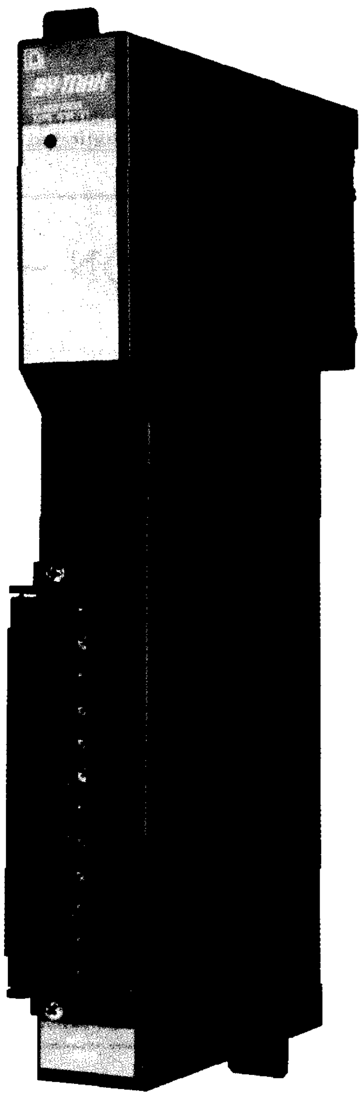
Instruction Bulletin

Subject: SY/MAX®
CLASS 8030 TYPE RIM-121
STANDARD ANALOG INPUT MODULE

DESCRIPTION:

The Class 8030 Type RIM-121 SY/MAX Standard Analog Input Module provides SY/MAX Family Programmable Controllers and PID Loop Controllers with the ability to receive standard electrical ranges of up to 4 high level analog input signals. This instruction bulletin describes the installation, programming, operation, and troubleshooting of the analog input module.



SQUARE D COMPANY

Supersedes 30598-203-01 dated January, 1984
Printed in U.S.A.

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CAUTION

SY/MAX devices contain electronic components that are very susceptible to damage from electrostatic discharge. DO NOT handle this device by the gold edge contacts.

A static charge can accumulate on the surface of ordinary plastic wrapping or cushioning material. If any SY/MAX device must be returned to Square D, the following packaging instructions must be followed:

PREFERRED: Use the original packaging material as supplied by Square D. Place the device inside the metallized plastic bag.

ACCEPTABLE: Wrap the device in some type of antistatic material. Antistatic plastic material can be identified by its pink color, and can be obtained in sheet or bag form.

UNACCEPTABLE: Do not use ordinary plastic film, foam, or styrene chips ("popcorn" or "peanuts"). These materials can accumulate static charges in excess of 10,000 volts, resulting in possible damage to the SY/MAX electronic components.

Antistatic (metallized plastic) bags can be obtained from the following manufacturers:
- 3M Company (800-328-1368) Type 2100 bag
- Static, Inc. (800-782-8424) 8000 Series bag
- Charles Water (617-964-8370) CP-303 bag

CAUTION

Improper handling may cause permanent damage to this device.

1) **Never remove this device from the rack while power is ON. Turn power supply switch to OFF and wait until all indicating lights are off before removing.**
2) **Do not subject to static discharge.**
3) **Do not touch gold edge contacts.**

NOTICE

The products and services described in this manual are useful in a wide variety of different applications. Therefore, the user and others responsible for applying the products and services described herein are responsible for determining their acceptability for each application. While efforts have been made to provide accurate information within this manual, the Square D Company assumes no responsibility for the application, completeness or usefulness of the information contained herein.

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The information contained in this manual is subject to change without notice.

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1.0 DESCRIPTION OF SY/MAX FAMILY STANDARD ANALOG INPUT MODULE

1.1 Introduction

1.1.1. GENERAL PURPOSE

The Class 8030 Type RIM-121 Standard Analog Input Module provides the capability of inputting four channels of high level analog input signals (4-20 mA, 1-5 VDC, 0-10 VDC, or ± 10 VDC) to any SY/MAX Family Processor which possesses register I/O addressing capability. The analog module may be inserted into any slot of a register rack (except slot 1) or the register slot of a digital rack. Each module utilizes four registers in the system (one register per channel) in which the analog current or voltage being measured is converted to a value ranging from 0 to 9995, in increments of 5. This provides a register value in percent of full scale (2 decimal places). Live zero (open-circuit) detection on the 4-20 mA range is indicated by −1 appearing in the register. Simple programming techniques allow these input readings to be scaled to engineering values, provided the processor being used has math capability. The module requires no external power supply to operate (drawing its power from the SY/MAX Family power supply connected to the rack) and requires no additional components (such as current loop resistors). No user adjustment of span and zero is required, as automatic calibration is performed by the on-board microprocessor. A removable terminal strip facilitates quick replacement with no rewiring necessary.

1.1.2 GENERAL OPERATION

The Class 8030 Type RIM-121 module performs its tasks utilizing several subsystems. The analog to digital converter (A/DC) performs the actual conversion of the selected input channel, while the input multiplexer (MUX), under the control of the on-board microprocessor, performs the channel selection. The auto-calibration system (ACS) includes multiplexed zero and voltage references. The module also contains a DC-to-DC converter, along with signal and power isolation circuitry. For a block diagram of the operation, see Section 7.1.

