GMW

GROUP3

ADI-123
ANALOG DEVICE INTERFACE
with IEEE-488 GPIB Interface
USER'S MANUAL

For units supplied with software ADIG V3.1

82030090A

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1. GENERAL DESCRIPTION

Model ADI-123 Analog Device Interface offers the means of computer interfacing almost any device which is provided with dc inputs and/or output(s), for example programmable power supplies and measuring instruments of all kinds. The ADI-123G is straightforward to drive with its comprehensive ASCII command set, and is easily configured into IEEE-488 GPIB systems.

FEATURES

One analog control output and two analog monitoring inputs.

Analog channels have 14-bit resolution.

Analog inputs are fully differential for excellent common-mode rejection.

Analog output is offered in unipolar and bipolar options, 5 volt and 10 volt.

Input/output module options allow standard or user-defined analog levels.

Three two-state (digital) channels for on/off control and status monitoring.

Two-state channels may be programmed individually as inputs or outputs.

Two-state channels are fully isolated by optical couplers.

Two-state channels may be energised externally or by internal floating supply.

All inputs and outputs are protected against voltage transients.

All operations are supported by powerful 6809 microprocessor, allowing useful control functions, data manipulation and communication options. Non-volatile memory stores user-entered parameters during power down.

ADI-123G has standard IEEE-488 interface built in. Serial communication options using fiber optics and/or RS-232-C available.

Fully supports all relevant GPIB functions and commands, including serial and parallel polling, service request, and talker-only.

Internal switches select device address on the bus; enable talker-only, dual primary addressing, service requests, EOI action, digital filtering; select string terminator characters; perform system reset.

Device is ac powered from 115, 208, or 230 volt 50 or 60 Hz source.
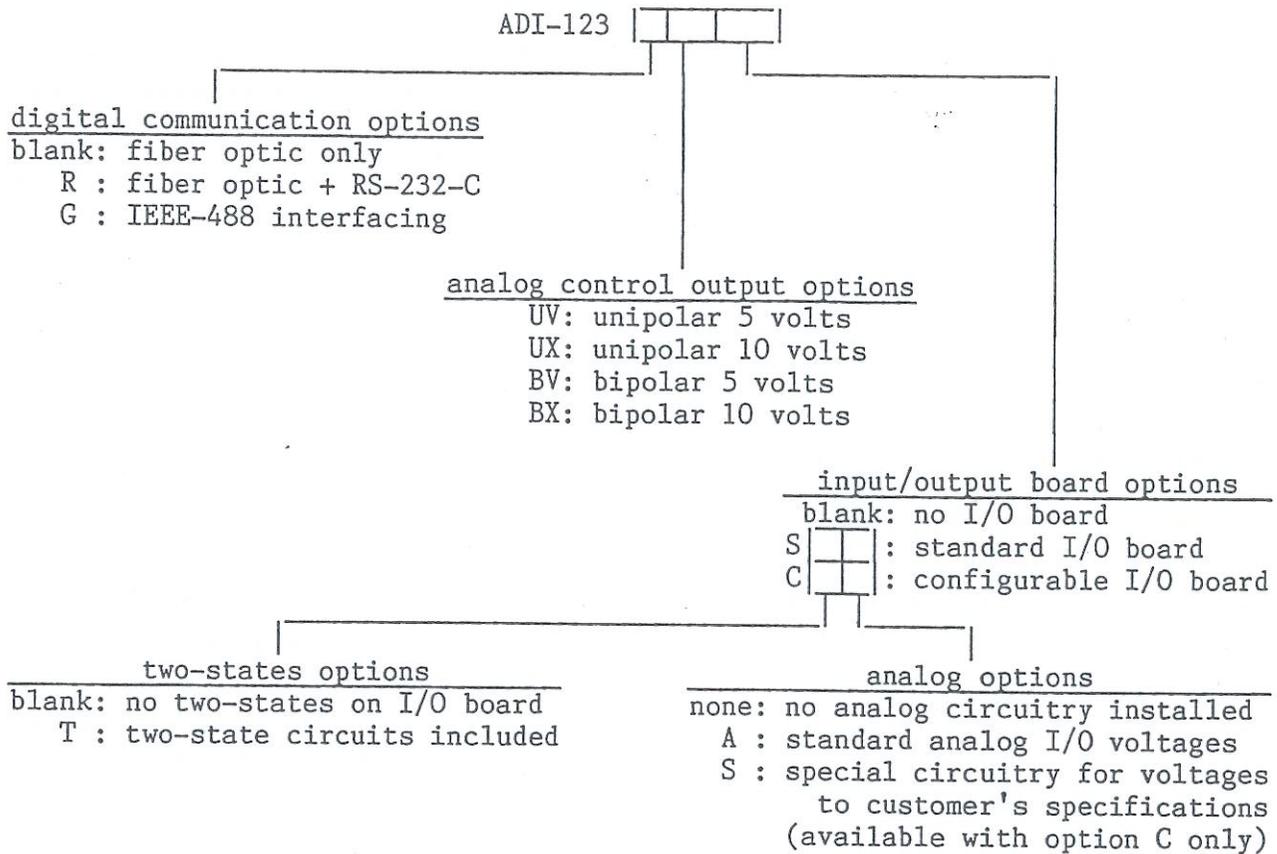
Typical application: magnet power supply -
                 control of current or voltage output,
                 monitoring of current and voltage,
                 two-state control of power on/off and reset after overload trip.

2. SPECIFICATIONS

Number of analog outputs   1
Number of analog inputs   2
Number of two-state channels   3

Analog output voltage range   0 to 5, 0 to 10, -5 to +5, -10 to +10 volts
Resolution of output   14-bit - 16384 steps over the span
Temperature drift of output   zero: 0.2 bit/°C max.
                               calibration: 20ppm/°C max.
Output impedance   100 ohm

Analog input voltage range   -10 to +10 volts
Resolution of inputs   15-bit - 32768 steps over the 20 volt span
Temperature drift of inputs   zero: 0.2 bit/°Cmax.
                               calibration: 50ppm/°C max.
Transient protection   transient voltage suppressors on all I/O

Analog-to-digital conversion   dual slope integrating, auto zeroing
Integration time   selectable 33.3 msec for 60 Hz noise rejection
                                       20 and 40 msec for 50 Hz noise rejection
Sampling rate   7.5, 6.25, and 12.5 conversions/sec

Digital filtering   selectable digital filtering of
                               inputs after digitizing smooths out small
                               fluctuations; large, rapid input changes are
                               not filtered; filtering time-constant is
                               remotely programmable

Two-state channels   floating, optically coupled
                               active and passive selected by board jumpers -
                               active: channel in series with on-board supply
                               passive: no power connections internal to ADI

Two-states electrical data   passive -
                               ON-state current: 15mA max.
                                                 4mA min. must be ON
                                                 0.6mA max. must be OFF
                               terminal impedance: 1000 ohm in series with
                                        3 volt switch ON-state voltage at 5mA
                               OFF-state voltage: 15V max applied externally

                               active -
                               12V floating supply connected internally
                               max ext resistance for ON-state status: 1000 ohm
                               open circuit voltage with control ON: 10V
                               ON-state internal resistance: 1000 ohm
                               leakage current with control OFF: 0.1uA typical
                                                                 2uA max.
Communications   ADI-123G has standard IEEE-488 GPIB interfacing.
                               other options: fiber optic (model ADI-123)
                                              fiber optic + RS-232-C (ADI-123R)

Digital data format   ASCII input commands and output data

System orientation	standard IEEE-488 system implementation
IEEE-488 functions	SH1 source handshake capability
	AH1 acceptor handshake capability

	T5 talker - basic talker
	      serial poll
	      talk-only mode
	  unaddressed to talk if addressed to listen

	TE0 no address extension talker capability
	L4 listener - basic listener unaddressed to listen if addressed to talk
	LE0 no address extension listener capability
	SR1 service request capability
	RL0 no remote local capability
	PP1 parallel poll capability configured by controller
	DC1 device clear capability
	DT1 device trigger capability
	C0 no controller capability
GPIB connector	standard Amphenol 57-20240 with metric standoffs
On-board switches	16 DIP switches for device address selection, GPIB modes, channel select, digital filtering.
Microprocessor	6809
Memory back-up	30 days data storage with power off
Power requirements	115, 208, or 230 volts ac 11 VA, 47 TO 63 Hz
Enclosure	steel and aluminum, 250 x 125 x 50 mm textured finish, light tan color
Temperature range	0 to 55°C operating
Weight	1.6kg, shipping weight 2 kg

Product series options

ADI-123 [| | |]

digital communication options
blank: fiber optic only
   R : fiber optic + RS-232-C
   G : IEEE-488 interfacing

analog control output options
         UV: unipolar 5 volts
         UX: unipolar 10 volts
         BV: bipolar 5 volts
         BX: bipolar 10 volts

input/output board options
         blank: no I/O board
         S [| | |] : standard I/O board
         C [| | |] : configurable I/O board

two-states options
blank: no two-states on I/O board
   T : two-state circuits included

analog options
none: no analog circuitry installed
   A : standard analog I/O voltages
   S : special circuitry for voltages
         to customer's specifications
         (available with option C only)

Standard I/O board has 9-way D connector for two-states,
      three 6-way AMP connectors for analog I/O, standard analog levels only.

Configurable I/O board has terminal strips for all connections,
      and provision for amplifiers & adjustments on analog I/O signals.

3. SETTING UP

3.1 INSTALLATION

The ADI-123 is intended for fixed mounting, either directly on the device it is to control/monitor, or on some fixed piece of hardware nearby such as an equipment rack.

