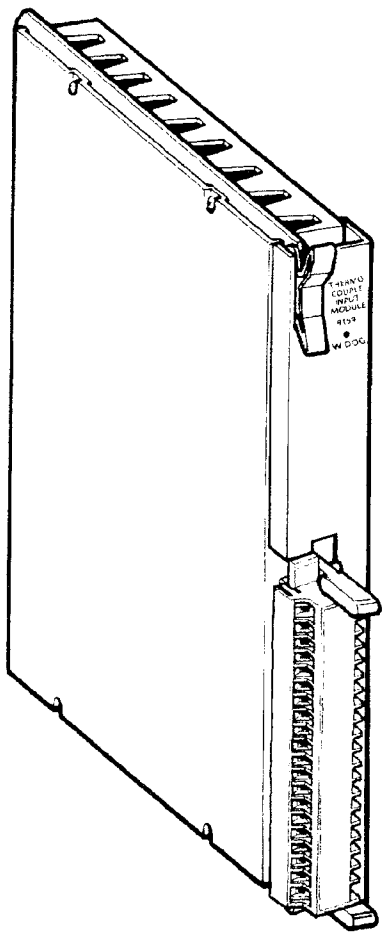
CEGELEC
INDUSTRIAL CONTROLS

Thermocouple Input Module 8159



GEM 80 *USER INFORMATION*

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1. INTRODUCTION

The 8159 Thermocouple Input module provides a direct link between a thermocouple temperature sensor and the GEM 80 controller. It is one of a range of modules that are used in conjunction with GEM 80 controllers that have Verification I/O capability.

Eight input channels are available, each one being user programmable to cater for any one of seven different types of thermocouple.

The module is self calibrating and auto ranging.

2. SPECIFICATION

POWER REQUIREMENTS

From GEM 80	:	+15V @ 40mA
	:	+5V @ 360mA
From Plantside Supply	:	+/- 15V @ 265mA

Note:

Modules later than Issue C do not have the facility to take a supply from the backplane.

INPUTS

Type	:	8 differential floating inputs.
Thermocouple Types	:	7 types acceptable - B, E, J, K, R, S and T

Accuracy :

Thermocouple Type	Temperature Range°C	% FSD
B	+ 50 to + 100	2.0
	+100 to +1820	1.0
E	-270 to - 230	0.5
	-230 to +1000	0.1
J	+25	0.1
	+60	0.2
K	-270 to - 250	0.7
	-250 to - 210	0.3
	-210 to +1372	0.1
R and S	- 50 to + 70	0.3
	+ 70 to +1767	0.2
T	-270 to - 250	1.3
	-250 to - 80	0.5
	- 80 to + 400	0.1

Millivolt Range	:	+/-100mV
Step Response Time	:	20ms 10% to 90%
	:	20ms 90% to 10%
Resolution	:	Better than 1 in 1536
Stability	:	Self calibrating
Linearity	:	0.024% of full scale
Input Impedance	:	50k ohm to 0V
	:	100k ohm between inputs
Isolation	:	1500V between analog signals and GEM 80
Input Protection	:	100V a.c./d.c. differential

MECHANICAL

Temperature	:	0°C to 60°C operating
	:	-25°C to 70°C storage
Humidity	:	10% to 90% non-condensing
Fire Resistance	:	UL94 Class V0
Standards	:	IEC584
	:	BS4937
	:	DIN43710
Weight	:	0.5kg approximately
Dimensions	:	Standard single width module
Mechanical Interlocks	:	10, 18 and 31

3. HARDWARE LAYOUT

Figure 3.1 shows the relative position of the module within a system.

