Model 3565-V1A

8-channel RTD Signal Conditioner

INSTRUCTION MANUAL

April, 1992

SPECIAL OPTION

Model 3565-S001

8/16-channel RTD Signal Conditioner

May, 1991

SPECIAL OPTION

The 3565-S001 is the same as a 3565-V1A except that it is designed to be used with 120 Ω RTDs rather than 100 Ω RTDs. All bridge completion resistors are 120 Ω, .05%, ±5ppm/°C. The calibration resistors are 140 Ω, .05%. ±5ppm/°C.

RMF:rem(WP)
May 28, 1991

*****Special Option*****

Model 3565-S002

8-channel RTD Signal Conditioner

December, 1992

*****Special Option*****

Model 3565-S002

The Model 3565-S002 is the same as the Model 3565-V1A except for the following changes:

1. The 100 ohm 0.05% current monitor resistors are replaced with 100 ohm 0.005% resistors.

2. Channels 4, 5 and 6 are used to monitor the current on channels 1, 2, and 3, respectively.

3. Channels 7 and 8 are tied to ground for use as a zero reference.

September 30, 1992
KPG:rem

Special Option

Model 3565-S003

8-channel RTD Signal Conditioner

December, 1992

*****Special Option*****

Model 3565-S003

The Model 3565-S003 is the same as the Model 3565-V1A except for the following changes:

1. The 100 ohm 0.05% bridge completion resistors are replaced with 10 ohm 0.05% resistors.

2. The 100 ohm 0.05% current monitor resistors are replaced with 10 ohm 0.05% resistors.

3. Each channel's constant current source is modified to provide 10 milliamperes, rather than the standard 1 milliampere.

September 30, 1992
KPG:rem

*****Special Option*****

Model 3565-S005

8-channel RTD Signal Conditioner

August, 1996

*****Special Option*****

Model 3565-S005

The Model 3565-S005 is the same as the Model 3565-V1A (Special Option 3565-S002) except for the following changes:

1. The 100 ohm current monitor resistors are replaced with 500 ohm ±0.005% resistors.

2. Channels 4, 5 and 6 are used to monitor the current on channels 1, 2, and 3, respectively.

3. Channels 7 and 8 are tied to ground for use as a zero reference.

August, 1996

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RMF/KPG:rem(WP)

KineticSystems Corporation

Standardized Data Acquisition and Control Systems **3565**

8-channel RTD Signal Conditioner

ADVANCE INFORMATION

(Rev. Apr. 92)

FEATURES

- **8 channels**
- **Bridge measurements with two-, three-, or four-wire 100 ohm RTDs**
- **Also accommodates current-excited four-wire RTDs**
- **On-board excitation source**
- **On-board calibration resistor**
- **Two-pole, lowpass filter per channel**
- **Multiplexer for use with 3518 ADC**

APPLICATIONS

- **Jet and rocket engine testing**
- **General-purpose data acquisition**

GENERAL DESCRIPTION

The Model 3565 is a single-width CAMAC module providing eight channels of RTD (Resistance Temperature Detector) bridge completion and input filtering as well as input multiplexing. It is used with the Model 3518 Scanning A/D Converter Host module.

The 3565 can accommodate RTD transducers of the two-, three-, or four-wire type. Each channel of this input module contains the remaining three legs of the bridge for 100 ohm RTDs. If RTDs other than 100 ohms are desired, please contact KineticSystems Corporation for additional bridge resistor options. In addition each channel can be strap-selected for current excitation of four-wire RTDs with resistance values to 1000 ohms. An excitation source adjustment is provided for each channel. An on-board calibration resistor may be switched in on a channel-by-channel basis by means of a calibration relay register. The calibration relay register can be written and read via the Dataway.

Wiring from the transducers is brought into the 3565 via AMP, 36-contact, high-density, rectangular connectors mounted to the front panel. These connectors mate directly with the Model 5944-Z1A mating connectors and with the Model 5855-Series of cable assemblies. The multiplexer output and control signals are bussed between the front panel of the 3565, other signal conditioning modules, and the 3518 ADC module via the Model 5840-Series of 10-wire flat ribbon cable assemblies. The front panel also contains a LED which flashes whenever the module is addressed.