As the mounting arrangements will vary widely in different circumstances, no mounting hardware is supplied with the unit. It is left to the user to devise a bracket or whatever is necessary in the particular system. The bottom cover has a number of holes which can be used for attaching hardware. The cover can be removed by loosening the central screw. If possible put the heads of attaching screws on the inside. Avoid long projections which may interfere with the circuitry inside. Once the mounting hardware is attached, the cover should be replaced and the unit then fitted in its final position.

Access to the processor board, which is inside the bottom cover, may be required before final installation, in order to set the on-board switches. Refer to section 3.4, page 3-3.

3.2 POWER INPUT CONNECTIONS

The ADI-123 is designed for fixed mechanical installation, as described above, and permanently installed power input wiring. Access to the power input terminals is obtained by taking off the orange cover; remove the 3 fixing screws to release the cover.

Use 3-conductor power cord. For safety from electrical shock it is essential to provide a reliable ground connection to the ADI-123 case. Make sure the ground wire is connected as shown in Fig. 1. Strip about 60 mm (2.5 in) of outer jacket from the cord, and strip 5 mm (3/16 inch) of insulation from the 3 wires. Pass the cord through the grommetted hole in the cover; loosen the screw securing the cable clamp and pass the cord through the clamp. Tighten the clamp on the outer jacket. Terminate the wires and fit links according to the supply voltage as set out out in Fig.1.

115 V   link 4 and 7   208 V   link 4 and 5   230 V   link 4 and 5
         link 3 and 5   power 2 and 6   power 2 and 7
         power 2 and 7   ground 1   ground 1
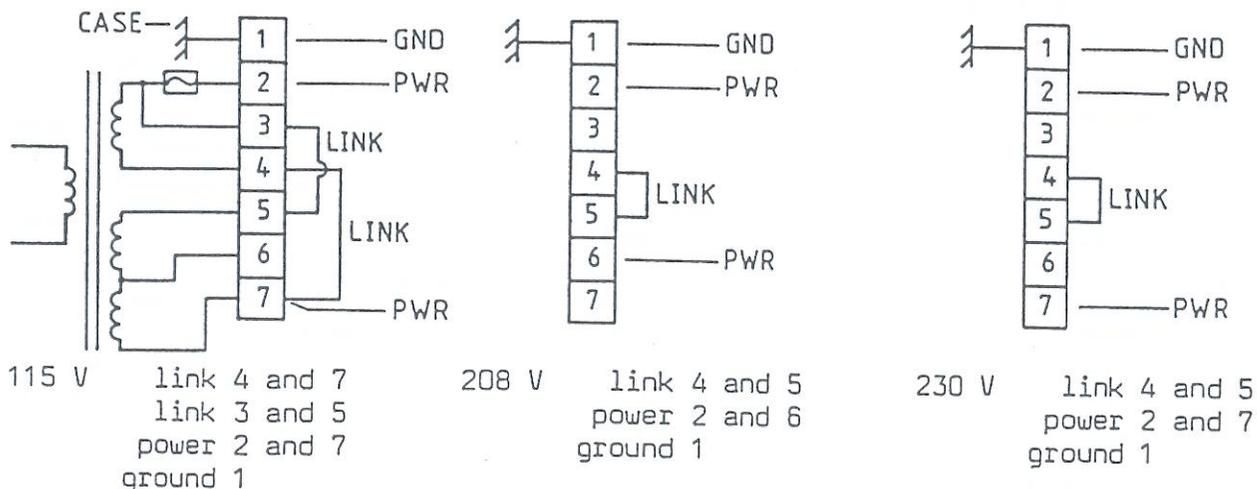   ground 1

Fig.1. Power Input Connections.

Replace the orange cover, making sure that wires are not pinched in the process. For safety reasons, do not operate the unit with the cover off.

Note that input power protection is provided by a thermal fuse wound into the power transformer. This fuse will open in the event of transformer overheating rather than on excess current. The power input must be connected as shown to include the thermal fuse in the circuit correctly. If a fault causes transformer overheating and subsequently the fuse opens, the transformer must be replaced with the genuine Group 3 part.

If desired, the wiring may be protected by installing an external fuse in the ac power feed. Suggested fuse ratings are 200 mA for 115 volts, or 100 mA for 208 and 230 volt operation.

3.3 GPIB CONNECTION

Connection to the GPIB connector on the rear of the ADI-123 is made using cables as specified in the IEEE-488-1978 standard document. Briefly, the cable has 24 conductors with an outer shield. The connectors at each end are 24-way Amphenol 57 series or similar with piggy-back receptacles to allow daisy-chaining in multiple device systems. The connectors are secured in the receptacles by a pair of captive locking screws with metric threads.

The total length of cable allowed in a system is 2 meters for each device on the bus, or 20 meters maximum. A system may be composed of up to 15 devices.

Fig. 2 shows the GPIB connector pin location and signal names as viewed on the ADI-123G rear panel. Table 1 is a listing of the pin assignments.
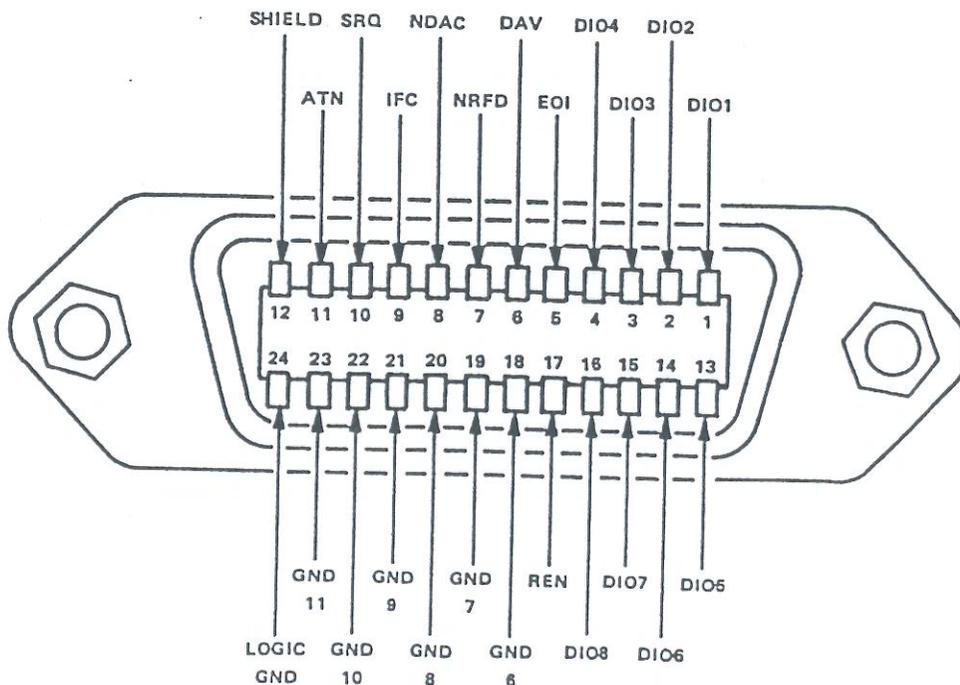

Fig. 2. IEEE-488 Standard Connector

```
pin        symbol    description
---        ------    --------------------------
 1         DIO1      Data Input Output line 1
 2         DIO2      Data Input Output line 2
 3         DIO3      Data Input Output line 3
 4         DIO4      Data Input Output line 4
 5         EOI       End Or Identify
 6         DAV       Data Valid
 7         NRFD      Not Ready For Data
 8         NDAC      Not Data Accepted
 9         IFC       Interface Clear
10         SRQ       Service Request
11         ATN       Attention
12         SHIELD    Cable shield - connects to ADI-123G case
13         DIO5      Data Input Output line 5
14         DIO6      Data Input Output line 6
15         DIO7      Data Input Output line 7
16         DIO8      Data Input Output line 8
17         REN       Remote Enable - not used in ADI-123G
18         GND 6     Ground wire of twisted pair with DAV
19         GND 7     Ground wire of twisted pair with NRFD
20         GND 8     Ground wire of twisted pair with NDAC
21         GND 9     Ground wire of twisted pair with IFC
22         GND 10    Ground wire of twisted pair with SRQ
23         GND 11    Ground wire of twisted pair with ATN
24         GND       logic ground
```

Table 1. GPIB Connector Pin Assignments

3.4 INTERNAL DIP SWITCH SETTINGS

The Processor Board in the ADI-123G is provided with two sets of DIP switches, allowing the user to set the device according to system requirements.

To obtain access to the switches, remove the bottom cover by loosening the single central screw. Refer to Fig. 3 for switch locations.

Switch functions are as follows:

S1   8-way DIP switch - sets device address on the bus;
                          enables dual primary addressing, talker-only mode,
                          selects offset control mode for bipolar options

S2   8-way DIP switch - selects communication options and operation mode.

Detailed switch settings are given in Table 2 on the next page.

* denotes switch position when the ADI-123G leaves the factory

switch	function	switch OFF	switch ON
S1-1	set device address	*adds 0 to address	adds 1 to address
S1-2	set device address	*adds 0 to address	adds 2 to address
S1-3	set device address	*adds 0 to address	adds 4 to address
S1-4	set device address	*adds 0 to address	adds 8 to address
S1-5	set device address	*adds 0 to address	adds 16 to address
S1-6	dual primary addressing	*disable	enable
S1-7	talker-only mode	*talker/listener	talker only
S1-8	control offset	unipolar control	bipolar control
S2-1	service requests	disabled	*enabled
S2-2	EOI operation	EOI not asserted	*EOI asserted
S2-3	select terminator	*line feed	carriage return
S2-4	double terminator	*disabled	enabled
S2-5	channel 1 lock	*channel 1 not locked	channel 1 locked
S2-6	channel 2 lock	*channel 2 not locked	channel 2 locked
S2-7	digital filtering	*filtering off	filtering on
S2-8	system reset	*no reset	reset executed

Table 2. DIP Switch Functions.