1.2 Front of Module

The front of the module shows a terminal strip and a RUN LED. The terminal strip contains four groups of three terminals; each group corresponds to one input signal or channel. One terminal exists for the positive wire of the signal source, one terminal for the negative, and the third terminal for the shield wire. For field wiring considerations, see Section 3.4.

The RUN LED indicates the digital logic circuitry in the module is functioning properly.

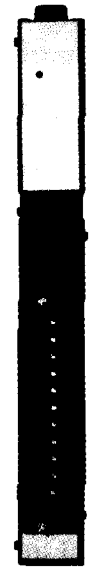


Figure 1

1.3 Side of Module

Accessible by removing the side cover plate are seven DIP switches which allow the user to select the desired range setting. This range setting will be common to all four channels on the module. See Section 3.3 for proper settings.

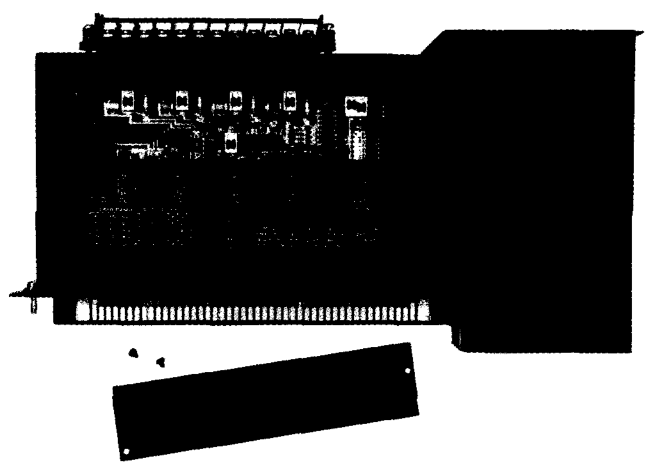


Figure 2

2.0 SPECIFICATIONS

2.1 Electrical Specifications

Inputs per module:	4 single ended (the selected range will apply to all).
Ranges:	1-5 VDC, 0-10 VDC, ± 10 VDC, 4-20 mA.
Accuracy:	±0.1% at 25° C, ±0.5% (of full scale) over 0-60°C temperature range.
Resolution:	1 part in 2,000 (full scale range in the storage register of 0-9995, in increments of 5).
Under-Range Indication:	Converted to 0000.
Over-Range Indication:	Converted to 9999.
Live Zero:	(Open circuit detection) converted to −1 (applicable to 4-20 mA range only).
Conversion Rate:	5 conversions per channel per second (all 4 channels are updated every 200 milliseconds). Note: 50 millisecond response can be obtained for a *single* channel (1) if selected per Section 3.3, (4-20 mA only) the remaining channels cannot be used.
Isolation:	200V channel to ground (or analog input circuit to digital logic circuit) continuously applied. 1500V transient isolation.
Maximum Input Overload:	34 mA (current), ± 50 VDC (voltage), applied continuously to the input terminals.
Current Loop Resistors:	250 ohms ±.01%, 5 PPM/°C (resident in the module).
Power Requirement:	1400 mA current draw from SY/MAX power supply connected to the rack.
Input Impedance:	.082μF in parallel with 5M ohms (voltage) or 250 ohms (current).
Common-Mode Rejection Ratio:	84 dB
A/D Converter Type:	Analog Devices Type 7550 (13-bit CMOS quad-slope A/D converter).
Multiplexer Type:	Harris Semiconductor Type 508B, 8 channel, single-ended CMOS MUX (the additional channels are used by the *auto-calibration system*).
Microprocessor Type:	Intel 8031 (controls the MUX, the A/D converter, the auto-calibration system, and diagnostics).
RUN Light:	Indicates digital logic circuitry is functioning properly.

2.2 Physical Specifications

Weight:	2.7 lbs (approximate), 1.2 kg.
Dimensions (WxHxD):	1.5 x 12.8 x 6.6 (in.) 3.8 x 32.5 x 16.8 (cm.)

2.3 Environmental Specifications

Ambient Temperature Ratings:	0-60°C (operational) Storage Temperature −40 to +100°C
Humidity Rating:	5-95%, relative humidity (non-condensing)

2.4 Compatibility with Racks

RRK-100, RRK-200, RRK-300 (except the first slot in top half and none of the slots in bottom half of RRK-300)
HRK-100, HRK-150, HRK-200 (register slot only)
CRK-210, CRK-300 (register slot only)
DRK-210, DRK-300 (register slot only)
GRK-110, GRK-210 (register slot only)

2.5 Compatibility with Processors

The following Class 8020 Type SCP programmable controllers:
311 and 312 (Series E and later)
323 and 344 (Series C and later)
313, 321, 322, 332, 333 (Series D and later)
All Model 400 programmable controllers.
All Model 500 programmable controllers.
All Model 600 programmable controllers.
All Model 700 programmable controllers. (Note: Series A or B RIM-121 installed in a local rack with a Model 700 may cause processor to HALT. Any series may be utilized in a remote rack via the local/remote interface module link.)
Class 8040 Type PCM-110 (RIM-121 must be Series C)

