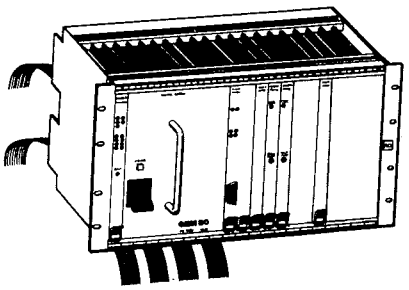
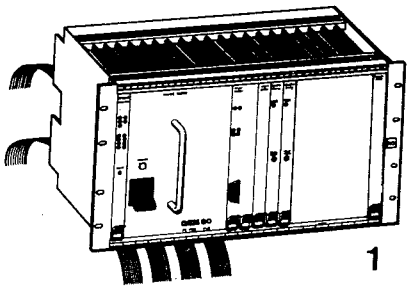
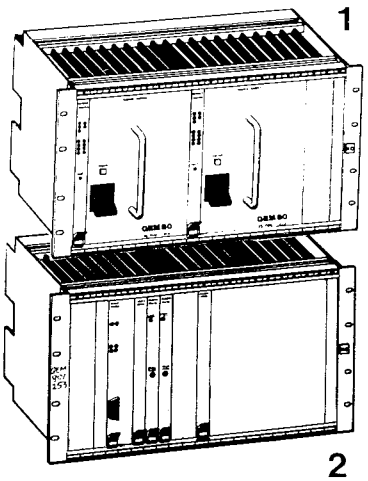
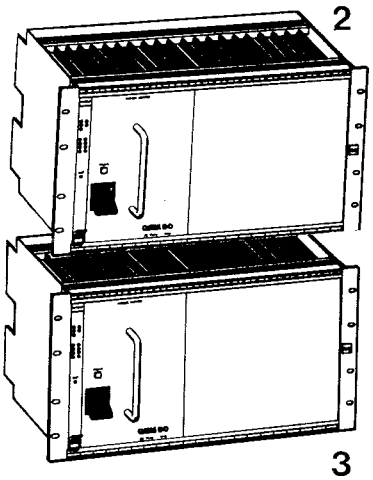
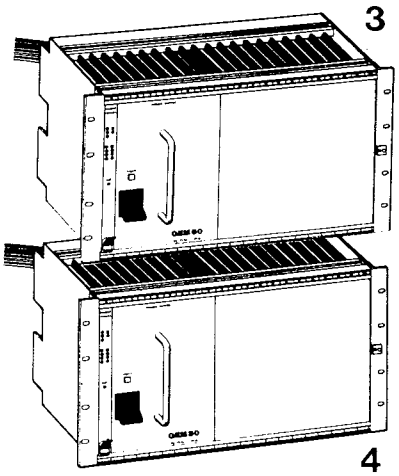
GEM80/250 Series Micro Controllers











GEM 80/251

Single subrack containing processors and power supply, with 2 slots of space for central modules and 4 slots of space for fast I/O modules.

GEM 80/252

1. Subrack containing processors and power supply with 6 slots of space for central modules.
2. Optional subrack containing power supply, with 12 slots of space for fast I/O modules.
3. Optional second fast I/O subrack, as (2) above.

GEM 80/253

1. Subrack containing 2 power supplies.
2. Subrack containing processors, with 11 slots of space for central modules.
3. Optional subrack containing power supply, with 12 slots of space for fast I/O modules.
4. Optional second fast I/O subrack, as (3) above.

INTRODUCTION

DESCRIPTION

The GEM 80/250 series are large, powerful programmable controllers designed for application to complex industrial plant. They are fully compatible with the GEM 80 family, using the same control language and I/O structure.

Standing alone, a 250 series controller can handle extensive digital and analogue control, multiple video displays, and report generation. In larger distributed systems, the availability of several multi-drop serial links makes the 250 series ideal for central supervisory systems.

The GEM 80/251 is a single subrack controller with a 2-slot space for central modules and a 4-slot space for fast I/O modules.

The GEM 80/252 is a controller with up to three subracks. The processor subrack has a 6-slot space for central modules, but no space for fast I/O modules. Second and third subracks can be connected to the processor subrack so as to provide 12-slots each of space for fast I/O modules.

The GEM 80/253 is a controller having from two to four subracks. The processor subrack has an 11-slot space for central modules, and is powered by a separate power supply subrack. Third and fourth subracks can be connected to the processor subrack so as to provide 12-slots each of space for fast I/O modules.

The 251, 252 and 253 are jointly known as the GEM 80/250 series.

FEATURES

- I/O up to 1024 points.
- Large program capacity (up to 11000 instructions).
- Fast execution, 5ms average per 1000 instructions.
- Up to 4 serial links, each can be multi-drop to 8 other controllers.
- On-line program changes.
- Large range of pre-written software routines ("special functions") built in as standard.
- Remote programming facility.
- Built-in text editor for generation of printer port messages.
- English language fault diagnostic messages.
- Flexible data table sizes (internal tables limited only by memory capacity).

SPECIFICATION SUMMARY

Memory capacity	: Typically 10000 instructions + 2000 words of preset data + 2000 words of variable data (automatic trade off - one instruction = 2 data table words).
I/O capacity	: Basic I/O up to 1024 bits. : Up to 4 serial links. : 4 or 24 fast I/O modules.
Execution speed	: 5ms per 1000 instructions.
Power supply	: 110 or 220/240V a.c., 50/60 Hz.
Temperature	: 0 to 60°C operating. : -20 to 70°C storage.
Environment and tests	: GEM 80 standard.
Mounting	: 19 inch (483mm) rack.

DETAILED SPECIFICATION

DETAILED SPECIFICATION

Contents

1. HARDWARE STRUCTURE

The GEM 80/250 series is a multi-processor system. The ladder diagram user program is executed by a ladder processor module. Separate I/O processor modules handle input/output activities. Optional video processor modules provide colour video display of data obtained from the controller s data tables.

