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PC-68
strain gauge
amplifier

Users' manual

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strain gauge amplifier

User manual

Contents

Introduction	2
Configuration	3
Connections	6
Calibration	7
Specifications	9
Component location	11
Circuit diagram	12

Introduction

The PC-68 is a high-performance, four channel signal conditioning card for resistive bridge transducers such as strain gauges. Although designed specifically for use with strain gauges, it can also be used simply as an ultra-high-performance instrumentation amplifier, with an adjustable ultra-stable power reference and filter. The card has four identical channels, each of which consists of three sections.

Bridge excitation supply

The bridge excitation supply is essentially a high-performance power reference, which is used to supply an excitation signal to a bridge transducer. This voltage is adjustable from 4 to 9 volts at 100mA. This section also supplies a half-bridge completion signal to the instrumentation amplifier, allowing the use of half bridge sensors, without external components.

Instrumentation amplifier

The instrumentation amplifier is responsible for amplifying the difference between the two signals from a full-bridge transducer, or the difference between the single signal from a half-bridge transducer and the channel's internal half-bridge completion signal. The channel gain may be set from 2 to 5000, by installing two resistors.

Low-pass filter

The low-pass filter is a two-pole Butterworth filter which is factory preset for a cutoff frequency of 1KHz. This cutoff frequency may be varied from 10Hz to 20KHz, by means of user-installed components. The low-pass filter can be used as a noise filter, and as an anti-aliasing filter.

Configuration

Each channel of the PC-68 can be configured:

Channel numbering

The PC-68 consists of four channels, A, B, C, and D. Channels B and D are installed first. A card with only a single channel installed is a PC-68/1, with two channels a PC-68/2, etc.

Every channel is identical. The circuit diagram in this manual shows one channel, but the component layout shows the entire card. Note that components are numbered so as to indicate both function and channel number. For example, the fixed gain resistor is shown on the circuit diagram as R5. Channel A, B, C, and D's gain setting resistors are known respectively as R5A, R5B, R5C and R5D.

Jumpers which must be installed

On release 1 versions of the PC-68, certain jumpers must always remain in a particular configuration. **IF THESE JUMPERS ARE NOT AS SPECIFIED BELOW FOR ALL CHANNELS WHICH ARE INSTALLED, PERMANENT DAMAGE TO THE PC-68 MAY RESULT.** These jumpers are the following:

Pin 4 must always be jumpered to pin 5.
Pin 6 must always be jumpered to pin 7.
Pin 9 must **NEVER** be jumpered to pin 10.

Output connection

The output from each channel can be connected to any one of eight pins of the output connector, BUT *only one channel output may be connected to any particular output pin.*

Connections are by jumper, as follows:

Output pin C10 - insert jumper 11
Output pin C12 - insert jumper 12
Output pin C14 - insert jumper 13
Output pin C15 - insert jumper 14
Output pin C17 - insert jumper 15
Output pin C19 - insert jumper 16
Output pin C21 - insert jumper 17
Output pin C23 - insert jumper 18

Half bridge completion

In order to allow the use of half bridge transducers, each channel has an internal half bridge completion signal. This is composed of a thin-film 1:1 resistive divider connected between Vexc and SL. If a jumper is fitted from pin 1 to pin 2, this signal is connected to the non-inverting input of the instrumentation amplifier. The signal from the transducer bridge must then be connected to the non-inverting input, and the non-inverting input connection left open.

Instrumentation amplifier gain

The gain of the instrumentation amplifier may be set by installing two resistors, one fixed and one variable (for trimming). The channel gain is found by the formula:

$Rg = R5 + VR3$
and
$Gain = 2 + 80/Rg$
where Rg is in KΩ.

Note that trimming varies VR3 between 0 and its maximum value.

Low-pass filter cutoff frequency

As supplied, each channel of the PC-68 has a two-pole Butterworth low-pass filter with a cutoff frequency of 1KHz. This frequency can be varied from 10Hz to 20KHz.

