Allen-Bradley
Analog Input Module (12-bit) Assembly

(Cat. No. 1771-IF)

Product Data

1. Protective cover

2. Fink identification label

3. Status indicators

4. Label identifies user input connections

5. Field wiring arm connects here

6. Slotted for I/O slot insertion only
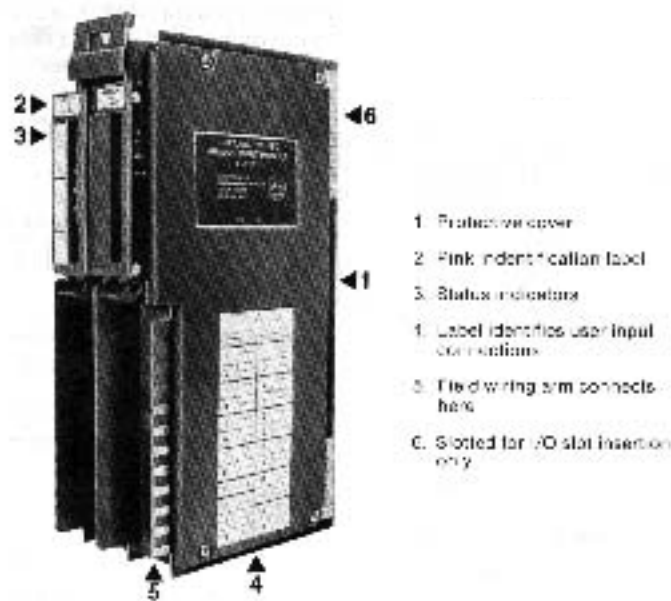
Description

The Analog Input Module (12-bit) Assembly (cat. no. 1771-IF) measures analog signals at its inputs and converts this data to a proportional three digit BCD or twelve bit binary value. Up to eight analog devices, sensing such variables as temperature, pressure, light intensity, and position, can be connected to the module. All the outputs of these devices should conform to the single voltage or current range for which the module has been calibrated. When ordering, the customer should specify the required voltage or current range. The module can be used with any PC processor employing the 1771 I/O structure.
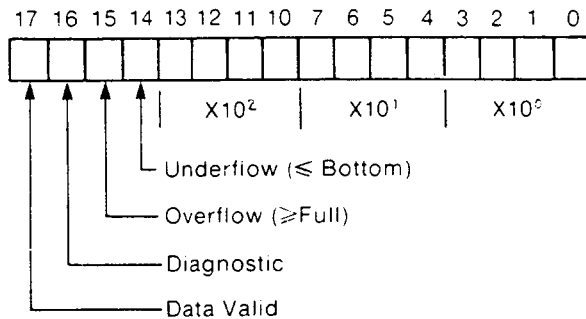
A series B analog input module (12-bit) assembly can be used alone or with Analog Input Expander Modules (cat. no. 1771E1, -E2, -E3). Expander modules provide an economical method (both in cost and I/O module slots) of increasing the input capacity of the system. For more information on expanding analog input systems, refer to the Analog Input Systems User's Manual (publication 1771-803).

The term "12-bit" indicates that the resolution of the module is 1 part in 2 12 (4096 10). This defines the number of units available to the module in dividing up its particular voltage or current range. The conversion of the analog value to a BCD format, if selected, limits the resolution to 1 part in 1000.
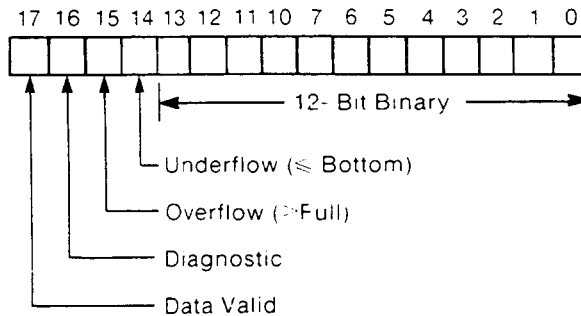
The BCD or binary value from each channel is contained in a 16 bit input data word that is stored in the module's memory. In addition to the channel value in the first twelve bits, the remaining four bits are used for diagnostic information (figure 1).

