

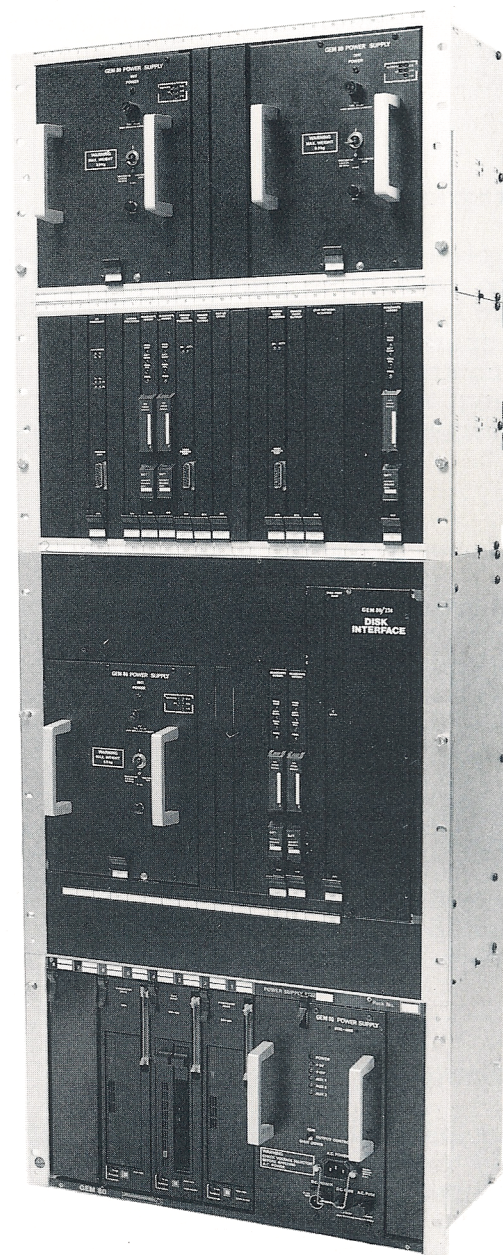
## GEM 80/734 CONTROLLER

### DESCRIPTION

The GEM 80/734 Industrial Controller combines the facility of bulk data storage on hard disk and magnetic tape with the extensive plant control features of the GEM 80/310 series Controllers.

### FEATURES

- Bulk data storage on 80 Mbyte Winchester Disks, addressed from Ladder Program
- Back-up archive on removable 150 Mbyte magnetic tape cartridges
- Up to 1 Mbyte RAM off-line data storage
- Up to 512 Kbytes extension video RAM
- Large program memory capacity (typically 37,000 instructions)
- Fast execution - 5 ms per 1000 instructions
- On-line program changes
- Remote programming facilities from serial links
- EPROM module for secure storage of user program, preset data or graphics information
- Diagnostic programmer messages in English, French, German, Italian or Spanish
- Distributed control networking via built in multi-drop serial links, or via STARNET or CORONET high speed communications modules
- Up to 32,768 I/O points with Verification plus up to 1024 x 16-bit words of Fast I/O
- Compatible with the PROGEM series SCADA (Supervisory Control And Data Acquisition) process control software.



## FACILITIES

### Bulk Data Storage

A dedicated microprocessor interface supplies the bulk data storage units with I/O control data from the Controller Central Highway, allowing the user to operate data logging techniques and to establish performance and efficiency trends. Up to six 80 Mbyte Winchester fixed disk units are used as the main storage medium. Archiving or back-up data storage on removable 150 Mbyte magnetic tape cartridges is possible, using up to two tape streamer units. Data storage and retrieval is controlled by six Special Functions included in the Ladder Program Instruction set.

### User Program

A comprehensive set of pre-written Special Function routines is provided in the Ladder Program Instruction set, including functions for: logical operations; signal processing; closed loop (PID) control; off-line data storage control; operating the 8087 floating point maths co-processor; and for bulk data storage functions.

### Serial Communications

Several inter-Controller serial links are included as standard in the GEM 80/734 and further networking facilities are available using STARNET and CORONET communications modules.

### Graphics

Extensive video plant monitoring facilities may be provided by adding IMAGEM graphic video processors.

