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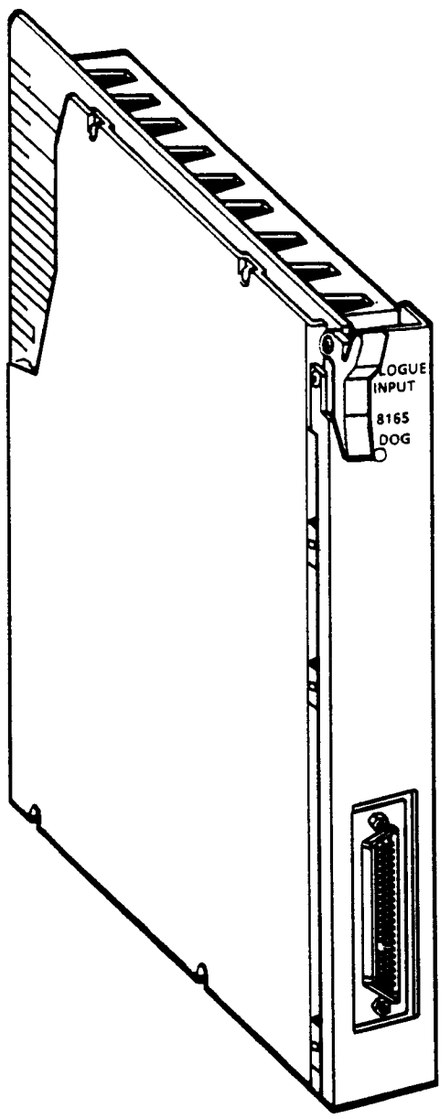
INDUSTRIAL CONTROLS

16-CHANNEL ANALOG INPUT MODULE 8165



GEM 80 USER INFORMATION

8165 16-Channel Analog Input Module

T1476 Issue 1 05/90

Please incorporate the following amendments:-

Figure 6.4

Against pins 1 and 34 on the 8165 Module

delete 'CHANNEL 0 CURRENT INPUT'

insert 'CHANNEL 0 VOLTAGE INPUT'

Please retain this Errata Sheet with the document for reference.

CONTENTS PAGE

LIST OF TABLES

LIST OF ILLUSTRATIONS

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1. DESCRIPTION

The 8165 is a 16 channnel Analog Input Module and is one of the GEM 80 range of Verification I/O modules. These modules must be housed in a subrack that provides connection to a Verification I/O Highway.

The Verification I/O Highway provides the User with secure data transfer between the 8165 module and the GEM 80 Controller.

The Module can convert 16 analog signals from the plant to digital values which are then read by the GEM 80 Controller at each I/O scan.

The Module can be operated in both voltage and current modes. Each input can be configured to measure either a single ended voltage or current. Alternatively inputs can be configured in pairs for differential voltage measurement.

A 3 metre Cable Harness may be ordered for use with the module to simplify connection to plant inputs and plantside power supplies.

2. SPECIFICATION

Number of inputs	16 single-ended or 8 differential pairs*

* Differential readings are the arithmetic difference of two input readings

Input voltage ranges	-10V to +10V -5V to +5V 0V to +10V 0V to +5V
Input current ranges	0mA to 20mA 0mA to 10mA -10mA to +10mA -20mA to +20mA
Input impedance	
voltage	10 Mohms
current	50 ohms
Input protection	Voltage inputs may be shorted to 45V ac or dc continuously. Current inputs may be connected to 140mA continuously.
Resolution	
unipolar inputs	12 bits
bipolar inputs	11 bits plus sign
Accuracy	
voltage & current	0.2% full scale at 25°C.
voltage	82ppm/°C
current	161ppm/°C
Isolation	2kV optical isolation between Verification highway and plant inputs. No isolation between inputs
Data input to the Controller	
unipolar ranges	0 to 4095
bipolar ranges	-2048 to +2047
differential ranges	-4095 to +4095 (Data limited to maximum or minimum values for input out of range.)
Conversion time	21ms for all 16 channels

Step response

10% to 90%	21ms
90% to 10%	21ms

Temperature

Operating	0°C to 60°C
Storage	-20°C to 70°C
Humidity	5% to 95% RH non-condensing.