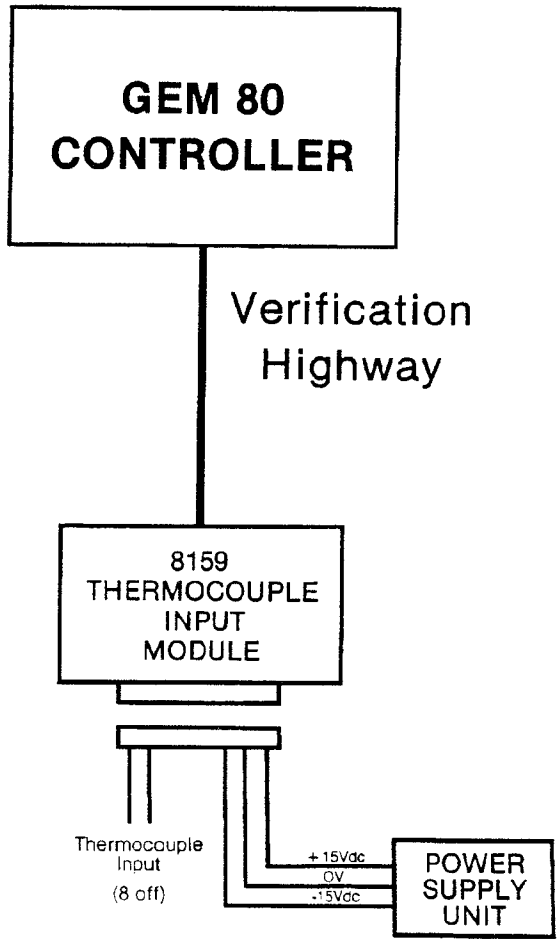


Figure 3.1 Relative Position of Module Within System

4. OPERATION

4.1 Introduction

The 8159 module accepts either thermocouple or millivolt inputs which are processed, converted to temperature and made available to the host controller as a 16-bit word. This word represents either millivolts or temperature in °C, °F, or K.

As the thermocouple output voltage is small and non-linear it is amplified by the module before being linearised by an on-board processor. The processor also converts the signal to a 16-bit digital representation of the junction temperature for the controller to process.

Alternatively, the amplified voltage may be presented to the controller directly to give the junction output in millivolts.

A separate -15V/0V/+15V power supply unit is required to power the unit. Full connection details are given in 7. Connections.

4.2 Inputs

Each of the eight input channels accept inputs within the range -100 to +100 millivolts or from any of the seven types of thermocouples listed in Table 4.1.

Table 4.1 Suitable Thermocouples

Type	Range °C	Range °F
B	150 to 1820	302 to 3308
E	-270 to 1000	-454 to 1832
J	-210 to 1200	-346 to 2192
K	-270 to 1372	-454 to 2502
R	-40 to 1767	-40 to 3213
S	-40 to 1767	-40 to 3213
T	-270 to 400	-454 to 752

To ensure accurate temperature measurement at the thermocouple junction, the voltage generated at the module must be allowed for. This is facilitated by a temperature sensing device that is mounted on the module, allowing the voltage generated by the junctions to be calculated and compensated for.

If the thermocouple is terminated at a point that is at a different temperature to the module, the temperature at this point must be known to allow compensation for the junctions formed. To enable this, input channels may also be used as compensating inputs to measure the temperature at the remote termination point.

4.3 Addressing

The Thermocouple Input module occupies eight Verification I/O addresses. The maximum number of Verification I/O addresses is 4096 (0 to 4095) which is 2^{12}. Therefore, to allow the module to be allocated any required address within the range of 0 to 4095, subject to the capacity of the host controller, twelve address switches are required.

The twelve switches are located at the bottom rear corner of the module and are accessible without removing the protective cover. The twelve switches are in a group of eight, bits 0-7, and a group of four, bits 8-11. When a switch is in the "ON" position, that bit is a logical "1". Figure 4.1 shows the layout of the address switches.

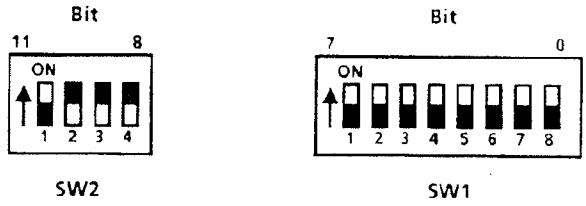


Figure 4.1 Address Switches

In Figure 4.1, the address switches for bits 8 (256), 9 (512), and 10 (1024) are set to the logical '1' position, giving a module address of 1792 (256+512+1024).

