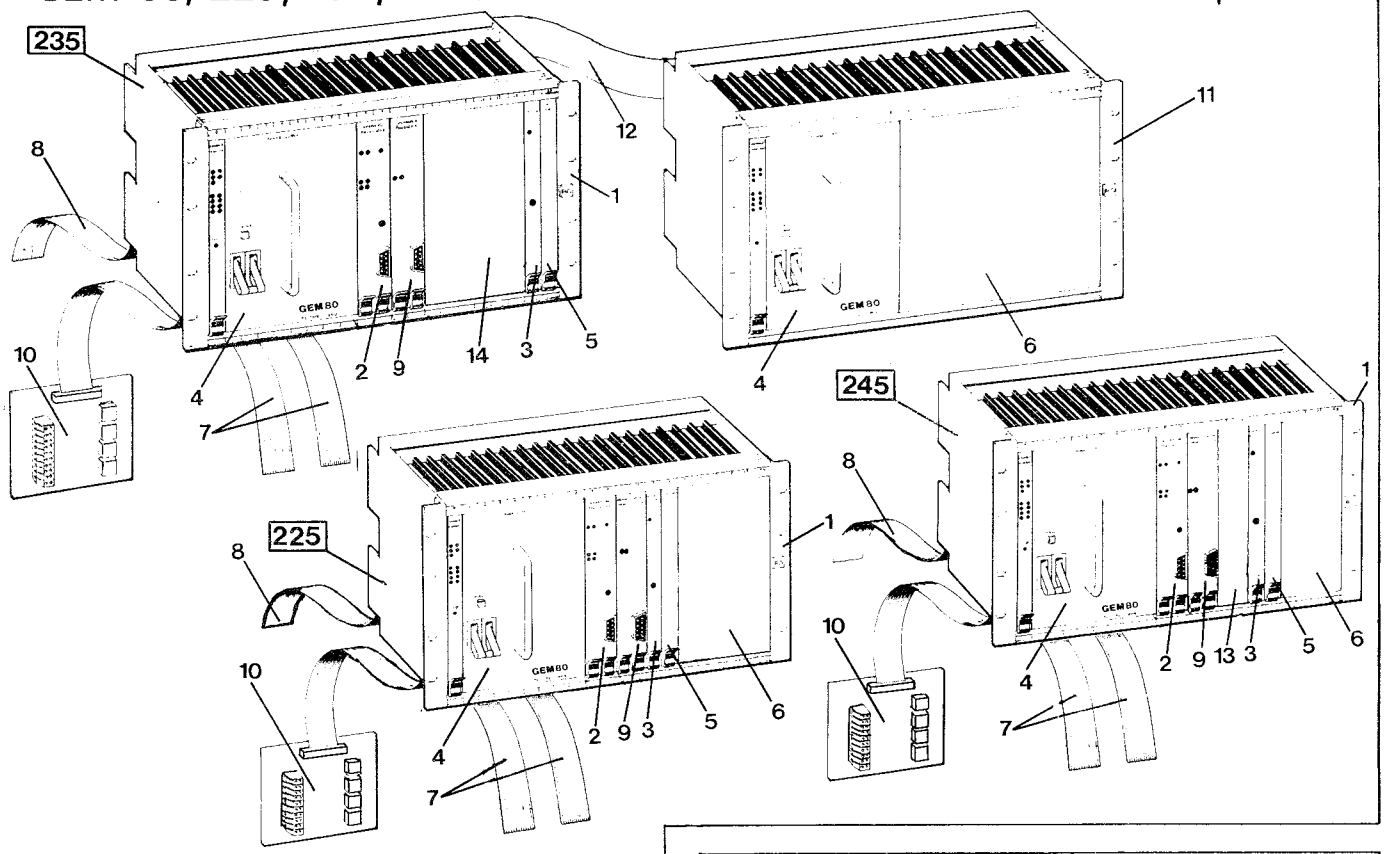
GEC Electrical Projects Limited
GEC Industrial Controls Limited
GEM 80

GEM 80/225/235/245(48K) Micro-Controllers with Video Output.



Illustrated are typical configurations fitted with single video processors.

1. Subrack.
2. Enhanced Processor (double width module).
3. Memory Module 48K (single width module).
4. Power Supply.
5. Fast I/O Driver (single width module).
6. Space for Fast I/O Modules.
7. Ribbon Cables to Basic I/O Equipment.
8. Ribbon Cable to Serial Link Termination Panel.
9. Video Processor (double width module).
10. Video Termination Panel.
11. Fast I/O Subrack.
12. Fast I/O Highway Ribbon Cable.
13. Space for Either a Video Processor or two 64K Memory Modules.
14. Space for up to three more Video Processors or up to six 64K Memory Modules or a mixture.

Note: GEM 80/225/235/245 (48K).
For simplicity within this data sheet the (48K) suffix is assumed but not stated.

DESCRIPTION

GEM 80/225/235/245 controllers consist of a processor, 48K memory module and power module.

The GEM 80/225 is a single subrack controller with space for 1 video processor and up to 6 Fast I/O modules.

The GEM 80/235 is a double subrack controller. It can accomodate up to 6 more 64K memory modules or 4 video processors or a mixture and also up to 12 Fast I/O modules.

The GEM 80/245 is a single subrack controller with space for 2 video processors or 1 video processor and 2 more memory modules, and also up to 4 Fast I/O modules.

The GEM 80/225E/235E/245E are controllers as described above but with different memory table sizes and the control program and preset data stored either in CMOS RAM or EPROM.

All these controllers are both powerful and flexible. They control and supervise industrial plant and processes. They perform logic, sequencing, reference setting, scaling, arithmetic data handling and closed loop control.

Interface with plant and operator is via the Basic Input/Output highway, Fast Input/Output highway, serial links, and video termination panel. Facilities to monitor plant status and performance are available with a wide range of GEM 80 equipment including video displays. Optional logging video is also available.

Through the serial link the controllers can communicate with printers giving hard copy print out (e.g. for alarms). The GEM 80/200 series has a built in clock for time and date.