### Plant Control

Plant equipment is controlled by an Input/Output highway providing up to 32,768 I/O points, programmed using the standard GEM 80 Ladder Language. The GEM 80/734 provides plant interface via Basic, Verification or Fast I/O modules, for digital or analog signals, pulse trains, remote I/O systems and main/standby changeover systems.

## SPECIFICATIONS

### 1. GENERAL

Memory Capacity : Up to 512K RAM program memory  
: Typically 37000 instructions + 32000 words of preset data and variable data (automatic trade off - one instruction = two data table words) for maximum memory size  
: Up to 1 Mbyte off-line data storage in RAM  
: Up to 512 Kbyte extension video RAM  
: Up to six Winchester hard disk units each providing 80 Mbytes off-line storage  
: Up to two tape streamer units for back-up storage on 150 Mbyte or 120 Mbyte tape cartridges  
: Optional transfer of program instructions, preset values, and video formats to EPROM

I/O Capacity : Up to 1024 words (16,384 points) expandable to 2048 words (32,768 points) of Verification I/O  
: 128 words of Verification I/O can be converted to 2048 points of Basic I/O  
: Up to 1024 words of Fast I/O (32 Fast I/O modules)

Communications : Up to 4 built-in serial links allowing configuration as either control, tributary or printer ports  
: Programming port  
: STARNET and CORONET modules

Execution Speed : 5 ms per 1000 Ladder Instructions

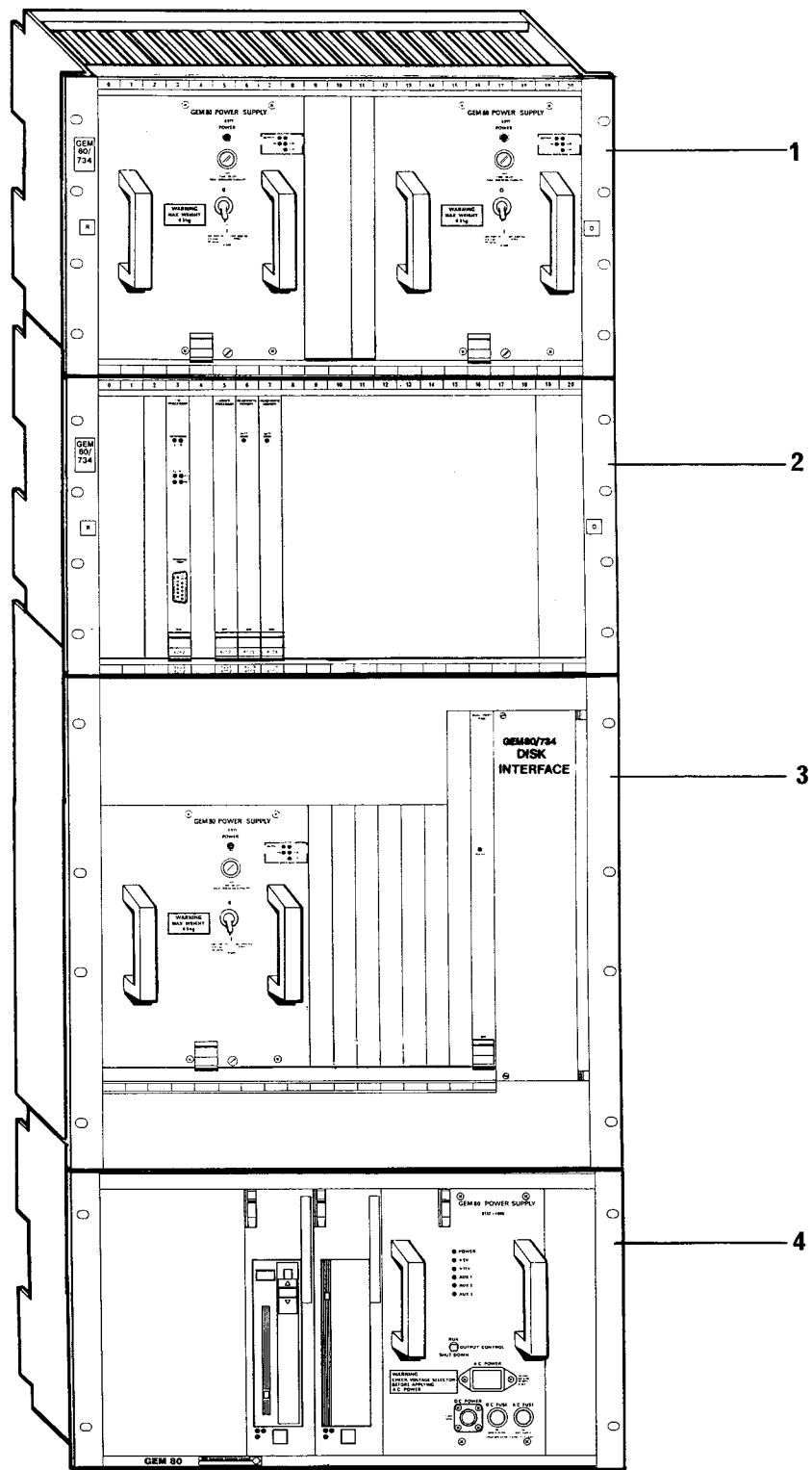
Power Input : 110 or 220/240V d.c. or a.c. 50/60 Hz, or 24/48V d.c. only

