of the controller. The ladder program instruction set and the use of data tables are also given.

3) Input/Output

This section describes the Basic I/O highway used in the controller, I/O module addressing techniques and the installation of I/O modules.

4) Serial Communications

Data communication from the GEM80/131 to other controllers and to printers is covered in this section. The built in communication methods (using the ESP protocol) are described; Point-to-Point and Multi-drop. Full details for configuring the communication ports are given. The CORONET Local Area Network is briefly described and communication with the GEMSTART CCU is explained.

5) Power Supplies

This section includes full details of the power supply used and describes the method for allocating power to the controller modules. Forms are provided for calculating the power consumption of the controller.

6) Installation

Instructions are given for installing the controller into equipment cubicles.

7) Commissioning

This section describes how the GEM80/131 is prepared for use.

8) Maintenance

Cleaning and inspection procedures are described together with lists of the Error Messages which are generated by the GEM80/131 Controller, and Fault table information.

9) Ordering Codes

This lists all the CEGELEC ordering codes for the controller, accessories and spares.

1.2 General Information

1.2.1 Overview

The GEM80/131 Controller is a microprocessor based programmable controller which is designed to control and monitor industrial processes and machinery. It can be programmed in situ with the aid of a GEM80 programming tool using GEM80 ladder diagram language. The controller communicates with external devices via a number of I/O modules and can be configured to suit a wide variety of applications.

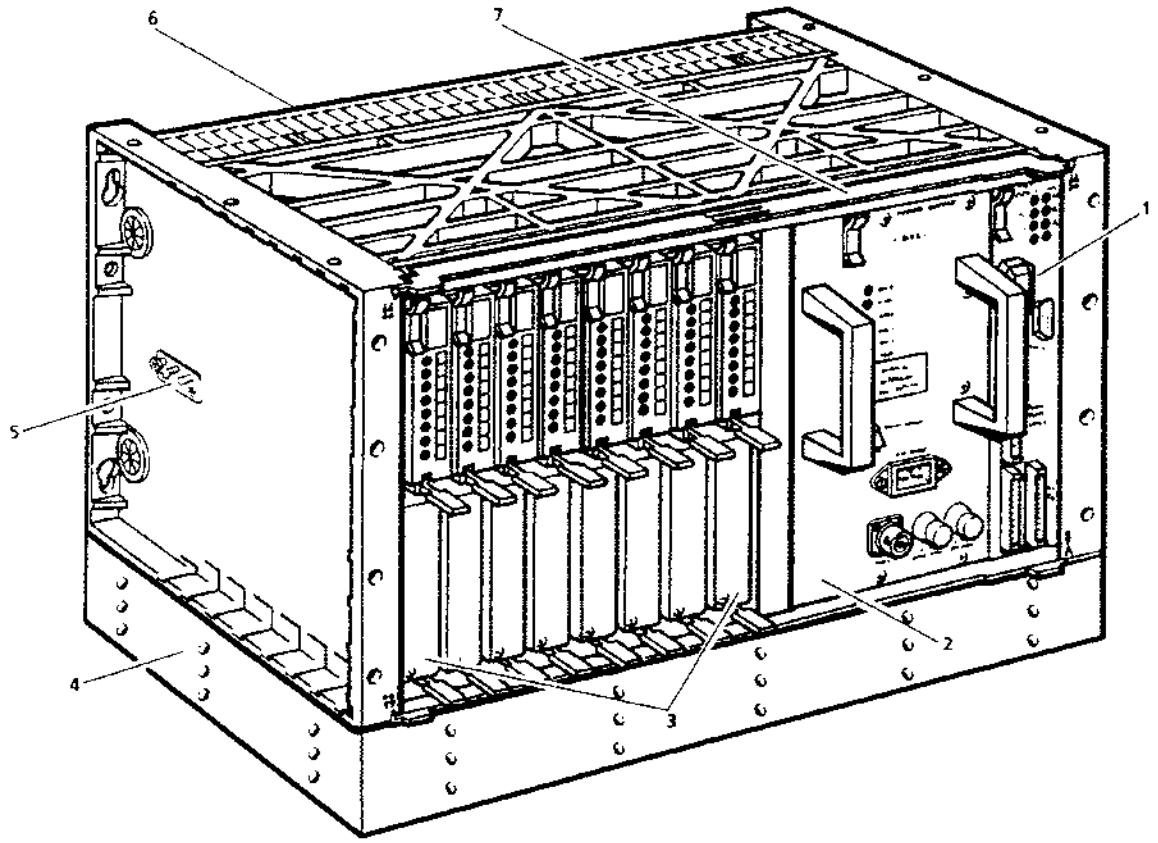
1.2.2 The GEM80/131 Controller

The GEM80/131 Controller comprises the GEM80/131 Processor Module, a Power Supply Unit, GEM80/131 19" Subrack and subrack spacer. The processor and power supply fit into the subrack which can also accommodate up to 8 GEM80 Compact I/O Modules. Extra I/O modules are accommodated in additional I/O subracks which are connected to the GEM80/131 processor through the GEM80 Basic I/O Highway.

The processor has 2 GEM80 serial communication ports which, with appropriate Serial Link Termination Units, may be used to connect to other GEM80 Controllers and a 20mA/RS232 programmer connection/printer port.

Figure 1.1 shows a GEM80/131 Controller fitted with optional I/O modules.

As a safety measure 'Watchdog' relays are fitted to the subrack's backplane. These relays are de-energised in the event of a controller (or user programmed plant) failure. Please refer to Section 5.4 for the recommended use of the watchdogs.



1. 8231 Processor Module
2. 9032 Power Supply Module
3. Basic I/O Modules (up to eight can be fitted)
4. Spacer
5. Earth Studs (fitted at both left and right ends)
6. Subrack
7. Module Retaining strip

Figure 1.1 - GEM80/131 Controller

1.2.3 Controller Description

The GEM80/131 Controller consists of an 8231 Processor module, a 9032 Power Supply Module and a backplane assembly housed in a 19-inch subrack. The Processor communicates with the system and plant components through the Basic I/O Highway and two GEM80 serial communications ports. A programmer/printer connection port is also provided.

The Controller is fully compatible with other controllers in the GEM80 range and utilises the same control language and Basic I/O structure.

(1) 131 Processor Module

The Processor Module handles all Basic I/O highway communication, serial communications and runs the user control program (holding both source and complied versions).

The Processor Module comprises the 80C186 microprocessor and its associated memory together with Serial Communication, Basic I/O and Programmer interfaces. The standard memory can be increased by adding a plug-in memory expansion board to the main system board. Four memory options are available depending on the system requirements. The memory is supported when the mains power supply is switched off by either battery backed RAM or EPROM versions of the processor module.

The front panel of the Processor Module carries the connectors for the Basic I/O Highway, 2 Serial Communications Ports and the Programmer Connection Port. The access cover for the memory support battery is also located on the front panel.

(2) Power Supply

The Power Supply module provides the power required for all of the modules contained in the Controller subrack including the I/O modules. A limited power capacity may be available for consumption elsewhere in the system, e.g. additional Basic I/O modules in an I/O subrack.

(3) Backplane

The Backplane assembly is a printed circuit board which carries connectors and the associated circuitry for the Processor Module and the Power Supply Module. The Basic I.O Highway is extended on to the backplane which is fitted with eight I/O Module connectors. The Backplane also carries addressing switches for the on-board I/O Modules and a terminal block for various external connections e.g. Watchdog circuits and auxiliary outputs from power supply.

The backplane is clip fitted into the Subrack.

(4) Basic I/O Highway

The Basic Input/Output Highway is a medium speed parallel digital highway used for transferring data between the Controller and Basic I.O modules or Operator Input Units. The Highway is connected between units by two 26-way ribbon cables which can be up to 30 metres in length although loading restrictions apply beyond 10 metres. Please refer to section 3 of this manual for further details.

(5) Serial Communication Links

Serial Links are used to communicate between the GEM80/131 Controller and other peripherals such as a printer, keyboard or other controllers. Several protocols are available including Extended Simple Protocol (ESP) and ESP with flexible data tables. The CORONET Local Area Network can also be used. Please refer to section 4 of this manual for further details.

(6) Printer/Programmer Connection Port

A Printer Programmer port is provided on the front of the Processor module. A System Programmer, Portable Programmer or a Programmer Emulator can load, dump or edit ladder programs via this connection or a printer can be connected directly to the controller. Please refer to section 4 of this manual for further details.

(7) Watchdog Contacts

Watchdog contacts provide a means of shutting down the Controller and any I/O subracks and hence shutting down the plant in the event of a serious problem in either the plant or the Controller. Please refer to section 5 of this manual for details on how the watchdog contacts should be used.

(8) Additional Facilities

(i) On-line programme changes

(ii) Remote programming from serial links

(iii) Large range of built-in pre-written software routines

(iv) Built in text editor

(v) Plug-in RAM boards for memory extension

(vi) Plug-in FLASH EPROM modules for memory expansion without battery

1.3 Controller Hardware Layout

The hardware layout of a GEM80/131 Controller is shown in Figure 1.1.

(1) Subrack Assembly

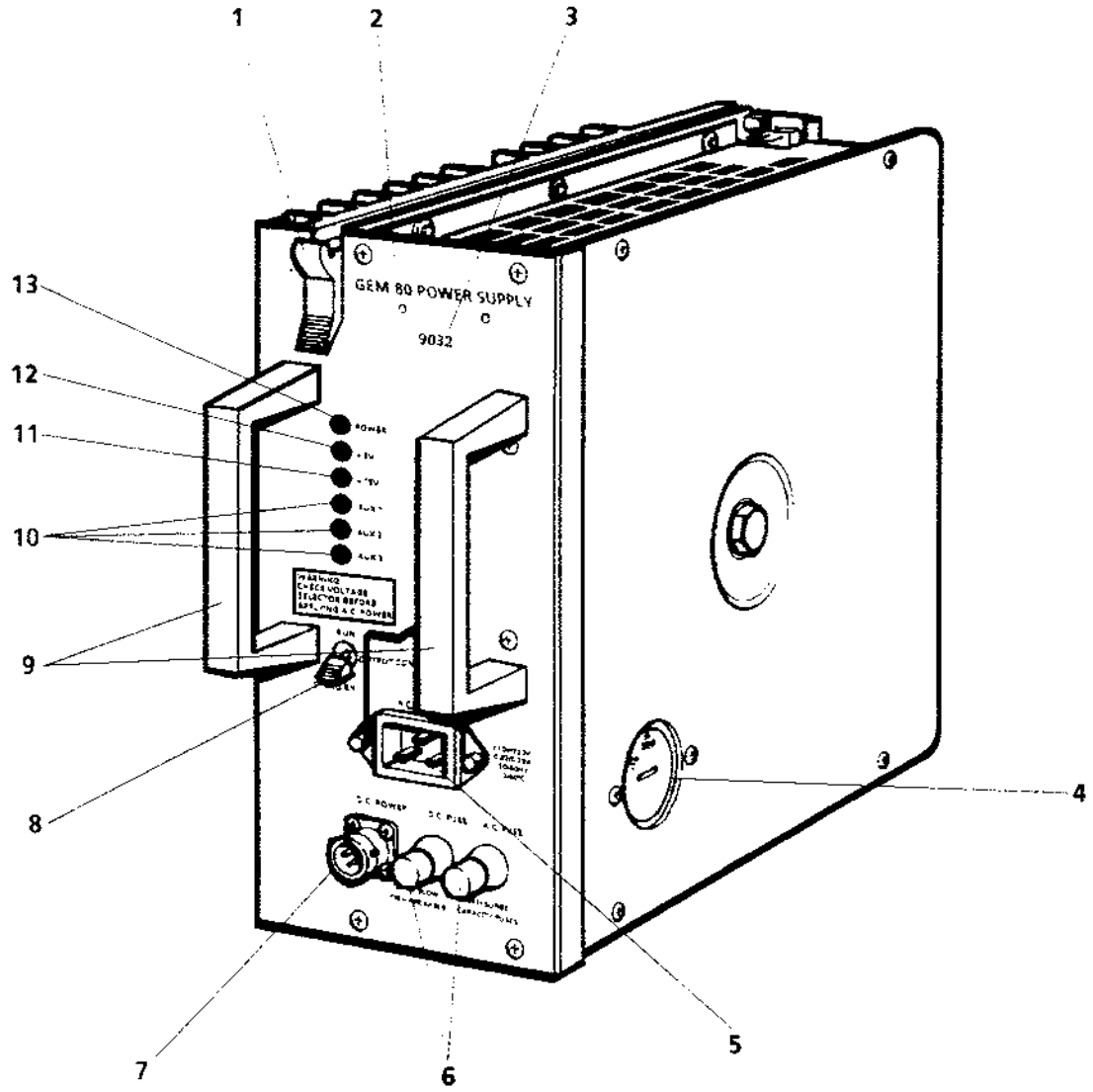
The Subrack is manufactured from flame retardant polycarbonate resin material with flame resistance to UL94-V0. It may be delivered either in 'flat pack' form for self-assembly by the customer or fully assembled. The subrack is constructed from 'clip together' mouldings and incorporates integral clips to secure the Backplane. Integral guides provide a number of slots for module insertion and a slot selection strip ensures that only the slots relevant to the application are used. Unused slots have single or double blanking panels fitted, as appropriate. See Section 9 of this manual for ordering codes.

The subrack is fitted with two locking 'bolts' to retain the modules in position in high shock or vibration applications.

The subrack may be either front or rear mounted - details are given in Section 6 of this Manual.

(2) 9032 Power Supply Module

The 9032 Power Supply module is illustrated in Figure 1.2. The specification for the Power Supply Module is contained in Section 5 of this Manual.

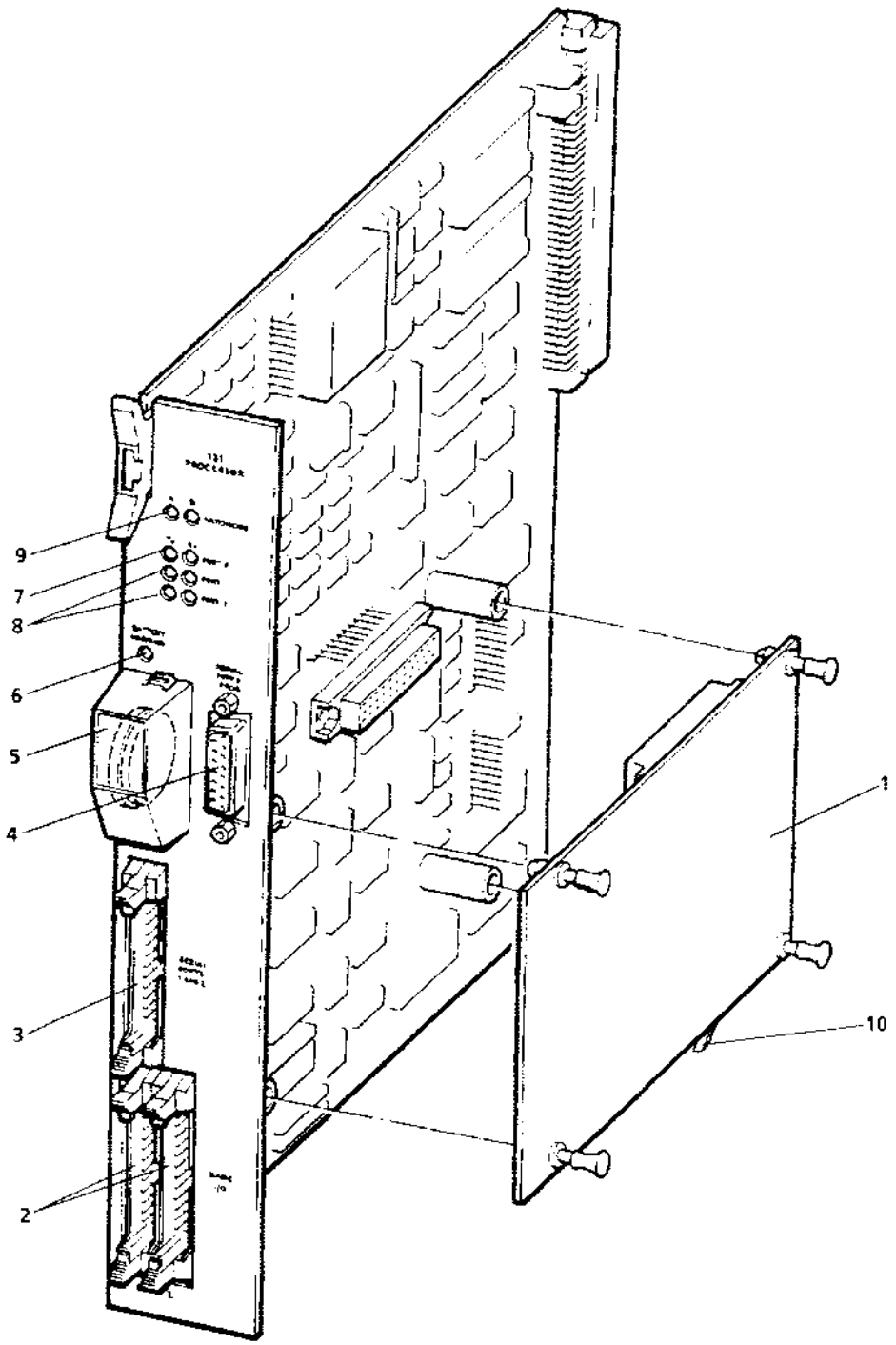


1. Ejector Handle
2. Module Function Label
3. Ordering Code Module Type Number
4. AC voltage selection switch
5. AC power input socket
6. Anti-surge fuses
7. DC power input socket
8. Output Control Switch
9. Lifting Handles
10. Not used
11. +15V LED (on for supply available)
12. +5V LED (on for supply available)
13. Power Input LED (on for power available)

Figure 1.2 - 9032 Power Supply Module - 110V to 240V A.C or 48V D.C.

(2) 8231 Processor Module

The 8231 Processor Module is shown in Fig 1.3. Details of the Processor Module can be found in Section 2.



1. Optional Memory Expansion Board
2. Basic I/O Ribbon Connectors
3. Serial Port Connector
4. Programming/Printer Port
5. Battery Cover
6. Battery Low Warning LED
7. Programmer Port Transmit/Receive LEDs
8. Port 1 and 2 Transmit/Receive LEDs
9. Watchdog Relay Indicator LEDs
10. Program/Protect switch on EPROM boards only

Figure 1.3 - 8231 Processor Module

(3) Basic I/O Modules

These modules provide interfaces for analog or digital signals passing to and from the Plant to the Controller. They provide a high noise immunity by using opto-isolators for each plant signal. These modules are not documented in this manual, detailed information on the complete range of Basic I/O modules is contained in the respective User Information Sheets.

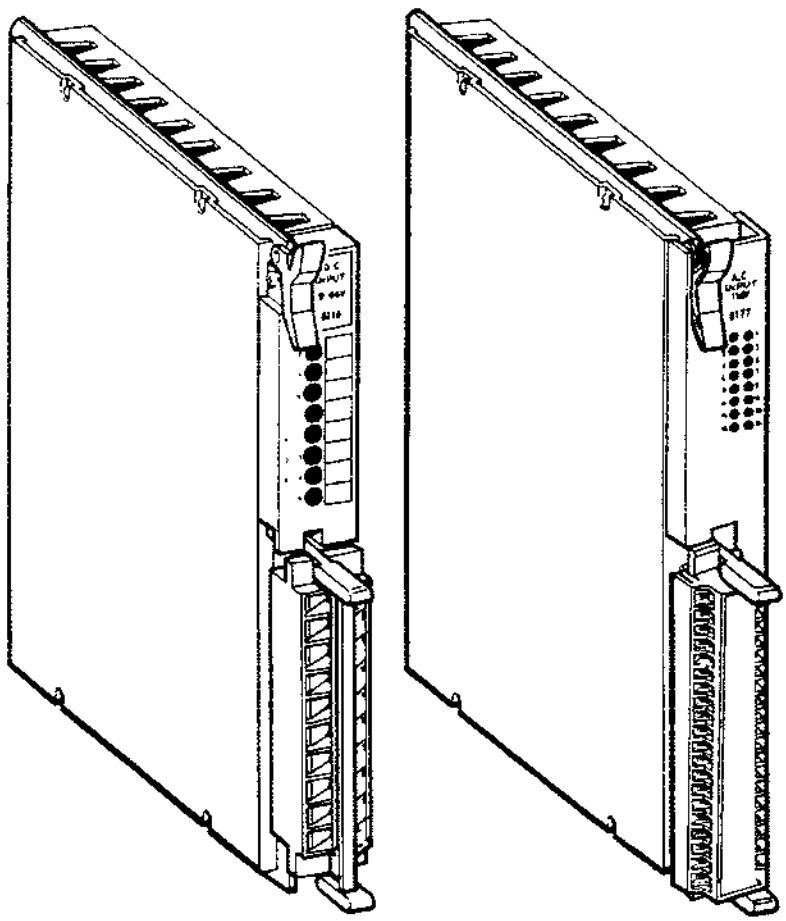
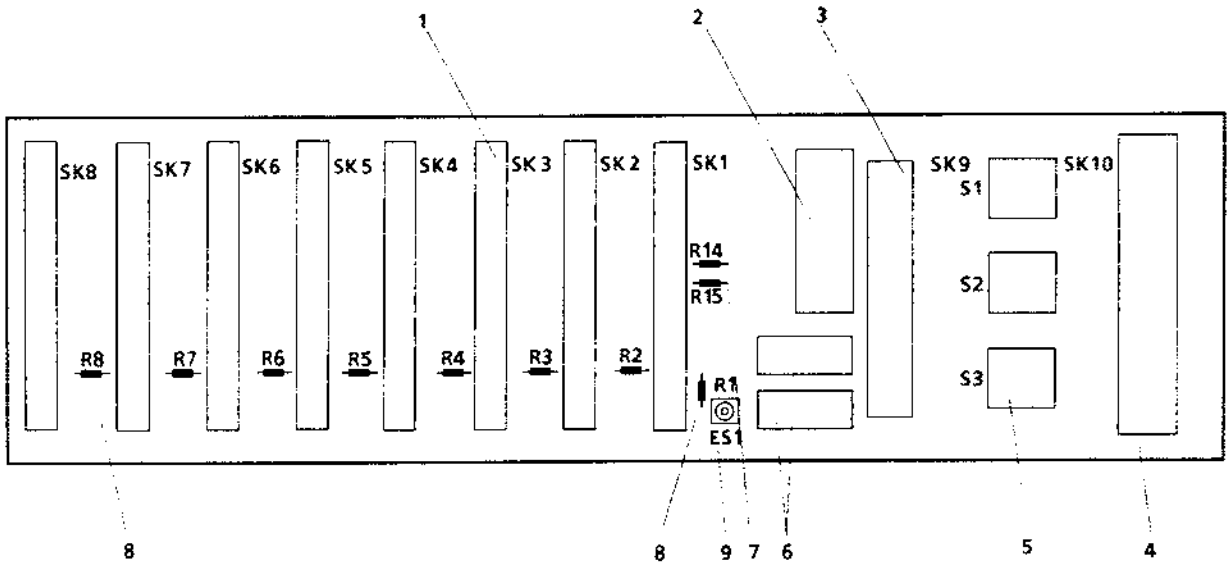
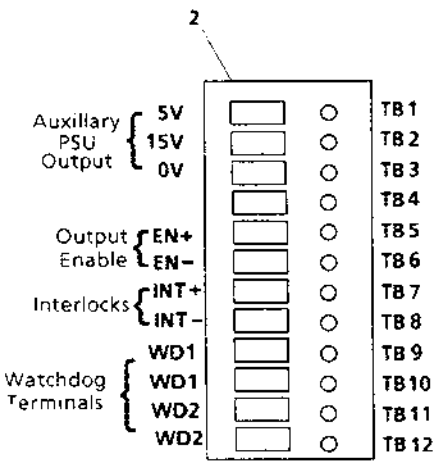


Figure 1.4 - Basic I/O Modules

(4) Backplane

The GEM80/131 Controller Subrack is fitted with a single backplane PCB which carries connectors for the Processor Module, Power Supply and eight I/O Modules. Figure 1.5 shows the GEM80/131 backplane.





1. Connectors for I/O Modules (SK1 - SK8)
2. Terminal Block (see detail)
3. Connector for 9032 PSU (SK9)
4. Connector for 131 Processor Module (SK 10)
5. I/O Address Setting Switches (S1,S2 and S3)
6. Watchdog Relays (RL1 and RL2)
7. Output Enable Resistors (R14 and R15)
8. Module Interlock Resistors (R1 to R8)
9. Earth Stud (ES1)

Figure 1.5 -GEM80/131 Backplane

1.4 System Layout

1.4.1 Typical System

A typical GEM80/131 control system is shown in Fig 1.6.

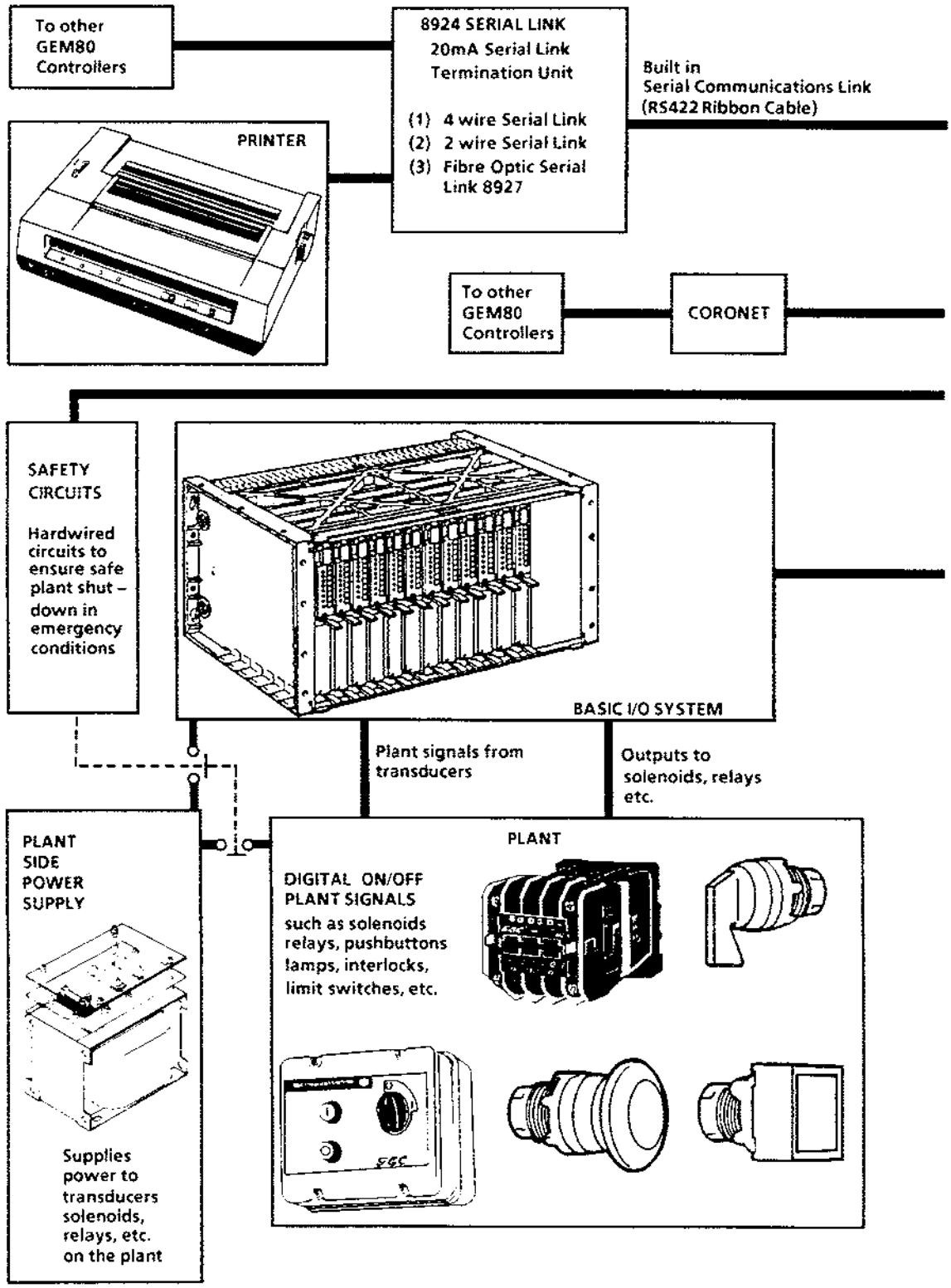


Figure 1.6 - Typical GEM80/131 System Layout

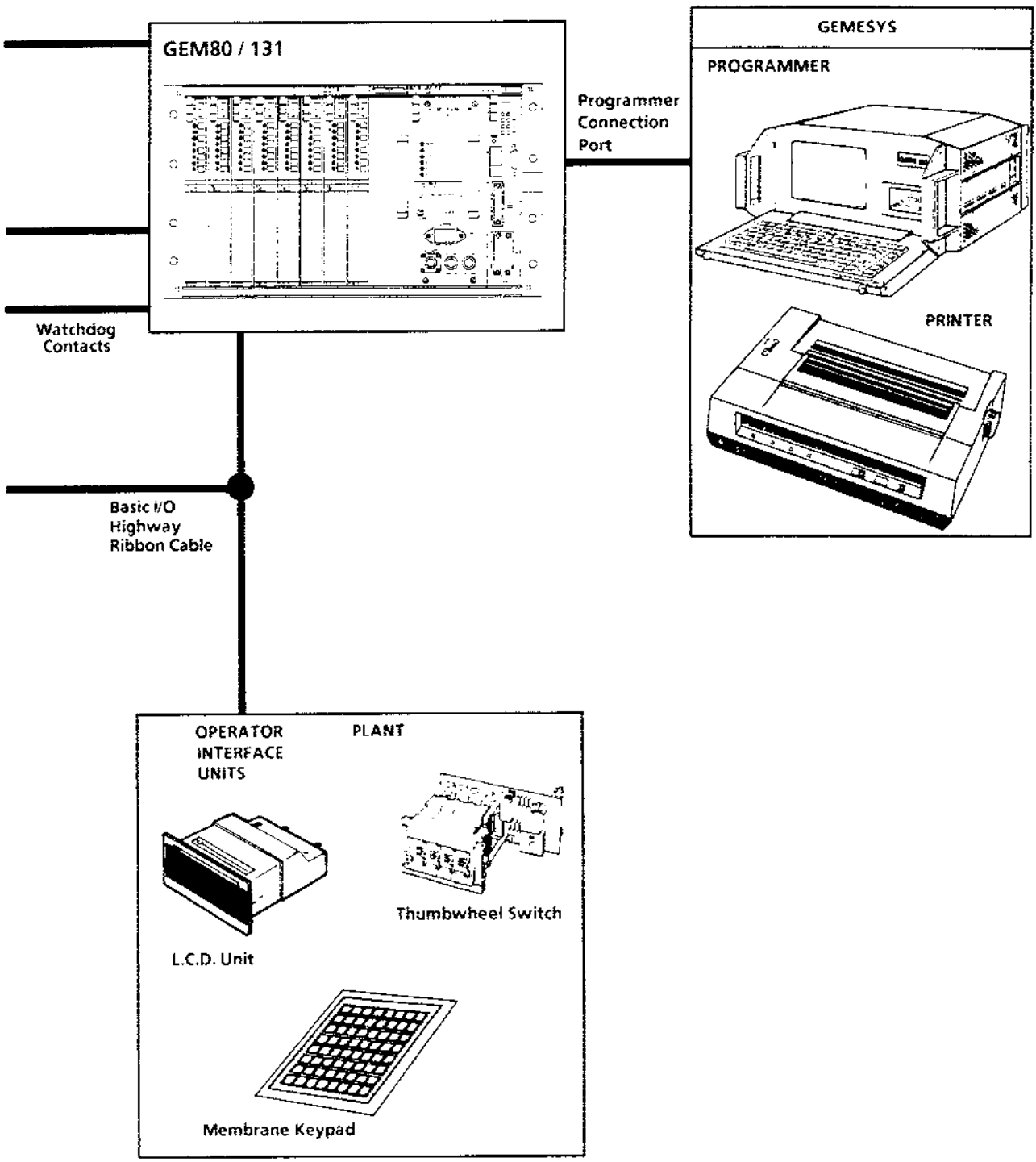


Figure 1.6 - Typical GEM80/131 System Layout (Cont.)

1.5 Site Requisites

1.5.1 Environment

The environmental requirements for GEM80 equipment are as follows:-

(1)	Temperature	:	0 to 60 °C operating
		:	-20 to 70 °C storage
(2)	Humidity	:	5% to 95% RH non-condensing

Note... Particular items may need de-rating, refer to Product Data Sheets for actual figures.

Do not use GEM80 equipment in corrosive atmospheres (e.g. Benzene, acid fumes, etc.) without special precautions being taken.

In dusty atmospheres great care must be taken to prevent dust from penetrating the GEM80 modules.

Rapid changes in temperature should be avoided as this may cause condensation on GEM80 equipment in areas of high humidity.

1.5.2 Power Supply

The Controller uses a single phase a.c. supply, nominally 110V or 220/240V, 50 or 60Hz or 22-85Vdc. (Section 5 gives full details).

If any doubt exists regarding the suitability of the supply, a line conditioner (ferro-resonant CVT) should be fitted in the feed to the Controller. (GEM80 Power Supply Requirements User Information leaflet T428 gives details).

1.5.3 Receipt of GEM80

When the equipment arrives on site it should be carefully unpacked and inspected for any sign of damage. The modules contain electrostatic sensitive devices (ESSDs) and the handling precautions in Section 1.7 must be observed.

The complete consignment should be checked against the delivery note for any loss or damage in transit. If any damage has occurred, or any parts are missing, contact CEGELEC Industrial Controls Limited, Kidsgrove, immediately and give the following details:-

(1) List of damaged or missing items.
(2) Description of any damage.
(3) Package numbers.
(4) Delivery/Advice Note numbers, dates and any other reference numbers such as order and item numbers.

Note... Failure to inform CEGELEC Industrial Controls Limited, Kidsgrove of damage to goods or shortages within three days from receipt of equipment will be held to free CEGELEC Industrial Controls Limited from liability.

1.5.4 Storing GEM80/131 Before Installation

Equipment which is not required for immediate installation should be stored in a clean, dry, atmosphere at a reasonably constant temperature (-20°C to +70°C). To minimise the ingress of fine dust, the equipment should be covered with a suitable canvas, tarpaulin or heavy duty polythene sheet. Any loose equipment should be kept in the original packing, which should be resealed after the delivery inspection.

The GEM80/131 Controller contains electrolytic capacitors which degrade if the system is not powered up. If the equipment is to be stored for more than nine months, it is essential that units with electrolytic capacitors (Controllers, Power Supplies and some Compact I/O modules) are powered up every 9 months.

The battery may be left connected to the Processor Module but the J-link LK1, situated on the p.c.b. close to the battery holder, must be set to position 'B' to avoid unnecessary discharge during storage (see Section 8 Figure 8.1).

1.6 Safety Information

1.6.1 Earthing

The equipment must be properly earthed in accordance the instructions in Section 5.

1.6.2 High Voltages

Dangerous voltages arising from the mains supply and feed back from the plant wiring may be present within the Controller.

1.6.3 Power Down Before Removing Modules or Connectors

To allow safe access, the GEM80 power and, (where applicable) plant-side power should be switched off before any module is withdrawn or replaced.

1.6.4 Power Down Safety Procedure

When maintaining or working on plant controlled by the GEM80 Controller, the Controller and the plant-side power supplies should be 'locked off' using a padlock, or similar mechanical locking mechanism, to prevent the system being inadvertently powered up. The Output Control or ON/OFF switch on the Power Module must NOT be relied on to immobilize the Controller.

1.6.5 On-line Programming

Controllers which are executing the control program from battery backed RAM accept on-line program changes, but the Controller will freeze all outputs and ignore all inputs for approximately 0.5s per 1000 instructions. Where the user has decided to execute the control program from EPROM, on-line programming changes will not be permitted.

Note...the Controller cannot tell whether the program change is safe and simply carries out the instructions given.

1.6.6 Testing a GEM80 System

In test modes GEM80 output signals must be disconnected or in some way de-activated to prevent accidental mobilization of plant and machinery or other possible hazards.

1.6.7 Watchdog and Safety Circuits

The requirements for Watchdog and safety circuits of Section 5 must be designed into the system.

1.6.8 System Running Indication

When the green LEDs labelled 'WATCHDOG' on the 131 processor module are illuminated, the Controller is running the user program and may be controlling moving machinery.

1.7 Handling Precautions for Printed Circuit Boards.

1.7.1 Introduction

The Processor Module and Memory Expansion printed circuit boards (p.c.bs) may suffer permanent damage due to electrostatic potentials (static) encountered in routine handling, testing and shipping, unless special precautions are observed.

1.7.2 Protection of Equipment from Static Damage

Protective measures are required when handling p.c.bs containing Electro- Static Sensitive Devices (ESSD).

When handling p.c.bs containing electro-static sensitive devices the following rules must be observed:-

(1) Personnel handling p.c.bs shall NOT wear outer clothing which will generate a static charge, e.g. synthetic materials like nylon; cotton is preferable.

(2) All personnel handling p.c.bs shall put themselves in contact with a grounded surface before removing p.c.bs from their protective packing, e.g. by use of a 3M's wrist strap Velostat type 2063. The wrist strap should be kept on during all p.c.b. handling.

(3) Avoid finger contact with devices on the p.c.b. and with its connectors.

(4) If it is necessary to place p.c.bs down 'unprotected', place on a static shielding bag, e.g. 3M's type 2100.

(5) p.c.bs shall be protected by a static shielding bag when out of equipment, e.g. 3M's type 2100.

1.7.3 Protection During Arrival, Handling and Storage at Site

P.C.Bs should be kept in their original packing wherever possible until they are required for installation in the equipment. If it is necessary to remove a p.c.b. from its packing it should always be protected by a static shielding bag or with the conducting foam shorting strip fitted to the edge connector. This should only be removed if the p.c.b. is to be tested or fitted to the equipment.

1.7.4 Protection During Setting Up of Equipment

The following precautions must be taken during testing/setting up operations on equipment containing p.c.bs with Electro Static Sensitive Devices:-

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

(2) The System Power and Test Equipment must be switched OFF before inserting or withdrawing p.c.bs.

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

(4) Dielectric strength and insulation resistance tests should not be carried out with the p.c.bs installed in the equipment.

(5) Do not use audible continuity tests on p.c.bs.

(6) Do not use 'Freeze' Aerosols on p.c.bs.

1.7.5 Protection During Maintenance and Spares Handling

If it is necessary to return any p.c.bs to CEGELEC Industrial Controls Ltd., for repair, enclose the p.c.b. in a static shielding bag, e.g. 3M's type 2100, wrap in foam plastic and pack in a box labelled 'Caution Static Sensitive p.c.b'.

1.7.6 Reference Reading

BS 5958 : Code of Practice for the Control of Undesirable Static Electricity - Part 1.

BS 5783 : Code of Practice for Handling of Electro-Static Devices.

1.7.7 Recommended Anti-static Equipment

The following 3M's Anti-static Equipment is recommended for use:-

(1) Velostat Wrist Strap Type 2063 - Strap with IMO resistor and alligator clip.

(2) Transparent Static Shielding Bags Type 2100 - size 10 in. X 12 in. (i.e. 254 x 305mm)

1.8 GEM80 Batteries (Memory Support) - Handling and Storage

The Renata CR2477 lithium manganese dioxide battery used for memory support in the GEM80/131 Controller has no handling, storage, disposal or air transport restrictions.

1.9 Radio Frequency Interference (RFI)

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

1.9.1 Transmitter Output

The field strength generated by a radio transmitter, received at a point 'p' in free space, is a function of the power output of the transmitter and the distance from the transmitter aerial.

$$E = \sqrt{\frac{377\,P_t}{4\pi r^2}} \quad \text{or} \quad r = \frac{5.5}{E}\sqrt{P_t}$$

where E = Field strength at point 'p', in Volts per metre (V/m).

P_t = Power output of the transmitter, in Watts.

r = Distance of point 'p' from the transmitter, in metres.

Note... At two metres, the power required to give a field strength of 10V/m is 13 Watts.

The following assumptions have been made in the formula above:-

1. The antenna gain is unity.
2. The antenna is isotrophic.
3. The Transmitter and the products are in free space.
4. Far field conditions exist where the wave impedance is 377 ohms.
5. In the near field, both the electric and the magnetic components of the field must be considered. Calculations based on the formula above which result in distances less than two metres are incorrect.

Using the formula above, the distance between the transmitter and the equipment should be calculated and must never be less than two metres.

1.10 Specification

Power Requirements

Input Voltage

: 88-121Vac (110V nominal)
or
: 204-264Vac 240V nominal) @ 47-63Hz
or
: 22-85Vdc (48V nominal)

Inrush
: 50A max. at 110Vac
: 25A max. at 240Vac
: 86A at 48Vdc

Communications — Three serial communication ports as follows:-

Ports 1 & 2
: GEM80 RS422 ports individually configurable for use as ESP tributary or control ports, printer/programmer ports, CORONET ports or CCU ports using optional termination units.

Port 3
: RS232 or 20mA port used for direct connection to a printer or system programmer

Environment

Temperature
: Operating 0 to 60°C
: Storage -20 to 70°C

Humidity
: 5 to 95% RH non-condensing
Tested to GEM80 Environmental Standards

Memory Capacity : 2,500 instructions + 3,000 data tables (standard) can be expanded to 20,000 instructions + 24,000 data tables by fitting optional memory expansion boards.

Instruction Capacity

The standard instruction capacity of 2,500 instructions + 3,000 data tables can be increased by fitting a memory expansion board to the processor module. Three memory upgrades are available as detailed in the following table:-

Number of User Instructions	Max. Data Tables	Max. P-Tables	RAM Expansion	EPROM Expansion
2,500	3,000	2,000	No	Yes
5,000	6,000	4,000	Yes	Yes
10,000	12,000	8,000	Yes	Yes
20,000	24,000	16,000	Yes	Yes

Notes... (1) Messages use up the available number of data tables

(2) The default 150 P-tables is included in the figures

Mechanical

Dimensions
: Height = 356mm
: Width = 483mm
: Depth = 332mm

Mounting
: 19 inch (483mm) panel mounting
: conforms to IEC 297-1 (1975) Dimensions of Panels and Racks

Weight
: Subrack (bare) = 4.75kg
: Processor Module = 0.6kg
: Power Supply = 6.0kg
: Total = 11.35kg

Note... Total weight of subrack depends on number and type of I/O modules fitted

Input/Output — Basic I/O highway providing 32 words (up to 512 points) of I/O.

Provision for up to 8 I/O modules in the Controller subrack.

Two Basic I/O ports for connecting additional I/O subracks.

This page left intentionally blank

2.1 Controller Architecture

The GEM80/131 Controller is based on a single processor and contains all the necessary logic components of a Programmable Logic Controller i.e. ladder diagram interface to the user, memory for ladder programs, data tables, workspace and an interface for communication with the Plant. In the larger capacity versions, a memory expansion sub-board is mounted directly onto the circuit board. Figure 2.1 shows the architecture of the Processor Module.

The standard version of the GEM80/131 has a user program capacity of 2,500 ladder instructions. The memory is sub-divided into a number of areas, which contain the following information:-

(1) Compiled program: containing the User program in compiled form for execution by the processor.

(2) Source code: containing the program in source form for monitoring or editing.

(3) Data tables and workspace : containing information in 16-bit word format.