The module address corresponds to the address of the first channel. The subsequent seven addresses are then assigned automatically to the remaining seven channels of the module. Any available address may be used by the module but care must be taken to ensure that when the seven addresses are automatically assigned, they do not overlap any other previously allocated address.

It must be remembered that the base address of the module must be at least eight addresses less than the maximum I/O address of the host controller. If this rule is not observed it will result in the loss of one or more of the top channels of the module. For example, if the maximum I/O address of the host controller is 256 and the module is given an address of 251 only six addresses are available. This results in a loss of channels 7 and 8 of the module.

Any channels that are unused on the module will still occupy one word of I/O and parameter data.

4.4 Programming

The module is configured by means of eight P-Tables. Each channel can be individually configured to give the data in millivolts, °C, °F, or K. Each channel requires to have set:-

1) Type of Input
2) Data Format
3) Location of Cold Junction Compensation

This data is presented in one P-Table (16 bits) per channel in the following form:

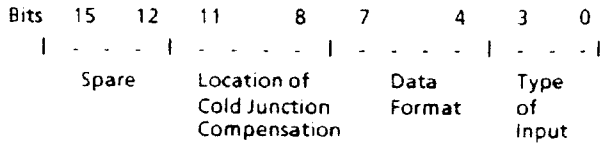


Table 4.2 Location of Cold Junction Compensation

Decimal Value	Compensation Location	Bit Pattern 11	10	9	8
0	On-board	0	0	0	0
1	Channel 1	0	0	0	1
2	Channel 2	0	0	1	0
3	Channel 3	0	0	1	1
4	Channel 4	0	1	0	0
5	Channel 5	0	1	0	1
6	Channel 6	0	1	1	0
7	Channel 7	0	1	1	1
8	Channel 8	1	0	0	0

Table 4.3 Data Format

Decimal Value	Output Units	Bit Pattern 7	6	5	4
0	Millivolts x 100	0	0	0	0
1	°Celsius x 10	0	0	0	1
2	°Fahrenheit x 10	0	0	1	0
3	Kelvin x 10	0	0	1	1

Table 4.4 Type of Input

Decimal Value	Input Thermocouple	Bit Pattern 3	2	1	0
0	Not used	0	0	0	0
1	J type	0	0	0	1
2	E type	0	0	1	0
3	B type	0	0	1	1
4	S type	0	1	0	0
5	T type	0	1	0	1
6	R type	0	1	1	0
7	K type	0	1	1	1
8	+/- 100mV	1	0	0	0

Note:

Types 1 to 7 are temperature compensated and linearised inputs. If no compensation or linearisation is required then type 8 input should be used. For a system with the following requirements the necessary P-Table configuration is shown as an example.

Requirement:	Channel	Type	Format	Compensation
	1	T	°C	Remote
	2	T	K	Remote
	3	T	°C	Remote
	4	T	°C	For channels 1,2, and 3
	5	B	°F	Local
	6	S	°F	Local
	7	E	mV	Local
	8	E	°C	Local

P-Table Configuration: P53 300

P300	0000 0100 0001 0101
P301	0000 0100 0011 0101
P302	0000 0100 0001 0101
P303	0000 0000 0001 0101
P304	0000 0000 0010 0011
P305	0000 0000 0010 0100
P306	0000 0000 0000 0010
P307	0000 0000 0001 0010

In the example, bit 10 is set at locations P300 (Ch.1), P301 (Ch.2), and P302 (Ch.3). This tells the controller that compensation is supplied by channel 4 thermocouple. At location P303, the P-Table associated with channel 4, bit 10 is not set, indicating that compensation for channel 4 input is by the modules on-board temperature sensor.

Note:-

1) P53 is written to by the user and holds the address of the start of the parameter tables.

2) If mV inputs are chosen then only the lower four bits are used.

4.5 Fault Tables

Two bits are available in the F-Tables, a warning bit and a fault bit.

The warning bit is set when the module has been set up incorrectly or the input is over/under range. Over/under range data values are limited to +/- full scale for a given input type.

The fault bit is set when the module has failed or there has been a verification highway error.