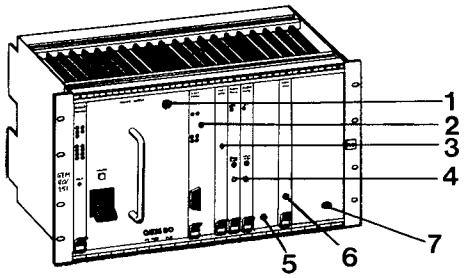
There are a minimum of two 64K byte read/write memory (RAM) modules. One RAM module contains the user program in "compiled" form for execution by the ladder processor. The other contains the user program in "source" form for program monitoring and editing plus the data tables and 16K of video format programs

Each controller may have one or two I/O processor modules The first. called the "master" I/O processor is always fitted. The second, called the "slave" I/O processor is optional and serves to double the basic and serial I/O capacity. Although the two identical I/O processors are both fitted with a front panel programming port, only the one on the master I/O processor can be used for programming purposes, but both may be used for monitoring.

The 251 252 and 253 controllers have processor subrack layouts as shown below

251

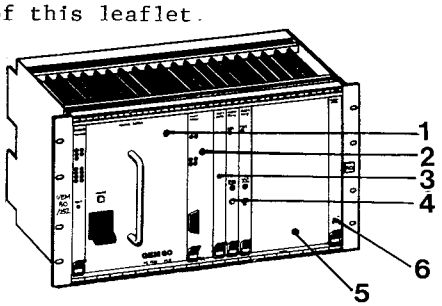
1. Power supply module
2. I/O processor module
3. Ladder processor module
4. 2 64K memory modules
5. 2 slots of space for central modules
6. Fast I/O driver module
7. 4 slots of space for fast I/O modules



252

1 Power supply module
2. I/O processor module
3. Ladder processor module
4. 2 64K memory modules
5. 6 slots of space for central modules
6. Fast I/O driver module

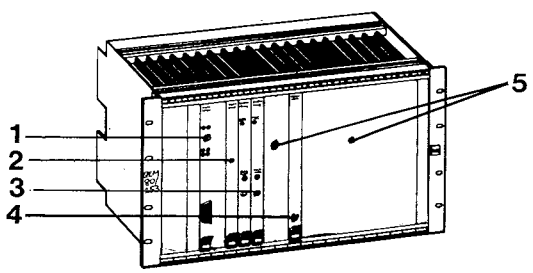
Fast I/O modules are fitted in one or two additional subracks - see picture on front sheet of this leaflet.



253

1. I/O processor module
2. Ladder processor module
3. 2 64K memory modules
4. Fast I/O driver module
5. 11 slots of space for central modules

Power supplies are fitted in a separate subrack and fast I/O modules are fitted in one or two additional subracks - see picture on front sheet of this leaflet.



DETAILED SPECIFICATION (continued)

For all the types of processor subrack shown above, the central module slots may be used for optional additional modules. These may be:

- A second I/O processor (2 slots wide)
- Video processors (2 slots wide each)
- Associated memory modules for extra video formats or for logging (1 slot wide each)

Note: With the 253 processor subrack, the rightmost slot (slot 19) is usable for memory modules only. Also, the standard position for the second I/O processor (if fitted) is at slots 11 & 12.

2. CONTROLLER OPERATION

Start up	: Performs comprehensive self-test. : Compiles user program. : Starts operating cycle. : Closes watchdog interlock.
Operating cycle	: I/O processor scans basic I/O highway and handles serial link while ladder processor simultaneously executes user program. : Between program scans, I/O data is copied to/from data tables. : Segment of self-test cycle performed and watchdogs serviced at regular time intervals.
Cycle time (free running)	: Execution time of program instructions, or basic I/O scan time, whichever is greater. : Serial link activity does not increase execution time.
Program repetition interval	: Preset by user in 10ms steps up to 9.5s. : Free running if user sets an interval less than the free running cycle time.
Fault shutdown	: Watchdog contact opens. : Text message displayed on programmer (when connected). : Program execution ceases at end of scan in progress. : I/O scanning ceases.
Restart after shutdown	: Initiated by switching power off/on. : Fault table and particular data tables cleared to zero on power up.
Memory support	: Lithium-copper oxide battery (non-rechargeable) on each memory module.
Battery life	: 4 years typical, 1.5 years minimum (continuous support with power off).
Shelf life	: 10 years typical, 5 years minimum (battery isolated or main power on).

3. USER PROGRAM

3.1 Programming and Monitoring

Means of programming	: Locally via front panel port, or remotely via user's serial links, using master I/O processor ONLY. : Standard GEM 80 programming units can be used.
Monitoring	: Locally via front panel ports or remotely via user's serial links, using master or slave I/O processor.

Note. To use the full facilities of a GEM 80/250 series controller (including on-line program alteration and printer message handling), the user will require either a system programmer type 8922, or else a portable programmer type 8920 with software version 4.5 or later.

3.2 Compilation

The user program is stored in two forms:
(a) Source program, for use in editing
(b) Running program, for execution by the ladder processor.

Conversion between the two is termed "compilation" and is carried out automatically on HALT/RUN status transition, and on power up. During compilation, the sizes of data tables are automatically set to those required by the user program, and basic and fast I/O configuration data are derived from the I/O addresses used in the program.

The "single cycle" facility provides the ability to recompile a program without entering RUN mode.

3.3 On-line Program Changes

Since the user program instructions are stored in two forms, the user can edit his source program while the controller continues to execute the unaltered compiled program (i.e. the controller remains in RUN mode). There is only one copy of the P-table, so changes to the preset data are effective immediately. The RECOMPILE command incorporates the changes to the ladder diagram instructions and preserves the data table contents.

3.4 Instruction Set

Language	: Ladder diagram format. : Up to 10 series elements per rung. : Up to 5 parallel branches per rung. : Up to 20 branch open's + 20 branch close's per rung. : Nesting of blocks up to 16 deep. : Standard GEM 80 instruction set (see Table 1). : Large set of pre-written software routines (special functions; see Table 2) for maths, control systems, manipulation of blocks of data, printer output, etc.