Temperature : Operational; 5 to 45°C  
: Storage; -20 to 60°C

Humidity : 20% to 80% non-condensing

Mounting : 19 inch (482mm) rack

Dimensions : See Figures 2 and 3



1. Power Supply Subrack  
 2. Central Processor Module Subrack  
 3. Disk Interface Subrack  
 4. Disk/Tape Subrack  
 Figure 1. GEM 80/734 Controller Subrack Layout

## Dimensions and Fixing Centres

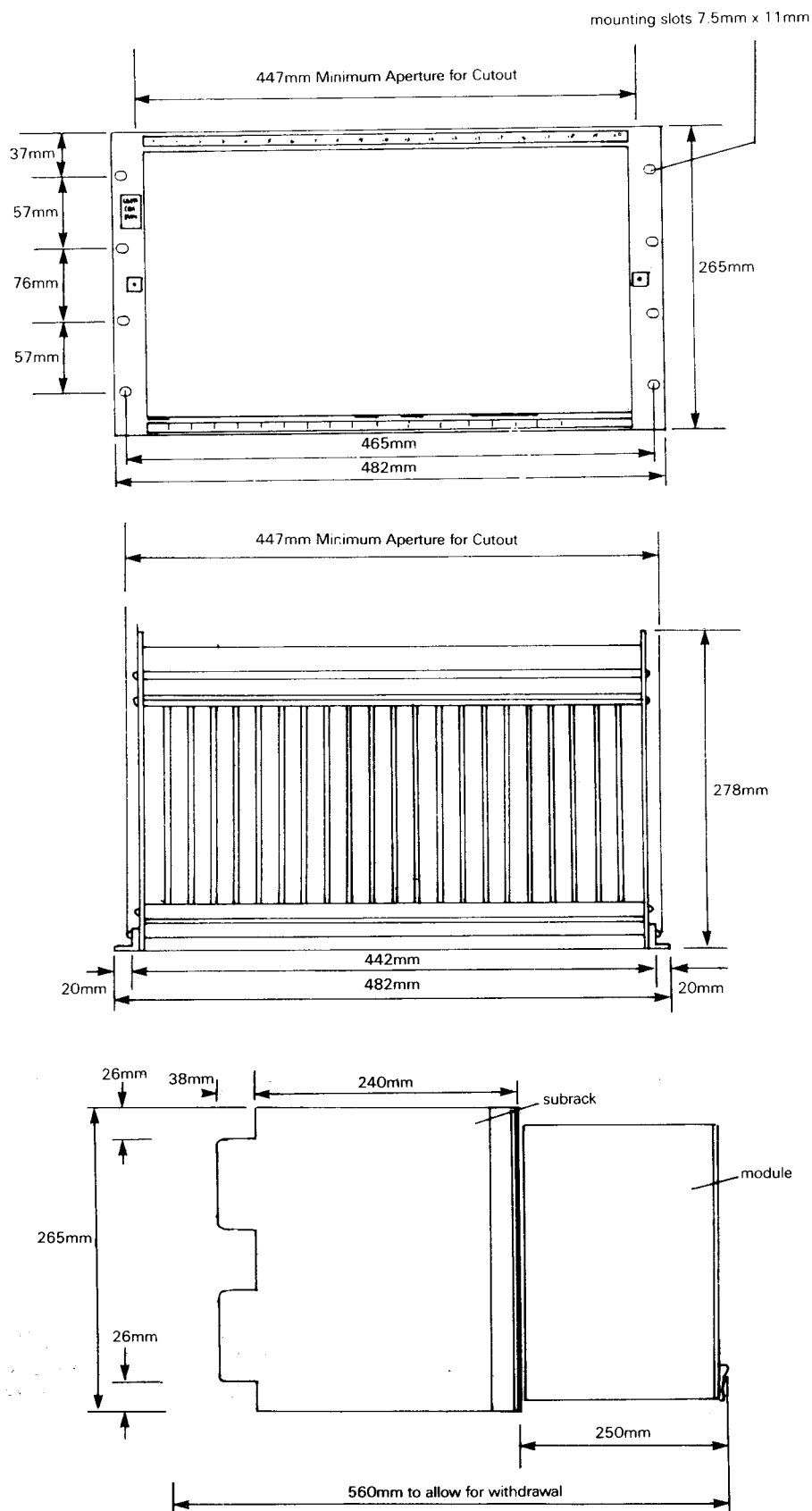


Figure 2. Compact Subrack Dimensions

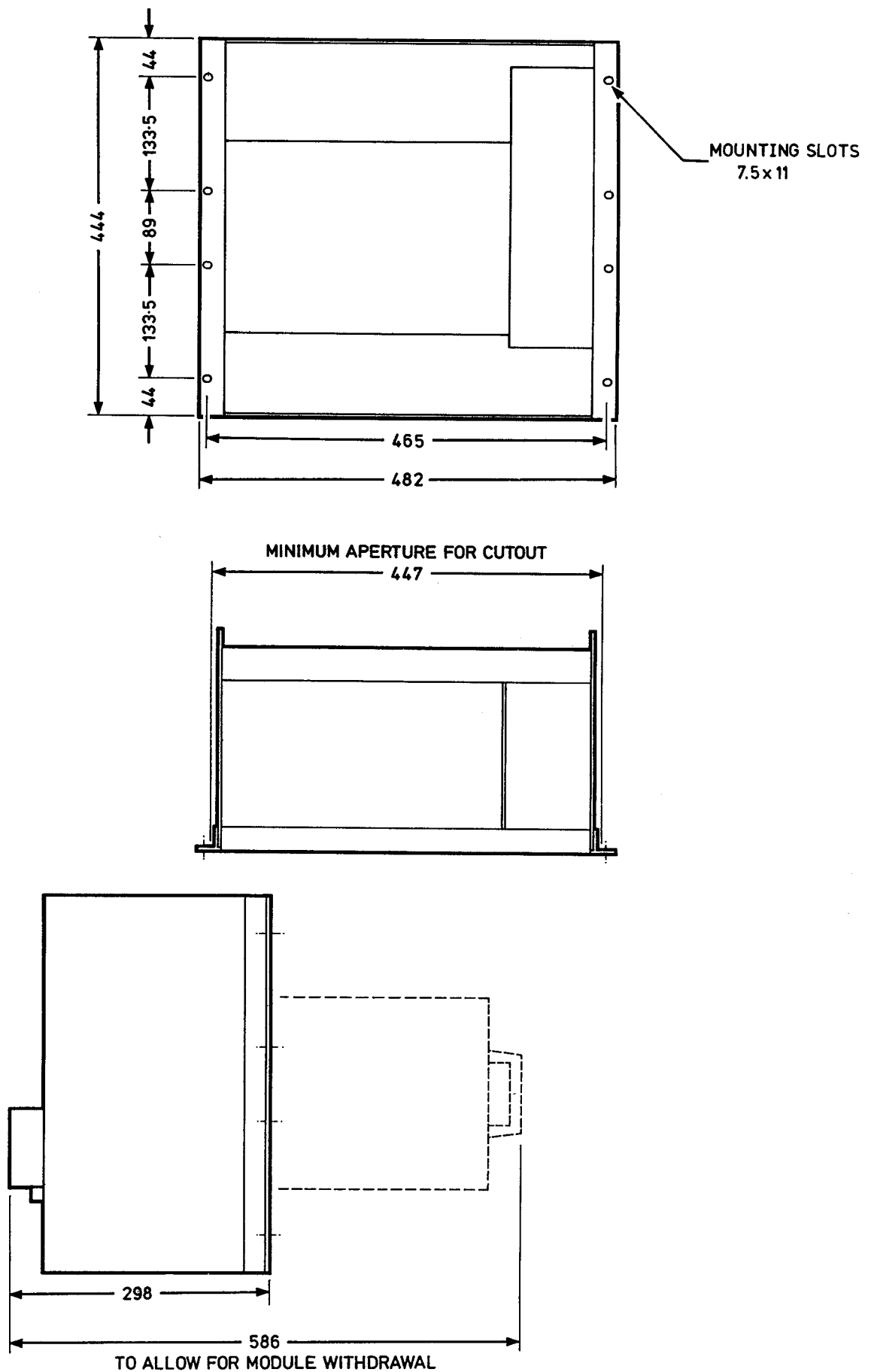


Figure 3. Disk Interface Subrack Dimensions

## 2. BULK DATA STORAGE

The Disk Interface module includes an 80186 microprocessor to control an SCSI (Small Computer Systems Interface) communications bus. The Winchester disks and tape streamer units are simply connected into the bus via a 50-way ribbon cable, daisy-chained between the front panel sockets.

A 64 Kbyte Dual Port RAM module queues commands from the ladder program to be performed by the Disk Interface. The Dual Port RAM also acts as a bidirectional buffer for data transfer.

Six Special Functions used in the ladder program operate the disk and tape units:

### DOPEN S65

Opens a path to a disk file or directory or creates the disk file or directory if it does not already exist.

### DCLOSE S66

Closes a path to a disk file or directory.