FUNCTION CODES

Command		Q	Action
F(0)·A(0)	RD1	1	Reads the calibration relay register.
F(1)·A(0)	RD2	1	Reads the state of the channel selection switches.
F(16)·A(0)	WT1	1	Writes the calibration relay register.
Z·S2	ZED		No action.
Note: X = 1 for all valid addressed commands.			

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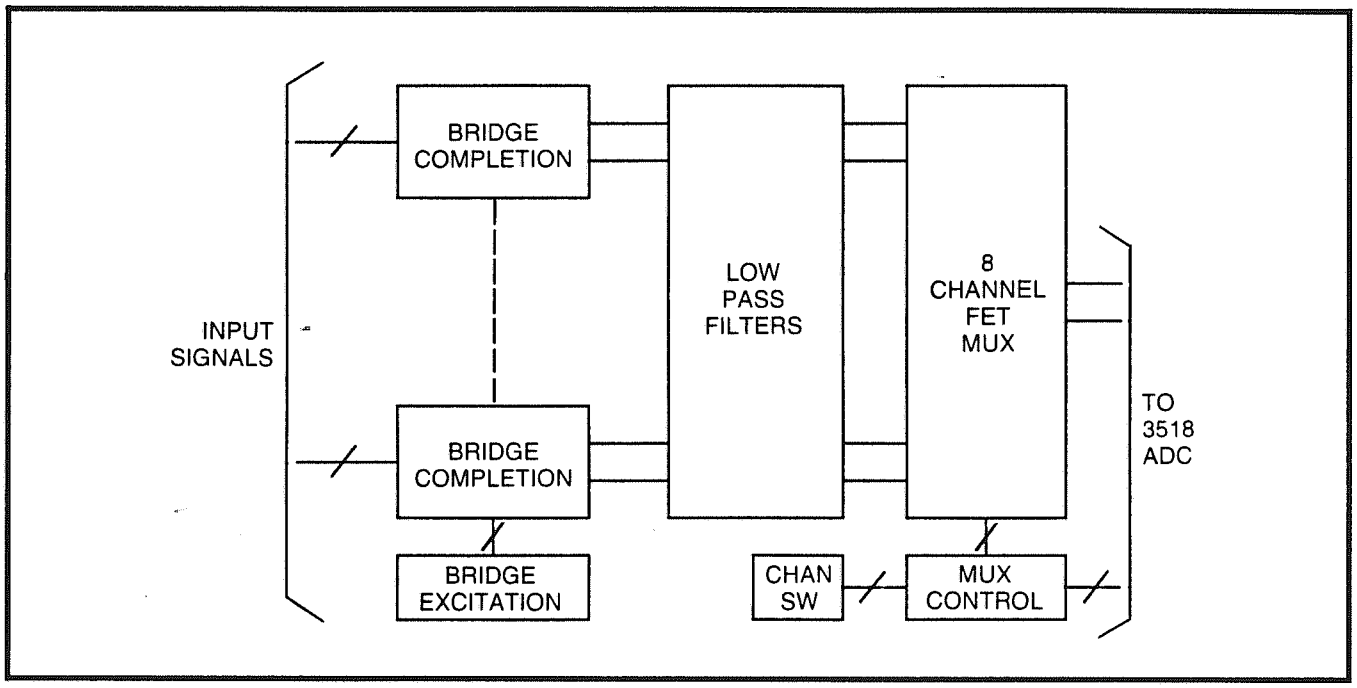
SIMPLIFIED BLOCK DIAGRAM



FILTERS

The 3565 contains a passive, lowpass filter per channel. These filters provide a nominal 3dB attenuation at 10 hertz with a rolloff of 12 dB per octave above 10 hertz. Contact KineticSystems Corporation for filters with other cutoff frequencies.

CHANNEL SELECTION

If the 3565 Channel Address switch is set to "0," then its first channel corresponds to the first channel of a 3518 scan. The Channel Address switch can be set from 0 to 7 (with the first channel from the 3565 in the appropriate four-channel group on the 3518). The number of scanned channels in the 3565 is also switch-selectable to four or eight. This allows maximum flexibility in configuring a system with multiple input modules connected to a 3518. The First Channel address and the number of scanned channels can be read via the Dataway for verification.