3.0 INSTALLATION

3.1 Physical Inspection

3.1.1 NEW MODULE

As packaged, the module requires no additional components to function, and has no manual adjustments for setting zero and span. This is performed by the automatic calibration system. The user should not, however, plug the module into a rack before completing the following compatibility checks explained in their parenthetical references:

The proper range for the application is available (Section 2.1).
The proper range is selected (Section 3.3).
The processor is compatible (Section 2.6).
The rack and necessary slot is available (Section 2.4).
The SY/MAX Family power supply is adequately sized (Instruction Bulletin 30598-159-01 or later).
The rack is not keyed to prevent module insertion (Section 3.2).
Field wiring terminations are understood (Sections 3.4 and 5.2).
The required programming, especially system addressing, is understood (refer to Instruction Bulletin 30598-174-XX or 30598-167-XX or SY/MATE programming Instruction Bulletin).

The module is installed by aligning the edge connector with the slot provided in the rack, and inserting the card so that it snaps into place. The module should then be secured to the rack with the captive fastening screw on the bottom.

CAUTION: The module should not be inserted or removed while the rack is powered up, or while wires carrying input signals are connected to the module. See Section 3.5 for general start-up procedures and Section 5.1 for application considerations regarding module insertion.

CAUTION

The RIM-121 cannot be used in the lower half of a Series B or later RRK-300.

3.1.2 REPLACING A MODULE

A module may be quickly and easily replaced with another module. There is no need to rewire the analog input points as the terminal strip may be removed by simply loosening the screws which secure this strip (Figure 3). The user must be certain that the DIP switches are properly coded for the desired range. No software re-programming is necessary. See Section 5.1 for application considerations regarding module insertion and removal.

Replacement terminal strips may be obtained by ordering Square D Class 8030 Type CBP-110 Terminal Strips.

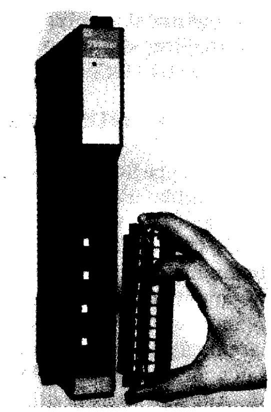


Figure 3

3.2 Keying

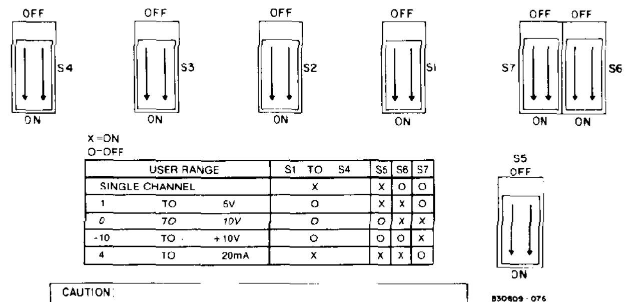
A particular slot on the rack assembly may be keyed to accept only the RIM-121 module. A keying pin kit, Class 8030 Type CBP-104, may be used to insert a keying pin between pins 82 *and 84 of the appropriate slot, as described in the register rack* Instruction Bulletin #30598-265-XX. The same procedure also applies to the register slot of any digital rack.

We recommend that the factory installed keying pins not be removed from the register slots, as they ensure proper alignment between slot pins and edge connector pads as the module is *inserted or removed.*

3.3 DIP Switch Setting

Removing the large cover plate of the side of the module allows user access to DIP switches for selecting the desired current or voltage range. The selected range will be common to all four channels except in the channel 1 fast update mode where *channel 1 is the only channel that can be used. This position* allows channel 1 to be updated every 50 milliseconds in the 4-20 mA range. These settings should never be changed while the module is powered up. See Figure 4 for the appropriate settings; note especially the labeling and orientation of the switches.

CAUTION: DIP switch settings should never be changed while power is applied to the module.



X = ON
O-OFF

USER RANGE			S1 TO S4	S5	S6	S7
SINGLE CHANNEL			X	X	O	O
1	TO	5V	O	X	X	O
0	TO	10V	O	O	X	X
-10	TO	+10V	O	O	O	X
4	TO	20mA	X	X	X	O

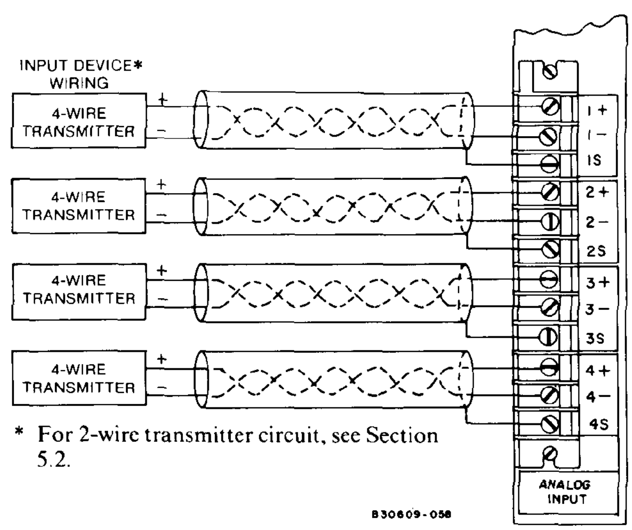
CAUTION:

REMOVE COVER PLATE TO SET SWITCHES AND ENSURE COVER PLATE IS REPLACED BEFORE INSERTING MODULE. FAILURE TO DO SO MAY RESULT IN FAULTY OPERATION.