DETAILED SPECIFICATION (continued)

Table 1 - Standard Instruction Set

Symbol	Instruction	Remarks
-] [-	N/O contact	Single bit input.
-]/[-	N/C contact	Inverted single bit input.
-( )-	Coil	Output to single bit in table.
DELAY	Time delay	0.1s to 54 min. in 0.1s steps
COUNT	Counter	maximum 32767 resettable
SEQR	Sequencer	16 step with reset
BLOCK	Start/end	Conditionally executed block of instructions
AND OR XOR INV	Logic AND Logic OR EXCLUSIVE OR INVERT	Logic executed individually for all 16 bits in a word.
ADD SUB	Addition Subtraction	Arithmetic with limits at ±32767
OUT	Output	16 state or numeric output to table.

Table 2 Pre-written Software Routines (Special Functions)

Title	No.	Mnemonic	Exec. (µs)
Debounce input signal.	S0	DBOUNCE	92
BCD input conversion.	S1	BCDIN	89
BCD output conversion.	S2	BCDOUT	66
Find highest ON bit.	S3	HISTATE	42
Swap half locations.	S4	SWAP	1
Change sign of numeric value.	S5	NEGATE	4
Find absolute value of positive or negative number.	S6	ABS	5
Expand rung input to 0 or -1.	S7	NONZERO	8
Intermediate output from rung.	S8	OUTPUT	6
Linear conversion of array.	S10	CONARAY	Note A
Linear conversion.	S11	LINCON	130
Square root extraction.	S12	SQRT	225
Locate table address.	S20	LOCATE	132
Group manipulation.	S25	INVGRP	Note B
	S26	BITSON	Note C
	S27	SHIFT	Note D
	S28	ROTATE	Note D
Function generator.	S30	FGEN	380
Deadband.	S31	DEDBAND	55
Limiter.	S32	LIMIT	85
Ramp generator.	S33	RAMP	3600

Table 2 Pre-written Software Routines (Special Functions) (Cont'd)

Title	No.	Mnemonic	Exec. (µs)
Absolute 3 term control.	S34	PIDABS	520
Incremental 3 term control.	S35	PIDINC	330
Incremental output.	S36	INCOUT	225
First order time constant.	S37	ANALAG	214
Output of text from data tables.	S38	PRITEXT	360
Comparator.	T0	COMPARE	52
Direct comparison of upper branch of rung with lower branch, resulting in -1 as output if condition is met, 0 if not met.	T1	EQ	7
	T2	NE	7
	T3	GT	7
	T4	LT	7
	T5	GE	7
	T6	LE	7
Integer multiplication.	T10	MULT	30
Integer division.	T11	DIV	48
Array manipulation.	T12	ADDARAY	Note E
	T13	SUBARAY	Note E
	T14	MULARAY	Note F
	T15	DIVARAY	Note F
Move block of data.	T20	MOVE	Note G
Group manipulation.	T21	CMPGRP	Note H
	T22	GETBIT	150
	T23	PUTBIT	Note J
	T24	ANDGRP	Note K
	T25	ORGRP	Note K
	T26	XORGRP	Note K
Cyclic store.	T30	STORE	270
Output of mixed text from message list and numbers from data tables.	T38	PRINT	Note L
Reads characters from printer port.	T39	CHARIN	315

NOTES (Execution times µs)

A. 247 + 166 x quantity of locations.
B. 214 + 9 x quantity of locations.
C. Simple operation : 113
   Group : 128 + 74 x quantity of locations.
D. 186 + 30 x quantity of locations.
E. 355 + 32 x quantity of locations.
F. 390 + 42 x quantity of locations.
G. 220 + 3.7 x quantity of locations.
H. 250 + 24 x quantity of locations.
J. Simple operation : 60
   Group operation : 160
K. 312 + 19 x quantity of locations.
L. 8 x message number + 1400 for pure text or 1600 to 2400 for mixture of text and numbers.

DETAILED SPECIFICATION (continued)

3.5 Data Tables

Each data table location may hold:

(a) 16 on/off bits or
(b) a numerical value in the range -32767 to +32767.

Data tables and instruction storage are allocated from a common area of memory of approximately 24.000 words. One table location occupies one word and one instruction occupies 2 words.

Table 3 Minimum Tables Sizes

Table	Min	Max	Use
A,B	0	32(64)	basic input/output
C,D	0	*	fast input/output
E	7	7	overflow flags, timing information
F	200	200	error reporting
G,H, N,O, Q,U	0	-	general workspace
I	0	18(36)	serial interface control
J,K	0	512(1024)	serial interface
L	32	32	video buffer control
M	0	-	maintainer codes
P	100	-	configuration and preset data
R	1	-	retained workspace
W	0	-	retained workspace

* Depends on hardware configuration, 128/896/896 for GEM 80/251/252/253.

Note:
1. Figures in brackets indicate sizes when 2 I/O processors are fitted.
2. Where no maximum is given, the limit is determined by the total 24,000 words available.
3. Program instructions and P-table may be stored and transported on magnetic tape, via a programming unit.
4. All user tables except E1-E6, P, R, W are cleared on power up.
5. All tables except E, F, P, R, W cleared on HALT/RUN transition unless R0.0 set ON.
6. Tables E1-E6, R, W cleared only when power first applied to system.
7. All tables accessible by video.
8. The P-table also contains printer text messages. The locations used for messages are protected, and can only be accessed through the message editor, or via printer special functions.
9. Although table locations exceeding 999 may be used, it is only possible to use bit addressing (e.g. G173.12) for table locations not exceeding 3 digits when using Programmers type 8920 or type 8922 with software version earilier than 1.8; this restriction does not apply with System Programmer 8922 with software version 1.8 or later.

3.6 Scan Times

A GEM 80/250 controller performs a cycle which is repeated at a regular time interval preset by the user. The cycle comprises the execution of the user program plus an exchange of I/O data with the user's tables. The total scan time is the sum of the I/O data exchange time, and the greater of the basic I/O scan time and the program execution time.

