

AIM6

RTD Analog Input Module

The AIM6 RTD Analog Input Module provides appropriate signal conditioning for either 100 Ω RTDs or AD590/AC2626 semiconductor temperature sensors. Four input channels are provided. All four channels must be configured for the same type of sensor.

The AIM6 module can accept common mode voltages to ± 6 V. Optional resistors convert current output to voltage output for the connection of AD590 and AC2626 temperature sensors.

All connections are made to on-card screw terminals.

The AIM6 module may be placed in slots 2 through 10 of a 500A or 500P chassis, or slot 3 of a 575 or 576 chassis. To install the module in a 500A or 500P, remove the baseboard top cover and insert it into the desired slot with the component side facing the power supply. To minimize temperature effects from the power supply and to keep noise pickup to a minimum, it is recommended that the AIM6 module be installed as close to the AMM module as possible. Generally, analog modules should be placed in the low-numbered slots while digital modules should be placed in the high-numbered slots to minimize these effects. For installation into a 575 or 576 chassis, consult the hardware manual for that chassis.

CAUTION: Always turn off the system before installing or removing modules. To minimize the possibility of EMI radiation, never operate the system with the top cover removed. Unused inputs should be connected to module ground.

User-Configured Components

One bank of screw terminals is provided on the AIM6 module. In addition to high (+), low (-) and ground terminals, the AIM6 module has a single terminal to provide a +10V excitation for AD590/AC2626 temperature sensors. A potentiometer allows adjustment of the excitation voltage.

Table 1. User-Configured Components on the AIM6 Module

Component	Designation	Function
Screw terminals	J164	Input screw terminals for channels 0-3, including high, low, and ground for each channel.
Screw terminal	E+	Excitation terminal for strain gages and/or AD590/AC2626 inputs.

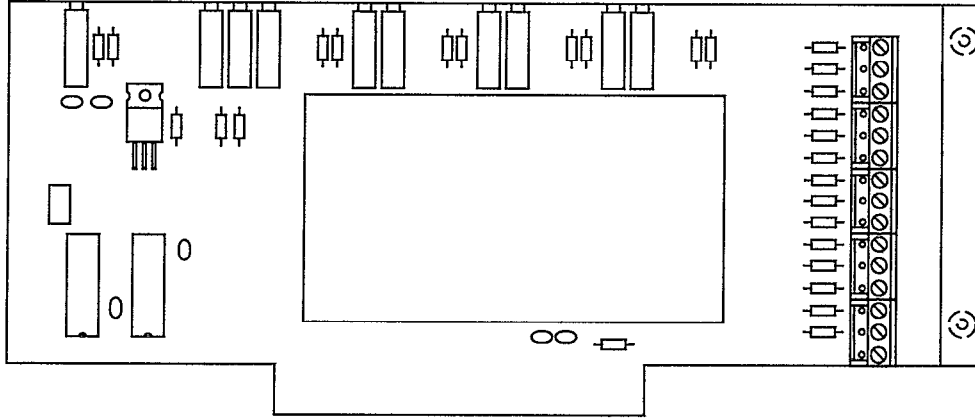


Figure 1. AIM6 Module Configuration

Connections

Terminals for the four channels available on the AIM6 are marked on the module board. A typical connection is illustrated in Figure 2. All terminals accept 16-24 gage wire, stripped to 3/16 of an inch.

CAUTION: The use of shielded cable is recommended to minimize the possibility of EMI radiation.

E+ is a single screw terminal which provides a +10V excitation source for AD590/AC2626 temperature sensors connected to the AIM6 module. Information on connecting these devices to the excitation terminal is covered in the following section.

Excitation for RTDs is not provided for by this terminal, but by the signal conditioning circuitry of the module.

Strain Gauges

The AIM6 can be used to measure strain gauges. Figure 2 below details the strain gauge bridge connections.