These controllers operate either as stand alone units or as groups of GEM 80's intercommunicating through serial links to perform co-ordinated operations. Each controller can supervise up to seven other GEM 80 controllers.

They are user programmable in the GEM 80 control language and include comprehensive monitoring and diagnostics and are fully compatible with the whole GEM 80 family.

To make a working system connect power supply, watchdog interlock, Input/Output and enter a GEM 80 program.

FEATURES

- 32K bytes of RAM memory for ladder diagram user program.
- 16K bytes of RAM memory for video formats, expandable.
- Multiple video processors - up to 4 different pictures at the same time each with mixed text, numbers and pictorial data.
- Paged video - up to 144K memory for storing up to 225 different formats.
- Logging video - up to 320K of additional read/write memory.
- EPROM option for highest security of operation.

SPECIFICATION SUMMARY

CONTROL PROGRAM

		225/235/245	225E/235E/245E
capacity	:	32K	32K
maximum instructions	:	4095	4042
corresponding preset data	:	1007	142

Instructions and preset data table locations are automatically exchangeable (1 instruction = 3 table locations)

format : rung ladder diagram

number of special functions included : 23

processor average execution speed : 30/us per instruction

MEMORY TYPE

		225/235/245	225E/235E/245E
memory	:	battery supported CMOS RAM	Two options either:- (a) battery supported CMOS RAM. (b) EPROM instructions and preset data all other memory battery supported CMOS RAM.

BASIC I/O (on/off states) : 512 points

FAST I/O (maximum capacities)

225/225E : 6 single width modules or equivalent.
235/235E : 12 single width modules or equivalent.
245/245E : 4 single width modules or equivalent.

SERIAL LINKS

Port 1 - Tributary Port or printer/ single character input port.
Port 2 - Tributary Port or multidrop control port capable of controlling up to seven other controllers.

VIDEO

video output : composite video for both colour and monochrome monitors
: up to 4 formats in 1 picture.

maximum number of video processors

225/225E : 1 module
235/235E : 4 modules
245/245E : 2 modules

The number of simultaneously different pictures equal number of video processors.

video program capacity (optional)

225/225E : 16K bytes giving 25 formats
235/235E : up to 80K bytes giving 125 formats (with 3 video processors)
245/245E : up to 144K bytes giving 225 formats (with 1 video processor)

VIDEO LOGGING

memory capacity (optional)

225/225E : not available
235/235E : up to 320K (with 1 video processor)
245/245E : up to 128K (with 1 video processor)

POWER SUPPLY : 110V or 220V/240V, 50 or 60Hz.

MOUNTING : 19 inch 483mm rack

ENVIRONMENT

Temperature (local ambient)
operating : 0 to 60°C
storage : -20°C to 70°C

Humidity : 10 to 90% non-condensing.

DETAILED SPECIFICATION

CONTENTS

1. HARDWARE CONFIGURATION

These controllers have a minimum of 48K bytes of RAM memory 32K of which is for data tables and control program and 16K for video formats. Optional additional modules may be added to provide video displays, memory for video logging or modules for connection to Fast I/O highway.

Maximum capacities are shown in Table 1.

Table 1 Hardware Configuration

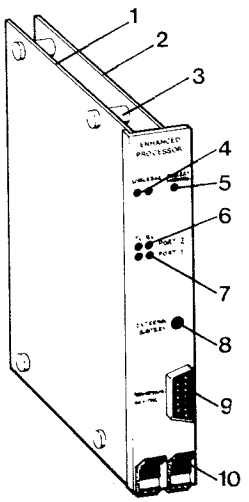
	GEM 80 225/ 225E	GEM 80 235/ 235E				GEM 80 245/ 245E		
Number of video processors	1	1	2	3	4	1	1	2
Video format RAM modules (each 64K)	0	1	1	1	0	0	2	0
Video logging RAM modules (each 64K)	0	5	3	1	0	2	0	0
Fast I/O modules (single width modules or equivalent)	6	12	12	12	12	4	4	4

2. CENTRAL MODULES

The controller central modules are the processor and 48K memory modules.

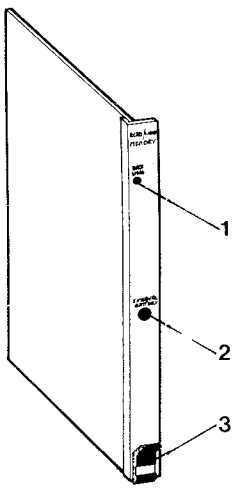
The controller performs a repetitive cycle; it scans the state of the inputs, executes the user's program, and sets the states of the outputs from the results of the program execution. All the I/O data and program execution results are stored in data tables whose contents may be displayed by plugging a programming unit into the processor front panel.

Processor Module



1. Processor base-module.
2. Personality sub-module.
3. Clamping pillars.
4. Watchdog healthy lamps.
5. Battery warning lamp.
6. Serial port 2 transmit/receive activity lamps.
7. Serial port 1 transmit/receive activity lamps.
8. Socket for external supply to memory.
9. Socket for programming and monitoring.
10. Withdrawal handle.

Memory Module



1. Battery warning lamp.
2. Socket for external supply to memory.
3. Withdrawal handle.

3. CONTROLLER OPERATION

start up : performs comprehensive self test
: starts operating cycle
: closes watchdog contact

operating cycle : scans inputs into data tables
: executes user control program, placing results in data tables
: performs segment of self test
: services watchdog at regular intervals

cycle time (free running) : 2.0ms + execution time of user control program + basic I/O scan time (if any) + fast I/O scan time (if any)
: serial link activity is distributed through cycle and loads cycle time by up to 16% per active link (load % proportional to signalling rate, 16% for 9600 bit/s)
: video display access to data tables has negligible effect on cycle (1% load)
: logging video loads cycle time by 1%
: all quoted times include allowance for programmer link monitoring activity, times typically reduced by 10% if programmer not in use

program repetition interval : preset by user in 10ms steps up to 10s
: free running if user chooses time less than free running cycle time

fault shutdown : opens watchdog contact
: places fault code in fault table
: ceases program execution at end of scan in progress
: ceases scanning I/O

restart after shutdown : initiated by switching power off/on
: fault table and particular data tables cleared to zero on power up

4. USER CONTROL PROGRAM

language : ladder diagram format
: up to 10 series elements per rung
: up to 5 parallel branches

instruction set : standard instruction set (Table 2)
: special functions (Table 3)
: suitable for logic, sequencing, arithmetic, data handling, scaling, closed loop control, printout of text messages and numeric data.