The switches are read by the processor once per second, so the effects of changed settings can be observed in real time without the need for powering down.

S1-1 through S1-5 set the ADI-123G address on the bus. A binary code is used, as shown in the table. Address 31 (all switches ON) is illegal.

S1-6 enables dual primary addressing of the ADI-123G on the GPIB. In this addressing mode the least significant bit of the device address is ignored, so that the device is activated by two adjacent addresses.

S1-7 when ON makes the ADI-123G a talker-only. In this mode it sends on the bus every analog input measurement made. The input channel used defaults to channel 1, or the channel locked by S2-5 or S2-6 (see below). In talker-only mode the ADI-123G does not respond to bus commands. This mode is useful in systems which have no controller, where the analog input values are continuously sent to listening devices, such as printers.

S1-8 when ON adds a half-scale offset to the number entered by W commands, which control the analog output. When the ADI-123G has unipolar analog output, as designated by the letter U in the model number suffix, S1-8 should be OFF. Then numbers in the range 0 to 16383 entered by W commands will give analog outputs from zero to full scale. If the ADI-123G has bipolar output (B in the model number) the switch should be ON. This will allow W commands in the range -8192 through 8191 to give outputs from minus full scale to plus full scale, while entering zero will give zero output.

S2-1 through S2-4 are set according to GPIB system requirements.

S2-1 is normally ON, which allows the ADI-123G to assert the SRQ line and the SRQ bit of the serial poll response. However, if the GPIB system controller routines are to run without interrupts, S2-1 should be switched OFF, thus disabling all SRQ action.

S2-2 controls the operation of the EOI bus management line. Normally the switch is ON, so EOI is asserted each time the ADI-123G sends a string terminator character on the bus, indicating the end of a response. With S2-2 OFF, the ADI does not assert the EOI line.

S2-3 selects the character sent as a string terminator. With the switch OFF, the terminator is the line feed character. When the switch is ON, carriage return is used.

S2-4 when ON introduces a pre-terminator character before the final string terminator selected by S2-3. The pre-terminator is the character not selected by S2-3. The terminator sequence as selected by S2-3 and S2-4 is as follows:

```
                           S2-3
                        OFF     ON

                 OFF    lf      cr
           S2-4
                 ON    cr/lf   lf/cr
```

Check which terminator characters are required by the system controller and/or other devices in your GPIB system, and set the switches accordingly.

S2-5 and S2-6 are used to select the channel lock default to channel 1 and 2, respectively. If the switches are both ON or OFF, no channel lock is in effect and the analog input channels are digitized alternately. If only one channel is to be used, the relevant channel may be locked to the analog-to-digital converter by turning ON the appropriate switch, thereby doubling the conversion rate for that channel.

S2-7 enables digital filtering of the analog inputs when switched ON.

S2-8 allows the user to perform a system reset, where all the numerical values entered by the operator are reset to their default values, and switch-selectable functions are instated as set on the switches. To perform the reset, switch S2-8 ON, then OFF again. If the switch is left ON, a system reset will occur each time the ADI-123G is powered up.

The functions of S2-1,2,5,6,7,8 can be selected remotely on the bus by ADI-123G commands. See page 4-8. To revert back to control from a DIP switch, alter the switch setting, then put the switch in the desired position.

3.5 ANALOG-TO-DIGITAL CONVERSION RATE SELECTION

Three ADC conversion rates are provided to let the user optimise data rate and noise rejection in a given application. The ADC used is of the integrating type; by arranging its input integrating time to be an integral multiple of power frequency cycles the effect of power-related noise is greatly reduced.

The ADC conversion rate is selected by positioning the jumper on header P2 in the corner of the analog board, as shown in Fig. 4.

Jumper position 1 gives an integration time of 33.33 msec, and should be used where the power frequency is 60 Hz. The corresponding ADC conversion rate is 7.5 conversions per second.

Jumper positions 2 and 3 give integration times of 40 and 20 msec for use where the power is 50 Hz, giving 6.25 and 12.5 conversions per second, respectively.
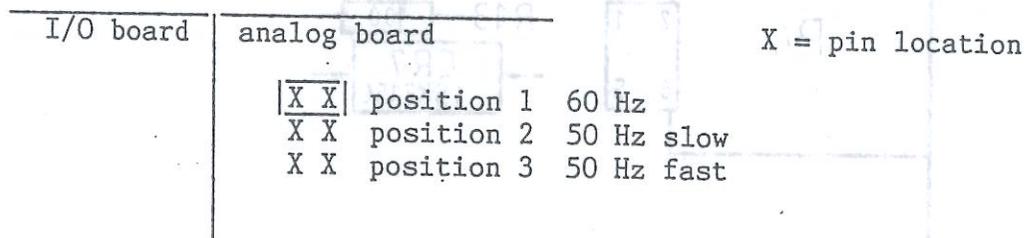
```
I/O board | analog board                      X = pin location

          |  |X X|  position 1  60 Hz
          |  X X   position 2  50 Hz slow
          |  X X   position 3  50 Hz fast
          |
```

Fig. 4. Analog Board ADC Rate Jumper Positions.

3.6 STANDARD I/O BOARD CONNECTIONS & JUMPERS

Group 3 supplies two kinds of I/O boards for the ADI-123G. These boards fit inside the ADI-123G case and connect to the analog board. The I/O board carries connectors for external wiring to the analog and two-state channels. Also, the I/O board has signal processing, two-state isolation, and transient protection circuitry.

For access to the I/O board, remove the ADI-123G top cover. The I/O board is the smaller of the two, towards the rear of the unit.

The I/O board may easily be removed from the device. First disconnect the ground lead from the corner of the board. Then lift that corner slightly so the board can be slid away from the analog board, thus disengaging the 20-way interconnection. The I/O board can then be lifted clear.

The standard I/O board, part no. 15000009, is fitted with AMP 6-way receptacles for analog signals, and a 9-way D connector for the two-states. This board leaves the analog signal levels unmodified, as detailed in the specifications (see section 2).

Refer to Fig. 5 for the location of connectors and jumpers, and to Table 3 for connector pin assignments.

```
TWO-STATE CONNECTOR J2          pin              use
                                 1      case ground
9-way D receptacle               2      channel 1 (-)
                                 6      channel 1 (+)
                                 3      channel 2 (-)
                                 7      channel 2 (+)
                                 4      channel 3 (-)
                                 8      channel 3 (+)
                                 5      12 volt supply (-)
                                 9      12 volt supply (+)


ANALOG CONTROL OUTPUT P4        pin              use
                                 1      output
6-way AMP connector              2      signal ground
                                 3      signal ground
                                 4      +15 volt supply
                                 5      -15 volt supply
                                 6      case ground


ANALOG STATUS INPUTS            pin              use
                                 1      input (+)
P5 channel 1                     2      input (-)
P6 channel 2                     3      signal ground
                                 4      +15 volt supply
6-way AMP connectors             5      -15 volt supply
                                 6      case ground
```

Table 3. Standard I/O Board Connector Pin Assignments.

When the ADI-123G has the T option, the I/O board comes complete with 3 isolated two-wire channels which can be used to control or monitor on/off or digital devices. Each of the channels can be made active or passive using the 8-way pin headers P1 through P3, numbered according to the channel served. Each header has three jumpers fitted. There are two legal arrangements of these jumpers to make the two-state channels either active or passive as shown in Fig. 6 below.

In the active state the internal floating 12 volt supply is connected in series with the channel so that no external power source is needed to make the channel work. In the passive state there is no internal connection to the channel; energising power must come from the user's external equipment.

Channels that are made active have a common connection internal to the ADI-123G, though this connection is isolated from the rest of the unit and from ground. Because of this common connection, no connection between channels external to the ADI-123G is allowed.

< towards connectors

```
  ┌─────┐        ┌──┬──┐
  │ X X │        │X │ X│
  ├─────┤        ├──┼──┤
  │ X X │        │X │ X│
  ├─────┤        ├──┼──┤
  │ X X │        │X │ X│
  ├─────┤        ├──┼──┤
  │ X X │        │X │ X│
  └─────┘        └──┴──┘
   active          passive
```
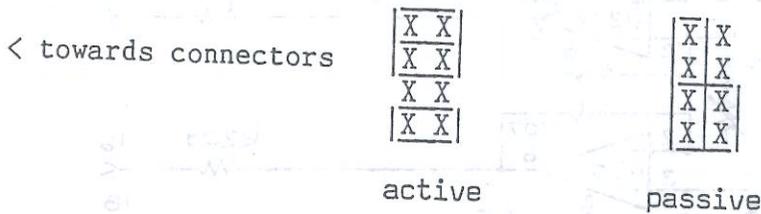
Fig. 6. Active/Passive Jumper Positions.

P7 and P8 are 3-way pin headers which are normally not jumpered. However, if an analog input signal is single-ended (referred to signal ground), it should be connected between P5 or P6 pins 1 or 2 and signal ground (pin 3), and the unused input can be jumpered to ground on P7 or P8. Jumpering pin 2 to pin 3 grounds the (+) input; jumpering pin 2 to pin 1 grounds the (-) input.

Maximum allowed voltage on any analog input for correct operation is ±10 volts measured with respect to signal ground. Over-voltage and transient protection is provided on the I/O board.

The 12 volt floating supply is available at J1 pins 9(+) and 5(-). Total permissible load on the supply, including current required to activate the channels, is 30mA maximum.