Note: Strain gauge channels can be mixed with AD590 channels on an AIM6. However, neither strain gauge nor AD590 channels can be mixed with RTD channels on the same AIM6. KDAC500 software does not support engineering units conversion of strain gauge data on the AIM6. The programmer must convert the raw voltage readings of the AIM6 module to engineering units.

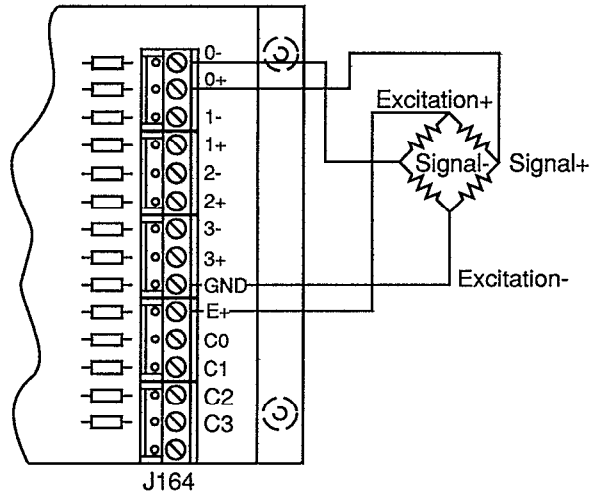


Figure 2. AIM6 STRAIN GAUGE Connection (Channel 0 shown)

Current to Voltage Conversion

By installing optional resistors each channel can be modified to accept current input from AD590/AC2626 temperature sensors. These resistors can be installed between the high (+) and low (-) input terminals, for each channel of current input.

A 210Ω resistor is recommended for the temperature sensor inputs. The resulting voltage output is determined by Ohm's law:

$$E=I \cdot R$$

$$\text{Voltage (volts)} = \text{Current (amps)} * \text{Resistance (ohms)}$$

Resistance Temperature Detectors (RTDs)

The most common type of RTD is the platinum resistance thermometer, simply a coil of very pure platinum wire calibrated to have a known resistance (often 100Ω) at 0°C. This coil responds to changes in temperature with predictable (but not linear) changes in resistance. By directing a current through the RTD and measuring voltage, the temperature can be determined as a function of the resistance.

The wire leads that connect the RTD to the measuring device also have a resistance which changes with temperature. This property is a potential source of measurement error, especially when the leads are long. For this reason, RTDs are available with a third lead which minimizes the effects of the resistance of the other leads.

Connecting RTDs to the AIM6

The AIM6 module will accept both two-wire and three-wire 100 Ω RTDs. An excitation current of 0.4mA is provided automatically when the module is set to the RTD mode. While the AIM6 can accept non-100 Ω RTDs (provided the resulting full scan voltage range is acceptable to the user), KDAC500 software does not support linearization and conversion of non-100 Ω RTD data into degrees.

A local gain of x50 allows the RTD to measure temperatures from 200 to +700 $^{\circ}$ C, with a voltage output ranging from 1.629 to 5.084V. Temperatures higher than 700 degrees should not be measured with the AIM6 in this configuration, since at higher temperatures the voltage output of the RTD will exceed the +5V range of the module.

RTDs of other types, with other calibrated resistances, may be connected to the AIM6 if voltage output will be compatible with the x50 gain factor. In all cases, the output voltage (after amplification) should not exceed ± 5 V, or measurement errors will occur.

When three-wire RTDs are used, the positive lead (from the single lead end of the RTD) should be connected to the positive screw terminal of the channel being measured. The negative lead from the other end should be connected to the negative terminal, and the ground lead connected to the ground terminal (see Figure 3).

When connecting two-wire RTDs, one lead should connect to the positive terminal, and the other to the negative terminal. A short jumper should be installed from the negative terminal to the ground terminal for that channel (see Figure 4).