Table 2 Control language instruction set

Symbol	Instruction	Remarks
-] [- -]/[- -( )-	N/O contact N/C contact Coil	Single state input to rung Inverted single state input Output to single state in table.
DELAY COUNT SEQR	Time Delay Counter Sequencer	0.1s to 54min in 0.1s steps Capacity 32767.Resettable 16 step sequencer with reset
BLOCK	Start/end	Conditionally executed rungs
AND OR XOR INV	Logic AND Logic OR EXCLUSIVE OR INVERT	Logic executed individually for each of 16 states
ADD SUB	Addition Subtraction	Arithmetic with limits at ±32767
OUT	Output	16 state or numeric output to data table location

Average execution time : 30/us per instruction (zero for instructions within non-executed blocks).
Delay and counter each use extra instruction for value.
Each branch open (⊏) uses 2 instructions.
Each branch close (⊐) uses 1 instruction.

Table 3 Special Functions in controller

Function No. & mnemonic	Title and average execution time (ms)	
S0 DBOUNCE	Debounce input signal	0.86
S1 BCDIN	BCD input conversion	0.39
S2 BCDOUT	BCD output conversion	0.40
S3 HISTATE	Find nighest ON state	0.26
S4 SWAP	Swap 1/2 locations	0.23
S11 LINCON	Linear conversion	1.80
S12 SQRT	Square root	1.33
S20 LOCATE	Locate table address	0.52
S22 WRITEXT	Print text	Note 1
S23 WRINUM	Print number	1.54
S30 FGEN	Function generation	2.75
S31 DEDBAND	Dead band	0.78
S32 LIMIT	Limiter	0.89
S33 RAMP	Ramp	4.86
S34 PIDABS	Absolute 3 term controller	7.00
S35 PIDINC	Incremental 3 term controller	4.90
S36 INCOUT	Incremental output	1.18
S37 ANALAG	First order time	3.52
T0 COMPARE	Comparator	0.59
T10 MULT	Integer multiplication	0.48
T11 DIV	Integer division	0.77
T20 MOVE	Move block of data	Note 2
T30 STORE	Cyclic store	1.36

NOTES:
1. 0.20 + 0.23 x message no. + 0.035 x quantity of characters.
2. 0.56 + 0.024 x quantity of locations.

means of programming : portable programmer type 8920
: instructions and preset data archive storage and transport on cassette tape
: ladder diagram/data table printout via programmer

memory capacity : 32K see Table 4 for details

data tables : each location usable as 16 on/off states or numeric value in range ±32767

Table 4 Host Controller Memory Capacity

(a) Control program and preset data

	225/235/245	225E/235E/245E
Control program (size user adjustable)		
maximum size	4095	4042
minimum size	1007	756
Preset Data (P table) when control program at maximum size	1097	142
when control program at minimum size	10000	10000

Automatic exchange:- 1 instr = 3 presets subject to limits of 4095 instr and 10000 presets.

Configuration data occupies bottom of P table (117 locations in 225; 123 in 235; 115 in 245)

(b) Data tables (variable)

Function		Table Size 225/225E	235/235E	245/245E	Remarks
Basic I/O	A	32	32	32	Total usable =
	B	32	32	32	32 locations I+O
Fast I/O	C	192	384	128	32C & 32D per
	D	192	384	128	module position
Timing & flags	E	7	7	7	Time & date. 0.1/1 sec markers; overflow flags
Diagnostics	F	200	200	200	127 built-in tests 73 user prog
General work space	G	1000	1000	1000	Internal registers etc.
Serial I/O	J	256	256	256	32J & 32K per
	K	256	256	256	possible route
Video requests	L	32	32	32	Format requests and logger control
Maintainer	M	10	10	10	Write access for maintainer
Retained work space	R	50	50	50	As G but contents retained through power loss

Working	W	Controller	Table Size	(a) "value" for special functions (b) extension of G and/or R tables
		225	1015	
		225E	2039	
		235	631	
		235E	1655	
		245	1145	
		245E	2167	

NOTES
1. Instructions and P table write protected and load/dump to cassette tape.
2. All tables except E1-6, P, R and W cleared on power up.
3. All tables except E, F, P, R and W cleared on halt to run transition unless user sets R0.0 ON.
4. Tables E1-6, R and W cleared only when power first applied to processor module after battery link has been in storage position.
5. Tables F and R not accessible by video.

memory of support of CMOS RAMs	: primary battery (lithium) on processor and 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)
write protection	: EPROM version control program and preset data unalterable. On other controllers alteration of control program and preset data prevented when controller running : automatic 16 bit cyclic redundancy check on write protected data

5. SELF TEST

execution	: one full cycle of start up tests (approx. 5 second) whenever power switched on : I/O tests repeated every scan : regular on-line repetition of running tests (spread over approx. 20 minutes)
watchdog	: automatic pick up on satisfactory completion of start up test cycle
faults which immediately trip watchdog	: a.c. supply break longer than 10ms : power module failure : processor module failure : fault interfering with data transfer on basic I/O highway or fast I/O highway : memory module failure to respond (bus timeout)
faults which trip watchdog when detected by running tests	: alteration detected in contents of ready only memory : failure of any part of read/write memory to store and recall data : power module confidence check
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
faults which user may program to trip watchdog	: any I/O block missing : basic I/O ribbon cable unplugged : dedicated controller self test failure : serial link disconnected or repeated message corruption : application dependent tests
fault diagnosis	: fault codes presented in fault data table

The diagnostic information obtained from the automatic self test routines is presented as numerical values at specific locations in the F table.