±15 volt supplies are available at the 3 analog connectors. Maximum permissible load on these supplies is 30mA total.

3.7 CONFIGURABLE I/O BOARD - FEATURES & CONNECTIONS

The configurable I/O board, part no. 15000010, comes with removable terminal strips for wired connection of all signals. Analog and two-state signals are on their separate terminal strips. Depending on the ADI-123G option ordered, the configurable I/O board may be supplied with or without two-states, and with or without wire links for standard analog levels. The user may install wire links and/or components to provide signal levels appropriate to the application.

Signal assignments for the terminal strips are given in Table 4 below.

Fig. 7 gives a complete schematic of the configurable I/O board, and Fig. 8 shows the component layout for the board. A description of the functions available on the board follows.

3.7.1 Two-states Circuitry

The circuitry around U1 through U6 and P1 through P3 interfaces the two-state channels. This area is identical to the corresponding part of the standard I/O board. Refer to section 3.6 concerning the use of the active/passive jumpers.

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```
TWO-STATES J2          terminal              use
                          1          case ground
9-way terminal strip      2          channel 1 (-)
                          3          channel 1 (+)
                          4          channel 2 (-)
                          5          channel 2 (+)
                          6          channel 3 (-)
                          7          channel 3 (+)
                          8          12 volt supply (-)
                          9          12 volt supply (+)