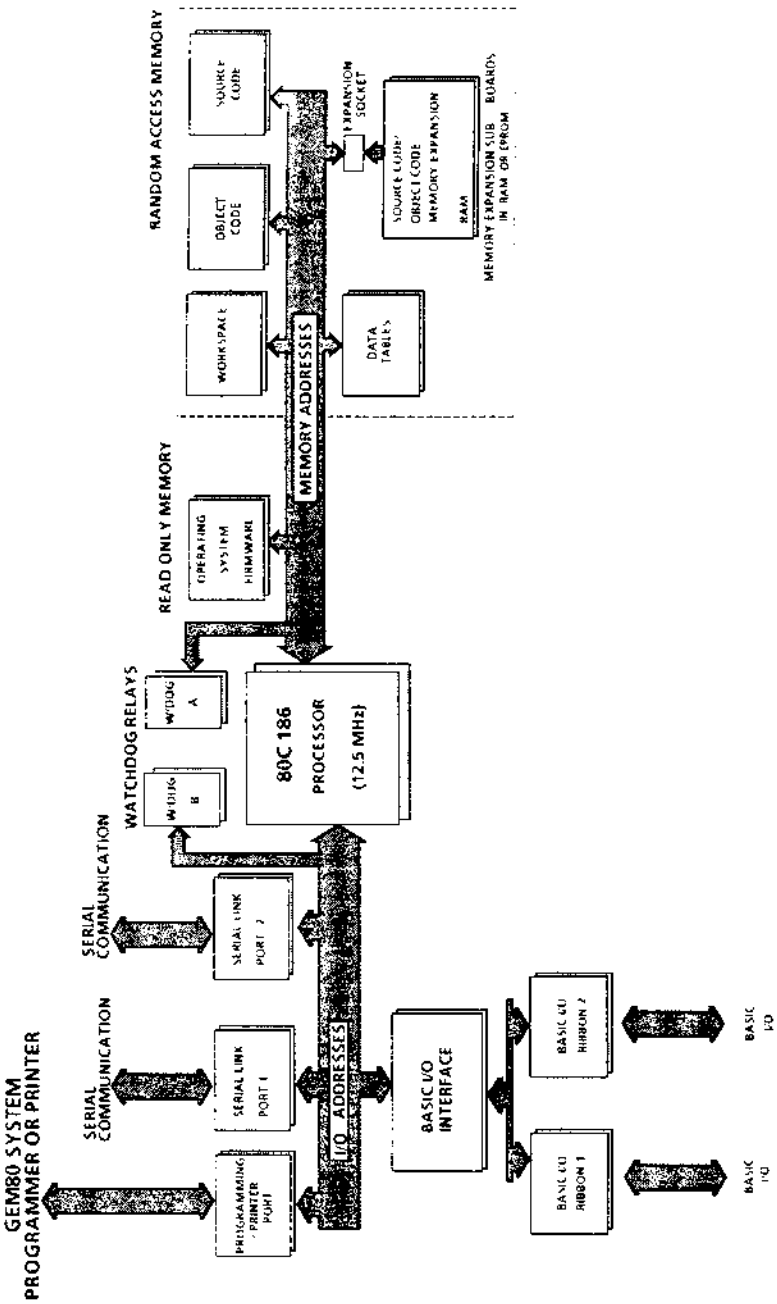


Figure 2.1 - Controller Architecture

2.2 Operating Cycle

The controller operating cycle can be divided into three separate parts.

(1) Initialisation
(2) Operating Phase
(3) Error Handler

The controller operating cycle is illustrated in Figure 2.2.

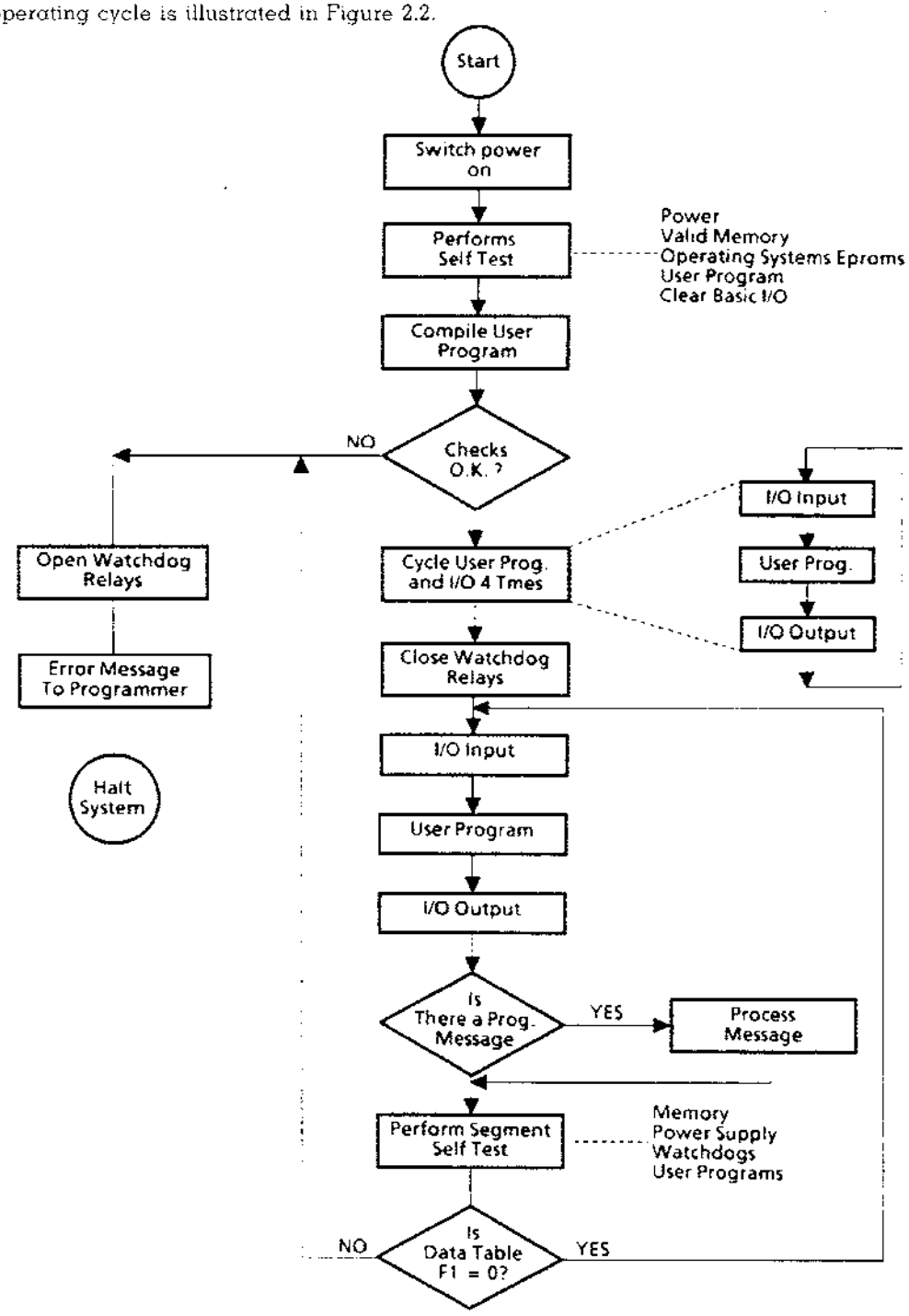


Figure 2.2 - Controller Operating Cycle

2.2.1 Initialisation

When the controller is switched on, a series of self tests is performed to check the following:-

(1) Power supply
(2) Memory
(3) Operating system EPROMS
(4) User program

On completion the Basic I/O is cleared and then the User program is compiled.

If a fault is detected during the Initialisation phase the Error handling routine is invoked, see Section 2.2.3. If no errors are detected the Operating phase is cycled four times (with the Watchdog contacts open). If no errors are generated by the Operating cycle the Watchdog contacts are closed and the Controller then begins its normal Operating phase.

2.2.2 Operating Phase

This is a continuous cycle and is the normal operating condition of the controller. The input data is read and the output data is computed by the User Program. The serial data in the (J and K) Data Tables is updated at the beginning of each cycle.

At the end of each program cycle a self-test is performed. If any errors are generated the error handler is invoked.

2.2.3 Error Handling

When an error occurs the Error Handler sends an error message to the programmer port and tests the error status flags to determine the category of the failure. Action is then taken to ensure that the controller goes to a safe condition.

There are three categories of error as detailed below:-

Category	Definition	Action by Controller
Catastrophic Error	Controller totally unreliable (eg firmware corrupted)	(a) Watchdog contacts opened (b) Controller halted (c) No communication to programmer (no error message).
Fatal Error	Failure of controller functions (eg Basic I/O failure)	(a) Watchdog contacts opened (b) Controller halted (c) Controller will communicate with programmer (error message generated).
Lock Error	Error which can be recovered by clearing the program store and reloading the program (eg program corrupt on power up).	(a) Watchdog contacts open (b) Program halted (c) Controller will communicate with programmer.

2.2.4 System Self tests.

While the GEM80/131 system is 'powered up' the system undergoes a number of continuous tests. These are :

(1) Read : write memory test of all used RAM. This includes system work space, object code and data table ram.

(2) A 16-bit checksum test of the following data areas : source code, object code, V-Table, P-Table and EPROM.

Note... i) CRC of operating system EPROM is checked at system power up.

ii) Source code only checked before any compilation takes place.

(3) The power supply to the processor module.

(4) The battery power supply.

(5) The system watchdogs.

(6) The bit unpacking logic.

The above tests, in their entirety, are performed on power up before the system is allowed to 'run'.

If tests (1), (2), (3), (5) or (6) fail it is deemed a fatal error; the system is 'halted' (if not already), 'locked' and an error message issued to the programming device, if connected. For further details see Section 8.

Note... Some errors, notably error no #710 'Battery Failure' do not generate any of the above error status flags, in this case the error message is sent to the programmer port and a fault bit is set in F2.4 but the Watchdog contacts are not opened and the system is not halted.

2.2.5 States of the GEM80/131 Controller.

When a programming device is connected to the GEM80/131, the current 'state' of the controller is displayed. These 'states' are defined as follows:-

'Halted - Normal Inputs'.

Watchdog Relays	-	Out. (ie. Watchdog LEDs and relay contacts)
Basic I/O input	-	is being executed, updating the A-Tables using the current input configuration (this is none if there has been no Ladder Diagram in the system or a 'Clear Store' command issued).
User Program	-	is not being executed.
Basic I/O Output	-	is not being executed, but any previous output maintained.
Serial Comms.	-	See Section 4 for details of individual protocols.

'Running - Normal Inputs'.

Watchdog Relays	-	In.
Basic I/O input	-	is being executed.
User Program	-	is being executed.
Basic I/O Output	-	is being executed.
Serial Comms.	-	See Section 4 for details of individual protocols.

'Changed - Normal Inputs'.

Watchdog Relays	-	In.
Basic I/O input	-	is being executed.
User Program	-	is being executed, but the source code from which the running code was generated has been modified. This means that either the Ladder Diagram or a value in a P-Table (range 0 to 149) has been changed. The changes are not effective until the system has been re-compiled.
Basic I/O Output	-	is being executed.
Serial Comms.	-	See Section 4 for details of individual protocols.

'Halted - Test Inputs'.

Watchdog Relays	-	Out.
Basic I/O input	-	is being executed, but the A Tables are not updated.
User Program	-	is not being executed.
Basic I/O Output	-	is not being executed, but previous data is maintained.
Serial Comms.	-	See Section 4 for details of individual protocols.

'Running - Test Inputs'.

Watchdog Relays	-	Out.
Basic I/O input	-	is being executed but A Tables are not updated.
User Program	-	is being executed.
Basic I/O Output	-	is being executed.
Serial Comms.	-	See Section 4 for details of individual protocols.

'Changed - Test Inputs'.

Watchdog Relays	-	Out.
Basic I/O input	-	is being executed but A-Tables are not being updated.
User Program	-	is being executed, but the source code from which the running code was generated has been modified. This means that either the Ladder Diagram or a value in a P-Table (range 0 to 149) has been changed. The changes will not take effect until the system has been re-compiled.
Basic I/O Output	-	is being executed.
Serial Comms.	-	See Section 4 for details of individual protocols.

Single Cycle 'Normal Inputs'.

Watchdog Relays	-	Out.
Basic I/O input	-	is executed once.
User Program	-	is executed once if the current Ladder Diagram has not been changed. If program has been changed the Ladder Diagram is first compiled.
Basic I/O Output	-	is executed once.
Serial Comms.	-	See comms. section for details of individual protocols.

Single Cycle 'Test Inputs'.

Watchdog Relays	-	Out.
Basic I/O input	-	is executed once but A-Tables not updated.
User Program	-	is executed once if the current Ladder Diagram has not been changed. If program has been changed the Ladder Diagram is first compiled.
Basic I/O Output	-	is executed once.
Serial Comms.	-	See Section 4 for details of individual protocols.

Note... (1) The 'state' of the controller under various Fault Conditions is given by F-table error codes (see Section 8).

(2) The GEM80/131 Controller will power up in the 'state' it was in at the last power down.The exception to this rule is when the controller was in a 'Changed' running state. In this case the controller will 'come up' in a 'Changed Halted' state with a covering error message. (see Error message in Section 8 for further details.)

(3) The checksum of the user Ladder Diagram, should always be correct when the system is 'powered down'.

2.2.6 Serial Communications

Serial Communications activity including the Programmer/Printer port interrupts the Controller Operating cycle and is processed as required, returning to the Operating cycle on completion.

2.2.7 Program Scan Times

GEM80/131 Controllers operate on a repetitive I/O scan and program execution cycle. The cycle time may be either:

(1) Free Running - The Controller cycle consists of a Ladder program scan, a Basic I/O scan and a partial self-test. The total cycle time is the sum of the times taken by each individual function plus the time taken by any serial communication activity. The free-running cycle time is therefore variable.

(2) Preset Cycle - The cycle time is preset to a fixed value. A waiting period is inserted at the end of the ladder program cycle and any serial communication activity time is subtracted from this wait period to give a substantially constant cycle time. The preset cycle time is stored in a P-table.

2.2.8 Calculating the Program Scanning Interval

The scanning interval of the 131 controller depends on many factors, making it difficult to derive an accurate estimate of the scan interval. For most applications a reasonable estimate of the scanning interval can be made by adopting the following method:-

The scanning interval can be considered to be the sum of seven components:

i.e.

Scan Interval = Ts + Tb + Tw + Ti + To + Tc + Tf

where:

(1) Ts = The System overhead - the time taken by the system checks in each scan loop; this is a constant 3ms.

(2) Tb = The Bit logic instructions - the total time taken to execute all the --] [--,--]/[-- and --( )-- instructions in the ladder program. To calculate Tb count the number of bit logic instructions in the ladder program and use the graph in Figure 2.3 to estimate the value.

(3) Tw = Word logic instructions - the total time taken to execute all the AND, OR, XOR and INVERT instructions in the ladder program. To calculate Tw count the number of word logic instructions in the ladder program and use the graph in Figure 2.3 to estimate the value.

(4) Ti = Plant inputs - total time taken for all plant inputs. To calculate Ti count the number of inputs and use the graph in Figure 2.4 to estimate the value.

(5) To = Plant outputs - total time taken for all plant outputs. To calculate 'To' count the number of outputs and use the graph in Figure 2.4 to estimate the value.

(6) Tc = Communications - time taken by serial link activity. This increases with the Baud rate of the serial links and can be found by consulting Figure 2.5. The figures in the graph were obtained by connecting two ports back to back and continuously exchanging 32 data tables, and represent a worst case.

(7) Tf = Special Functions - total time taken by all special functions used in the ladder program excluding those in (1) and (2). The execution times of the Special functions differ considerably and can be calculated by summing the individual times given in Table 2.1.

Note... Table 2.1 gives the execution times in microseconds, times derived from the graphs are in milliseconds.

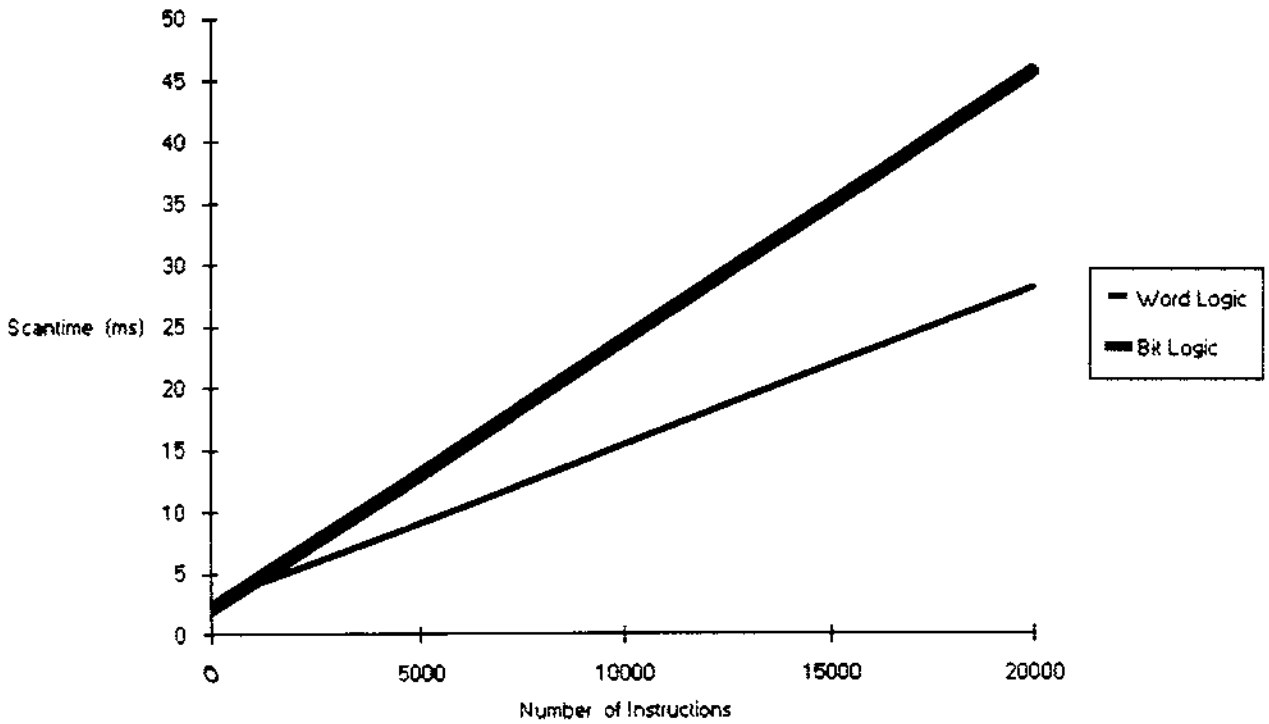


Figure 2.3 Execution Times for Bit Logic and Word Logic Instructions

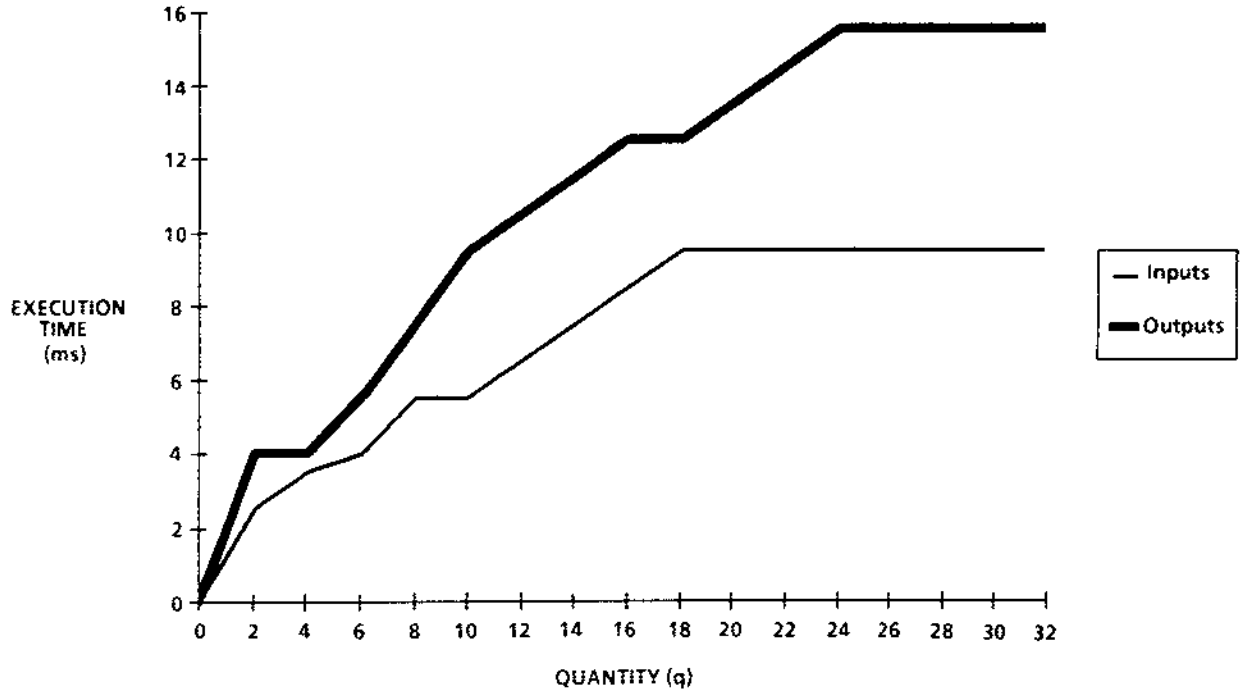


Figure 2.4 Execution Times for Inputs and Outputs

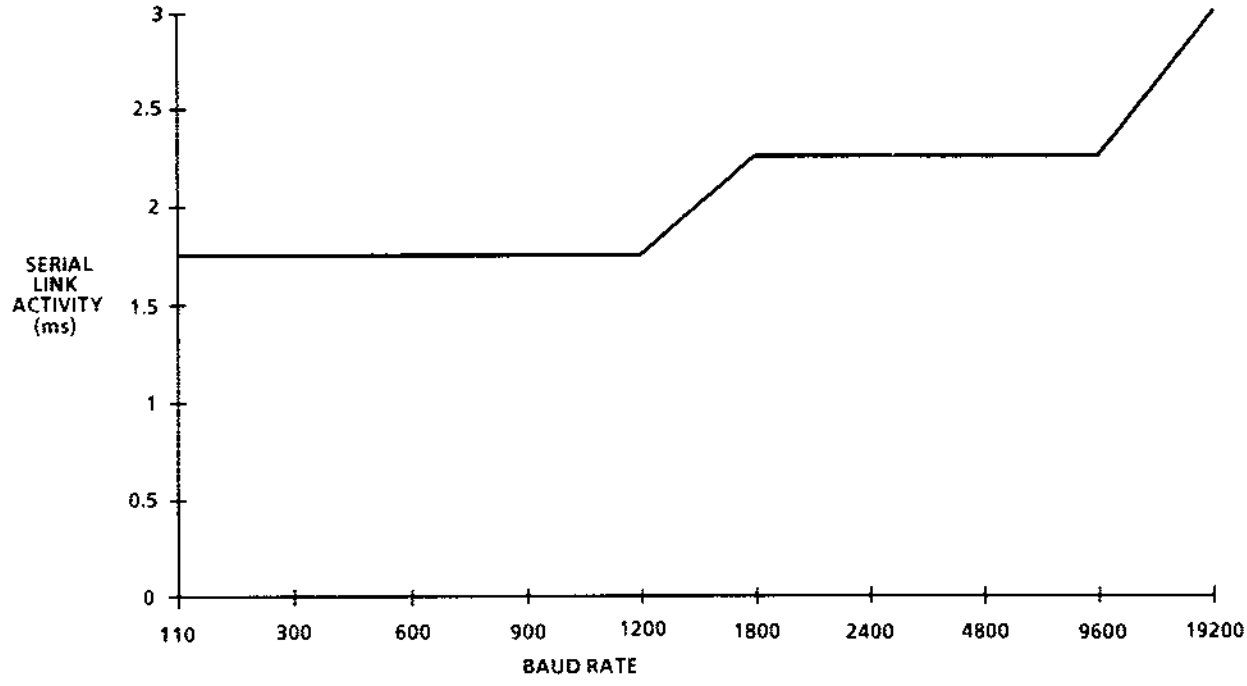


Figure 2.5 Serial Link Activtity versus Baud Rate

2.3 Program Operation

2.3.1 Programmer Units

To obtain the correct display of diagnostic messages and to use the on-line program change facility, one of the following is needed:-

GEMESYS,

an 8922 System Programmer,

a 9022 Enhanced System Programmer,

an 8940 Enhanced System Programmer with disk storage,

an 8920 Portable Programmer version 4.5 firmware (or later).

2.3.2 Program and Data Table Capacity

Any defined text messages will be stored in the P-tables, reducing the number of P-tables available for the user program.

2.3.3 Remote Programming

GEMESYS, 8922, 8940 or 9022 System Programmer can operate on a multi-drop serial link connected to several Controllers, and at whatever signalling rate is selected. The 8920 Portable Programmer can only operate on a point-to-point link at 9,600 bits/s, and therefore can only be connected to one Controller at a time. The signalling rate which can be used for a given distance between the Controller and Programmer can be found by consulting the Serial Links User Information Leaflet, Publication No.T456.

2.3.4 Message Output Facility

Text messages edited in the System Programmer can be stored in the GEM80 Data Tables. The Controller can be programmed to output messages to selected serial ports using the Special Functions S38 PRITEXT and T38 PRINT.

2.3.5 Connecting the Programmer

Figure 2.6 shows a System Programmer connected to the Printer/Programmer (port 3) of the Controller. If program print-outs are not initially required, connection to a printer is not necessary.

Figure 2.7 shows an 8920 Portable Programmer connected to the controller. The audio cassette recorder should be connected for program storage but the printer may not initially be necessary.

When a programmer is connected to port 3, the GEM80/131 automatically detects the programmer and selects the correct baud rate (either 9,600 or 19,200 baud). Wiring details for the programmer/printer connection ports are given in Section 4.3.2.

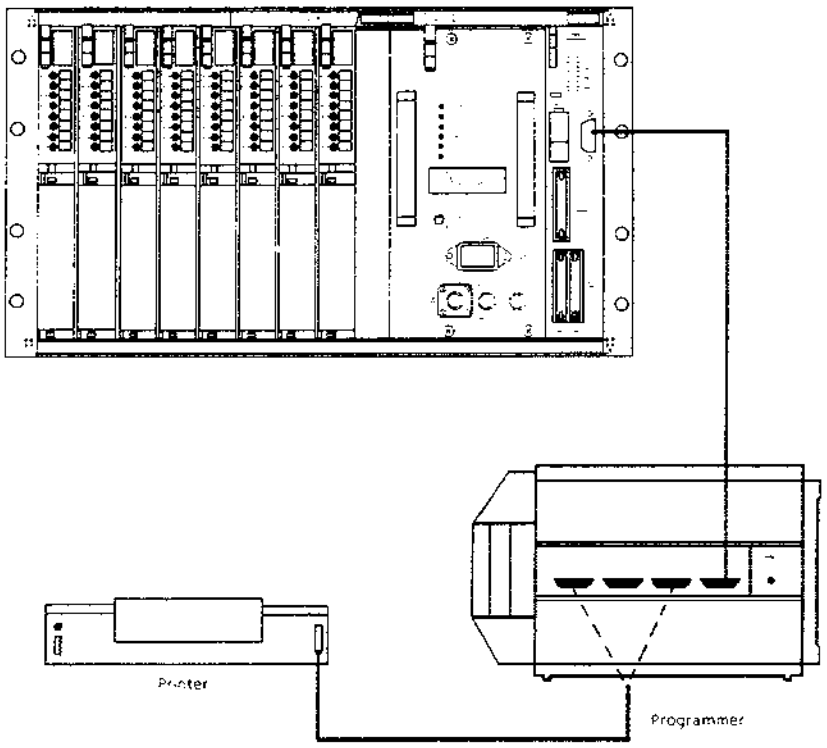


Figure 2.6 - System Programmer Connected to Controller

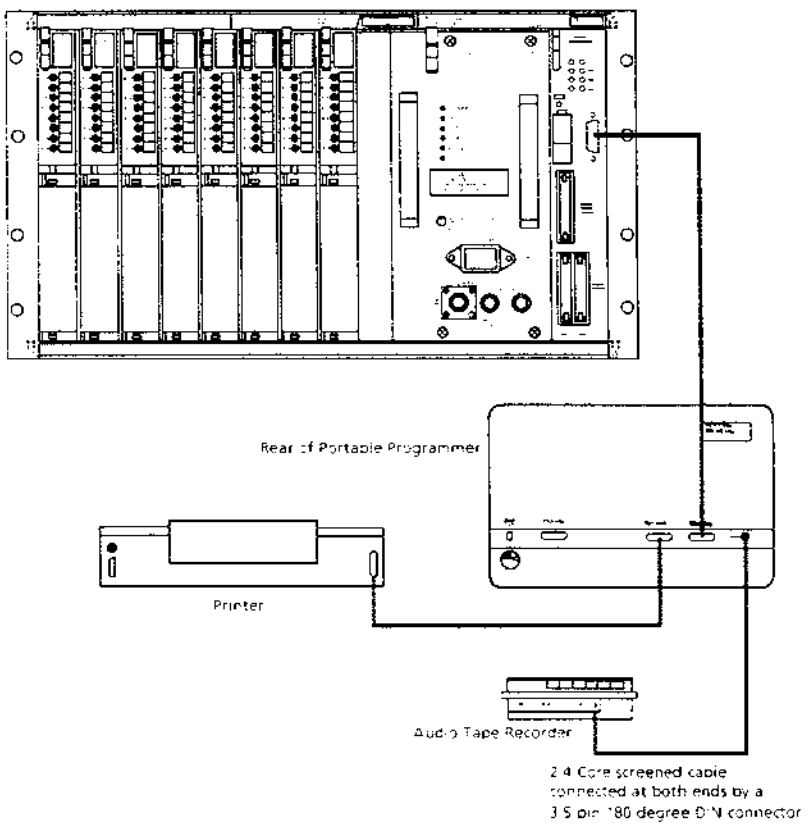


Figure 2.7 - 8920 Portable Programmer Connected to Controller

2.3.6 Program Compilation

The User Program is stored in two forms: as 'source' code for editing purposes and 'compiled' form for execution by the Processor. Conversion from source code to compiled code is called 'Compilation' and is carried out under the following conditions for RAM based systems:-

(1) At power up (automatically)

(2) On halt/run transitions (automatically)

(3) When the user issues a RECOMPILE command with the program running

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

For EPROM based systems the program is compiled and retained in the FLASH EPROMS by actioning a RUN request. The compilation process will compile the source program and up-load copies of P-table, V-table and other system variables.

Compilation is carried out under the following conditions:-

(1) On issuing a RUN command when the EPROM module is set to program mode. A RUN request will be rejected if the eprom module is set to protect mode.

(2) On issuing a SINGLE CYCLE request.

No editing of the source program will be allowed, however it may be read back. Regardless of the switch position, once the program has been run editing of the source program will be rejected.

P-tables may be copied to the Controller and edited as for a RAM based system, however once the program has been run the P-tables cannot be edited.

Note.. that if the Controller is powered off without first RUNNING the program, then the program will be lost and will be erased when the controller is powered up.

Errors detected during compilation will prevent the program being executed.

2.3.7 On-line Program Changes

The uncompiled source program can be edited while the compiled program is running and controlling the plant. This edited version can be printed out or copied to tape or disk without halting the controller. To incorporate the changes made during an editing session, a 'RECOMPILE' command is issued from the Programmer. The Controller pauses for a short time (typically 0.5 seconds per 1000 user instructions) while compilation is in progress.

During this time all outputs will freeze and inputs will be ignored. If compilation is successful, the Controller will run the modified program. If not, the Controller will run the previous compiled program. A message to this effect will be displayed on the Programmer.

Note... Any change to P-data tables above P149 will affect the running program immediately without re-compilation being necessary. Section 3.3 gives more information about the controller data tables.

The on-line RECOMPILE command does not affect data table contents.

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

2.3.8 Off Line Program Debugging

A program can be de-bugged on a system with no I/O present using the TEST INPUTS mode. Program timing is not significantly altered compared with when the I/O is present. When the TEST INPUTS mode is selected from a Programmer:

(1) The Watchdog contacts do not close.

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

(3) Output scanning is executed.

Off-line debugging should be carried out before running on an EPROM based system.

2.4 Programming the Controller

User Programs for operating the GEM80/131 controller are written in the GEM80 Ladder Programming Language. Full details of how to use this programming language are given in the GEM80 Programming Manual, Publication No.T391.

EPROM based systems cannot be programmed, only downloading from the programming tool is allowed.

2.4.1 Instruction Set

The comprehensive instruction set includes standard GEM80 instructions and 'Special Functions'.

Details of the Standard Instruction Set are contained in the GEM80 Programming Manual.

2.4.2 Special Functions

Special functions are pre-written software routines and are called up in the ladder diagram program using the 'SPEC' key.

The special functions are detailed in Table 2.1 and cover multiply, divide, function generator, closed loop controls, etc. All Special Functions are described in Software Data Sheets and the GEM80 Programming Manual.

Table 2.1 Instruction Set

Function		Instruction	Special Function	Remarks	Number of Instructions	Number of Table Locations used by VALUE	Execution Time (μs)
2. Relay replacement functions	N/O contact	---] [---	-	Functions as a normally open relay contact	1		<2
	N/C contact	---]/[---	-	Functions as a normally closed relay contact	1		<2
	Coil	---( )---	-	Functions as a relay coil	1		<2
	Time Delay	DELAY	-	Time range 10ms to 5.4 minutes	1		10
	Counter	COUNT	-	capacity 32767 (resettable)	1		16
	Sequencer	SEQR	-	16 step sequencer with reset	1		10
2. Logic functions	Logic AND	AND	-	bit by bit ANDing of 2 x 16 bit words	1	-	<1
	Logic AND group of words	ANDGRP	T24	bit by bit ANDing of 2 groups of 16 bit words	2	3	150 + (8 x qty)
	Logic OR	OR	-	bit by bit ORing of 2 x 16 bit words	1	-	<1
	Logic OR group of words	ORGRP	T25	bit by bit ORing of 2 groups of 16 bit words	2	3	150 + (8 x qty)
	Logic exclusive OR	XOR	-	bit by bit XORing of 2 x 16 bit words	1	-	<1
	Exclusive OR group of words	XORGRP	T26	bit by bit XORing of 2 groups of 16 bit words	2	3	150 + (8 x qty)
	Invert	INVERT	-	Inverts each bit of 16 bit word	1	-	<1
	Invert group	INVGRP	S25	Inverts each bit of a group of 16 bit words	2	3	90 + (4 x qty)
	Sequence Diagnostics	SEQDIAG	T19	Enable automatic monitoring of any sequence of events	2	11 + N	-

Table 2.1 continued

Function		Instruction	Special Function	Remarks	Number of Instructions	Number of Table Locations used by VALUE	Execution Time (μs)
3. Math functions	Addition	ADD	-	Limits +32767 to -32768	1	-	9
	Array addition	ADDARAY	T12	Limits +32767 to -32768	2	3	185 + (15 x qty)
	Subtraction	SUB	-	Limits +32767 to -32768	1	-	9
	Array subtraction	SUBARAY	T13	Limits +32767 to -32768	2	3	185 + (15 x qty)
	Multiply	MULT	T10	Integer multiplication limits +32767 to -32768	1	-	12
	Array multiplication	MULARAY	T14	Integer multiplication limits +32767 to -32768	2	3	190 + (11 x qty)
	Division	DIV	T11	Integer division limits +32767 to -32768	2	1	20
	Array division	DIVARAY	T15	Integer division limits +32767 to -32768	2	4	200 + (19.5 x qty)
	Linear Conversion	LINCON	S11	Provides arithmetic calculations	2	4 See also note 12	95
	Array Linear Conversion	CONARAY	S10	Provides multiplication, division and addition calculations for two arrays of data	2	3 + 3N See also Note 2	100 + (60 x qty)
	Square Root	SQRT	S12	Limits +32767 to -32768	2	1	110
	Checksum	CHKSUM	T9	Calculates the checksum of Data Table contents	2	1	50 + (13.5 x qty)
	Standard Deviation	STDDEV	T18	Calculate mean and standard deviation of a number of values	2	11	See note 5
4. Signal Processing	Debounce Input Signal	DBOUNCE	S0	Provides signal conditioning to logic signals prone to spurious or transient problems	2	5 (See also note 1)	50
	Function Generator	FGEN	S30	Four quadrant operation	2	4 + N (See also note 2)	175
	Dead Band	DEDBAND	S31	Includes offset	2	3 (See also note 1)	24
	Limiter	LIMIT	S32	High and low limits	2	3 (See also note 1)	40
	Ramp Generator	RAMP	S33	Comprehensive Ramp generator (includes rounding)	2	15 (See also note i)	400
	First Order Time Constant	ANALAG	S37	Smooths fluctuating numerical values	2	5 (See also note 1)	85
	Time Constant	TCONST	S60	Programmable time constant	2	6	27600
	Ramp Generator	RAMPGEN	S61	Ramp signal time dependent	2	13	28100

Table 2.1 continued

Function		Instruction	Special Function	Remarks	Number of Instructions	Number of Table Locations used by VALUE	Execution Time (μs)
5. Closed Loop Control	Absolute 3 Term Controller	PIDABS	S34	Provides absolute proportional, integral and derivative control	2	15 (See note 1)	230
	Incremental 3 Term Controller	PIDINC	S35	Provides incremental proportional, integral and derivative control	2	9 (See note 1)	200
	Incremental Output	INCOUT	S36		2	5 (See note 1)	130
6. Binary Tests	High State	HISTATE	S3	Reports bit number of highest bit of 16 bit word set on (1)	1	-	22
	Bits ON	BITSON	S26	Reports number of bits set on (1) in a group of 16 bit words	2	2	See note 6
	Compare Group	CMPGRP	T21	Compares two groups of 16 bits and reports details of the first difference	2	3	100 + (11 x qty)
	Get Bit	GETBIT	T22	Performs a test of on state individual bits in group of words	2	2	70
7. Binary Manipulation	Swap 1/2 Locations	SWAP	S4	Swap 1/2 locations	1	-	<1
	Shift	SHIFT	S27	Left and right shift on a group of 16 bit words	2	3	See note 7
	Rotate	ROTATE	S28	Left and right rotations on a group of 16 bit words	2	3	See note 7
	Put Bit	PUTBIT	T23	Allows setting and resetting bits of a word and generating specified words	2	3	Simple 30 Group 75
	Shift Bits in Word	QSHIFT	T27	Shifts bits of word left or right	1	0	Zero fill 10-14
	Rotate Bits in Word	QROTATE	T28	Rotates bits of word left or right	1	0	one fill 12-33

Table 2.1 continued

Function		Instruction	Special Function	Remarks	Number of Instructions	Number of Table Locations used by VALUE	Execution Time (μs)
8. Numerical Tests	Compare	COMPARE	T0	These special functions	2	1	15
	Comparison			report if:			
		EQ	T1	(a) X = Y	1	0	4
		NE	T2	(b) X not equal to Y	1	0	4
		GT	T3	(c) X greater than Y	1	0	4
		LT	T4	(d) X less than Y	1	0	4
		GE	T5	(e) X greater than = Y	1	0	4
		LE	T6	(f) X less than = Y	1	0	4
	Select Maximum in Array	MAXARAY	S13	Maximum value in array	2	3	60 + (6 x qty)
	Select Minimum in Array	MINARAY	S14	Minimum value in array	2	3	60 + (6 x qty)
	Select Maximum	MAX	T7	Maximum of two inputs	1	0	22
	Select Minimum	MIN	T8	Minimum of two inputs	1	0	22
	Compare Array	CMPARAY	T16	Array comparison	2	4	See note 8
	Delay Array	DELARRAY	S15	Causes multiple delays			See note 10
	Negate	NEGATE	S5	Changes the sign of a number. Makes a number positive. Outputs all 16 bits if input is non-zero	1	0	2
	Absolute	ABS	S6		1	0	2
	Non-zero	NONZERO	S7		1	0	2
10. Block Instructions	Enclose conditionally executed rungs	START OF BLOCK	-	Conditionally executed block of ladder diagram instructions can be nested to a depth of 16	1		2
		END OF BLOCK	-		1		0
11. Data Moving	Locate Data Table Address	LOCATE	S20	S20 and T20 are usually used together for moving groups of data from one area of memory to another	2	1	140
	Move Data Between Table Addresses	MOVE	T20		2	0 or 1	100 + (0.7 x qty)
	Cyclic Store	STORE	T30	First in first out store	2	4 + N See note 3	180
	Get Word	GETWORD	S19	Indirect data access	2	1	135
	Fill Array	FILL	T17	Array set up	2	0 or 1	130 + qty
	Put Word	PUTWORD	T29	Indirect output	2	1	135
	Collate	COLLATE	T37	Collates random bits or words into a group of adjacent data table locations	1	0	See note 9

Table 2.1 continued

Function		Instruction	Special Function	Remarks	Number of Instructions	Number of Table Locations used by VALUE	Execution Time (μs)
12. Code Conversion	B.C.D. input conversion	BCDIN	S1	Converts up to 4 decades of binary.	1	0	50
	B.C.D output conversion	BCDOUT	S2	Converts binary to up to 4 decades of binary coded decimal	1	0	45
	Convert Gray Code to Binary	GRAYBIN	S9	Converts gray code input	2	1	40
13. Serial Port Alphanumeric Input and Output	Print Text	PRITEXT	S38	Enables messages stored in controller memory to be output to serial port	2 Port	(C + 1)/2 See note 4	200
	Print	PRINT	T38	Enables user definable messages to be output on a serial port	2	N See note 2	See note 11
	Character Input	CHARIN	T39	Enables characters input on the serial ports to be stored in controller memory	2	(C + 1)/2 See note 4	160
14. Output Functions	Output	OUT	-	Outputs 16 bit word to specified data table location	1		1
	Output	OUTPUT	S8	Intermediate output from rung	2	1	2

Notes on Table 2.1

1. Typically uses stated number of locations in both pre-set and working tables
2. N = number of tabulated points or array length (message length)/2
3. 4 + store length
4. N = quantity of numbers to be output
5. Acquire 750 μs
   Reset 350μs
   Calc 20,000μs
   Acquire + Calc 25,000μs
6. Simple 60μs
   Group 60 + (38 x qty)μs
7. 110 + ((8 + (0.5 x shift)) x qty)μs
8. Const 140 + (8.5 x qty)μs
   Array 190 + (10 x qty)μs
9. 500 + (11 x MSG No.) + (150 x No. of words) + (170 x No. of bits) μs
10. Reset 270
    Run 190 + (13 x qty) + (7 x qty while running) + (17 x qty when reset) μs
11. For text (4 x MSG No.) + 260μs
    For text and numbers (4 x MSG No.) + (360 to 840) μs

2.5 Program Capacity

The program capacity of the GEM80/131 depends on the amount of memory installed. The amount of memory installed is detected by the controller hardware. On start up the following message is sent to the programmer port:-

"GEM80/131 XXXX Instructions in RAM" for RAM based systems,
or "GEM80/131 XXXX Instructions in EPROM" for EPROM based systems.

Table 2.2 gives details of the program and data table capacities available to the user:

Table 2.2 Program and Data Table Capacity

No. of User Instructions	Data Tables	Max No of P Tables
2,500	3,000	2,000
5,000	6,000	4,000
10,000	12,000	8,000
20,000	24,000	16,000

Note... (1) The P-tables are part of the total data tables available.