The location of the two bits within the F-Tables will depend on the address allocated to the particular module. However, they will always be in a block of sixteen bits, the fault bits being the odd numbered bits and the warning bits being the even numbered bits. Depending on the addresses allocated to the module, the block of sixteen bits may be split between two F-Table locations.

Table 4.5 Fault Locations

Fault Table	Address	Fault Table	Address	Fault Table	Address	Fault Table	Address
F45	0-7	F53	64-71	F61	128-135	F69	192-199
F46	8-15	F54	72-79	F62	136-143	F70	200-207
F47	16-23	F55	80-87	F63	144-151	F71	208-215
F48	24-31	F56	88-95	F64	152-159	F72	216-223
F49	32-39	F57	96-103	F65	160-167	F73	224-231
F50	40-47	F58	104-111	F66	168-175	F74	232-239
F51	48-55	F59	112-119	F67	176-183	F75	240-247
F52	56-63	F60	120-127	F68	184-191	F76	248-255

Any fault table with its associated block of 8 I/O addresses can be calculated from the formula :

$$Fn = (n : 8) + 45$$

where n is the I/O address.

e.g. To find the fault table associated with A231.

$$\begin{aligned} F231 &= (231 : 8) + 45 \\ &= 28 + 45 \\ &= F73 \end{aligned}$$

The remainder from the integer division is used to identify the low order bit of the pair associated with the I/O address in the fault table.

$$231 : 8 = 28 \text{ rem } 7$$

The low order bit is obtained by multiplying the 7 by 2

$$7 \times 2 = 14$$

Hence F73 bits 14 and 15 correspond to A231

5. APPLICATION NOTES

Figures 5.1 and 5.2 show examples of typical ladder diagram.

Figure 5.1 takes four readings from inputs A0 to A3 in the same units and outputs the lowest temperature to B8. The sensor giving the lowest reading is identified in G1.

Figure 5.2 turns on output B10.0 while the temperature is less than 160° and then uses output B10.1 to maintain the temperature between 170° and 175°. If the temperature rises above 200°, B10.2 is turned on until the temperature falls below 190°.