### DWRITE T66

Writes data from GEM 80 data tables or off-line RAM store into a disk file specified by a path previously opened by DOPEN.

### DREAD T65

Reads data from disk file specified by previously opened path, into GEM 80 data tables or off-line RAM locations.

### DELETE S67

Deletes disk file specified by path.

### DCOPY T67

Archives disk files, directories or complete disks onto removable 150 Mbyte tape cartridges and restores data from tape to disk.

## 3. MEMORY

The GEM 80/734 is available with three standard program memory sizes; 256K, 384K and 512K. The 256K and 384K memory versions can be easily expanded to 512K by adding extra memory modules to the slots provided in the Controller subrack.

Table 1

Memory Sizes (Standard) for Program and Table

| Memory size                                | 256K | 384K | 512K |
|--------------------------------------------|------|------|------|
| Source code + data tables                  | 64K  | 64K  | 64K  |
| Extension spaces for source codes          | —    | 64K  | 128K |
| Compiled code                              | 96K  | 160K | 224K |
| Video formats (Pages 0 and 1)              | 32K  | 32K  | 32K  |
| Reserved for inter-processor communication | 64K  | 64K  | 64K  |

## 4. USER PROGRAM

### Instruction Set

- Ladder diagram format
- Up to 10 series elements per rung
- Up to 5 parallel branches per rung
- Up to 20 branch opens + 20 branch closes per rung
- Nesting of blocks up to 16 deep
- Standard GEM 80 instruction set (see Table 2)
- Large set of pre-written software routines (Special Functions - see Table 3) for maths, control systems, manipulation of blocks of data, printer output, bulk storage communications, etc.

Table 2 - Standard Instruction Set

| Symbol | Instruction  | Remarks                                                 |
|--------|--------------|---------------------------------------------------------|
| -] [-  | N/Ocontact   | Single bit input                                        |
| -]/[-  | N/Ccontact   | 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    | Logic AND    | } Logic executed individually for all 16 bits in a word |
| OR     | Logic OR     |                                                         |
| XOR    | Exclusive OR |                                                         |
| INV    | Invert       |                                                         |
| ADD    | Addition     | } Arithmetic with limits at $\pm 32767$                 |
| SUB    | Subtraction  |                                                         |
| OUT    | Output       | 16 bit or numeric output to table                       |

