MODEL 436
Three Channel DC Differential Signal Conditioner

INSTRUCTION MANUAL

ENDEVCO

San Juan Capistrano, California, USA

IM436
REVISION A
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SECTION 1:

GENERAL DESCRIPTION

1. SYSTEM OVERVIEW

The ENDEVCO® Model 436 DC Differential Voltage Amplifier is a three-channel signal conditioner designed for use with two and four arm piezo-resistive (PR) accelerometers, pressure transducers, strain gages, and the Endevco MICROTRON variable capacitance accelerometers. The unit provides one AC output per channel proportional to the AC voltage input.

The AC output can amplify the input signal up to 1,000 times. It has a default 10 kHz, 4-pole Butterworth lowpass filter that can be enabled or disabled. The corner frequency and filter type can be changed by an internal module (Endevco Model 31875). The Endevco Model 436 Signal Conditioner card provides an excitation voltage of either 0, 5, 10, or 15 VDC. The excitation voltage levels can be modified at the factory for applications requiring excitation voltages different from the default 5, 10, 15 VDC.

The Endevco Model 436 Signal Conditioner card is designed to be used with the Endevco Model 4990 (RS-232 or Ethernet option) 19" Rack. The Endevco Model 436 can be remotely programmed by using the controller software model 4991.

2. MANUAL ORGANIZATION

This manual is organized into two sections, plus parts lists and engineering drawings. The manual has been structured to provide whatever information may be needed by an operator to set up and successfully operate the Model 436.

Section 1 provides general information on the Model 436 including operating parameters and specifications. Section 2 provides detailed information on the installation and operation of the Model 436.

3. SPECIFICATIONS

Electrical Characteristics: Inputs

Differential Voltage Input

Input Impedance	1 MΩ minimum	
Input Range		
	Differential	0 to ±10 VDC or peak AC
	Common-Mode	±10 VDC or pk VAC, inclusive of signal
		50 V-pk without damage
Common-Mode Rejection	70 dB minimum	
		200 Ω or less input imbalance, DC to 60 Hz
Input Imbalance Adjustment	±100 mVDC, 100 ≤ gain ≤ 1000	
		±1 VDC, 10 ≤ gain < 100

±10 VDC, 0 < gain < 10

Calibration Input

High impedance, single-ended, DC-coupled with one side connected to signal ground.

Input Impedance 1 MΩ

Electrical Characteristics: Outputs

AC/DC Signal Output

Type Single ended, short circuit protected

Output Impedance 0.2 Ω maximum

Maximum Linear Output 10 Vpk minimum

Minimum Current Output 10 mA (10V into a 1 kΩ load)

Output DC Bias (offset) Less than 10 mVDC (After executing auto-zero or auto-balance)

Output DC Bias Stability with Temp. ±5 uV/°C RTI for G > 100 (typical)

Output DC Bias Stability with Time ±20 uV RTI or ±5 mV RTO, whichever is greater, for 24 hours, after 1 hour warm-up.

GUARD Voltage Output

Selection Selectable with jumper at headers W101, W201, W301. DC voltage selected with jumper across pins 1/2, 0V DC selected with jumper across pins 2/3

GUARD Voltage Amplitude 7.5VDC, 5VDC, 2.5VDC, or 0VDC

GUARD Voltage Accuracy ± 2% or 50 mVDC, whichever is greater

GUARD Current 25mA typical

GUARD Noise 1mV typical (DC...50kHz)

Excitation Voltage Output

Excitation Voltage Amplitude 15 VDC, 10 VDC, 5 VDC, or 0 VDC (Measured by ±PSEN lines)

Excitation Voltage Accuracy ± 1% or 50 mVDC, whichever is greater

Current 85 mA maximum, short circuit protected

Noise & Ripple 1 mVRMS max 10 Hz to 50 kHz, 1 kΩ load

Maximum Compliance Voltage ±P Lines provide a maximum of +20 VDC

Maximum Series Line Resistance < 100 Ω

Minimum Load Resistance > 100 Ω

TRANSFER CHARACTERISTICS

Gain

Range Programmable from 0 to 1000

Resolution 0.0025, $0 \leq$ gain < 10

0.025, $10 \leq$ gain < 100

0.25, $100 \leq$ gain ≤ 1000

Accuracy ±0.5% of full scale maximum DC to 1 kHz, filters disabled.