Figure 4

3.4 Field Wiring Terminations

Each analog input signal is wired to a group of three front terminals. The plus and minus terminals for the respective channels indicate the polarity of the analog input signal. The "S" terminal is provided for the shield wire of each analog input. It is recommended that the wiring used be shielded twisted pair (Belden 8760 or equivalent) with the shield being connected at the analog input module *only.* The user should note that all four minus terminals share a common analog ground. See Section 5.2 for a discussion of wiring considerations.



* For 2-wire transmitter circuit, see Section 5.2.

Figure 5

HARDWARE CONFIGURATION

CRK,DRK,GRK,or HRK Rack		
RIM-121	MODEL 300	Digital I/O Slots
Register Slot 2	CPU Slot 1	

RACK ADDRESSING

CPU Slot 0
Channel 0
Drop Number 0
Slot Number 1 108
Slot Number 2 112

COMMENTS

This will assign analog input channels 1-4 to registers 109-112 in the processor.

Example 1 - Model 300 in a Digital I/O Rack With Register Slot

HARDWARE CONFIGURATION

RRK-100, RRK-200 or RRK-300			
MODEL 300	CRM-210	RIM-121	Empty Register Slots
Slot 1	Slot 2	Slot 3	

RACK ADDRESSING

CPU Slot 0
Channel 0
Drop Number 0
Slot Number 1 —
Slot Number 2 108
Slot Number 3 112

COMMENTS

This will assign analog input channels 1-4 to registers 109-112 in the processor.

Example 2 - Model 300 in a Register Rack

HARDWARE CONFIGURATION

RRK-100, RRK-200 or RRK-300			
MODEL 500 (double width)		RIM-121	Empty Register Slots
Slot 1	Slot 2	Slot 3	

RACK ADDRESSING

CPU Slot 0
Channel 0
Drop Number 0
Slot Number 1 460
Slot Number 2 —
Slot Number 3 464

COMMENTS

This will assign analog input channels 1-4 to registers 461-464 in the processor.

Example 3 - Model 500 in a Register Rack

3.5 Start-Up

3.5.1 NECESSARY PROCESSOR INSTRUCTIONS

After observing the conditions outlined in Section 3.1.1, with rack power off, and with no input signals connected to the terminals of the module, the module may now be inserted into the appropriate slot. If the systems addressing has been correctly assigned to recognize the module in that particular slot and the analog input module's microprocessor is functioning properly, upon power-up bits 25 to 32 of the register status field for the assigned registers will reflect the following code:

11000001
[Bit 32]↑ ↑[Bit 25]

If the above bit pattern is not found in the expected registers, then either the system has been misaddressed or the module has failed its initialization sequence and is sending back an alternate bit pattern to describe the nature of the failure. See Section 4.1.1 for an explanation of the error codes. The module's RUN light may also fail to illuminate.

It is possible that the user will see non-zero values contained in the data field of those processor registers which are monitoring the analog input channels, even when those channels have no input signals connected to them. This is not unusual when operating on any of the voltage range settings, due to the nature of the CMOS multiplexing circuitry.

Should the user wish to be more systematic about checking out the operation of these modules, the above test configurations and systems addressing assignments may be used. These are only intended as examples of possible configurations. Actual system layout is dependent upon the user's understanding of the system definition or rack addressing as outlined in Instruction Bulletin 30598-174-XX or 30598-167-XX or SY/MATE programming software.

3.5.2 NORMAL INDICATING LIGHTS

Illumination of the green RUN light indicates the onboard microprocessor is functioning properly, but does not automatically mean that any incoming analog signals are being properly converted. One of the following situations may exist:

1. The slot into which the module is inserted may be misaddressed.
2. The user may be operating in a range other than what was intended.
3. The pattern of the range switch settings may be invalid.
4. The module may be experiencing one of several miscellaneous non-fatal errors.

See Section 4.1.1 for possible error code conditions, and Section 6 for troubleshooting procedures.

4.0 PROGRAMMING

4.1 Register Usage for System Addressing

Each analog input module will occupy four registers of the system. These four registers should be assigned to the slot in which the module is inserted, and will exist even if some of the channels remain unused.

4.1.1 STATUS AND ERROR REGISTER TABLE

This section describes the possible codes which may be found in bits 25 through 32 of the status field of the assigned registers, generated by the analog input module's on-board microprocessor.

STATUS BITS

32	31	30	29	28	27	26	25	Description
1	1	0	0	0	0	0	1	Normal Operation
0	1	1	0	0	0	1	0	EPROM Failure
0	1	1	0	0	0	0	0	DC-DC Failure
0	1	1	0	0	0	0	1	Range Switch Settings Invalid
0	0	0	1	0	1	0	0	No card acknowledged in slot
0	1	1	0	1	0	0	1	Diagnostics in progress
0	0	0	0	0	0	0	0	Slot not addressed

See Section 6.2 for further explanation of these conditions.

4.2 Types of Programming Equipment

Programming may be accomplished with any series of Class 8010 Type SPR-250, SPR-260, SPR-300 or SPR-310 CRT Programmers or SY/MATE Programming Software.