Basic I/O scan time (by I/O processor)
2.0ms plus 0.4ms per 16 bit I/O word.

I/O exchange time:
750us for master I/O processor,
plus 600us if slave I/O processor fitted.
plus 10us per word of fast I/O data to be transferred

Program execution time
5us average per instruction
plus extra for each special function used
Block instructions may be used to reduce the execution time for each program scan by arranging for parts of the program to be skipped.

Note: If the controller contains two I/O processors, the basic I/O scan time must be worked out separately for each I/O processor and the greater of the two figures used (not their sum).

3.7 Self Test

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 watchdog
- a.c. supply break longer than 10ms.
- Power module failure.
- Failure of ladder or either I/O processor module.
- No response from either of system memory modules.
- Fault interfering with data transfer on basic I/O or fast I/O highways.

Faults which trip watchdog when detected by running tests
- Alteration detected in contents of read only memory.
- Failure of any part of read/write memory to store and recall data.

Faults from which recovery is automatic
- a.c. supply reapplied after break.
- Corrupt message received on serial link.
- Wrong acknowledgement to message transmitted on serial link.

DETAILED SPECIFICATION (continued)

Faults which user may program to trip watchdog	: Power module confidence check. : Basic I/O verification module failure. : Dedicated controller self test failure. : Serial link disconnected or repeated message corruption. : Application dependent tests. : Failure of battery on a memory module.

3.8 Fault Diagnostics

If self test detects a fault which does not allow the controller to continue running, then the watchdogs are tripped, and the fault is reported as a code number and an English language text message when a programming unit is connected.

Other diagnostic information obtained from automatic self test routines is reported by information stored in the F-table. Failure indications which, depending on the application, may be tolerated without interruption of the equipment operation do not directly trip the watchdog. The user enters specific program rungs for those faults which do warrant a watchdog trip for his application. For example a serial link to a mimic display might be regarded as non-essential, but a similar link to an operator control station might be vital.

3.9 Time, Date and Timing Markers

Source	: Crystal controlled oscillator mounted on a small backplane behind the power module.
Accuracy	: Better than 1 minute per month. : Timing maintained while controller halted. : Clock stops during power interruptions.
Time	: Held in E-table locations E1-E3. E1 = seconds (0-59) E2 = minutes (0-59) E3 = hours (0-23)
Date	: Held in E-table locations E4-E6. E4 = days (1-31) E5 = months (1-12) E6 = years (1901-2099 or 0-99)
Calendar	: Correct for the lengths of all months up to the year 2099 A.D. : User may abbreviate year to two digits (e.g. 86 for 1986) if desired.
Markers	: Set ON for one program cycle, then reset, at given intervals. : 0.1 second marker in E0.0. : 1 second markers in E0.1.

4. BASIC INPUT/OUTPUT

Type	One standard GEM 80 highway per I/O processor module
Capacity per I/O processor	: Logic I/O up to 512 ON/OFF states. } or any : Numeric I/O up to 32 values in the range ±32767. } mixture
Connection	: 2 off 26-way ribbon cables per highway. : Plug/socket between subrack and ribbon, ribbon and I/O equipment. : Each ribbon length up to 10m extendable to 30m with loading constraint I(amps) less than 21 divided by the length of the cable (metres).

5. SERIAL LINKS

5.1 Ports Available

Front panel ports	: For local programming and monitoring only.
Ports 1, 2	: Configurable as control tributary or printer/keyboard.
Ports 3, 4	: Available only when two I/O processors fitted. : Configurable as for ports 1 and 2.

Configuration is user adjustable by preset data: user must recompile program to implement changes - it is not necessary to power down.

5.2 Tributary Ports

Application	: Data table exchange with other GEM 80 controllers : On master I/O processor ONLY facility for remote programming with option of "block" messages. : On master and slave I/O processor, facility for remote monitoring with option of "block" messages.
Capacity	: Data table exchange of up to 32 input and 32 output table locations. : "block" messages for read or write of up to 16 adjacent instructions, or up to 32 adjacent table locations.
Modes	: Configurable by preset data as free running or under user control.

DETAILED SPECIFICATION (continued)

Free running mode	: Transmission initiated at end of current program scan. : Length of transmitted message preset in P-table. : I-table not used.
user control mode	: I-table set to indicate reception and length of received message. : Transmission of reply initiated at end of program scan ir which I-table bit set : Length of transmitted message taken from I-table.

5.3 Printer/Keyboard Ports

Application	: Output of text and numeric data to printer, VDU, etc. : Input of characters or strings from keyboard. : Option of automatic echoing and editing of input. Also supports XON-XOFF protocol in this mode.
Character-istics	: Depends on termination panel (e.g. 20mA current loop for panel type 8924). : ASCII character set (equivalent to ISO-7). : 1 start bit, 7 character bits, optional parity or 8th character bit, 2 stop bits. : Parity options configurable by preset data for odd, even or no parity on output, and odd, even, or stripped parity on input. : Automatic insertion of up to 132 null characters as "padding" at end of each line, to suit particular printers.
Capacity	: Buffer for up to 507 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 transferred.

5.4 Control Ports

Application	: Data table exchange with up to 8 GEM 80 tributaries per control port.
Modes	: Configurable by preset data as free running or under user control.
Free running mode	: Transfer occurs automatically on a cyclic basis to tributaries in use. : Transmission initiated between scans of user program. : Length of transmitted message preset in P-table. : I-table not used
User control mode	: A transfer only occurs when an I-table bit is set : Destination tributary address determined by which bit set in I table. : Length transmitted taken from I table. : Transmission initiated at end of scan in which I table bit set. : I table set to indicate reception and length of reply received.
Capacity	: 32 input and 32 output locations per route.