Linearity ±0.1% of full scale, best fit straight line at 1 kHz

Stability ±0.2% of full scale, 0°C to +50°C

Broadband Frequency Response (DC Input)

Magnitude Frequency Response ±5%, DC to 50 kHz, referenced to 1 kHz

Lowpass Filter Characteristics

Filter can be enabled or disabled through the front panel. Corner frequency may be changed by replacing internal module 31875 (one for each channel). Each channel may be configured with a different corner frequency. The unit will display the corner frequency set by the header by reading an ID voltage unique to each corner frequency.

Type 4-pole Butterworth (default)

Corner Frequency (-3 dB) 10 kHz ± 12% (default) Other corners optional

Magnitude % Error at Corner Frequency ±22% max

Roll-off (slope) -24 dB per octave

Magnitude Frequency Response See PS31875

Phase Frequency Response See PS31875

Highpass Filter Characteristics (AC Input)

Type 1-pole (1MΩ/0.1μF)

Corner Frequency (-3dB) 1.55Hz

Noise

20 uVRMS RTI plus 1 mVRMS RTO, DC to 50 kHz, with a 1 kΩ source resistance. Unit in non-monitoring state. Internal standard 10 kHz, 4-pole Butterworth lowpass filter enabled

Crosstalk Between Channels

80 dB RTI minimum

Crosstalk specification valid for the following conditions:
(a) Inject signal into one channel set at Gain=1
(b) Other channel set as follows: input shunted with 1000 Ω

POWER REQUIREMENT

Voltage Requirement

+5VDC, ±15 VDC, +24 VDC

Current Consumption (typical, excitation = 0VDC)

+5VDC: 75mA
+24VDC: 47mA
+15VDC: 100mA
-15VDC: 160mA

Power Dissipation

5.42 Watts typical Plus up to 2 Watts per Channel to power sensor.

Isolation

Channel to Channel Signal Grounds	No isolation between channels
Output Signal Ground to Case Ground	No isolation

PHYSICAL CHARACTERISTICS

Dimensions and Weight

Card Dimensions	144.45mm (4U per DIN 41494) x 280 mm (5.68" x 11.02")
Front Panel	6.81" (173.15mm) x 1.00" (5HP)
Weight	20g (11.2 ounces) typical

Connectors on Cards

Sensor Input / Output (each channel) 9-pin DB9 Female D-connector ITT Cannon P/N DEMM9PD

Pin 1: PSEN+ Excitation Sense Input
Pin 2: Jumper Selectable: -15 VDC Output (not fused), or Bridge Completion (BC+)
Pin 3: Shunt Cal (RSH)
Pin 4: S- Sensor Signal Input
Pin 5: S+ Sensor Signal Input
Pin 6: PSEN- Excitation Sense Input
Pin 7: P+ Excitation Voltage
Pin 8: P- Excitation Voltage
Pin 9: Guard/Shield (1/2 P+ or GND)

Connector to Backplane DIN 41612 type C, 96 contacts, male, right angle. Mates to 4990 Rack backplane

ENVIRONMENTAL CHARACTERISTICS

Temperature

Operating Temperature	32° F to 122° F (0° C to 50° C)
Storage Temperature	-40° F to 185° F (-40° C to 85° C)

Humidity

0 % to 90 % non condensing

4. EQUIPMENT SUPPLIED

Description	Endevco Part No.	Quantity Supplied
Instruction Manual	IM436	1
Shunt Calibration & Bridge Completion Adapter	EX84	3
Resistor Header for 4-pole Lowpass Filter, selectable frequency	31875-1000-0	3

SECTION 2

INSTALLATION AND OPERATION

1. INTRODUCTION

This section contains information on the incoming inspection, installation and checkout of the Model 436.

2. UNPACKING AND INSPECTION

WARNING
OBSERVE SOUND ESD PRECAUTIONS WHEN UNPACKING AND HANDLING THE MODEL 436

The Model 436 has been thoroughly tested at the factory before shipment and should be ready for operation when received. However, an inspection should be made to ensure that no damage occurred during shipment.

The Model 436 signal conditioning module is shipped with its instruction manual, 31875-XXXX filter modules, and EX84 shunt calibration and bridge completion adapter in one packing box. Carefully unpack and check all items for shipping damage. Any obvious damage should be immediately reported to the carrier and no attempt should be made to operate the equipment. Also, carefully compare each item shipped in its packing box against the Packing List and notify the factory if any discrepancies are discovered.

It is recommended that all packing material be retained for future use.