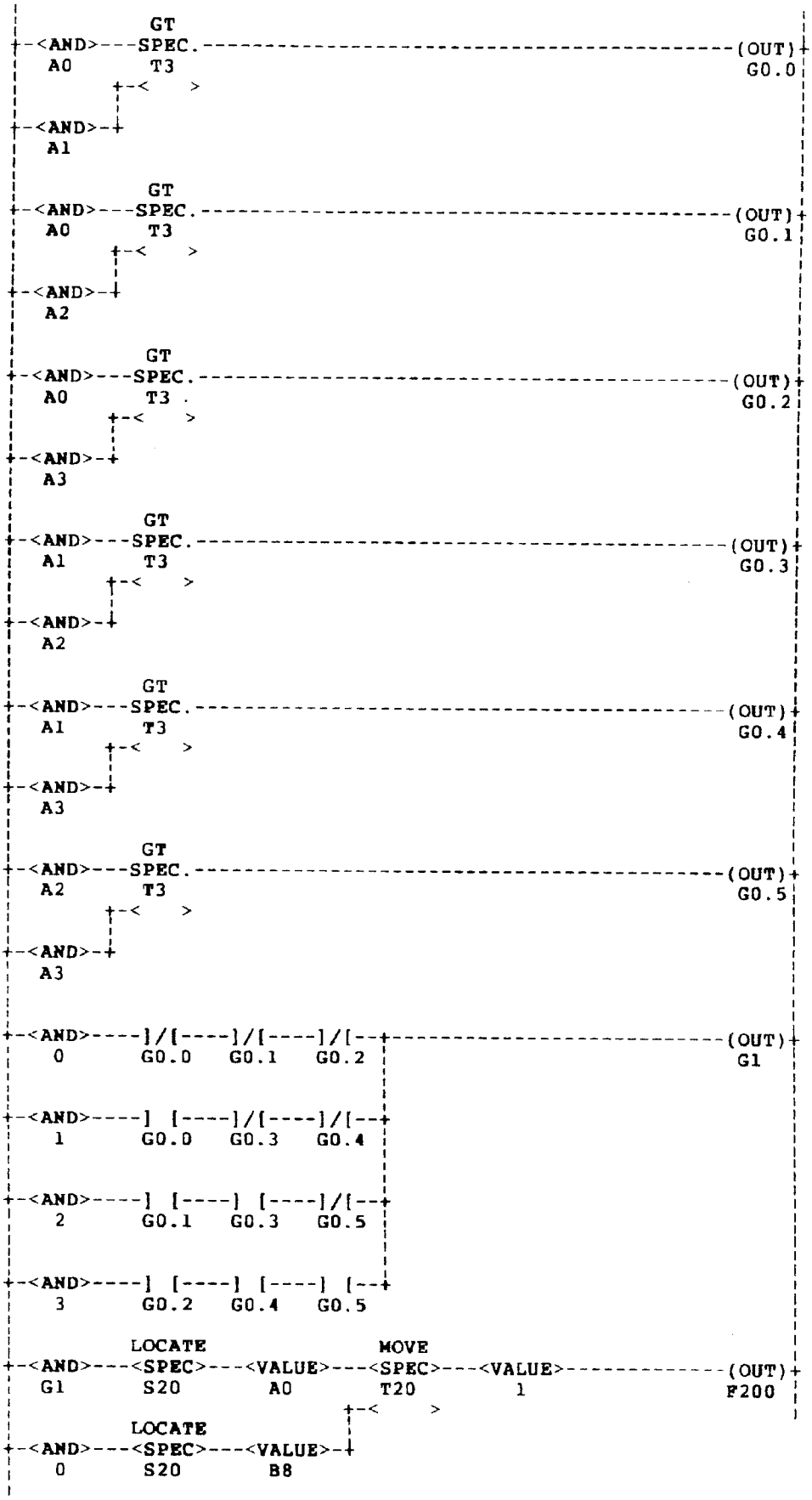
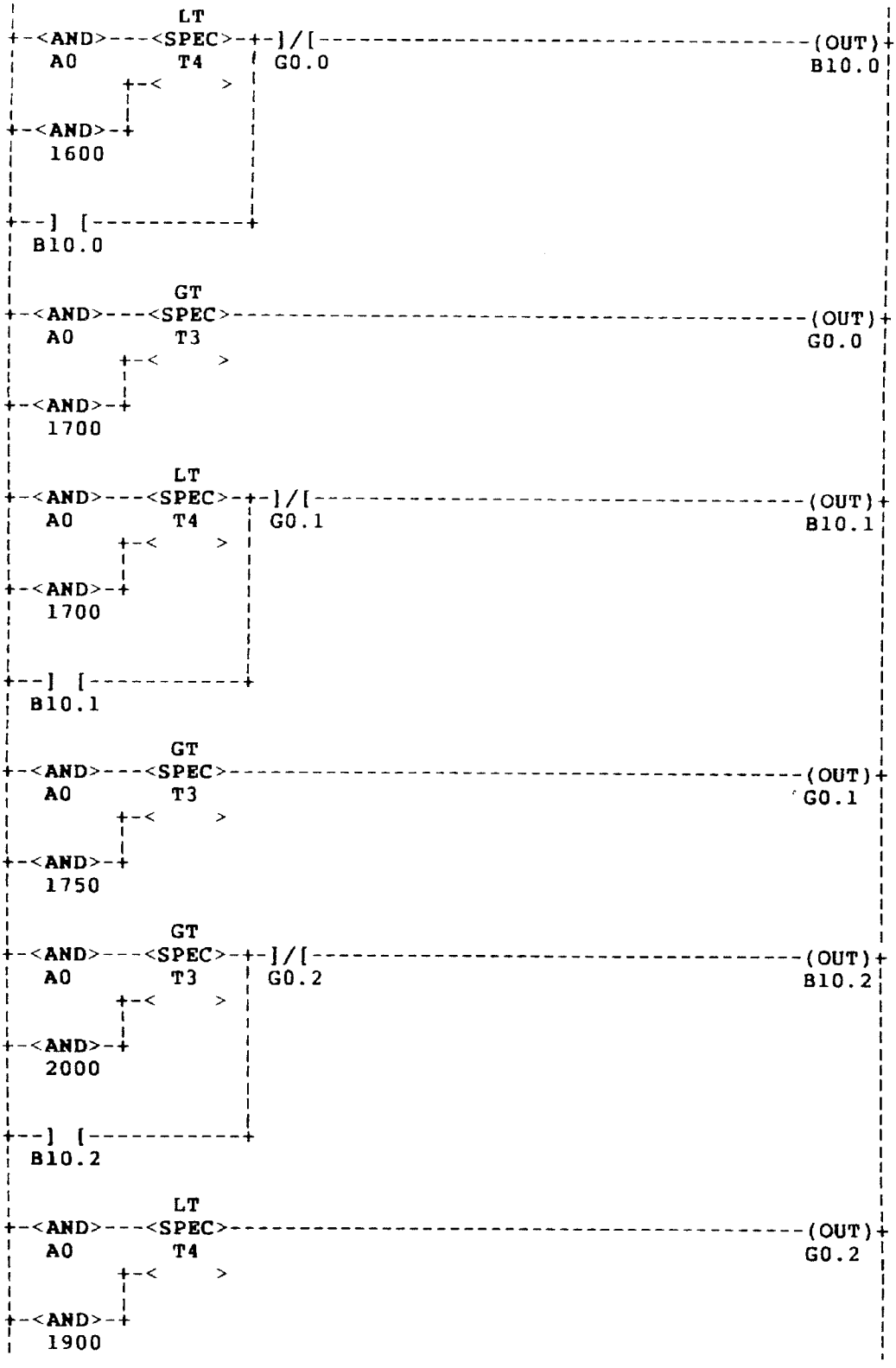