(2) The maximum no of data tables does not include data tables allocated by the system eg P-tables 0 to 149.

(3) The maximum number of data tables and instructions is fixed for each memory size, i.e. there is no trade off between data tables and instructions.

2.5.1 Program Development

Programs can be developed prior to installation and commissioning, and by connecting the 8902 I/O Simulation Panel, limited operational tests can be performed on the newly developed programs. For further information on program development see GEM80 Programming Manual Publicatin No.T391.

2.6 Data Tables

The GEM80 stores data in memory in Data tables. The data is stored in 16-bit word format. Several different tables are required, each storing data relating to a particular function (e.g. the P-table stores pre-set data, the J- and K- tables store data received and transmitted via the serial communication links respectively.

2.6.1 Data Table Addressing

The data tables are addressed using the initial letter of the table followed by a number e.g. P41 points to the word 41 in the P-table. To address individual bits in the P-table a decimal value is used, e.g. P41.2 points to bit 2 in word 41 of the P-table.

Table 2.3 shows the Data Table addresses available and information that can be found in these memory locations.

2.6.2 Data Storage.

The data table content can be interpreted as:

(1) an equivalent decimal number.
(2) 16 individual bits each of value 1 or 0.
(3) an equivalent hexadecimal number.

For example, address G2 may contain:-

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

which can be interpreted as:-

BINARY	1	0	1	0	1	1	0	0	0	0	1	1	0	1	0	1

DECIMAL -21,451

HEXADECIMAL @AC35

Decimal

As shown in the above example, when converting from binary to decimal, 2's complement notation is used. Bit 15 is taken as the sign bit and the number displayed is a signed integer in the range +32767 to -32768.

When bit 15 = 1 a negative number is represented and when bit 15 = 0 a positive number or zero is represented.

Hexadecimal

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

2.6.3 Data Table Sizes

Data tables E and F are of a fixed size (as shown in Table 2.3). Data table sizes are calculated by the Controller from the User Program. If for example, the highest G-table address in the user program is G345 then G0 to G345 will be reserved.

Where addresses are implied, e.g. when using LOCATE and MOVE Special Functions the user must include a dummy rung or rungs to declare the highest address.

When constructing the User Program, memory wastage occurs if large gaps of unused data tables are left with only high numbered and low numbered tables used. Also, even if only one or two bits of a word are used (e.g. G104.1) the whole word G104 is reserved by the Controller.

System Programmers with software version 2.8 or earlier and all Portable Programmers cannot work with bit addresses above 999.15. This restriction means for example, G999.15 can be used, but address G1000.1 cannot be used, as individual bits cannot be accessed. However, word G1000 can be used and words up to 24,000 can be used where access to individual bits is not required. The limitation is on the System Programmer itself where there is space for only 7 characters on the screen.

Action of Clear Store on Data Tables

The CLEAR STORE command has the following effects:-

(1) Removes the ladder diagram program from memory, including expanded RAM systems.

(2) Resets all P-tables to zero except numbers 0 to 149, which have to be retained so that serial link configurations can be maintained. This is essential for remote programming.

(3) Remove all user defined messages.

Table 2.3 - GEM80/131 Data Tables

FUNCTION	Data Table	Content	Minimum Table Size	Maximum Table Size	Cleared to Zero at Halt/Run Transition	Cleared to Zero at Power Off	Cleared to Zero by Clear Store Command
BASIC I/O INPUT	A	This table of addresses stores the states of INPUT transducers connected to Basic I/O	0	32 words, each 16 bits	YES	YES	YES
BASIC I/O OUTPUT	B	This table of addresses stores the OUTPUT states (derived from the execution of the user program) for output to the Basic I/O highways	0	32 words, each 16 bits	YES	YES	YES
	C,D	Not Used					
TIMING AND FLAGS	E	These tables are written to by the Controller and indicate overflow, time date and timing flags	9	9	NO	YES (except E1-E6)	NO
FAULT CODES	F	These tables contain fault codes, which are written by the Controller as a result of the built-in self test routines or as a result of execution of the User Program. Some tables are available for the user to use as he wishes.	210	-	NO	YES	YES
GENERAL WORK SPACE	G,H,-N,O,-U	These tables are available for the User Program to store counter values, sequencers and general data.	0	-	YES (except when R0.0 = 1)	YES	YES
SERIAL LINK CONTROL	I	This table enables the User Program to control serial link exchanges	120	120	YES (except when R0.0 = 1)	YES	YES
SERIAL COMMUNICATION LINKS DATA	J	This table stores data RECEIVED by the Controller through the serial communications links	0	1536	YES (except when R0.0 = 1)	YES	
	K	This table stores data derived by execution of the User Program for TRANSMISSION on the serial communication links				YES	YES

Table 2.3 continued

FUNCTION	Data Table	Content	Minimum Table Size	Maximum Table Size	Cleared to Zero at Halt/Run Transition	Cleared to Zero at Power Off	Cleared to Zero by Clear Store Command
	L	Not Used					
MAINTAINER	M	Available for user programmed tests. Write access from programmer with key removed.	0		YES	YES	YES
PRESET DATA	P0 to P149	Controls Program Repetition Interval, System Identification Codes, Serial Link operational data (signalling rate, printer data, etc.).	150		NO	NO	NO
	P 150 on	for use by user program and storing text messages					YES
	Q	Not Used					
GENERAL WORK SPACE	R	Retained workspace	1		NO	NO	YES
	W	Retained workspace	0		NO	NO	YES
	V	Internal system use	51	51	NO	NO	YES
	S	Not Used					

2.6.4 P-Data Table

Data written to the P-table is used for the following:-

(1) To control the program scan (repetition time)

(2) To control the serial links

(3) To store printer text messages

The P-Data Table is not cleared at power off or at halt/run transition, although a clear store command will clear P150 upwards. The content of the other P-tables can be altered by over-writing. Table 2.4 details the use of the P-table locations.

Table 2.4 P-Table Contents

Address	Content	Remarks
P0	Available for user s system identification code	
P1	Program repetition interval (scan rate) Range 0 to 9,500(ms), zero for free-running	Resolution 1ms
P2	Length of pre-set message area in bytes **Note...**This effectively limits the message length.	Should not be written to by user. Automatically up-dated by message editor
P3-P9	Reserved	
P10-P29	Data for Serial Port 1	See Section 4
P30 and P49	Data for Serial Port 2	See Section 4
P50-P69	Data for Serial Port 3 or printer/programmer port	See Section 4
P70-P149	Reserved	

2.6.5 E-Tables

The E-table contains timing markers, flags and duration of previous program scan. The table is available for the User Program to read. The information contained in the E-table locations is shown in Table 2.3.

Table 2.5 E-Table

Address	Content	Remarks
E0.0	0.1 second timing marker	Set ON for one program cycle at 0.1 second intervals.
E0.1	1 second timing marker	Set ON for one program cycle at 1 second intervals.
E0.2	0.01 second timing marker	Set ON for one program cycle at 0.01 second intervals.
E0.3 - E0.5	Reserved	
E0.6	Recompile Flag	
E0.7	Limit flag set ON or OFF after each ADD or SUB instruction.	
E0.8 E0.9 E0.10	Buffer filling flags for Serial Port 1. Buffer filling flags for Serial Port 2. Buffer filling flags for Serial Port 3.	
E0.11	Reserved	
E0.12 E0.13 E0.14	Buffer empty flags for Serial Port 1. Buffer empty flags for Serial Port 2. Buffer empty flags for Serial Port 3.	
E0.15	Reserved	
E1 E2 E3	Seconds (0 - 59) Minutes (0 - 59) Hours (0 - 23)	Time
E4 E5 E6	Date (1 - 31, as appropriate to month) Month (1 - 12) Years (1989 - 2099)	Date
E7	Duration of previous program scan (Cycle time)	In ms. This has a resolution of 1ms. On a halt to run transition, or on a single cycle, this is set to 100.
E8	Cummlative total of cycle times (0 to @FFFF)	In ms. Resets to zero at @FFFF

2.6.6 The F-Tables

Table 2.6 The F-Table

Address	Content	Remarks
F0	Not used	
F1	Error flag	Any non-zero value placed in F1 by user program trips the watchdog, terminates program execution and displays a fixed diagnosis message on programming unit screen.
F2	System Fault bits	
F2.0		Set to 1 for program cycle if previous cycle exceeds preset scan time.
F2.1		Set to 1 if re-compile successful. Set to 0 if unsuccessful.
F2.2		Set to 1 if re-compilation will occur on the current scan.
F2.3		Reserved
F2.4	Battery condition	Set to 1 if Battery power low
F2.5 to 2.15	Reserved	
F3 to F9	Reserved	
F10 to F69	Serial link diagnostics	See Section 8.6
F70 to F129	Serial link statistics	See Section 8
F130 to F209	Reserved	

2.6.7 I-Tables

The I data tables are allocated as shown in Table 2.7

Table 2.7 The I-Table

Address	Content	Remarks
I0 to I39	User Control mode for serial port 1	
I40 to I79	User Control mode for serial port 2	
I80 to I119	Reserved (for future user control mode for port 3)	

2.6.8 J- and K-Tables

The J- and K-tables are allocated when serial communications ports are configured in the P-Tables. The allocations depend upon the communications protocols in operation (Section 4 refers).

Table 2.8 The J/K-Tables

Address	Content	Remarks
J/K0 to J/K511	Serial port 1	
J/K512 to J/K1023	Serial port 2	
J/K1024 to J/K1535	Serial port 3	

2.6.9 R-Tables

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

2.6.10 V-Tables

The V-Tables are used by system software and most are of no interest to the user. V-table locations V47, V48 and V49 may be usefull during fault finding. The V-table may be read but not written to by the user.

Table 2.9 V-Table

Address	Content	Remarks
V0	Not used	
V1	Lower byte contents are incremented after each successful compilation	
V2 to V47	Used by system software	
V48	Contains checksum derived from user ladder diagram source code and P-table checksums	V49 to V52 are not included in the V-table checksum.
V49	Contains code giving size of system in use	} 1= 2,500 instructions } 2= 5,000 instructions } 3= 10,000 instructions } 4= 20,000 instructions
V50	Contains a code giving the type of memory	} 1= RAM } 4= EPROM
V51	Used by system software	
V52	Contains the length of message strings	

2.7 Non-Volatile Memory Option.

An EPROM based 131 controller can be achieved by connecting any of the four FLASH EPROM memory modules available. The FLASH memory modules are available in equivalent instruction and P-table sizes to the RAM based range. See table 2.2. Once connected the 131 controller is automatically configured for FLASH memory operation.

The FLASH EPROMS contain the source ladder program, the compiled object program and the P-table data. Other system data will also be retained to allow the system to be used without a battery. If R and W-tables are to be retained then a battery must be fitted. The battery removed or discharged warning LED will operate as for a RAM system when in FLASH EPROM mode.

2.7.1 Program Development.

It is recommended that the user program development be done on a RAM based system first. Not only is it inconvenient to develop a program on an EPROM based system but it is worth remembering that there is a finite number of PROGRAM/ERASE cycles (around 10,000) allowed before the FLASH memory module becomes unreliable.

2.7.2 Connecting FLASH memory modules.

The FLASH memory module connects to the expansion connector on the 131 Processor module and is retained in position by four corner press fit rivets. The module has a two position switch, and when connected to the 131 Processor is only accessible when the 131 Processor is removed from the rack for configuration into either the PROTECT or the PROGRAM mode.

2.7.3 Down-loading a Program to a FLASH memory module.

To down-load a program to a FLASH Memory Module follow this procedure.

1. Develop the ladder program and data tables on a RAM based 131 system. Ensure that it operates appropriately and no further changes to the program are anticipated.

2. Copy the program into a GEM80 programming tool.

3. Power down the 131 System and remove the 131 Processor module from the subrack.

4. Remove the RAM expansion module (if one has been used) from the 131 processor.

5. Connect a FLASH EPROM Module of instruction size equal or greater than that of the RAM memory size used.

6. Check that the switch on the FLASH memory module is set to the PROGRAM position then insert the 131 processor into the subrack.

7. Power up the 131 controller and re-connect the programming tool. The programmer banner will confirm the system is configured for FLASH EPROM and the size connected.

8. Issue a CLEAR STORE command. This will erase the FLASH EPROMS ready for programming.

Note the Programming tool may time out at this point as the 131 processor carries out the clear store command. This is because erasing of the FLASH EPROMS takes a number of seconds to complete. If the programming tool times out the clear store will complete successfully.

9. Copy the ladder program from the programming tool to the 131 Controller.

10. Run the user program. This will compile the program and copy the P, V-tables and system data into the FLASH memory module.

11. Power off the 131 controller and remove the processor module.

12. Move the switch on the FLASH memory module to the PROTECT position and re-insert the module. The battery may be removed at this point if it is not required.

13. Power up and the controller will run from FLASH memory. No further editing of the program is permissable without again going through this procedure.

2.7.4 Start Up Sequence and Controller State.

The 131 controller start up sequence is slightly different when in EPROM mode. It depends upon the following:

Is there a program in the EPROMS ?
Is it corrupted ?
Is there a battery fitted ? Is it discharged ?
Has the FLASH memory module been changed ?
Is the memory module in PROGRAM or PROTECT mode ?
Is the program the same as the last time it was powered up ?

More information on the action of the controller depending on the above variables can be found in the Error Messages Section 8, tables 8.1 and 8.2.

2.7.5 Important Safety Notes.

1. If a FLASH memory module contains a compiled program and the switch is set to PROTECT then if it is inserted into a 131 Processor which has no battery fitted then the controller will power up running the program in the FLASH memory module regardless of what it was doing when it was powered off.

   To guard against this initially set the FLASH memory module to the PROGRAM mode.

2. If an EPROM based system relies on the maintenance of R and W-tables during a power break then if there was to be a power break and the battery was discharged the system would come up running with the R and W-table cleared.

To guard against this test the power fail bit (F2.4) in the ladder program and initiate a user watchdog trip by setting F1 to a non zero value.

This page left intentionally blank

3.1 Introduction.

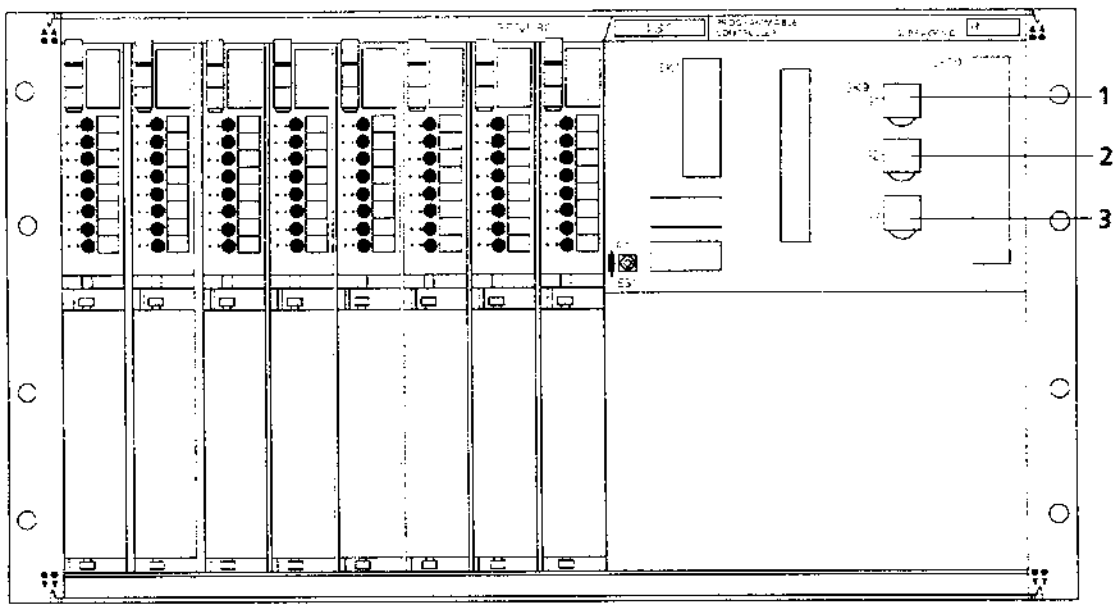
The GEM80/131 I/O modules are connected via the Basic I/O Highway. There are connectors for eight I/O Modules on the Controller Backplane and two connectors on the front panel of the Processor Module to allow Basic I/O subracks containing additional Basic I/O modules and operator interface devices to be connected to the Highway with ribbon cables. The ribbon cables are designated R1 and R2 and each can support up to 256 I/O points.

3.2 Address Settings

The GEM80/131 Controller and the I/O subracks can be used for 8, 16 and 32 point modules. The address of each module has to be unique, and it is set up on the subrack. Some addresses are determined by module position alone and some by decoder switches.

The following paragraphs explain in detail how to configure the I/O modules for a GEM80/131 Controller. It should be noted that the details applicable to the 12-slot I/O subrack have been included to assist the User in configuring a complete system.

Figure 3.1 shows a 131 Controller subrack with 8 Basic I/O modules fitted. The 8231 Processor and 9032 Power modules have been omitted to expose the decoder switches.



1. Decoder Switch 1
2. Decoder Switch 2
3. Decoder Switch 3

Figure 3.1 - Controller Subrack.

3.2.1 Address Decoder Switches.

Tables 3.1 and 3.2 show the scope of the switches for different subracks

Table 3.1 - 131 Controller subrack

8-point modules	16-point	32-point	Switch
1 to 4	1 to 2	NA	S1
5 to 8	3 to 4	NA	S2
NA	5 to 6	NA	S3

Table 3.2 - 12-slot I/O subrack

8-point modules	16-point	32-point	Switch
1 to 4	1 to 2	NA	S1
5 to 8	3 to 4	NA	S2
9 to 12	5 to 6	NA	S3

Note...32-point modules have their addresses fixed by position alone, as do 16-point modules placed in slots 7 and above.

The GEM80 uses 16-bit words. Each word may be a word of INPUT or a word of OUTPUT, but not both. This is why 8-point modules must be placed in groups of two inputs or two outputs.

Table 3.3 shows that each switch setting corresponds to two 16-bit words. This means that each switch can set the address of four 8-point modules or two 16-point modules. Remember that there are two ribbon cables carrying the I/O so the switch settings will give different addresses on different ribbons.

Table 3.3 - Switch Settings

Switch Setting	Addresses Selected on Ribbon 1	Addresses Selected on Ribbon 2
0	0 & 1	16 & 17
1	2 & 3	18 & 19
2	4 & 5	20 & 21
3	6 & 7	22 & 23
4	8 & 9	24 & 25
5	10 & 11	26 & 27
6	12 & 13	28 & 29
7	14 & 15	30 & 31
8 & 9	Variable addressing unused	

Table 3.4 shows the effects of the decoder switches on 8-point modules, illustrating in more detail that each switch position will cover 32 I/O points.

Table 3.4 - Effect of Switches on 8-point modules

	Second Word		First Word		
	Points 8 to 15	Points 0 to 7	Points 8 to 15	Points 0 to 7	Switch Used
SLOT	4	3	2	1	S1
SLOT	8	7	6	5	S2
SLOT	12	11	10	9	S3

Table 3.5 shows the effect of the switches on 16-point modules. It is important to note that the decoder switches case only covers the first six slots of I/O in any subrack. If 16-point modules are fitted into the remaining slots, the address is determined by slot position only.

Table 3.5 - Effect of Switches on 16-point modules

	Second Word	First Word	Switch Used
SLOT	2	1	S1
SLOT	4	3	S2
SLOT	6	5	S3

3.2.2 Arranging the I/O

The most convenient way of arranging the I/O modules in a complete system is to start with the 8-point modules, record their addresses, continue with the 16-point modules and then the 32-point modules. Using the following instructions systematically will ensure a trouble-free installation:-

(1) 8-Point modules.

Group all the 8-point modules in pairs of input and pairs of output modules. Modules left over are dealt with later. Record the groupings.

Pairs of 8-point inputs _____

Pairs of 8-point outputs _____

Total number of Pairs _____

The decoder switches on each I/O subrack control the address of four 8-point modules. Groups of four can be made by combining two pairs together.

Number of Fours (Two pairs) _____

Take the first group of four 8-point modules and place them in the first four slots of the Controller subrack. Set all the decoder switches to zero. Take subsequent groups of modules and place them in the subracks in groups of four slots whose addresses are controlled by one decoder switch (i.e. slots 1 to 4, 5 to 8 or 9 to 12). Set the decoder switches so that each group of four has a unique address - start low and work up. Since there are only 8 slots available for I/O modules in a Controller subrack, SW3 is not used when only 8-point modules are fitted and must therefore be set to 8 or 9.

Use Tables 3.8, 3.9 or 3.10 to record the configuration. Write the module type and address in the space provided at the bottom of each slot. Record the switch settings in the panel at the right-hand end of the subrack.

Place any additional modules in the next available group of four, (remember the rules about pairs of INPUT and OUTPUT modules and place these in the next available group of four slots. Record the address and the switch setting.

(2) 16-point modules.

Place 16-point modules in the subrack starting with the next ODD numbered slot. Record the position on the appropriate table. If the address for that position is controlled by a decoder switch, select the next available address and record it on the Table along with the switch setting. If the address is fixed, record this on the Table.

(3) 32-point modules.

Position any 32-point modules and record the address. All the addresses are fixed, depending on the Ribbon number and subrack position only. Tables 3.6 and 3.7 show these addresses.

In a 12-slot I/O subrack some slots cannot be used by 32-point modules. Table 3.7 gives details.

Note... Each module MUST have a unique address or the system will not work. Where switches are not being used for addressing, set the switch to position 8 or 9.

Table 3.6 GEM80/131 Controller subrack.

	RIBBON 1		RIBBON 2	
Slot	16-point	32-point	16-point	32-point
1	NA	0 & 1	NA	16 & 17
2	NA	2 & 3	NA	18 & 19
3	NA	4 & 5	NA	20 & 21
4	NA	6 & 7	NA	22 & 23
5	NA	8 & 9	NA	24 & 25
6	NA	10 & 11	NA	26 & 27
7	6	12 & 13	22	28 & 29
8	7	14 & 15	23	30 & 31

Table 3.7 GEM80 12-slot I/O subrack

	RIBBON 1		RIBBON 2	
Slot	16-point	32-point	16-point	32-point
1	NA	0 & 1	NA	16 & 17
2	NA	2 & 3	NA	18 & 19
3	NA	4 & 5	NA	20 & 21
4	NA	6 & 7	NA	22 & 23
5	NA	UNUSED	NA	UNUSED
6	NA	8 & 9	NA	24 & 25
7	10	UNUSED	26	UNUSED
8	11	10 & 11	27	26 & 27
9	12	UNUSED	28	UNUSED
10	13	12 & 13	29	28 & 29
11	14	UNUSED	30	UNUSED
12	15	14 & 15	31	30 & 31

Table 3.8 GEM80/131 Controller subrack

Rack No._____

Slot	8	7	6	5	4	3	2	1	Decoder Switches
Module I/O Points	32/16 8	32/16 8	32/16 8	32/16 8	32/16 8	32/16 8	32/16 8	32/16 8	S1 = S2 = S3 =
Address									
Current (mA)									Total Current used in Subrack (mA)

Table 3.9 GEM80 12-Slot Subrack Rack No. ____

Slot	12	11	10	9	8	7	6	5	4	3	2	1	Decoder Switches
Module I/O Points	32/16 8	16 8	32/16 8	16 8	32/16 8	16 8	32/16 8	16 8	32/16 8	32/16 8	32/16 8	32/16 8	S1 = S2 = S3 =
Address													
Current (mA)													Total Current used in Subrack (mA)

(4) Operator Interface Units

8872 Membrane Keyboard
9005 Membrane Keyboard (Tactile)
8932/33 Decade Display
8944 Thumbwheel Input

Each of the above units has an address decoder switch. These have ten positions numbered 0 to 9 (apart from the 9005 which has 16 positions numbered 0 to F). Settings 0 to 7 relate to the A/B-table addresses as shown in Table 3.3, settings 8 and above are not used.

3.3 Data Table Addresses for Each I/O Point

In the example shown in Figure 3.2, module numbers 1 and 2 are input modules and will have an A-table address. Each module has 8 channels so the two modules have 16 points and form one 16-bit word A0 as shown in Figure 3.2. Word A0 will store the input states for these 16 points.

Module numbers 3 and 4 are 8-point output modules and as output addresses are B-table, will have a B-table address.

In this example, address A0 are input modules, so address B0 does not exist and also B1 are output modules, so address A1 does not exist. Addresses are allocated to locations 0 to 31 as A or B according to whether input or output modules are fitted. Also, pairs of 8-point modules form one word, so each pair must be the same, either a pair of input modules or a pair of output modules. Figure 3.3 shows an example of two Basic I/O Highway ribbon cables on a GEM80/131 Controller.

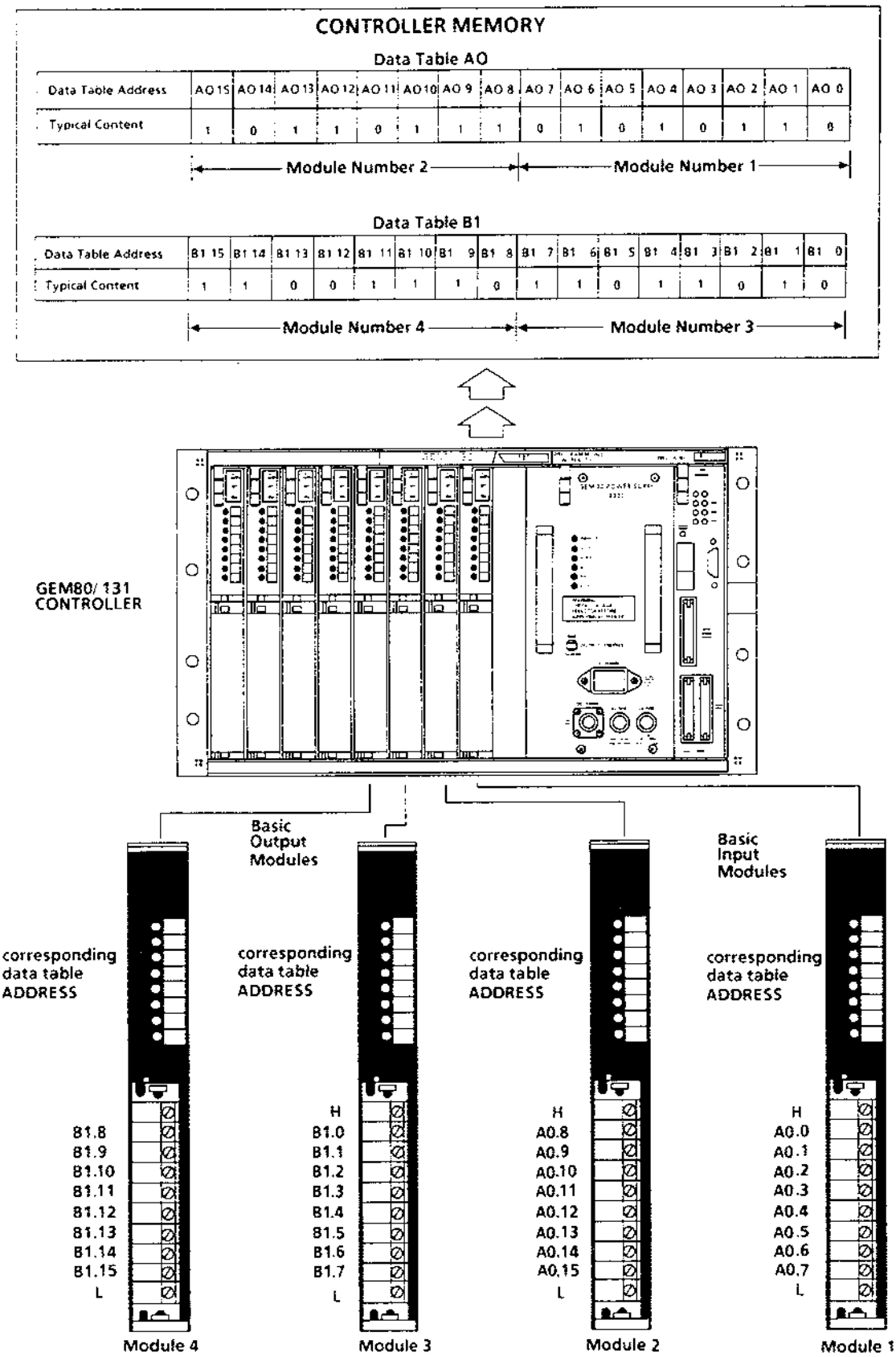
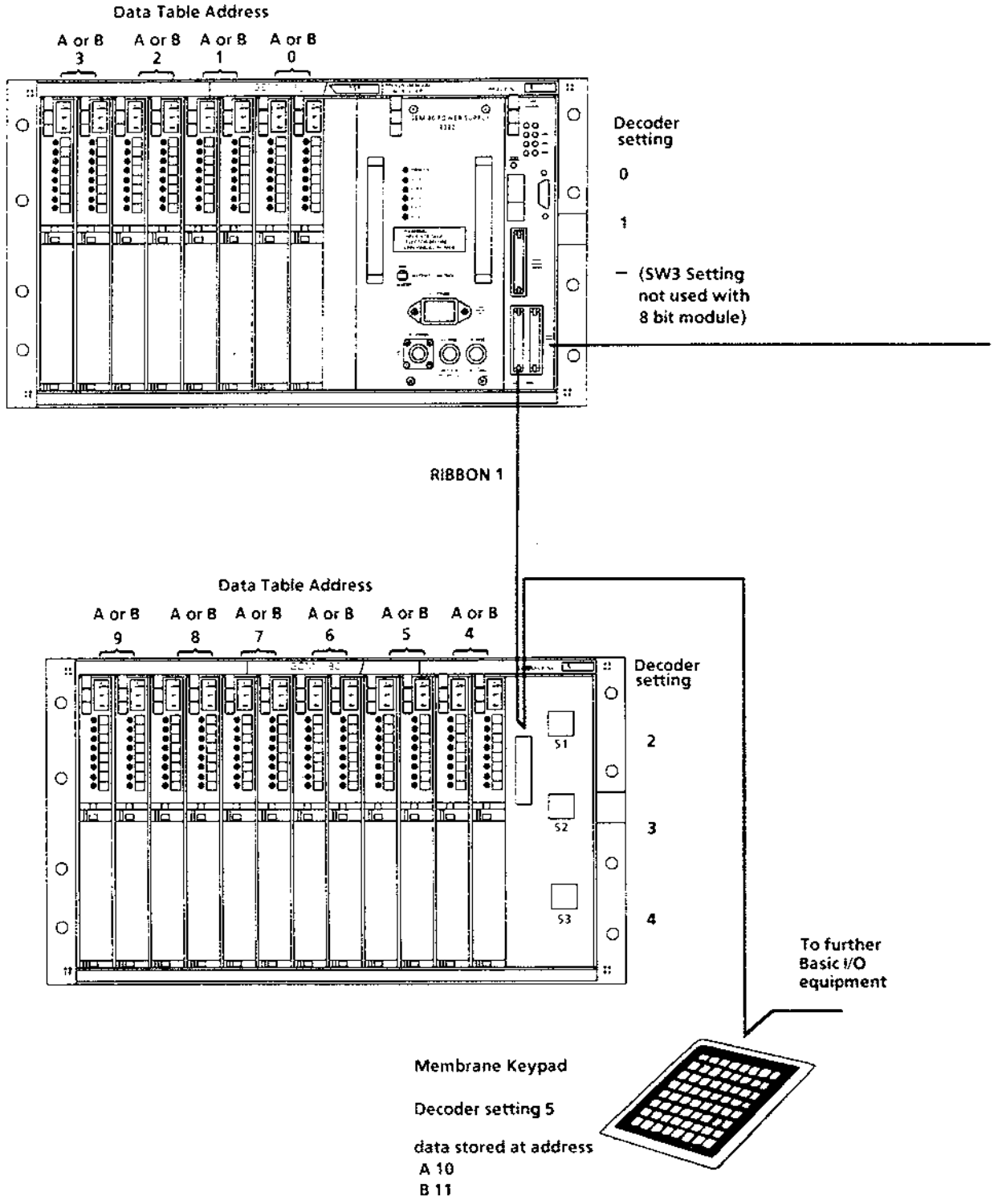


Figure 3.2 - GEM80/131 Basic I/O Addressing



Basic I/O Ribbon Cables 1 & 2 are VERY CLEAN category (Section 6 refers).

Figure 3.3 - Typical Basic I/O Highway

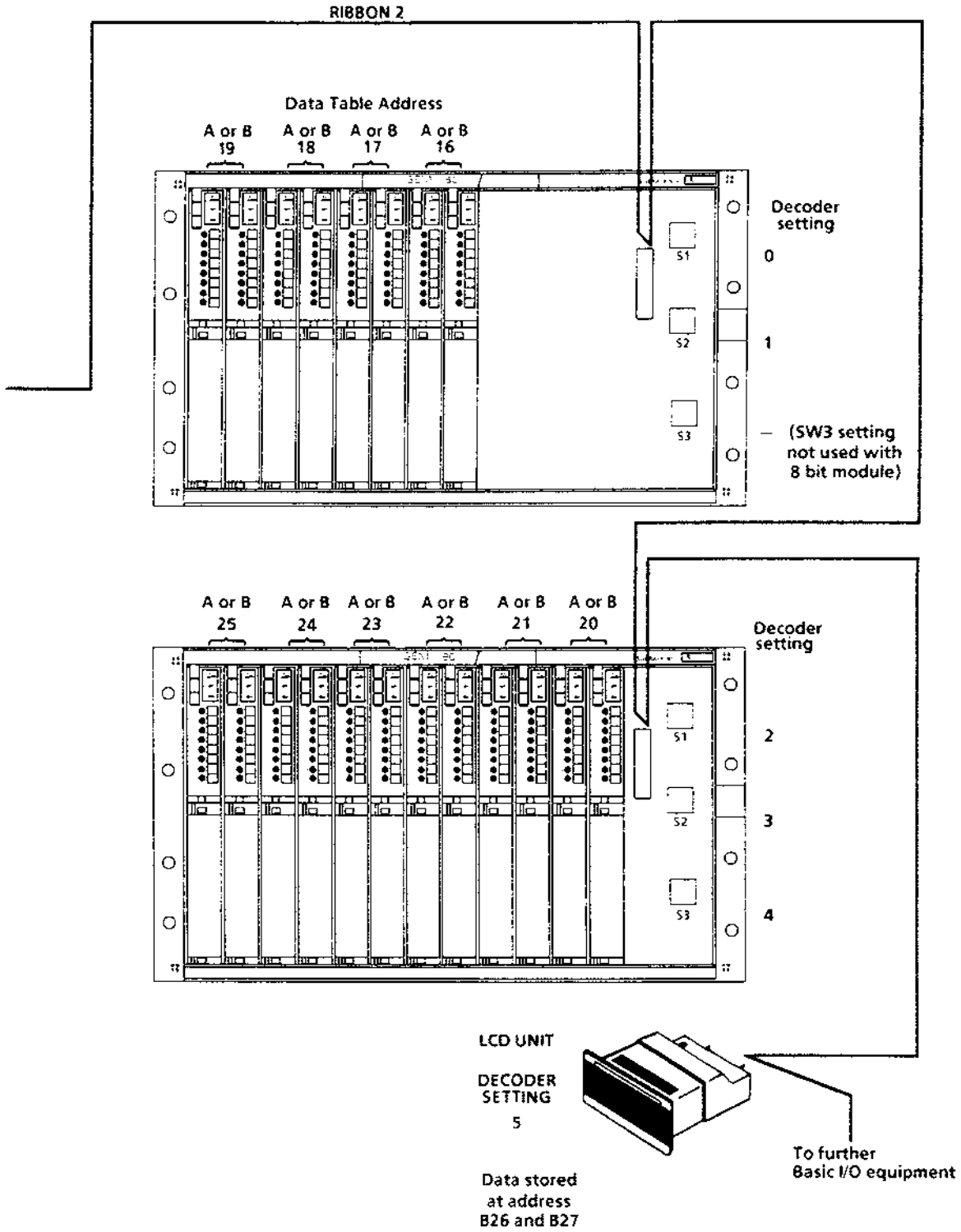


Figure 3.3 - Typical Basic I/O Highway (cont)

3.4 Power for the Basic I/O Equipment

3.4.1 Introduction

Basic I.O modules require a +15V power source which is provided from the subrack backplane. The modules may be situated either in the controller subrack, in which case they are powered from the 9032 Power Supply in the Controller subrack, or in additional I.O subracks. Where additional I.O subracks are used these may be powered in one of four ways:

(1) From the Controller power supply through the Basic I.O ribbon cable.

(2) From the Controller power supply through separate power supply cable.

(3) From a power supply fitted to an (8-slot) I.O subrack.

(4) From an external power supply provided by the User.

3.4.2 The 9032 Power Supply

The 9032 Power Supply fitted to the Controller subrack provides the +5V and + 15V supplies required by the Processor Module and can also provide an additional 4.5A at 15V which can be used to power Basic I/O modules. The +15V supply can be routed to additional subracks either through the basic I/O Ribbon cables or by running a separate power supply cable between the Controller subrack and the I/O subracks.

The 9032 can provide a maximum of 4.5A at +15V to drive I.O modules and any Serial Termination panels.

3.4.3 Powering I/O Modules through the Basic I/O Highway Ribbon cables.

The simplest method of powering an I/O subrack is through the Basic I.O Ribbon cables, provided the current carrying capacity of the cables is not exceeded and the capacity of the 9032 power supply is not exceeded.

The maximum current carried by each ribbon cable should not exceed 2.1A for cables up to 10m long. If the ribbon cable is longer than 10m the current carrying capacity is calculated as follows:-

Maximum current (Amps) = 21.Length in metres.

The total current carried by both Ribbon 1 and Ribbon 2 should not exceed 2.5A.

Also the length of the Ribbon cable must not exceed 30 metres and the voltage drop in the cable must not exceed 3V. The current carrying capacity of Basic I.O Ribbon cables up to 30m in length is given in Table 3.11.

The remaining current available, if any, can be taken by discrete wiring from the 131 backplane terminal block.

Table 3.11 - Basic I/O Ribbon Cable Current Carrying Capacity

Length of Basic I.O Ribbon Cable (metres)	Maximum Current Carried (amps)
10	2.1
15	1.4
20	1.05
25	0.84
30	0.7

When the Basic I/O Ribbon cable is used to power the 8859-4003 12-slot I/O subrack a link must be connected between Terminals 4 and 6 of Terminal Block TB1 to connect the ribbon cable supply to the subrack backplane.

If sufficient capacity is available from the 9032 power supply and the ribbon cable has sufficient carrying capacity, more than 1 subrack can be powered from each I/O Ribbon cable. Figure 3.4 shows multiple subracks powered from the Basic I/O Ribbon cable.

3.4.4 Powering I/O Subracks from the Controller Power Supply Using Discrete Wiring

If the 9032 Power Supply has sufficient capacity but the capacity restrictions of the Basic I.O Ribbon cable are exceeded, additional I.O subracks should be connected to the Controller Power supply using discrete wires. The power supply wiring is connected to TB2 (+15V) and TB3 (0V) on the terminal block on the Controller backplane and TB1.7 (+15V) and TB1.8 (0V) on the I/O subrack backplane. Figure 3.5 shows the method of connecting I.O subracks using discrete wiring. TB1.7 and TB1.4 on the I.O subrack backplane must NOT be linked.

The length limit for discrete wires depends on the size of the wires used. The terminals on the subracks can accommodate wire sizes up to 2.5 sq. mm. but 1.0 or 1.5 sq. mm. wire sizes should be adequate.

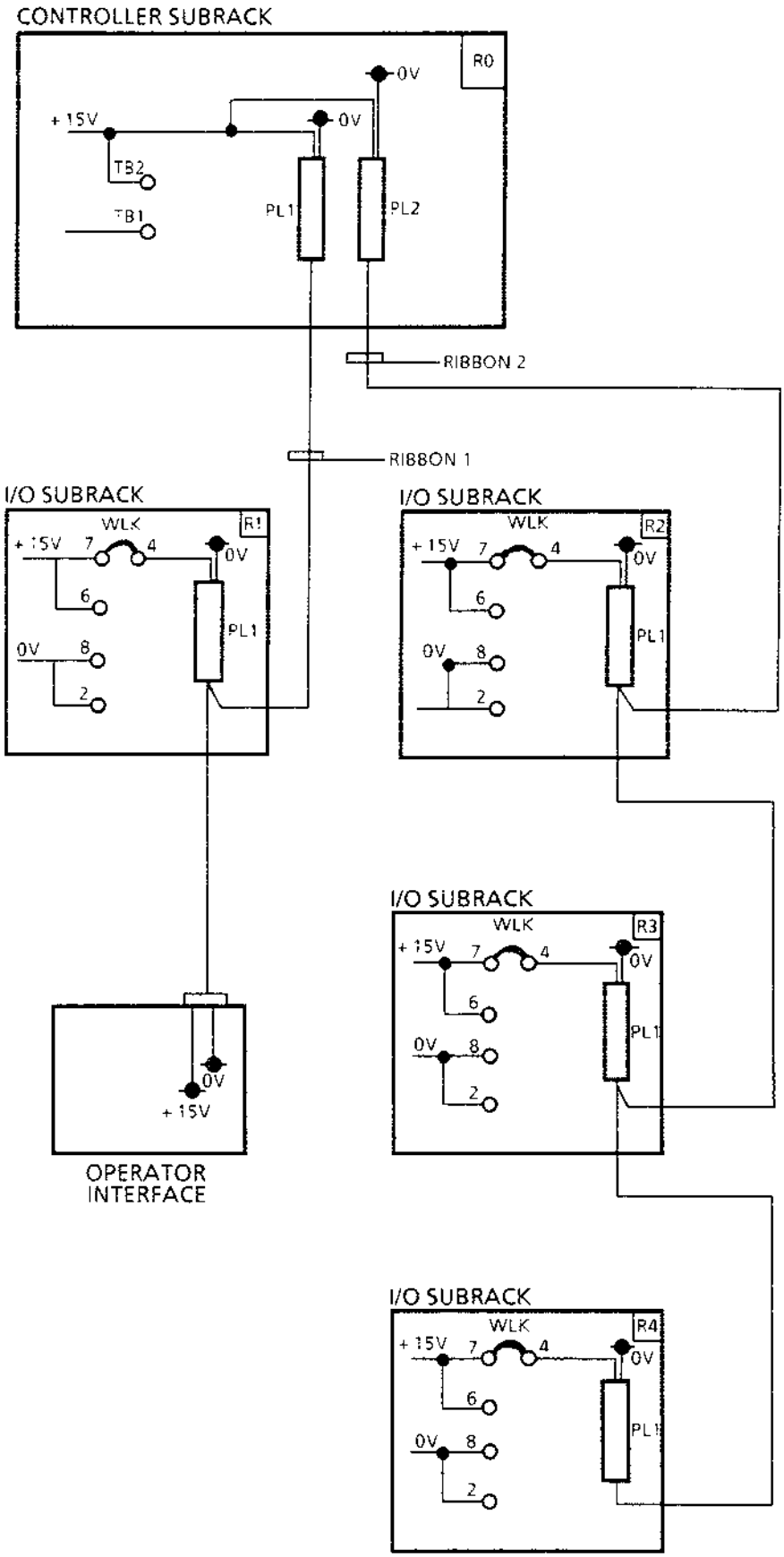


Figure 3.4 - Powering I/O Subracks through the Basic I/O Ribbon Cable

3.4.5 Connecting an External Power Supply

If an external +15V power supply is used it will be connected by discrete wires and the terminal block links must NOT be fitted. Figure 3.5 shows the method of connecting I/O subracks using an external +15V power supply.