POWER REQUIREMENTS

+6 volts — 670 mA
+24 — 45 mA
−24 — 20 mA

ORDERING INFORMATION

Weight:.62 kg. (1 lb. 6 oz.)

Model 3565-V1A — 8-channel RTD Signal Conditioner

Accessories —
Model 3518-Z1A 16-bit Scanning A/D Converter Host
Model 5944-Z1A Mating Connector
Model 1854-A2A Termination Panel with 5855-B30J Cables
Model 5855-A30J Cable Assembly

MODULE CONNECTIONS

Wiring from the transducers is brought into the 3565 via the Amp 36-position front-panel connector P2. This connector mates directly with Model 5944-Z1A mating connectors and Model 5855-Series cable assemblies. See Figures 4, 5, and 6 (pages 7, and 8) for proper signal connections.

The multiplexer output and control signals are bussed between front-panel connector P3 of the 3565, other signal conditioning modules and the 3518 ADC module via a 10-wire flat-ribbon cable (Model 5840 Series).

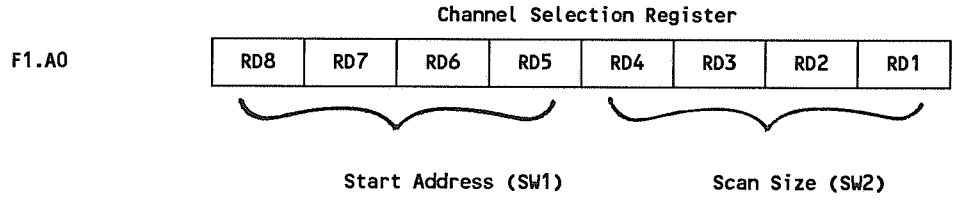
CHANNEL SELECTION REGISTER AND SWITCH SETTINGS

The 3565 is part of the 3518 family of signal conditioning modules. The 3518 acts as a signal conditioner host and interfaces to any combination of 3563, 3564, 3565 and 3569 modules through a single, 10-pin, front-panel connector. Since all of the signal conditioning modules share this common bus, address switches must be set on each module to enable the analog output onto the bus at the appropriate times. The 3518 is capable of digitizing 32 channels of analog input. The output from a given signal conditioning module may lie anywhere within the 3518's 32-channel spectrum. The starting channel and number of channels to be scanned are switch-selectable in groups of four at the signal conditioning module. Figure 1 (see page 4) shows a sample configuration involving multiple types of signal conditioning modules. Figure 2 (see page 5) shows the switch selections required for various starting addresses and scan sizes. When setting these switches at each signal conditioning module, care must be taken to insure that no two modules occupy the same portion of the 3518's address spectrum.

If an overlap condition does occur, the 3518 will detect it and flash the error LED until the configuration is corrected. The 3518 will also disable all signal conditioners during the overlap period to protect the equipment. The first-channel-scanned switch (start address) is switch SW1. The number of channels to be scanned (scan size) is selected by the scan size switch, SW2. Both switches can be read via the Dataway for verification by using the CAMAC command F(1)A(0).

Channel	Input	Start Addr. Switch	Scan Size Switch
0	3564-V1A Filtered Strain Gage (4)	0	N.A.
1			
2			
3			
4	3563-V1D Filtered Thermo-couple (12)	1	2
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16	3565-V1A Filtered RTD (8)	4	1
17			
18			
19			
20			
21			
22			
23			
24	3569-V1D Filtered Analog (8)	6	1
25			
26			
27			
28			
29			
30			
31			

FIGURE 1 - Sample Configuration



SW1 Switch Position	First Channel Scanned	Start Address RD8-RD5	SW2 Switch Position	Number of Channels Scanned	Scan Size RD4-RD1
0	0	0 0 0 0	0	4	0 0 0 0
1	4	0 0 0 1	1	8	0 0 0 1
2	8	0 0 1 0	2	Not valid	0 0 1 0
3	12	0 0 1 1	3	Not Valid	0 0 1 1
4	16	0 1 0 0	4	Not Valid	0 1 0 0
5	20	0 1 0 1	5	Not Valid	0 1 0 1
6	24	0 1 1 0	6	Not Valid	0 1 1 0
7	28	0 1 1 1	7	Not Valid	0 1 1 1