Figure 1
Input Word Format

BCD Format

17 16 15 14 13 12 11 10 7 6 5 4 3 2 1 0

$X10^2$ $X10^1$ $X10^0$

Underflow ($\leqslant$ Bottom)

Overflow ($\geqslant$Full)

Diagnostic

Data Valid

Binary Format

17 16 15 14 13 12 11 10 7 6 5 4 3 2 1 0

12- Bit Binary

Underflow ($\leqslant$ Bottom)

Overflow ($>$Full)

Diagnostic

Data Valid

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The analog input module (12-bit) assembly includes the following units:

- Analog Input Module (12-bit) (cat. no. 1771-IFC)

- Two Field Wiring Arms (cat. no. 1771-WB)

The analog input module (12-bit) is compatible with the requirements of the Instrument Society of America Standard ISA S50.1 (1975), Compatibility of Analog Signals for Electronic Industrial Process Instruments.

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Selection of Input Channel Ranges

The analog input module (12-bit) has eight single-ended input channels. All input channels on an individual module have the same voltage or current range. This range must be specified when the module is ordered. Although this range is factory set and adjusted, the module can be recalibrated according to procedures outlined in the Analog Input Systems User's Manual (publication 1771-803), provided the proper instrumentation is available.

Refer to Table A. When ordering the analog input module (12bit) with a certain voltage or current range, the identifying code which specifies the needed voltage or current range should be appended to the catalog number of the assembly. For example, if +0 to +10 volt range is required, then the assembly should be ordered with this number: cat. no. 1771-IF 04.

Table A
Module Coding

1771-IF   XX

① Basic Catalog No.

② Identifying Code

Mode	Codes XX	Range
Voltage Mode	01	+1 to +5V
	02	0 to +5V
	03	−10 to +10V
	04	0 to +10V
Current Mode	05	+4 to +20mA
	06	0 to +20mA
	07	-20 to +20mA

The voltage and current ranges given in the specifications section are nominal. Precise voltage and current ranges for these nominal ranges are shown in tables B and C. In addition, these tables give the voltage, or current-per-bit for each range. In the voltage mode, the module has input overvoltage protection to ± 35VDC, 25V rms (sinusoidal). In the current mode, the maximum continuous current limit is ± 30mA. Exceeding these limits may damage the module. However, 1500V opto-electrical isolation protects the rest of the system from damage due to overvoltage or overcurrent at the module's inputs.

Table B
Input Voltage Ranges

3 Digit BCD Operating Mode:

Nominal Voltage Range	Actual Range	Corresponding BCD Output Range	V/BIT
± 1 to +5V	+ 1 to +4.996V	000 – 999	4mV/Bit
0 to +10V	0 to +9.990V	000 – 999	10mV/Bit
-10 to +10V	-10 to +9.980V	000 – 999	20mV/Bit
0 to +5V	0 to +4.995V	000 – 999	5mV/Bit

12-Bit Binary Operating Mode:

Nominal Voltage Range	Actual Range	Corresponding Octal Output Range	V/BIT
+ 1 to +5V	+1 to +4.99902V	$0000 – 7777_8$	0.98mV/Bit
0 to -10V	0 to +9.99756V	$0000 – 7777_8$	2.44mV/Bit
-10 to +10V	-10 to +9.99512V	$0000 – 7777_8$	4.88mV/Bit
0 to +5V	0 to +4.99878V	$0000 – 7777_8$	1.22mV/Bit

NOTE: The input voltage range is selectable for all eight channels as a unit. Thus all channels function with tne same input voltage range.

Table C
Input Current Ranges

3 Digit BCD Operation Mode:

Nominal Current Range	Actual Range	Corresponding BCD Output Range	I/BIT
+4 to +20mA	+4 to +19.984mA	000 – 999	0.016mA/Bit
0 to +20mA	0 to -19.980mA	000 – 999	0.020mA/Bit
-20 to +20mA	-20 to +19.960mA	000 – 999	0.040mA/Bit

12-Bit Binary Operating Mode:

Nominal Current Range	Actual Range	Corresponding Octal Output Range	I/BIT
+4 to +20mA	+4 to +19.9961 mA	$0000 – 7777_8$	0.0039mA/Bit
0 to +20mA	0 to +19.9951mA	$0000 – 7777_8$	0.0049mA/Bit
-20 to +20mA	-20 to +19.9902mA	$0000 – 7777_8$	0.0098mA/Bit

NOTE: The input current range is selectable for all eight channels as a unit. Thus all channels will function with the same input current range.