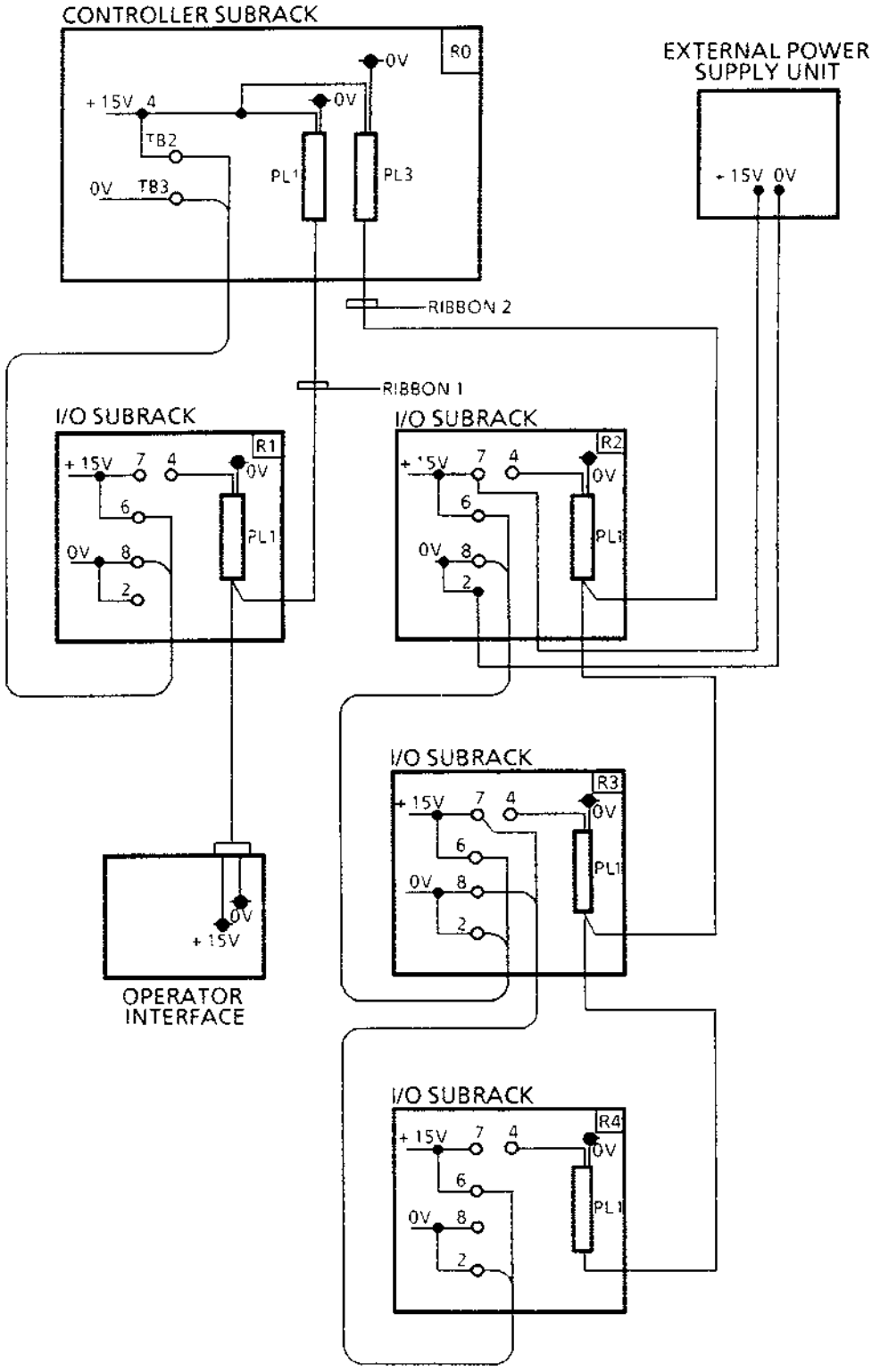


Figure 3.5 - Powering Basic I/O Subracks Using Discrete Wiring

3.5 Basic I/O Ribbon Cables

WARNING: DO NOT INSERT OR REMOVE RIBBON CABLES WITH THE POWER ON.

3.5.1 Ribbon Cable Connection Details

These cables connect the Basic I/O highway from the Controller subrack to each item of Basic I/O in a 'daisy chain' arrangement.

Ribbon cable 1, for addresses 0 to 15, connects to Basic I/O connector 1 on the 131 Controller module.

Ribbon cable 2, for addresses 16 to 31, connects to Basic I/O connector 2 on the 131 Controller module.

The ribbons are in the 'very clean' category (refer to Section 6). They should be kept as short and flat as possible.

3.5.2 Assembly of Basic I/O Ribbon Cables.

There are three cabling options available:

(1) Standard Ready Assembled Cables

These are for use in simple systems to connect between the Controller subrack and up to three Basic I/O subracks. There are four different cables available each having a pre-defined length between the 1st socket (Controller) and the 2nd socket (1st I/O subrack) (length A). The length between I/O subracks (sockets 2, 3 and 4) is 1 metre in each case, see Figure 3.6 for details.

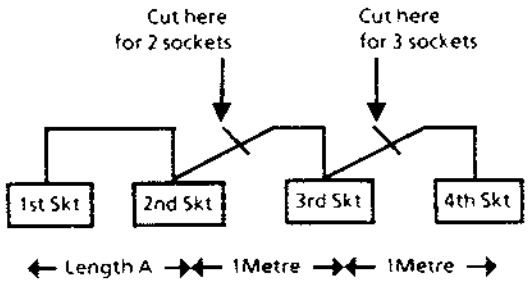


Figure 3.6 - Standard Ready Assembled Basic I/O Ribbon Cables.

If either a 2- or 3-socket cable is required, the ribbon cable should be cut as close as possible to the last socket.

Ensure that the standard dimensions suit the installation.

Ordering codes for standard ready assembled cables are given in Section 9.

(2) Non-Standard Ready Assembled Cables

Non-standard cables can be supplied to order. The distance between sockets is user-specified to suit the installation and up to 9 sockets can be fitted.

Simply fill in part A of Figure 3.7.

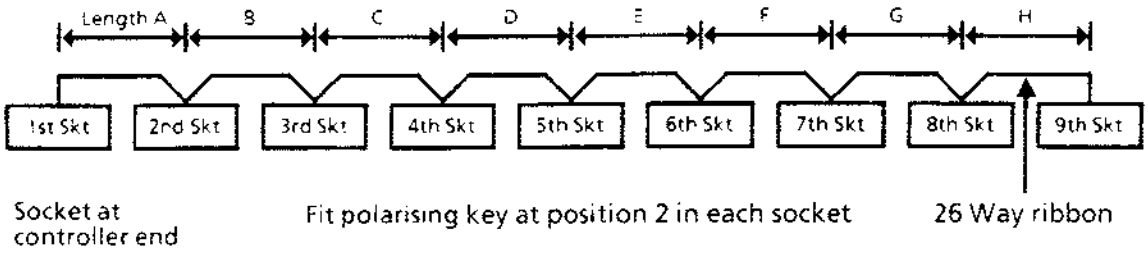
(3) Parts required for Make Up Cables

Parts may be specified using part B of Figure 3.7. See Appendix A for cable assembly information.

Ribbon Cable	:	26-way flat ribbon
	:	width 33mm
	:	Spectra type 843-191-2801-026 or equivalent
Connectors	:	Harting type 0918 526 5823 connector
	:	Polarising key in position 2

3.5.3 Length Limits for 26-way Basic I/O Ribbon Cables

The length of Basic I/O Ribbon cables is limited by the current carrying requirements. The method of calculating the permissible length of cable is shown in Section 3.4.3.



Notes

1 Complete Part A only when ordering assembled cables.
2 Complete Part B only when ordering parts to make up your own cables.

PART A-ASSEMBLED CABLES (Delete if not required)

No. of Sockets	Order Code
2	8890-4601
3	8890-4602
4	8890-4603
5	8890-4604
6	8890-4605
7	8890-4606
8	8890-4607
9	8890-4608

No. of Sockets				
Order Code	8890-460	8890-460	8890-460	8890-460
Ribbon No.(1,2 etc.)				
Length	Length in metres			
A				
B				
C				
D				
E				
F				
G				
H				
Finished Length (Total of A to H)				

PART B - PARTS (Delete if not required)

Part	Order Code	Comments	Length (metres)*	No. off
Ribbon Cable (26 Way)	56685/418	Max. Length = 30 Metres		
Socket (26 Way)	80560/098			
Polarising Key & Label	8890-4004	1Per Socket		

*Add 20mm per socket to finish length to allow for socket termination

Figure 3.7 - 26-Way Basic I/O Highway Ribbon Cables

3.5.4 Segregation of 26-Way Basic I/O Highway Ribbon Cable

These ribbon cables are noise sensitive and they should be as short as possible and segregated from other noisy cables. With cubicle mounted Controllers, it is not recommended to run this cable outside the cubicle or cubicle suite. Section 6, Installation covers the cabling and segregation of Basic I/O ribbons.

3.6 Basic I/O Module Interlock System

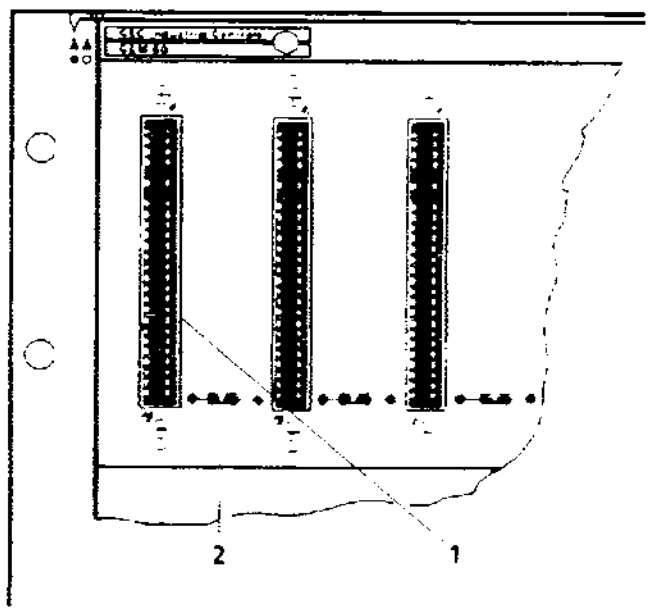
All subracks that contain Basic I/O modules include a circuit consisting of links within the Basic I/O modules and subracks. This is arranged so that when all the modules are fitted, a series chain of links is completed giving a short circuit. If, however, a module is removed, the series chain of links is broken giving an open circuit.

It is envisaged that this system could be used to interlock with a relay coil or an input channel of a Basic I/O module. This may, if required, be part of the system healthy checks in the user program, so that if the Basic I/O input channel, to which these interlocks connect, is high, then all Basic I/O modules are fitted. Connections for this are shown in Figure 3.9.

Where the Basic I/O subrack is not completely full of modules, a shorting link in the form of a zero ohm resistor is fitted on the backplane so that the series chain of interlocks would be completed by the zero ohm resistors if no modules were put in the subrack. To activate the module interlock system, it is necessary to cut out the zero ohm resistor at each connector where a Basic I/O module is fitted, see Figure 3.8. The zero ohm resistor is located immediately to the right of the Basic I/O module connector.

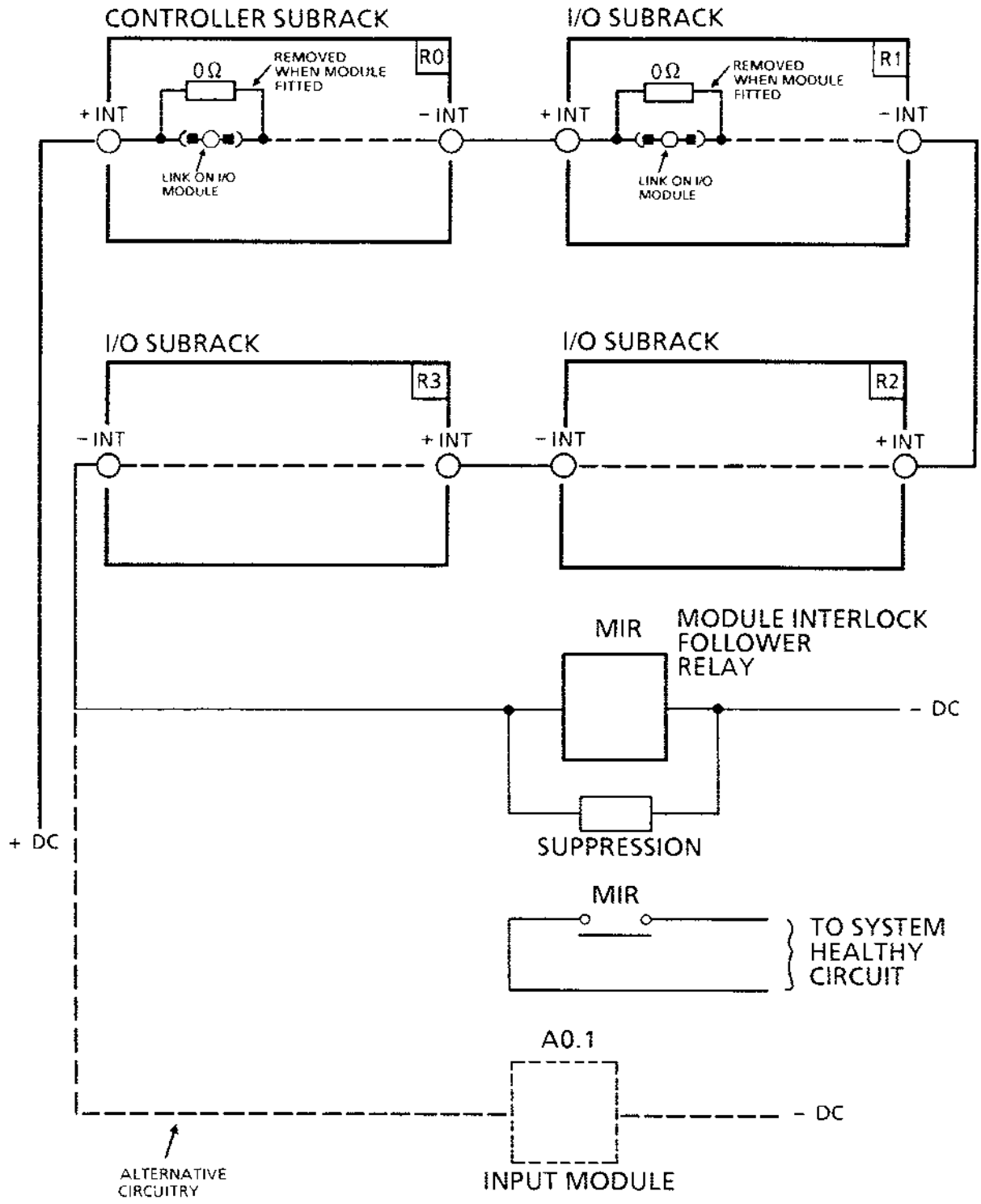
3.6.1 Module Interlock Circuit Ratings

Circuit	Volt-free contact
	For use in d.c. circuits only with restrictions of 50V d.c. and 0.5A peak
Operation	Closed when all Basic I/O modules are fully inserted into the rack
Connections	Terminals on subrack backplane. Remove the Power module for access. Maximum wire size 2.5 mm^2



1. Edge connector for the I/O module.
2. Associated zero ohm resistor (cut out when a module is to be fitted).

Figure 3.8 - Zero Ohm Resistors for Basic I/O Module Interlock System



Notes... 1. All wiring is 'DIRTY' category

2. Maximum size of wiring that can be terminated at +INT and -INT terminals is 2.5 sq.mm.

Figure 3.9 - Typical Module Interlock Circuit

3.7 Output Enable Modules

Some Output modules incorporate 'output enable' circuitry. This ensures that all outputs are held in the 'OFF' state until:

(1) An enable signal of +15Vd.c. ±3.5V is present

and

(2) The GEM80 Controller initiates the output 'ON'.

The enable signal is applied to the subrack and will enable all 'output enable' modules contained in the subrack. The enable signal would normally be provided via the Watchdog relay so that the outputs are inhibited on initial switch on and when the Watchdog opens.

Other subracks which have this feature are:

8857-4006 - Power Supply and 8-slot I/O subrack

8859-4003 - 12-Slot I/O subrack

3.7.1 Output Enable Connections

Output Enable connections to the subracks are shown in Figures 3.10 and 3.11. Figure 3.10 illustrates the use of GEM80 +15V power supplies and Figure 3.11 illustrates the use of External +15V power supplies. R14 and R15 should be removed as indicated.

Note... Each Output Enable module connected using the GEM80 power supply draws an additional 10mA.

3.8 Wiring Segregation

The segregation category depends on the power supply providing the enable signal. If the signal is derived from the Controller power supply or another GEM80 power module, it is considered to be 'very clean' and must be separated from any 'dirty' plant-side wiring. If however, the signal is supplied from a remote power supply which is also supplying 'dirty' circuits, the enable wiring can run with other 'dirty' plant-side wiring. It MUST NOT be run alongside clean' or 'very clean'

3.8.1 Wiring Size

The maximum size of wiring that can be terminated at +EN and -EN terminals is 2.5 sq.mm. These terminals are located on a Terminal Block, on the Backplane (refer to Section 1 Figure 1.5).

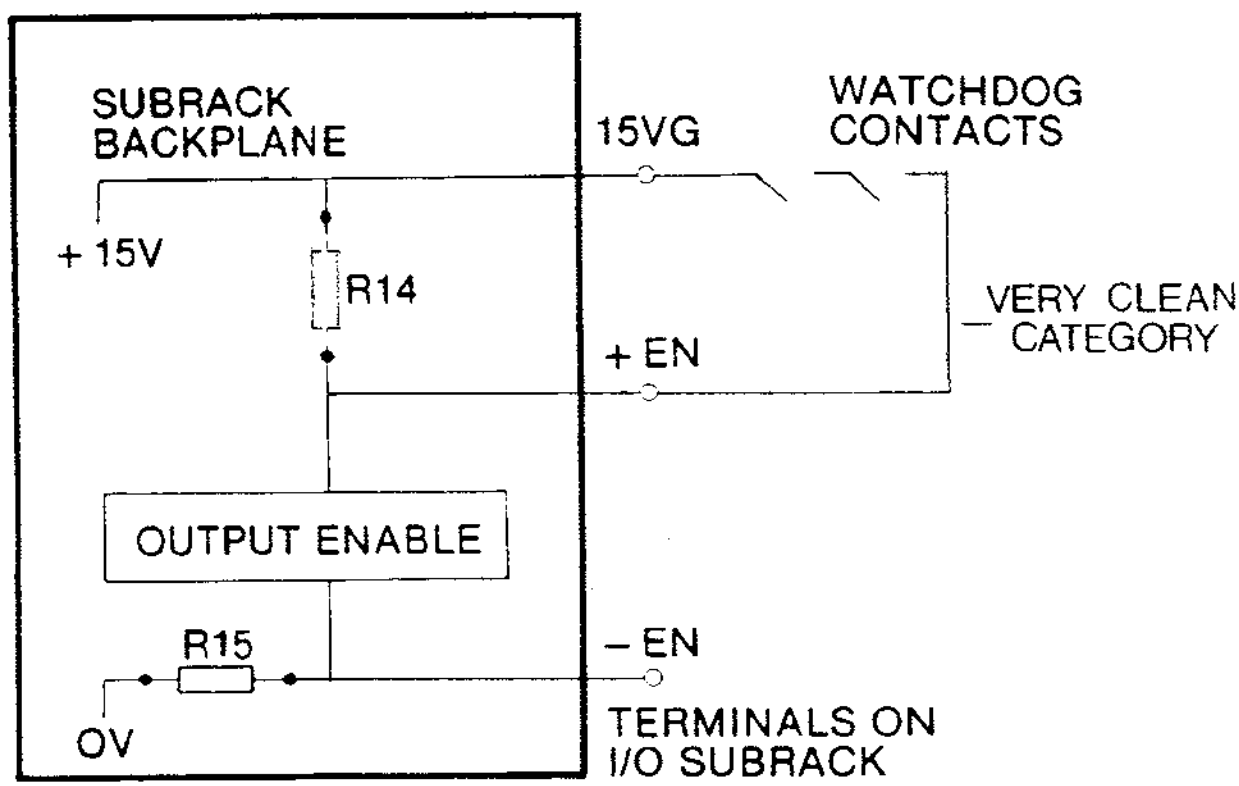


Figure 3.10 - Connection of Output Enable Signal using the GEM80 Power Supply

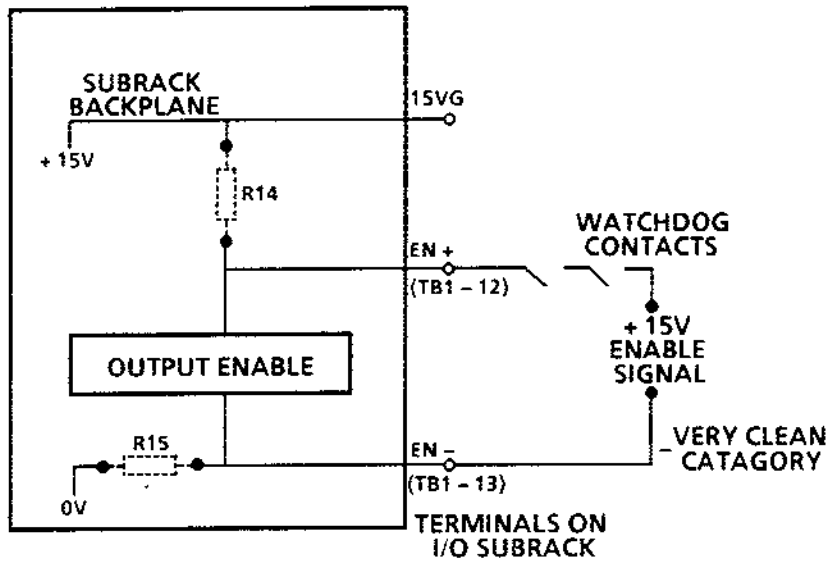


Figure 3.11 - Connection of Output Enable Signal using an External Power Supply

4.1 Introduction

GEM80 control systems use serial communications links to pass information between controllers, to connect a controller to a System Programmer, to drive printers and to connect other peripheral equipment such as operator keypads and the GEMSTART Contactor Control Unit (CCU). The GEM80/131 Controller has three serial communications ports and these are numbered port 1, port 2 and port 3. A 26-way Ribbon cable connector is used to connect ports 1 and 2 and a 15-way D-type connector is used to connect port 3, these are situated on the front panel of the 8231 Processor Module.

Port 3 is an RS232C 20mA port and is used to connect either a programmer or printer to the controller. Ports 1 and 2 are general purpose GEM80 RS422 Serial ports which support five different GEM80 serial communications protocols, these are:

(1) Extended Simple Protocol (ESP).

(2) ESP with flexible data tables

(3) GEMSTART.

(4) CORONET.

(5) ASCII (Printer/VDU Terminal).

Ports 1 and 2 can also be used as printer ports or as Terminal (Programmer) ports.

Connecting Serial Ports 1 and 2

Serial ports 1 and 2 must be connected via a termination unit which is used to convert RS422 signals to a suitable format. The following Termination Units are available:-

(1) 8587 - RS422 to RS485.

(2) 8924 - RS422 to 20mA.

(3) 9009 - RS422 to RS232.

Full details of these Termination Units and the methods of connecting Serial Links is given in the 'Serial Interface Termination Units and Panels Combined user Information', Publication No.T456 and the 'GEM80 Serial Communications Manual' Publication No.T457.

Data Tables

The GEM80/131 Controller uses the following data tables for serial communications:-

The P-table - used to set the port configurations.

The I-table - used to control the transmission and reception of messages.

The J-table - used to hold received data.

The K-table - used to hold data for transmission.

The F-table - used for error reporting and link statistics.

Table 4.1 Data Tables used for Serial Ports 1, 2 and 3.

Data table	Port 1	Port 2	Port 3
P-table	P10 to P29	P30 to P49	P50 to P69
I-table	I0 to I39	I40 to I79	I80 to I119
J-table	J0 to J511	J512 to J1023	J1024 to J1535
K-table	K0 to K511	K512 to K1023	K1024 to K1535
F-table	F10 to F29	F30 to F49	F50 to F69
F-table (link statistics)	F70 to F89	F90 to F109	F110 to F129

Configuring the Serial Ports

Ports 1, 2 and 3 are configured by pre-setting data in the the P data table, and then entering a RECOMPILE command (powering down is not required). The type of serial port is determined by the value entered in P11 for port 1, P31 for port 2 or P51 for port 3 and the function of the rest of the P-table locations is dependant upon this value.

The signalling (baud) rate is User defined between 110 and 19,200 bits per second. The rate is selected by entering the baud rate in P10, P30 or P50 for ports 1, 2 and 3 respectively. The following values of baud rate are allowed within the limits given in Tables 4.2 to 4.8 below:-

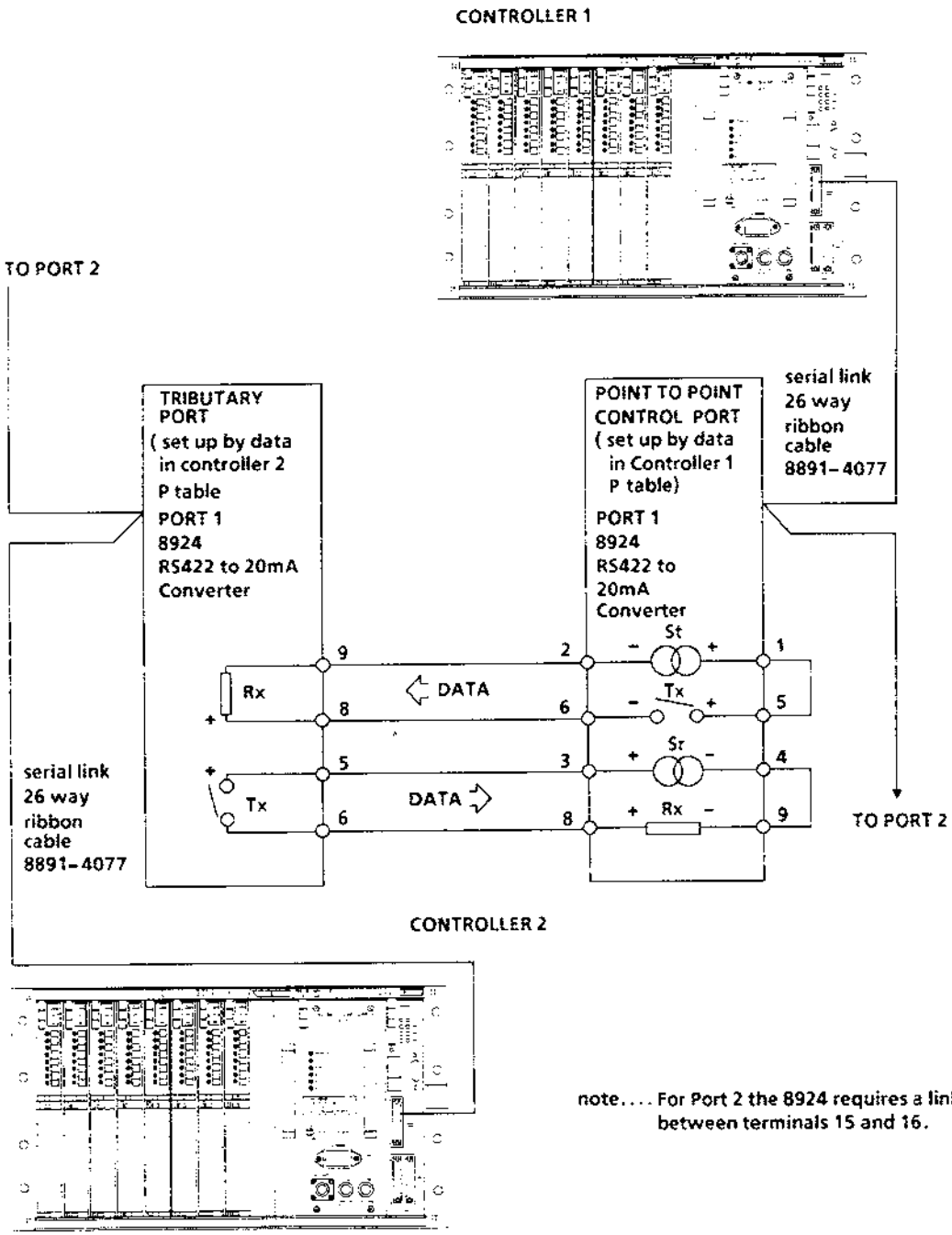
110; 300; 600; 1,200; 2,400; 4,800; 9,600 and 19,200.

4.2 Serial Link Communication Systems

Communications can be established by Point-to-Point or Multi-drop Serial Link systems.

4.2.1 Point-to-Point Serial Link

Figure 4.1 shows a point-to-point serial link. Here two Controllers interchange data. The serial communication port of one Controller is set up as a Control port and the other as a Tributary port.



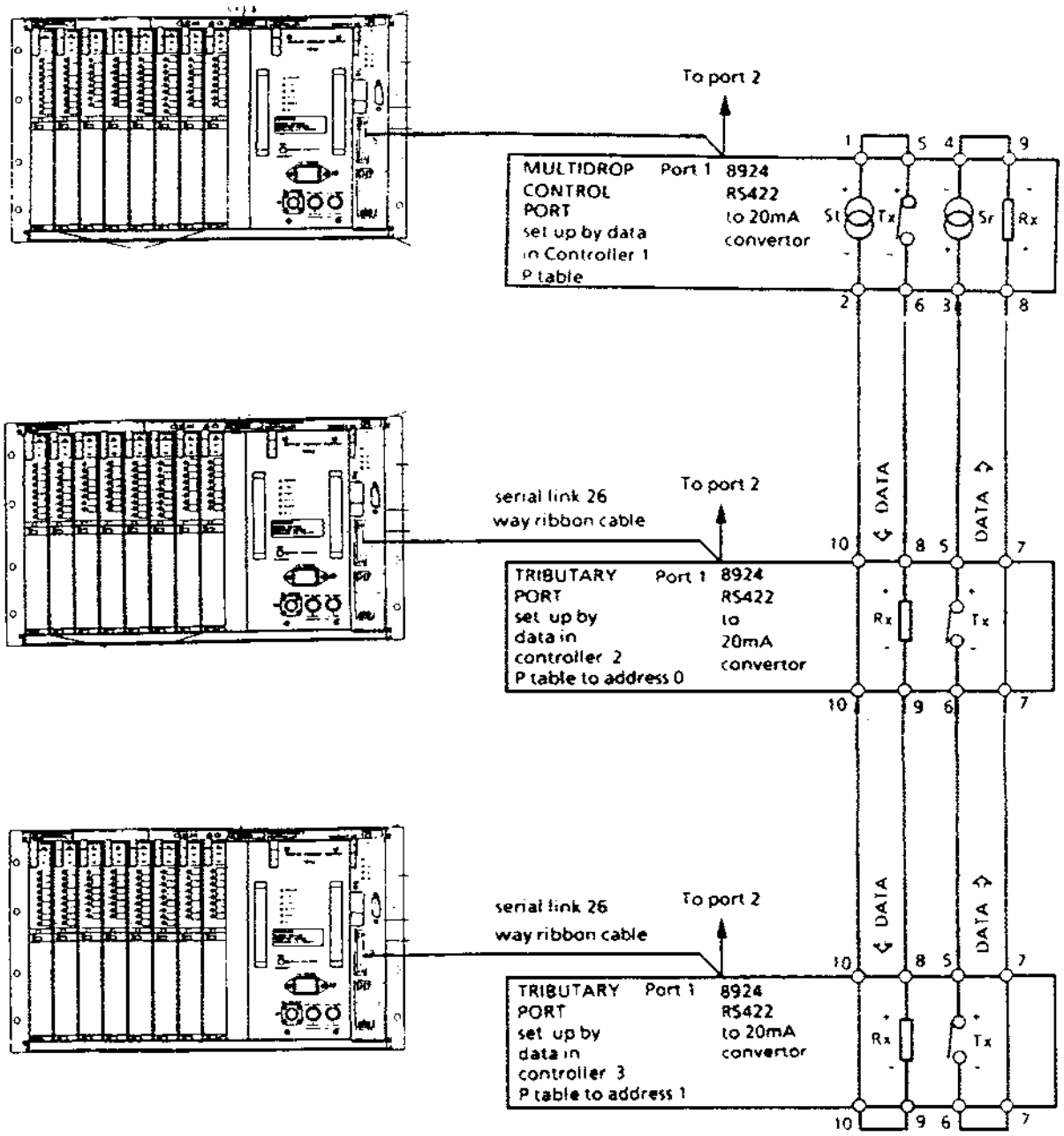
note.... For Port 2 the 8924 requires a link fitting between terminals 15 and 16.

Figure 4.1 - Point-to-Point Serial Communications Link Between Two 131 Controllers, 4-wire 20mA.

4.2.2 Multi-drop Serial Link

Figure 4.2 shows a multi-drop serial link in which up to 3 Controllers can interchange data. One Controller's serial communication port is set up as a Control port and the others are set up as Tributary ports.

The control port communicates with each tributary on a cyclic basis. Direct communication between tributaries is not possible though data can be exchanged between tributaries via the control port.



Note.... For Port 2 the 8924 requires a Link Fitting between terminal 15 and 16

Figure 4.2 - Multidrop Serial Communication Link Between Three Controllers 4-wire 20mA

4.3 Applications

The serial links can be used for the following applications:-

(1) To communicate with a printer, system programmer or VDU Terminal

(2) To communicate with a GEMSTART (CCU)

(3) To exchange data with other GEM80 controllers:

(a) as a tributary.

(b) as a controller.

(4) On a Local Area Network (CORONET)

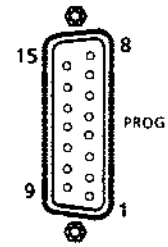
4.3.1 Using the Programmer/Printer Port

The Controller automatically detects whether either a programmer or a printer is connected to port 3. This is achieved by fitting a link in the programmer/printer cable connector (see Figure 4.3 for details)

When used as a programmer the port may be used at either 9,600 or 19,200 baud. The baud rate is automatically selected by the GEM80/131. Enhanced GEM80 system programmers have the option under the setup menu to select the faster baudrate. Selection of the faster baud rate enables faster communication with the GEM80 131, allowing faster downloading of tapes and faster monitoring etc.

4.3.2 Programmer/Printer Port (Port 3) Connections

The Programmer/Printer port connector is a 15-way D-Type socket connector with threaded retention pillars. The pinouts are as shown below:-



Pin	Connection	
1	RX+	
2	RX-	20mA
3	TX+	
4	TX-	
5	15V	
6	0V	
7	15V	
8	0V	
9	RXD	
10	TXD	RS232
11	CTS	
12	RTS	
13	See note	
14	0V	
15	5V	

Figure 4.3 - Printer/Programmer Port (Port 3) Pinouts

Note... If the programmer/printer port is to be connected to a printer using RS232 then link the following:-

Pin 13 to Pin 15
Pin 1 to Pin 15
Pin 2 to Pin 14.

If it is to be connected to a programmer using RS232 then link

Pin 1 to Pin 15
Pin 2 to Pin 14.

4.4 Communication with a Printer, VDU or Programming Tool

4.4.1 Specification

Application

Output of text and numeric data to printer, VDU or Programming tool.
Input of characters or strings from keyboard.
Option of automatic echoing and editing of input. Also supports XON-XOFF protocol in this mode.
Free format of input and output data to any serial device.

Characteristics

Depends on termination panel, e.g. 20mA current loop for panel type 8924.

ASCII character set (equivalent to ISO-7).

1 start bit, 7 or 8 character bits with odd/even or no parity with 2 stop bits.

Capacity

Buffer for up to 1,020 characters in each direction.
Line length up to 132 characters.
Indications when output buffer has room for one full line or is completely empty.
Buffers empty automatically as data is transferred.

4.4.2 Setting Up a Printer/Keyboard Port

Table 4.2 shows the P-table address and the data the user must write to these addresses to enable the port to operate as a Printer or Keyboard Port.

Changes to the P-table are implemented on RECOMPILE.

Table 4.2 - P-table for Printer/Keyboard Port

Port 1	Port 2	Port 3	Contents
P10	P30	P50	Baud rate (110 to 19200)
P11	P31	P51	0
P12	P32	P52	0 = Printer mode 1 = Terminal mode 2 = Free format mode
P13	P33	P53	No of Characters per line (1 to 132)
P14	P34	P54	No of padding characters (1 to 131)
P15	P35	P55	Parity Enable 0 = 8 data bits no parity 1 = 7 data bits plus 1 parity bit 2 = 8 bits plus 1 parity
P16	P36	P56	Parity select 0 = even parity 1 = odd parity
P17 to P29	P37 to P49	P57 to P69	Not used

4.4.3 Operation of a Printer/Keyboard Port

Figure 4.4 shows an example of a serial printer connected in a 20mA current loop from an 8924 unit, driven by a controller. The Printer/Keyboard port can operate in either 'Direct Mode' or in 'Terminal Mode'.

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

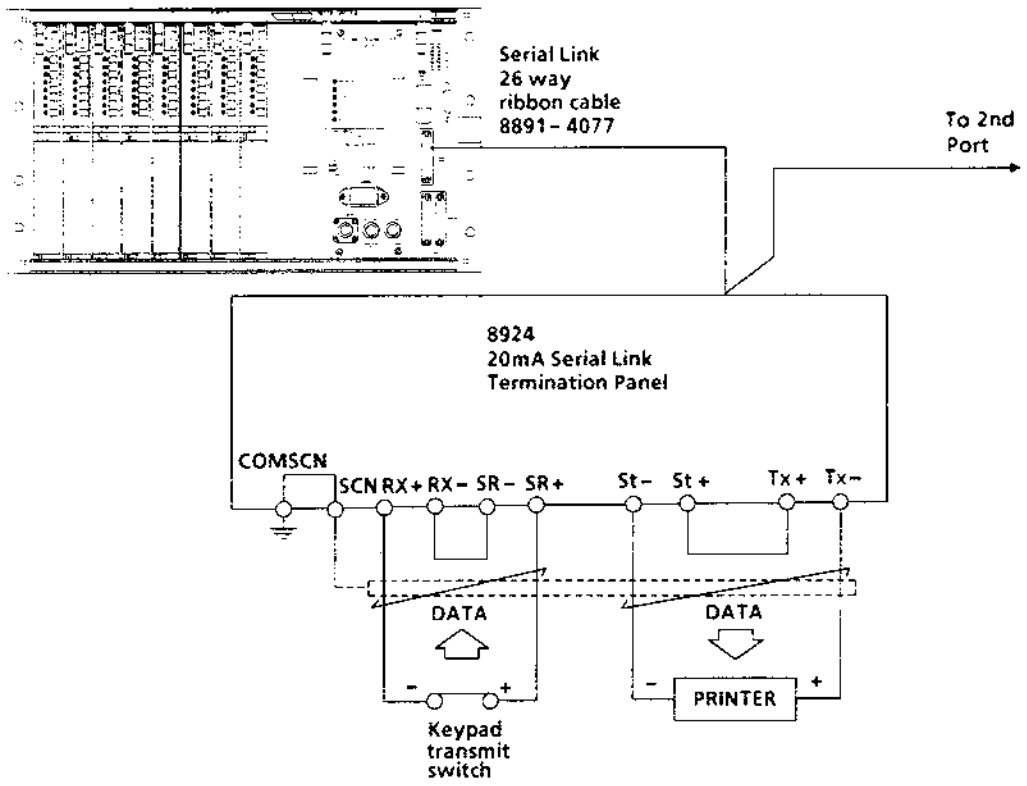


Figure 4.4 - Connection of 20mA Current Loop Printer Keyboard to a Serial Port

4.4.3.1 Direct Mode

This mode is intended for use with a printer and a separate serial input device, such as a matrix keyboard. The port has two cyclic buffers, one for input and one for output. Data can only be written to the output buffer, and read from the input buffer, by means of Special Functions.

All characters received from the keyboard are directly transferred to the input cyclic buffer as they arrive. If parity is enabled, any character with a parity error is replaced by @FF.

Output data is taken from the output cyclic buffer after the previous output has finished. Transmission does not commence until an ETX (@03) characteror an end-of-line marker (@0A) is found. An end-of-line marker is transmitted as carriage-return (@0D), line-feed (@0A), plus any user defined quantity of NUL (@00) characters. An ETX character is not itself transmitted, but simply initiates output from the cyclic buffer, allowing partial lines to be output.

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

4.4.3.2 Terminal Mode

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

4.4.3.3 Using a VDU Terminal

If a VDU is to be used it must have the following characteristics (ASCII character names are shown in parentheses):

(1) Pressing the carriage-return key generates @0D (CR).

(2) Pressing the Delete/Rubout key generates @7F (DEL).

(3) Receipt of @0D, @0A (CR,LF) moves the cursor to the left-hand edge of the screen on the next line, scrolling the display if on the last line of the screen.

(4) Receipt of @00 (NUL) performs no action.

(5) Receipt of @07 (BEL) sounds an audible alarm.

(6) Receipt of @08 (BS) moves the cursor one character position to the left.

(7) Receipt of @20 (SP) blanks out the current display position.

(8) Receipt of @1A (SUB) displays a non-blank character.

The port has an input cyclic buffer and an output cyclic buffer. Data can be written to the output buffer, and read from the input buffer, by means of Special Functions. This is the only way to access these buffers from the ladder diagram program.

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

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

(a) Any non-printing character other than CR, DEL, XON or XOFF is discarded (not loaded into the line buffer) and echoed as BEL.

(b) XOFF is discarded, and causes output (including echoing) to be suspended.

(c) XON is discarded, and causes output suspended by XOFF to resume.

(d) DEL is discarded, and causes the previous character loaded into the line buffer to be removed. It is normally echoed as BS, SP, BS. If, however, the line buffer is already empty, BEL is echoed.

(e) CR is echoed as CR, LF, plus the user-defined quantity of NUL characters. It is stored in the line buffer as an end-of-line marker (@0A). Once this has been done, the contents of the line buffer are transferred to the input cyclic buffer, and the line buffer is cleared.

(f) Any character other than CR which would cause the line buffer to contain as many characters as the user-programmed line length is discarded, and echoed as BEL.

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

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

Output data is taken from the output cyclic buffer after the previous output has finished. Transmission does not commence, however, until an ETX (@03) character or an end-of-line marker (@0A) is found. An end-of-line marker is transmitted as carriage-return (@0D), line-feed (@0A), plus any user defined quantity of NUL (@00) characters. An ETX character is not itself transmitted, but simply initiates output from the cyclic buffer, allowing partial lines to be output.

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

4.4.3.4 Free Format Mode

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

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

4.4.4 Operation of Printer/Terminal Buffer Store

When used in printer-terminal mode the space allocated for the J- and K-tables for the port is used for input and output buffers. The J- and K-table locations cannot be:

(1) referenced in the user program

(2) used for the value tables of Special Functions

(3) written to via a Programmer (although they may be monitored)

To furnish the user program with information regarding the state of the output buffer, two flags called the 'empty flag' and the 'filling flag' are provided. See Section 2 for more information.