4.3 Connections of Programming Equipment

Proper programming equipment is to be connected to the processor which controls the slot to which the analog input module is inserted. The module cannot be interrogated separately.

4.4 Program Steps

The values stored in the analog input registers may be utilized as would any storage register value, i.e. in IF's, LET's, COMMS statements, etc. Valid data as contained in the storage registers will range from 5 through 9995 in increments of 5. Thus, the value stored in the register reflects to two decimal places the percentage of the selected range input signal being received. The values 0 and 9999 indicate under-range and over-range conditions, respectively, indication that the signal being inputted falls at the limits or outside the selected range.

4.5 Example Programs

In many cases, the user will wish to scale the incoming signal to reflect the actual voltage or current values being received. The table below indicates the resolution provided with the respective signal ranges, and demonstrates mathematically how the register values may be scaled or converted to their actual input values. The same technique is used to convert a register value to engineering units such as degrees Fahrenheit or Centigrade.

For the following examples assume register 109 contains the signal being measured by the analog input channel, and register 100 contains the mathematical result which has been scaled to reflect the actual voltage or current being input, and that these registers are used strictly for this purpose. Note that a value of 0 or 9999 in register 109 could be flagged as a limit or out-of-range condition.

4.6 Program Editing

Ladder rung statements containing analog input registers may be edited as would any statement containing other storage registers.

RANGE	PROGRAM RUNG	RESULT	RESOLUTION PROVIDED BY ANALOG INPUT MODULE
4-20mA	LET S100 = S109 ÷ 5x8 + 4,000	Read Register 100 in micro-amps	8 micro amps per bit
1-5 VDC	LET S100 = S109 ÷ 5x2 + 1,000	Read Register 100 in millivolts	2 millivolts per bit
0-5 VDC	LET S100 = S109 ÷ 2	Read Register 100 in millivolts	2.5 millivolts per bit
0-10 VDC	LET S100 = S109	Read Register 100 in millivolts	5 millivolts per bit
± 10 VDC	LET S100 = S109x2 — 10,000	Read Register 100 in millivolts	10 millivolts per bit

5.0 APPLICATION CONSIDERATIONS

5.1 Module Insertion and Removal

As noted in Section 3.5.1, the rack should be powered down prior to module insertion. Insertion or removal of a module while the rack is under power may induce a bus error, causing the processor which is addressing the card to go HALT, with the indication of an I/O error. If the processor keyswitch is in RUN, the user should attempt to clear the error by toggling the processor keyswitch momentarily to HALT and then back to RUN. If this fails to clear the error, turn the keyswitch back to HALT and cycle power on the processor and the RIM-121 module. If the error persists, remove power from the rack and attempt to re-seat the module. Similarly, when swapping modules, power should be removed from the rack to avoid the possibility of generating a bus error.

Factory installed keying pins should not be removed from the register slots, as they ensure proper alignment between slot pins and edge connector pads. Removal of the keying pins leaves open the possibility that the module may be inserted or removed at some angle other than straight on, resulting in a mismatch of slot pins and edge connector pads.

It is also recommended that the user connect the signal wires to the input terminals of the module only when the transmitter or signal generating device is powered down. The analog circuitry of the module does not have the same ground reference as the digital circuitry, consequently, since the analog signals are allowed to "float", the actual potential difference which exists between the module channels and the local earth ground will depend on the system layout configuration. See Section 7.3 for a simplified schematic of the module.

5.2 Wiring

The transmitter or signal generator should always be connected to the analog input module via shielded, twisted pair cable, such as Belden 8760. The shield serves to protect the current carrying wires from noise, while the twisting of the wires helps to insure that any noise which does penetrate to corrupt this signal influences both wires equally. In this way, the differential signal level between the two wires is maintained, and the signal will be preserved due to the common-mode voltage rejection designed into the module.

When wiring the RIM-121 channels to the analog signal source or transmitter, proper configuration will depend on the polarity and conventions followed by the manufacturer. The RIM-121 should be treated as any load which is part of the signal loop. Note, 2-wire and 4-wire transmitters will typically be wired with different polarities. For instance, Figure 5 is applicable in cases where the signal generating device provides power to the loop, as with 4-wire transmitters. A 2-wire transmitter, however, would be wired with the polarity opposite as shown, since it acts as a load to the external power supply driving the loop. See the manufacturer's wiring diagram for proper connections.

The following is a list of other recommended practices:

1. The shield must only be connected at one end—at the input module where a terminal is provided for the shield of each pair of signal carrying wires. At the other end (i.e. near the transmitter) the shield should be peeled back and insulated from any contact with the signal carrying wires. This practice of "singly grounding the shield" is especially applicable when a cable has been spliced or nicked; the user should exercise care to insure that the shield is insulated along its entire length, and that it never comes in contact with any other surface.
2. The unshielded portions of the wire run (such as at the transmitter and at the analog input module) should be kept as short as is practical.
3. Wires carrying analog signals should be routed as much as possible away from potential sources of noise such as motors, transformers, contactors, etc. Be especially suspicious of any AC devices. Analog signal wires must NEVER share the same conduit with AC wiring. On those occasions where you must pass close by to AC wiring, do so at right angles.
4. Transmitters should not share the same signal return wire. Furthermore, since all four minus terminals on the module share the same analog ground, all transmitters connected to the module must reference the same ground at the other end. Failure to observe this practice will result in ground loops which will destroy the integrity of the individual signals.
5. The 4-20 mA setting will have better noise immunity. When operating on a voltage range, the allowable length of the wire is limited by the capacitance build-up to a distance of approximately 50 feet. Allowable distance on the current setting is limited by the drive capability of the transmitter (typically 600-1000 ohms) and the total loop resistance.
6. Consult bibliography at the end of this instruction bulletin for extensive information regarding wiring considerations for analog signals.