Switch Selectable Programming Options

The incoming data in each channel word has the option of appearing at the processor in either BCD or binary format. If the BCD format is selected, the processor can directly manipulate this value in comparisons or arithmetic functions, but is limited to a resolution range of 000 to 999. The binary option allows an increased range of 0000 to 4095 10 (0000 to 7777), but certain processors must reconstruct the BCD number from its inputted binary value to make it compatible with arithmetic instructions. The data format option is switch selectable.

Single transfer programming can be used with PLC® or PLC-2 family processors. This type of programming shifts a word of data each program scan from the module's memory into an area designated in the data table. To use single transfer programming, the transfer mode switch on the module must be set to single transfer.

Block transfer programming, not available with all Allen-Bradley PC processors, moves all eight channel words from the module's memory to a designated area in the data table in a single scan. To use block transfer, the transfer mode switch on the module must be set to block transfer.

Refer to the Analog Input Systems User's Manual (publication 1771-803) for details on programming and sample programs.

Switch Settings

These programming features are selected on a single switch assembly that is located on the PC board underneath the component cover.

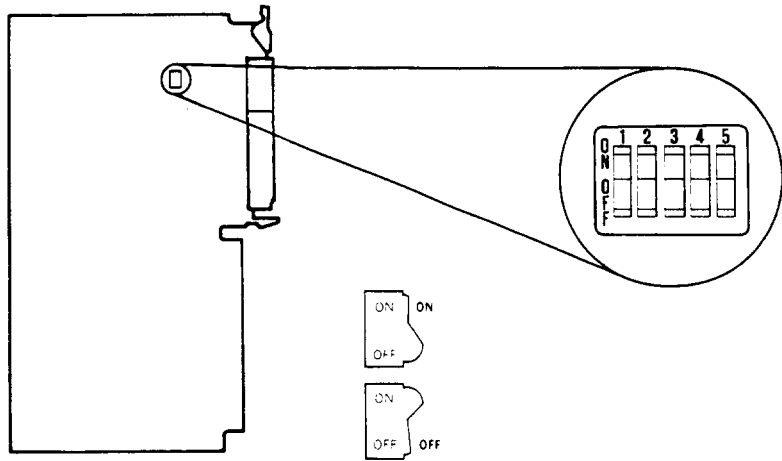To select these programming options, proceed as follows:

Step 1 — Refer to figure 2. Take off the component (left side) cover by removing the four screws.

Figure 2
Removing Component Cover

Remove Screws

Component Side Cover

Remove Screws
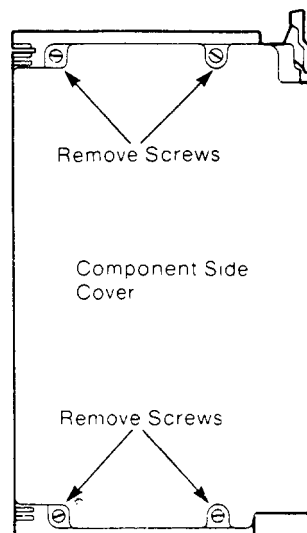
Step 2—Refer to figure 3. Identify the programming option switch assembly.

Figure 3
Programming Options Switch Assembly

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Step 3 — Using table D, set the switches to select the desired programming options.

Step 4 — Replace the cover and secure with the four screws.

The tip of a ball-point pen can be used to set the rocker arms of a switch. Do not use a pencil, because the tip can break off and jam the switch.

Table D
Programming Options Switch Settings

| Switch	Function	
	Series A	Series B
1	Must be off	Off – Master 1 or Standalone On – Master 2
2	Off – Binary mode On – BCD mode	Off – Binary mode On – BCD mode
3	Off – Single transfer On – Block transfer	Off – Single transfer On – Block transfer
4	Must be off	Off – Standalone On – Master
5	Must be off	Off – Normal operation On – Calibration

Specifications for the A/D Converter

The A/D (analog-to-digital) converter has the following specifications:

- Conversion time: Less than 0.6ms per channel

- The output is monotonic with no missing codes

- Resolution: Selectable 3 digit BCD (000-999), or 12 bit binary (0000-4095)

- Linearity (at 25°C): ±0.05% of full scale

- Absolute accuracy including linearity, gain, and offset (at 25°C): ±0.1% of full scale ±1/2LSD (BCD mode), or ±1/2LSB (binary mode)

- Quantizing error ±1/2LSB or ±1/2LSD

- Temperature Coefficient: < ±45ppm/°C of full scale range for 0°C to 60°C ambient

- Recalculation time: Calibration should be checked at 6 month intervals to maintain specified accuracy.