Example:

RD8	RD7	RD6	RD5	RD4	RD3	RD2	RD1
0	0	1	0	0	0	0	1

= Start at channel 8, scan 8 channels

FIGURE 2 - Switch Selection for Starting Address and Scan Size

EXCITATION

Each of the channels on the model 3565 has a precision current source for Excitation. The Excitation source is a 1 mA constant current source which can be strap-selectable to provide Excitation for either the Bridge configuration (for two-wire or three-wire RTDs) or for the four wire RTD configuration. In the four-wire RTD configuration, each channel can provide current Excitation to a four-wire RTD up to 1000 Ω. An adjustment potentiometer is provided for each channel's excitation source. The source output can be monitored using a digital voltmeter across a 100 Ω, .05%, ±5PPM/°C precision resistor (placed in series with the source). Test points for + and - are provided on either side of the resistor.

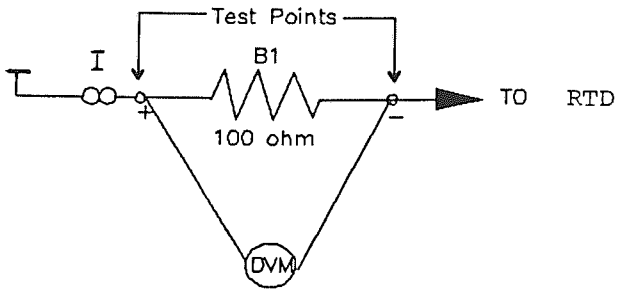


FIGURE 3 - 3565 EXCITATION SOURCE

Example: With DVM across + and - test points adjust potentiometer A1 until a reading of 0.1 volts is obtained across series resistor A1. (1 mA = 0.1v/100 Ω)

The following channels are shown with their respective resistor and potentiometer.

Adjustment Components

Channel	Resistor-Potentiometer		Channel	Resistor-Potentiometer	
Chan 1	A1	A1	Chan 5	A5	A5
Chan 2	A2	A2	Chan 6	A6	A6
Chan 3	A3	A3	Chan 7	A7	A7
Chan 4	A4	A4	Chan 8	A8	A8

BRIDGE COMPLETION (Two-, Three-Wire RTDs)

The model 3565 module can accommodate RTD transducers of two-, three- or four-wire type. Each channel of this module contains the remaining three legs of the bridge for 100Ω RTDs of two and three wire types. The RTDs and three 100 Ω, .05%, ±5PPM/°C precision resistors make up the bridge. These resistors are mounted in sockets to provide easy access for any specific component selection. Socketing also protects against heat damage caused by soldering to the precision resistors.

CALIBRATION RELAY REGISTER

This is a Write/Read register used to switch a precision 120 Ω, .05% resistor in place of the RTD in the four-wire mode. Calibration may be enabled individually on any channel by writing to this register with an F(16)A(0) command. The register is read with an F(0)A(0) command. After enabling the calibration resistor, the resulting data may be compared to the ideal data for a 120 Ω resistor to establish a gain factor for that channel.

	D16															D1
F16.A0 F0.A0	X	X	X	X	X	X	X	X	Chan 8	Chan 7	Chan 6	Chan 5	Chan 4	Chan 3	Chan 2	Chan 1

Chan 1-8 Set to 1 to Enable Relay

CHANNEL CONFIGURATIONS

Each channel of the 3565 is strap-selectable for two-wire, three-wire, or four-wire configurations. The following diagrams show proper strapping and wiring for each two-,three-, and four-wire configuration.