Figure 5.1 Ladder Diagram - Example 1



B10.0 Heater 1
B10.1 Heater 2
B10.2 Cooling Fan

Figure 5.2 Ladder Diagram - Example 2

6. INSTALLATION

Each subrack backplane edge connector is fitted with plastic coding keys (called Mechanical Interlocks) in positions 10, 12, 18 and 31. The key fitted in position 31 is used as a guide to accurately locate the module's edge connector and must not be removed.

This module is constructed to accept the coding keys in slots 10, 18, and 31 only, therefore the coding key in position 12 must be removed. This identifies the slot as being allocated to a Verification input module.

The voltage generated by a thermocouple is proportional to the temperature difference between the two ends of the thermocouple. To accurately measure the temperature at one end of the thermocouple it is necessary to know the temperature at the other end.

If on-board compensation is to be used, the thermocouple must be connected to the module directly using the same material as the thermocouple is made of.

If the distance from the module makes this method of connection impractical, remote junction compensation can be used. In this configuration, the thermocouples are terminated at a remote point and the connections to the module are made using ordinary copper wire. The temperature at the remote termination point must be known so an additional thermocouple needs to be connected and kept at the same temperature as the remote termination. This remote compensating thermocouple must be connected directly to the module using the thermocouple material. If screened cables are used, the screens must be terminated at the module 0V terminals (19 and 20) only.

7. CONNECTIONS

The cabling from the plant mounted thermocouples is terminated in a flying socket (supplied with the module) that connects to a plug on the front of the module and is held by retaining clips. The socket has screw terminals and will accommodate cores of up to 2.5 mm^2.

A separate -15V/0V/+15V power supply, sized to take into account the number of Thermocouple Input Modules fitted, is required and is connected via the plant-side connector on the front of the module.

Socket terminal allocation is as follows:

Pin no.	Thermocouple
1	1 +ve
2	1 -ve
3	2 +ve
4	2 -ve
5	3 +ve
6	3 -ve
7	4 +ve
8	4 -ve
9	5 +ve
10	5 -ve
11	6 +ve
12	6 -ve
13	7 +ve
14	7 -ve
15	8 +ve
16	8 -ve
17	+15V
18	-15V
19	0V
20	0V

Figure 7.1 shows a typical installation. It is based on the example quoted in 4.4 Programming.