Diagnostics

The module has certain diagnostics features that monitor the conversion and transmission processes for faults. This information can be displayed in several different ways: 1) the diagnostics LED will illuminate: 2) certain bits in the channel word will be set: or 3)a combination of the two. The LED can be examined by removing the right-hand snap off cover on the front of the module (figure 4). The LED will be on under these conditions:

**Figure 4
Location of Diagnostic LED**
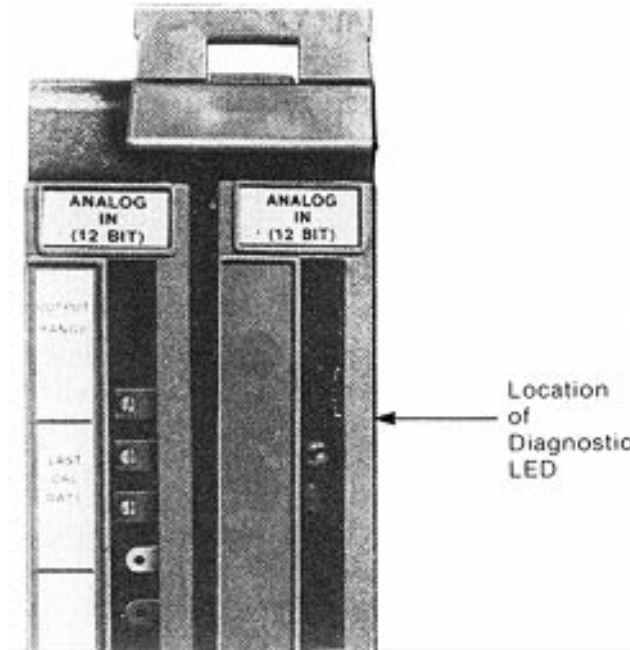
- The module's microprocessor detects a fault in its memory at power-up. If a fault is detected with the module in the block transfer mode, all communications to the processor are halted. In single transfer, bit 16 will be set.

- The module cannot perform block transfer (if that mode has been selected).

Bits 14 to 17 in the channel data word are used as diagnostic bits (figure 1). Bit 14, if set, indicates that the analog signal for that channel has reached the minimum range value. If the signal drops any further, the module cannot detect it. Bit 15, if set. indicates that the signal has exceeded the range. It is suggested that these bits be monitored in the program to prevent the processor from acting on invalid data.

Bit 16 is set by a module self-check on the A/D coverter and certain other processes. Because this bit reflects the module's status, bit 16 of any channel can be monitored in the program. However, since some of the fault conditions for this bit will also halt block transfer (if programmed in that mode), unless the block transfer function is also checked, a communication failure may go undetected. An additional program diagnostic should be developed using the block transfer complete bit (bit 7) in the input image table. Refer to the Analog Input Systems User's Manual (publication 1771-803) for details on diagnostic programming using block or single transfer.

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When the diagnostic bit 16 is set to one, all data being received from the module is invalid. The module's microprocessor will attempt to write zeroes into the input channel words. It is possible that the fault will not allow the module to reset all bits to zero.

If customer 5V power to the front of the module is lost or the power available signal is not present (or the terminals are not jumpered), bit 17 of the channel word is reset to zero. Since loss of customer power affects all the channels, each channel should show bit 17 at zero after one module scan. This data valid bit, from any of the channels, can be checked in the program to detect a loss of customer power.

If the data is invalid, bit 17 in each input channel word will be reset to zero. Additionally, if bit 17 is on, and this data is used in a mathematic function, it will inhibit certain mathematical instructions in the PLC controller.

System Power

System power is supplied through the I/O chassis backplane from the rack power supply. The module requires a current of 1.3 amp from the 5V DC output of this supply. This amount should be totalled with the current requirements of other modules in the rack to avoid overloading the suppuly or exceeding the backplane capacity .