Power Supply Requirements

From plantside power supply	±15V at 200mA.
Inrush current	2A decaying to 200mA in 0.3ms
From GEM 80 or from an external source	+15V at 40mA +5V at 290mA

Tests GEM 80 standard

3. HARDWARE DESCRIPTION

The 8165 Analog Input module is a single width module which plugs into a Verification I/O Controller subrack or an I/O subrack providing connection to a Verification I/O Highway. The front panel of the module is fitted with a 50-way D type plug which is used to connect the analog inputs from the plant and the ±15V plantside power supplies which are required to drive the module analog circuits.

The front panel incorporates an LED indicator, labelled WATCHDOG, which lights to confirm the self tests have been completed and the module is functioning correctly. If a fault is detected while the module is running, warning or fault bits are set in the F table of the host controller and the LED is extinguished.

At the rear of the module there are twelve DIL switches which are used to set the base address of the module on the Verification I/O Highway.

Figure 3.1 shows the general arrangement of the 8165 Analog Input Module.

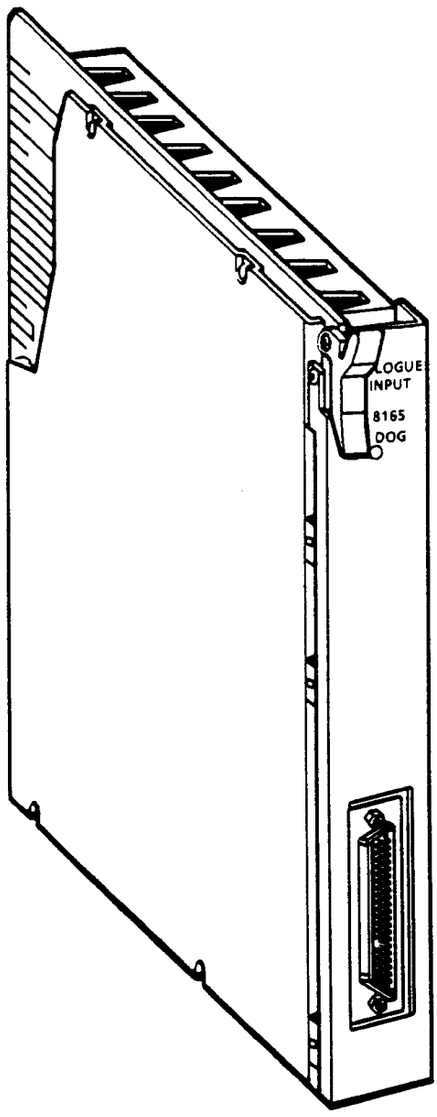

Figure 3.1 - 8165 Analog Input Module

4. OPERATION

4.1 Introduction

The 16 analog inputs from the plant are multiplexed and fed into a single sample and hold circuit which feeds a 12 bit Analog to Digital Converter. The digital voltage or current reading from the A to D converter is stored in one of 16 memory locations (one for each input channel) as a 16 bit word, of which 12 bits are data and 4 bits are unused. The 16 values are read by the host controller at each I/O scan.

If two channels are configured to read a differential voltage then the value read by the host controller is calculated by the module processor by subtracting the odd numbered channel of the pair from the even numbered channel. The result is stored in the A-table for the even numbered channel of the differential pair.

$$V_{diff0} = V_0 - V_1 \text{ etc}$$

where V_{diff0} = differential channel 0 voltage
V_0 = channel 0 voltage reading
V_1 = channel 1 voltage reading

The total conversion time for all 16 channels is approximately 21ms. The modules occupy 16 addresses on the Verification I/O Highway, one for each channel.

Figure 4.1 Shows the Analog Input and Power Supply Connections Circuits of the 8165 Module.