The empty flag is set ON between program scans when the cyclic buffer is empty and all characters have been transmitted. It is set OFF by execution of any Special Function which outputs to that buffer.

The filling flag is set on during execution of any Special Function which outputs to the cyclic buffer and leaves it with room for less than one line of output (the quantity depends on the pre-set line length). It is re-set between program scans by the printer driver removing characters from the buffer so that room for one full line is once more available.

A special case of the filling flag being set occurs when a Special Function attempts to output more characters than there is space for in the buffer. In this case:

(1) The output is truncated so as not to overwrite the data already in the buffer.

(2) The last character to be placed in the buffer will be an exclamation mark (!),

(3) The appropriate fault code will be generated by the Special Function.

Overflow of the input buffer can occur, and causes the oldest data to be overwritten and lost.

4.4.5 Alphanumeric Output

Alphanumeric information can be output on any of the serial ports using Special Function S38 PRITEXT. General text and numeric output is provided by the Special Function T38 PRINT. See the Software Data Sheets for further details.

4.4.6 Editing Alphanumeric Output Messages

(1) Printer Port Messages

The items used by PRINT to generate output are called messages and may contain fixed text and format definitions for numeric output in any combination. The fixed text may also contain end of line markers so that one message can generate several lines of output. The messages are stored as part of the P-table and may be loaded and dumped with the User Program. They are protected from access by Special Functions and from being written to by the programming unit when in data list mode. If an attempt is made to write to the message area of the P-table the messages will be moved and the extra P-table created filled with zeros. The quantity of messages which can be stored in a system is restricted only by the memory occupied by data tables and the User Program. Remember that data table P2 contains the length of the pre-set message area in bytes and is therefore limited to the maximum number which can be stored. Each message can contain up to 255 bytes, although this could define considerably more characters for output because a format definition only occupies 2 bytes.

The system is provided with an editor to enable the user to enter, examine, update and take a hard copy of the messages available to the user program. The editor is accessed using a programming unit connected to any tributary port. (This includes the front panel port). Where more than one Programmer is connected, a similar locking mechanism to that described in Section 4.8 is implemented. The lock is released when the Exit command is executed.

Messages are entered in a manner which is intended to be similar to the way they will be displayed when used by PRINT. Fixed text is enclosed by quotes ("); format definitions employ a pictorial representation where '^' (caret) is used to represent leading spaces, '0' is used to represent leading zeros and '#' is used to represent significant digits. End of line markers are entered by typing carriage-return and may be placed inside or outside quotes. A comma is used to separate format definitions from each other and from fixed text.

Note... On the 8920 Portable Programmer, the caret symbol (^) is obtained by pressing the upward arrow key.

A format definition specifies how the contents of one data table will be formatted for output. Four quantities need to be specified; the field width, whether leading zeros are to be output, the number of characters after and including the decimal point, and the scaling as a power of ten. The first two quantities are limited to a maximum value of 15.

Examples:

"This is a fixed text containing 2 end-of-line markers"

^ ^ ^ ^ # # . #	defines a field width of 7 with 1 decimal place
^ ^ ^ # . # #	as above but with 2 decimal places
000 # . # #	as above but with leading zeros

With appropriate scaling the second format above could display as '1.23' or '123.45' depending on the value in the data table; i.e. the field width is fixed, not the quantity of leading spaces. The same is true if leading zeros are specified.

(2) Using the Editor

After loading a taped program containing messages, the program must be compiled before using the editor. The editor cannot be entered until this has been done.

Whenever the editor is ready to accept input it will output the """" symbol known as the prompt. Entry of input is terminated in one of two ways:

(a) By pressing the ESC key which aborts the current command;

(b) By pressing the ""<"" key.

The terminator is only recognized when not enclosed by quotes, i.e. not part of fixed text. An editor command consists of:

(a) a command identifier which tells the editor what to do,

(b) an optional command body which supplies additional information to the editor,

(c) a terminator which signals the editor to start processing the command.

The command identifier may be a single character or the entire command name, e.g. the exit command may be entered as E or EX or EXIT. The exit and help commands do not require a command body.

The command identifiers and their actions are as follows:-

E

Stands for Exit. Terminates the editing session and causes the programming unit to return to initial selection.

H

Stands for Help. Displays a list of the available commands on the programming unit screen.

D,L

Stand for Display and List respectively. The actions of the commands are very similar. The command body is a list of messages whose contents are to be displayed. The structure of this input is a list of 'output requests' separated by commas. Each output request may contain a single message number or a range represented by two numbers separated by a dash (-). Zero length messages are not displayed. For example the following commands could be used to display messages 1, 2 and 3:-

D1,2,3 or
D1-2,3 or
D1,2-3 or
D1-3

The output of each message is prefixed with the message number and has the terminator appended. One blank line is output before any subsequent display. Output of a list of messages may be aborted by pressing the ESC key. The difference between D and L is that D produces output only on the programming unit screen while L produces a listing on the printer attached to the programming unit.

A format definition will be displayed as it was entered, except that the leading spaces/zeros and significant digits will be displayed in a normalized form, with only one significant digit before the decimal point. For example, a format entered as ^ # # # . # # will be displayed as ^ # . # #.

M

Stands for Message and is the command for adding new messages and replacing existing ones. The editor automatically repositions other messages if the size of an existing message is changed. The command body contains the message number to be updated followed by an equals symbol (=) followed by the new contents. This may consist of fixed text delimited by quotes and format definitions to describe how a data table value will be output. The different fields are separated by commas.

A format definition uses '0','#', and '^' to pictorially describe the layout of the number in terms of character positions before and after the decimal point (if present). The caret (^) is used to signify leading spaces, a zero (0) is used to signify leading zeros and the hash symbol (#) significant digits. If a message contains format definitions a prompt is issued to request the user to enter the scaling values to be applied to the data table contents. The scaling is entered as '/' or '*' followed by a number which is a power of ten. The '/' indicates division and the '*' multiplication. Each scaling value may be separated from the others by an optional comma.

End-of-line markers may be included in the message by typing carriage-return either within a block of fixed text or between format definitions. In the latter case quotes are not needed but the preceding format definition must end with a comma. Non-printing characters (or characters not available on the keyboard) may be included in fixed text by entering their hexadecimal value preceded by '@' and delimited by a comma, e.g. '@' itself may be entered as '@40,'.

(3) Errors

The following error messages are produced by the editor, and the likely cause is given where appropriate:-

'Unrecognized command'

The first letter of the current line was not a command identifier.

'Invalid command line'

The current command line does not conform to the structure expected by the editor. An arrow indicates the approximate point where the error was detected. The usual cause is a mis-placed or missing comma or quote during entry of a message.

'Message not found'

The message number supplied to Display or List was beyond the highest message currently stored.

'Insufficient space for item'

While attempting to create space for a new (or expanded) message the editor found that there was not enough memory available. The message is not stored and any existing messages are left unchanged.

4.5 Serial Communication Between Two or More 131 Controllers (ESP protocol)

When communication is required between two or more controllers, one of the controllers must be used as a (master) controller and the rest as tributaries. The Controller can receive data from and transmit data to all the tributaries and controls the transmission and reception of data within the system.

The Tributaries can only receive data from and transmit data to the Controller, though data can be transferred between tributaries via the Controller. Table 4.3 shows the P-table data to be set to configure a 131 Controller as an ESP Tributary.

Table 4.3 Configuring Ports 1 and 2 as an ESP Tributary

Port 1	Port 2	Contents
P10	P30	baud rate (110 to 19200)
P11	P31	1
P12	P32	0 = Free running 1 = user control
P13	P33	Tributary address (0 to 14)
P14	P34	Number of tables to be transmitted (free running mode only) 0 to 32 for fixed data tables 0 to 128 for flexible data tables
P15 to P29	P35 to P49	Unused

Table 4.4 - J-Table for Tributary Port

Contents	Port 1	Port 2
J-Table (Data Received by the Controller)	J0-511	J512-1023

Table 4.5 - K-Table for Tributary Port

Contents	Port 1	Port 2
K-Table (Data to be Transmitted by the Controller)	K0-511	K512-1023

Table 4.6 - I-Table for Tributary Port

Contents	Remarks	Port 1	Port 2
Flags	SEND FLAG is bit 0 of the words shown on the right (I0, I40) RECEIVE FLAG is bit 8 of the words shown on the right (I0, I40)	I0	I40
Quantity of words received or transmitted	bits 8-15 received length bits 0-7 length to transmit	I1	I41

4.5.1 Operation as an ESP Tributary Port

Data Table transfers and I-Table examinations only occur between user program scans.

For J/K-Table exchanges between controllers the user can select either user- control mode or free-running mode.

In either mode an indication is provided in F10 for Port 1 or F30 for port 2 when a port has not received a valid message for a period of approximately 30 seconds.

(1) Free-Running Mode

When Free-running mode is selected the reply to a received message is generated immediately, at the end of the program scan the quantity of locations for the reply being taken from the P-table.

(2) User-Control Mode

User-control mode uses data in the I-table to control the generation of a reply. The I-table is set to indicate reception and length of received message. The transmission of the reply is initiated at the end of the program scan in which the I-table bit is set. The length of the message transmitted is taken from the I-table. The following description is for port 1 but applies equally to all ports if the relevant data tables are substituted.

When a message is received the data is placed in I0 onwards (as when free-running). The number of locations written is placed in bits 8 to 15 of I1 (this may be extracted using SWAP (S4) and masking the result) and bit I0.8 is set ON. The user is thus notified of the arrival of a message. Appropriate action may then be taken and the data for the reply placed in K0 onwards. The length of this data is placed in bits 0 to 7 of I1. When the user has set bit I0.8 OFF and I0.0 ON the reply will be generated. I0.0 will be set OFF to indicate this.

Note... ESP Tributary ports will only operate in a 'running-normal inputs' or 'running-test inputs' state. It will not operate in a 'single cycle' or 'halted' state.

4.5.2 Operation as an ESP Control Port

ESP Control ports can be used either with fixed J/K data tables with message length limited to a maximum of 32 words or with flexible data tables which allow a maximum message length of 128 words per route (subject to a total J/K table allocation of 512 words on all routes).

Table 4.7 shows the P-table addresses and data the user must write into these addresses to enable the port to operate as a control port.

When the port is configured as a standard ESP control port, data is received and transmitted at the data table addresses shown in Table 4.9.

I-table information to operate the serial link in the user control mode is shown in Table 4.10.

Re-compile to implement changes to P-table. Changes to transmission lengths and tributary selections are effective immediately.

Note.. ESP Control ports will only operate when the Controller is in a 'running-normal inputs' state. It will not operate in a 'single cycle' or 'halted' state.

4.5.2.1 Configuring ports 1 and 2 as an ESP Control Port

Table 4.7 shows the P-table data to be set to configure a 131 Controller as an ESP Control port and Table 4.8 shows the P-table data for an ESP control port using flexible data tables.

Table 4.7 Configuring an ESP Control Port

Port 1	Port 2	Contents
P10	P30	baud rate (110 to 19200)
P11	P31	2 (ESP Control Port Mode)
P12	P32	0 = free running 1 = user control
P13	P33	bits 0 to 7 enable transmission to addresses 0 to 7 bits 8 to 15
P14	P34	Number of tables to be transmitted to address 0
P15	P35	Number of tables to be transmitted to address 1
P16	P36	Number of tables to be transmitted to address 2
P17	P37	Number of tables to be transmitted to address 3
P18	P38	Number of tables to be transmitted to address 4
P19	P39	Number of tables to be transmitted to address 5
P20	P40	Number of tables to be transmitted to address 6
P21	P41	Number of tables to be transmitted to address 7
P22 to P29	P42 to P49	Unused

Table 4.8 Configuring an ESP Control Port (flexible data tables)

Port 1	Port 2	Contents
P10	P30	baud rate (110 to 19,200)
P11	P31	3
P12	P32	0 = Free running mode 1 = User control mode
P13	P33	bits 0 to 7 enable transmission to addresses 0 to 7 bits 8 to 15 unused
P14	P34	No of tables to transmit/assigned - route 0*
P15	P35	No of tables to transmit/assigned - route 1*
P16	P36	No of tables to transmit/assigned - route 2*
P17	P37	No of tables to transmit/assigned - route 3*
P18	P38	No of tables to transmit/assigned - route 4*
P19	P39	No of tables to transmit/assigned - route 5*
P20	P40	No of tables to transmit/assigned - route 6*
P21	P41	No of tables to transmit/assigned - route 7*
P22 to P29	P42 to P49	Unused

Notes... (1) Low byte = number of tables to transmit on route when free running. High byte = number of tables assigned to route if greater than number of tables to transmit.

(2) The number of tables assigned must not exceed 512.

(3) The timeouts are set on the number of tables assigned for reception.

Table 4.9 - J- and K-Table Addresses for Standard ESP Control Port

Function	Port 1	Port 2
Tributary address 0	J/K0-31	J/K512-543
Tributary address 1	J/K32-63	J/K544-575
Tributary address 2	J/K64-95	J/K576-607
Tributary address 3	J/K96-127	J/K608-639
Tributary address 4	J/K128-159	J/K640-671
Tributary address 5	J/K160-191	J/K672-703
Tributary address 6	J/K192-223	J/K704-735
Tributary address 7	J/K224-255	J/K736-767

Note...Locations J/K256 to 511 for port 1 and locations J/K768 to 1023 are not used.

4.5.3 J- and K-Tables for an ESP Control Port with Flexible Data Tables.

When an ESP control port is configured for flexible data tables (P11/31 = 3) the tables are assigned dynamically according to the two-byte values set in P14 to P21/P34 to P41. The number of tables assigned to a route is the greater of high and low byte set in each P-table (P14 to 21/P34 to P41). Each route is assigned consecutively. eg:

P14 = @20 - assigns the first 32 tables to K0 to K31
P15 = @3420 - assigns the next 52 tables to K32 to K83
P16 = @1002 - assigns the next 16 tables to K84 to K99
P17 = @0048 - assigns the next 72 tables to K100 to K171

etc.

Table 4.10 - I-table for an ESP Control Port

Port 1	Port 2	Contents
I0	I40	Transmit and receive flags bit 0 - Transmit flag tributary address 0 bit 1 - Transmit flag tributary address 1 bit 2 - Transmit flag tributary address 2 bit 3 - Transmit flag tributary address 3 bit 4 - Transmit flag tributary address 4 bit 5 - Transmit flag tributary address 5 bit 6 - Transmit flag tributary address 6 bit 7 - Transmit flag tributary address 7 bit 8 - Recieve flag tributary address 0 bit 9 - Recieve flag tributary address 1 bit 10 - Recieve flag tributary address 2 bit 11 - Recieve flag tributary address 3 bit 12 - Recieve flag tributary address 4 bit 13 - Recieve flag tributary address 5 bit 14 - Recieve flag tributary address 6 bit 15 - Recieve flag tributary address 7
I1	I41	Tributary 0 Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 32 bits 8 to 15 (Rx) = 0 to 32)
I2	I42	Tributary 1 Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 32 bits 8 to 15 (Rx) = 0 to 32)
I3	I43	Tributary 2 Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 32 bits 8 to 15 (Rx) = 0 to 32)
I4	I44	Tributary 3 Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 32 bits 8 to 15 (Rx) = 0 to 32)
I5	I45	Tributary 4 Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 32 bits 8 to 15 (Rx) = 0 to 32)
I6	I46	Tributary 5 Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 32 bits 8 to 15 (Rx) = 0 to 32)
I7	I47	Tributary 6 Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 32 bits 8 to 15 (Rx) = 0 to 32)
I8	I48	Tributary 7 Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 32 bits 8 to 15 (Rx) = 0 to 32)
I9 to I39	I49 to I70	Unused

Table 4.11 - I Tables for an ESP Control Port Using Flexible Data Tables

Port 1	Port 2	Contents
I0	I40	Transmit and receive flags bit 0 - Transmit flag Route 0 bit 1 - Transmit flag Route 1 bit 2 - Transmit flag Route 2 bit 3 - Transmit flag Route 3 bit 4 - Transmit flag Route 4 bit 5 - Transmit flag Route 5 bit 6 - Transmit flag Route 6 bit 7 - Transmit flag Route 7 bit 8 - Recieve flag Route 0 bit 9 - Recieve flag Route 1 bit 10 - Recieve flag Route 2 bit 11 - Recieve flag Route 3 bit 12 - Recieve flag Route 4 bit 13 - Recieve flag Route 5 bit 14 - Recieve flag Route 6 bit 15 - Recieve flag Route 7
I1	I41	Route 0 Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 128 bits 8 to 15 (Rx) = 0 to 128)
I2	I42	Route 1 Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 128 bits 8 to 15 (Rx) = 0 to 128)
I3	I43	Route 2 Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 128 bits 8 to 15 (Rx) = 0 to 128)
I4	I44	Route 3 Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 128 bits 8 to 15 (Rx) = 0 to 128)
I5	I45	Route 4 Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 128 bits 8 to 15 (Rx) = 0 to 128)
I6	I46	Route 5 Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 128 bits 8 to 15 (Rx) = 0 to 128)
I7	I47	Route 6 Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 128 bits 8 to 15 (Rx) = 0 to 128)
I8	I48	Route 7 Tx and Rx message length (bits 0 to 7 (Tx) = 0 to 128 bits 8 to 15 (Rx) = 0 to 128)
I9	I49	Route 0 Tx and Rx addresses (bits 0 to 7 (Tx) = 0 to 15 bits 8 to 15 (Rx) = 0 to 14)
I10	I50	Route 1 Tx and Rx addresses (bits 0 to 7 (Tx) = 0 to 15 bits 8 to 15 (Rx) = 0 to 14)

Table 4.11 - I Tables for an ESP Control Port Using Flexible Data Tables (continued)

Port 1	Port 2	Contents
I11	I51	Route 2 Tx and Rx addresses (bits 0 to 7 (Tx) = 0 to 15 bits 8 to 15 (Rx) = 0 to 14)
I12	I52	Route 3 Tx and Rx addresses (bits 0 to 7 (Tx) = 0 to 15 bits 8 to 15 (Rx) = 0 to 14)
I13	I53	Route 4 Tx and Rx addresses (bits 0 to 7 (Tx) = 0 to 15 bits 8 to 15 (Rx) = 0 to 14)
I14	I54	Route 5 Tx and Rx addresses (bits 0 to 7 (Tx) = 0 to 15 bits 8 to 15 (Rx) = 0 to 14)
I15	I55	Route 6 Tx and Rx addresses (bits 0 to 7 (Tx) = 0 to 15 bits 8 to 15 (Rx) = 0 to 14)
I16	I56	Route 7 Tx and Rx addresses (bits 0 to 7 (Tx) = 0 to 15 bits 8 to 15 (Rx) = 0 to 14)
I17 to I39	I57 to 79	Not used

Note... Address 15 is used to send a broadcast message. This message is received and is stored by all tributaries, but no replies are sent.

4.5.4 Operation as a Control Port

Data table transfers occur only between user program scans and the I-table is also only examined between scans in the user-control mode.

If a message is received that is longer than the space allocated, the message is truncated and a fault flag is set (See Section 8).

The control port can be operated in the free-running mode or the user-control mode and the user can select either of these options.

(1) Free-running Mode

When free-running mode is selected the Controller cycles round the routes indicated in the pre-set data to be in use and attempts a J/K exchange, transmitting the quantity of locations requested in the P-table. If a valid reply is not received after the system of re-tries has been exhausted the route is classified as failed and the corresponding bit in F10 is set ON. In the event of a tributary failing to communicate, the errors are not clocked up on a cyclic basis but only after 8 complete scans. If a failed route re-commences communication the F-table bit is set OFF and the route is no longer classified as failed.

(2) User-Control Mode

User-Control mode allows the user to vary the length of transmissions and to dynamically select the next route for transmission. If flexible data tables are used (P11:P31 = 3), the user may also select the tributary address for that route dynamically.

To initiate a message transfer on a route, proceed as follows:-

(a) Set the Tx message length in the I-table.

(b) If P11:P31 = 3 (flexible data tables), set the Tx address in the I-tables.

(c) Set the transmit data in the appropriate K-tables.

(d) Set the transmit flag for the route in the I-table - (the message will be transmitted immediately).

(e) The reply message if received is placed in the J-tables and the length, if using flexible data tables, is placed in the appropriate I-tables. The receive flag is then set to inform the user program of the arrival of the reply message and the link statistics are updated to show that the transfer was successful. If a reply is not received (after re-tries), a fault is flagged in the Fault Table (F10) and the link statistics are updated to show that the transfer was not successful and the type of error.

Note... The Receive flag for a route must be cleared by the user before another message can be sent down that route.

(3) Extended Time-out Option

When a GEM80 control port outputs a message, it waits a period of time (which varies with the signalling rate) before assuming that the tributary is not going to respond. When communicating with a tributary port configured in User-control mode the GEM80/131 control port provides the option of increasing the standard time-out values.

This is achieved by setting the signalling rate to the negative of that required, e.g. to select extended time-outs on port 1 at a signalling rate of 9,600 bits/s, P10 should be set to -9,600. Table 4.12 shows the relationship between the signalling rate and the time-out period.

Table 4.12 Time-out Periods

SPEED (Bits/s)	MAXIMUM TIME (seconds)					
	MESSAGE LENGTH (words)					
	0-32		33-64		65-128	
	standard	extended	standard	extended	standard	extended
19200	00.5	01.00	01.00	02.00	02.00	04.00
9600	00.75	01.50	01.50	03.00	03.00	06.00
4800	01.00	02.00	02.00	04.00	04.00	08.00
2400	01.25	02.50	02.50	05.00	05.00	10.00
1200	01.75	03.50	03.50	07.00	07.00	14.00
600	02.75	05.50	05.50	11.00	11.00	22.00
300	05.00	10.00	10.00	20.00	20.00	40.00
110	13.75	27.50	27.50	55.00	55.00	110.00

(4) Broadcast Message Facility

The Broadcast Message Facility is available only in User-Control mode when using flexible data tables. It allows a message to be sent to all tributaries at the same time. No replies are returned by the tributaries and there are no re-tries or acknowledgements.

To initiate a broadcast message on a route proceed as follows:-

(a) Set the Tx message length in the I-tables.

(b) Set the Tx address in the I-tables to 15.

(c) Set the transmit data in the appropriate K-tables.

(d) Set the transmit flag for the route in the I-table.

(e) When the message has been transmitted, the transmit flag is automatically cleared.

Notes... (1) The tributaries do not reply to a broadcast message.

(2) Tributaries which are in User-Control mode must not attempt to reply to a Broadcast message.

(3) When a Broadcast Message is initiated, the fault flags are NOT updated.

4.6 CORONET Option

4.6.1 Introduction

CORONET is a Local Area Network (LAN) communication system which allows any controller on the network to communicate directly with any other controller at any time.

Communication between controllers operating on a CORONET LAN is known as 'peer-to-peer' because all the controllers on the network have equal priority.

Up to 32 controllers, or other units such as system programmers, or IBM or DEC computers if these are part of the system, may be connected to the CORONET LAN. It is also possible to double, treble or quadruple the size of the network using gateway units.

Table 4.13 Configuration as a CORONET Port

Port 1	Port 2	Contents
P10	P30	baud rate = 9,600 or 19,200 (with CORONET 250)
P11	P31	4
P12	P32	1 = User control mode
P13	P33	Not used
P14	P34	No of tables to assigned to route 1 (0 to 128)
P15	P35	No of tables to assigned to route 2 (0 to 128)
P16	P36	No of tables to assigned to route 3 (0 to 128)
P17	P37	No of tables to assigned to route 4 (0 to 128)
P18	P38	No of tables to assigned to route 5 (0 to 128)
P19	P39	No of tables to assigned to route 7 (0 to 128)
P20	P40	No of tables to assigned to route 8 (0 to 128)
P21	P41	No of tables to assigned to route 9 (0 to 128)
P22 to P29	P42 to P49	Unused

Note... The maximum number of data tables assigned in P14 to P21 or P34 to P41 must not exceed 512 in total.

4.6.2 9515 CORONET Interface Module

The 9515 CORONET 250 Interface Module is a single width module which must be inserted into the slot next to the Power Supply Module in the GEM80/131 Controller.

Opto-isolation is provided at the output stage to the LAN, and connection is made by a 9-way D-type socket. The LAN is powered by an on-board regulator which is also isolated from the GEM80 power supplies.

A 26-way socket connects directly to Serial Port 1 of the 26-way serial link ribbon cables.A 9-way D-type socket is also provided for connecting a printer or VDU. All three sockets are mounted on the front panel of the 9515 module for ease of access.

4.6.3 Operation

The CORONET LAN must be configured in P-tables before use. All the controllers, or units, on the network must be configured in a similar manner. Data is transferred from J/K-tables, and I-tables are used to control the data exchanges.

The address of the destination and the sender are loaded into I-tables. The data to be transmitted is moved into K-tables. The data is transmitted when the send flag is set. The F-tables are updated if any faults occur during transmission.

When the data is successfully received at the destination, the send flag is cleared automatically.

At the destination, a receive flag is set when data is received in the I-tables. The data must be moved from the I-tables and the receive flag cleared before further data can be received.

The senders address, as well as that for the destination, is included as part of the data transmitted. This ensures that the two controllers exchanging data can identify each other.

All data exchanges, including any message acknowledgements must be written into the user program. Because there is no single controller 'overseeing' the network, all the controllers must be programmed to respond in the expected manner.

Note... The CORONET port will operate in all Controller operating states.

4.6.4 Additional Information

More information can be obtained on the CORONET LAN by consulting the Serial Communications Manual, Publication No.T457) and the CORONET Interface Module User Information, Publication No.CST0004.

4.7 Contactor Control Unit Option.

4.7.1 Introduction

The GEMSTART Contactor Control Unit provides the necessary control and protection facilities required for Low Voltage Motor Starter applications. Within the GEM80, the CCU option is selected by the P-table configuration shown in Table 4.14. The facility allows direct control of Contactor Control Units (CCU) by the GEM80 Controller through the RS422 serial link ports.

Using a Programming Tool, the user can view and edit the CCU data tables via the Programming port on the 131 Controller.

Note...A CCU port will operate only when the Controller is in the 'running-normal inputs' state. It will not operate in 'running-test inputs', 'single cycle' or 'halted' states.

4.7.2 P-tables

Table 4.14 shows the configuration data that must be entered into the P-table to set the GEM80 serial links to operate in the CCU mode.

Table 4.14 Configuration as a GEMSTART Contactor Control Unit (CCU) Port

Port 1	Port 2	Contents
P10	P30	baud rate 300 to 9,600
P11	P31	CCU mode (6 for GEMSTART 1) (8 for GEMSTART 2)
P12	P32	0 (selects free-running mode)
P13	P33	Lowest CCU address (0 to 63)
P14	P34	Highest CCU address (0 to 63)
P15	P35	Table letter for configuration data (any valid table letter)
P16	P36	Table index for configuration data (any valid table number)
P17	P37	Configuration flag
P18 to 29	P38 to P49	Not used

Note...P10 to P16 take effect only on re-compiling. P17 can be changed with the Programming Tool and takes immediate effect. P17 indicates the configuration to use if there is a configuration conflict.

4.7.3 J/K-Tables

These tables hold the data to be sent and the data to be received from the CCU. Four locations in each table are reserved for each CCU. The interpretation of the data contained in these tables is detailed in the CCU Technical Manual, Publication No.78260.

4.7.4 I-Table

This table is used to control serial link exchanges. I0.0 for Link 1 and I40.0 for Link 2 are used as SEND flags when the GEM80 sends new configuration data to the CCU. The user sets up the new configuration data in the USER tables, sets the address of the CCU in I1 or I41 and then sets I0.0 or I40.0. The configuration is continually transmitted to the CCU until the addressed CCU acknowledges the data. The I0.0 flag is then cleared automatically. In CCU2 mode I0.1 and I40.1 are used to request static data from the CCU. The user sets the CCU address in I1 or I41 and sets a table location to receive the static data in I2, I3 or I42, I43. (I2 = table letter, I3 = table number). Note that the tables must be writeable by the user program. The I0.1 or I40.1 flag is then set to request the static data. When the static data is received from the CCU it is placed in the specified tables and I0.1 or I40.1 is cleared.

4.7.5 User specified tables

The user can specify, using P15 and P16 or P35 and P36, which table is used to contain the configuration data for the CCUs. The User Specified tables must be in contiguous locations with 5 words per CCU in CCU1 mode or 10 words per CCU in CCU2 mode, plus 5 words inCCU1 mode or 10 words in CCU2 mode to hold the IOP control information. The allocated tables are then split, the first 5 tables in CCU1 mode or 10 tables in CCU2 mode are for Control data (non-user changeable), the rest of the tables contain configuration data (user changeable). The configuration tables are used in order of CCU address starting at the address in P13 (or P33) and ending at the address in P14 (or P34). The control information should not be changed, otherwise the configuration is lost.

During re-compilation, only the configuration data used before re-compiling is considered valid. Therefore, any new CCU included in the scan will have its configuration data set to zero. The GEM configuration data will be updated by the CCU once communications are established.

Should the control information in the user tables be altered, all the CCUs on the scan will have the Controller copy of the configuration data set to zero. Again this will be updated by the CCUs during the first few scans.

To program the CCU from the GEM80, the configuration data is placed in the user selectable tables at the appropriate address.

For example: if P11 = 6, P15 = 'R' and P16 = 5, the configuration information starts at R5. R5 to R9 contain the control data (non-user changeable) R10 contains the start of the configuration data for CCU 0, R15 for CCU 1 etc.

The CCU Technical Manual gives details of the values to place in these tables. Once the desired values have been placed in the tables, the I-Table can be used to re-configure the CCU by placing the CCU address in I1 (I41 for Link 2) and setting I0 to 1 (I40 for Link 2). After the message has been sent and acknowledged by the CCU, I0 will be cleared to 0.

The 8587 Termination Unit must be used to connect the GEM80/131 Controller to a CCU. Publication No.T456 gives details of the operation and installation of the Termination Unit. Section 9 of this Manual gives ordering information.

4.8 Remote Programming

Remote programming and monitoring facilities are available on all ports. These facilities are available when the Controller port is configured as an ESP tributary. The Controller automatically recognises the programming messages without any additional switching.

GEMESYS or a System Programmer must be used, since it has a selectable signalling rate and the slow signalling rate necessary for long distance serial links to be set up. The Portable Programmer which works at 9,600 bits/s. only, could be used only for short distance serial links and can talk only to tributary port 0.

When remote programming is being undertaken, the system prevents more than one programming channel from altering the program simultaneously by activating a locking mechanism. The lock is released by issuing a Run or Re-compile command. If a user neglects to issue such a command the system releases the locking mechanism after a period of five minutes in which no access to the locked item has been made. If the user program lock has been activated by a user on another port, any attempt to access the user program results in a LINK REJECTED message being displayed on the programming unit of the user who is locked out. If the message editor lock has been activated then the editor option is removed from the initial menu. See also Section 2.3.7 - On-line Program Changes and Section 2.3.1 - Programmer Units.

4.9 Fibre Optic Serial Links

An 8927 Fibre Optic Transceiver may be connected to an 8924 RS422 to 20mA converter using adaptor cable 8891-4079 to provide fibre optic serial links.

4.10 Ribbon Cable Connection Details

Cable

26-way flat ribbon width 33mm
ITT type 455-240-26 or equivalent
Maximum length 2m

Connectors

Harting type 0918 526 5823 connector
Polarising key in position 10

Segregation

Very Clean (very sensitive to noise)

Section 6 - Installation, covers the installation of serial link ribbon cables.

This page left intentionally blank

5.1 Power Supply Requirements

The GEM80.131 Controller requires the following power supplies:-

110V a.c. or 220/240V a.c. power input, single phase

OR

22 to 85V d.c.

The Controller subrack contains a 9032 Power Supply module. This module will supply the power requirements for the Processor module and the Basic I/O modules in the Controller subrack. It is the User's responsibility to calculate the total power consumption of the I/O equipment used and decide whether sufficient power is available from the Controller Power Supply module or if it is necessary to provide additional Power Supply modules to supply the I/O modules.

Table 5.1 details the specification of the 9032 Power Module.

Table 5.1 9032 Power Supply Module Specification

Nominal power input	110 or 220V a.c. 50.60Hz 48V d.c.	Two a.c. ranges, switch selectable.
Operating range	88-121V a.c 47-63Hz OR 204-264V a.c. 47-63Hz OR 48V d.c.	
Current available in Amps @ 0-60°C	7.0A @ +5v 2.0A @ +15V	The current available from the 15V rail may be increased to a maximum of 5A by trading off 2A @ +5V for every additional 1A required @ +15V.
Consumption	100W per Power module when supplying full rated load. Decreases approximately linearly with decreasing load.	For a.c. operation, input current at full rated load consists of pulses of up to 3.5A peak and up to 5.5ms duration each half-cycle. For d.c. operation, input current is substantially constant.

Table 5.1 9032 Power Supply Module Specification (cont.)

Inrush	50A @ 110V a.c. 25A @ 240V a.c. 86A @ 48V d.c. (i.e. 1.8A/V)	For either a.c. or d.c. operation, current peak decays exponentially with a 4ms time constant. Suitable for operation from a current limited source.
Input supply interruption	20ms ride-through on 110V or 220V a.c. at full load. 20ms ride-through on nominal 48V at full load	Shutdown after ride-through time. Automatic recovery when supply resumes.
Undervoltage protection	Shutdown if any output falls 5% below nominal value.	
Overvoltage protection	Shutdown if any output rises 27% above nominal value.	
Self-test	Performed once every complete self-test cycle. Best 5 seconds, Worst 5 mins.	
Status indication LEDs	Power ON (green). +5V healthy (green). +15V healthy (green).	

5.1.1 Power Consumed from Power Module

The 8231 Processor Module draws power from the 9032 Power Supply

(a) 1.2A at +5V.

and

(b) 0.2A at +15V.

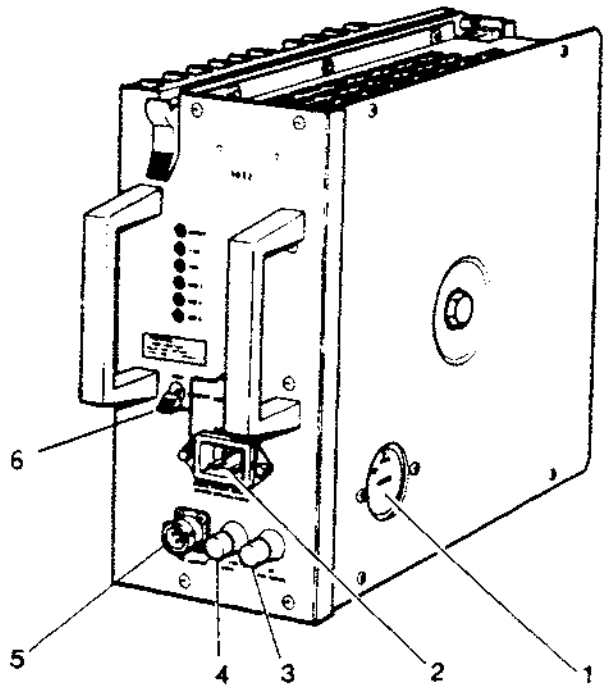
5.2 Power Supply Connections

5.2.1 A.C. Fed Only

Power input connections are on the front of the power supply module as shown in Figure 5.1.

A.C. Power input is via the a.c. power connector which is supplied loose with the equipment. Line, neutral and earth connections are as marked on the connector.

The location of the earth studs is shown in Figure 5.2 and the connections for the safety earths for an a.c. fed GEM80/131 are shown in Figure 5.3.



1. A.C. Voltage Selection Switch
2. A.C. Power Input Socket
3. A.C. Input Anti-Surge Fuse
4. D.C. Input Anit-Surge Fuse
5. D.C. Power Input Socket
6. Output Control Switch

Figure 5.1 - Power Supply Module A.C. and D.C. Connections.

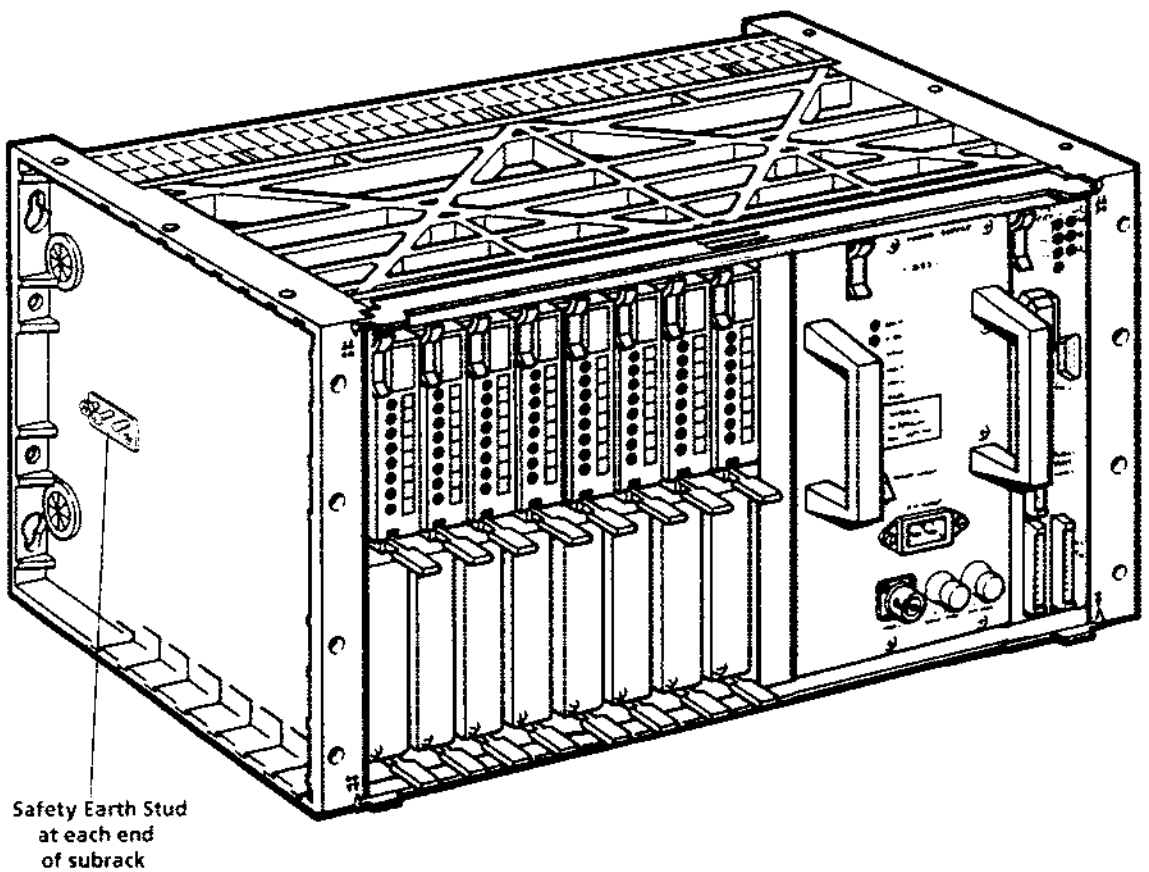


Figure 5.2 - Location of Safety Earth Studs

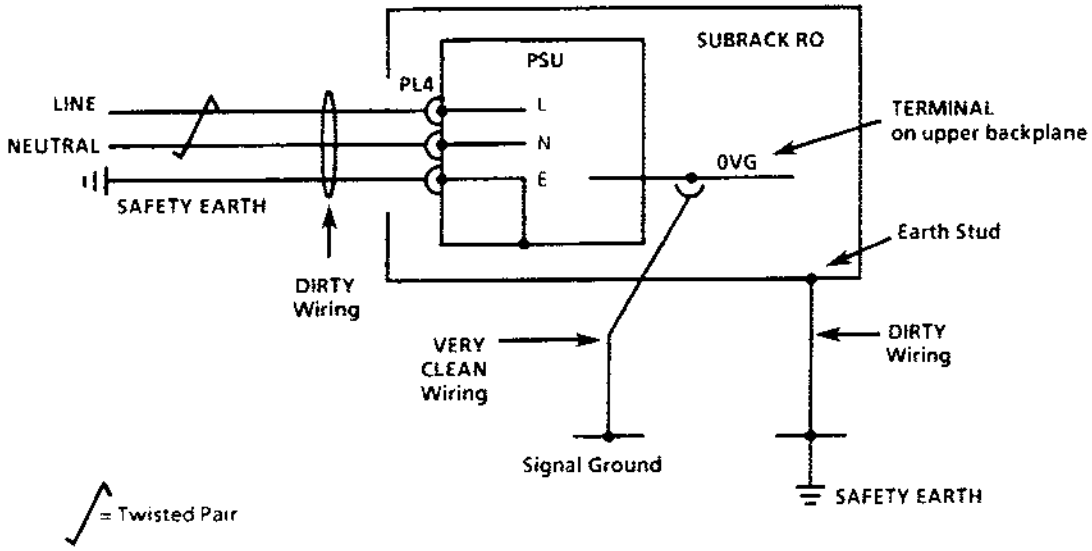


Figure 5.3 - Signal ground and safety earth connections for A.C. Fed GEM80/131.

5.2.2 .D.C Fed Only

Power input connections for d.c. are on the front of the power modules as shown in Figure 5.5. The system is designed for negative earth connection only.

A 3-metre lead is available for the d.c. power input socket, order code 8891-4072. The wires are colour coded as follows:-

+ve Brown

-ve Blue

Earth Yellow/green

Connections for power input safety earths and signal grounds for D.C. only fed GEM 80/131 are shown in Figure 5.4.

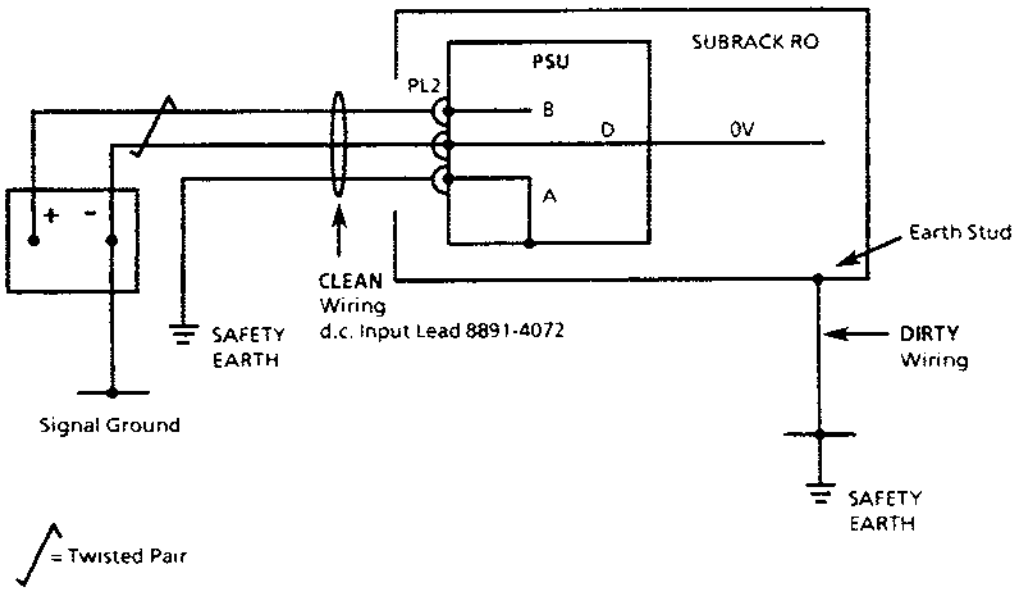


Figure 5.4 - Signal Ground and Safety Earth connections for D.C. fed GEM80/131.