3. INSTALLATION

INSPECT FOR PROPER INSTALLATION OF THE 31875 FILTER MODULES

The Model 436 is designed to be installed only into the ENDEVCO Model 4990 series rack.

Install the Model 436 signal conditioning module into the front side of the 4990.

Carefully align the module with the card guides, push the module into the rack and secure it with the attached mounting screws. Check that all modules are secure in the rack.

4. OPERATION

The Model 436 is designed to be operated only in the ENDEVCO Model 4990 series rack using ENDEVCO OASIS 2000 Model 1xx/4xx Configuration Editor Software.

DO NOT PROCEED WITHOUT HAVING IM4990 AND IM2000 AVAILABLE

Prior to operating the Model 4990 the operator should verify the DIP switch setting per the following instructions. (Refer to IM4990 for further information)

A. Baud Rate and Signal Routing Selection

Baud Rate and Signal Routing is selected through two 8-position DIP switches, located on the card-side of the back plane, accessible from the front side of the unit. To access the DIP switches, the card in slot 16 has to be removed. The DIP switches offer three modes of operation:

4990-2 mode: Serial connector on front panel connected to back plane

4990-1 mode: Serial connector of EDAS controller connected to back plane. Optionally, the backplane signals may be monitored via the front panel serial connector.

EDAS configuration mode: Serial connector on front panel connected to EDAS controller. This setting is to be used when configuring the ITP address and other characteristics of the EDAS controller.

The baud rate of the rack is determined by position 8 of switch S2. It is also possible to accommodate reversed TX/RX cables (null-modem cables) using positions 1 and 2 of S2.

B. Default Jumper Settings for RS-232 Rack (4990-2):

POS	S1 SWITCH SETTING	REMARK	S2 SWITCH SETTING	REMARK
1	ON	front panel RX ← → back plane RX	OFF	(use POS1 ON for reversed cable, TX <- -> RX)
2	OFF		OFF	(use POS2 ON for reversed cable, RX <- -> TX)
3	OFF		ON	straight cable (TX ← → TX)
4	ON	front panel TX ← → back plane TX	ON	straight cable (RX ← → RX)
5	OFF		X	
6	OFF		X	
7	X		X	
8	X		ON	baud rate = 9.6 kbd (OFF for 19.2kbd)

C. Default Jumper Settings for Ethernet Rack (4990-1):

POS	S1 SWITCH SETTING	REMARK	S2 SWITCH SETTING	REMARK
1	OFF	(ON for snoop mode)	OFF	
2	ON	EDAS RX ← → back plane RX	OFF	
3	OFF		OFF	(ON for snoop mode)
4	OFF	(ON for snoop mode)	OFF	(ON for snoop mode)
5	ON	EDAS TX ← → back plane TX	X	
6	OFF		X	
7	X		X	
8	X		OFF	baud rate = 19.2 kbd