5.5 Communication Between Controllers

Type	: Standard GEM 80 serial link : Automatic data checking. : recovery by automatic retry.
Signalling rate	: 110 to 9600 bit/s. : User adjustable by preset data for each port
Connection	: Optional termination panel (see ordering information)

For 20mA serial link, maximum link length depends on:-
(a) User choice of single or twin pair cable.
(b) Signalling rate.
(c) Cable capacitance and resistance.
(d) Number of tributaries.

Refer to the Serial Links User Information leaflet (publication T418) for full details

6. FAST INPUT/OUTPUT

Type	: Standard GEM 80 fast I/O highway.
Module capacity	251 252 253 : 4 28 28
Connection	: Printed circuit backplane in subrack, carrying a connector for each module position. : Plant termination panels supplied with fast I/O equipment.

DETAILED SPECIFICATION (continued)

7. POWER SUPPLIES

Nominal power input	110 or 220/240V a.c. : 50 or 60Hz.
Operating range	96-132V or 192-264V 45-63 Hz.
Inrush (110V) Inrush (240V)	160A maximum for 5 ms. : 20A maximum for 200 ms
Consumption	80-200W per power supply module depending on configuration.
Input supply interruption	10ms ride through Shutdown after 10ms. : Automatic recovery.
Self test	Each output voltage ±2% : Healthy lamp for each output Regular exercising of fault detection.
Manual test	Partial withdrawal from subrack disconnects load Test pushbutton checks no-load operation. Sockets provided for measuring output voltages.

Power supply availability from 8915/8916 power module:-

Temperature	+5V	+15V	-15V
0 - 50°C	20.0	6.3	1.0
60°C	15.0	4.3	1.0
Power consumption:-			
Ladder processor	2.5	-	-
I/O processor	2.5	0.03	0.04
64K RAM	0.65	-	-
Paged or logging video processor	2.75	-	-
extra per 20mA source	-	0.02	-
Fast I/O driver	1.0	0.05	-
8924 20mA serial unit	0.22	0.01	-
extra per 20mA source	-	0.02	0.02

Basic I/O and fast I/O - see data sheets.

The power distribution on the different modules of controller is as follows:

251 Single power supply provides all power.

252 Single power supply in processor subrack provides all power for central modules, basic I/O and fast I/O driver. If any fast I/O is required, power for this is provided by a power supply per fast I/O subrack.

253 Two power supplies in a separate subrack provide power for the processor subrack. The left hand power supply feeds the modules fitted in slots 3-10, and whatever basic I/O and serial links are driven from these modules. The right hand power supply feeds whatever modules are fitted in module slots 11-19, and whatever basic I/O and serial links are driven from these modules. If any fast I/O is required, power for this is provided by a power supply per fast I/O subrack.

Notes:

1. For the fast I/O subracks used optionally with the 252 and 253, it may on rare occasions be possible to feed two fast I/O subracks from a single power supply. The user should check carefully what the total fast I/O power consumption will be from the data given in fast I/O data sheets to see whether one power supply will be adequate. If in doubt, assume that a power supply will be required for each I/O subrack.

2. For the 253, the standard placement for the second I/O processor (when required) is in slots 11 and 12, and therefore taking its power from the right hand power supply.

8. WATCHDOG

User circuit	: Volt free contact. : Closed when host controller healthy and its status is running with normal inputs. Held closed during user program on-line re-compilation. : Watchdog circuits activated on Slave I/O processor for confidence purposes but not electrically connected to relays. If slave watchdogs open those on the master will also be opened.
Resistive rating	: a.c. 200VA 1A 250V make/break. : d.c. 100W 1A 250V make/break.

DETAILED SPECIFICATION (continued)

9. SUBRACKS AND TERMINATIONS

9.1 Processor Subracks

Dimensions (including projections)	: 267 x 483 x 338mm (height x width x depth).
Mounting	: 19 inch (483mm)rack : 6U high, U = 44.45mm (1.75in).
Weight including modules	: 13 to 16kg per subrack depending on configuration.

9.2 Power Supply Subrack for 253

Dimensions and mounting	: As for processor subrack
Weight including modules	: 17.5kg per subrack

9.3 Optional subrack support assembly, type 43Y 1979.

Dimensions	: 309 x 540 x 275mm (height x width x depth).1 : 19 inch (483mm) rack. : Forward projection from rack 314mm (over power module). : Rear projection fron rack 25mm (over wiring).
Weight	: 4.4kg.

9.4 Video termination panel type 8034-4001

Dimensions	: 156 x 118 x 40mm (height x width x depth). : 0.25 rack width on two mounting channels at 5U (222mm) centres.

9.5 Serial link termination panel type 8924-0000

Refer to 8924 Product Data Sheet.

APPLICATION NOTES

APPLICATION NOTES

1. Sizes of Data Tables

The minimum and maximum possible sizes of the data tables in a GEM 80/250 series controller are given in Table 3, in Section 3.5 of the detailed specification above.

You will see from Table 3 that only the sizes of the E-table, F-table and L-table are fixed. The sizes of all the other data tables are computed by the controller itself to suit your program. For instance, if the highest G-table reference appearing in your ladder diagram is G245, then the controller will set up space in memory for a G-table containing 246 words, from G0 to G245.

Note that the controller only takes into account the highest address found for each table in your ladder diagram, not the lowest, and always sets up tables starting from address 0 upwards. Note also that, if the highest reference were for a bit (e.g. G245.2), the controller would include space for the whole of the word containing this bit (for this example, G245).

The controller carries out its computation of the table sizes for both the internal workspace tables and for the I/O tables. There is no limit to the size of any table, except for an overall limit of 24,000 words total for all tables and instructions.

However, the size of I/O tables must match the I/O hardware you are actually using with the controller, so that it is the hardware (not the firmware) which imposes a limit on I/O data table sizes.

Besides configuration data (mainly for serial links), the P-table includes your preset data up to the highest address appearing in your ladder diagram (as for other tables), and printer text messages (if you makes use of the message facility).