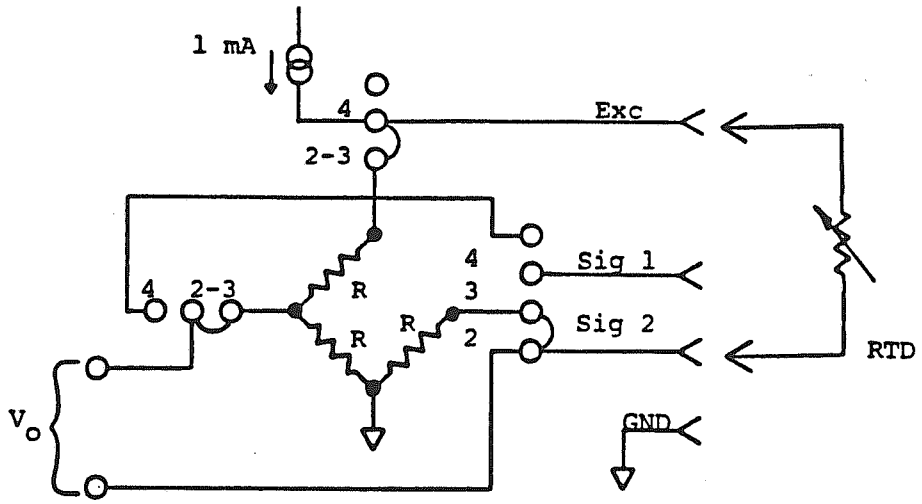


FIGURE 4 - TWO-WIRE CONFIGURATION

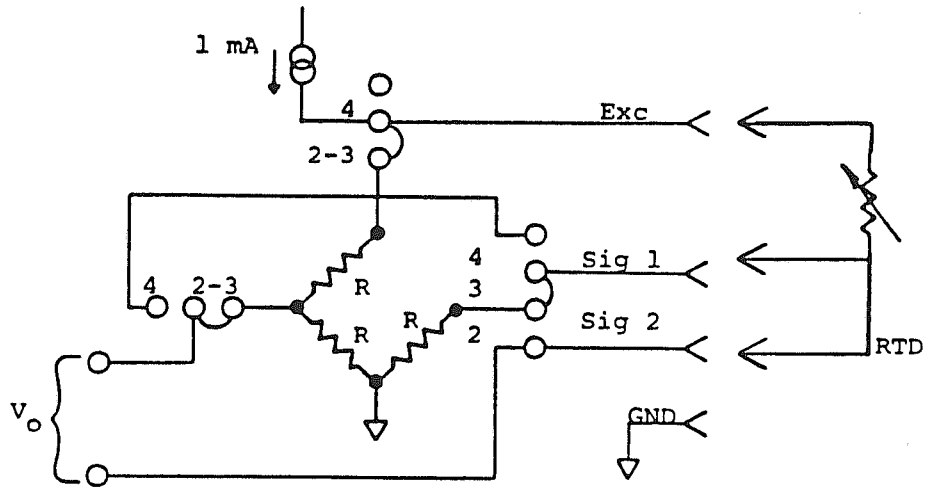


FIGURE 5 - THREE-WIRE CONFIGURATION

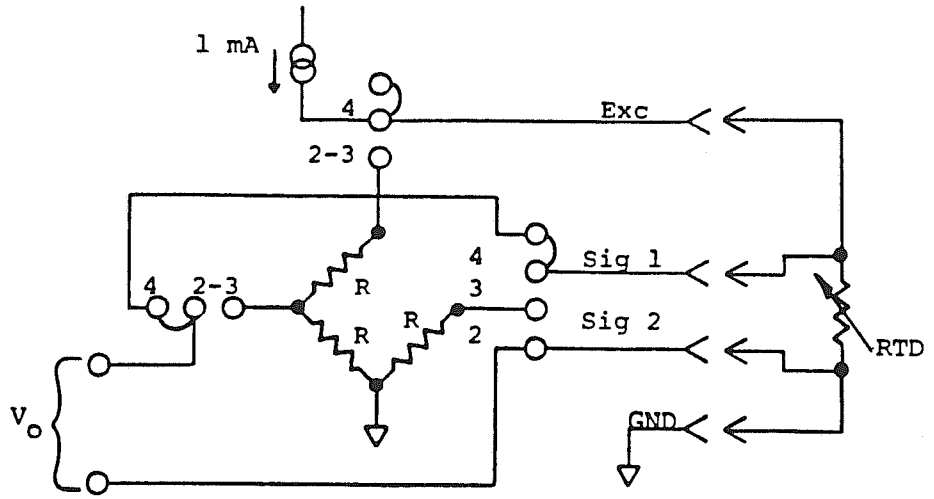


FIGURE 6 - FOUR-WIRE CONFIGURATION

OPERATION

After selecting the channel configuration, the 3518 Gain Factor should be determined. This is done by finding your maximum and minimum voltage output deflection.