Any failure indication related to gross maloperation of the equipment also results in an automatic watchdog trip.

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-vital, but a similar link to an operator control station might be vital.

A substantial part of the F table is available for user fault diagnostics e.g. related to plant sensors and actuators. The user enters program rungs to detect fault conditions related to the specific appliction, and to trip the watchdog when appropriate.

5.1 Watchdog Contacts

Circuit for user	: volt free contact : closed when host controller healthy and status running with normal inputs
resistive rating	: AC 200VA 5A 250V make/break : DC 100W 5A 250V make/break

6. BASIC INPUT/OUTPUT

type	: standard GEM 80 basic I/O highway
capacity	: up to 32 x 16 bit words, each word either input or output : logic I/O up to 512 ON/OFF states : numeric I/O up to 32 values in range $\pm$32767 (: or any mixture)
connection	: 2 off 26 way ribbon cables from rear of subrack : each ribbon connects to 16 x 16 bit I/O words : all ribbon connections by plug/socket : each ribbon length up to 10m extendable to 30m with loading constraint I(Amp) $\leq$ 21$\div$length (metres)
basic I/O scan time	: 2.0ms plus 0.4ms per 16 bit word of I/O

7. FAST INPUT/OUTPUT

type : standard GEM 80 fast I/O highway

capacity : 225/225E 6 fast I/O } single
: 235/235E 12 fast I/O } width
: 245/245E 4 fast I/O } modules or equivalent
: up to 32 x 16 bit words each of input and output data per module position; user adjustable by preset data to suit chosen type of fast I/O module

connection : printed circuit backplane in subrack carrying a connector for each module position
: plant termination panels supplied with fast I/O equipment

fast I/O scan time : 1.0ms plus 1.0ms per 16 words of I/O data

8. SERIAL LINKS

8.1 Ports available

Port 1 : configurable as either a standard GEM 80 tributary port or a printer port

Port 2 : configurable as either a standard GEM 80 tributary port or a standard GEM 80 control port with multidrop capability for up to 7 routes

Configuration is user adjustable by preset data; user MUST switch power off/on to re-initialise after changing between tributary, printer or control.

8.2 Tributary port

application : data table exchange with control port of any other GEM 80 controller
: suitable for point-to-point or multidrop link

capacity : exchange up to 32 input and 32 output data table locations

8.3 Printer port

application : output of text and numeric data to serial printer or equivalent unit e.g.TELETYPE or 'TELETYPE compatible' VDU; typically up to 7 such units in series at 2V max. volt drop per device
: input of individual characters from serial keyboard

'TELETYPE' is a product of Teletype Corporation

capacity : output buffer for 255 characters
: indication (E0.8 ON) when buffer 2/3 full
: input restricted to single character per scan of program

characteristics : 20mA current loop working
: ASCII character set (equivalent to ISO-7)
: 1 start bit, 7 character bits, even parity bit, 2 stop bits
: output data transmitted as complete lines up to 125 characters per line
: parity bit disregarded for input characters

signalling rate : 110 to 9600 bit/s user adjustable by preset data (same for input and output)

character printing rate : user adjustable by preset data to match capability of printer
: automatic insertion of up to 127 null characters in each line

8.4 Control port

multidrop capability : connects to maximum of 7 tributaries with addresses 1 to 7 respectively

application : each route either remote I/O or data table exchange with tributary port of any other GEM 80 controller

capacity : data table exchange up to 32 input and 32 output locations per route
: remote I/O any mixture of input and output locations up to a total of 32 (same capacity as basic I/O highway)

8.5 Communication between Controllers

type : standard GEM 80 serial links
: automatic data checking
: recovery by automatic retry

signalling rate : 110 to 9600 bit/s user adjustable by preset data for each port

signalling time at 9600 bit/s : 12.5ms per route plus 2.5ms per table location } time inversely proportional to signalling rate

maximum link length depends on:-
(a) type of controller providing control port
(b) signalling rate
(c) cable capacitance and resistance
(d) number of tributaries in link

Table 5 Maximum lengths (km) of serial links from control port

Speed kbit/s	Number of tributaries on serial link 1	2	3	4	5	6	7
9.6	0.92	0.68	0.52	0.42	0.34	0.28	0.24
4.8	1.95	1.6	1.35	1.15	0.98	0.86	0.76
2.4	3.2	2.8	2.5	2.2	2.0	1.8	1.6
1.2	4.8	4.4	4.0	3.8	3.5	3.2	3.0
0.6	7.2	6.8	6.4	6.0	5.6	5.4	5.0
0.3	10.5	10.0	9.4	8.4	7.4	6.6	5.6
0.11	11.0	10.0	9.4	8.4	7.4	6.6	5.6

Quoted figures apply to twin twisted pairs of DEF STAN 61-12 part 5 type 16-2-2C cable with typical core resistance 40 ohm/km and capacitance 110 nF/km.

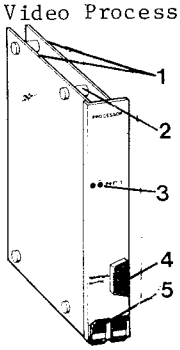
9. VIDEO

9.1 Controller/video display relationship

The video display system operates independently of the host controller, except that the video has read only access to the data tables of the host.

The self test, watchdog and status (halt/run) of the host controller are independent of the video system.

Video Processor Module



1. Video processor printed circuit boards.
2. Clamping pillars.
3. Printer transmit activity lamp (screen print or program listing).
4. Socket for programming and monitoring.
5. Withdrawal handle.