5.2.3 A.C. and D.C. Fed

Power input connections for an a.c. and d.c. fed controller are shown in Figure 5.5. It is necessary to set the A.C. voltage selector as required. There is an internal diode OR which allows both a.c. and d.c. supplies to be present at the same time. Typically, for 24V d.c. no power is drawn from the d.c. input but above 40V d.c. some power is drawn depending on the a.c. voltage.

The d.c. circuit is not isolated from the output of the power supply, though it is isolated from the a.c. input by a transformer. The system is designed for negative earth connection with signal ground and safety earths connected as shown in Figure 5.5.

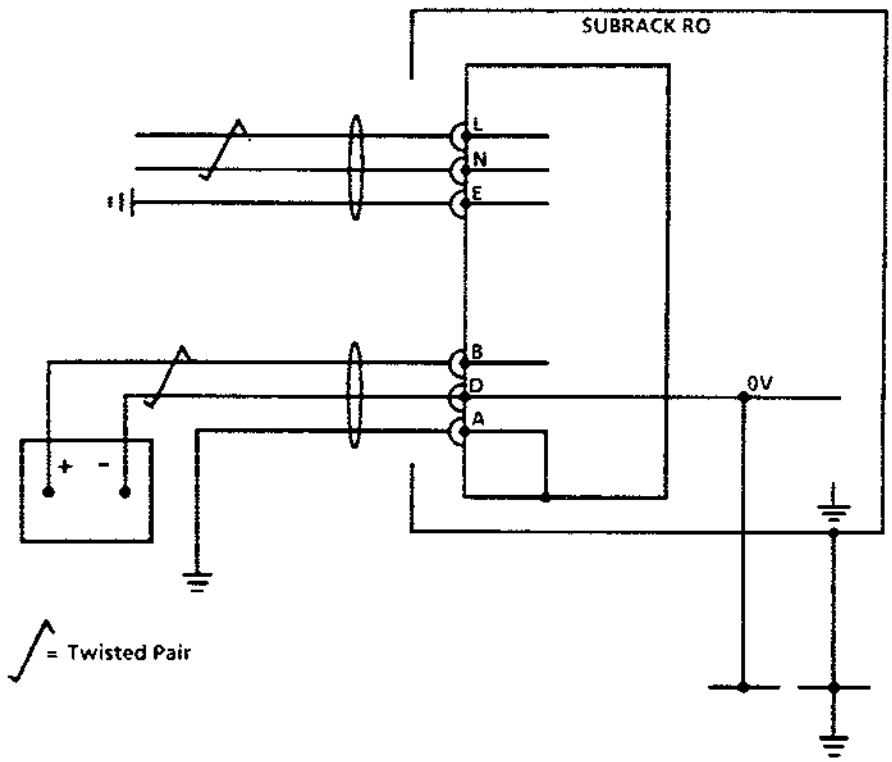


Figure 5.5 - Signal Ground and Safety Earth Connections for D.C. and A.C. fed GEM 80/131.

5.3 Safety Earth Connections.

Safety earth studs are located on the subrack side panels at either end of the subrack.

The equipment must be earthed by a secure safety earth connection of 2.5sq. mm. minimum cross-sectional area.

5.4 Watchdog Contacts

The Watchdog contact terminals are situated on the Terminal Block on the backplane as shown in Fig 5.6.

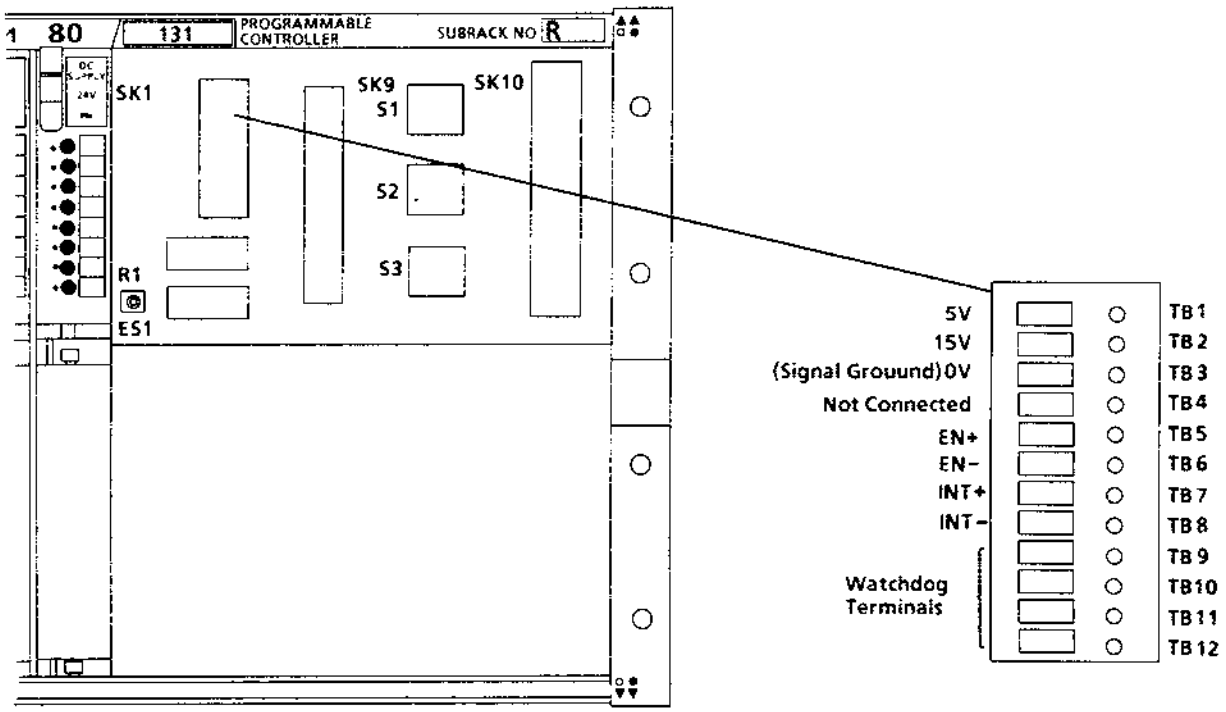


Figure 5.6 - Watchdog Contact Terminals

5.4.1 Typical Watchdog Circuits

Figure 5.7 shows an example of a typical Watchdog safety circuit. The input equipment will be energised when the plant side power supply is on. However, the output equipment is only energised when the plant-side power supply and the user supplied Watchdog follower relay are energised. Other interlocks, such as emergency stop push-buttons, can be connected in this circuit as required in series with the Watchdog contacts. Figure 5.7 shows just a single emergency stop push button; in practice there could be several in series.

5.4.2 Watchdog Contact Ratings

Circuit

Volt-free contact provided

Rating

a.c. 200VA 1A 250V make/break
d.c. 100W 1A 250V make/break

Operation

Closed when host Controller healthy and its status is running with normal inputs. Held closed during user program on-line re-compilation.

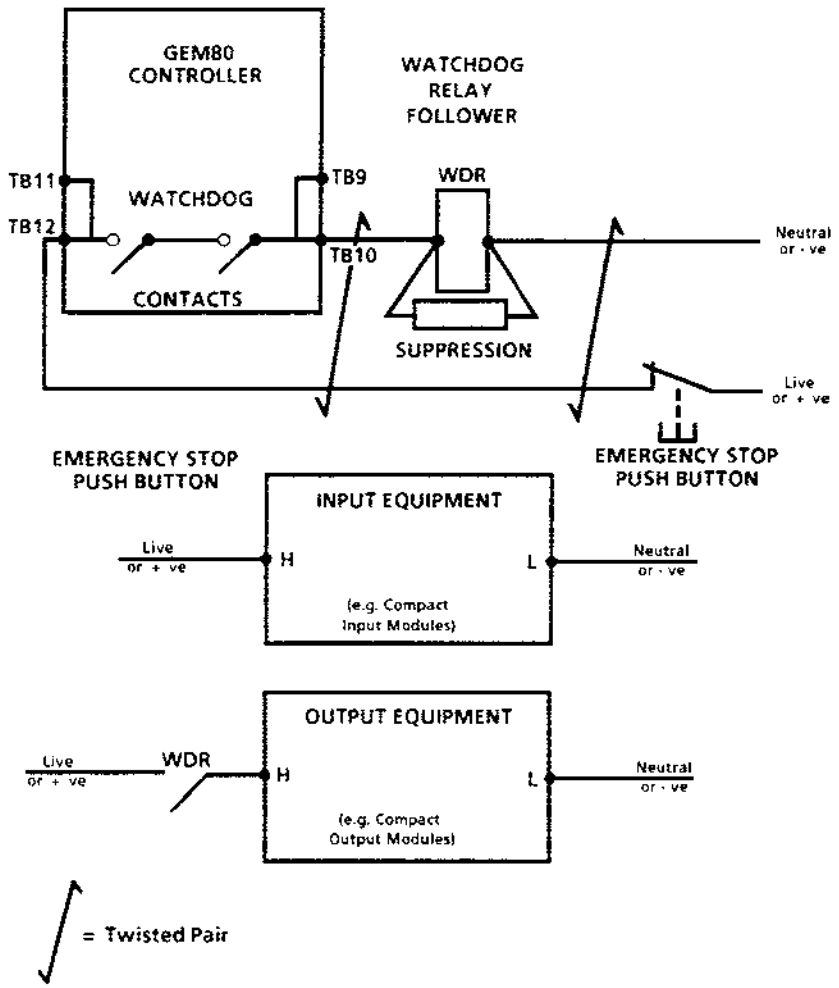


Figure 5.7 - Typical Watchdog Circuit

This page left intentionally blank

6.1 Subrack Specification and Mounting Instructions

The subrack is constructed from 'clip together' mouldings with 'clip on' backplanes. Module guides, on a 0.4-inch pitch, are an integral part of the moulding.

System bulders must ensure that power supply units are removed from subracks before shipping.

Modules are inserted from the front of the subrack and are retained by two sliding strips built into the subrack which lock the modules in position by engaging slots at the top and bottom of the modules.

Dimensions for the subrack are illustrated in Figure 6.1.

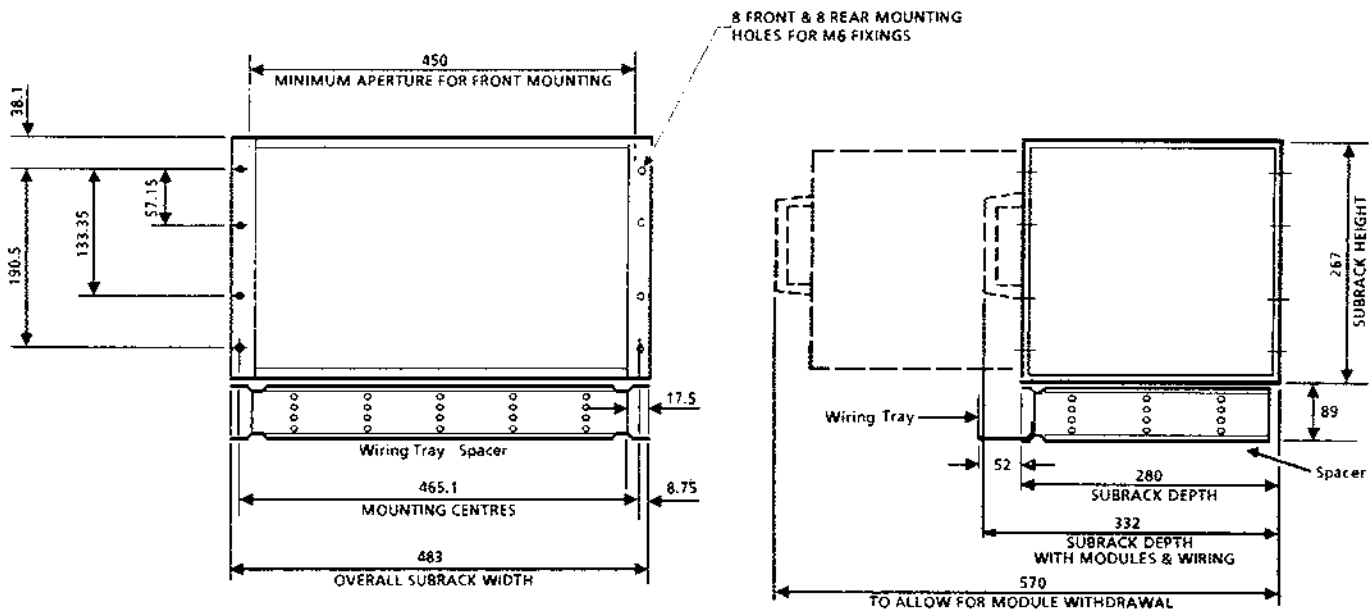


Figure 6.1 - Subrack Dimensions

6.2 Specification

Weight with backplanes but without modules	:	4.75kg
Mounting	:	19in. (482mm) rack mounting
Temperature	:	0 to 60°C operating -25 to 70°C storage
Humidity	:	5 to 95% RH non-condensing
Dimensions	:	356mm high x 483mm wide x 332mm deep with modules and front connectors fitted. The 6U high subrack is consistent with IEC297 (1975) - Dimensions of Panels and Racks.
Fire resistance	:	UL94V-0

6.3 Mounting

The subrack has a very simple mounting procedure which utilises the side plate front or rear flange for fixing purposes. Both front and rear flanges have four fixing holes. Under normal circumstances only the top and bottom holes will be required to secure the subrack assembly. In conditions of high shock/vibration it may be necessary to use the additional holes. To aid rear mounting, the top hole on each rear flange has a 'keyhole' shape.

6.3.1 Front Flange Mounting.

Front flange mounting requires a flat surface at the rear of the mounting panel.

To assist with the mounting procedure, threaded inserts which accommodate the mounting screws have been fitted in the subrack fixing holes. 7mm holes are required in the mounting panel to give clearance for the mounting screws. Mounting pegs are provided which enable the subrack to be held in the 'mounted' position prior to securing with the fixing screw.

When direct access to the rear face of the mounting panel is possible, the subrack mounting procedure is as follows:-

(a) Insert a mounting peg into the top fixing hole of each of the subrack flanges.

(b) Offer the subrack assembly up to the rear of the mounting panel and locate the two pegs in the top fixing holes of the panel. The pegs will hold the assembly in the correct fixing position.

(c) Fit and tighten the lower fixing screws into position.

(d) Replace the mounting pegs with the upper fixing screws.

(e) Tighten all securing screws to a torque of 28 lb/ins (3.16 Nm).

If direct access to the rear of the mounting panel is NOT possible, the subrack assembly mounting procedure is as follows:-

(1) Ensure that the space at the rear of the mounting panel is a minimum of 600mm wide and 500mm deep with an aperture of 450mm.

(2) Insert a mounting peg into the top fixing hole of each of the subrack flanges.

(3) Insert the subrack assembly sideways through the mounting panel aperture, rotate the subrack to offer the front of the assembly to the rear of the mounting panel and locate the two pegs in the top fixing holes of the panel. The pegs will hold the assembly in the correct fixing position.

(4) Repeat items (c) to (e) above.

6.3.2 Rear Flange Mounting

Rear fixing is either by inserts fitted into the rear mounting panel or by 'taptite' screws. The length of the screws is 7mm plus the length required into rear mounting panel. The screw head should be POSIPAN.

Each rear flange has four fixing holes. Under normal circumstances only the top and bottom holes are required to secure the subrack assembly, however in conditions of high shock/vibration it may be necessary to use the additional holes. To aid rear mounting, the top hole on each flange has a 'keyhole' shape. Subrack mounting using the rear flanges is carried out as follows:-

(1) Insert a mounting screw into each of the uppermost fixing holes on the mounting panel leaving at least 10mm of thread projecting.

(2) Offer the subrack assembly up to mounting panel allowing the screw heads to pass through the keyhole shape. The subrack assembly will locate onto the screws and be held in position prior to securing.

(3) Insert the two lower fixing screws.

(4) Tighten all four screws to a torque of 28lbs/ins (3.16Nm).

6.4 Subrack Spacer/Wiring Tray

A spacer is fitted below the subrack to provide a 2U (88.5mm) space beneath the Controller. The spacer must be earthed.

The Controller subrack and any I/O subracks can be made up into an assembly prior to mounting in an enclosure. The spacer below an upper subrack is fitted to the top of the lower subrack. Fixing dimensions for each subrack are as shown in Figure 6.1 with a pitch of 356mm between the subracks. Mounting is similar to that described previously except that mounting pegs or mounting screws are only required to be fitted for the top subrack.

The wiring tray, available as an optional extra, fits on to the spacer to form a channel in which plant-side cables can be laid. Holes for tying the cables down are provided in the bottom of the tray. However, wiring can be fitted directly to the spacer using ribbon cable clamps or 'push-in' tie wraps (T&B TY 554, CEGELEC part number 44780/255) or similar. Alternatively, trunking can be fitted to the spacer using the 5mm holes provided.

6.5 Installing GEM80 in a Cubicle

When GEM80 equipment is supplied loose for the customer to mount in a cubicle, the installation procedure is as follows:-

(1) Plan the layout of GEM80 equipment in the Cubicle.

(2) Assemble the cubicle and fix in position.

(3) Mount the equipment in the cubicle.

(4) Cable the equipment.

(5) Connect plant cables to GEM80 Equipment.

(6) Set address decoder switches and mark labels.

(7) Install modules.

Whenever it is necessary to handle GEM80 modules, the handling precautions detailed in Section 1.7 must be observed.

6.5.1 Equipment Layout

In laying out the equipment the following recommendations are made:-

(1) Determine whether plant cables will enter at the top or bottom of the cubicle and leave adequate space for plant cable glanding.

(2) Equipment or wiring which carries signals that could contain electro-magnetic noise from the plant is termed 'dirty'. Equipment or wires which carry filtered, noise free signals is termed 'clean'. Establish areas for mounting 'clean' equipment such as Controller, serial link termination units etc. Establish areas for mounting 'dirty' equipment such as Basic I/O subracks.

(3) If possible fit 'dirty' equipment in separate enclosures from 'clean' equipment. Where all equipment is to be mounted in one cubicle fit 'dirty equipment' near the entry of the plant cables. This prevents 'dirty cables' passing close to 'clean equipment'.

(4) Provide separate trunking for 'clean' and 'dirty' plant cables.

(5) Fit a signal ground bar and safety earth bar in the GEM80 controller enclosure close to the point of entry of the plant cables.

(6) Subracks should be mounted above each other to form a column of equipment. This will produce a cooling chimney effect. Do not obstruct the flow of air through the 'chimney'.

6.5.2 Examples of Cubicle Layout

Figures 6.2 and 6.3 show examples of typical cubicle layout. Clearly many different layouts are possible, depending on GEM80 equipment required, and the cubicle dimensions and fittings.

6.5.3 Positioning a GEM80 Controller

It is recommended that the Controller be mounted at a reasonable height for access (i.e. between waist and eye level) to permit:

(1) Connection of Programmer

(2) Access to Control Switches

(3) Viewing Indication Devices

(4) Removal and Replacement of Modules

6.5.4 Access Requirements

(1) Controller - Access is required to the front and rear of the Controller only.

(2) Basic I/O address decoder switches and the terminal blocks containing the Watchdog terminals and the power supply output terminals are accessible from the front of the subrack with the 9032 Power Supply and the 8231 Processor module removed.

(3) Clearance is required at the front of the subrack for the removal and fitting of the Basic I/O modules, the 9032 Power Supply and the 8231 Processor module.

(4) The Basic I/O Ribbon cables Serial Ports 1 and 2 Ribbon cables and the Printer/Programmer connection port are all situated at the front of the 8231 Processor module.

6.5.5 Heat Dissipation of Basic I/O Modules

Basic I/O equipment in particular can dissipate great amounts of heat. See Product Data Sheets for details.

Where plant circuits use high operating currents, care must be taken to avoid hotspots and overheating to the point where the ambient temperature in the enclosure never exceeds the environmental conditions for temperature, given in Section 1.

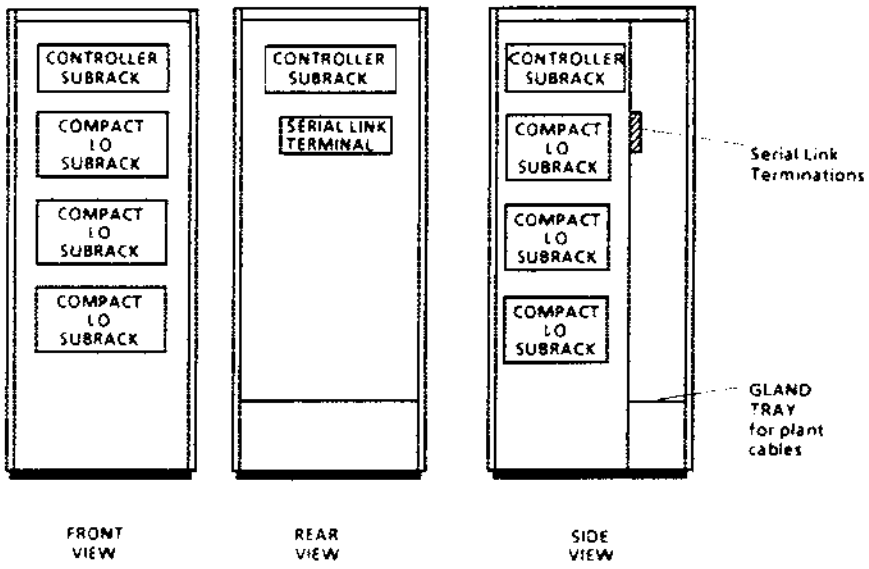


Figure 6.2 - Typical GEM80 Single Cubicle Layout

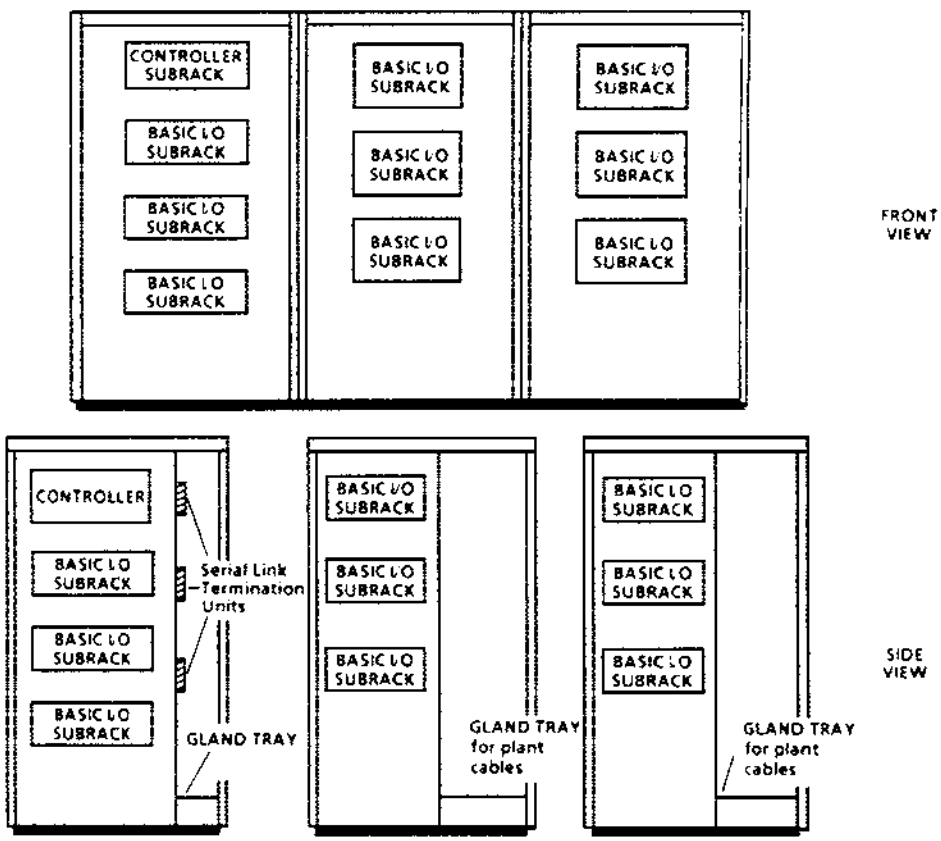


Figure 6.3 - Typical GEM80 3-Cubicle Layout

6.5.6 Minimum Panel Spacings

To help remove the possibility of noise problems the minimum panel spacings given at Figure 6.4 must be achieved.

6.5.7 Cable Routing and Segregation

To help remove the possibility of noise problems, GEM80 interconnecting cables are categorised into groups and these separate groups must be run physically separated by at least the distances given in Section 6.8.4.

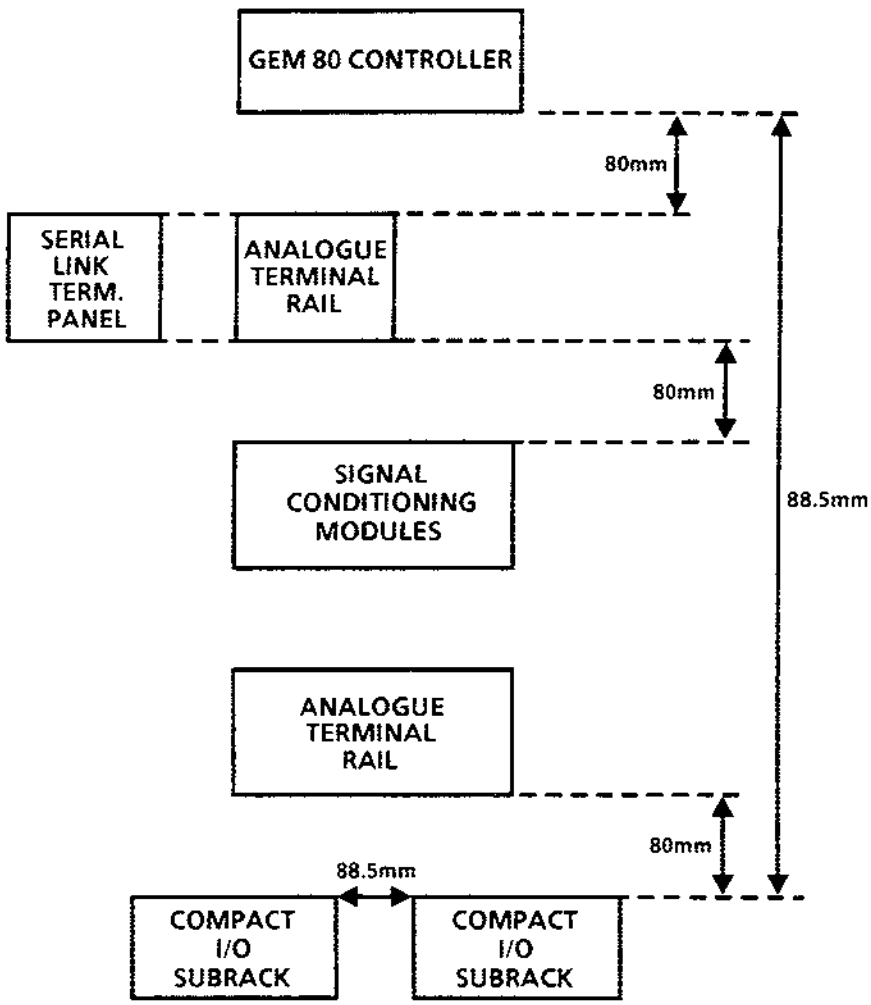


Figure 6.4 - Minimum Panel Spacings for GEM80 Controllers

6.6 Cubicles

The cubicle should now be erected and the various cubicle fixtures and fittings incorporated.

6.6.1 Movement of Cubicles

When equipment is supplied ready mounted in cubicles, the cubicles can be moved into the required position either by lifting or rolling.

Where the user provides an enclosure, similar techniques may be used provided that the weights are evenly distributed. Adequate lifting bars should also be fitted.

(1) Lifting

Cubicles should be lifted using rope slings attached to each cubicle. See Figures 6.5 and 6.6.

(2) Rolling

Cubicles which are being moved in a building of restricted height or without lifting facilities may be rolled into position using scaffolding poles as detailed at Figure 6.7.

6.6.2 Cubicle Foundations

The site should be prepared to the Foundation Tolerances as follows:-

(1) Mounting hole positions +6.5mm.

(2) Mounting Plane Face Flat within 2mm per 1m x 1m area (Not to be convex).

(3) Mounting plane level in both directions within 1mm/m (4' arc) max. deviation from level; 10mm when the length of the foundations exceeds 10m.

(4) The above tolerance must NOT be cumulative.

6.7 Mounting GEM80 Equipment

The GEM80 equipment should now be mounted in the cubicle. The empty subracks should be mounted without fitting the modules, which should be fitted later. The order of work depends on the cubicle layout but usually the following order of work is recommended:-

(1) Fit all mounting channels or trunking

(2) Fit transformers

(3) Fit termination panels

(4) Fit subracks

Fixing details for the GEM80 equipment are also given in the Product Data Sheets.

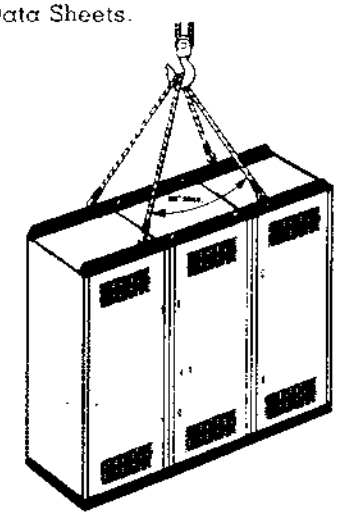


Figure 6.5 - Cubicle Lifting - Typical Q80 Cubicle Suite

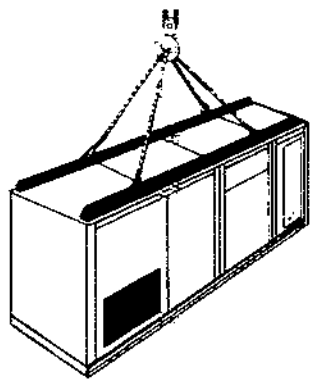


Figure 6.6 - Cubicle Lifting - Typical QP Cubicle Suite

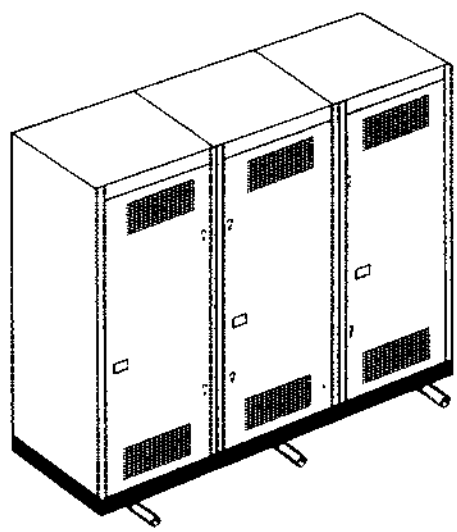


Figure 6.7 - Cubicle Rolling - Typical Q80 Cubicle Suit (QP is rolled in a similar manner)

6.8 Cabling GEM80

6.8.1 Tools for Cabling

(1) Ribbon Cables

No special tools are required for the installation of factory assembled ribbon cables. Tools are required for assembling connectors onto ribbon cables, if the user wishes to assemble his own cables and details are given in Appendix A.

(2) Push-on Connections

BICC Pre-insulated terminals are recommended for all push-on type connectors.

The recommended tool for crimping these connectors is type MR14P6.

Connectors and tools are available from:

ITT:CANNON (UK) Ltd.,
Interconnect Division,
St. Helens,
Merseyside
WA91PR

Telephone: 0744-24000
Telex: 628035

(3) Fibre-Optic Cables

Serial Links using fibre-optic cables require special tools and termination methods. These are detailed in Appendix B.

6.8.2 Safety Earth Wiring

It is essential that the GEM80 system is properly earthed and a safety earth circuit must be connected. See Figures 5.2, 5.3, 5.4 and 5.5 for the earthing arrangements and the location of the earth studs.

Safety earth cable must be a minimum of 2.5mm^2 (green/yellow) insulated wire and must be fitted in accordance with the segregation requirements in Section 6.8.4.

6.8.3 Signal Ground Wiring

(1) Signal Ground Bar

This should be fitted in the controller enclosure, which must be insulated from the safety earth bar as shown in Figure 6.8. A removable, 2.5mm^2 jumper wire should be fitted between the safety earth bar and the signal ground bar. The signal ground bar will be the local common point for all the enclosure signal ground wires.

(2) GEM80 0V

This should be run directly from the 0V connection on the controller subrack to the signal ground bar. Minimum wire size should be 6.5mm^2 run as a VERY CLEAN wire in accordance with the segregation requirements in 6.8.5, Figure 6.8 shows the location of 0V connection.

(3) Screen Signal Grounds

These should run from signal ground terminals on termination units to the signal ground bar. They should be run with the cable whose screen is being connected to signal ground, and in accordance with the segregation requirements in 6.8.4.

6.8.4 Wiring Segregation Within GEM80 Cubicles

Electrical noise and electromagnetic interference can be introduced into a micro-electronic system through the cables and wires connected to it.

To avoid this, wiring which could carry noise needs to be kept away from cables which are sensitive to noise.

The wiring segregation within the cubicle is shown in Figure 6.9. Wires which fall in the same group can be run together, but wires falling into different groups MUST be run separately (though paths may cross at right angles). Wires of different groups must be spaced apart by at least the distance shown in Figure 6.9.

Spacings may be reduced:

(1) For runs of less than one metre - spacings may be haived

(2) Within the vicinity of connections a minimum spacing of 25mm should be aimed for

6.8.5 Interconnecting GEM80

(1) Connecting Power Supplies - see Section 5 and 3.

(2) Connecting Basic I/O Highway Ribbon Cable - see Section 3.

(3) Connecting Watchdog and Safety Circuits - see Section 5.

(4) Connecting Serial Links Ribbon Cables - see Section 4.

(5) Other equipment - see relevant Product Data Sheet or User Information.

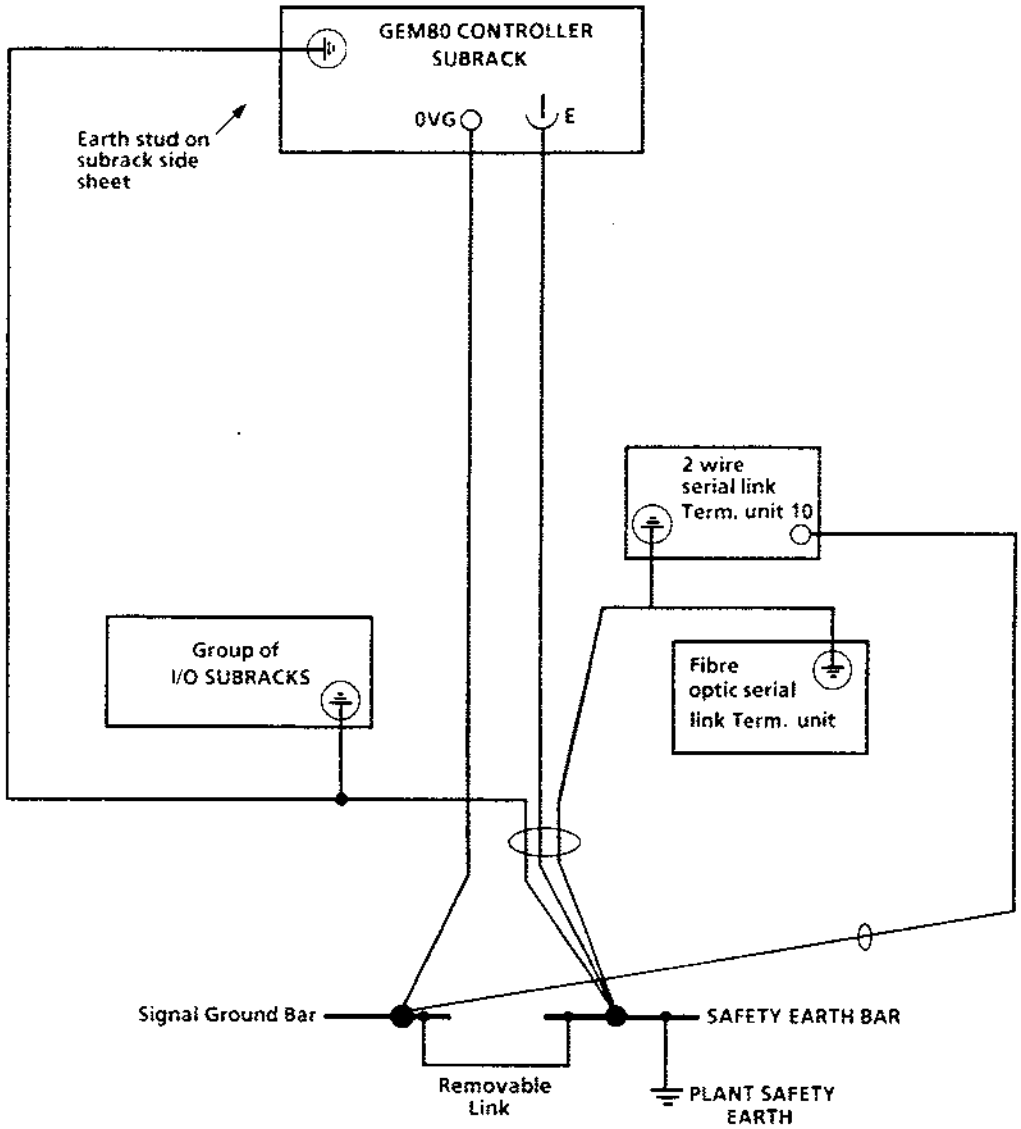


Figure 6.8 - GEM80/131 Series Signal Grounds and Earthing - typical example

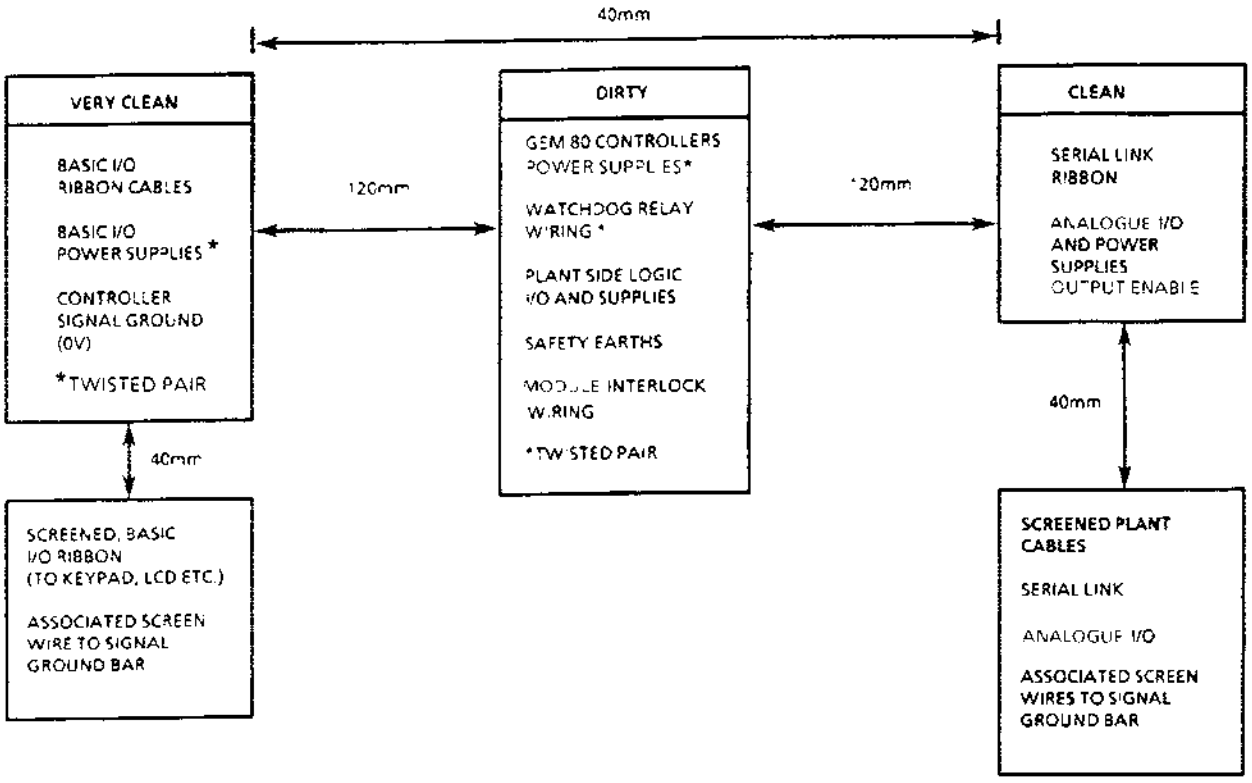


Figure 6.9 - Wiring Segregation

6.9 Plant Cabling External to GEM80 Cubicles.

6.9.1 General

Conductors of CLEAN groups should always be kept separate from conductors of DIRTY groups. It is also recommended that CLEAN analog signals are run in a different cable from CLEAN digital signals. CLEAN cables should be screened and the screens should be connected to signal ground at one end only to avoid earth loops. The preferred end is that at which the current or voltage source exists.

6.9.2 Segregation

(1) General

The spacing between CLEAN and DIRTY cables should be at least 360mm, i.e. increased by a factor of 3 on spacings within the enclosure.

This distance may be halved (180mm) if cables are run in earthed steel conduit or trunking.

The spacings given above may be halved for a cumulative total of 10 metres at the point of entry to the equipment.

(2) Basic I/O Ribbons

Should be run in screened ribbon, preferably in earthed steel trunking.

(3) Signal Ground

In the majority of applications the incoming safety earth wire will be adequate for signal ground purposes. If it proves inadequate or if the user has a separate clean earth system, a clean earth cable will be required.

This should be:

(1) Run separately from all other cables

(2) Insulated

(3) Kept clear of machinery bedplates/mounting brackets, etc., and any other noise generating equipment, e.g. electrical welding machines

(4) As short as possible and connected directly to the clean earth system or as close to the plant earth source as is practicable

(5) Run in 4/6mm^2 cable

6.9.3 Further Information on Plant Cabling

See Table 6.1

6.9.4 Basic I/O Plant-Side Power Supply Connection

(1) The Basic I/O Subrack plant-side power supply cabling must be protected by a fuse. For 1.5mm² PVC insulated (30/0.25) cable, the total maximum current* must not exceed 12A at an ambient temperature of 60°C, and must be short circuit protected by a fuse rated at less than 60A. For ambient temperatures above 60°C the total maximum current taken by the cable must be de-rated accordingly.

(2) Basic I/O module plant-side power supply terminals may be looped together, bearing in mind the load restriction of paragraph (1) above.

*actual currents depend on the configuration for the system.