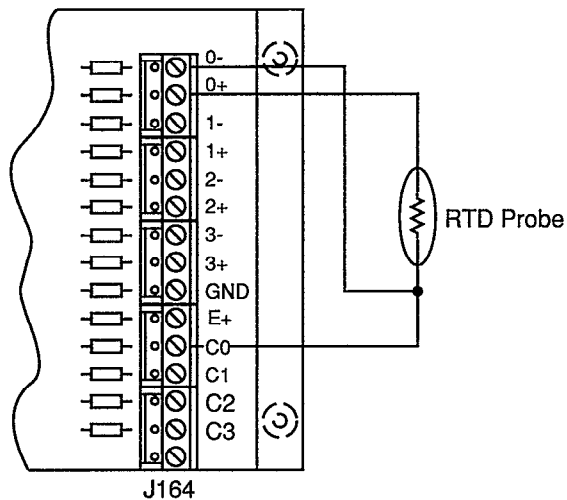


Figure 3. AIM6 3-wire Connection (Channel 0 shown)

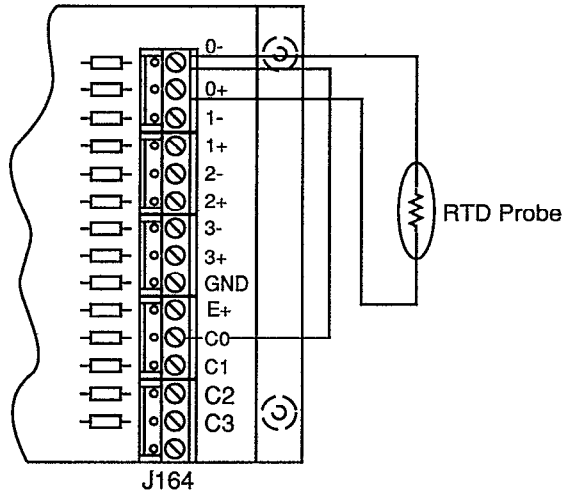


Figure 4. Typical AIM6 2-wire RTD Connections (Channel 0 shown)

Before selecting a channel, the RTD command (location CMDB) should be loaded with 1. This command sets the module to RTD mode, enabling the automatic excitation feature and selecting a gain of x50.

The voltage measured by the A/D converters will be related to the resistance of the RTD according to the following formula:

$$V_{OUT} = ((0.0004 * R_{RTD} - 0.04) * G)$$

Where V_{OUT} is the voltage measured by the AMM A/D converter, R_{RTD} is the resistance of the RTD, and G is the gain factor applied to the signal. The gain factor should take into account the gain of x50 applied when the RTD (CMDB) location is loaded with 1 as well as the global gain of the AMM module (slot 1). If the global gain of the AMM card is set to 2, then $G = 50 \times 2 = 100$.

AD590 and AC2626 Semiconductor Temperature Sensors

Because these sensors produce a current output, a resistor with a value of 210 Ω should be installed across the + and - input terminals or in the user installed area on the AIM6 (see Figure 5) for each channel. The resistors will convert the current range into an appropriate voltage range.

The positive lead of the AD590/AC2626 should be connected to the excitation terminal of the AIM6, which provides a +10V excitation source. The negative lead should be connected to the positive terminal of the input channel. It is also necessary to install a short jumper wire between the negative and ground terminals of each channel being measured (see Figure 5).

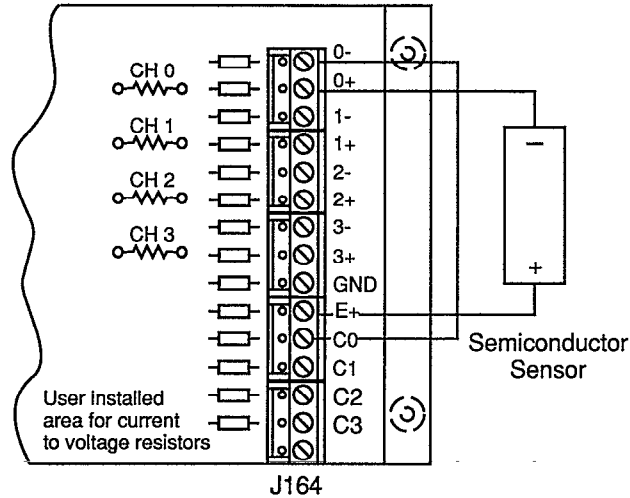


Figure 5. Typical AIM6 Semiconductor Temperature Sensor

When measuring an AD590/AC2626, the RTD (CMDB) location should be loaded with value 3. Loading this value selects the AD590 mode, and automatically applies a local gain of x50. RTD (CMDB) should be issued before the SELECT CHANNEL command. If the A/D converter is set to a range of $\pm 10V$, a global gain of x2 should be applied via the PGA on the AMM module.