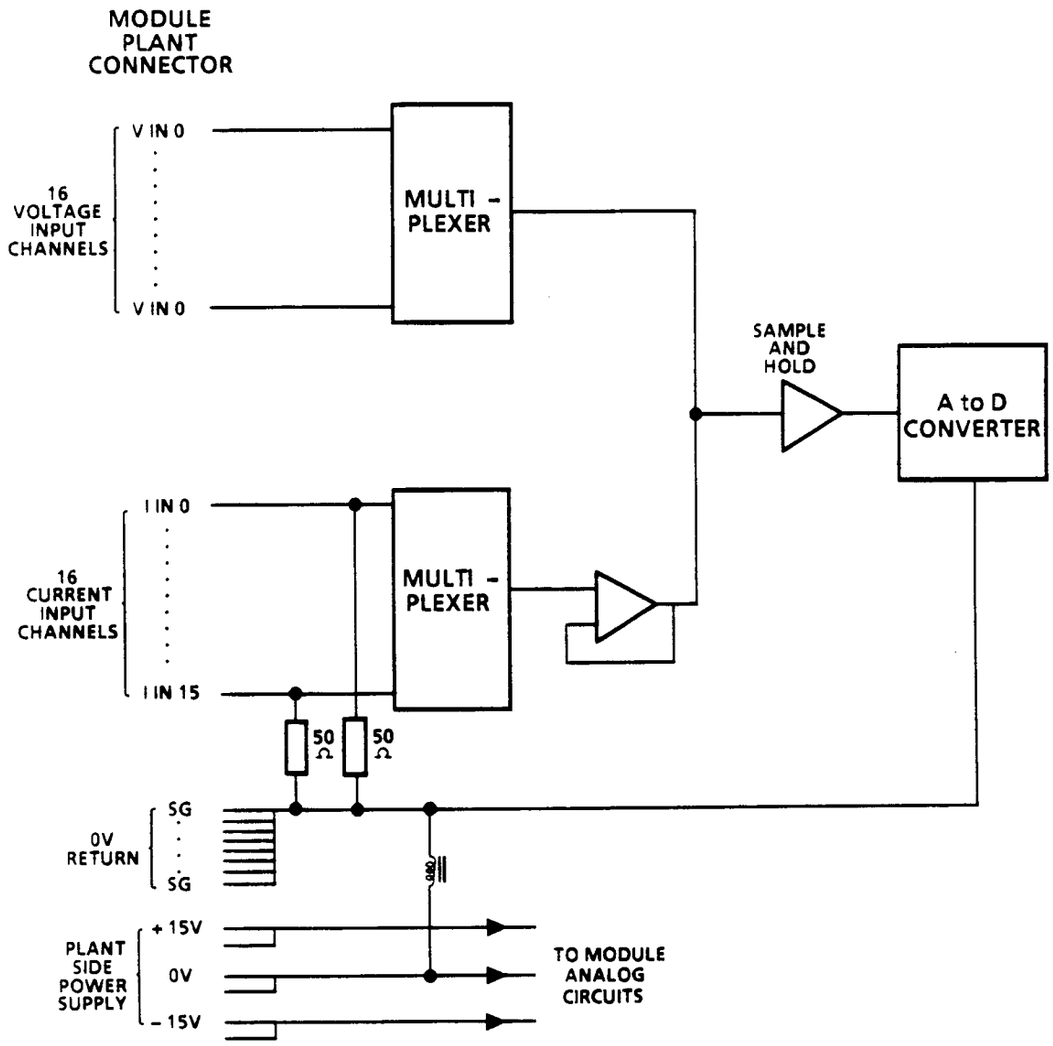

Figure 4.1 - 8165 Module Analog Input Circuit

4.2 Analog Input

The analog voltage inputs have an input impedance of 10Mohms and the current inputs have an input impedence of 50ohms.

Input overload protection is provided which allows the analog inputs to be shorted to ±45Vdc continuously or to withstand a continous current overload of ±40mA without damage.

4.2.1 Voltage/Current Scaling

The scaling of the A to D converter (ie the value passed to the A-table in the controller) depends upon the voltage or current range selected. Section 7 Table 7.1 gives scaling details for the various voltage and current ranges.

4.2.2 Channel Configuration

The type of input of each channel (ie single ended voltage, differential voltage or current and the voltage/current range) is defined by the configuration data which is set in the Host Controller P-table data for that channel (Section 7 refers).

4.2.3 Differential Voltage Channel Pairing

When used to measure differential voltage the channels are paired to give eight differential voltage channels. The pairing of the channels is shown in table 4.1.

Table 4.1 - Differential Channel Pairing

Differential Channels	Physical Channels
0	0 and 1
2	2 and 3
4	4 and 5
6	6 and 7
8	8 and 9
10	10 and 11
12	12 and 13
14	14 and 15

4.3 Address Setting

The 8165 Input module occupies 16 contiguous addresses on the Verification I/O Highway each corresponding to an input channel. The 12 bit base address is set on the DIL switches on the module. This address is read by the GEM 80 Controller at start up provided there is a reference to A-tables in the user program.