9.2 Video display operation

start up
: performs simple self test of video processor executive programs and on-board memory.
: displays test format (zeros) followed by dummy format (GEM 80).
: starts operating cycle

operating cycle
: reads format requests in host controller L table
: if any change to format requests, reads format defintion(s) from video memory modules into video processor
: reads variable data for display from data tables of host controller
: updates displayed picture

cycle time (typical)
: 1 to 2s complete new picture
: 1/3 to 1s update full picture
: 1/10 to 1/2s update small area

} free running independent of host

multiple video processors
: each video processor produces independent video output, displaying different video formats
: format definition programs are shared between all video processors in a system

9.3 Video display program

display
: as Figure 1

character set
: standard character set as Table 6. Contact GEC for details of special character sets

language
: interactive procedure for setting up basic format data
: text editor for programming format definitions
: simple instructions for setting up areas of repeated fixed data
: powerful instructions (DRN's) for display of variable data by change of colour or flashing, or as numbers, symbols text, and bar charts. (Table 8).

means of programming
: portable programmer type 8920
: program archive storage and transport on cassette tape
: printout of format definitions

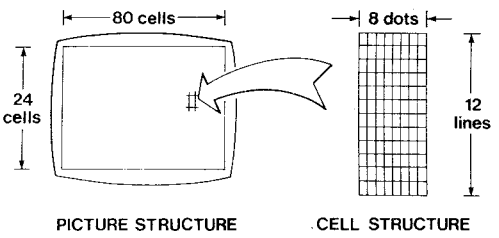
memory capacity
: 16K plus optional 64K modules for paged/logging video processor
: 8 typical complicated full screen formats per 16K page of memory
: 25 typical simple formats per 16K page of memory
: 25 formats maximum per 16K page

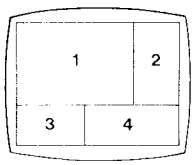
memory support
: primary battery (lithium) on each memory module
: battery life 4 years typical 1.5 years minimum (continuous support with power off)
: shelf life 10 years typical 5 years minimum (battery isolated or main power on)

write protection
: video processor write enabled only when programmer lead inserted (logging video is permanently write enabled)

data tables
: read only access to host controller data tables for display of variable data (DRN's Table 8)

screen print : printout of displayed picture or single format area (paged/logging video only)
: unpaged video freezes picture for 75s during print; paged/logging video displays normally during print
: suitable only for normal size text and numeric data





Control program selects independent pictures for each format area 1 to 4. Format data in video program defines position of screen partitions.

Figure 1 Display structure

Table 6 Video character set

Type	Characters available
ASCII/ISO-7 character set 1x1 cell	letters A to Z, a to z numbers 0 to 9 punctuation !" (),./:;?[]`{} arithmetic +<=>= symbols #$%&*@^|
Extra large characters 3 x 3 cells	letters A to Z numbers 0 to 9 punctuation ?
Block graphics	 All 64 combinations of 6 elements per cell (each element 4 x 4 dots)
Bar charts	1 cell wide, height in 1/12 cell increments
Boundary or pipe symbols	Set of corners, horizontal lines, vertical lines and joints, with arrows to indicate flow. Lines 2 dots wide.
Fine lines	Horizontal and vertical line 1 dot wide.
Miscellaneous	GEC logo; double width ON/OFF

Each character can be displayed normal width or double width. Each line of cells starts normal width; each subsequent width change occupies one cell i.e. there is a space between normal and double width characters.

Table 7 Attributes for each cell

Attribute	Description
Colour	Independent choice of foreground and background colour:- Black, white, red, green, blue, light blue (cyan), yellow, purple (magenta).
Flashing	Alternating character and space at 0.8Hz 50% mark-space ratio.
Reverse video	Interchanged foreground and background colours.

Monochrome output is white on black irrespective of chosen colours except that character suppressed if foreground and background colours identical (black on white if reverse video).

Table 8 Variable data instructions (DRNs)

Variable	Description
Attributes	Switched or variable attributes for whole area or n cells across up or down.
Numbers	Range ±32767. Optional decimal point or hex display. Optional double width (paged/logging video only) or triple size.
Characters	Any characters from character set
Text	Text string e.g. shared with printer.
Bar charts	Vertical or horizontal.

9.4 Paged Video

Paged video processor offers all the facilities of unpaged video but with the ability to expand the video format program in 16K "pages" (hence the name paged video).

memory capacity : see table 9 (video format RAM bytes)

screen printout : not frozen during printing.
: part or whole picture printout.

editing : display maintained while format editing.

numerical characters : single width/double width/triple size.
: with/without decimal point.
: with/without leading zeros

Each 16K page of video formats memory can contain up to 25 formats e.g. 8 typical full screen formats.

9.5 Logging Video

By fitting a video processor with logging video firmware and additional 64K logging video RAM memory modules a logging video can be made.

Table 9 shows the logging video memory capacity for each controller. It can be used in one of two ways either (a) On Demand
(b) Regular Sampling

(note it is not possible to have some channels on demand and some channels regular sampling. This logging memory must be either all "on demand" or all "regular sampling").

(a) On Demand:- This allows blocks of controller data tables to be stored in the logging memory. If there are, for example, 1000 locations in the logging memory and 100 adjacent controller table locations then 10 complete sets of data can be stored. Any set can be recalled by the host controller. The cyclic store places new data at the most recent end of the store and when the store is full this new data replaces the oldest.

(b) Regular Sampling:- Up to 100 channels from the host controller data tables can be sampled and the maximum capacity is 5000 samples per channel providing there are sufficient 64K memory modules. (note first 64K memory module holds about 32000 samples, subsequent ones hold 32768 samples). Each individual channel can be programmed to sample at different intervals from 0.1s to 54 minutes in 0.1s increments or 1s to 9 hours in 1s increments. The cyclic store will overwrite oldest data as new data arrives automatically thereby storing trend information.

This logged data is stored through power off by the battery memory support system. Full access is available to the video logger with the portable programmer for design and maintenance.

Through the host controller serial link printer port data could be ouput to a printer if required.

Video can display the logged data in several ways, for example, by bar charts. Alternatively the data can be superimposed onto more complex video formats. The video logger has all the facilities of the paged video, except the editor.