ANALOG J3              terminal              use
                          1          analog output ground
10-way terminal strip     2          analog output
                          3          case ground
                          4          channel 1 input (-)
                          5          signal ground
                          6          channel 1 input (+)
                          7          case ground
                          8          channel 2 input (-)
                          9          signal ground
                         10          channel 2 input (+)
```

Table 4. Configurable I/O Board Connector Pin Assignments.

3.7.2 Analog Control Output Circuitry

The control voltage generated on the analog board comes on to the I/O board via J1-2. J1-1 is analog ground. The control signal may be reduced by a divider formed by RV1, R13, and R14. The division ratio is given by

$$DR = \frac{R13 + aRV1}{RV1 + R13 + R14} ,$$

where aRV1 the resistance of the part of RV1 between its slider and R13.

The total resistance value of RV1 + R13 + R14 should be 5k ohm or greater to avoid excessive load on the analog board output circuit.
If no trimming adjustment is required, RV1 may be replaced by wire links.

If no reduction in control voltage is required, install links in place of RV1 and R14, omitting R13.

The control voltage is passed on to an optional operational amplifier U7. The amplifier may be used as a unity gain buffer to provide a low output impedance following the divider, or it may have more than unity gain to give the desired range of control in conjunction with RV1. The output voltage may be boosted to about 12 volts maximum, depending on the op amp chosen and the ±15V supplies on the board.

The op amp gain is set by means of R15 and R16, and is given by

Fig. 8. Configurable I/O Board Component Layout.

$$GAIN = \frac{R15 + R16}{R15}$$

Capacitor C4 may be included to slow the response of the amplifier and reduce its noise output. The amplifier bandwidth is given by

$$BW = \frac{1}{2 \text{ pi } R16 \text{ } C4}$$

R17 is included to avoid high-frequency instability when the external wiring presents a significant capacitive load to the amplifier. A value of 100 ohm is suitable.

For unity gain, omit R15. Retain C4 (0.1 uF) and R16 (10 kohm) as a precaution against oscillation. Bandwidth reduction does not occur in this case.

RV2 is a trimmer to null the offset voltage of U7. Depending on the op amp used, the slider of RV2 may be connected to +15V or -15V by a jumper on P4. Connecting the center pin of P4 to its upper pin (pin 1) gives +15V on RV2. To get -15V on RV2, connect P4 pins 2 and 3. Consult the data sheet of the op amp chosen for the correct value of RV2 and the supply polarity required on its slider.

If the op amp is not required, place a wire link from pin 3 to pin 6 of position U7, and a link in place of R17.

R18 and CR7 form a transient protection network. Recommended components are 100 ohm and ICTE15C or 1.5KE12C, respectively.

3.7.3 Analog Status Inputs

Each of the analog input channels is provided with board space for an adjustable-gain differential op amp pair to allow monitoring of low input voltages. Alternatively, the amplifiers may be omitted and the inputs connected straight through, or the input signals may be divided down so that voltages higher than the basic full scale of 10V may be monitored.

U101 and U102 are the amplifiers for channel 1. The gain of the pair is given by

$$GAIN = \frac{RV101 + R106 + R107 + R108}{RV101 + R106}$$

R103 and R104 are normally replaced by wire links.

R109 and R110 should be 100 ohm each, since the common mode rejection of the analog board is factory set for a source impedance of this value on each input lead.

RV102 is used to trim the offset voltage of the differential pair. See section 3.7.2 above for rules concerning the selection of this trimmer and the position of the jumper on P101.

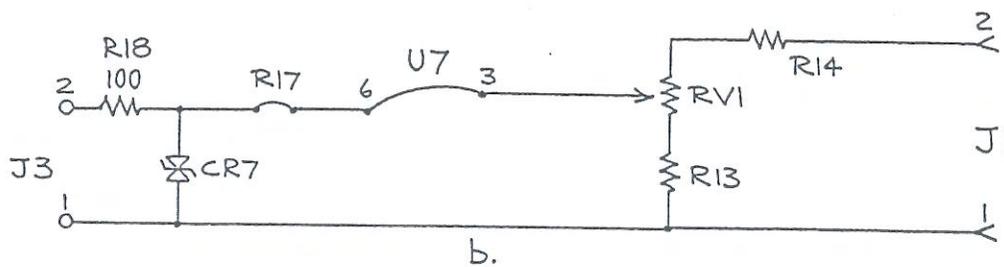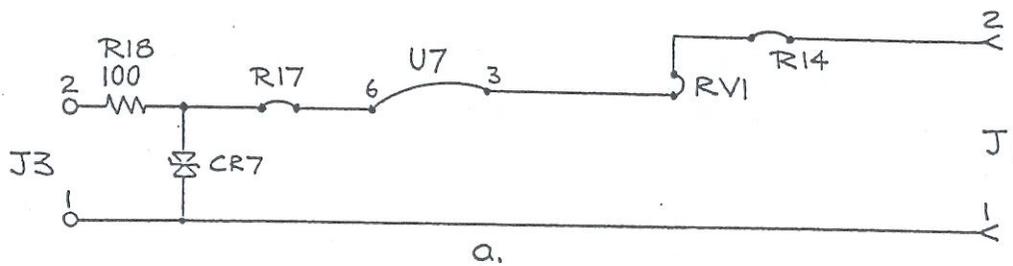If the amplifiers are to be omitted and straight through connection used,

Fig. 9a,b. Configurable I/O Board Applications.

place wire links for R103 and R104, and from pins 3 to pins 6 of U101 and U102 positions. Omit RV101, R106, R107, and R108. Replace R109 and R110 by wire links, and make R101 and R102 100 ohm each. See Fig. 9c.

If input voltage reduction is required, place links across U101, U102, R107, and R108 positions as above, and install RV101 and R103 through R106 to obtain the desired division ratio, as given by

$$DR = \frac{RV101 + R106}{RV101 + R103 + R104 + R106}.$$ See Fig. 9e.

R101, R102, CR101, CR102 form a transient protection network. The recommended resistor values are 100 ohm, and the diodes ICTE15C or 1.5KE12C.

The circuitry for channel 2 is repeated with 200 series component references.

3.7.4 Maximum input voltages

For correct operation of the analog board, the output voltages from the I/O board should not be allowed to exceed ±10 volts measured with respect to signal ground at J2-5,9 on the I/O board.

In addition, there are restrictions on the common-mode voltage at the inputs. Common-mode is the average of the two input levels. When the amplifier pair is used on the I/O board, common mode should be limited to ±5 volts measured with respect to signal ground.

In applications where the ADI-123G is used to control and monitor voltages in a single external device, for example when controlling a programmable power supply and monitoring its output voltage and/or current, the common mode level of the analog inputs may be established by the analog output ground connection. This allows the analog inputs to operate in a truly differential mode. Care must be taken to ensure that the common mode levels remain within the capabilities of the ADI-123G input circuit, as described above.

3.7.5 Some examples

Not all applications require all the components to be installed. The following are some arrangements which are commonly used:

a) Where the analog control output is to be used unmodified as delivered by the analog board, links are installed as indicated in Fig. 9a.

b) Where a simple adjustable divider is appropriate on the control output, the configuration of Fig. 9b can be used. Here the output impedance may not be as low as in the previous example.

c) If one or both analog status input channels do not require additional amplification or attenuation, links can be fitted as shown in Fig. 9c.

d) If the input signal is single-ended (referenced to signal ground), only a single input amplifier need be used. Fig. 9d shows this arrangement with
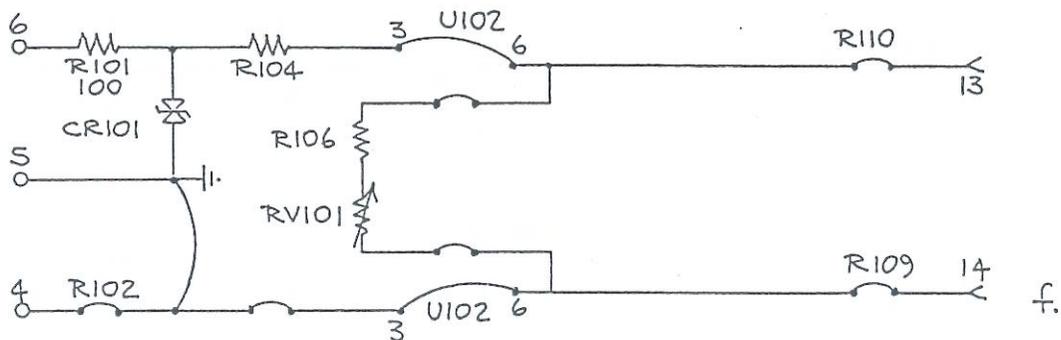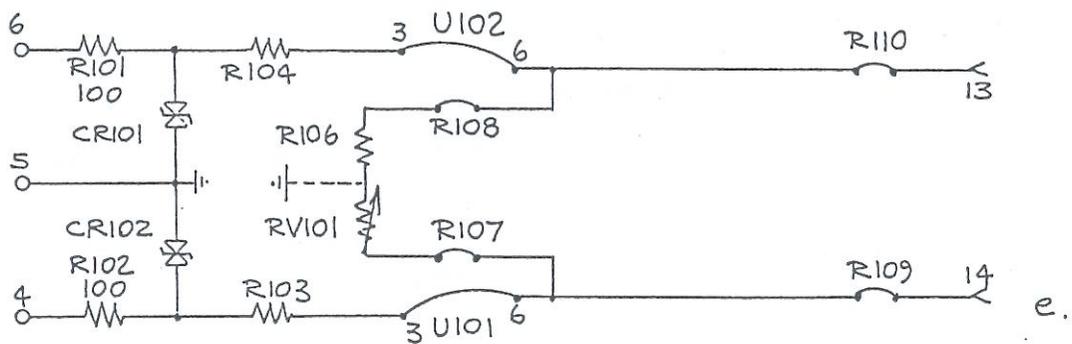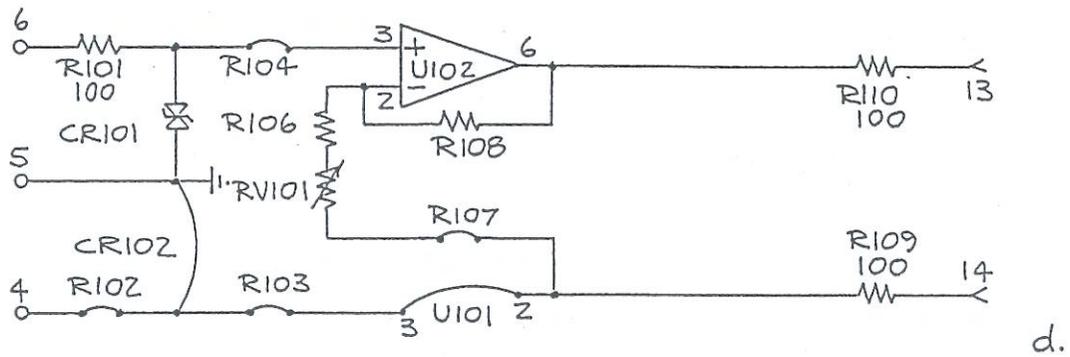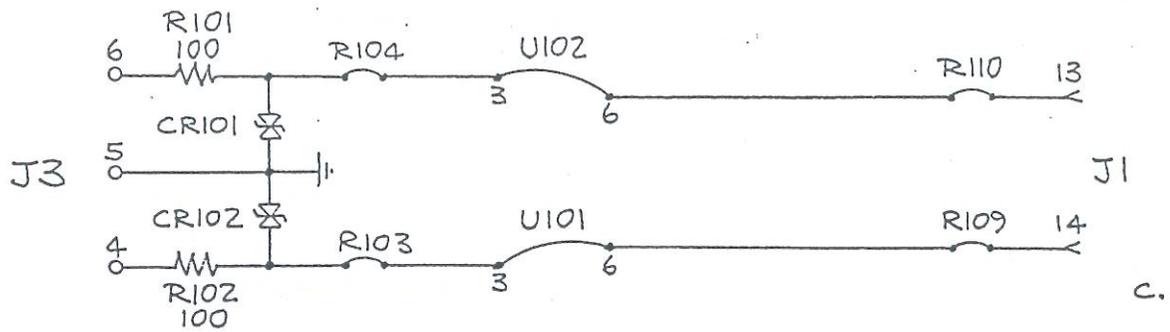
Fig. 9c,d,e,f. Configurable I/O Board Applications.

adjustable gain.

e) If the differential input voltage on either channel is greater than 10
volts, the arrangement of Fig. 9e can be used. This circuit provides
differential mode attenuation but no common mode attenuation. If high common
mode (average input voltage) exists, install a wire link from the junction of
RV101 and R106 to signal ground at the junction of CR101 and CR102. The
circuit will then attenuate the common mode input. RV101 trims the circuit for
zero response to common mode inputs.

f) This example is similar to e) above, except it is arranged to attenuate a
single-ended input. Here RV101 can be used to trim the attenuation.

The impedances presented by the I/O board to the differential inputs of the
analog board should be 100 ohms each where possible in order to maintain
optimum common mode rejection. Where two op amps are used on the I/O board,
R109 and R110 should be 100 ohms each. Also, in example d) above 100 ohms
should be used. In example c), common mode performance will be preserved if
R101 and R102 are 100 ohms each and the external signal source impedance is
comparatively low. In example e) best common mode rejection will be obtained
if the values of RV101 and R106 are as low as possible.

When amplifiers are used on the I/O board, supply bypass capacitors C5 and C6
should be installed. 47nF ceramic capacitors may be used.

Many other circuit arrangements are possible with the configurable I/O board.
The optimum choice depends greatly on the application, but to achieve the
full performance capabilities of the ADI-123G good instrumentation amplifier
design practice should be observed.

In many cases it is not necessary to achieve exact adjustment of the gain or
attenuation of input circuits on the I/O board, since the ADI-123G software
can compute a correction factor and automatically adjust the values
transmitted. Select the gain or attenuation components according to the
maximum nominal input voltage expected, allowing for some over-range, say 5%
or 10%. Then set the ADI-123G in operation. Connect both input leads of the
channel in question to signal ground. Read the channel with the Rc command
(see page 4-8 for a description of the commands). If there is a zero trimmer
on the I/O board, adjust it for zero reading. Otherwise zero the ADI-123G with
the Zc command. Now apply a known voltage, near full scale, to the input. Send
the command Ccn to the unit, where c is the input channel number, and n is the
response in bits you wish the calibrating input voltage to produce. Full range
is -16384 to +16383 bits. All input voltages to this channel will now be
scaled according to the calibration just performed. The calibration factor can
be inspected with the ICc command, and it will be stored in memory for up to
30 days with power off.

3.8 ANALOG BOARD INTERFACING.

The user can build a custom I/O board, incorporating connectors and circuitry suited to a particular application.

Supply voltages of ±15 volts, +5 volts, and an isolated 12 volt supply are available on the 20-way analog board connector. Maximum currents which may be drawn are 30 mA each from the ±15 volt and isolated 12 volt supplies, and 100 mA from +5 volts.

Mechanical dimensions of the I/O board are given in Fig. 10.

See Table 5 for the 20-way analog board connector pin assignments.

pin	use	pin	use
1	analog output ground	11	-15V
2	analog output signal	12	+15V
3	two-state control 1	13	analog input ch 1 (+)
4	two-state status 1	14	analog input ch 1 (-)
5	two-state control 2	15	analog input ch 2 (+)
6	two-state status 2	16	analog input ch 2 (-)
7	two-state control 3	17	analog input ground
8	two-state status 3	18	analog input ground
9	logic ground	19	12V (-)
10	+5V	20	12V (+)

Table 5. Analog Board I/O Connector Pin Assignments.

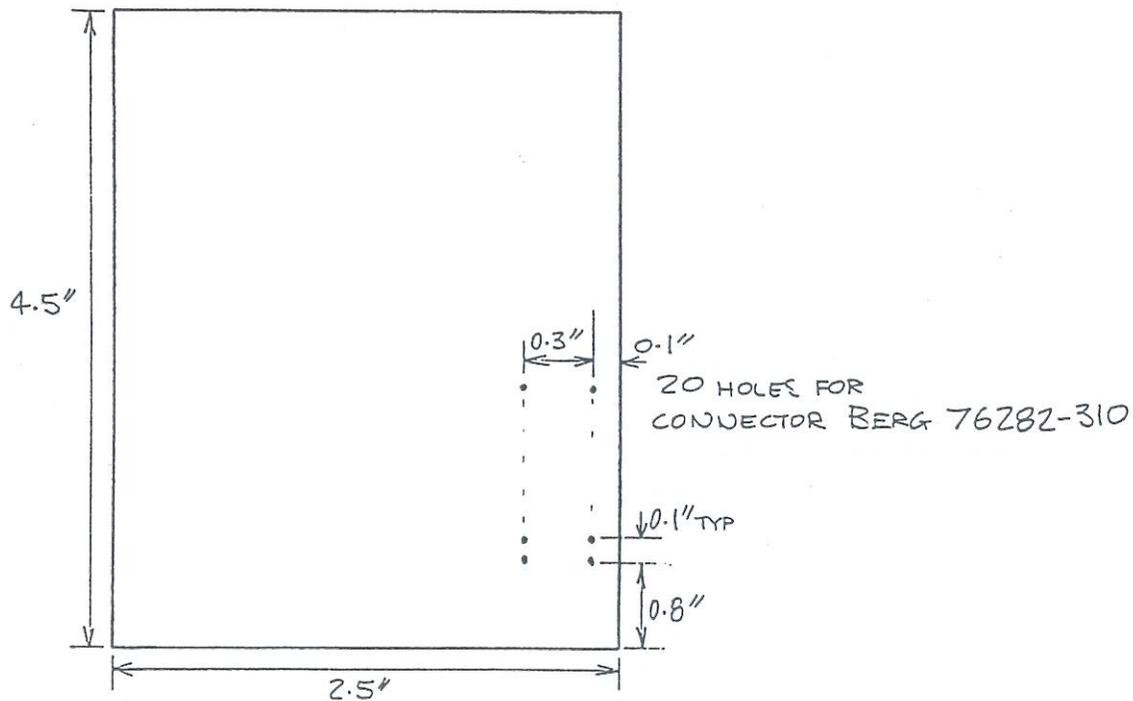Fig. 10. I/O Board Mechanical Details.

3.9 GROUNDING

All parts of the ADI-123G case are connected together to form an integral electric shield around the circuitry inside.

The internal circuitry is not connected to the case. Signal ground and the case are electrically isolated from each other. Depending on the application circumstances, it is usually better not to ground the ADI-123G circuitry directly, particularly if the controlled/monitored device already has a ground connection to its circuitry.