4.3.1 Example of Address Setting

To set the module base address to 964, corresponding to A-table locations A964 to A979, the base address is converted to binary format. In binary form 964 is equal to 0011 1100 0100 or 03C4 hexadecimal. Figure 4.3 shows how the DIL switches are set.

The Address setting DIL switches are situated at the rear of the module and access to the switches is through a cutout in the dust cover.

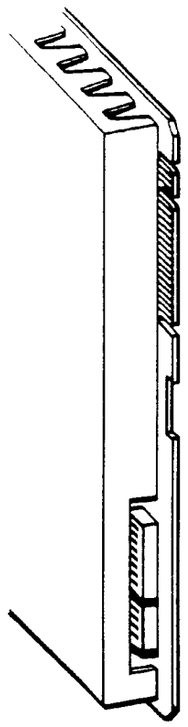

Figure 4.2 - Position of DIL Switches

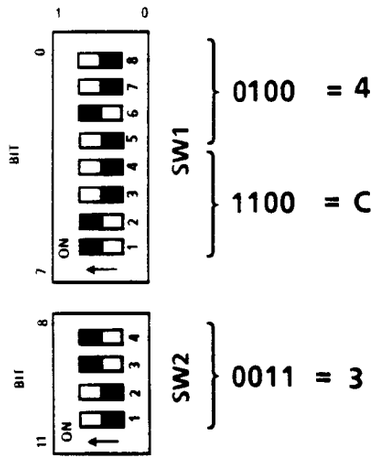

Figure 4.3 - Example of Address Setting

Note... Setting a switch to ON sets the address bit to 1 and setting a switch to OFF sets the address bit to 0.

5. POWER SUPPLIES

The 8165 Module requires an external plantside power supply providing ±15V at 200mA. The power supply is connected through the D-type plant connector mounted on the front panel of the module (see Table 6.1 for wiring details of plant connector).

The module also requires +15V and +5V which may be supplied either from the GEM 80 Controller or from an external regulated and smoothed power supply (see Section 2 for power supply requirements).

If the GEM 80 power supply is used the +15V can be supplied from the Verification I/O ribbon cable provided the current carrying capacity of the cable is not exceeded (Refer to the Subrack Technical Manual for details). The +5V which is not present on the Verification I/O ribbon cable must be connected to the I/O subrack backplane Terminal block TB1. For the 8859 12 slot subrack use TB1/5.

The power supply requirements and method of connecting an external +5V and +15V power supplies to I/O subracks are described in the appropriate subrack Technical Manual or User Information sheet.

6. PLANT CONNECTIONS

All inputs from the plant are via a 50 way D-type plug on the front panel of the module. There are two pins allocated for each input channel, one for voltage and one for current reading, and eight common 0V return connections. Figure 6.1 shows the module input connections.

Table 6.1 gives the wiring details for the input connector.

If the user wishes to manufacture his own connecting cable then the wiring details given in Table 6.2 should be followed. The cable must be fitted with a 50 way D-Type plug.

6.1 Mechanical Coding

The Cable Harness connector is mechanically coded by fitting a coding pin into socket 41 of the D-type connector. The corresponding pin 41 on the module D type plug is cropped to clear the coding pin (see Figure 6.1).

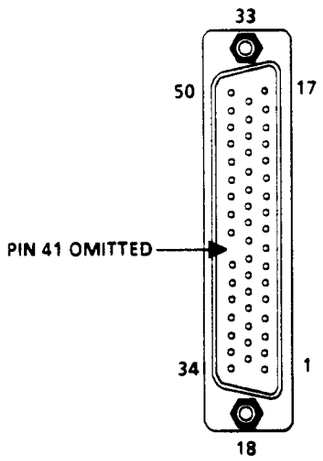

Figure 6.1 - 50-Way D Type Connector

6.2 3 Metre Cable Harness

A ready made connecting cable is available as an option. The wiring details for the cable is shown in Table 6.1.