External Power

The analog input module (12-bit) requires wiring arm connection to a power supply separate from any other supply in the controller system. Refer to the connection diagram (figure 9). Using a separate supply protects the analog signals against transients caused by the switching of digital circuits.Specifications for this external DC power source are listed in table E.

Table E
Customer Power Supply Requirements [1]

	+5 Volts	+ 15 Volts	-15 Volts
Output Current	150mA	60mA	60mA
Output Voltage Tolerance	± 5%	± 1%	± 1%
Regulation (type)	Series	Series	Series
Line Regulation (for 10V AC Load Regulation	± .04%	± .02%	± .02%
Ripple (RMS)	2mV	2mV	2mV
Overvoltage Protection	-7V	+18V	-18V
Current Limit (percent of FL)	125%	125%	125%

1 No protection on the module is provided for overvoltages from customer power.

The Power Supply (cat. no. 1770-P1) is available as an external power source for the analog input module. Refer to figure 5. This supply operates on either 120V AC or 220/240V AC input. It provides sufficient output power for two Analog Input (12-bit) Module Assemblies (cat. no. 1771-IF).

The PLC Remote Power Supply (cat. no. 1778-P2) can also be used as the external power source to the module. With this supply. you must also order the Analog I/O Power Cable (cat .no. 1778-AM) or the Module Power Cable (cat. no. 1770-CF).Wiring arm connections from this cable are illustrated in figure 6.

The PLC remote power supply can provide external power to a maximum of 16 analog input (12-bit) modules. If a remote supply is used to power these modules, however, it must not be used for I/O rack power at the same time.
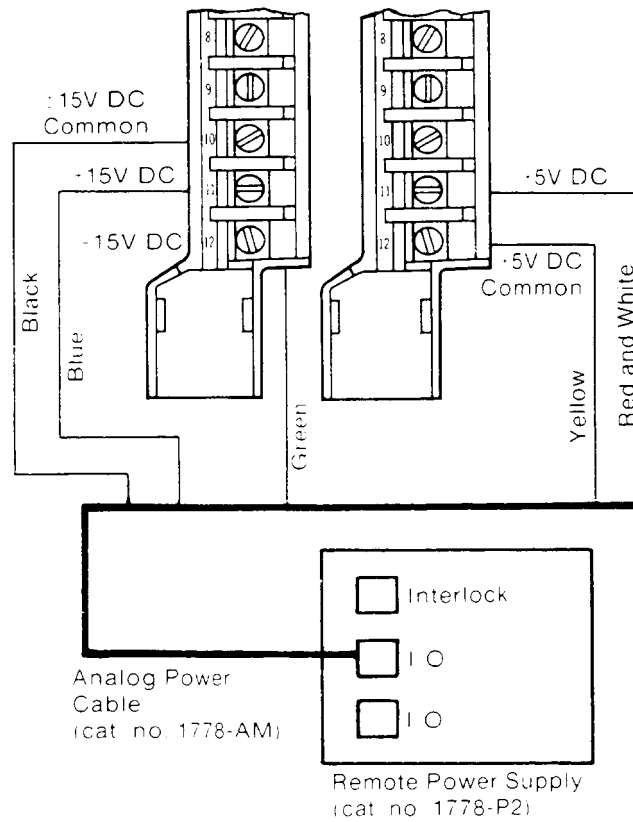
It is recommended that no more than 15 analog input modules be connected using a single Analog I/O Power Cable.

Figure 5
Power Supply Connections (cat. no. 1770-P1)
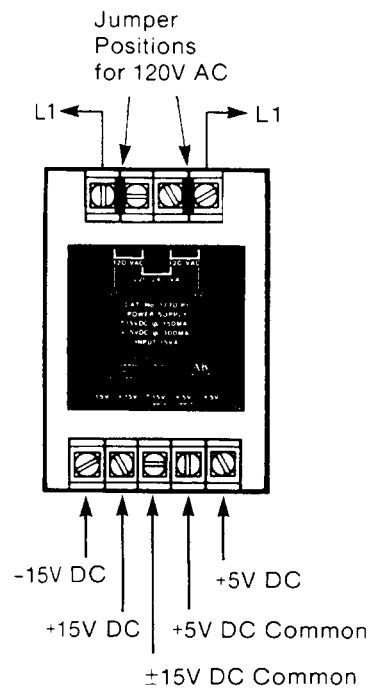
Figure 6
Connection of Field Wiring Arms to a Remote Power Supply
(cat. no. 1778-P2)

Power and common connections can be jumpered from one analog input module to the next.