9.6 Output from Video Processor

video output : composite video suitable for colour and monochrome industrial monitors.
: 1V into 75 ohm.
: red/green/blue signals (sync. on green).
: independent monochrome signal.
: 320 lines per field, 64 /us line period
: 48.8 fields per second

NOTE: Monitors are often fitted with "loop through" input terminals enabling one video processor to drive more than one monitor by a "daisy chain" connection.

printer output : printout of format definitions or screen contents.
: 20mA current loop.
: ASCII character set (equivalent to ISO-7).
: 1 start bit, 8 character bits, 2 stop bits (last character bit is zero, corresponding to unused parity bit, for ASCII set).
: 300 bit/s; 80 characters per line.

NOTE: Screen printout of graphics and large characters will produce 8 bit character codes not recognised correctly by standard ASCII printers; paged/logging video substitute asterisks (*) for such codes.

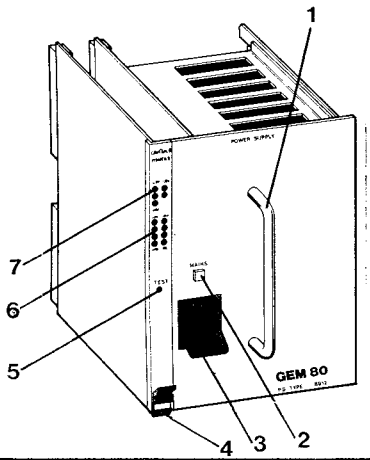
connection : ribbon cable from rear of subrack to video termination panel (2m std. length).
: 75 ohm B.N.C. connectors on termination panel for video output.
: screw clamp connectors on termination panel for printer output.
: 3 video leads are provided each 2 metres long, with B.N.C. connectors on both ends.

Table 9 Video Options

	GEM 80 225/ 225E	GEM 80 235/ 235E				GEM 80 245/ 245E			
number of video processors	1	1	2	3	4	1	1	2	
number of video format RAM modules	0	1	1	1	0	0	2	0	
video format RAM bytes	16K	80K	80K	80K	16K	16K	144K	16K	
number of video formats	25	125	125	125	25	25	225	25	
number of logging RAM modules	0	5	3	1	0	2	0	0	
number of logging RAM bytes	0	320K	192K	64K	0	128K	0	0	
number of logging RAM locations	0	160K	96K	32K	0	64K	0	0	

NOTE: figures above show maximum capacities.

Power Module



1. Carrying handle.
2. A.C. supply lamp.
3. On/Off switch.
4. Withdrawal handle.
5. Test pushbutton.
6. Voltage measuring sockets.
7. Output healthy lamps.

10. POWER SUPPLIES

power input : 96 to 132V or 192 to 264V
: 45 to 63Hz*

* Accuracy of time and date in built in clock depends on average mains frequency 50 or 60Hz.

Inrush(per power module) : 160A @ 110V for 5 ms
: 20A @ 240V for 200 ms

Consumption (depending on configuration)

225/225E : 80 to 200W } includes I/O
235/235E : 80 to 400W } load on
245/245E : 80 to 200W } host.

input supply : 10 ms ride through.

interruption : shutdown after 10 ms.
: 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.

Table 10 8911/8913 Power Supply Availability

Local ambient temp°C	Power module max. output amps +5V	+15V	-15V	Remarks
0 to 46	16.3	8.0	0.80	Extra +5V availability = 4.6 x unused current @ -15V
50	16.6	8.0	0.72	
60	12.5	6.0	0.52	

235/235E series has option of independent power modules for each subrack.

Table 11 8915/8916 Power Supply Availability

Local ambient temp°C	Power module max. output amps +5V	+15V	-15V	Remarks
0 to 50	20.0	6.3	1.0	Extra +15V availability = 1.6 x unused current @ -15V
60	15.0	4.3	1.0	

235/235E series has option of independent power modules for each subrack.

Table 12 Internal current consumption

Item	Current mA +5V	+15V	-15V
Enhanced processor module	3000	-	-
Video processor module (paged or logging)	2750	-	-
Non paged video processor module	3000	-	-
Memory modules (each)	650	-	-
Fast I/O driver module	1000	50	-
Extra if any basic I/O	-	30	-
Extra per current source used for serial links (1 or 2 for control port and 1 or 2 for printer/keyboard)	-	20	20
Extra per continuity relay (tributary ports)	-	20	-
Basic I/O equipment	-	*	-
Fast I/O modules	*	*	*

* Refer to data sheets

11. TIME AND DATE

The built-in clock presents the time and date as numerical values in the E table.

location	contents	range	example
E1	seconds	0 to 59	0
E2	minutes	0 to 59	3
E3	hours	0 to 23	23
E4	days	1 to 31	5
E5	months	1 to 12	2
E6	years	0 to 2099	1985

Example shows clock at 11.03p.m. on 5th Feb.1985.

On initial power up of a brand new controller the time will clear to zero, the user must arrange to set the clock either by manual input to the E table using a programming or monitor unit, or by including program rungs to read the time and date from an operator or plant input. After subsequent power interruptions the clock will continue from where it left off, it may be appropriate for the user to provide the operator with facilities for putting the clock right.

The E0.0 and E0.1 flags are crystal derived, and an accuracy between 25ppm and 100ppm is expected. This is equivalent to the range 1 min per month to 1 min per week, but only if the controller is continuously in run status.

The time and date in E1 to E6 is derived from the frequency of the mains input, and is maintained in both halt and run status. An accuracy within a few seconds will be achieved over a long period, provided that there are no power supply interruptions, and the mains frequency itself is accurately controlled.

UK mains will be accurate to a few seconds over several years provided there are no power interruptions. The calendar will be correct for lengths of all months until 2099 A.D. User has option to abbreviate years to two digits e.g. "85" for 1985.