Table 6.1 - Plant Cabling

Unit	Location of Connections	Size of Conductors	Remarks
Basic I/O Subrack	Lower, Front part of individual Basic I/O modules	Up to 1.5mm²;- one conductor per terminal	The plastic shroud must be fitted after plant terminations have been made.
Serial Link Termination Panel (4-wire)	Upper, front part of the termination panel	Up to 2.5mm²	Recommended cable is 16/0.20mm twin twisted pairs with overall screen. Maximum serial link cable lengths and recommended types are detailed in User Information Sheets.
Serial Link Termination Panel (2-wire)	Lower, front part of the termination panel	Up to 2.5mm²	Recommended cable is 16/0.20mm twin twisted pairs with overall screen. Maximum serial link cable lengths are detailed in User Information Sheets.
Optical Fibre Transceiver Unit	Lower, underside part of the unit	See Product Data Sheets under 'Application Notes'	Termination of fibre-optic cable is made by a Radiall SMA Connector. **CAUTION:** Special techniques/tools are required to terminate fibre-optic cable - see Appendix C. Maximum fibre-optic cable lengths and recommended cables are detailed in the Product Data Sheets.
Serial Communications Termination Panel	Upper and lower front part of the termination panel	Up to 2.5mm²	
Analog Terminal Rail (used with Analog Input/Output Modules)	Upper, front part of the Terminal Rail	Up to 2.5mm²	See the Product Data Sheets for detailed information on plant terminations.
Contact Input and Lamp Driver	Connections marked PL2 and PL3	34-way twisted ribbon cable	

6.10 Installation of Modules

After cabling, the Controller modules can be fitted into the subrack. They contain static sensitive devices and the handling precautions of Section 1 must be observed. The layout of the modules in the Controller subracks is shown in Section 3. The slots for the I/O modules are mechanically coded to suit the modules being fitted, therefore, a module will only fit into its designated position. These modules must be pushed home into the connectors at the rear of the subrack, so slightly more force will be required for the last few millimetres of travel. I/O subracks are also mechanically coded to suit the modules to be fitted.

6.10.1 Module Retention

MODULE RETENTION IS ONLY NECESSARY IN HIGH SHOCK OR VIBRATION APPLICATIONS WHERE THE MODULES COULD BECOME DISCONNECTED.

The subrack has integral sliding 'bolts' at the top and bottom front edges which slide into notches cut into the module p.c.bs. Open and closed indication is provided by a pointer on the mechanism being positioned opposite the open or the closed symbols marked on the subrack flanges.

To lock the modules in position proceed as follows:-

(1) Ensure the 'bolt' is in the open position.

(2) Check that each module has a small slot cut into the upper and lower edges of the p.c.b. approximately 10 mm from the front edge.

Note...I/O modules may have a blanking plug fitted in the top slot. Before fitting the module into the subrack remove this plug but retain it for future use. Should it be required to insert the module into a metal subrack, the plug must be re-fitted.

(3) Fit modules into their correct positions in the subrack. Ensure that they are all fully inserted.

(4) Slide the top 'bolt' toward the left until the pointer is opposite the closed symbol.

(5) Slide the bottom 'bolt' towards the right until the pointer is opposite the closed symbol. All modules will now be retained in position.

Note... Any one module without the cut in the p.c.b edge, still with the blanking plug on or not fully inserted will prevent the correct operation of the 'bolt'

(6) To remove a module, slide the upper and lower 'bolts' to the open position and eject the module.

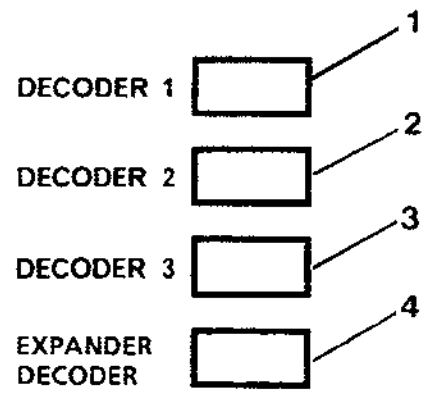
6.11 Address Decoder Switches and Address Marking

6.11.1 Address Decoder Switches

The Address Decoder Switches should now be set up, as discussed in Section 3.

6.11.2 Address and Module Label Marking

The data table addresses can be written on the self-adhesive label which is supplied loose for the User to stick on the inside of the right-hand cheek of the subrack, see Figure 6.10. Module type and order numbers should be written on to the lower rail 'slide in'labels of the I/O subracks.



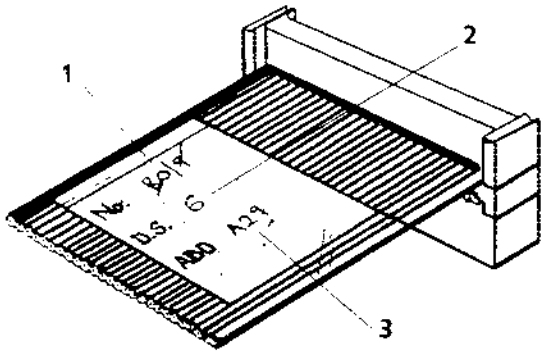
1. Decoder Switch Setting S1
2. Decoder Switch Setting S2
3. Decoder Switch Setting S3

Figure 6.10 - I/O Subrack Label

6.11.3 Ribbon Cable Connectors

There is a self-adhesive strip label on the cable next to the connector which has a 'write on' area for identifying where it connects to and other information, see Figure 6.11 for details.

If extra labels are required, they are available from CEGELEC Industrial Controls on: Order Ref. 20T0094/01 (10 labels per sheet).



1. Cable Destination (Subrack Slot No. or Plug No.).
2. Decoder Setting of panel into which Cable plugs (if applicable).
3. Half Panel Address or Address range (if applicable).

Figure 6.11 - Typical Example of Ribbon Cable Labelling

7.1 Introduction

the GEM80 Controller and I/O will have been configured to meet particular requirements. It is extremely unlikely that these requirements are the same as those of other GEM80 customers. Therefore, only general commissioning procedures rather than specific ones for the particular system can be given.

7.2 Preparation

Before commissioning the GEM80 system, the following tasks should have been completed:-

- The equipment should be fully installed and cabled up, including all earth (ground) connections as given in Section 6 of this manual.
- The watchdog and safety circuits should be connected in accordance with the guidelines given in Section 5
- All modules should be fitted in the subracks, observing the handling precautions described in Section 1.
- Connect a Programmer unit ensuring that spare cassettes or disks to suit the model of Programmer are available.

7.2.1 Documents Required

During Commissioning the following documents will be required:-

- The appropriate GEM80 Programmer Technical Manual.
- GEM80 Programming Manual, Publication No.T397.
- User Information leaflets or Technical Manuals, for all the constituent Basic I/O modules.

7.3 Overview of Commissioning Procedure

The recommended sequence for commissioning is as follows:-

- Hard-wired Watchdog safety circuits checks.
- Power module checks.
- 131 Processor module checks.
- Basic I/O, inputs, then outputs.
- Serial links to other Controllers, printers etc.

7.4 Safety Circuits Checks

(1) If possible, remove the control supply that feeds the safety circuit. If, however, this circuit is continuously energised from a main circuit breaker that cannot readily be opened during commissioning, break the circuit using any convenient contact that can be held open, such as a stop/lock-off emergency stop push-button. This is one reason why the watchdog follower relay should be put at the neutral end of the circuit.

(2) Check with a multimeter that there is no voltage on either of the watchdog terminals on the GEM80 Controller subrack relative to ground, and that they are safe to work on. Then connect a shorting link across these terminals.

(3) Re-connect the supply to the safety circuit.

(4) Check that the Watchdog follower relay energises.

(5) Operate each contact in the safety circuit in turn.

(6) Check that in every case the Watchdog follower relay drops out, and re-energises when each contact is re-made.

(7) Break the supply as in paragraph 1 above, remove the shorting link across the Watchdog contacts, and then re-make the supply.

(8) Check that the Watchdog follower relay remains de-energised.

(9) For further stages in commissioning, especially if the GEM80 Controller drives moving machinery, there should be an emergency stop push-button close by which can be used as a panic button.

7.5 Power Module Checks

(1) Disconnect all I/O equipment from the 131 Controller subrack as follows:-

- Disconnect the Basic I/O ribbon cables.
- Disconnect the Serial I/O ribbon cables.

(2) Withdraw all modules from the Controller subrack sufficiently to break their edge-connector connections. The front panel of each module will be about 30mm from the front face of the subrack.

(3) Check that the power module is of the correct type.

(4) Check also that the type number on the power module agrees with the subrack identification for its position.

(5) Check that the switch on the power module front panel is set to STANDBY.

(6) Push the power module into the subrack to remake the connections on the backplane. Plug in the Power lead.

(7) Check that the POWER indicator lamp on the power module is lit.

(8) Set the switch on the power module front panel to RUN.

(9) Check the +5V and +15V LED indicators are lit.

(10) Set the switch on the power module to STANDBY. Remove the power input.

(11) Check that the POWER indicator lamp on the power module is extinguished.

(12) If the system has more than one power module, repeat the above procedure for each one, finally leaving all power modules on STANDBY.

7.6 131 Processor Module Checks

(1) Plug the Processor Module into the subrack in the correct location (see Fig 7.2).

(2) Check that the lithium/manganese-oxide battery on the module is fitted as detailed in Section 8.4.1 and that the battery connection link, LK1, is in position A.

(3) Check that the ordering code of each module agrees with that shown on the lower subrack label strip.

(4) Power up the Programmer unit.

Note... If this is an 8920 Portable Programmer, check the voltage and frequency of the supply before connecting the Programmer, and set it up appropriately first. See the 8920 Product Data Sheet for details. System Programmers 8922/8940/9022 do not require any setting up.

(5) Connect the Programmer and any peripheral equipment, e.g. printer. Connect the programmer to a suitable power supply in accordance with the instructions in the programmer manual and switch the programmer on.

(6) Connect the Programmer to the Processor module in the subrack using the lead that is terminated by a 15-way, D-type connector at each end. Connect the cable end marked GEM80 to the socket on the front panel of the Processor module in the Controller, and connect the end marked PROG to the Programmer. This lead is not reversible; if connected incorrectly, it will not work.

(7) Insert the key in the Programmer key-operated switch and switch to the PROGRAM mode.

(8) Re-connect the power input to the subrack(s). Power up the GEM80 equipment, then set the switch(es) on the power module(s) in the subrack(s) to RUN. When the GEM80 is powered up, a sequence of program self-testing commences.

(9) Check the watchdog sequence as follows:-

Using the Programmer, select the mode allowing monitoring/editing of GEM80 ladder diagram rungs (see the Programmer Technical Manual for details). Then, in the command mode, select 'C' for the CLEAR STORE command.

Note... On the 8920 Portable Programmer, 'command mode' is referred to as 'control mode'.

(a) Check reply on the Programmer.

- If there is no link failure, the reply will indicate 'GEM80 131', in which case go to the check at (b).

- If no link is established, the screen will show 'NOT CONNECTED TO GEM80'. If a link is established but fails subsequently, it will show 'LINK FAILURE'. In either case, continue with the checks below:-

(i) Power any of the power modules STANDBY and RUN again, to re-initiate the start up self-test routine. Repeat the CLEAR STORE command from the Programmer.

(ii) Check the reply to see if the link failure has cleared. If so, proceed with the checks at b) below:-

(iii) If the link failure is still present, check that:

- the Programmer is correctly plugged into the Processor Module (as given in paragraph (6) above);
- the 9032 Power Module is still operating;
- all subrack modules are correctly plugged into the subrack;
- no pins have been bent on any of the connectors at the rear of the modules.

(iv) Repeat items (i) and (ii). If the link failure has cleared, continue with the checks at (b).

(v) If none of these checks succeed, remove the Processor module and remove the battery. Leave for 5 minutes, then replace the battery and replace the memory module.

(vi) Repeat items (1) and (ii). If the link failure has cleared, continue with the checks at (b).

(vii) If this check fails, replace the Processor module and repeat items (i) and (ii) above. If the link failure has cleared, proceed with the checks at (b) below.

(b) Set the Controller into the RUN mode.

(c) Check that the Watchdog LEDs on the Processor light and extinguish a number of times, and finally remain lit.

(d) Simultaneously with (c) check that the Watchdog relays can be heard to click in and out and finally remain energised.

(e) Also check that, if there are no breaks in the safety circuit (such as emergency stop push-buttons operated), the Watchdog follower relay follows the action of the Watchdog relay, and also finally remains energised.

(f) Satisfactory completion of the Watchdog sequence indicates that the GEM80 system self-checks are healthy. Switch the power module in the Controller subrack to STANDBY.

7.7 Basic I/O Input Checks

A GEM80 series Controller will only scan I/O addresses that are referred to in the user ladder program.

Each A-table word reference will cause the Controller to scan all the bits contained in it, e.g. a reference to A3 in the ladder program will cause the Controller to scan all the bits from A3.0 to A3.15).

To check the Basic I/O inputs proceed as follows:-

(1) Check the Address Decoder switches are correctly set on the Basic I/O subrack backplanes relevant to the particular inputs to be checked. See Section 5 for the addressing principles.

(2) Re-connect the Basic I/O ribbon cables at the Controller

(3) Check that the Basic I/O ribbon cabling is complete to the Basic I/O subracks.

(4) Check that the plant cabling is completed, both to the Basic I/O equipment and to the plant input transducers.

(5) Apply plant-side power to Basic I/O input transducers but NOT to Basic I/O output equipment.

(6) Power up the GEM80 Controller.

(7) Set the Programmer connected to the GEM80 to MONITOR/EDIT GEM80 DATA LIST mode.

(8) Select the ADDRESS ENTRY mode.

(9) Enter input references you want to check, e.g. A6.0, A7.1, etc.

(10) Press ESCAPE and then select the MONITOR mode.

(11) Operate the plant devices one at a time.

(12) Check that each input state can be seen to change on the Programmer screen when the corresponding plant device is operated.

(13) Check also each input by LED indication on the module front panel.

If checks 12 and/or 13 fail for an input device check the following:-

- that all cables are terminated at the correct terminals and at the correct module. Check the input LEDs to see whether another one changes state that ought not to.
- that the decoder switches are set correctly on the I/O subrack(s).
- that the ribbon cables are plugged in properly.

7.8 Other Basic I/O Inputs

(1) To test analog inputs, operate the transducer to provide an input signal or where this is not possible, disconnect the transducer and simulate its output with a battery and potentiometer.

(2) Check that a variation in each analog input signal is registered as a change in value in the appropriate A-table word.

(3) Check also that the values and changes of value are of the correct polarity. This is most important if the signal is used as the input to a closed loop control. If the polarity is wrong, it can usually be corrected by interchanging the connections on two adjacent terminals on a terminal rail.

(4) Test any counter by operating it to provide an input.

(5) Check that the relevant A-table word counts up. For bi-phase inputs, check that rotation in one direction causes counting up and in the other direction causes counting down and that the counter is operating in the correct sense. This is most important if the signal is to be used as the input to a closed loop position control. If the polarity is wrong, it can usually be corrected by interchanging the connections, for one of the two phases only, at a terminal rail.

7.9 Basic I/O Output Checks

The Basic I/O output only occurs when the I/O output is addressed by the ladder program. Testing the I/O outputs involves writing ladder test programs which write to the A-table and then checking that the subsequent output is consistent with the A-table data, first at the I/O modules and then at the plant output devices.

To check the basic I/O output proceed as follows:-

Ensure that plant-side power is disconnected from the output modules.

With the Programmer set to monitor mode, check each Basic I/O output in turn by writing to the B-table addresses and checking that the output at the appropriate module corresponds.

Check that indicator LEDs light on the corresponding Basic I/O output equipment when outputs are driven high by B-tables that are set to 1.

7.10 Connecting Output Equipment

Having completed the output checks at the modules, check that the plant output devices are connected to the plant-side power supply and switch on.

Check that, each output device responds to the controller in an appropriate manner, e.g. when a B-table bit is set to 1, the corresponding coil or solenoid energises. The purpose of the checks is to verify that all cabling has been correctly carried out.

At the GEM80 output modules check that the output equipment has not overloaded any of the modules, i.e. that no 'fuse blown' indicator LEDs are lit. If any fuses have blown, the fault should be investigated and corrected.

7.11 Loading the User Program

When the power supply, and input and output checks have been completed satisfactorily the user Program can be commissioned. The user program is loaded from tape or floppy disk using the System Programmer.

Information on User Program comissioning can be found in the GEM80 Programming Manual, Publication No.T391.

For the design, setting up and commissioning of closed loop controls, refer to the GEM80 Closed Loop Control manual, Publication No.T451.

7.12 Serial Links

If the system uses serial links, it is recommended that the program is first run with the serial links disconnected. If, as a result, the program has to wait for serial link data, the program can be altered temporarily, for commissioning purposes, so that the section of program that causes problems is by-passed, i.e. enclosed within START OF BLOCK and END OF BLOCK instructions. When the system is working satisfactorily without the serial links, the serial links can be re-connected, the START BLOCK and END BLOCK instructions removed. The system can then be tested with the serial links connected.

Note... The Tx LEDs on the Processor module light when it attempts to transmit, even if no serial link connections are made.

There are several types of serial link these include:

(1) Printers or programers - connected directly to the GEM80/131 Controller.

(2) Other Controllers or remote programmer units connected via termination panels.

The values to be loaded into the P-table for the various types of link are detailed in Section 4. Further information and examples of the P-table pre-set data for the various serial port configurations are given in the Serial Communications Manual, Publication No.T457.

7.12.1 Printer Ports

For outputting data to a printer or VDU, include the PRITEXT Special Function in the program. The Printer port must be pre-set with the following data for the printer in use:-

- the baud rate (bit/s),
- the character format (quantity of bits/character, odd/even/no parity), and
- any null characters required at the end of a print line (not normally needed on printers that have input buffer memory).

7.12.2 Serial Links Connecting Controllers

Where serial links are used to provide communications between different GEM80 Controllers, all the Controllers must be commissioned before the serial links can be commissioned.

The simplest form of serial link is free-running with standard table allocation. For this type of link, write data into the K-table locations at the Controller providing the control port, and check that it appears in the appropriate J-table locations of the tributary. Similarly, data written to the K-table locations of a tributary should appear in the appropriate J-table locations at the control port.

Note...Control and tributary ports must be set to the same baud rate.

7.12.3 Further Details

Refer to Section 4 of this manual for details of P-table settings. See also the section on serial links in the GEM80 Programming Manual for an introduction to serial links. For further details on these and the printer port see the GEM80 Serial Communications Manual.

7.13 Fitting a Memory Expansion Board

CAUTION...

The ESSD precautions described in Section 1 must be observed while handling the 131 Processor Module and the Memory Expansion board to prevent damage by electro-static discharge.

To fit a memory board to the 131 Processor module proceed as follows:-

(1) Remove the 8231 Processor Module from the subrack and lay it on a flat surface.

(2) Remove the Memory board from its packing and pull out the four rivet fasteners at the corners of the board.

(3) Position the memory board over the Processor module and align the connectors. Push home the memory board until the connectors are fully mated.

(4) Push in the four rivet fasteners, applying only moderate force, until each one clicks into position.

(5) Check visually that the memory board is correctly fitted and re-fit the Processor module into the subrack.

7.13.1 Effect of fitting a Memory Expansion Board

When a memory expansion board is fitted, the system will power up as a new system.

If a memory expansion board is exchanged for another of the same size the system will not power up as a new system, but will fail the checksum self-tests. In this case a CLEAR STORE command should be issued to initalize the memory on the board.

This page left intentionally blank

8.1 General

This section gives details of the upkeep and general maintenance requirements of the GEM80/131 Controller and includes fault finding information which can be used in the event of either an in-service fault or faults which occur because of ladder program development.

8.2 Spare Modules

The fault finding procedures rely on substitution of suspected faulty modules with spare modules. These spare modules may be stored powered up, i.e. functional spares.

It is recommended that all spares modules are powered up every 9 months.

8.3 Cleaning and Visual Inspection of GEM80

Cleaning and visual inspection of GEM80 should be carried out at time intervals determined by the customer. The equipment should be isolated from its main supplies and associated equipment.

8.3.1 General Maintenance and Cleanliness

(1) Periodically, dust and dirt should be removed from enclosures using a vacuum cleaner, brushes and soft cloths.

CAUTION...

Never blow air into an enclosure to remove dust and dirt.

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

(3) Check all terminations within enclosures for security.

8.4 Batteries

The Read/Write memory is supported by a type CR2477 battery. The battery life times are given below:-

Controller Version	Temperature Range (°C)	Battery Life (years)
2.5K user instructions in RAM or any FLASH EPROM system	0-60	greater than 5
5K user instructions in RAM	0-40 40-60	greater than 5 greater than 4
10K user instructions	0-40 40-60 in RAM	greater than 5 greater than 4
20K user instructions in RAM	0-40 40-60	greater than 5 greater than 2

When the battery warning LED is lit or when specified life times have expired the batteries should be renewed.

Lithium/manganese dioxide batteries have a typical shelf life of 6 years (4 years minimum).

8.4.1 Battery Connection Procedure

Before attempting to use the 8231 Processor ensure that the J-link, refer to Figure 8.1, is in position A in order to connect the battery to the RAM support circuit. The battery warning LED on the front panel should be extinguished.

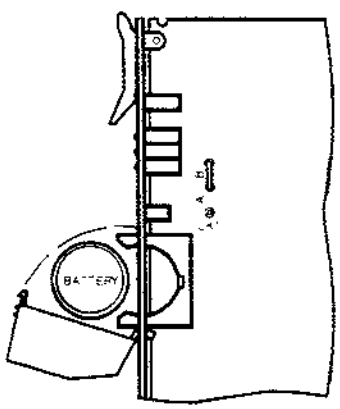


Figure 8.1 - Details of Battery Fitting and J-Links

8.4.2 Battery Replacement Procedure

Note...The system should be powered up while the battery is being changed to prevent the contents of the memory being lost, i.e. user program and data tables.

The 8231 Processor Module battery is replaced as follows:-

(1) Open the battery cover located on the module front panel.

(2) Withdraw the battery.

(3) Fit the new battery ensuring that the wider diameter (negative) is to the left, looking at the module.

(4) Close the battery cover.

(5) Dispose of old battery. There are no disposal restrictions.

8.4.3 Battery Type

Battery type: CR2477 950mA/H

8.5 Fault Finding

8.5.1 Introduction

When a fault occurs in a system, it will be indicated initially by the indicator LEDs on either the 8231 Processor module or the I/O modules. GEM80/131 Controllers have built-in comprehensive fault finding facilities to indicate possible causes of the fault not only throughout the plant but also within the GEM80 itself and these can be accessed by connecting a System Programmer to the Processor module. Faults are reported at the System Programmer by a three-digit error code and a text message.

The faults which are reported are divided into five groups:

(1) Compilation Errors

(2) System status errors

(3) Self-Test errors

(4) Task/Intertask Communications error messages.

(5) System errors

Additional information to aid fault diagnosis is provided in the F-Table and the V-Table which can be accessed via the System Programmer.

8.5.2 User Program Checksum Calculations

The User Instructions, running program and pre-set data areas are protected from unnoticed corruption by a checksum calculation, which is performed on the relevant areas of memory at power up and as part of the background self-test. When a change is made to the User program or pre-set data, the checksum is re-calculated immediately. This allows the user to remove power without waiting for the checksum to be re-calculated.

8.5.3 Monitoring and Test Facilities

It is possible to monitor program execution while the GEM80 is running, subject to observing the safety precautions detailed in Section 1 of this manual.

With the Programmer connected and the appropriate option of the initial screen selected, either specific rungs of ladder diagram or data table locations can be monitored by selecting 'permitted command' - 'M' (monitor).

When monitoring a rung of ladder diagram program, contacts and coils are displayed as shown in Figure 8.2 to indicate their state (energised, de-energised, open or closed) and word mnemonics are replaced by the content of the element's data table.

The command mode allows a choice of mode for the Controller:

HALT, RUN, SINGLE CYCLE, TEST INPUTS or NORMAL INPUTS.

In Data Mode, up to 32 data tables can be displayed simultaneously and their contents monitored in hex, decimal, binary or ASCII text.

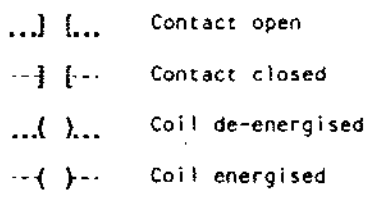


Figure 8.2 - Symbols Displayed in Monitor Mode

8.5.4 Indicator LEDs

Where a fault is evident, a quick guide to the state of the system can be obtained from the front panel indicators.

Controllers have monitoring LEDs mounted on the module front panels. Section 1.2 details the meaning of these LEDs.

I/O modules have fuse indication LEDs and plant-side state indicator LEDs; see relevent User Information sheets for details.

8.5.5 Compilation and Compilation Error Messages

On compilation, the Controller performs the following:-

(1) Matches the data-table sizes to the program requirements by searching for the highest specified location in each table.

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

(b) The existing data table locations will be removed if they are no longer required by a program which has been modified. This can create confusion in the case of P-tables since they may be created simply by attempting to access them through a programming unit.

(2) Generates and checks the I/O configuration data for Basic I/O.

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

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

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

8.5.5.1 Compiler Error Messages

If a compilation error is detected, the compiler issues an error number, in the range #101 to #199 and an error message. Compiler errors do not halt the Controller, and the old program continues to run. Table 8.1 details the compiler error messages.

8.5.5.2 Programming Routine for Correction of Compilation Errors

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

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

If the compilation is successful the following message is displayed on the programming unit screen for 10 seconds:-

"COMPILED. INSTRUCTIONS AVAILABLE" NNNN
"DATA TABLES AVAILABLE NNNN"

CAUTION:

It should be noted that if the only reference to a B-table is deleted from a program and a re-compilation performed, the I/O hardware associated with that table will no longer be scanned. This could result in outputs being left in an uncontrolled state until the next power up.

8.5.5.3 Compilation Errors and the Controller

Compilation errors will cause the Controller to continue executing the previous version of the user program, and give a fault report from the compilation.

When the Controller is running and changes are made to the source version of the program, the status is displayed on the Programmer as CHANGED instead of RUNNING until such time as the source code is re-compiled.

If the Controller is running with status CHANGED and there is a power interruption, the Controller will go into the halt mode after power up and give a fault report.

"POWER REMOVED WHILE PROGRAM IN A CHANGED STATE".

Table 8.1 - Compiler Error Messages

CODE	Fault Message	Possible Causes	Recommended Recovery
# 101	SOURCE CORRUPTION ERROR NEAR INSTRUCTION (data), (data) TOTAL	Many possible causes. eg loading corrupt tape. Persistent problems could be due to hardware or noise problems.	Re-load the ladder diagram program and re-compile.
# 102	OBJECT RAM FULL.	The ladder program has generated an excessive amount of object code.	Contact CEGELEC Industrial Controls.
# 103	BLOCKS OVER NESTED. ERROR NEAR INSTRUCTION (data), (data) TOTAL	Maximum depth of nesting is 16. End of block command overlooked.	Reduce nesting of blocks.Insert missing end of block command, if applicable.
# 104	DATA TABLE RAM FULL.	The allocated amout of data tables have been used	Use larger memory expansion board. Optimise ladder diagram.
# 105	BASIC I/O Ref. ERROR NEAR INSTRUCTION (data), (data) TOTAL	Same word referred to as both input and output, e.g. cannot refer to A0 and B0 in same program.	Change ladder program.
# 107	SPECIAL NOT INCLUDED. ERROR NEAR SPECIAL (data), (data) TOTAL	The specified special function is not available in the controller. Special Function reference number entered wrongly.	Re-write program using only defined special functions. Edit program.
# 109	INVALID ADDRESS IN VALUE. NEAR INSTRUCTION (data), (data) TOTAL	Non-existent address specified for VALUE. Writing to a write-protected block table. Insufficient tables after that in VALUE table for parameter block of special function.	Change to valid address. Change to a write-enabled table. Ensure highest table reference creates sufficient space.
# 110	WRITE PROTECT VIOLATION. ERROR NEAR INSTRUCTION (data), (data) TOTAL	Cannot output to P- or V-tables.	Alter address to write enabled data table.
# 111	ILLEGAL J/K REFERENCE. ERROR NEAR INSTRUCTION (data), (data) TOTAL	Attempting to access a J/K table associated with a non-configured port, or one configured as a printer, or a reference over the table limit.	Configure port correctly, or change address to a different table. If port configured as a printer, then J/K tables corresponding to that port cannot be used. If referencing outside the table limit, alter to be within the limits.

Table 8.1 continued

CODE	Fault Message	Possible Causes	Recommended Recovery
# 112	ILLEGAL S,T REFERENCE. ERROR NEAR INSTRUCTION (data). (data) TOTAL	S- or T-tables used other than in special function call. **Note**...may be trapped by portable programmer.	S- and T-tables can only be used in special function.
# 113	REFERENCE OVER TABLE LIMIT. ERROR NEAR INSTRUCTION (data). (data) TOTAL	Attempt to read/write from non-existent location in a fixed size table (E,F).	Alter instruction to be within the limits.
# 117	ILLEGAL L REFERENCE. ERROR NEAR INSTRUCTION (data). (data) TOTAL.	Attempt ot write to non-existent L-table.	Alter instruction to use allowed data tables.
# 118	NO OFF-LINE DATA.	Off-line data not allowed in GEM80/131.	Alter program so as not to use off-line data.
# 119	NO OFF-LINE DATA.	Off-line data not allowed in GEM80/131.	Alter program so as not to use off-line data.
# 120	VALUE INSTR. PRESENT - NOT REQUIRED. ERROR NEAR INSTRUCTION (data). (data) TOTAL.	A VALUE instruction is present after a special function which does not require one.	Delete the VALUE instruction.
# 122	INSTR. CAN'T ACCEPT FLOATING POINT. ERROR NEAR INSTRUCTION (data). (data) TOTAL.	As # 121.	As # 121
# 123	INSTR. CAN'T ACCEPT INTEGER. ERROR NEAR INSTRUCTION (data). (data) TOTAL.	As # 121.	As # 121
# 124	INVALID INSTR. ENCOUNTERED. ERROR NEAR INSTRUCTION (data). (data) TOTAL.	User program has become corrupted. (Could be corrupted in programmer.)	Replace the invalid instruction.
# 125	SPECIAL FUNCTION WITHOUT "S" OR "T". ERROR NEAR INSTRUCTION (data). (data) TOTAL.	A special function with a table letter other than S or T has been specified.	Modify instruction.
# 127	INSTR. HAS INVALID LETTER.. ERROR NEAR INSTRUCTION (data). (data) TOTAL.	Instruction has a table letter outside the the range A to W.	Modify instruction.
# 128	INSTR. NEEDS A TABLE LOCATION VALUE. ERROR NEAR INSTRUCTION (data). (data) TOTAL.	VALUE instruction when it should be a data table.	Modify instruction.

Table 8.1 continued

CODE	Fault Message	Possible Causes	Recommended Recovery
# 129	INSTR. NEEDS A DATA TABLE VALUE. ERROR NEAR INSTRUCTION (data), (data) TOTAL.	VALUE instruction uses a table location when it should be a constant.	Modify instruction.
# 130	NO VALUE AT END OF INSTR. ERROR NEAR INSTRUCTION (data), (data) TOTAL.	The last instruction has been encountered before the VALUE for a special function call has been found.	Insert appropriate value.
# 131	RUNG STACK UNDERFLOW. ERROR NEAR INSTRUCTION (data), (data) TOTAL.	User program corrupt.	Replace specified instruction.
# 132	RUNG STACK OVERFLOW. ERROR NEAR INSTRUCTION (data), (data) TOTAL.	User program corrupt.	Replace specified instruction.
# 133	RUNG INBALANCED. ERROR NEAR INSTRUCTION (data), (data) TOTAL.	Last rung is not complete, usually caused by halting transfer from system programmer before it is complete.	Modify last rung.
# 134	NO 'C' TABLES IN GEM80/131. ERROR NEAR INSTRUCTION (data), (data) TOTAL.	The GEM80/131 does not support fast I/O, hence references to C-tables are not allowed.	Remove reference to C table.
# 135	NO 'D' TABLES IN GEM80/131. ERROR NEAR INSTRUCTION (data), (data) TOTAL.	The GEM80/131 does not support fast I/O, hence references to D-tables are not allowed.	Replace reference to D table.
# 136	INVALID SOURCE OF INSTRUCTIONS.	The compliler is attempting to fetch instructions from an incorrect area of memory.	Power off/on and re-try compilation. If problem persists replace controller.
# 137	INVALID OBJECT REGION.	The compiler is storing object code to an incorrect area of memory.	Power off/on and retry. If problem persists replace controller.
# 138	NO 'Q' TABLES IN GEM80/131. ERROR NEAR INSTRUCTION (data), (data) TOTAL.	The GEM80/131 does not support floating point operations. Hence Q-tables are not allowed.	Alter program so as not to use Q-tables.
# 139	P-TABLE LIMIT EXCEEDED FOR SYSTEM ERROR NEAR INSTRUCTION (data),(data) TOTAL.	Reference to P-Table higher than allowed by system.	Optimise program or fit larger memory expansion board.

8.5.6 System Status at Power Up (#601 to #699)

If, during a power up self-test cycle, one of these fault conditions is detected, the GEM80 Controller will remain in the 'halt' condition and return the fault message until the fault is cleared.

Table 8.2 - System Status Error Messages

CODE	Fault Message	Possible Causes	Recommended Recovery
#602	POWER REMOVED WHILE USER PROGRAM IN A CHANGED STATE.	The user program has been edited and the controller powered down before the program was re-compiled. The controller will be halted on power up.	Re-compile program.
#603	V-TABLE CORRUPTED. PROGRAM STORE CLEARED	Memory corruption of important data occurred, treated as a new system. Could be caused by turning power off during compilation, or a faulty processor module. It may be a flat battery, but battery warning should occur first.	Power off/on and re-load. If problem persists, suspect processor or data table RAM module, and substitute spare. Check for flat battery, and substitute spare if needed.
#604	NEW SYSTEM. PROGRAM STORE CLEARED	Brand new system. Occurs if RAM boards are swapped or replaced.	Continue as for a new system.
#620	EPROM COMPATABILITY LEVEL DOES NOT MATCH THIS SYSTEM	The EPROM board memory layout has changed. Caused by a firmware upgrade.	Place the EPROM board in program mode. Clear store and reload the program.
#631	EPROMS CORRUPTED. CLEAR STORE REQUIRED	EPROMS have been corrupted whilst powered down.	Place the EPROM board in program mode. Clear store and reload the program.
#632	EPROM PROGRAM NOT STORED. CLEAR STORE REQUIRED	EPROM program not compiled before powering off.	Clear store and reload program.
#633	NEW SYSTEM. EPROM EMPTY	Brand new system. Occurs if expansion boards are swapped or replaced.	EPROMS are empty so load program.
#634	NEW SYSTEM. PROGRAM IN EPROM	Brand new system. Occurs if expansion boards are swapped or replaced.	Run program.
#635	PROGRAM IN EPROM IS DIFFERENT FROM PREVIOUS VERSION	EPROM board swapped for different program.	Verify new program is correct. Do not run the new program if it is incorrect. Clear store and reload correct program. Run new program.

8.5.7 Self-test and Self-test Failure Error Messages (#701 to #799)

8.5.7.1 Self-test System

The self-test system operates as shown below:-

Execution

One full cycle of start up tests on power up.
I/O tests repeated every scan.
Regular on-line repetition of running tests.

Faults which immediately trip the watchdog

1. a.c. supply break longer than 10ms ride-through period.
2. Power module failure.
3. Failure of Processor Module.
4. No response from either of system memory modules.
5. Fault interfering with data transfer on the Basic I/O highways.
6. Power module confidence check.

Faults which trip the watchdog when detected by running tests

1. Alteration detected in contents of read only memory.
2. Failure of any part of read/write memory to store and recall data.

Faults from which recovery is automatic

1. a.c. supply re-applied after break.
2. Corrupt message received on serial link.

Faults which user may program to trip the watchdog

1. Wrong acknowledgement to message transmitted on serial link.
2. Serial link disconnected or repeated message corruption.
3. Application dependent tests.
4. Failure of battery.

Table 8.3 Self-test Error Messages

CODE	Fault Message	Possible Causes	Recommended Recovery
#702	OBJECT RAM CHECKSUM TEST FAILURE	On-line corruption, probably faulty RAM on either Controller or memory board.	Subsitite memory board and/or controller.
#703	USER PROGRAM CHECKSUM TEST FAILURE	Source code corrupted.	Substitute either memory board or controller.
#704	V-TABLE CHECKSUM TEST FAILURE	Importan. data corrupt	Power on/off gives #603. Reload program. If problem persists change controller.
#705	PROCESSOR LOCAL RAM FAILURE AT (data).	Memory failure on controller.	Replace Controller.
#707	BIT LOGIC TEST FAILURE.	Failed Controller.	Change controller.
#708	WATCHDOG TEST FAILURE.	Failed Processor Module.	Change Processor Module
#709	PSU TEST FAILURE	Suspect faulty PSU or faulty processor module.	Substitute spare PSU. If problem persists, change the Processor module.
#710	BATTERY FAILURE	Flat or disconnected battery. **Note...** Watchdogs do not trip.	(Plant shut down not required).
#716	USER-REQUESTED WATCHDOG TRIP, F1 = (data)	F1 set to non-zero value by user program.	
#718	PROGRAM CORRUPTED DURING POWER DOWN	Only occurs on power up. P-table or instructions corrupted possibly due to faulty memory module, or flat battery.	Clear store, power off/on and re-load, check battery warning indication. If problem persists substitute spare data table RAM board.
#719	(proc) WATCHDOG SELF TRIP	Watchdog detected error, contacts open. Faulty backplane or processor module.	Substitute processor module. If problem persists substitute spare subrack.
#724	BASIC I.O ADDRESS FAILURE:RIBBON (Data)	Faulty connection, cable short, or faulty processor module.	Investigate connections and referenced I/O device. If problem persists change processor module if problem persists change controller subrack.

Table 8.3 continued

CODE	Fault Message	Possible Causes	Recommended Recovery
#725	BASIC I/O STROBE FAILURE:RIBBON (Data)	faulty connection, cable short, or faulty processor module.	Investigate connections and referenced I/O device. If problem persists, change processor module. If problem persists, change controller subrack.
#729	BASIC I/O DATA FAILURE:RIBBON (Data)	faulty connection, cable short, faulty I/O module or faulty Processor module.	Investigate connections and referenced I/O device. If problem persists, substitute spare I/O processor and lastly, spare subrack.
#730	USER PROGRAM RAM TEST FAILURE.	Faulty RAM on Processor module or memory board.	Change Processor module or memory board.
#731	DATA TABLE RAM TEST FAILURE.	Faulty RAM on Processor module.	Change Processor module.
#732	OBJECT RAM TEST FAILURE.	Faulty RAM on Processor module or memory board.	Change Processor module or memory board.
#733	FIRMWARE CHECKSUM FAILURE.	EPROMS have	Change Processor module.
#734	BATTERY FAILURE AND POWER REMOVED WHILE IN A CHANGED STATE	Battery has failed and changes to user program have been lost by power off/on. failed.	Re-load user program and re-edit.

8.5.8 Intertask Communications (Error Messages #800 to #899)

Table 8.4 Details Task/Interprocessor Communications Error Messages.

Table 8.4 Task/Intertask Communication Error Messages

CODE	Fault Message	Possible Causes	Recommended Recovery
#809	CHICS ERROR WHILE CREATING A MESSAGE. TASK (data).	Possible hardware fault	Power off/on. If problem persists, change processor module
#810	CHICS ERROR WHILE WAITING FOR MESSAGE. TASK (data).	Possible hardware fault	Power off/on. If problem persists, change Processor module.
#811	CHICS ERROR WHILE SENDING A MESSAGE. TASK (data).	Possible hardware fault	Power off/on. If problem persists, change Processor module.
#813	PMES ERROR. WRONG REPLY RECEIVED.	Possible hardware fault	Power off/on if problem persists change Processor module.

8.5.9 System Errors (Error messages # 900 to # 999)

Table 8.4.1 Details the System Error Messages

Table 8.4.1 System Error Messages

CODE Fault Message	Possible Causes	Recommended Recovery
# 900 VARIOUS to # 951	Fatal board error	Replace processor board. If problem persists consult GEM80 Customer Support. See Section 8.11.1.
# 952 EPROM FAULTS to # 955	Fatal EPROM board error	Replace EPROM board. If problem persists consult GEM80 Customer Support. See Section 8.11.1.

8.6 The F-Data Tables

Data in the F-table provides further information on fault diagnosis. The contents of the F-table are detailed in Table 8.5 to 8.6. The serial link statistics are shown in Tables 8.7, 8.8 and 8.9.

The F-tables are used by the system to store fault codes and Serial Link Statistics and are allocated as shown in Tables 8.1.

Table 8.5 The F-Table

Address	Content	Remarks
F0	Not used	
F1	Error flag	Any non-zero value placed in F1 by user program trips the watchdog, terminates program execution and displays a fixed diagnosis message on programming unit screen.
F2	System Fault bits	
F2.0		Set to 1 for program cycle if previous cycle exceeds pre-set scan time.
F2.1		Set to 1 if re-compile successful. Set to 0 if unsuccessful.
F2.2		Set to 1 if re-complilation will occur on the current scan.
F2.3		Reserved
F2.4	Battery Condition	Set to 1 if Battery power low
F2.5 to 2.15	Reserved	
F3 to F9	Reserved	
F10 to F69	Serial link diagnostics	See Section 8.6
F70 to F129	Serial link statistics	See Section 8.7
F130 to F209	Reserved	

8.6.1 Serial Communications F-Table

Each of the three Serial Ports is allocated 20 F-tables as follows:-

Port 1 - F10 to F29
Port 2 - F30 to F49
Port 3 - F50 to F69

The meaning of the data stored depends upon the working mode of the Serial Port, e.g. Printer, ESP Tributary, Coronet etc.

8.6.2 Printer Port

Table 8.6 Printer Port F-Tables

Port 1	Port 2	Port 3	
F10.0	F30.0	F50.0	Printer off line.
F10.1	F30.1	F50.1	Buffer not available

8.6.3 ESP Tributary Port

Table 8.7 ESP Port F-Table

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

8.6.4 ESP Control Port

Table 8.8 ESP Control Port F-Table

Port 1	Port 2	Remarks
F10.0	F30.0	Route 0 failed.
F10.1	F30.1	Route 1 failed.
F10.2	F30.2	Route 2 failed.
F10.3	F30.3	Route 3 failed.
F10.4	F30.4	Route 4 failed.
F10.5	F30.5	Route 5 failed.
F10.6	F30.6	Route 6 failed.
F10.7	F30.7	Route 7 failed.
F10.8	F30.8	Last message on route 0 was truncated.
F10.9	F30.9	Last message on route 1 was truncated.
F10.10	F30.10	Last message on route 2 was truncated.
F10.11	F30.11	Last message on route 3 was truncated.
F10.12	F30.12	Last message on route 4 was truncated.
F10.13	F30.13	Last message on route 5 was truncated.
F10.14	F30.14	Last message on route 6 was truncated.
F10.15	F30.15	Last message on route 7 was truncated.
F11	F31	Route 0 diagnostics.
F12	F32	Route 1 diagnostics.
F13	F33	Route 2 diagnostics.
F14	F34	Route 3 diagnostics.
F15	F35	Route 4 diagnostics.
F16	F36	Route 5 diagnostics.
F17	F37	Route 6 diagnostics.
F18	F38	Route 7 diagnostics.

The diagnostics words are defined as follows:-

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

Fault codes

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

F19 to F29)
F39 to F49) Unused

8.6.5 CORONET Port

Table 8.9 CORONET Ports F-Table

Port 1	Port 2	Remarks
F10	F30	Reserved for future use.
F11	F31	Route 0 transmit diagnostics.
F12	F32	Route 1 transmit diagnostics.
F13	F33	Route 2 transmit diagnostics.
F14	F34	Route 3 transmit diagnostics.
F15	F35	Route 4 transmit diagnostics.
F16	F36	Route 5 transmit diagnostics.
F17	F37	Route 6 transmit diagnostics.
F18	F38	Route 7 transmit diagnostics.
F19	F39	Route 0 receive diagnostics.
F20	F40	Route 1 receive diagnostics.
F21	F41	Route 2 receive diagnostics.
F22	F42	Route 3 receive diagnostics.
F23	F43	Route 4 receive diagnostics.
F24	F44	Route 5 receive diagnostics.
F25	F45	Route 6 receive diagnostics.
F26	F46	Route 7 receive diagnostics.