Example:

Assume: 100Ω Platinum RTD, 3-wire
range = 18.49Ω at -200°C to 322.86Ω at 629°C
(from Platinum RTD Table)

To find desired 3518 gain, calculate V_o range of 3565 for this RTD by

$$V_o = \frac{R}{1000}\left(\frac{RTD-R}{3R+RTD}\right)$$

Note: R = Value of Bridge Resistors

$$V_{-200} = \frac{100}{1000}\left(\frac{18.49-100}{300+18.49}\right) = -25.59mV$$

$$V_{629} = \frac{100}{1000}\left(\frac{322.86-100}{300+322.86}\right) = 35.78mV$$

For Bi-polar ±10 volt range, desired gain is

$$G = \frac{10v}{35.78mV} = 279$$

Use next lower available gain, or G = 256.

Model 3565-V1A

TWO-, THREE-WIRE CONFIGURATION

In the Bridge Configuration, the equation

$$RTD = \frac{3000\,V_o\,R+R^2}{R-1000\,V_o}$$

is used to determine the ohmic value of the RTD.

Where:

R = value of Bridge Resistors

$$V_0 = 3518\ Data\ x\ \frac{20v}{2^{16}}\ x\ \frac{1}{gain}\quad (\pm 10v\ Range)$$

or

$$V_o = 3518\ Data\ x\ \frac{10v}{2^{16}}\ x\ \frac{1}{gain}\quad (0\text{-}10v\ Range)$$

Example:

If 3518 returns 15000 counts,

Step 1 $V_o = 15000\ x\ \frac{20V}{2^{16}}\ x\ \frac{1}{256} = 17.88mV$

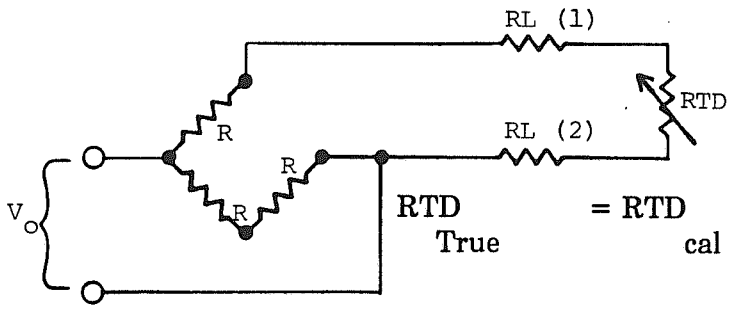
Step 2 $RTD = \frac{(3000)(17.88\ x\ 10^{-3})(100)+(100)^2}{100 - (1000)(17.88\ x\ 10^{-3})} = 187.1\Omega$

Step 3 *From the RTD Table,* $T = 231°\,C$ *at* $RTD = 187.1\Omega$

Since an RTD is very nearly linear over small ranges, linear interpolation may be used to calculate the exact temperature.

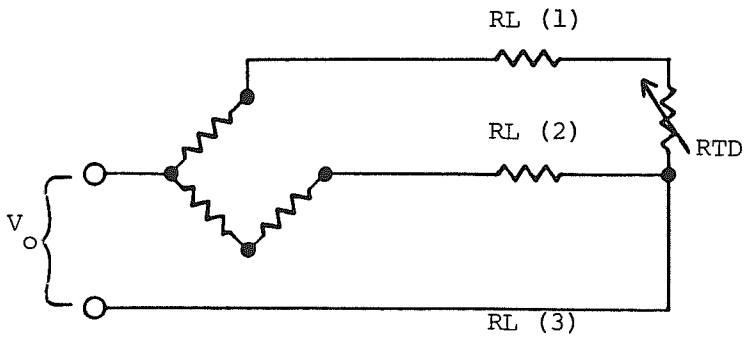
This equation assumes that the resistance of the wires connecting the RTD and the Bridge are negligible. In cases where wire lengths go beyond a few feet its resistance must be taken into account.