12. MOUNTING

subrack	: 267 x 483 x 338mm (high x wide x deep) : 19 inch (483mm) rack mounting : up to 16 kg depending on configuration.
optional subrack support assembly type 43Y-1979	: 309 x 540 x 275mm (high x wide x deep) : 19 inch (483mm) rack mounting : forward projection from rack 314mm (over power module) : rearward projection from rack 25mm (over wiring) : 4.4kg
video termination panel type 8034-4001	: 156 x 118 x 40mm (high x wide x deep) : 1/4 rack width on two mounting channels at 222mm centres.
Optional 4 wire serial link termination panel type 8038-4002	: 156 x 238 x 30mm (high x wide x deep) : 1/2 rack width on two mounting channels at 222mm centres.

NOTE: Only one required for both ports.

Optional 2 wire serial link termination panel 8925-0000	: 146 x 119 x 38mm (high x wide x deep) : 0.4kg : quarter rack width on two mounting channels at 222mm centres

NOTE: One required for each port used.

Optional Fibre-Optic Transceiver 8927-0000	: 146 x 119 x 38mm (high x wide x deep) : 0.33kg : quarter rack width on two mounting channels at 222mm centres.

NOTE: One is required for each port used and one per route if used as multidrop control port.

Optional mounting channel type 8959	: 102 x 483 x 51mm (high x wide x deep) 2.5kg

APPLICATION NOTES

1. 225,235 and 245 Memory Module Type

The memory module used for the control program is a 64K module subequipped to 48K (8209-4002). Memory expansion is by fully equipped 64K modules (8209-4001), which are interchangeable with each other, but are NOT interchangeable with the subequipped modules. When ordering spares, at least one is required for each type.

2. Memory addressing

The base address of each memory module is determined by links at the backplane.

The first memory module uses addresses 0 to 16K for the first page of video formats, and 24K to 56K for the ladder diagram control program and data tables. The paged video and logging video uses addresses 64K to 128K for video format pages 1 to 4 (format numbers 26 to 125), and 128K to 192K for video format pages 5 to 8 (format numbers 126 to 225). The logging video uses addresses from 512K upwards for logged data.

3. Subrack types

When a 225, 225E, 235, 235E, 245 or 245E subrack is manufactured, particular slots are fitted with the power module, ladder diagram processor module and 48K memory module which together form the basis of any controller.

Other slots are prepared to accept optional modules, some of which will be fitted according to the order placed by the user. The empty slots will be fitted with blanking panels, but if desired it is a simple task to upgrade on site by fitting the additional modules for which the slots have been prepared.

A set of different subrack types are available to cater for a wide range of different video and memory configurations. The user is advised to take great care when selecting the subrack type, because it is a substantial task to alter the type of module to be fitted in a particular slot once the appropriate backplanes and connectors have been fitted.

4. 225E, 235E and 245E Generation of EPROM's

Normally it is expected that a 225E/235E/245E processor module will be used with a standard 48K CMOS RAM modules for user program development, and this can be performed on site using the subrack which will eventually have an EPROM memory module substituted.

If more convenient, the program may be developed in any GEM 80 controller, provided that the user does not exceed the instructions capacity or data table sizes of the 225E/235E/245E, sets up the P table configuration data to suit the 225E/235E/245E, and does not use absent special functions.

When the user sends the program tape to the factory, it is essential to quote the type of controller for which the EPROM's are required (i.e. 225E or 235E or 245E), whether a battery is required, and the issue of the system EPROM's on site. Note particularly the need to quote the system issue code. The EPROM's must be programmed in the factory using the same issue, otherwise the internal addresses in the EPROM's could be wrong, and the controller could maloperate.

If the user program is not of the maximum size, it is possible to minimise the time and effort in programming EPROM's by limiting the EPROM program to 8K or 16K instead of the maximum 24K. To make use of this facility, the user must state explicitly the required EPROM size (i.e. 8K or 16K), because the RAM system in the factory has to be set for the appropriate memory size BEFORE loading the program tape.

The following formula may be used to calculate the size of EPROM required:-

EPROM bytes = 2 x P locations
+ 6 x instructions + 40

EPROM bytes = 8192 for 8K
= 16384 for 16K

In the factory, the operator sets up a GEM 80 200 series subrack with a processor module carrying executive EPROM's of the type and issue exactly as specified by the user, and with a special version of the 48K RAM module (8209-4009) fitted with a DIL switch to set the usable memory size in 8K byte increments. The 4th and 5th switches (addresses 24K to 40K) must always be on; the 6th switch (40K to 48K) must be off to program 8K, on to program 16K or 24K of EPROM; the 7th switch (addresses 48K to 56K) must be off to program 16K, on to program 24K of EPROM. A standard 48K RAM module 8209-4002 is suitable for programming 24K of EPROM only.

The tape supplied by the customer is loaded into the GEM 80 controller. A microprocessor development system (Intel MDS) is connected via a 20mA serial interface to the programming port of the controller, the program extracted in hex form, and a set of up to 12 off 2716 EPROMs programmed from the MDS.

At the factory, a unique identification number (8209-xxxx) is allocated to the memory module, and a set of 12 numbers (76301-100-xxxx) allocated to the EPROM's. An Ordering Information Sheet (OIS) is completed to define these details, whether the optional battery is to be fitted, and mechanical coding if the user wishes EPROM modules to be physically non-interchangeable.

After programming each EPROM is labelled with its EPROM number on top and its CRC value on the underside. Each of the EPROM sockets on the 8209 module is labelled with the appropriate CRC value, the EPROM's are inserted, the 8209 module labelled in paint on the pcb, and a typed label inserted in the withdrawal lever at the front of the module.

Links are cut on the carrier at IC63 to correspond to the 8K blocks of memory chips (RAM & EPROM) fitted to the module. Note particularly that these links will require alteration if the quantity of EPROM is subsequently altered. The link at IC63 pin 3 has to be made if 16K of EPROM is fitted, and the link at pin 2 made if 24K of EPROM is fitted.

The battery on the processor and memory modules are temporarily isolated for transit to site. When the EPROM memory module is fitted into the controller subrack, the battery (if fitted) is re-connected into circuit, and the subrack labelled with the new 8209-xxxx module number. The user has the option of different mechanical coding for each EPROM memory module, but it is recommended that this be avoided unless the customer specifically requests the option, because of the difficulty of substituting RAM modules for program development.