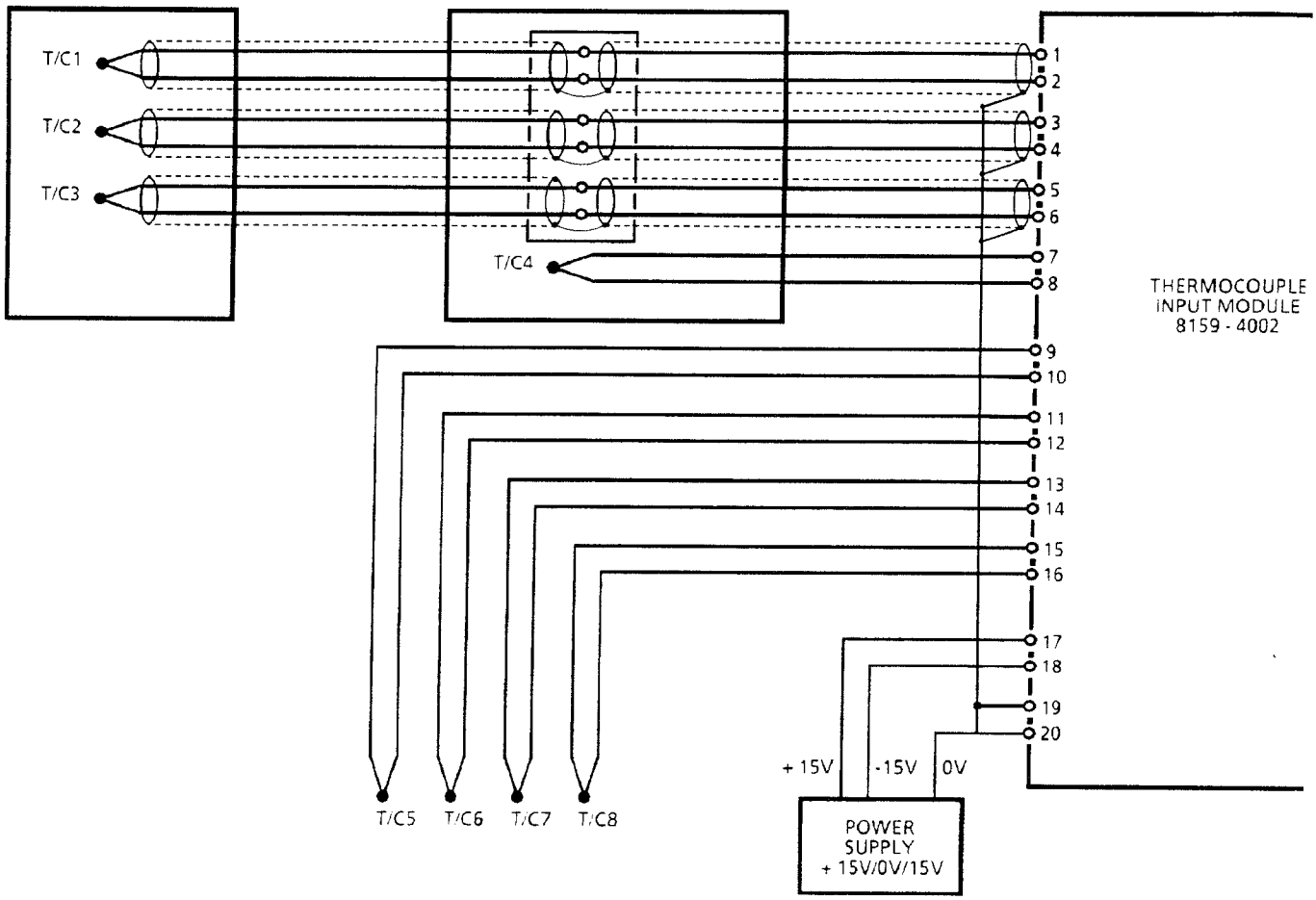


Figure 7.1 Connections for a Typical Installation

8. ORDERING CODES

Thermocouple Input Module	8159-4004

9. ADDITIONAL INFORMATION

If you require any further information, or wish to discuss an application in detail, do not hesitate to contact the GEM 80 Customer Support Unit at;

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