The voltage measured by the AMM A/D converter will have the following relationship to the current produced by the temperature sensors.

$$V = (I * 210) * G$$

Where V is the voltage measured by AMM A/D converter, I is the current output from the sensors (in amps), and G is the gain applied to the signal. Note that the total gain is the product of the local gain factor (x50) and the global gain factor (selected via PGA on AMM module). Note that the AD590 sensor outputs $298.2\mu A$ @ $25^{\circ}C$. Its output changes $1\mu A$ per $^{\circ}C$ over its usable range of $-50^{\circ}C$ to $+150^{\circ}C$.

Commands

The AIM6 module commands are listed in Table 2. Table 3 summarizes the locations for slot-dependent commands.

Table 2. Commands Used with the AIM6 Module

Command	Location
SELECT CHANNEL	Slot-dependent CMDA
RTD	Slot-dependent CMDB

Table 3. Locations for Slot-dependent Commands

Slot	CMDA	CMDB
Slot 2	CFF82	CFF83
Slot 3	CFF84	CFF85
Slot 4	CFF86	CFF87
Slot 5	CFF88	CFF89
Slot 6	CFF8A	CFF8B
Slot 7	CFF8C	CFF8D
Slot 8	CFF8E	CFF8F
Slot 9	CFF90	CFF91
Slot 10	CFF92	CFF93

Note: Above addresses assume IBIN address switch set to CFF80.

SELECT CHANNEL

Location: Slot-dependent CMDA

The SELECT CHANNEL command location is used by all analog input modules to select a channel. When selecting a channel, the number of that channel is written into the appropriate CMDA location. On the AIM6 module, any one of four channels, numbered 0-3, can be selected with the SELECT CHANNEL command (see Table 4).

SELECT CHANNEL always either follows or precedes the SELECT SLOT command, which should be issued with the number of the slot in which the AIM6 module is installed. SELECT SLOT affects the global multiplexer on the AMM module and is described in the reference section for that module.

When measuring the same channel repeatedly, the SELECT CHANNEL command need not be reissued for every measurement. Similarly, when several channels on the same AIM6 module are read in succession, the SELECT SLOT command need only be issued once at the start of the sequence. Both SELECT SLOT and SELECT CHANNEL must be issued at least once before starting any A/D conversions, or the data will be invalid.

Table 4. Values Written to SELECT CHANNEL

Function	Binary	Hex	Decimal
Channel 0	00000	H0	0
Channel 1	00001	H1	1
Channel 2	00010	H2	2
Channel 3	00011	H3	3

RTD

Location: Slot-dependent CMDDB

This command location is used to set two parameters of the RTD Input Module: the mode (RTD or AD590) and the gain applied to the input (x50 or x166.6).

This command, like SELECT GAIN (which applies to the AMM module) should always be issued at least once at the start of the program, or the settings of the module will be determined randomly (see Table 5).

Only the two lowest ordered bits (D0 and D1) of this location are used, D0 sets the gain (high = x50, low = x166.6), while D1 selects between the RTD and AD590 modes (high = AD590, low = RTD). Table 5 shows gains and modes for specific decimal values.

Table 5. Decimal Values Written to RTD

Value	Gain	Mode
0	x166.6	RTD
1	x50	RTD
2	x166.6	AD590/strain gauge
3	x50	AD590/strain gauge

AIM6 Module Calibration

The AIM6 module calibration procedure may be divided into two steps: +10V excitation source calibration and RTD mode calibration. See Figure 6 for adjustment locations.