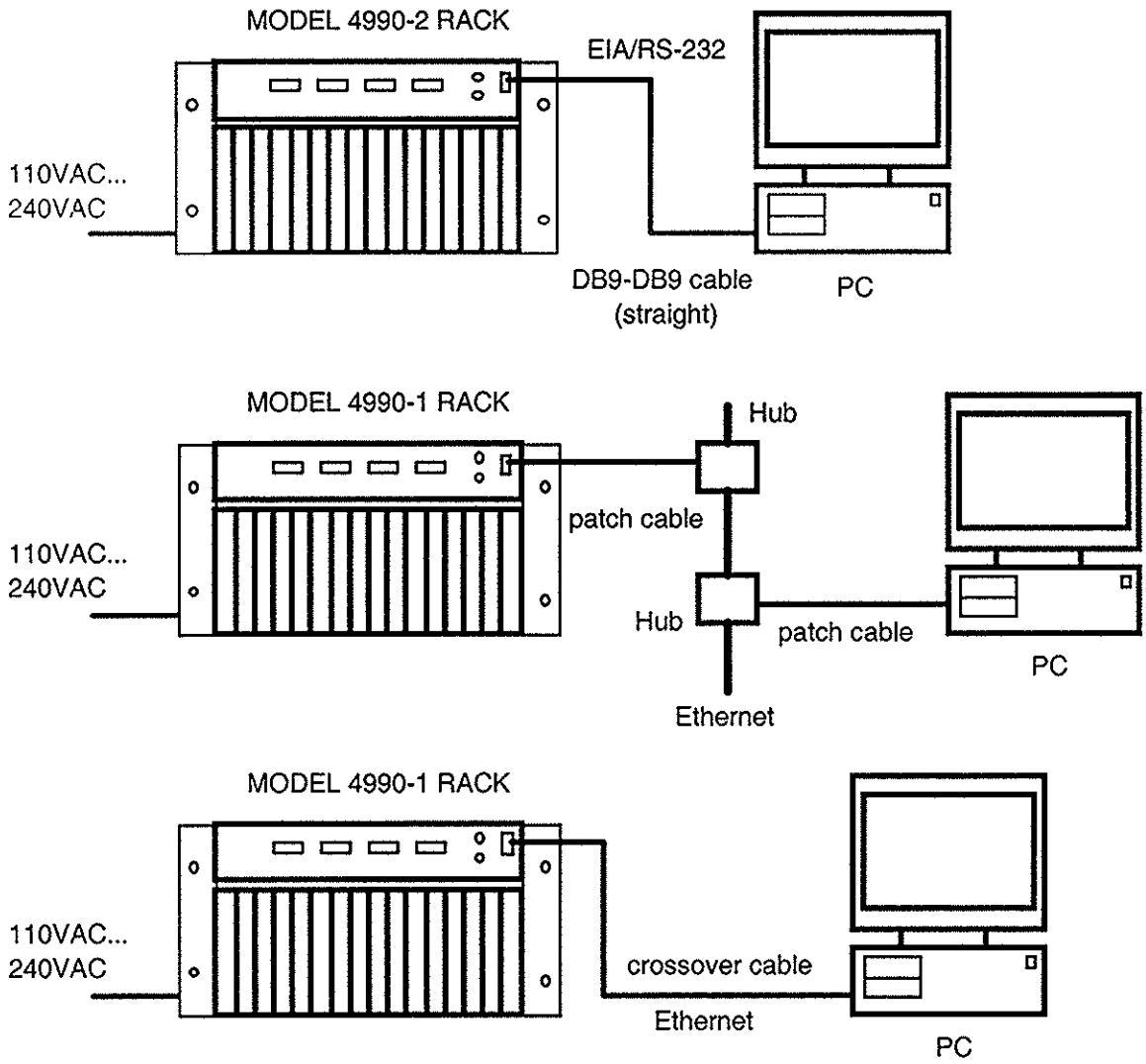
In snoop mode, the serial signals generated by the cards will appear on the RX pin of the front panel and the serial signals generated by the EDAS controller will appear on the TX pin of the front panel. This can be used for monitoring purposes. In this mode, only "listening" devices (i.e. RX inputs) may be connected to the serial connector on the front panel. TX outputs, i.e. devices that actively drive RS-232C signals, will interfere with the communication between the EDAS controller and the card. Jumper Settings for EDAS Configuration are listed in the table below. After configuring the EDAS controller, S1 and S2 have to be switched back to the 4990-1 default settings.

D. Optional Jumper Settings for EDAS Configuration only (4990-1):

POS	S1 SWITCH SETTING	REMARK	S2 SWITCH SETTING	REMARK
1	OFF		OFF	
2	OFF		OFF	
3	ON	EDAS RX ← → front panel RX	ON	EDAS TX ← → front panel TX
4	OFF		ON	EDAS RX ← → front panel RX
5	OFF		X	
6	ON	EDAS TX ← → front panel TX	X	
7	X		X	
8	X		X	baud rate = 9.6 or 19.2 kbd

E. Connection of Model 4990 with PC.

Connect the Model 4990 rack to your PC in one of the three configurations shown below. Connect the host computer interface cable to the RJ45 connector (4990-1) or the 9 pin "D" connector (4990-2). Refer to IM4990.



F. **Powering Up Of The Rack Assembly** (Refer to IM4990)

WARNING: PRIOR TO INSERTING THE POWER CORD INTO THE POWER ENTRY MODULE, VERIFY THE FOLLOWING:

POWER SOURCE IS BETWEEN 90 AND 264 VAC, 50 TO 60 Hz.

THE INSTALLED FUSE IS THE SAME RATING AS LABELED ON THE RACK NEXT TO THE POWER ENTRY MODULE.
COMMON CONNECTION (THIRD WIRE) OF THE POWER SOURCE IS CONNECTED TO EARTH GROUND.

Power up the Model 4990 by activating the switch on the power entry module. Verify the fan is operating and the fan filter is in place. Verify the LED on the front of the Model 436 is lit.