5.3 Miscellaneous Considerations.

All four channels are updated by the module every 200 milliseconds. This rate is fixed at 50 msec. per channel. Furthermore, the autocalibration system will periodically "steal" a conversion cycle to insure that the span and zero are set correctly.

If update times faster than 200 msec. are desired, the Channel 1 Fast Update Mode (refer to Figure 4) can be used. This mode applies to 4-20 mA signals only and results in channel 1 being updated in 50 milliseconds. Channels 2-4 cannot be used, however; they should be rack addressed but should not be used in the program. If an input signal *other* than 4-20 mA is required, wiring the same input signal to all 4 channels will result in that signal being read every 50 msec., provided the signal source can drive all 4 channels.

When using the analog input module with the Model 500 or 700, it is mandatory that four registers be assigned to each slot in which an analog module is installed. When used with the Model 300, it is possible to assign less than that number if some channels will remain unused; in these cases, input signals should be wired to channels 1 through 4 in descending order, or they will not be accessible.

Due to the nature of the CMOS multiplexing circuitry, non-zero values may appear across the plus and minus terminals when operating on a voltage range, even with no wires connected to them. This is an inherent characteristic of the high *input impedance exhibited by solid state multiplexers, and is a* normal condition which the user should be aware of.

When used with the Class 8040 PCM-110, a jumper on the RIM-121 must be inserted between pins 2 and 4 to provide update synchronization. This jumper is accessed by removing the modules side panel. Factory position of the jumper is between pins 1 and 2.

Module "minus" inputs are not individually isolated. Connecting analog input signals with different ground references from each other to the same module could result in erroneous readings.

Analog values are inherently temperature sensitive; the specified accuracy of 0.5% of full scale range over 0-60°C range improves to 0.1% at room temperature. High resolution without improved accuracy is meaningless to the point of being misleading.

The RIM-121 is unable to properly interpret DC voltages below -13 VDC (± 10 VDC range). DC voltages *below* this will result in incorrect data (values other than Ø) present in the register assigned to that analog input point. No damage will result to the module up to ± 50 VDC.

6.0 TROUBLESHOOTING

6.1 Diagnostic Light

The RUN LED indicates the on board microprocessor is functioning properly. Section 3.5.2 lists some situations in which the RUN LED may be ON, but the analog signals are not being properly converted. Hence, while an illuminated light does not always indicate proper operation, one can assume that a light which fails to come on indicates a definite problem.

Failures experienced by the analog input module are classified as fatal or non-fatal. Fatal errors are indicated by the RUN light remaining OFF. Recovery (when possible) can only be accomplished by cycling power to the rack in which the module is located. In the case of a non-fatal error, the RUN light will illuminate but the processor (or drop) may refuse to go into RUN. Simple toggling of the processor keyswitch to HALT and back to RUN may be sufficient to clear the error. Distinctions between fatal and non-fatal errors are handled in this fashion because under certain "cold start" conditions, module circuitry may require a brief warm-up period. Such a condition is not a true module error, but rather a physical circuitry limitation which clears itself after a brief period of time. In these cases, toggling the processor keyswitch is sufficient to allow the system to recover.

If the light fails to come on at all, the module is not receiving DC power; check to see that the rack is connected to a properly sized SY/MAX power supply which is itself producing power. If the RUN light flashes briefly upon the application of power, this indicates that the module has failed to complete its power-up sequence of checks and is annunciating a fatal error. Once again, this does not necessarily indicate a defective analog input module. The DC power being provided may be inadequate to sustain operation. This will also occur if ther is no processor or remote interface module located in the same rack, since the module's microprocessor can sense that there is no device present with which to communicate.

When confronted with an analog input module whose RUN light refuses to illuminate, the user would therefore do well to try the module in a configuration in which these possibilities can be ruled out. See Section 3.5.1 for examples of simple trial layouts. If the module is proven to be defective, register status bits will identify the reason.

6.2 Using Programming Equipment

Assuming the RUN light is ON, the user should now check the controlling processor to verify that communication has been established. This is best done by using the CRT in the MONITOR mode to examine the storage registers which the user believes to be reading the analog input channels. Status bits 25 through 32 of the respective registers reveal a wealth of information. Section 4.1.1 contains a table of the status bits describing conditions associated with the analog input module; failure of *any* of the listed codes to appear most likely indicates a rack slot addressing problem. See Instruction Bulletin 30598-174-XX or 30598-167-XX or SY/MATE programming software.