Table 6.1 - Wiring Details for (3 Metre) Cable Harness

Signal Name	Wire Colour	Connector Pin No.
ch. 0 voltage	Green/orange/red	1
ch. 0 current	Orange/red/blue	2
ch. 1 voltage	Orange/red	3
ch. 1 current	Blue/red/orange	4
ch. 2 voltage	White/black	5
ch. 2 current	Blue/red	6
ch. 3 voltage	Black/orange/red	7
ch. 3 current	Red/black	8
ch. 4 voltage	Red/green	9
ch. 4 current	Orange/green	10
ch. 5 voltage	Green/black	11
ch. 5 current	White/red/green	12
ch. 6 voltage	Black/white/red	13
ch. 6 current	Red/black/green	14
Do not use	Green/black/orange	15
-15V I/P	Orange/black/green	16
-15V I/P	Blue/white/orange	17
ch. 7 voltage	White/black/blue	18
ch. 7 current	Red/white/blue	19
ch. 8 voltage	Black/red	20
ch. 8 current	White/red	21
ch. 9 voltage	Orange	22
ch. 9 current	Blue	23
ch.10 voltage	White	24
ch.10 current	Black	25
ch.11 voltage	Red	26
ch.11 current	Orange/black	27
ch.12 voltage	Blue/black	28
ch.12 current	White/black/red	29
ch.13 voltage	Red/black/white	30
ch.13 current	Green/black/white	31
0V	Orange/black/white	32
0V	Black/white/orange	33
0V return	Black/white/blue	34
0V return	Blue/red/green	35
0V return	Orange/red/green	36
0V return	Blue/white	37
0V return	Green	38
ch.14 voltage	Green/white/blue	39
ch.14 current	Black/white	40
Coding Pin	Green/white*	41
Not Used	Red/white/green*	42
ch.15 voltage	White/black/green	43
ch.15 current	Red/white	44
0V return	Black/red/green	45
0V return	Black/white/green	46
0V return	White/red/blue	47
Do not use	Blue/black/white	48
+15V I/P	Orange/white/blue	49
+15V I/P	White/red/orange	50

* These wires can be terminated at spare terminals or folded and tied back to the harness.

6.3 Typical Input Connections

6.3.1 Current Input

Figure 6.2 shows a method of connecting the 8165 Module to measure the current from an active source.

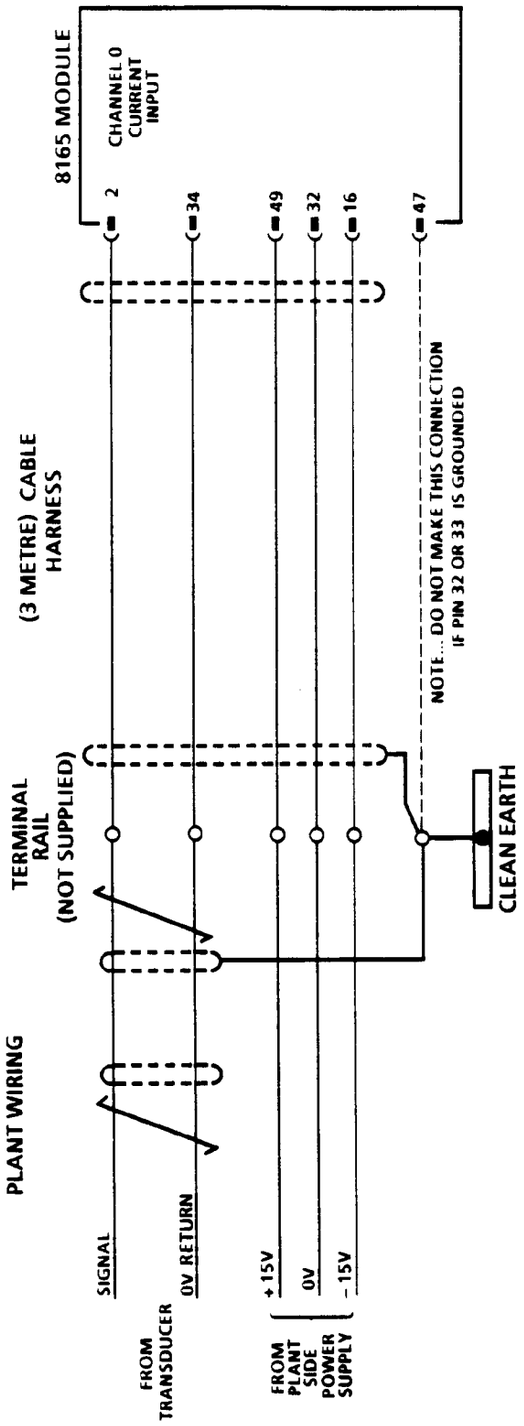

Figure 6.2 - Current Input from an Active Source.