**Table 3 - Pre-written Software Special Functions**

|                             |     |                              |                                |     |                              |
|-----------------------------|-----|------------------------------|--------------------------------|-----|------------------------------|
| <b>Logic Functions:</b>     |     |                              | <b>Numerical Tests:</b>        |     |                              |
| ANDGRP                      | T24 | Logical AND of two words     | COMPARE                        | T0  | Compare X and Y, output if:  |
| ORGRP                       | T25 | Logical OR of two words      | EQ                             | T1  | X equals Y;                  |
| XORGRP                      | T26 | Exclusive OR of two words    | NE                             | T2  | X not equal Y;               |
| SEQDIAG                     | T19 | Sequential monitoring        | GT                             | T3  | X greater than Y;            |
| <b>Maths Functions:</b>     |     |                              | LT                             | T4  | X less than Y;               |
| ADDARRAY                    | T12 | Array addition               | GE                             | T5  | X greater than or equal Y;   |
| SUBARRAY                    | T13 | Array Subtraction            | LE                             | T6  | X less than or equal Y.      |
| MULT                        | T10 | Value multiplication         | MAXARRAY                       | S13 | Maximum value in array       |
| MULARAY                     | T14 | Array multiplication         | MINARRAY                       | S14 | Minimum value in array       |
| DIV                         | T11 | Value division               | MAX                            | T7  | Maximum of two inputs        |
| DIVARRAY                    | T15 | Array division               | MIN                            | T8  | Minimum of two inputs        |
| LINCON                      | S11 | Linear equation calculation  | CMPARRAY                       | T16 | Compare arrays               |
| CONARRAY                    | S10 | Linear conversion of array   | DEARRAY                        | S15 | Multiple delay array         |
| SQRT                        | S12 | Square Root                  | SORT                           | S16 | Data array numerical sort    |
| CHKSUM                      | T9  | Table checksum calculation   | <b>Numerical Manipulation:</b> |     |                              |
| STDDEV                      | T18 | Mean and Standard Deviation  | NEGATE                         | S5  | Change sign of number        |
| SIN                         | S70 | Sine                         | ABS                            | S6  | Absolute value of input      |
| COSINE                      | S71 | Cosine                       | NONZERO                        | S7  | Output if input is non-zero  |
| TANGENT                     | S72 | Tangent                      | FPOINT                         | S76 | Floating point to integer    |
| ASIN                        | S80 | Inverse sine                 | FPFLAGS                        | S78 | Floating point maths error   |
| ACOS                        | S81 | Inverse cosine               | FIX                            | S79 | F.P. to multiple integer     |
| ARCTAN                      | S82 | Inverse tangent              | <b>Data Moving:</b>            |     |                              |
| DEGRAD                      | S75 | Degree to radian conversion  | LOCATE                         | S20 | Locate data table address    |
| RADDEG                      | S85 | Radian to degree conversion  | MOVE                           | T20 | Move data between addresses  |
| LOG10                       | S73 | Logarithm to the base 10     | STORE                          | T30 | First in first out store     |
| LOGE                        | S74 | Natural logarithm            | GETWORD                        | S19 | Indirect data access         |
| PI                          | S77 | Pi                           | FILL                           | T17 | Array set up                 |
| EXP                         | S84 | 'e' raised to power          | PUTWORD                        | T29 | Indirect output              |
| POWER                       | T70 | Value raised to power        | COLLATE                        | T37 | Store bits consecutively     |
| FSCALE                      | T73 | Floating point scale         | <b>Code Conversion:</b>        |     |                              |
| <b>Signal Processing:</b>   |     |                              | BCDIN                          | S1  | Convert B.C.D to binary      |
| DBOUNCE                     | S0  | Signal transient filter      | BCDOUT                         | S2  | Convert binary to B.C.D      |
| FGEN                        | S30 | Function generator           | GRAYBIN                        | S9  | Convert gray code to binary  |
| DEDBAND                     | S31 | Unity gain with dead band    | <b>Serial Port Control:</b>    |     |                              |
| LIMIT                       | S32 | High and low limit           | PRITEXT                        | S38 | Output text to serial port   |
| RAMP                        | S33 | Ramp signal (rate dependent) | PRINT                          | T38 | Output user defined message  |
| RAMPGEN                     | S61 | Ramp signal (time dependent) | CHARIN                         | T39 | Store text from serial port  |
| ANALAG                      | S37 | 1st order time constant lag  | GETTEXT                        | S21 | Store message strings        |
| TCONST                      | S60 | Programmable time constant   | <b>Off-Line Data:</b>          |     |                              |
| <b>Closed Loop Control:</b> |     |                              | CLEAR                          | S29 | Reset off-line data          |
| PIDABS                      | S34 | PID loop absolute output     | PUT                            | T31 | Store data off-line          |
| PIDINC                      | S35 | PID loop incremental output  | GET                            | T32 | Retrieve off-line data       |
| INCOUT                      | S36 | Incremental output           | <b>STARNET Functions:</b>      |     |                              |
| PIDCON                      | T60 | PID control with mode select | CONFIG                         | T33 | Configure STARNET            |
| PIDSIM                      | T61 | Programmable PID control     | SEND                           | T34 | Transmit data on STARNET     |
| <b>Binary Tests:</b>        |     |                              | RECEIVE                        | T35 | Receive incoming data        |
| HISTATE                     | S3  | Highest bit number set to 1  | STATS                          | T36 | Flag STARNET errors          |
| BITSON                      | S26 | Total number of bits set     | <b>Bulk Storage Functions:</b> |     |                              |
| CMPGRP                      | T21 | 1st difference between words | DOPEN                          | S65 | Open/create file/directory   |
| GETBIT                      | T22 | Test individual bits of word | DCLOSE                         | S66 | Close disk file or directory |
| <b>Binary Manipulation:</b> |     |                              | DREAD                          | T65 | Read data from disk file     |
| SWAP                        | S4  | Swap 1/2 locations           | DWRITE                         | T66 | Write data to disk file      |
| INVGRP                      | S25 | Invert each bit of word      | DELETE                         | S67 | Delete disk file/directory   |
| SHIFT                       | S27 | Left and right word shift    | DCOPY                          | T67 | Copy disk to tape or restore |
| ROTATE                      | S28 | Left and right word rotation |                                |     |                              |
| PUTBIT                      | T23 | Set and reset bits of word   |                                |     |                              |
| QSHIFT                      | T27 | Shift bits left or right     |                                |     |                              |
| QROTATE                     | T28 | Rotate bits left or right    |                                |     |                              |