The codes of Section 4.1.1 may be interpreted as follows:

A. Normal Operation—All *digital* circuitry is functioning reliably. The application of a signal within the intended operating range should cause changes in the assigned storage register to reflect the changing input. If this does not occur, suspect either the signal generating device or the analog circuit portion of the analog input module. Note that it is possible for the multiplexer or the analog to digital converter chip to malfunction and still give the indication of normal operation with RUN LED illumination.

B. EPROM Failure — The module is defective and must be replaced.

C. DC-DC Failure — The DC power being supplied to the digital circuitry of the module is insufficient for reliable operation. If the SY/MAX power supply powering the rack is functioning properly, the fault lies with the DC-to-DC converter in the analog input module. The module should be replaced.

D. Range Switch Settings Invalid—As part of the initialization sequence of the module, a check is performed on the DIP switch settings for the range selection (see section 3.3). Power down the rack, remove the module and recheck the switches for a valid combination.

E. No Card Acknowledged In Slot—The processor is not recognizing the presence of the module. Try reinserting the module to make sure that it is seated properly. Check rack slot addressing for proper allocation of registers and slots.

F. Slot Not Addressed — The system is not properly configured.

6.3 Erratic Operation

If the user remains uncertain as to which element in the system may be causing a problem, suggest trying the hardware configuration of one of the examples of Section 3.5.1. By virtue of their simplicity, numerous factors are eliminated to help narrow down the source of the problem.

7.0 THEORY OF OPERATION

7.1 Block Diagram

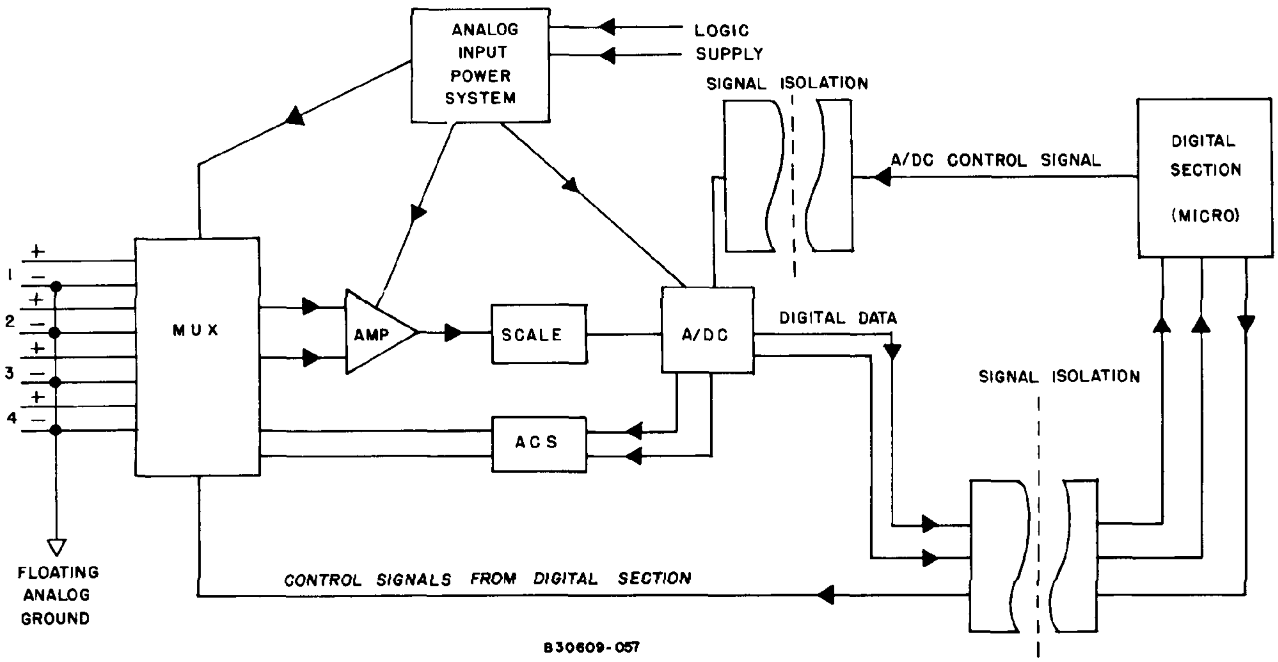


Figure 6

7.2 Detailed Description

This section describes the subsystems shown in Section 7.1.

The analog input module has its own DC/DC power supply, converting the 5 VDC from the SY/MAX power supply connected to the rack to the ±15 VDC level required by the analog circuitry. This conditioned ±15 VDC is used to furnish a regulated reference of 5 VDC and 10 VDC required by the other analog subsystems.

The module employs an eight-channel, single-ended CMOS multiplexer (Harris Type 508B) to switch in turn each of the four channels providing the input signals to the analog to digital converter (four channels are used to read the input signals, while the remaining channels are used by the auto calibration system in selecting 5 VDC and 10 VDC voltage references).

After the multiplexer has selected the input channel, the analog signal is then scaled to a proportional level which the analog to digital converter is able to interpret.

The card employs the Analog Devices Type 7550 BD CMOS quad-slope integrating analog to digital converter (A/DC). The quad-slope integrating technique is especially suitable for use in the industrial environment due to its superior noise immunity. It also provides both auto-zeroing and low sensitivity to component error, variations in the supply, and temperature changes. The 13-bit resolution of the A/DC combines with these factors to ensure the accuracy and reliability of the 11-bits (1 part in 2000) seen by the user. Without additional calibrating techniques, the zero drift and gain temperature coefficients are less than 1 ppm per °C maximum.