However, it is best to ground the case in order to reduce pickup of interference signals and transients. Usually the case will be grounded automatically when the device is mounted on the controlled equipment or rack. Grounding may also occur via the GPIB cable shield when the cable is connected to other grounded instruments. The case is connected to pin 12 of the GPIB receptacle.

For electrical safety, the case of the ADI-123G must be grounded through the third wire of the power input cord.

Connection to the case is available at a number of points on the analog and two-state connectors. These points are useful for terminating cable shields to ensure the shield extends continuously around the ADI-123G circuitry.

Standard I/O Board Case Grounding Points

Two-state connector J1: pin 1

Analog control and status connectors P4, P5, & P6: pin 6.

Configurable I/O Board Case Grounding Points

Two-state terminal strip J2: terminal 1

Analog terminal strip J3: terminals 3 & 7.

4. OPERATING INSTRUCTIONS

4.1 USING THE IEEE-488 GPIB INTERFACE

4.1.1 General Purpose Interface Bus - Overview

The IEEE-488 standard describes a means of communication to and from programmable instruments through a standard bus and associated protocol called the General Purpose Interface Bus (GPIB). Any instrument manufactured to this specification will be able to communicate on the bus. Up to 15 instruments may be connected on the bus at any one time, and they are considered to be listeners (able to receive data), talkers (able to transmit data) or controllers (able to control and configure the bus).

A typical GPIB setup is shown in Fig. 11. This system contains a controller and a selection of talkers and listeners. However, a wide range of system complexity is possible, from systems with just one talker-only and one listener-only and no controller, to systems including several controllers linked with many talker/listener devices.

The GPIB interconnection cable contains 16 signal lines in three groups:

> a) 8 data lines
> b) 3 handshake lines
> c) 5 bus management lines.

All these lines connect to all the instruments on the bus. The logic sense on the actual bus wires is low true.

The 8 data lines allow bit-parallel, byte-serial data transmission between units on the bus. The data lines are used to send data from talkers to listeners, and to send data and commands from controllers to talkers and listeners.

The three handshake lines are: Data Valid - DAV
Not Ready For Data - NRFD
Not Data Accepted - NDAC.

NRFD is high (false) to indicate that all devices on the bus are ready for the next data transmission. If any device is not ready, it pulls NRFD low (asserted) which inhibits data transmission. When a talker is ready to send data it places the data on the 8 data lines and asserts the DAV line. As each listener on the bus accepts and reads the data, it removes its assertion of the NDAC line. Thus the NDAC line stays asserted until the slowest unit on the bus has accepted the data and releases the line. Now the talker can take the data off the bus which becomes available for the next transaction.

There can be only one System Controller on the bus. However the System Controller can pass control to another controller which is then called the active controller. It is the responsibility of the active controller to determine which device can next talk and which can listen. At any time there can be only one active talker, but as many active listeners as desired. The speed of data transmission between talker and listener will be limited by the speed of the slowest listener.

Each device on the bus is assigned a unique address in the range 0 to 30. The address is usually set by switches on the device. The switches may be located on the back panel or internally.

When the controller wishes to designate the talker and listeners for the next sequence of bus transmissions, it asserts the bus management line called Attention (ATN) and then sends the appropriate talker and listener address commands to assign the desired talker and listener(s) required for the next transaction. The controller then releases the ATN line, thus allowing the talker to start sending its data on the bus. The ATN line distinguishes commands from data. When a controller is about to set up such a transaction, it is normal practice first to send a single command which causes all devices to unlisten.

Devices which have not been addressed to listen simply ignore the data being sent and so have no effect on the transmission.

When configuring a system, the controller can send commands to the other devices in one of three ways:

a) a command can be sent by asserting one of the 5 bus management lines; for example, asserting the Interface Clear (IFC) line resets the bus to an idle state irrespective of bus activity at the time;

b) a command can be sent by asserting the ATN line and placing the command on the data lines; the command is read by every device on the bus, with normal handshaking, as described above; an example of this is the Device Clear command which resets all devices on the bus to their specific predefined device-dependant states;

c) a command can be sent to specific devices. First the controller sends the listen address command of the devices which are to receive the command. Then the command itself is sent, to be received only by the devices addressed to listen.

Command messages are sent on the data bus using 7-bit ASCII codes, and are distinguished from data messages by the state of the ATN line – ATN is asserted for commands. Command messages fall into four groups as shown in Table 6 below. The groups are the Primary Command Group, the Listen Address Group, the Talk Address Group, and the Secondary Command Group.

Address Commands

When the controller wants to make a device behave as a listener, it places the appropriate listen address command on the bus. The command is given by

listen address command = decimal 32 + device address.

For example, if the device address is decimal 18 (hex 12), then the decimal number 50 (hex 32, ASCII 2) is placed on the data lines as a binary coded 7-bit number, while the ATN line is held asserted. This causes the device whose address is decimal 18 to become a listener. In GPIB parlance, the device is said to be "selected". Any or all devices on the bus which have listener capability may be in the selected state simultaneously.

decimal value	hex value	ASCII character	GPIB mnemonic	description
			PCG	Primary Command Group
1	01	SOH	GTL	Go To Local
4	04	EOT	SDC	Selected Device Clear
5	05	ENQ	PPC	Parallel Poll Configure
8	08	BS	GET	Group Execute Trigger
9	09	HT	TCT	Take Control
17	11	DC1	LLO	Local Lockout
20	14	DC4	DCL	Device Clear
21	15	NAK	PPU	Parallel Poll Unconfigure
24	18	CAN	SPE	Serial Poll Enable
25	19	EM	SPD	Serial Poll Disable
			LAG	Listen Address Group
32-62	20-3E	sp thru >		Listen addresses 0 through 30
63	3F	?	UNL	Unlisten
			TAG	Talk Address Group
64-94	40-5E	@ thru ^		Talk Addresses 0 through 30
95	5F	underscore	UNT	Untalk
			SCG	Secondary Command Group
96-126	60-7E	' thru ~		Secondary Commands 0 through 30
96-111	60-6F	' thru o	PPE	Parallel Poll Enable (SC0 through SC15)
112	70	p	PPD	Parallel Poll Disable (SC16)
127	7F	DEL		ignored

Table 6. GPIB Command Codes.

When the controller wants to make a device into a talker, it places the device's talk address command on the bus. This command is given by

talk address command = decimal 64 + device address.

For example, a device whose address is decimal 18 has a talk address of decimal 82 (hex 52, ASCII R). At any time, only one device may be a talker.

To cause all listeners to stop listening, the controller sends the Unlisten command, decimal 63 (hex 3F, ASCII ?).

To stop the talker being a talker, the Untalk command is sent, i.e. decimal 95 (hex 5F, ASCII _).

Bus Management Lines

ATN   Attention - asserted when the controller is sending commands.
      Not asserted while data is on the bus.
      Also used with EOI - see EOI below.

IFC   Interface Clear - when asserted by the controller, all bus activity is
      unconditionally   terminated and the System Controller regains active
      control if control has previously been passed to another controller. Any
      talkers or listeners are unaddressed.

REN   Remote Enable - if asserted while a device listen address is on the bus,
      then the device will go into its remote mode.

EOI   End Or Identify - dual function.
      1) when output from a talker, indicates the end of a multi-byte message
      when asserted during transmission of the last byte.
      2) during parallel polling,   the controller asserts EOI and   ATN
      simultaneously. This causes each device which has been configured for
      parallel poll to place its status on the appropriate status line.

SRQ   Service Request - asserted by a device when it requires attention from
      the controller. The controller responds by servicing the device in an
      appropriate way. Often the service request is used to indicate that the
      device has data ready to be sent. The controller is not obliged to
      respond to the service request, but the device will hold the line
      asserted until it has been serviced.

Service Requests

Often GPIB compatible devices have the ability to generate a service request
when they require some action on the part of the active controller. A service
request is usually issued when the device has completed a task, or if an error
condition has occurred. To request service, the device asserts the SRQ line.
This usually causes an interrupt in the active controller, so it enters an
interrupt service routine which services the event. In general, the service
routine will take the following actions:

1) determine which device is requesting service (parallel poll)

2) ascertain the action required (serial poll)

3) execute the required action

4) re-enable interrupts

5) return to the task in hand before being interrupted.

The SRQ line is released by the device when the serial poll is performed.

Serial Polling

When a serial poll is done on a device, it causes the device to output a byte which indicates its status or condition. Each bit indicates the status of some device dependant parameter. Usually data line 7 reflects the status of the SRQ line.

Parallel Polling

The fastest way for the active controller to ascertain the status of several devices on the bus is to perform a parallel poll. The devices to be polled must have parallel poll capability and must have been previously configured by the controller. During a parallel poll each configured device responds by placing its status on its own designated bus data line. More than one device can respond on each data line.

The data line assigned to a device and the logic sense of the response is configured by a PPOLL CONFIGURE sequence, as follows:

1) the device is addressed to listen

2) the Parallel Poll Configure command PPC, hex 05, is sent

3) the Parallel Poll Enable code is sent. This code belongs to the Secondary Command Group, decimal 96 to 111. In this code bits 6 and 7 are always set. Bits 1, 2, and 3 carry a binary code to specify which of the 8 data lines the device will use to send its status, and bit 4 is used to determine the logic sense of the status. For example, if bits 1 through 4 were all 0, the device would place 0 on data line 1 during a parallel poll if its status response were in the affirmative.