Cutoff frequency less than 1KHz: In order to decrease the cutoff frequency to below 1KHz, capacitors C1 and C2 must be installed. Their values are calculated as follows:

C1 = 0.015([1000/Fc] -1)
and
C2 = 0.0022([1000/Fc] -1)

where C1 and C2 are in μF, and Fc is the cutoff frequency in Hz. For example, if cutoff frequency is 100Hz, then C1 is 0.15μF and C2 is 0.02μF (rounded to standard values).

Cutoff frequency greater than 1KHz: In order to increase the cutoff frequency to above 1KHz, resistors R6, R7 and R8 must be installed. Their values are calculated as follows:

R6 = 20([Fc/1000] -1)
and
R7 = 16([Fc/1000] -1)
and
R8 = 40([Fc/1000] -1)

where R6, R7 and R8 are in KΩ, and Fc is the cutoff frequency in Hz. For example, for a cutoff frequency of 10000Hz, R6 is 2K21, R7 is 1K78 and R8 is 4K42.

Connections to the PC-68

Connections to the PC-68 from the strain gauge: front panel D-connector

The connections from the PC-68 to the strain gauge are shown on the circuit diagram at the back of this book. Note that it is important that the sense lines, SH and SL, are connected directly to the terminals of the strain gauge as shown. These lines should not be shorted to V_{exc} and common at the PC-68. All connections are made via the D-type connector. Pin connections for this connector are shown on the circuit diagram.

The PC-68 can also be used as a very high performance instrumentation amplifier. In this case, only the +ve input and -ve input connections are used, SH is connected to V_{exc} and SL is connected to common.

Connections from the PC-68 to the host system (PC-30, etc): 96-way DIN connector

There are two sets of signals which must be connected to the host measuring device:

The outputs of the four channels. These outputs are all via the 96-way DIN 41612 connector. The pin connections are jumper selectable, and are described under "Output connection".

Analogue ground. This is on the following pins of the 96-way connector:

C32, A28, A29, A30, A31, A32.

This must be connected to the analogue ground of the measuring instrument.

Power supply connections: 96- way DIN connector

Three power supply connections must be made:

Positive supply, VS+. This must be in the range +12 to +18 volts, and is connected to pin C30 of the 96-way connector.

Negative supply, VS-. This must be in the range -12 to -18 volts, and is connected to pin C28 of the 96-way connector.

Common ground. This is connected to pins C32, A28, A29, A30, A31, and A32 of the 96-way connector.

Calibration

The following procedure must be used for each channel:

Excitation voltage

Remove jumper between jumper pins 1 and 2.

Connect the strain gauge as shown in the circuit diagram.

Using VR4, adjust the voltage between the SL and the SH lines at the strain gauge to the desired excitation voltage.

Replace the jumper between pins 1 and 2.

Input offset

Short the +ve input and -ve input lines together.

Adjust the voltage at jumper pin 10 to 0V relative to common, using VR1.

Gain

Connect the negative input of the channel in question to common.

Short the +ve and -ve input lines together.

Measure the voltage on jumper pin 9 of the selected channel.

Connect the +ve input of the selected channel to a known calibration voltage.

Using VR3, adjust the voltage on jumper pin 9 such that the change in voltage since it was previously measured is the required gain times the calibration voltage. **NOTE:** The voltage at this pin must be at least 5V less than the power supply voltages for an accurate setting. If this is not the case, then reduce the calibration voltage.

Output offset

The output offset control is used to adjust the offset of the output filter, as well as to compensate for dead load or source imbalance. The adjustment procedure is as follows:

Connect the strain gauge as shown in the circuit diagram.

Set up the system so that the parameter to be measured is at its minimum. For example, in a load cell application, remove the load which is to be measured.

Adjust the voltage at jumper pin 9 to the desired minimum output voltage, using VR2.