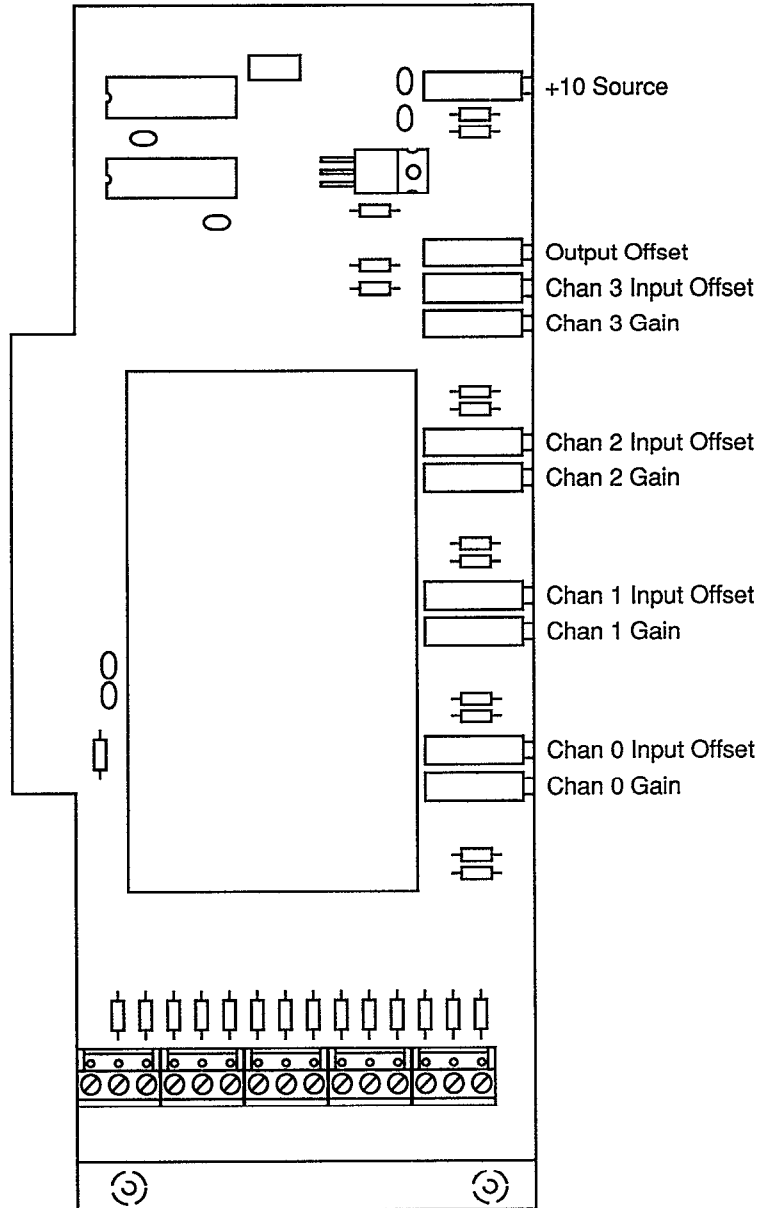


Figure 6. AIM6 Calibration Adjustments

+10V Source Calibration

Calibrate the +10V excitation source as follows:

1. Place the AIM6 in the desired slot.
2. Connect the DMM high input to the E+ terminal on the module. Connect the DMM low input lead to module ground.
3. Adjust the +10V excitation trim control (R119) for a reading of $10V \pm 1mV$ on the DMM.

RTD Mode Calibration

Individual channels may be calibrated for the RTD mode with the following procedure.