4) the Unlisten command is sent

Now if the controller executes a parallel poll by asserting the ATN and EOI lines simultaneously, the configured device(s) respond as described above and the controller reads the data lines.

The parallel poll response can be disabled in two ways:

a) a Parallel Poll Unconfigure (PPU) command from the controller will cause all devices on the bus to ignore subsequent parallel polling. The devices are not addressed to listen before this command.

b) the PPC command followed by Parallel Poll Disable (PPD) will disable parallel polling only in devices which have been selected (addressed to listen).

Device Clear and Selected Device Clear

A device on the bus is cleared by sending a Device Clear Command. The device is then initialized to a pre-defined, device dependant state. There are two forms of this command; the Device Clear command (decimal 20) causes all

devices on the bus to be cleared, whereas the Selected Device Clear command (decimal 4) clears only devices selected to listen.

Talker-Only Mode

If a device is set to be a talker-only, it will output data on the bus, using normal handshaking, whenever it has data to send. This mode is useful in simple systems where a talker-only is connected to one or more listener-only devices without the need for a controller. A talker-only cannot receive data and it cannot be programmed through the bus.

Listener-Only Mode

A listener-only can only receive data. It cannot be programmed through the bus, nor can it output data. For example, a printer as a listener-only will continuously print all data it receives.

For full details on the GPIB, the reader is referred to the IEEE standard 488-1978.

4.1.2 ADI-123G GPIB Capability

The IEEE-488 Standard defines ten interface functions, some with as many as 28 allowable subsets. The ADI-123G supports the interface functions as listed below. See also Appendix C of the IEEE-488-1978 Standard.

SH1 source handshake capability

AH1 acceptor handshake capability

T5 talker (basic talker, serial poll, talk-only mode,
                            unaddressed to talk if addressed to listen)

TE0 no address extension talker capability

L4 listener (basic listener, unaddressed to listen if addressed to talk)

LE0 no address extension listener capability

SR1 service request capability

RL0 no remote local capability

PP1 parallel poll capability (configured by controller)

DC1 device clear capability

DT1 device trigger capability

C0 no controller capability

In general, the ADI-123G may act as a listener to receive commands from a system controller, and as a talker to send input voltage measurements and other responses to the controller and other listening devices in the bus system.

The ADI-123G may be set by means of an internal switch to act as a talker-only. See page 3-4. This mode is used in systems which have no system controller, in which the ADI-123G continuously sends input voltage measurements from the channel locked by S2-5 and S2-6 on the bus to listener-only devices, for example printers, terminals, or the Group 3 COM-488 GPIB to Serial Adaptor which converts the bus traffic to serial data format.

The ADI-123G responds to the following command messages on the bus. This is a subset of the complete repertoire of bus commands given earlier.

decimal value	hex value	ASCII character	GPIB mnemonic	description
4	04	EOT	SDC	Selected Device Clear
5	05	ENQ	PPC	Parallel Poll Configure
8	08	BS	GET	Group Execute Trigger
20	14	DC4	DCL	Device Clear
21	15	NAK	PPU	Parallel Poll Unconfigure
24	18	CAN	SPE	Serial Poll Enable
25	19	EM	SPD	Serial Poll Disable
32-62	20-3E	sp thru >		Listen addresses 0 through 30
63	3F	?	UNL	Unlisten
64-94	40-5E	@ thru ^		Talk Addresses 0 through 30
95	5F	underscore	UNT	Untalk
96-111	60-6F	' thru o	PPE	Parallel Poll Enable (SC0 through SC15)
112	70	p	PPD	Parallel Poll Disable (SC16)

Table 7. ADI-123G GPIB Command Codes.

The Device Clear and Selected Device Clear commands perform device specific functions. In the ADI-123G these commands cause the following to occur:

    a) analog output set to zero
    b) peak hold values of both input channels set to zero
    c) GPIB buffers reset
    d) GPIB software reinitialized
    e) serial poll byte and SRQ cleared
    f) parallel poll unconfigured

4.2 ADI-123G Commands

In addition to the GPIB commands listed in the previous section, the ADI-123G responds to a set of ADI-123G commands which are listed in Table 8 below. These commands are in the form of ASCII coded data which are sent to the device interface by the system controller on the bus. Note that ADI-123G commands are data as far as the bus is concerned and are not to be confused with GPIB commands. The distinguishing feature is that with GPIB commands the controller asserts the ATN line.

The commands are in the form of one to three ASCII alphabetical characters, often followed by a channel number c and a numerical value n. If no number is entered where one is expected, zero will be entered automatically. A decimal point is not required in whole number entries.

Except for W and TW commands, numerical values entered by commands are retained in non-volatile memory when power is off. Default values shown below apply after system reset command CTRL X or if S2-8 is switched ON. The processor automatically executes a reset if the memory back-up has failed after more than 30 days without power applied.

Switch-selectable defaults are instated on power up, reset, and when a switch setting is changed. See Table 2, page 3-4.

All of the ADI-123G responses start with a space character. Decimal numbers include a decimal point. Some are in exponential format.

If an error message is returned, the complete command must be re-entered.

Analog input and output values n are numbers of bits as decimal integers.
Other analog values are decimal numbers.
For analog input channels, channel number c = 1 or 2.
For two-state channels, channel number c = 1, 2, or 3.

Table 8. ADI-123G Commands.

code	description
Ccn	Calibrate - calls up the calibrate function and sets a calibration factor such that the present voltage input is defined to be equal to the entered value n for channel c (c = 1 or 2). Default factor = 1.
Dcn	Digital filtering of channel c n = 0, filtering OFF n = 1, filtering ON Default set by S2-7
ECc	Erase calibration - sets calibration factor to 1 on channel c.
ELc	Erase scale factor - sets scale factor to 1 on channel c.
EOc	Erase offset - sets offset to 0 on channel c.
EPc	Erase (reset) peak hold value for channel c.

EZc   Erase zero - cancels zero correction on channel c.

Fc   Channel select lock - selects the channel to be digitized -
       immediately effective, and over-rides all other channel selection.
       c = 0, no channel preference, cancels channel lock
       c = 1 or 2, selects channel 1 or 2.
       Default set by S2-5 and S2-6.

GC   General function - continuous ADC operation (default condition)

GV   General function - puts device in triggered mode (see V command below)

ICc   Inspect calibration factor for channel c -
                         returns calibration factor as mantissa and exponent.

IDc   Inspect digital filtering status for channel c -
                         returns 0 if filtering is OFF, 1 if ON.

IF   Inspect channel lock - returns 1 or 2 for channel in lock mode, or 0 if
                         neither channel is locked. Default set by S2-5 and S2-6.

IG   Inspect general function - returns C for continuous, V for triggered.

IJc   Inspect filter factor for channel c -
                         returns filter factor as mantissa and exponent.

IKc   Inspect sampling interval for channel c.
       returns interval in seconds between transmissions following SM1 command.

ILc   Inspect scale factor for channel c - returns current scale factor.

IOc   Inspect offset for channel c - returns current offset.

IT   Inspect timeout - returns current period in seconds after which control
                         outputs are set to zero if no communication is received. See STn.

IYc   Inspect window for channel c - returns current value of window
                         within which digital filtering operates.

IZc   Inspect zero for channel c - returns current zeroing offset.

Jcn   Filter factor - enters filter factor n for channel c. Default n = 10.
                 n = 0 or 1, no filtering
                 n > 1, filtering more severe as n increases
                 0 < n < 1, reading overshoots.

Kcn   Sampling interval - enters time interval between output values for
                 channel c following SM1 command. Default n = 0, every reading sent.
                         n = any integer, time in seconds between outputs.

Lcn   Scale - calls up scale mode and enters scale factor n for channel c.
                 All measurements from this channel are now multiplied by n
                 which may be in the range -9.9999 to +9.9999. Default n = 1.

Nc   Natural data - returns unmodified channel c data. Similar to Rc.

Ocn   Offset - calls up offset mode and enters offset n for channel c.
                    n is added to all channel c measurements. Default n = 0.

Pc   Peak data - returns peak value measured for channel c since last EPc.

Rc   Read data from analog input channel c - returns number of bits,
          initially in range -16384 to +16383,
          but modified by zero, scale factor, offset and calibrate functions.

SEn   Assert EOI line when string terminator is sent: n = 0, no
                                                      n = 1, yes
                                                      Default set by S2-2

SMn   Send-mode selection:
          n = 0, output on request using Rc command
          n = 1, output from channel last selected by Fc or Rc command or S2-5,6
                        at intervals set by Kn command. Default set by S2-1.

SRn   Service request when data is available: n = 0, no
                                              n = 1, yes
                                              Default set by S2-1.

SSn   Send mode for error messages:
          n = 0, literal error messages are sent
          n = 1, single-digit message codes are sent - see page 4-11.
                 default is n = 0.

STn   Set timeout period n in seconds. Timeout starts when device
          receives an address command or other command while selected.
             If timeout occurs, control outputs are set to zero or off.
          Maximum period 163.83 seconds. Default mode: function disabled (n = 0).

TRc   Two-state read of channel c status, c = 1, 2, or 3 -
                              returns 0 or 1 according to state of channel c.

TRG   Two-state read of every channel,
                 returns 3-bit binary number, channel 3 as most significant bit.

TWcn Two-state write to channel c of data n, n = 0 or 1.

TWGn Two-state write to every channel of data n, n = 0 or 1.

V   Causes all devices which have been placed in the triggered mode by
      GV command to perform an A/D conversion of channel selected by Fc
      command. If SM1 command has been given, data is transmitted after V
      command. See section 4.5.

Wn   Write data n (number of bits) to analog control output;
           n in range -8192 to 8191 if S2-4 is ON, 0 to 16383 if S2-4 is OFF.