Specifications

Gain	
Range	2 to 5000 V/V
Temperature drift	25ppm per °C (max)
Nonlinearity	+/-0.005% max
Input bias current	
Initial	+/-20nA max
Drift	+/-10pA per °C max
Input impedance	
Differential	1 GΩ/100pF
Common mode	1 GΩ/100pF
Input voltage	
Linear differential	+/-5V
Max. common mode input	10V (Gain = 1)
CMR, 1K source imbalance	
G = 2, DC to 60Hz	86dB min
G = 100 to 500, 1KHz bandwidth, DC to 60Hz	110dB min
G = 100 to 500, 10Hz bandwidth, DC	110dB min
G = 100 to 500, 10Hz bandwidth, 60Hz	140dB min
Input noise (G = 1000)	
Voltage, 0.1 - 10Hz	0.3μV p-p
Voltage, 10 - 100Hz	1μV p-p
Current, 0.1 - 10Hz	60pA p-p
Current, 10 - 100Hz	100pA p-p

Filter

Number of poles	2
Roll-off	40dB/decade

Bridge excitation

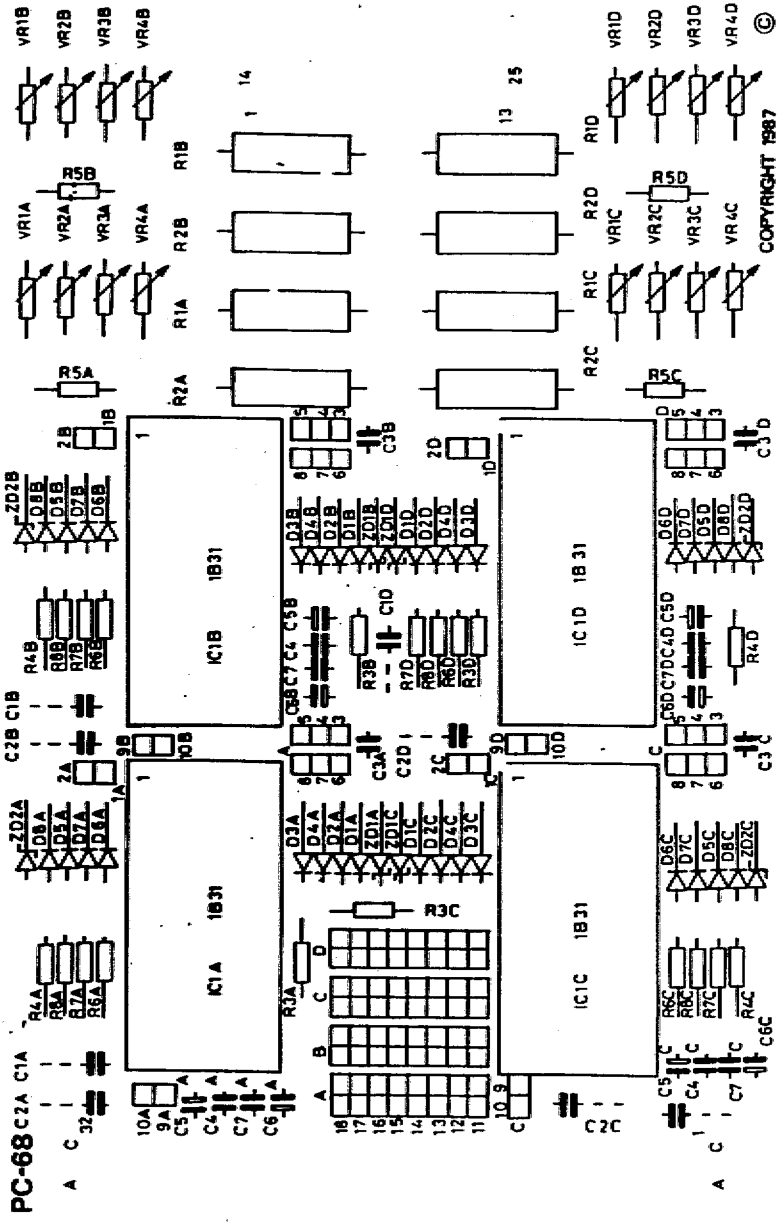
Output voltage range	+4 to +9 volts
Output current	100mA
Input regulation	0.05%/volt
Load regulation, 1mA - 50mA	0.1%
Temperature stability	0.004% per °C
Output noise	200μV p-p