## 5. DATA TABLES

The data tables consist of 16-bit binary words stored in the GEM 80 memory.

The contents of each data table address can be interpreted as :

- (a) 16 individual bits, each of value 1 or 0;
- (b) an equivalent decimal integer;
- (c) an equivalent hexadecimal (base 16) integer;
- (d) a floating point number.

Decimal - 2's complement notation is used, giving a range of integers  $\pm 32,767$ .

Hexadecimal - permits a range of values from 0000 to FFFF.

Floating Point - holds each number in two consecutive 16-bit Q data tables as; a sign-bit, an 8-bit biased exponent; and a 23-bit significand.

Table 4 gives details of the data tables and their use.

**Table 4 - Data Table Sizes**

| Data Table         | Content                                                | Size (No. of 16-bit Words)                                                                                         |
|--------------------|--------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| A and B            | Basic/Verification Input/Output                        | Up to 1024 (with one I/O Processor) or up to 2048 (with two I/O Processors)                                        |
| C and D            | Fast I/O                                               | Up to 1024                                                                                                         |
| E                  | Overflow flags, timing information and real time clock | 9                                                                                                                  |
| F                  | Fault Codes, error reporting.                          | 350                                                                                                                |
| G,H,N,O,R, U and W | General work space                                     | The size is determined by the number of words being used in the other data tables, out of a total of 32,000 words. |
| I                  | User programmable serial links                         | Up to 18 (with one I/O Processor) or up to 36 (with two I/O Processors)                                            |
| J,K                | Serial communications                                  | Up to 512 (with one I/O Processor) or up to 1024 (with two I/O Processors)                                         |
| L                  | Video format control data                              | 32 +                                                                                                               |
| M                  | Maintainer codes for user programmed tests             | 0 +                                                                                                                |
| P                  | Configuration and preset data                          | 150 +                                                                                                              |
| Q                  | Floating Point maths workspace                         | 0 +                                                                                                                |
| S                  | RAM/EPROM control                                      | 1                                                                                                                  |