If another supply is chosen, this supply must also conform to the specifications listed in table E.

NOTE: Do not confuse the SIGNAL RETURN wire with the cable shield. The SIGNAL RETURN wire will be one of the insulated wires encased by the cable shield.

Note that the POWER AVAILABLE terminal must be jumpered to the POWER AVAILABLE COMMON terminal in order for the module to transfer data to the processor. If the external power supply has a POWER AVAILABLE signal, then it can be tied directly to the POWER AVAILABLE terminal without jumpering the terminal.

⚠ **CAUTION:** To avoid damage to module circuitry, do not remove or insert the module into the chassis while controller power to the chassis is on. For the same reason, do not remove or install the wiring arm while external power is

The analog input module (12-bit) may be placed in any rack and any module group within a rack of the controller being used. However, the module must be inserted only in a single module group: it cannot straddle two groups. To minimize noise, group analog input modules together within an I/O chassis whenever possible. Avoid placing analog modules close to AC modules or high voltage DC modules.
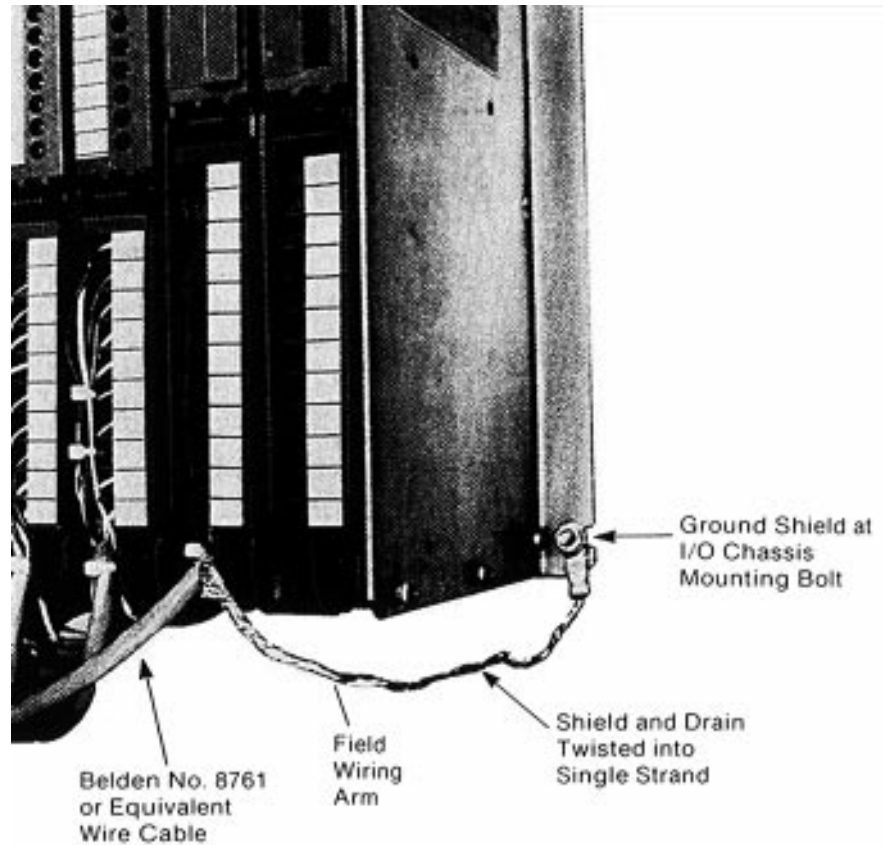
Use Belden 8761 or equivalent cable to connect the analog devices to the module's field wiring arm (figure 9).

Refer to figure 7. Belden 8761 or equivalent cable has a foil shield with a bare stranded drain wire. These are to be grounded at one end of the cable only. The best ground for this connection is usually the enclosure ground at an I/O chassis mounting bolt or stud. At the other end of the cable, which connects to the device, the shield must be cut short and taped back to insulate it from any electrical contact.