In two-wire configurations, the wire resistance adds to the RTD resistance to create an offset error. This error can be corrected by subtracting the sum of the wire resistance from the calculated value of RTD.



$$RTD_{True} = RTD_{cal} - \{RL(1) + RL(2)\}$$

In the three-wire configuration, this effect is minimized because each RL is in an opposite leg of the Bridge and the third wire acts as a sense lead and carries essentially no current.



Although wire resistance in three-wire configuration is less obvious than two-wire, it still is a factor in finding absolute temperature. The following equation can be used to compensate for RL in the three-wire configuration:

$$RTD = \frac{3000\ V_o\ R + 2000\ V_o\ RL + R^2}{(R - 10000\ V_o)}$$

where R = Value of Bridge Resistors

$$V_o = 3518\ Data\ x\ \frac{20v}{2^{16}}\ x\ \frac{1}{gain} \quad (\pm 10v\ Range)$$

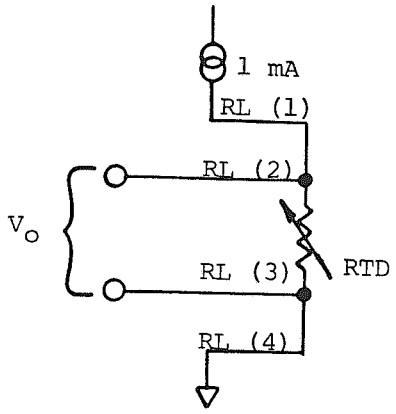
or

$$V_o = 3518\ Data\ x\ \frac{10v}{2^{16}}\ x\ \frac{1}{gain} \quad (0\text{-}10v\ Range)$$

RL = RL(1) = RL(2) = Wire Resistance

FOUR-WIRE CONFIGURATION

The four-wire configuration is the best approach for measuring absolute temperature. This configuration alleviates many problems associated with the bridge configurations. The four-wire configuration utilizes the 1mA constant current source to provide the Excitation directly to the RTD as shown.



Wire resistance is not a factor in this configuration. RL(2) and RL(3) are used to measure output voltage across the RTD and have essentially no current flow.

The equation to find the value of an RTD in four-wire configuration is:

$$RTD = 1000\ V_o$$

where again,

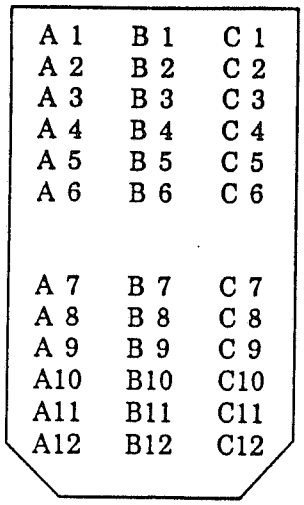
$$V_o = 3518\ Data \times \frac{20v}{2^{16}} \times \frac{1}{gain} \quad (\pm 10v\ Range)$$

or

$$V_o = 3518\ Data\ \frac{10v}{2^{16}} \times \frac{1}{gain} \quad (0\text{-}10v\ Range)$$

3565-V1A
36 Pin Connector Pin Out

Channel	Nomenclature	Pin No.
1	EXC	A 1
	Signal 1	A 2
	Signal 2	A 3
	Ground	A 4
2	EXC	A 5
	Signal 1	A 6
	Signal 2	A 7
	Ground	A 8
3	EXC	A 9
	Signal 1	A10
	Signal 2	A11
	Ground	A12
4	EXC	B 1
	Signal 1	B 2
	Signal 2	B 3
	Ground	B 4
5	EXC	B 5
	Signal 1	B 6
	Signal 2	B 7
	Ground	B 8
6	EXC	B 9
	Signal 1	B10
	Signal 2	B11
	Ground	B12
7	EXC	C 1
	Signal 1	C 2
	Signal 2	C 3
	Ground	C 4
8	EXC	C 5
	Signal 1	C 6
	Signal 2	C 7
	Ground	C 8
	Ground	C 9
	Ground	C10
	Ground	C11
	Ground	C12


A 1 B 1 C 1
A 2 B 2 C 2
A 3 B 3 C 3
A 4 B 4 C 4
A 5 B 5 C 5
A 6 B 6 C 6
A 7 B 7 C 7
A 8 B 8 C 8
A 9 B 9 C 9
A10 B10 C10
A11 B11 C11
A12 B12 C12