## ORDERING CODES

### GEM 80/734 Series Processor Subracks

| Model  | Sub-rack Qty | Modules included as standard: |     |               |                  |               |               |                 |                   | Slots provided for:      |                          | Ordering Code |
|--------|--------------|-------------------------------|-----|---------------|------------------|---------------|---------------|-----------------|-------------------|--------------------------|--------------------------|---------------|
|        |              | Power module                  |     | I/O Proc 8213 | Ladder Proc 8211 | 256K RAM 8222 | 128K RAM 8222 | D/Port RAM 8221 | Storage Proc 8898 | Optional Central modules | Optional Fast I/O driver |               |
|        |              | Type                          | Qty |               |                  |               |               |                 |                   |                          |                          |               |
| (256K) | 3            | 110/220 ac/dc                 | 3   | 1             | 1                | 1             | 0             | 1               | 1                 | 17                       | 1                        | 8864-4341     |
| (256K) | 3            | 24/48V dc                     | 3   | 1             | 1                | 1             | 0             | 1               | 1                 | 17                       | 1                        | 8864-4342     |
| (384K) | 3            | 110/220Vac/dc                 | 3   | 1             | 1                | 1             | 1             | 1               | 1                 | 16                       | 1                        | 8864-4343     |
| (384K) | 3            | 24/48V dc                     | 3   | 1             | 1                | 1             | 1             | 1               | 1                 | 16                       | 1                        | 8864-4344     |
| (512K) | 3            | 110/220Vac/dc                 | 3   | 1             | 1                | 2             | 0             | 1               | 1                 | 16                       | 1                        | 8864-4345     |
| (512K) | 3            | 24/48V dc                     | 3   | 1             | 1                | 2             | 0             | 1               | 1                 | 16                       | 1                        | 8864-4346     |

Note: All the above processor subracks have bulk storage capability - the minimum system includes a single 80 Mbyte Winchester disk unit (The disk unit and subrack must be ordered separately). Up to 5 more disk units and two tape units may also be added. Advice about the number of power supplies and subracks required for additional bulk storage equipment can be obtained from GEC Industrial Controls Customer Services Dept.

### I/O Subracks

| Subrack                                                                          | Ordering Code |
|----------------------------------------------------------------------------------|---------------|
| 12 slots for Verification, numeric and Basic I/O                                 | 8859-4003     |
| 8 slots for Verification, numeric and Basic I/O with provision for 9032-4001 PSU | 8857-4006     |

### Fast I/O Subracks

| Subrack | Power Modules |      | Ordering Code |
|---------|---------------|------|---------------|
|         | Type          | Qty. |               |
| 12-slot | 110/200 ac/dc | 1    | 8870-4105     |
| 12-slot | 24/48V dc     | 1    | 8870-4104     |

## SPARES

Power module for processor and Fast I/O subracks:

For 110/220V a.c. or d.c. input

8917-4003

For 24/48V d.c. input

8918-4003

Power module for I/O subracks:

For 110/220V a.c.(isolated) or 24-60V d.c.(non-isolated)

9032-4001

Ladder Processor module

8211-473\*

Master I/O Processor module

8213-473\*

Dual Port RAM module

8221-4730

80 Mbyte Winchester disk unit

9269-4001

Streamer Tape unit

9269-4101

Disk Interface processor (Intel SBC 186/03A with GEC firmware)

8898-4040

10A power fuse for 8917 power supply

82030/111

20A power fuse for 8918 power supply

82022/287

Battery for memory module

20T0319/01

\*The final digit in the ordering codes of the Ladder Processor and the I/O Processor must be the same as that originally supplied.

## OPTIONAL EXTRAS

### Central Modules:

Second (Slave) I/O Processor  
IMAGEM graphic video processor  
IMAGEM graphic video output module  
CORONET module  
STARNET module  
256K RAM module (without EPROM sub-module)  
128K RAM module (without EPROM sub-module)  
256K EPROM sub-module

### Ordering Code

8800-4028  
8219-4003  
8216-4003  
8193-4001  
8218-4003  
8222-4001  
8222-4012  
9210-4001

Note: Additional wire-wrap links may be necessary when adding any of the above modules to an existing processor subrack.

### Serial Communications accessories:

20mA serial termination unit  
RS485 serial link termination panel  
20mA serial link to optical fibre interface unit  
Mounting channel (for termination units and panels)  
RS232 serial termination unit (isolated)  
2 way ribbon cable for 8587/8924/9009  
Harness to connect 8924 to 8927:  
Part 1  
Part 2

8924-0000  
8587-4001  
8927-0000  
8959-0000  
9009-4001  
8891-4077  
  
8891-4079  
8891-4083

### **ADDITIONAL INFORMATION**

Further information and help on GEM 80 products  
or applications can be obtained from;

Your local GEM 80 representative,

or GEM 80 Customer Services Dept.  
Tel. 0782 783511. Ext. 2651 or 2574.



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