2. I/O Scanning

Besides computing the sizes of data tables, a GEM 80/250 series controller also computes what I/O ought to be present from the addresses appearing in your program. It only attempts to read input data from and send output data to those I/O devices whose addresses appear in your program. The rules the controller uses in its computation of which I/O table words to scan are as given below.

2.1 Basic I/O

Only those basic I/O words appearing in your program will be included in the I/O scan. For instance, if your program contains a contact referenced A1.0, then the whole word A1 will be read from the input modules and units.

If you fit a module and set it to an address which is not referred to in your program, then this module will not be scanned, and no data will be read from or written to it.

When you attempt compilation, your program will not run if you have used forbidden addresses in your program, and the Programmer screen will display a diagnostic message.

Forbidden addresses are:
(a) where A-table and B-table addresses have the same number (e.g. A4 and B4)
(b) where addresses have a number greater than the maximum imposed by the hardware (i.e. greater than 31 with one I/O processor, or greater than 63 with two I/O processors).

2.2 Fast I/O

Each fast I/O module slot in the controller's subrack or subracks is allocated a possible 32 C-table and 32 D-table words. Thus, the first fast I/O slot can use C0 to C31 and D0 to D31; the second slot can use C32 to C63 and D32 to D63, etc. The lowest table addresses for any given slot are referred to as the base addresses, e.g. C0 and D0, C32 and D32, etc.

If you have provided no configuration data for the fast I/O in P-table, the controller assumes that each fast I/O module is of single width. In this case, fast I/O addresses are included in the scan starting from the base address for a particular module slot, and continuing to the highest address included in your ladder program for that module; the computation then jumps to considering addresses beginning at the base address for the next module slot. The controller works out separately which C-table and which D-table addresses to include in the scan.

You must, however, set configuration data in the P-table to declare the positions of any fast I/O modules requiring status linking. The controller assumes that such modules are of double width and can use up to 64 C-table words and 64 D-table words.

For example, if you include address C47 in your ladder program, then normally addresses C32 to C47 inclusive will be scanned. If, however, you configured the first slot as a double width module, then addresses C0 to C47 inclusive would be scanned.

When you attempt compilation, the program will not run if an invalid fast I/O address is used, because there will be no response from the invalid address. The Programmer screen will display a diagnostic message.

2.3 Serial I/O

The controller cannot deduce from your ladder program what signalling rate you require, or what tributary No. you have given a particular controller. You therefore have to enter you serial I/O configuration data in the P-table as required.

3. Timing of I/O Scan

GEM 80/250 series controllers operate on a repetitive I/O scan and program execution cycle. The cycle time may either be undefined, in which case the program free runs and repeats as soon as it can, or else you may preset it with a P-table value to a regular defined interval.

With a GEM 80/250 series controller, the output scan is the first item in the cycle. If you have preset a regular repetition interval, the controller inserts a waiting period after the program execution at the end of the cycle. The program execution time itself will vary due to blocks within your program, and because of serial link activity. The waiting period will also vary so as to make the cycle time up to the preset interval. The timing of the output scan is therefore held to a regular interval, varying very little, an advantage for continuous analogue control applications.

If you have set a repetition interval which is shorter than either the program excecution time or the I/O scan time, the repetitive cycle will not be regular, and the controller will free run. If your program is short, such that its execution time is shorter than the I/O scan time, then your program will wait at the end of its execution until the I/O scan is complete before repeating. If, as is more usual in practical applications, your program takes longer to execute than the I/O scan, the next I/O scan will not begin until after the program execution has been completed.

4. User Program

Since a GEM 80/250 series controller works out the sizes of tables and which words to include in the I/O scan from your program as given earlier, you should note the following points.

1. If you have not loaded any ladder program, then no I/O scanning will occur. To check out the I/O equipment in the absence of a user program, you should enter and compile a dummy program which includes references to the appropriate I/O addresses.

2. The controller computes the sizes of tables and which words to include in the I/O scan from whatever addresses appear explicitly in your program. Where addresses are only implied (e.g. when you have used the special functions LOCATE and MOVE), then you will need to include a dummy rung or rungs in your program in which you declare the appropriate highest addresses.

4.1 Execution Speed

On average, the execution of a ladder diagram instruction in a GEM 80/250 series takes 5us. Use of the pre-written software routines ("special functions") listed in Table 2, in section 3.4 of the detailed specification, allows you to save considerable numbers of rungs. These special functions also perform calculations which, although giving answers rounded to the nearest integer, operate internally in double precision or floating point. The group and array special functions greatly reduce the number of instructions needed for handling large quantities of data.

4.2 On-line Program Changes

Because GEM 80/250 series controllers include a compiler, there are two versions of your program held in memory, as given in section 3.2 of the detailed specification:

- the uncompiled or "source" version
- the compiled or executable version

There is, however, only one version of P-table (for configuration and preset data, and for printer text messages).

While the compiled version of program is running and controlling the plant, you can edit the source version without halting the controller. You can also obtain a print-out of your modified version, or dump it onto tape, again without halting the controller.

To incorporate the changes made to the source version of program into the running version, you can give a RECOMPILE command from the Programmer. Assuming that compilation is successful, the controller will then continue to run but using the modified program. If compilation is unsuccessful, the controller will resume running the previous compiled version of program.

As the P-table is stored in only one form, any changes to the data contained in the P-table affect the running program immediately, without recompilation being necessary.

4.3 Diagnostics

With GEM 80/250 series controllers, fault reports are displayed on the Programmer screen as an English language text message, preceded by a code of format #nnn.

Faults causing watchdog trips will cause fault reports in this form.

Compilation errors will cause the controller to continue executing the previous version of your program, and give a fault report from the compilation.

When the controller is running and you make changes to the source version of your program, the status is displayed on the Programmer as CHANGED instead of RUNNING, until such time as you recompile.

If the controller is running with status CHANGED and there is a power interruption, then the controller will go into halt mode after power up and give a fault report "PROGRAM DIFFERENT FROM RUNNING VERSION".