1. Place the AIM6 module in slot 4.
2. Connect the - terminal of the channel being calibrated to module ground. Connect a jumper wire between the + and - terminals of channels not being calibrated. Leave unused inputs shorted.
3. Connect the DMM high input to module analog output (W102). Connect DMM low to module ground.
4. POKE the SELECT CHANNEL location (CFF86) with the channel number to be calibrated (channel 0 = 0, channel 1 = 1, etc.).
5. Set the module to the RTD mode with a gain of x50 by POKEing a value of 1 into the RTD location (CFF87).
6. Connect a $100\Omega \pm 1\%$ resistor between the + and - terminals of the channel being calibrated.
7. Adjust the input offset control for that channel for a reading of $0V \pm 1mV$ on the DMM. If the adjustment has insufficient range, adjust the output offset control. If the output offset is adjusted, previously calibrated channels will require readjustment of their respective input offset controls.
8. Remove the 100Ω resistor and substitute a $200\Omega \pm 0.1\%$ resistor in its place.
9. Adjust the channel gain control for a reading of $2V \pm 1mV$ on the DMM.
10. Adjust the other channels, if desired, using the above procedure. POKE the SELECT CHANNEL location with the channel number being calibrated, and be sure to connect the - input terminal for that channel to module ground. Also, leave unused inputs shorted.

Theory of Operation

The AIM6 schematic is located on drawing number 500-186.

The primary component of the RTD Input Module is U101, which provides signal conditioning and multiplexing for four channels of input from RTDs and AD590/AC2626 temperature sensors. When the RTD mode is enabled, an excitation current of 0.4mA is provided automatically. Gain factors of x50 and x166.6 can be selected from software. The inputs of U101 are connected to input screw terminals, and output is routed to an AN OUT path leaving the module.

Circuit U102 controls channel selection in U101. U102 is a 74LS75 quad transparent data latch which stores the status of data lines D0 and D1 in response to the SELECT CHANNEL command (signal line CMDA).

A second segment of U102 drives the mode and gain selection for U101, storing the status of signal lines D0 and D1 in response to the RTD command (signal line CMDB).

Each channel has a resistor-potentiometer combination to control the gain, as well as another potentiometer to adjust input offset. R101, R105, R109 and R113 adjust the gain of channels 0-3 respectively, while R104, R108, R112 and R116 provide input offset trim. A single output offset control, R120, affects all channels.

The +10V excitation for temperature sensors is provided by VR101 (LM317), which regulates the +15V baseboard supply down to the required +10V. An adjustment of range of $\pm 10\%$ is provided by R119.

AIM6 Specifications

Input channels: 4, configurable for RTD measurements

Output channels: RTD excitation current

Input Characteristics:

Gain: x50, software selectable for each channel

Input range: x50, $\pm 100\text{mV}$ max; x166.6, $\pm 30\text{mV}$ max

Accuracy:

Gain:

x50, $\pm 0.6\%$ adjustable to 1 lsb

x166.6, $\pm 0.8\%$ adjustable to 1 lsb

Gain non-linearity: $\pm 0.01\%$ max

Offset: $\pm 150\mu\text{V}$ max, adjustable to zero (RTI)

Temperature coefficient:

x50, x166.6: $\pm 0.0025\%/^{\circ}\text{C}$

Input offset: $+1\mu\text{V}/^{\circ}\text{C}$

Input noise voltage: $1.5\mu\text{V}$ p-p, 0.01Hz to 100Hz, $R_s < 1\text{k}\Omega$

Input bias current: 10nA

Input resistance: $20\text{M}\Omega$

Protection: 130V RMS max normal mode, $f \leq 60\text{Hz}$

Common mode voltage: $\pm 6\text{V}$ peak

Common mode rejection: 94dB, $R_s 100\Omega$, $f \leq 60\text{Hz}$, x166.6

Normal mode rejection: 22dB, $f \geq 50\text{Hz}$

Settling time: 0.4sec to 0.01%

Output characteristics:

RTD excitation current: $0.4\text{mA} \pm 1\%$

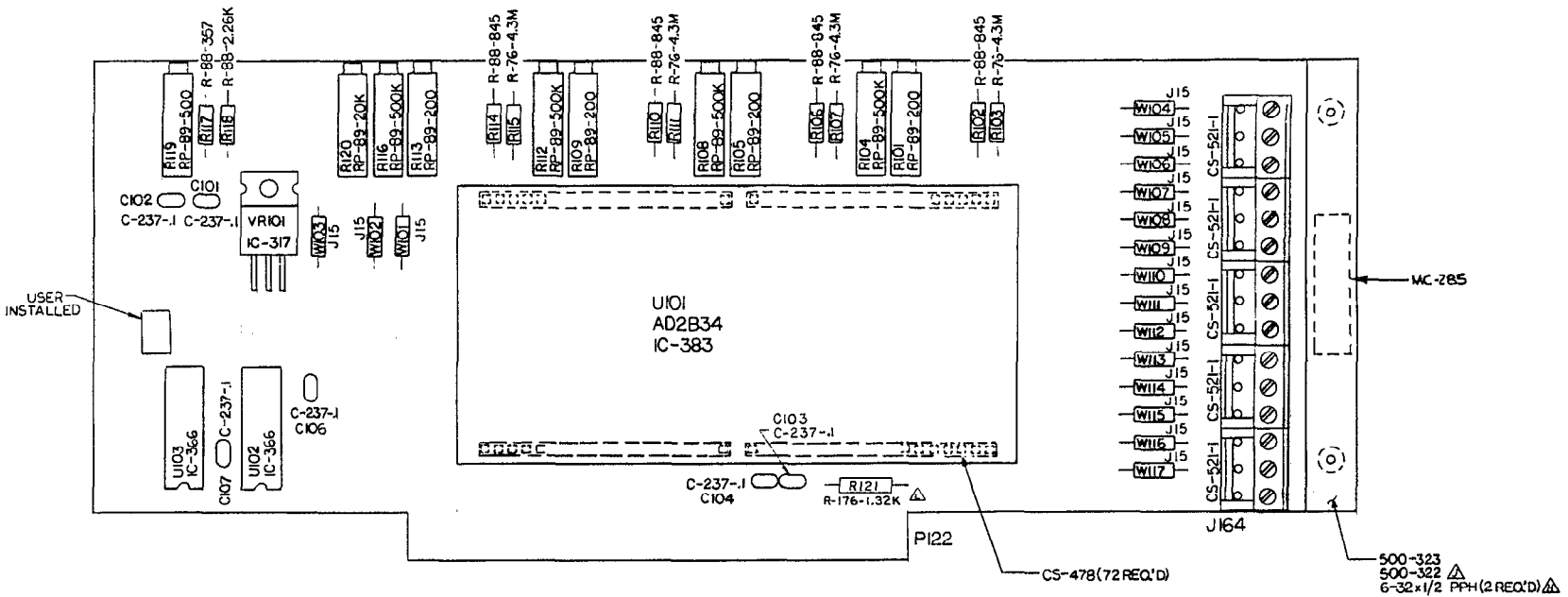
Temperature coefficient: $\pm 0.001\%/^{\circ}\text{C}$