5. 225E, 235E and 245E Optional Batteries

Normally a 225E/235E/245E controller is supplied with batteries on the processor and memory modules for supporting the CMOS RAM.

The battery on the processor module supports the status flags, and E and R tables. The battery on the memory module supports the user program, W table and video formats program.

If the customer specifically wishes to have no batteries, and the system has no requirement for video formats, then the EPROM user program facility provides the ability to omit the batteries.

Under these circumstances the E, R and W tables will not be retained through a power interruption, but will be cleared to zero on power up. The controller will also adopt normal run status regardless of the status at power down.

Users who wish to consider the possibility of operation without batteries should be warned that it is a characteristic of CMOS RAM that it may retain data to some extent without power. If power is interrupted for a short period (a few minutes), then it is not possible to be certain whether the E, R and W tables will be cleared or retained.

ORDERING CODES

1. CONTROLLERS

Each controller consists of four parts:

(1) Subrack and backplanes.

(2) Processor base module and personality sub-module.

(3) Power Supply.

(4) Memory module.

The order codes for these parts are given below.

The subrack and backplanes include facilities for optional additional modules as detailed in the table.

The modules themselves can be selected from 2. Optional Extras.

(1) Subrack and backplanes.

GEM 80	video processor spaces	format RAM module spaces	logging RAM module spaces	reference number
225/225E	1	0	0	8893-4251
235	1	1	5	8893-4351
235	2	1	3	8893-4352
235E	3	1	1	8893-4353
235E	4	0	0	8893-4357
245	1	0	2*	8893-4451
245	1	2	0	8893-4451
245E	2	0	0	8893-4452

GEM 80/235/235E if fast I/O subrack is required this must be selected in 2. Optional Extras.

* Memory address set for logging only if logging video ordered with subrack.

(2) Processor base module and personality sub-module

225 with battery	8896-4225
225E with battery	8896-4226
225E without battery	8896-4227
235 with battery	8896-4235
235E with battery	8896-4236
235E without battery	8896-4237
245 with battery	8896-4245
245E with battery	8896-4246
245E without battery	8896-4247

It is anticipated that there will be some demand for the "E" version without any requirement for EPROM's, because the shifted boundary between variable data tables and user program gives a larger W table, which may be needed for applications storing large quantities of plant data. To order this facility one of the following processor modules with personality sub-modules is required 225E, with battery, 235E with battery or 245E with battery depending on type of controller. Also in (4) memory module the 48K CMOS RAM module type 8209-4002 is required.

(3) Power Supply

110V AC mains input	8911-0000
110V AC mains input *	8915-0000
220V AC mains input	8913-0000
220V AC mains input *	8916-0000

* Higher power options

(4) Memory Module

GEM 80/225/235/245 and 225E/235E/245E without EPROM's

48K CMOS RAM module 8209-4002

GEM 80/225E/235E/245E with EPROM's

It is recommended that a customer wishing to do program development should order a 48K RAM module in addition to the memory module to carry EPROM's

Memory module with 16K RAM for video formats, 8K RAM for data tables, 8K or 16K or 24K EPROM containing user program, optional battery.

* 8209-xxxx

* Number allocated by GEC on receipt of order

2. OPTIONAL EXTRAS

2.1 Fast I/O

Fast I/O driver 8300-4001

Each of the controller subrack includes a space prepared for a fast I/O driver but this module should be ordered only if fast I/O modules are to be fitted.

GEM 80/235 Fast I/O subrack and backplanes.

prepared for Fast I/O modules and power supply	8893-4101
prepared for Fast I/O modules only	8870-4314

Power supply for GEM 80/235 Fast I/O subrack.

110V AC mains input	8911-0000
110V AC mains input *	8915-0000
220V AC mains input	8913-0000
220V AC mains input *	8916-0000

* Higher power options.

2.2 Video Processors

The following kits each consist of a video processor base module with a sub-module clamped to it, plus a video termination panel with a ribbon cable for connection to the subrack, and a set of 3 coaxial leads 2 metres long for connection from termination panel to video monitor.

unpaged video	8811-4004
paged video	8811-4006
logging video	8811-4008

To order a non-standard character set add one to the last digit above. The 8204 module is then omitted from the kit, and the user must order the special 8204 module as a separate item.

2.3 Additional Memory Module for Paged Video or Logging Video

64K memory module	8209-4001

2.4 Miscellaneous

4 Wire Serial link termination assembly (2 ports) (comprises panel type 8038-4002 with 2m ribbon cable to subrack)	8871-4002
2 Wire Serial link interface unit (one port)	8925-0000
Fibre optic transceiver serial link interface unit (one port)	8927-0000
Subrack mounting kit (for one subrack)	43Y-1979 Parts 01, 02 and 03
Mounting channel (for termination panels)	8959-0000

3. SPARES

Power module (110V AC)	8911-0000
Power module (220V AC)	8913-0000
Power module (110V AC)	8915-0000
Power module (220V AC)	8916-0000
Enhanced processor base-module and personality sub-module:-	
225 with battery	8896-4225
225E with battery	8896-4226
225E without battery	8896-4227
235 with battery	8896-4235
235E with battery	8896-4236
235E without battery	8896-4237
245 with battery	8896-4245
245E with battery	8896-4246
245E without battery	8896-4247
48K memory module	8209-4002
64K memory module	8209-4001
Video processor base-module with standard character set:-	
Unpaged video	8204-4001
Paged or logging	8204-4003
Video processor sub-module:-	
Unpaged video	8603-4002
Paged Video	8603-4004
Logging Video	8603-4005
Battery for enchanced processor	20T-0318
Battery for memory modules	20T-0319
External battery lead	43F0102/10

Note The Company's policy is one of continuous development and improvement and therefore the right is reserved to supply products which may differ in detail from those described and illustrated in this publication. All our products and materials are sold subject to Conditions of Sale available from us on request

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