6.3.2 Input from a Potentiometer

Figure 6.3 shows a method of connecting the 8165 Module to a potentiometer.

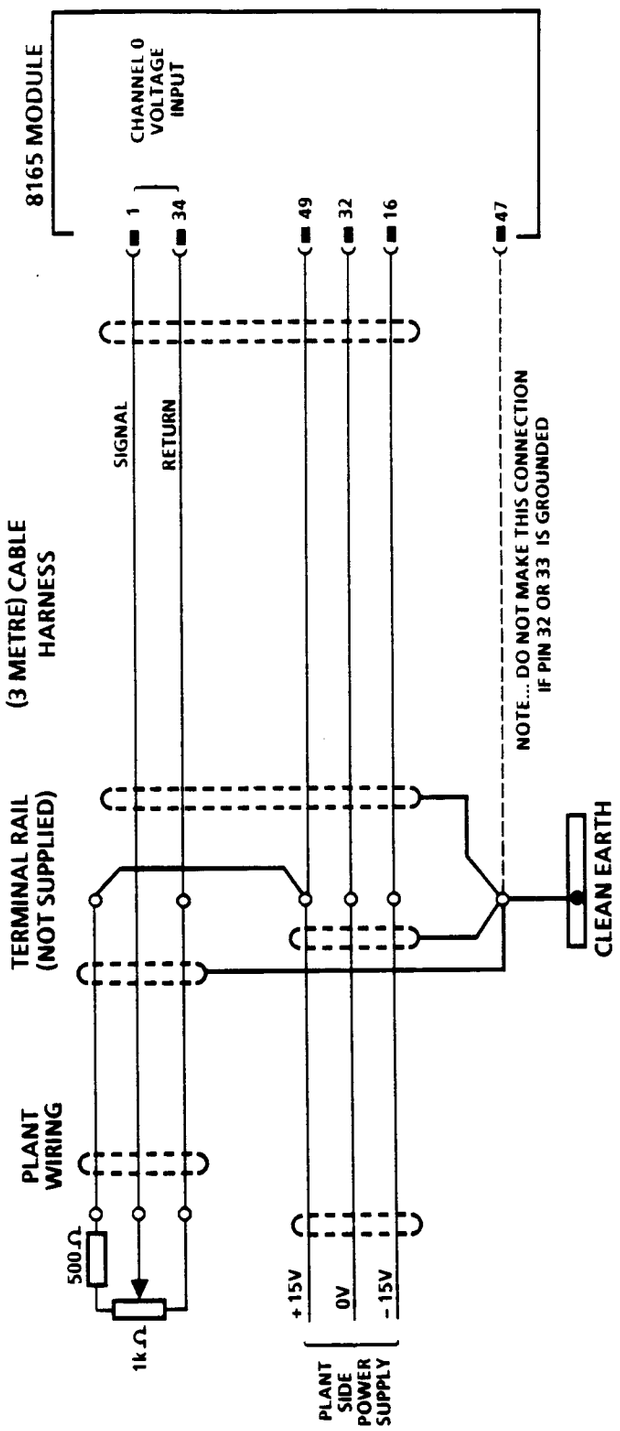

Figure 6.3 - Input from a Potentiometer.

6.3.3 Voltage Input from an Active Source

Figure 6.4 shows the method of connecting the module to measure the voltage of an active source. Two channels are shown connected.