CTRLX System reset - reinstates all default values. Returns the message RESET.

Ycn   Window - enters window n within which digital filtering occurs for
                        channel c. Default = 10. See section 4.4.

Zc   Zeroing – calls up zeroing mode and defines present measurement from
            channel c as zero. Default is to cancel zero correction.

Some examples using the commands:

1)   R1   requests channel 1 input to be transmitted.

2)   F1   locks ADC to channel 1 input – channel 2 not digitized.

      SM1K10   every conversion sent – this produces the maximum data rate
                  from 1 input channel – if service requests are enabled, device
                  generates a service request and can send data every time it
                  makes a conversion.

      SMOFO   turns off continuous transmission and removes channel lock.

3)   F1GV   locks device to channel 1 and sets device on triggered mode.
      V   device performs a/d conversion.
      R1   reads out data captured by V command.

4)   W-8192   sets analog output of bipolar device to negative full scale.

4.3 ADI-123G ERROR MESSAGES

Error messages are transmitted as a result of bad command entries or other
conditions. The messages are normally in the literal form given below, but may
be changed to the single character form shown in square brackets by issuing
the command SS1 (see Table 8 above).

All error messages are preceded by an exclamation mark character (!), and are
followed by the string terminator(s) selected by S2-2 and S2-3.

A listing of the error messages follows:

[1] "INVALID COMMAND ENTRY" indicates that the command entered did not fit the
specifications in Table 8.

[2] "POSITIVE NUMBER REQUIRED" indicates erroneous entry of minus sign.

[3] "NUMBER TOO BIG" indicates that the number entered in a command was
                                        greater than the allowed maximum.

[4] "OUTSIDE LIMITS" indicates entry of a number outside allowed range.

[5] "DIVIDE BY ZERO" indicates Calibrate commmand was given with the input
                                        value at zero.

[6] "OVERRANGE" in response to Rc command indicates input voltage is too high.

[7] "OVERFLOW" in response to Rc command indicates computed response is too
                                        large.

4.4 DIGITAL FILTERING

The ADI-123G software includes a digital filtering algorithm which may be invoked by remote command. Filtering is useful for smoothing out small fluctuations in the input voltage values.

In order to speed up the response to large input changes when filtering is on, a window can be set to define a band about the most recent value. Filtering will only occur while the unfiltered value remains within the window. If the input changes rapidly enough and far enough, the filtered measurement will not be able to follow within the window, and filtering is temporarily disabled. This allows the output values to follow large rapid changes, while providing good filtering of constant or slowly varying inputs.

Filtering may be set up individually for the two input channels.

The window width can be set using the Y command. The value entered is the half-window on either side of the present filtered measurement. The default value on system reset is 10 bits for a total window width of 20 bits.

The digital filter takes the input value before processing by zero, calibrate, offset, and scale functions, and performs the following computation:

$$F(new) = F(old) + \frac{F - F(old)}{J} \; ,$$

where
F(old) is the previous filtered value
F(new) is the updated filtered value
F is the most recent unfiltered value
J is the filter factor.

The effective time constant of the filter is dependent upon both the rate at which measurements are made and the value of J, according to the formula:

$$T = \frac{P}{\ln [J/(J-1)]}$$

where
and
T is the filter time constant
P is the period between measurements.

4.5 TRIGGERED OPERATION

Triggering allows one or more ADI-123Gs on a loop to make synchronized measurements on demand.

The ADI-123G is set for triggered operation by entering the command GV. This stops continuous sampling of the input value.

Once the GV command has been entered, there are two ways of triggering a measurement:

1) send the GPIB Group Execute Trigger (GET) command. This invokes the device trigger capability of the ADI-123G's GPIB interface, and is implemented by placing the GET code (decimal 8) on the data lines and asserting the ATN line.

2) enter the command V, as follows:

    a) address as listeners all the ADI-123Gs which are to be triggered
    b) send the ADI-123G command V. As with all other ADI-123G commands, the V is sent as ASCII data on the bus without the ATN line asserted.

The two triggering methods produce identical results, except that the GET command triggers all ADI-123Gs which have been set for triggering by GV, while V triggers only those units which have been addressed to listen.

The new measurement can be read out on the bus by entering the Rc command. Alternatively, if the ADI-123G is set for continuous transmission with the SM1 command after being set for triggered operation, then following the V or GET the device will issue a service request (if service request is enabled). The device can then be parallel polled and the input value read without needing the controller to send the Rc command.

As a useful diagnostic aid while a system is being set up, the effects of the GV, V, and GET commands on the ADI-123G can be observed directly by removing its top cover and watching the LED on the analog board. During normal continuous operation the LED will be seen to flash continuously. After the GV command the LED will stop flashing. Then each time the GET or V command is given, the LED will flash once. Continuous operation is restored using the GC command.

4.5.1 Channel selection for triggered operation

The channel which is measured in response to the V command is the channel which was last addressed by the Rc command, or the channel which is locked using the Fc command. Locking can also be done using switches S2-5,6 (see page 3-4).

4.5.2 Digital filtering with triggered operation

If filtering is ON, then each time a measurement is triggered the filtering algorithm will calculate a new input value as described in section 4.4.

The effective time-constant will depend on the timing of the V commands.
If the input values obtained on triggering are required to reflect only the
input at the time of triggering and not contain any history, then filtering
should be turned OFF.

4.5.3 Triggered operation timing

The ADI starts sampling the input 0.5 to 1 msec after the V has been received.

Input sampling time is 20, 33.33, or 40 msec, depending on the position of the
ADC timing jumper (see section 3.5).

After sampling, the value is digitized and computations are done.

The new value is ready no later than 3 times the input sampling time after the
V.

Do not request transmission of the value (using Rc) sooner than 3 times the
input sampling time after the V command, or the old value may be transmitted.

4.5.4 When the V command is ignored

The V command is ignored by ADI-123Gs which have not been initialized for
triggering by the GV command.

The V command is ignored by ADI-123Gs which have been initialized for
triggering, if the command is received while the device is still in the
process of making a measurement in response to a previous V command.

4.6 PROGRAMMING THE TWO-STATE CHANNELS

The two-state channels can be used as inputs, outputs, or both. The three channels can be controlled individually and read by commands included in Table 8 starting on page 4-8.

A channel is switched ON by sending to the ADI-123G the command TWc1, where c is the channel number 1, 2, or 3. In the ON state the channel will conduct current if supplied with a power source and provided the circuit is completed externally.

A channel is switched OFF by issuing the command TWc0. This puts the channel in a high-impedance state where only leakage current will flow.

When a channel is programmed to the ON state by the TWc1 command, it can be tested for current flow by the command TRc. The response will be 0 if the channel current is less than 0.6 mA. Currents of 4 mA or more will give a response of 1. For currents between 0.6 and 4 mA the response may be 0 or 1.

To use a channel as an input, first initialize it with the command TWc1. Thereafter read the channel status with the TRc command.

To use a channel as an output, control it ON with TWc1 and OFF with TWc0. At any time a check can be made that the channel is delivering current with the TRc command.

Commands TWGn (n = 0 or 1) and TRG operate on all three channels simultaneously.

Full electrical specifications on the two-state channels are given on p. 2-1.

Note that when a channel is controlled to the ON state and is delivering current, its LED on the I/O board is lit. This is a useful diagnostic aid when checking a control system. However the LED will glow even when the channel current is below the 4mA level needed for a guaranteed ON status to be read.

Section 3.6 describes how the channels are set to be either active (internally powered) or passive (externally powered). Note that in the passive mode the channels are electrically isolated from one another and from the ADI circuitry generally, This gives the user great flexibility in the deployment of the channels.

Channels that are made active have a common connection internal to the ADI-123G, though this common is isolated from the rest of the device and from ground. Because of the common internal connection, no connection between channels external to the unit is allowed.

GROUP 3 TECHNOLOGY LIMITED

LIMITED WARRANTY

Group 3 Technology Limited (hereinafter called the Company) warrants instruments and other products of its manufacture to be free from defects in materials and workmanship that adversely affect the product's normal functioning under normal use and service for a period of one year from the date of shipment to the purchaser.

The obligation of this warranty shall be limited to repairing or replacing, at the discretion of the Company and without charge, any equipment which the Company agrees is defective as set out above within its warranty period.

The Company will reimburse lowest freight rate two-way charges on any item returned to the Company's factory or any authorized distributor or service center, provided that prior written authorization for such return has been given by the Company.

This warranty shall not apply to any equipment which the Company determines to have become defective owing to mishandling, improper installation, alteration, negligence, inadequate maintenance, incorrect use, exposure to environmental conditions exceeding specifications, or any other circumstance not generally acceptable for equipment of a similar type.

The Company reserves the right to make changes in design without incurring any obligation to modify previously manufactured units.

No other warranties are expressed or implied, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. The Company is not liable for consequential damages.

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