The single ground at the chassis must be the only electrical contact of the shield. Where necessary, use electrical tape to insulate the shield from any other contact.

Recommended maximum cable length for voltage mode input devices is 50 feet. This recommendation is based on considerations of signal degradation and noise immunity in typical industrial environments. Cable length for current mode input devices, however, need not be as restrictive. (Current mode analog signals are less sensitive than voltage signals to noise induced along transmission cables.)

Figure 7
Cable Shield Grounding

Ground Shield at
I/O Chassis
Mounting Bolt

Shield and Drain
Twisted into
Single Strand

Field
Wiring
Arm

Belden No. 8761
or Equivalent
Wire Cable

Because the module is extremely sensitive to the analog signal, care should
be taken to prevent noise and interference from destroying the integrity of
the signal. For detailed installation instructions, refer to publication
1771-803, Analog Input Systems User's Manual.

Keying

In initial design stages, the analog input module (12-bit) may be inserted
into any I/O module group in the I/O chassis. However, once a group has
been designated for a module, care should be taken so that other types of
modules will not be placed into these slots. Plastic keying bands, shipped
with each I/O chassis, provide an easy method for keying I/O slots to
accept only one type of module. Use of these keying bands is strongly
recommended.

This type of I/O module is slotted in two places on the rear edge of each
board. The position of the keying bands on the backplane connector must
correspond to these slots to allow insertion of the module. Any I/ O rack
connector may be keyed to receive the analog input module (12-bit)
assembly.

Refer to figure 8. Because the analog input (12-bit) module uses two slots, both slots have to be keyed. Snap the keying bands onto the upper backplane connectors between these numbers printed on the backplane:

- Left Connector

    Between 6 and 8
    Between 22 and 24

- Right Connector

    Between 4 and 6
    Between 32 and 34

Figure 8
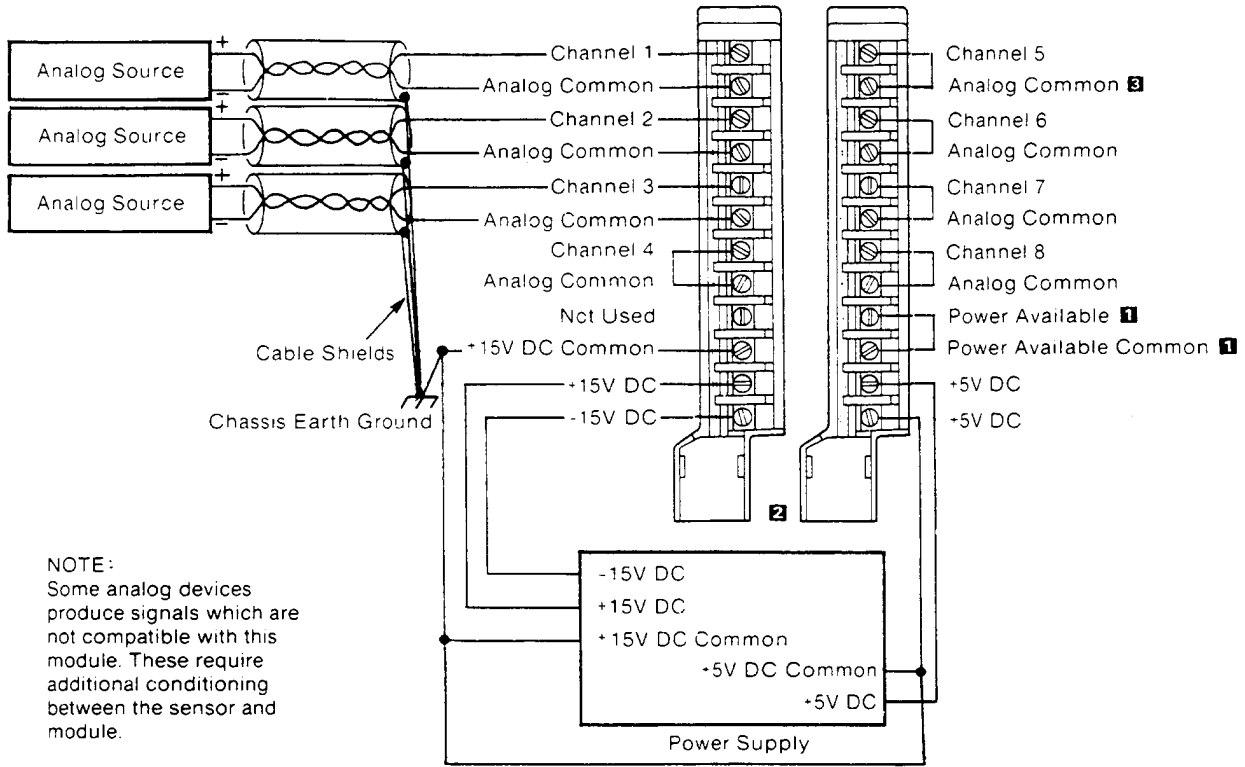**Keying Diagram**
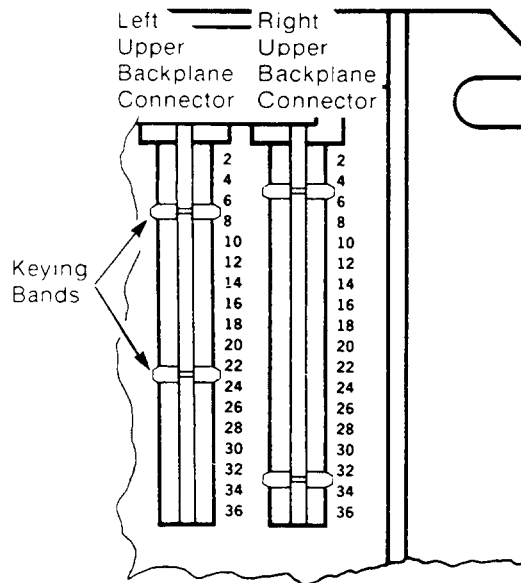
The position of these bands may be changed if subsequent system design and rewiring makes insertion of a different type of module necessary.