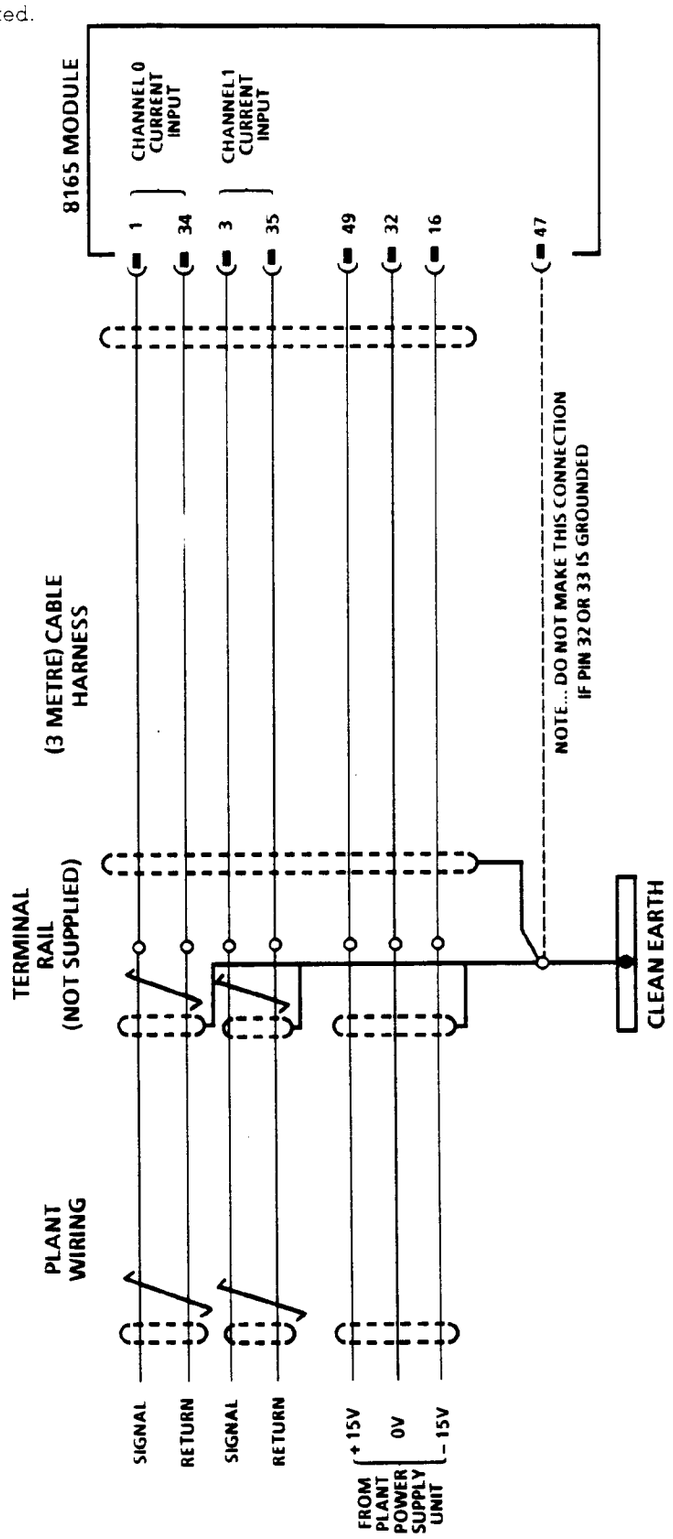

Figure 6.4 - Voltage Input from an Active Source

7. GEM 80 DATA TABLES

When installed in a GEM 80 system the 8165 module has 3 associated GEM 80 data tables which provide the controller with information as follows:

1) Module channel configuration data is stored in the P-table

2) The digital voltage/current readings are stored in the A-table

3) Error codes are stored in the F-table.

7.1 The P-Table

One P-table location is used to store the four bits of configuration data for each channel. Sixteen P-table locations are required for each module. These 16 locations must be consecutive but can be anywhere in the range available. P-table location P53 is used to define the P-table location associated with address 0 on the I/O highway.

For example:-

If the sixteen P-tables used for the configuration data for addresses 0 to 15 on the Verification I/O Highway are P200 to P215, then P53 must be set to 200.

The four configuration bits are used as follows:

Bit 3 (D) defines the channel as single ended or as one of a differential pair. Bit 3 is set to 1 for differential or 0 for single ended.

Bit 2 (C) selects either the voltage or current circuit. Bit 2 is set to 1 for current or 0 for voltage.

Bits 1 and 0 (RR) define the voltage/current range. Table 7.1 gives a full list of configuration codes for all the configuration options

Table 7.1 - Input Scaling and P-Table Configuration Data

Single Ended Voltage						**P-table Data**
Voltage Range			Value in A-table			DCRR
-10V	to	+10V	-2048	to	2047	0 0 0 0
-5V	to	+5V	-2048	to	2047	0 0 0 1
0V	to	+10V	0	to	4095	0 0 1 0
0V	to	+5V	0	to	4095	0 0 1 1

Differential Voltage						**P-Table Data**
Voltage Range			Value in A-table			DCRR
-20V	to	+20V	-4095	to	+4095	1 0 0 0
-10V	to	+10V	-4095	to	+4095	1 0 0 1
0V	to	+10V	0	to	4095	1 0 1 0
0V	to	+5V	0	to	4095	1 0 1 1