As part of the self-test procedures which the controller undertakes, there is a check that there has been no alteration to program instructions and data in P-table. Each time you make changes to your program or P-table data, the controller has to recalculate a CRC value. If power is interrupted before this calculation is complete, the warning message "CRC NOT STORED, PROGRAM MAY HAVE CHANGED" is displayed on power up, and the controller goes into HALT mode. You may, however, run your program if you desire.

4.4 Clearing Store

If you issue a CLEAR STORE command, part of the P-table does not clear. This part (P0 to P99, except P51 and P52) holds your configuration data for serial links.

This section of P-table is not cleared because GEM 80/250 series controllers may be programmed either from the front port of the master I/O processor, or remotely via one of the serial ports. If the controller lost data about the serial port configurations, it could make it impossible for the controller to communicate with a remote Programmer. This data is therefore retained even when the rest of the memory store is cleared.

Before loading a program, you are recommended to 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 your program (see Application Note 1 above). 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 that, when you load a program, any instructions and P-table data already in store are overwritten. If, as we recommend, you clear store before loading, then P0 to P99 (which are not cleared, except P51 and P52) will be overwritten by data from the program you are loading. Where you are programming the controller remotely via one of the serial ports, the configuration data you are loading must be the same for this port as the values already in store, otherwise you will lose communication after a recompilation or power off-on.

Note also that, when the data you are loading includes messages, the messages area made write-accessible by the CLEAR STORE command becomes write-protected again when you do a compilation, except via the message editor.

5. ASSOCIATED HARDWARE

5.1 Basic I/O

When fitted with one I/O processor, a GEM 80/250 series controller has 512 I/O points. These are provided via 2 basic I/O ribbon cables, for addresses A/B 0-15 and 16-31.

When fitted with a second I/O processor, a GEM 80/250 series controller has an additional 512 I/O points, or 1024 total. An additional 2 basic I/O ribbon cables cater for addresses A/B 32-47 and 48-63.

It is important that you check the loading of the +15V rail when you are using quantities of I/O approaching the maximum.

Basic I/O module verification for a pair of adjacent basic I/O words is invoked automatically when you include a reference to either of these addresses in your ladder program. The results of the verification are presented as an array of bits in the F-table, one bit per 4 bits of I/O, set ON for a module absent or failed.

When utilising this data, you must take into account that bits in F-table will be set ON for module positions not used (i.e. left empty) and for any basic I/O equipment which does not incorporate the verification facility.

5.2 Fast I/O

For the GEM 80/251, space is available in the processor subrack for 4 single width Fast I/O modules or 2 double width modules, or a mixture of equal width.

APPLICATION NOTES (continued)

For the GEM 80/252 and 253 controllers, if you require any Fast I/O modules, these are mounted in one or two optional additional subracks, as given in the picture on the front sheet of this leaflet. Each of these additional subracks can mount the equivalent of 12 single width Fast I/O modules.

For any GEM 80/250 series using Fast I/O modules, you need to fit a Fast I/O driver module type 8300-4003 in the processor subrack.

If no Fast I/O is installed, then this module must not be fitted.

5.3 Serial Links

The GEM 80/250 series uses a termination panel type 8924, which provides 20mA serial links in either 2-wire or 4-wire configurations.

When fitted with one I/O processor, a GEM 80/250 series controller provides one serial link ribbon cable, which you can connect to one or two 8924 termination panels to provide one or two serial links respectively. With a second I/O processor, you can have a second serial link ribbon cable, which can be connected to two further 8924 termination panels, providing a maximum of 4 serial ports.

You can configure each serial port individually as a control, tributary, or printer port (see Section 5 of the detailed specification above).

If you want to carry out remote programming, then you must configure one port of the Master I/O processor as a tributary port, so that message traffic on this port can be controlled by the Programmer. With such a port, you can also load programs from or dump programs to a computer, if the computer has been programmed to provide messages of the appropriate formats. These message formats are given in the Serial Links User Information leaflet (publication T418).

Note also that this data sheet gives the maximum signalling rates considered satisfactory on serial links of different lengths. Where you are going to carry out remote programming from a Programmer, you should note that the 8920 Portable Programmer operates at a fixed signalling rate of 9600 bits/s, which may preclude its use, whereas the 8922 System Programmer has a signalling rate which you can set up to a lower value for long distance links.

You can also connect a remote Programmer to a tributary port on the second I/O processor (if fitted), but in this case you can only use the Programmer for monitoring, and not for modifying data or instructions.

An 8927 fibre-optic transceiver may be used a an 'add-on' adaptor to an 8924 termination panel using an adaptor cable type 8891-4079.

5.4 Central Modules

For the GEM 80/251 controller, space is available for one double width central module, such as a second I/O processor or a video processor module.

The GEM 80/252 has space equivalent to 6 single width modules.

The GEM 80/253 has space equivalent to 11 single width modules, suitable for not only a second I/O processor and several video processors, but also additional memory modules for storing additional video formats or for logging. The maximum number of video processors which can be fitted to a 253 controller is 4. The rightmost slot in a 253 processor subrack (slot 19) may only be used for a memory module.

For use with a 250 series controller, the video processor sub-module type 8603 must have software issues (as shown by the final letter on the EPROM chip labels) of C or later for the 8603-4004 (paged), and B or later for the 8603-4005 (logging). Video modules with earlier versions of software, and the earlier unpaged video processor, will not work with 250 series controllers.

5.5 Programmer Units

To obtain the correct display of diagnostic messages and to use the on-line program change facility, you will need either an 8922 System Programmer, or else an 8920 Portable Programmer version 4.5 software (or later). Further, without Programmers of the above types, you will not be able to enter the general edit mode of messages for printers, VDU's or other display devices.

If you already own an 8920 Portable Programmer but with software versions earlier than 4.5, we therefore recommend you to consult the factory about having your unit updated to the latest software version.