The diagnostics words are defined as follows:-

bits 0 to 7	Address of last message received/transmitted
bits 8 to 11	Fault code.
bits 12 and 13	Not used.
bit 14	Set when transfer failed.
bit 15	Set when transfer successful.

Fault codes

0	Successful transfer.
2	Remote timeout (no ACK received from remote end).
3	Local transmission failed (timeouts/NAKs).
8	Received message too long for table allocation.
9	Remote NAK received.
A	Configuration error.

F27 to F29)
F47 to F49) Unused

8.6.6 GEMSTART (CCU) Port

The fault bits for the GEMSTART protocol indicate which addresses are connected and are replying correctly to the masters polls. The fault bit is set when an address has failed.

Table 8.10 GEMSTART Port F-Tables

Port 1	Port 2	Remarks
F10.0	F30.0	Address 0 failed
F10.1	F30.1	Address 1 failed
.	.	.
.	.	.
.	.	.
F13.14	F33.14	Address 62 failed
F13.15	F33.15	Address 63 failed
F14 to F29	F34 to F49	Not used.

8.7 Link Statistics

Each of the three Serial Ports is allocated 20 F-tables for Serial Link Statistics as follows:-

Port 1	F70 to F89
Port 2	F90 to F109
Port 1	F110 to F129

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

= (65,536 x Upper Value) + Lower Value

The other statistics are stored in a single location and can have a maximum value of 65,535 (@FFFF).

The meaning of the data stored, depends upon the working mode of the port as shown below:-

8.7.1 Printer ports

Link statistics not used.

8.7.2 ESP Tributary Ports

Table 8.11 ESP Tributary Port Link Statistics

Port 1	Port 2	Contents
F70 and F71	F90 and F91	Number of messages received.
F72 and F73	F92 and F93	Number of replies sent to Control port.
F74	F94	Number of hardware errors.
F75	F95	Number of Timeouts.
F76	F96	Number of CRC errors.
F77	F97	Number of data errors.
F78	F98	Number of transmit data errors.
F79	F99	Number of stuffing errors.
F80	F100	Number of ENQs received.
F81	F101	Mode error.
F82	F102	Transmission timeouts.
F83	F103	Overrun error.
F84	F104	Break error.
F85 to F89	F105 to F109	Not used.

8.7.3 ESP Control Ports

Table 8.12 ESP Control Port Link Statistics

Port 1	Port 2	Contents
F70 and F71	F90 and F91	Number of message requests.
F72 and F73	F92 and F93	Number of attempted transmissions (including re-tries).
F74	F94	Number of hardware errors.
F75	F95	Number of timeouts.
F76	F96	Number of CRC errors.
F77	F97	Number of NAK replies.
F78	F98	Number of Terminator errors.
F79	F99	Number of Data errors.
F80	F100	Transmit timeouts.
F81	F101	Overrun error.
F82	F102	Break error.
F83 to F89	F103 to F109	Not used.

8.7.4 CORONET Ports

Table 8.13 CORONET Port Link Statistics

Port 1	Port 2	Contents
F70 and F71	F90 and F91	Number of transmission requests.
F72 and F73	F92 and F93	Number of attempted transmissions (including re-tries).
F74	F94	Hardware errors.
F75	F95	CRC errors.
F76	F96	Local timeouts.
F77	F97	Remote timeouts
F78	F98	Local NAKs.
F79	F99	Remote NAKs.
F80 to F89	F100 to F109	Not used.

8.7.5 GEMSTART CCU Ports

Table 8.14 GEMSTART Port Link Statistics

Port 1	Port 2	Contents
F70 and F71	F90 and F91	Number of message requests.
F72 and F73	F92 and F93	Number of attempted transmissions (including re-tries).
F74	F94	Hardware errors.
F75	F95	Timeouts.
F76	F96	CRC errors.
F77	F97	Data errors.
F79 to F89	F99 to F109	Not used.

8.8 V-Tables

The majority of the locations in the V-table are for system internal functions and have no significance to the User. However, a few are useful and these are described in Table 8.15.

Table 2.9 V-Table

Address	Content	Remarks
V0	Not used	
V1	Lower byte contents are incremented after each successful compilation	
V2 to V47	Used by system software	
V48	Contains checksum derived from user ladder diagram source code and P-table checksums	V49 to V52 are not included in the V-table checksum.
V49	Contains code giving size of system in use	} 1= 2,500 instructions } 2= 5,000 instructions } 3= 10,000 instructions } 4= 20,000 instructions
V50	Contains a code giving the type of memory	} 1= RAM } 4= EPROM
V51	Used by system software	
V52	Contains the length of message strings	

8.9 Clear Store Command

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

The reason for not clearing this section of P-table is that GEM 80/131 Controllers may be programmed either from the front port of the Processor, or remotely via one of the serial ports. Loss of data about the serial port configurations could make it impossible for the controller to communicate with a remote Programmer, and so this data is retained even when the rest of the memory store is cleared.

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

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

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

Note... When a program is loaded, any instructions and P-table data already in store are overwritten. If, as we recommended, store is cleared before loading, P0 to P149 (which are not cleared) will be overwritten by data from the program being loaded.

Where the controller is programmed remotely via one of the serial ports, the configuration data must be the same for this port as the values already in store.

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

Note... On EPROM systems the clear store command is used to erase the flash EPROMS. Therefore the EPROM board must be in program mode for this command to operate.

The erasing of the flash EPROMS is by its nature a slow process and can take a number of seconds to complete. As a result the programming tool may timeout. The clear store will still operate and the link will recover when the clear store has completed. When downloading a program to an EPROM system the user may prefer to clear store before attempting to download instead of clearing store as part of the download.

8.10 Intermittent Tripping Problems

GEM80 Equipment is normally reliable in operation provided that it is installed in accordance with guidance in this manual (Section 6).

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

Possible causes of equipment tripping are:

(1) Electrical Noise or Electromagnetic Interference

GEM80 equipment has been tested against noise immunity from RFI and EMC. However, high levels of RFI noise in close proximity to GEM80 equipment, especially the controller subrack, can trip out the system. Hand-held radio transceivers should not be used within 200mm of the controller. Segregation requirements and signal ground arrangements are detailed in Section 6.

(2) Connector/Termination Problems

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

(3) Overheating

The installation should conform to the environmental conditions detailed in Section 1. The Basic I/O should be installed as per Section 3.

8.11 Repairs to GEM80 Equipment

GEM80 equipment is repaired by replacement of faulty modules and units. GEM80 modules are not considered to be user repairable and any attempt to carry out repairs to modules will invalidate all warranties and guarantees.

CEGELEC Industrial Controls cannot accept responsibility for GEM80 equipment which has been repaired, other than by CEGELEC Industrial Controls.

8.11.1 Fault Finding Back-up and Module Repair Service

To assist the user in the diagnosis and rectification of faults to GEM80 equipment, the following services are available from CEGELEC Industrial Controls.

(1) Customer Support - available to any GEM80 User.

(2) GEMSQUAD - a rapid 'service contract' scheme for complete GEM80 systems.

(3) Service Exchange - a rapid repair scheme available for certain individual items of GEM80 equipment.

(4) Normal Repair Service - available for repair of GEM80 equipment.

Any faulty modules should be returned for repair to:

GEM80 Spares and Repairs Dept.
CEGELEC Industrial Controls Ltd.,
West Avenue,
Kidsgrove,
Stoke on Trent,
ST7 1TW
England

Tel: (0782) 783511
Fax: (Group 3) 0782 776329
Telex: 36293/4 CICKID G

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

CAUTION...

IF A COMPLETE SUBRACK IS TO BE SHIPPED, ANY POWER MODULE SHOULD BE REMOVED FROM THE SUBRACK AND PACKED SEPARATELY. CEGELEC INDUSTRIAL CONTROLS CANNOT ACCEPT RESPONSIBILITY FOR ANY MECHANICAL DAMAGE TO THE SUBRACK IF IT IS SHIPPED WITH POWER MODULES FITTED.

For Customer Support on any aspect of GEM80 Applications, please call:

GEM80 Customer Support

Tel: (0782) 783511 Ext. 2651
Fax: (Group 3) 0782 776329
Telex: 36293/4 CICKID G

This page left intentionally blank

9.1 GEM80/131 Controller

	Ordering Codes
2.5k instructions (RAM)	8870-4970

9.2 Memory Expansion Boards

5k instructions (RAM)	9291-4002
10k instructions (RAM)	9291-4003
20k instructions (RAM)	9291-4004
2.5k instructions (FLASH EPROM)	9291-4021
5k instructions (FLASH EPROM)	9291-4022
10k instructions (FLASH EPROM)	9291-4023
20k instructions (FLASH EPROM)	9291-4024

(1) I/O Modules

Details of Basic I/O modules in the number range 81xx are given on separate data sheets and are therefore omitted from this manual.

(2) Optional Extras

Serial Link Termination Unit providing terminals for one 20mA port	8924-0000
RS485 Termination Panel	8587-4003
RS232 Termination Panel	9009-4001
Ribbon Cable to connect up to 2-off Serial Link Termination units to the Controller subrack	8891-4077
Fibre Optic Interface Unit (converts 20mA serial link from an 8924-0000 unit to Fibre Optic)	8927-0000
Ribbon Cable for connecting the 8927 Port 1 to an 8924	8891-4079
Ribbon Cable for connecting the 8927 Port 2 to an 8924	8891-4083
Wiring Tray	8890-4705
Rear Cover	8891-4247
Mounting Channel(for termination units)	8959-0000
D.C. Input Lead	8891-4072
Blanking Panel - Single	8122-4001
Blanking Panel - Double	8122-4002

(3) Spares

Power Supply module 110 to 220V a.c. power input with additional power input for 48V d.c. (non isolated, negative earth)	9032-4002
Processor	8231-4002
5k instructions (RAM)	9291-4002
10k instructions (RAM)	9291-4003
20k instructions (RAM)	9291-4004
2.5k instructions (FLASH EPROM)	9291-4021
5k instructions (FLASH EPROM)	9291-4022
10k instructions (FLASH EPROM)	9291-4023
20k instructions (FLASH EPROM)	9291-4024
Fuse for a.c. power input on 9032-4001 power module (3A,time delay,high breaking capacity)	82030/146
Fuse internal to 9032 power module (7A, quick blow)	82030/110
Female a.c. Connector for 9032	80720/131
D.C. Input Lead	8891-4247
Battery, CR 2477 950mA.H	78802/350

Table 9.1 - Ordering Codes for Standard Ready Assembled Cables

Pitch between Connectors 1 & 2 (metres)	Pitch between Connectors 2, 3 & 4 (metres)	Number of Sockets	Ordering Codes
1.25	1	4	8890-4611
2	1	4	8890-4612
3	1	4	8890-4613

9.3 Replacement Battery Suppliers

AUSTRIA, YUGOSLAVIA AND COMECON

ELBATEX GmbH
Eitnergasse 6

A-1232 WIEN

Tel 0222 86 32 11 / Fax 0222 86 32 11 200

BELGIUM

MICROTRON S.A.
Generaal Dewittelaan 7

B-2800 MECHELEN

Tel 015 21 22 23 / Fax 015 21 00 69

CANADA

DESKIN SALES CORP.
155 Clayton Drive

MARKHAM Ontario L3R 5T9

Tel 416 475-1412/ Fax 416 474 9105

DENMARK

DANELEC ELECTRONICS APS
356, Gladsaxevej

DK-2860 SOBORG

Tel 01 69 05 11 / Fax 01 69 05 04

FINLAND

TAHINIK OY
Kutomotie 2, PL 117

SF-00381 HELSINKI

Tel 0 565 3233 / Fax 0 565 3571

FRANCE

COMEPA S.A.
34, rue Jacquart

F-93697 PANTIN CEDEX

Tel 1 48 44 87 39 . Fax 1 48 44 10 11

GREAT BRITAIN

DOWTY BATTERIES
18, Nuffield Way

GB- ABINGDON, OXON 0X14 1TG

Tel 0235 20502 / Fax 0235 35766

ISRAEL

AMBI TECH Electronics Engineering Ltd
Clal House, 5 Droianov Street

TEL AVIV 63143/ISRAEL
Mailing Address: P.O. Box 5172
HOLON 58151/Israel

Tel 3 503 44 77 / Fax 3 84 42 27

ITALY

POLITEL Italia srl
Via L. Mancini 1

1-20129 MILANO

Tel 02 55 16 417 / Fax 02 55 18 0212

KOREA

CENTRA CORPORATION
4th FL. Backin Bldg.
517-11, Dogok-Dong, Seocho-ku

SEOUL, KOREA

Tel 02 576-7680 / Fax 02 576-2339

NETHERLANDS

LANDIS & GYR B.V.
Kampenringweg 45
Postbus 444

NL - 2803 PE GOUDA

Tel 01820 65432 / Fax 01820 32437

NORWAY

HEFRO ELEKTRONIKK A.S.
Haavard Martinsensv. 19
P.O. Box 6 Haugenstua

N-0915 OSLO 9

Tel 02 10 73 00 / Fax 02 10 65 46

PORTUGAL

COMPONENTA Lda
Rua Luis de Camoes, 128

P-1300 LISBOA

Tel 1 632563 / Fax 1 637655

SPAIN

AMITRON PASIVOS S.A.
Avd. de Valladolid 47 A

E-28008 MADRID

Tel 91 241 54 02 / Fax 91 248 79 58

SWEDEN

ACAL AURIEMA AB
Johannesfredavagan 9A

S-16131 BROMMA

Tel 08 252750 - Fax 08 806938

SWITZERLAND

FENNER ELEKTRONIK AG
Gewerbestrasse 10

CH-4450 SISSACH

Tel 061 98 00 00 / Fax 061 98 56 08

RENATA A.G.

CH 4452 ITINGEN

Tel 4161 982925 / Fax 986483

TAIWAN

GENCO INTERNATIONAL INC
6F. 689 Ming Sheng East Road

TAIPEI, TAIWAN

Tel 02 7131621 / Fax 02 7122149

USA

RENATA U.S.
2263-C Valdina Street

DALLAS, TEXAS 75207/USA

Tel 214 630-2563 / Fax 214 630-2568

GERMANY

BIT ELECTRONIC AG
Dingolfinger Strasse 6

D-8000 MUENCHEN 80

Tel 089 418007-0 / Fax 089 41800720

HERBERT C. JAUCH
In der Muslen 39

D-7730 VILLINGEN- SCHWENNINGEN

Tel 07720 3907-0 / Fax 07720 390722

This page left intentionally blank

A1 Ribbon Cable Sizes

The ribbon cables detailed at Table A1 are used on GEM80 equipment:-

Table A.1 Ribbon Cables used on GEM80 Equipment

Cable Used For	No. of Ways	Supplier *	Suppliers Ref.
1) Verification/Basic I/O Highway 2) Serial Communications Highway	26	Spectra	455.240.26
1) Ext 15V Power Supply (for Basic I/O) 2) Power for Lamp Driver	20	Spectra	455.240.20

* Denotes CEGELEC Recommended Supplier

Note...Following problems with the termination of ribbon cables, we have been advised by the cable manufacturers that:

"ALL RIBBON CABLES ON REELS MUST BE STORED ON END"

Flat storage of these reels leads to compression of the conductor pitching which results in incorrect termination on the connectors.

A2 Ribbon Cable Connectors

The connectors used are detailed in Sections 3 and 4.

A3 Ribbon Cable Accessories

An accessory kit is available comprising

One - polarizing pin
One - label

Ordering Code 8890-4004

A4 Special Tools/Equipment Required for Ribbon Cable/Connector Assembly

The following tools will be required to assemble connectors onto ribbon cables:-

T & B/Ansley 779-2100	Tool Frame
T & B/Ansley 779-2150	Die for use with Tool Frame (suitable for all GEM80 ribbon cables)
T & B/Ansley 779-5030	Cable Cutter

These tools are available from:-

Thomas & Betts Limited
Sedgwick Road
Luton, LU4 9DT
Bedfordshire

Telephone: Luton (0582) 597271

Telex: 826051 TOMBET G

A5 Ribbon Cable Installation

Ribbon cables used on GEM80 equipment are normally made up for the customer by CEGELEC Industrial Controls Limited.

For the customer wishing to install his own ribbon cables the procedure detailed below should be followed:-

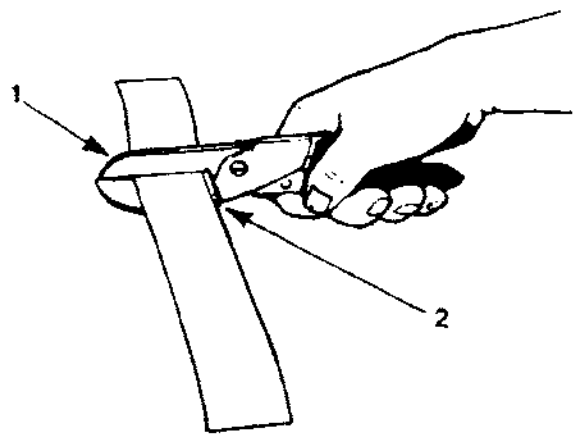
(1) Mechanical Polarization

A polarizing pin may be inserted into the socket if required. This pushes into the connector from the socket side.

Note...This operation must be done BEFORE the connector is fitted to the ribbon cable.

(2) **Termination Using Cable End Connectors**

(a) Cut the ribbon cable to length ensuring that edge of cable is flush with alignment guide on cable cutter as shown at Figure A1.



1. Cable Cutter
2. Alignment Guide

Figure A1 Ribbon Cable Cutting

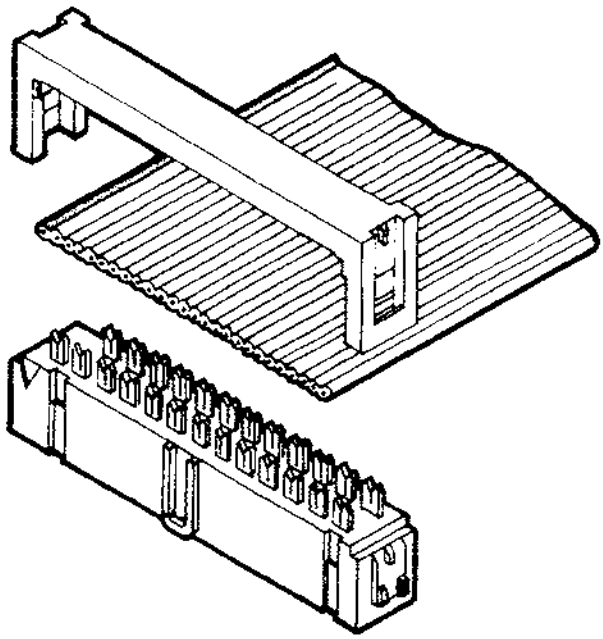
(b) Twisted pair ribbon cables must always be cut in the center of a flat section.

(c) Fit cover half way onto insulation base plate ensuring that metal locking clips enter slots in cover (see Figure A2).

(d) Insert cable between cover and base plate WITH END OF CABLE FLUSH WITH EDGE OF BASE PLATE.

Notes... (1) Ensure that coloured edge of cable (or brown wire for twisted pair cable) is adjacent to identification mark (pin 1) detailed in Figure A2.

(2) Also ensure that cable is inserted from the 'wrong side' since it will be doubled back when strain relief is fitted (see Figure A5).



1. Colored Edge of Cable (or brown wire for twisted pair cable).
2. Cable
3. Identification mark
4. Base plate
5. Cover

Figure A2 Cable End Connectors Fitting of Cable and Cover

(e) Using T & B/Ansley hand tool fitted with die, press cover down, ensuring that cable does not move, so that contacts on the base plate penetrate cable insulation (see Figure A3). Ensure that cover is pressed fully home as detailed at Figure A4.

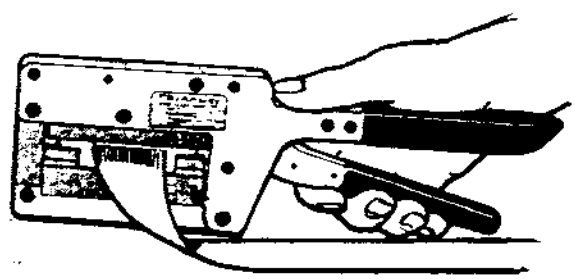
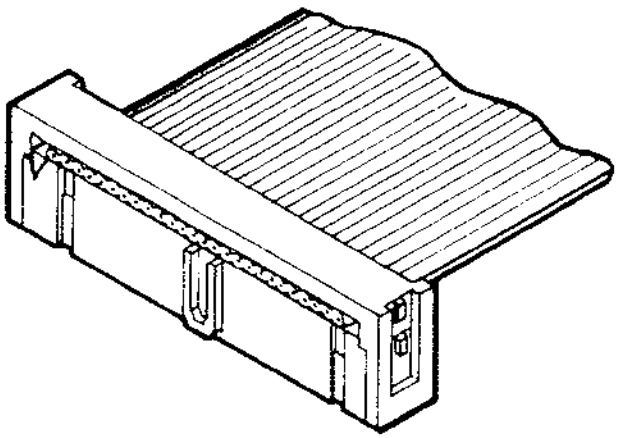


Figure A3 Use of Hand Tool

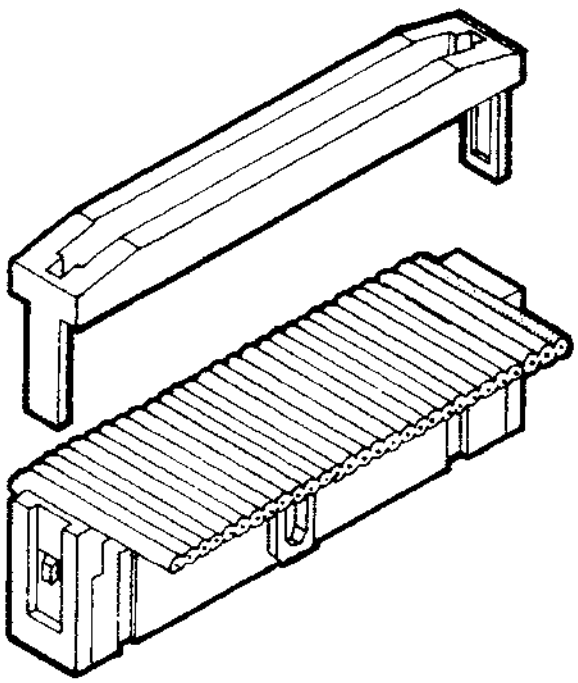


1. Cover
2. Base Plate

Figure A4 Clamped Cable

(f) Complete ribbon cable label for Basic I/O assembly as detailed in Installation section of this manual.

(g) Push strain relief down until clips lock into cover indicated by a small 'click' (Figure A6 shows the completed end termination).



1. Strain Relief
2. Cable Folded Back

Figure A5 Fitting of Label and Strain Relief

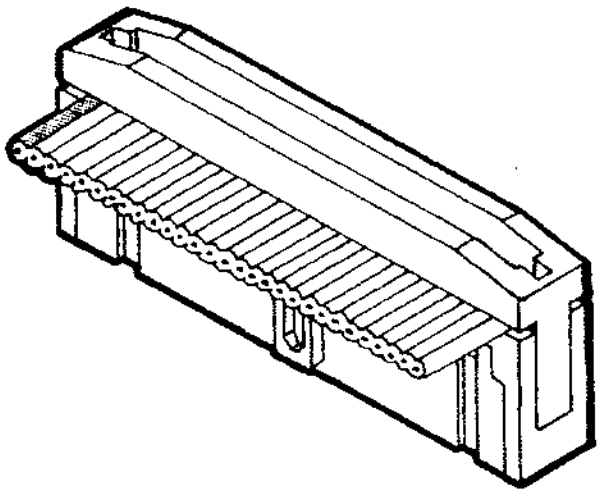


Figure A6 Completed End Connection

When fitting the same cable at both ends, ensure that the cable is inserted from opposite sides of the connectors. The completed ribbon should be as illustrated in Figure A7.

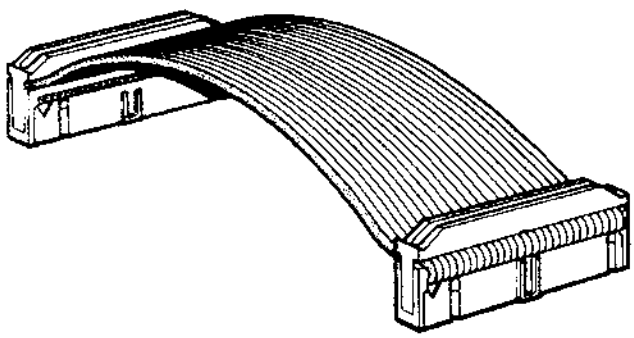


Figure A7 Completed Ribbon Cable

(3) Terminating Middle Connectors

Notes... (1) This type of connector cannot be assembled unless one free end of cable is available. Always ensure that amount of cable is sufficient to complete length of run.

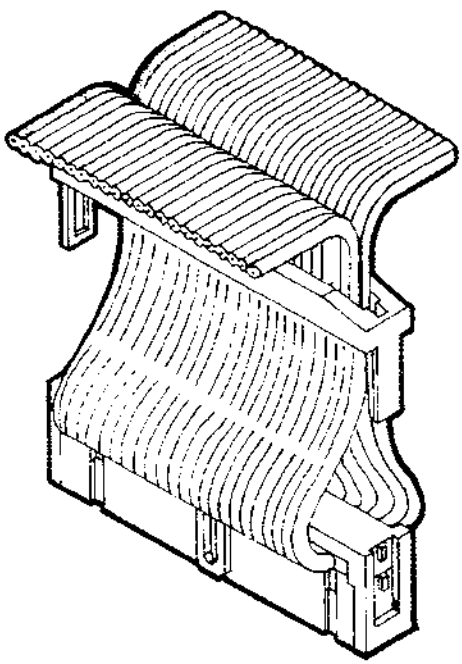
(2) When using twisted pair cable, termination can only be made in the center of flat sections.

(a) Pass free end of cable through slot in top of strain relief (i.e. side without clip).

(b) Thread enough cable through slot to allow connector to reach header.

(c) Mount cover to baseplate as described at (2)(c) to (e).

(d) Pass free end of cable back through strain relief as at Figure A.8 and remove slack before pushing strain relief fully home as at (2)(g).



1. Cable
2. Strain Relief
3. Cover
4. Base Plate
5. Identification Mark

Figure A8 Cable Middle Connectors - Fitting of Strain Relief

(4) Right Angled Bends in Cable

1. Where ribbon cable has to be run flat with a right angled bend the cable can be folded in one of two ways, either a single fold as at Figure A9 or, if this would cause the wrong edge to come out on top, the cable should first be doubled back as at Figure A10.

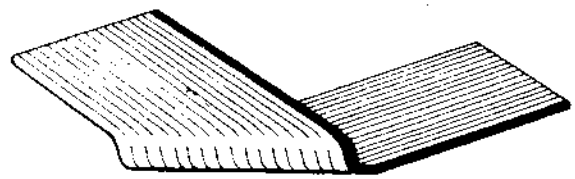


Figure A9 Right Angled Bend - Single Fold

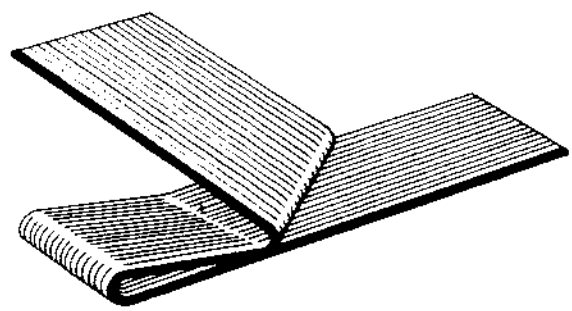


Figure A10 Right Angled Bend - Double Fold

(5) Fitting Ribbon Cable Label

The label is wrapped around the ribbon cable as shown in Figure A11. Refer to Section 13.8.3 for label marking.

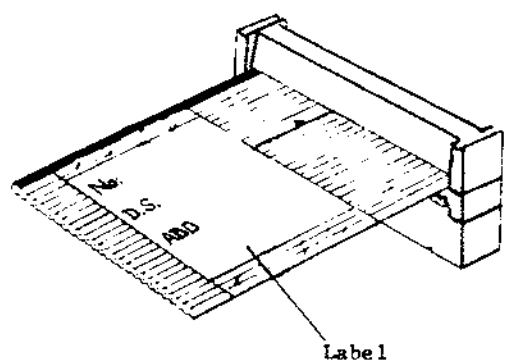


Figure A11 Label Fitting

APPENDIX B - FIBRE OPTIC CABLE CONNECTIONS FOR FIBRE OPTIC TRANSCEIVER UNITS

B1 Introduction

This appendix describes the method for terminating fibre optic cables.

CAUTION

The fibre optic core is soft and fragile: handle with care and do not bend fibre sharply.

B2 Fibre Optic Cables

The fibre optic cables detailed in Table B.1 are recommended for use on GEM80 equipment:-

These cables are available in the U.K. from:-

Pilkington Communications Systems Ltd.
Kinmel Park,
Bodelwyddan,
Rhyl,
Clwyd
LL18 5TY.

Table B.1 - Recommended Fibre Optic Cables

Type	Make/Part No.
Without armoured cladding (core dia. 200μm)	Pilkington LS/QSF 200A
With armoured cladding (core dia. 200μm)	Pilkington MLS/QSF

B3 Special Tools/Equipment Required for Fibre Optic Cable Termination

The tools detailed in Table B.2 should be used to terminate fibre optic cables:-

Table B.2 - Tools for Fibre optic cable termination

Tool	Make/Part No.
Termination kit - comprises fibre cutting tool, crimping tool, positioner and stripping tools	Radiall type F780.010.000
Crimping tool	Radiall type R282.240 with jaws R282.242
Spanner torque wrench	Radiall type R282.326

Conventional wire stripping tools are suitable for cutting back the outer sheath of fibre optic cable although great care must be taken not to damage the fibre optic core. A suitable tool is available in the U.K. from Optronics Ltd., as 'Ideal Stripmaster'.

The Radiall tools are available from:

Radiall Microwave Components
Invincible Road
Farnborough
Hants

and are also available from:

Optronics Ltd
Cambridge Science Park
Milton Road
Cambridge
CB4 4BH

B4 Cable Terminations and Couplers Required for Fibre Optic Termination

The terminations and couplers detailed in Table B.3 are required for terminating fibre optic cables. They are available from the suppliers mentioned in paragraph B3.

Table B.3 - Terminators/Couplers for Fibre optic cables

Equipment	Make/Part No.
Terminator (for cable with or without armored cladding)	Radiall type F705.017.040
Panel mounted Cable Coupler	Radiall type F705.700.000
Straight cable coupler (for joining two terminated cables)	Radiall type F705.720.000

B5 Fibre Optic Cable Installation - Non Armored Cable Radiall Type

(a) Cut the fibre optic cable to the required length, +80mm for each connection made to the cable.

(b) Strip back the outer sheath 60mm with the wire strippers.

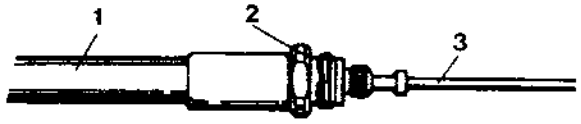
CAUTION

Avoid damaging the fibre optic inside the outer sheath.

(c) Push the metal collar over the outer sheath - see Figure B.1.

(d) Locate the fibre optic cable carefully onto the cable ferrule assembly, ensuring that the outer sheath is pushed over the knurled part of the ferrule, and butts up against the ferrule body - see Figure B.1.

APPENDIX B - FIBRE OPTIC CABLE CONNECTIONS FOR FIBRE OPTIC TRANSCEIVER UNITS

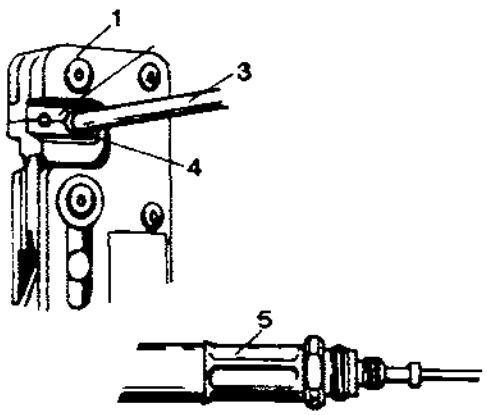


1. Fibre optic cable - outer sheath
2. Cable ferrule.
3. Fibre optic.

Figure B.1 - Cable Ferrule - assembly onto fibre optic cable

(e) Push the metal collar up to the body of the cable ferrule.

(f) Using the Radiall Crimping tool, type R282.240 (with jaws type R282.242) crimp the metal collar onto the outer sheath of the cable. Compress the handles of the tool together until the ratchet releases - see Figure B.2.



1. Head of crimping tool
2. Jaws of tool
3. Fibre optic cable
4. Metal collar
5. Crimped collar

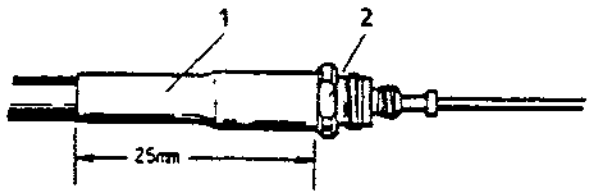
Figure B.2. - Crimping of metal collar onto Fibre optic cable

(g) Cut some heatshrink sleeving* to fit over the crimped joint and cable outer sheath.

(h) Shrink onto the heatshrink sleeving with a 250W hot-air pistol - see Figure B.3.

CAUTION

Do not overheat the heatshrink sleeving or the (PVC) outer sheath of the fibre optic cable.

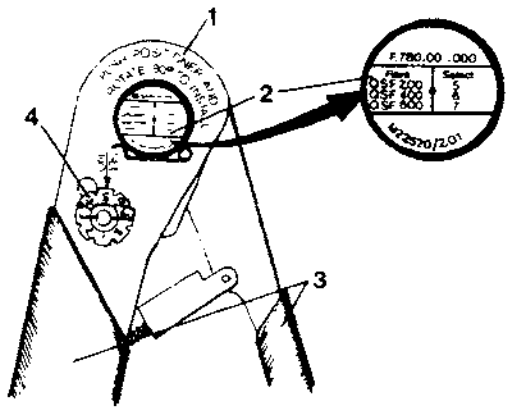


1. Heatshrink sleeve shrunk over crimped metal collar and outer sheath of fibre-optic cable.
2. Cable ferrule.

Figure B.3 - Heatshrink sleeving applied over crimped metal collar

(i) Using the Daniels crimping tool with the positioner F780.002.000, from the Radiall termination kit, carefully crimp the cable ferrule onto the fibre optic - see Figures B.4 and B.5.

Note... Ensure that wheel A is set to the correct setting for the particular diameter of fibre optic used, as indicated by the positioner label - see Figure B.4.

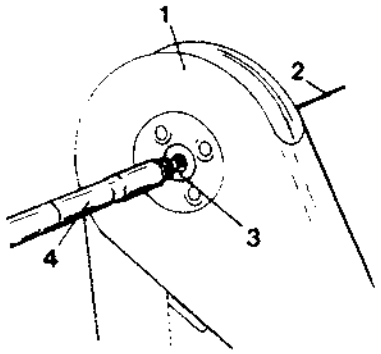


1. Head of tool
2. Positioner
3. Handles of tools
4. Wheel A

Figure B.4 - Daniels crimping tool and positioner

* Recommended make and types of heatshrink sleeving are as follows:-

Hellerman LVR95, 9.5mm internal bore
or
Ness NTRV95, 9.5mm internal bore

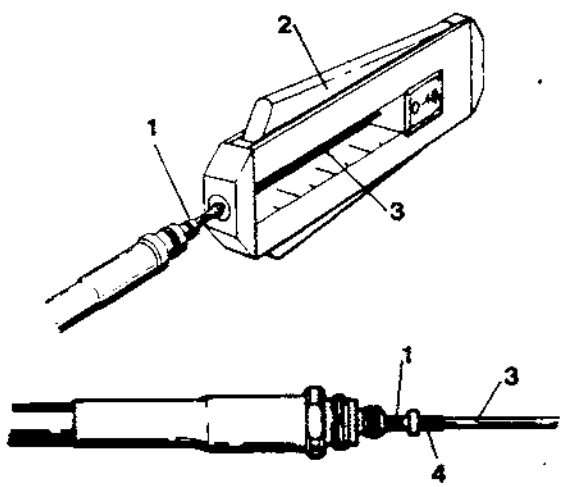


1. Head of tool
2. Fibre optic
3. Jaws of tool
4. Fibre optic cable ferrule assembly

Figure B.5 - Daniels crimping tool

(j) Remove the crimped ferrule assembly from the tool.

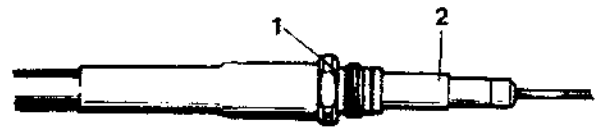
(k) Carefully strip the protective sheath from the fibre optic using the correct stripping tool shown in Figure B.6 (supplied with Radiall termination kit). Strip back the protective sheath in 20mm lengths to prevent 'bunching' of the sheath.



1. Cable ferrule assembly
2. Stripping tool
3. Fibre Optic
4. Protective sheath

Figure B.6 - Stripping protective sheath from Fibre optic

(l) Screw on the optical barrel over the ferrule - see Figure B.7.



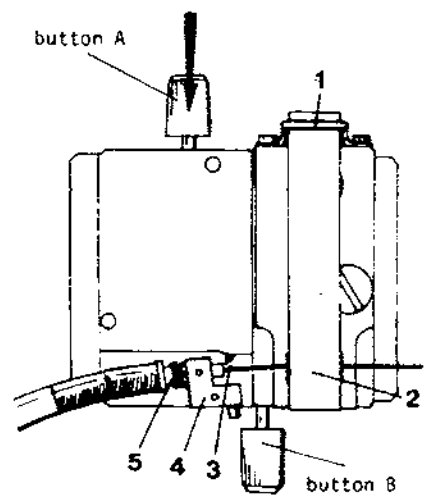
1. Ferrule assembly
2. Optical barrel

Figure B.7 - Mounting optical barrel

(m) Mount the assembly into the cutting tool supplied with the Radiall termination kit - see Figure B.8.

CAUTION

To prevent damage to the diamond cutter, never operate the cutting tool (button A) without an optical ferrule assembly fitted in the holder.



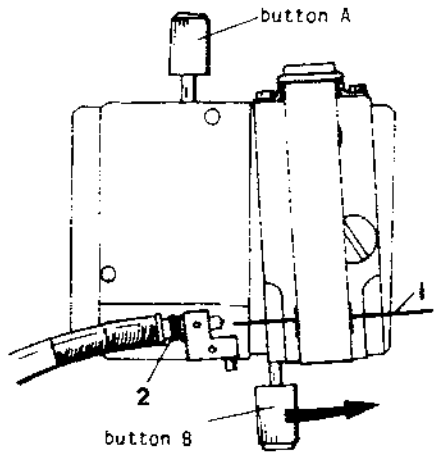
1. Clamp retaining clip
2. Clamp
3. Cutting point
4. Ferrule/barrel assembly holder
5. Ferrule/barrel assembly

Figure B.8 - Fibre Optic cutting tool

(n) Clamp the fibre optic into the V groove on the cutting tool.

(o) Push knob A smoothly and without excess force to cut the fibre optic.

(p) Push knob B to pull away the cut fibre - see Figure B.9.



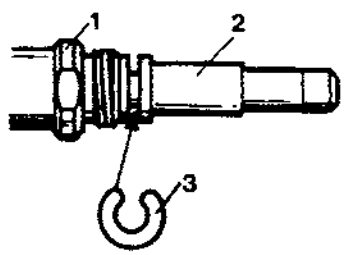
1. Cut fibre
2. Ferrule/barrel assembly

Figure B.9 - Fibre Optic cutting tool

(q) Remove assembly from the ferrule/barrel assembly holder.

(r) Unscrew the optical barrel a 1/2 turn and fit the circlip as shown in Figure B.10.

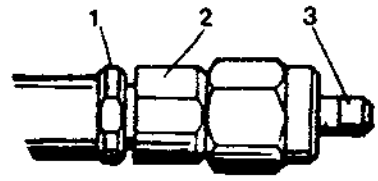
(s) Screw down the optical barrel onto the circlip - Figure B.10.



1. Ferrule assembly
2. Optical barrel
3. Circlip

Figure B.10 - Optical barrel and circlip assembly

(t) Finally mount the ferrule/barrel assembly into the interface assembly and tighten using the torque wrench, Radial type R.282.320, to 80 to 120N.cm torque. See Figure B.11 for completed termination.



1. Ferrule assembly
2. Interface assembly
3. Optical barrel

Figure B.11 - Completed termination for Fibre optic cable

B6 Fibre Cable Installation - Armored Cable

(a) Cut the fibre optic to the required length plus 80mm for each connection made to the cable.

(b) Carefully strip back the outer sheath 60mm with a sharp knife - see Figure B.12.

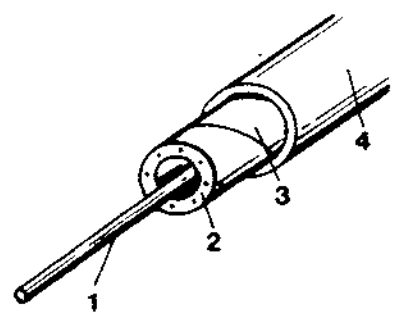
CAUTION

Avoid damaging the aluminium sheath under the outer sheath.

(c) Carefully strip back the inner sheath with wire strippers as shown in Figure B.12 and trim back the aluminium sheath as required.

CAUTION

Avoid damaging the fibre optic inside the inner sheath.



1. Fibre Optic
2. Inner sheath
3. Aluminium sheath
4. Outer sheath

Figure B.12 - Stripping Armored Fibre Optic Cable

(d) Push the metal collar over the aluminium sheath until it butts up against the outer sheath.

(e) Locate the fibre optic cable carefully onto the cable ferrule assembly, ensuring that the inner sheath is pushed over the knurled part of the ferrule, and butts up against the ferrule body - see Figure B.13.

1. Outer sheath of cable
2. Metal collar
3. Ferrule assembly
4. Fibre Optic

Figure B.13 - Cable ferrule - assembly onto Fibre cable

(f) Follow the procedure described in paragraphs (f) to (l) in section B5 (non armored cable).

APPENDIX B - FIBRE OPTIC CABLE CONNECTIONS FOR FIBRE OPTIC TRANSCEIVER UNITS

This page left intentionally blank

ALSTOM Power Conversion

France
9, rue Ampère
91345 Massy Cedex
Sales Tel: +33 (0) 8 25 02 11 02
Support Tel (International):
+33 (0) 3 84 55 33 33
Support Tel. (National):
08 25 02 11 02

Germany
Culemeyerstraße 1
D-12277 Berlin
Sales Tel: +49 (0) 30 74 96 27 27
Support Tel (International):
+49 (0) 69 66 99 831
Support Tel (National):
01 80 3 23 45 72

UK
Boughton Road, Rugby
Warwickshire, CV21 1BU
Sales Tel: +44 (0) 1788 563625
Support Tel: +44 (0) 1788 547490

USA
610 Epsilon Drive
Pittsburgh, PA 15238
Sales Tel: +1 412 967 0765
Support Tel: +1 800 800 5290

ALSTOM