Current						**P-Table Data**
Current Range			Value in A-table			DCRR
-20mA	to	+20mA	-2048	to	+2047	0 1 0 0
-10mA	to	+10mA	-2048	to	+2047	0 1 0 1
0mA	to	+20mA	0	to	4095	0 1 1 0
0mA	to	+10mA	0	to	4095	0 1 1 1

When configuring two channels as a differential pair, both channels should be configured identically. If the configuration data for the channels differs then a warning bit will be set in the F-table. This error is not fatal. The controller configures both channels according to the data for the first (even numbered) channel of the pair.

7.2 The A-Table

At each I/O scan the host controller reads the 16 input channels of the 8165 module and stores them in 16 consecutive locations in the A-table. A-table locations start at A0 for the input channel with the lowest address. If the 8165 occupies the lowest address on the I/O Highway then channels 0 to 15 will occupy locations A0 to A15 and any additional input modules will occupy A-Table locations A16 onwards.

7.3 The F-Table

Two F-tables are required by each module for error reporting. Two bits are used for each channel. The lower bit is set to 1 to indicate a non-fatal error and is a warning condition. The higher bit is set to 1 to indicate a fatal error.

First F-table

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Channel	7		6		5		4		3		2		1		0	

Second F-table

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Channel	15		14		13		12		11		10		9		8	

Table 7.2 - F-Table Data

The particular pair of F-tables used depends on the GEM 80 controller and on the module address.

If the first F-table address for the Verification I/O is F45 then addresses 0 to 7 module on the highway will use F45 and F46, addresses 8 to 15 F47 and F48, etc.

The fault bit will be set when the module does not respond correctly when addressed by the GEM 80 Controller. This could be due to incorrect address setting or a faulty or missing module.

7.4 Examples of Configuration Data

Requirements:

channel	0)	±5V differential
channel	1)	
channel	2	±10V
channel	3	0-20mA
channel	4	0-20mA
channel	5	0-10mA
channel	6)	+10V differential
channel	7)	
channel	8)	0-5V differential
channel	9)	
channel	10	0-10V
channel	11	0-5V
channel	12)	±10V differential
channel	13)	
channel	14	±5V
channel	15	0-20mA

Configuration data loaded into P-tables:
(Assuming the module occupies addresses 0 to 15 on the highway.)

P53	=	200		
P200	=	0000000000001001	=	9
P201	=	0000000000001001	=	9
P202	=	0000000000000000	=	0
P203	=	0000000000000110	=	6
P204	=	0000000000000110	=	6
P205	=	0000000000000111	=	7
P206	=	0000000000001000	=	8
P207	=	0000000000001000	=	8
P208	=	0000000000001011	=	11
P209	=	0000000000001011	=	11
P210	=	0000000000000010	=	2
P211	=	0000000000000011	=	3
P212	=	0000000000001000	=	8
P213	=	0000000000001000	=	8
P214	=	0000000000000001	=	1
P215	=	0000000000000110	=	6

Corresponding 16-bit words sent to 8165:

Word 0	00 00 00 00 00 00 10 01
Word 1	** ** ** ** ** ** ** **
Word 2	00 00 00 00 00 00 00 00
Word 3	00 00 00 00 00 00 01 10
Word 4	00 00 00 00 00 00 01 10
Word 5	00 00 00 00 00 00 01 11
Word 6	00 00 00 00 00 00 10 00
Word 7	** ** ** ** ** ** ** **
Word 8	00 00 00 00 00 00 10 11
Word 9	** ** ** ** ** ** ** **
Word 10	00 00 00 00 00 00 00 10
Word 11	00 00 00 00 00 00 00 11
Word 12	00 00 00 00 00 00 10 00
Word 13	** ** ** ** ** ** ** **
Word 14	00 00 00 00 00 00 00 01
Word 15	00 00 00 00 00 00 01 10

* Configuration data ignored for odd numbered differential channels.

8. ORDERING CODES

Analog Input Module	8165-4004
3-metre Cable Harness	8891-4102

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INDUSTRIAL CONTROLS

Kidsgrove, Stoke-on-Trent, ST7 1TW, England
Tel: (0782) 783511 Fax: (0782) 776329 Telex: 36293/4 CICKID G
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T1476 Issue 1 5.90