Half-bridge completion

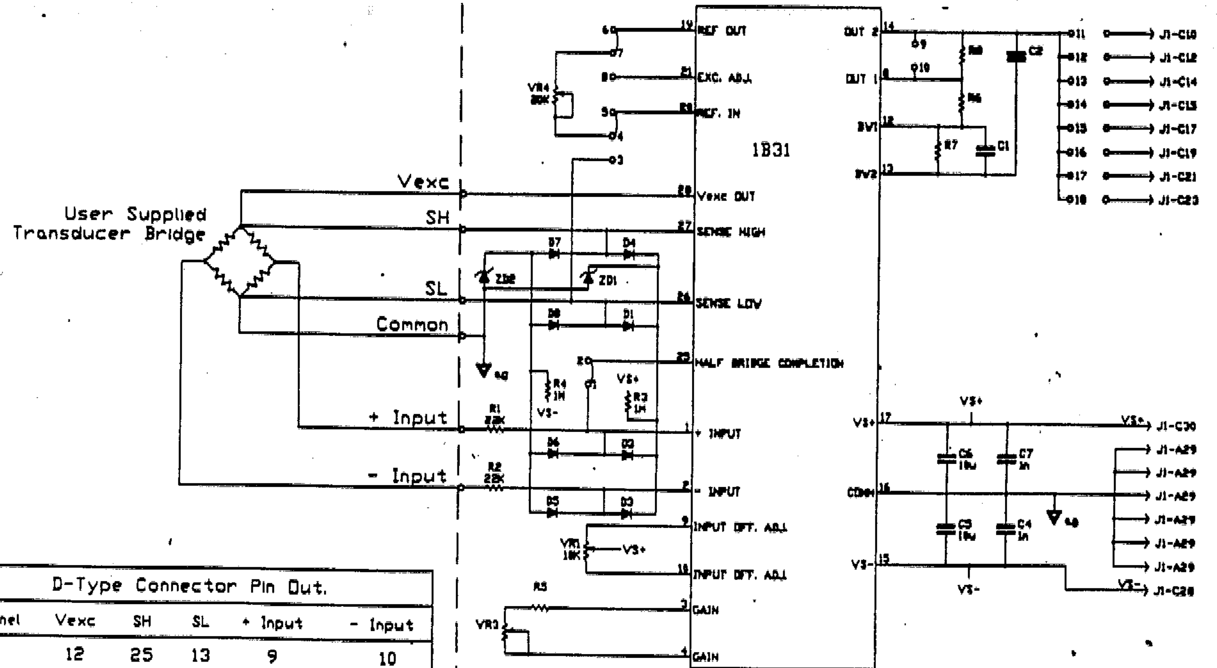
Resistor value	20K +/-1%
Temperature tracking	+/-5ppm

Power supply

Voltage, rated performance	+/-15VDC
Voltage, operating	+/-12 to +/-18VDC
Supply current (including excitation supply)	+/-10mA/channel



4 CHANNEL STRAIN GAGE CHART
COMPONENT LEGEND
SCALE: 2:1



D-Type Connector Pin Out.					
Channel	Vexc	SH	SL	+ Input	- Input
A	12	25	13	9	10
B	23	11	24.	7	8
C	14	15	16	17	4
D	1	2	3	6	5
Common Pins	18, 19, 20, 21, 22				

Notes

Signature	Date.
Designed	
Drawn	
APPR.	
APPR.	

Title Strain Gage Signal Conditioner

Designed by: A.D. McGuffog

Revision 1 | Document Number

Scale – | Sheet 1 of 1