The analog circuitry of the module is designed to float at the potential of the analog input common. Power isolation is accomplished by an Analog Devices AD949 DC-to-DC converter. Signal isolation is accomplished by means of HP optical couplers and Litronix opto-isolators.

The automatic calibration subsystem (ACS), under control of the module's own microprocessor, replaces the need for calibrated input signals in order to make adjustments to eliminate initial errors in system offset and gain. The ACS uses extra channels of the MUX network to apply DC voltage references to the A/DC. These signals are used as a base line so that when subsequent conversions are performed on field analog input signals, the conversion circuitry uses this offset and gain information to correct the digital value. This ACS cycle takes place initially at power-up and at random intervals thereafter. The reliability of the ACS is a function of the following points:

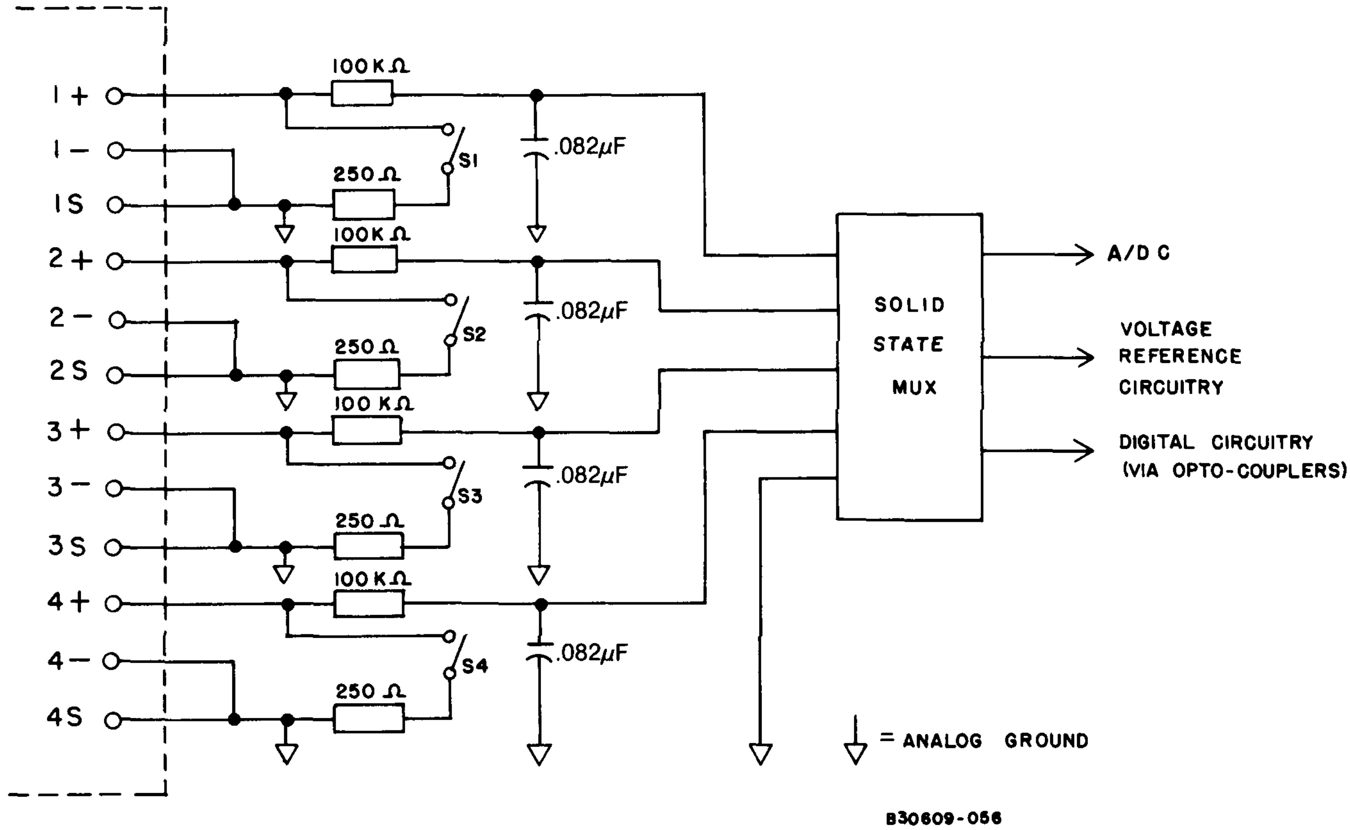
1. Most of the initial error and temperature drift in the system resides in the amplifier and scaler portions of the circuit (as opposed to the MUX or the A/DC).

2. The ratiometric A/DC used has low drift over the temperature range, is monotonic, and has more resolution (13 bits) then what is seen by the user.

3. The DC voltage reference has good initial accuracy and low drift.

The operation of the module is governed by the Intel 8031 microprocessor, performing such tasks as power-up and operating diagnostics checks, as well as the auto-calibration and the timing associated with the entire conversion process. The Intel 8255A PPI chip is used to govern bus traffic.

7.3 Simplified Schematic (Input Circuitry)



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