Note that, if you are using it for remote programming, the 8922 System Programmer can operate on a multi-drop serial link connected to several controllers, and at whatever signalling rate you select. The 8920 Portable Programmer, however, can only operate on a point-to-point link operating at 9600 bits/s, and can therefore only be connected to one controller at any one time. You should check on what signalling rate will be satisfactory for the given distance between the controller and Programmer, as noted in section 5.3 above.

6. Message Output Facility

GEM 80/250 series controllers include facilities for entering and editing message format definitions. These definitions are similar to the "pictures" or "images" found in some programming languages, and can include

either or both literal and replacement characters.

The message formats are handled as a single list, which the controller automatically shuffles as you enter, edit or delete items. A print-out facility allows you to list the message formats in a numbered and readily understandable form.

You can program the controller to output messages to any selected port using the special functions S38 PRITEXT and T38 PRINT (see Table 2 in the detailed specification above).

ORDERING CODES

ORDERING CODES

1. SUBRACKS

(a) Processor Subracks

Each of these is prepared to accept 1 I/O processor module, 1 Ladder processor module, 2 64K memory modules, and power supply (except for 8893-4535, which has no power supply). They include no modules or power supplies, which must be defined separately.

251	with 2 slots for central modules and 4 slots for fast I/O modules definable by user.	8893-4515
252	with 6 slots for central modules definable by user.	8893-4525
253	with 11 slots for central modules definable by user.	8893-4535

(b) Preparation of Processor Subracks to cater for the addition of extra central modules

The following ordering codes must be defined, in addition to any of the processor subrack ordering codes given in section (a) above, to make those subracks suitable for mounting additional central modules.

For second I/O processor (2 slots width)	8899-4214
For video process (2 slots width per processor; maximum of 4 processors)	8899-4204
For memory module for additional video formats (1 slot width; maximum 2)	8899-4216
For memory module for logging (1 slot width; maximum 8)	8899-4217

Note:

A decode system is in preparation whereby it will be possible to define a complete subrack by a chain of digits on the end of the GEM 80 model number. When available, this decode system will eliminate the need to quote the ordering codes given above.

(c) Fast I/O Subracks

These are for use with 252 and 253 controllers optionally when fast I/O modules are required. Depending on the quantity of fast I/O modules, either one or two subracks may be required. They include no modules or power supplies, which must be defined separately.

With 12 slots for fast I/O modules and space for power supply.	8893-4101 (See note 1)
With 12 slots for fast I/O modules and space for power supply.	8893-4102 (See note 2)
With 12 slots for fast I/O modules but no power supply	8870-4315 (See note 3)
With 16 slots for fast I/O modules but no power supply	8870-4031 (See note 3)

Notes:
1. For systems where any power supply fitted to this subrack is only the second power supply in the controller (e.g. first fast I/O subrack for a 252). Never used with a 253.
2. For systems where any power supply fitted to this subrack is the third or fourth power supply in the controller (e.g. any fast I/O subrack for a 253, or second fast I/O subrack with a 252)
3. For systems where there is adequate power available from a power supply unit in another subrack.

(d) Power Supply Subracks

This is for use with 253 only, which has no space in the processor subrack for power supplies.

With space for 2 power supplies	8893-4536

2. MODULES

(a) Power Supply Units

Normally, one power supply unit is required per subrack, except that with the 253 system the processor subrack requires none but its associated power supply subrack requires 2.

For 110V a.c. input	8915-000
For 220/240V a.c. input	8916-0000

(b) Central Modules

Ladder processor	8211-425* (See note)
I/O processor	8213-425* (See note)

Note: Specify as shown with an asterisk. The actual module supplied will have an ordering code where the asterisk is replaced by a digit dependent on the version of firmware. The last four digits must be the same for both 8211 and 8213 modules in any working system.

Paged video, standard dual character set Comprises paged video module and sub-module, ribbon cable and termination panel.	8811-4016

ORDERING CODES (continued)

Page video, special character set As for 8811-4016, except that the video module is defined separately to a special ordering code allocated by GEC.	8811-4007
Logging video, standard dual character set Comprises logging video module and sub-module, ribbon cable and termination panel.	8811-4018
Logging video, special character set As for 8811-4018, except that the video module is defined separately to a special ordering code allocated by GEC.	8811-4009
Memory module, for ladder program and tables, video formats, or logging	8209-4001
Fast I/O Driver Module only. Required whenever the system contains fast I/O modules. Must not be fitted if there is no fast I/O.	8300-4003

Note: Memory modules and fast I/O driver occupy 1 slot. I/O processors and video processors occupy 2 slots. These widths must be taken into account when assessing how many modules can be fitted into a GEM 80/250 series processor subrack.

(c) Fast I/O Modules

Details of fast I/O modules are given on individual data sheets in the number ranges 884x and 886x, and are therefore omitted from this data sheet.

3. OPTIONAL EXTRAS

20mA serial link termination unit (provides terminals for one port)	8924-0000
Ribbon cable for connecting the above to the controller (connects up to 2-off 8924 units to the processor subrack; max. 1-off per I/O processor).	8891-4077
Fibre optic interface unit (converts 20mA serial link from an 8924-0000 unit to fibre optic)	8927-0000
Cable loom for connecting the above to an 8924-0000 unit, ports 1 or 3	8891-4079
Cable loom for connecting the above to an 8924-0000 unit, ports 2 or 4	8891-4083
Subrack mounting kit (for one subrack)	43Y1979 Parts 01, 02 and 03
Mounting channel (for I/O panels and termination panels)	8959-0000

4. SPARES

Modules	See above
Battery for memory module	20T0319/01
Video processor base-module standard dual character set non-standard character set *	 8204-4004 8204-xxxx

*Number as allocated by GEC on receipt of original order.

Video processor sub-module paged video logging video	 8603-4004 8603-4005
Power supply backplane (carrying crystal for timing pulses)	8530-4001
External battery lead for memory (plugs into jack socket on 8209 memory module when the user wants to retain the memory contents while changing the internal battery, allowing a transistor radio battery to be connected externally).	43F0102/10

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