RTD mode

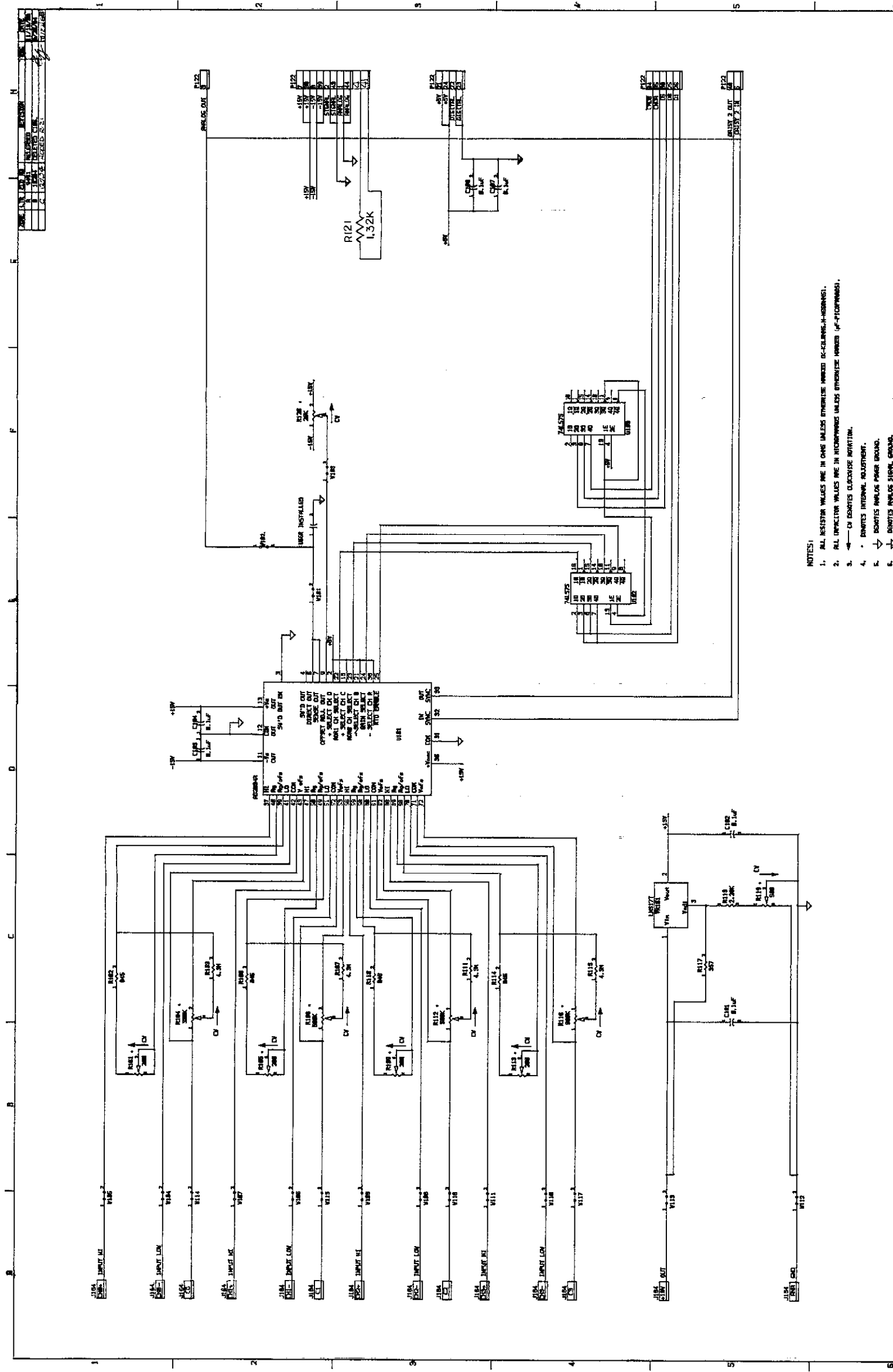
Input range: 0-350 Ω , x50 gain

Measurable temperature span with 100 Ω RTD: -200°C to $+700^{\circ}\text{C}$

AIM6 COMPONENT LAYOUT



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- NOTES:
1. ALL RESISTOR VALUES ARE IN OHMS UNLESS OTHERWISE INDICATED (K=KILOHMS, M=MEGAS).
 2. ALL DIMENSIONAL VALUES ARE IN INCHES UNLESS OTHERWISE INDICATED (F=FRAC). (F=1/16).
 3. ← C1 INDICATES CLOCKWISE ROTATION.
 4. • INDICATES INTERNAL ADJUSTMENT.
 5. ∇ INDICATES ANALOG POWER GROUND.
 6. ∇ INDICATES ANALOG SIGNAL GROUND.
 7. ∇ INDICATES DIGITAL GROUND.

DATE	BY	REVISION
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FILE	KEITHLEY 4000
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PROJECT IDENTIFICATION	SCHEMATIC IDENTIFICATION	DATE	BY
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