Needle-nose pliers may be used to insert or remove keying bands.

Figure 9
Connection Diagram

(See all applicable codes and laws)

NOTE:
Some analog devices
produce signals which are
not compatible with this
module. These require
additional conditioning
between the sensor and
module.

1 Most terminal designations are self-explanatory. One exception is terminal 9 and 10 on the right swing arm. The POWER AVAILABLE and POWER AVAILABLE COMMON terminals are designed to be connected to a power supply which provides POWER AVAILABLE SIGNAL. If the power supply does not provide a POWER AVAILABLE SIGNAL, jumper terminals 9 and 10 together.

2 The 1771-IF Analog Module (12-bit) requires two slots in the 1771 I/O chassis. It must be positioned in one module group.

3 All commons are connected internally

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Specifications

Inputs per Module
- 8 single-ended

Module Location
- 1171I/O Rack – 2 slots

Input Voltage Ranges (nominal)
- +1 to +5V DC
- 0to -5V DC
- -10to +10V DC
- 0to -10V DC

Input Current Ranges (nominal)
- +4 to +20mA
- 0to+20mA
- -20 to +20mA

Digital Resoltion
- Selectable 3-digit BCD or 12-bit binary

Input Overvoltage Protection
- $\pm$ 35VDC
- $\pm$ 25V rms (sinusoidal) with -15V and +5V maintained

Input Impedance
- $> 10^9$ ohms for voltage ranges
- 250 ohms for current ranges

Power Supply Current Requirements
- 1.3A

BCD Output to Processor
- 000 to 999 10 for any input range

Binary Output to Processor
- 0000to4095 10 for any input range

Ambient Temperature Rating
- $0°$ to $60°$C (operational)
- $-40°$ to $85°$C (storage)

Humidity Rating
- 5 to 95% (without condensation)

Electrical-Optical Isolation
- 1500V (transient)

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As a subsidiary of Rockwell International, one of the world's largest technology companies — Allen-Bradley meets today's challenges of industrial automation with over 85 years of practical plant-floor experience. More than 11,000 employees throughout the world design, manufacture and apply a wide range of control and automation products and supporting services to help our customers continuously improve quality, productivity and time to market. These products and services not only control individual machines but integrate the manufacturing process, while providing access to vital plant floor data that can be used to support decision-making throughout the enterprise.

With offices in major cities worldwide