CAUTION: The channel settings of the signal conditioning modules are not automatically stored in non volatile memory. If power is removed from the Model 4990 rack, or a signal conditioning module is removed

while the rack is powered up, (not recommended) all channel settings will revert to whatever was last saved in non-volatile memory. Refer to SW2000- for instructions on saving the rack configuration to a file, or writing the individual module setup in EEPROM.

G. **Running the OASIS 2000 software** (refer to IM2000 for further information)

OASIS 2000 Overview

The OASIS 2000 software works with all Endevco Model 4xx Series rack mounted signal conditioner and amplifier units. The Model 436 falls into this category.

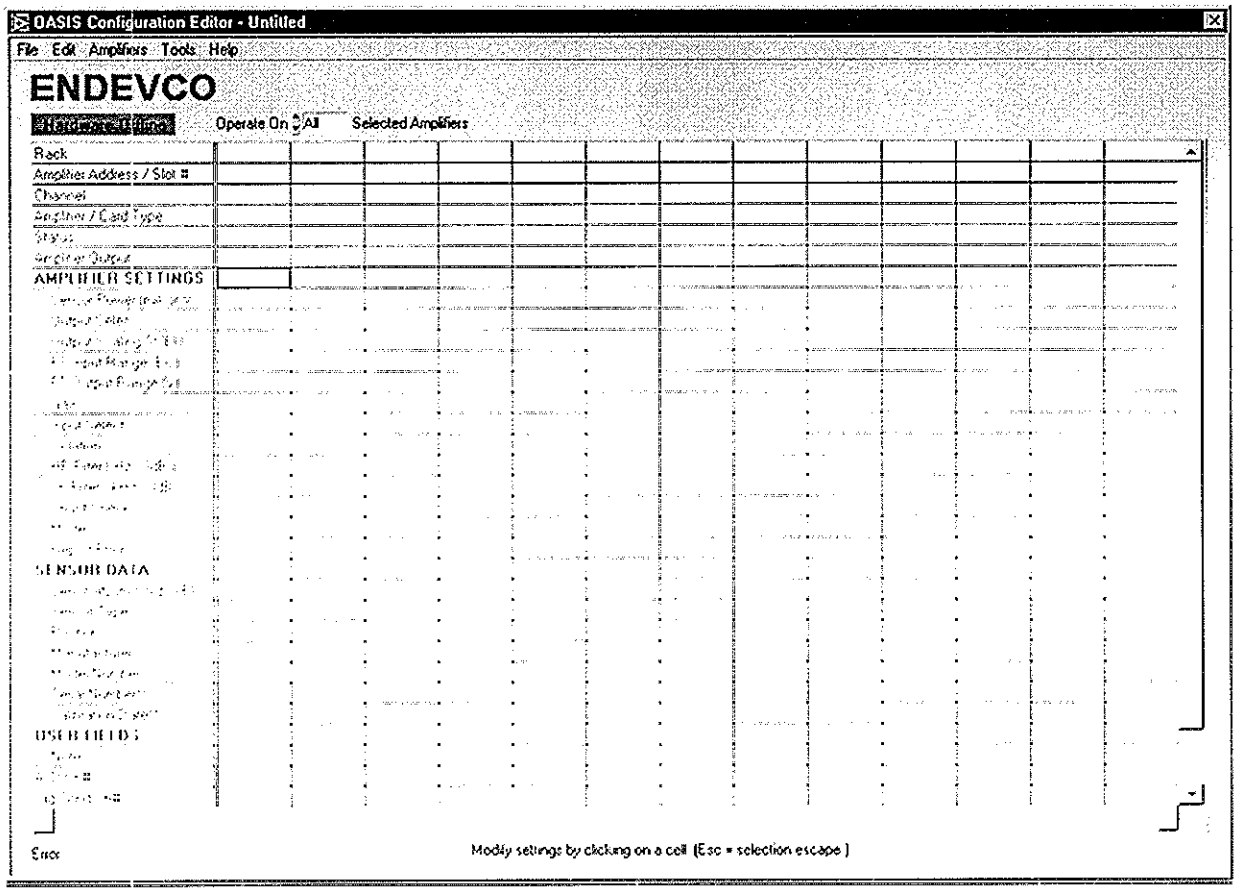
Configuration Limits

The software can configure up to a maximum of 16 racks with up to 16 units in each rack. If 16 racks contained 16 Model 436 units then the channel count would be 768 (16x16x2). The racks needn't however, contain the same unit type in each slot of each rack. The different unit types can be intermixed freely at the users discretion.

Using The OASIS Configuration Editor

The OASIS software can be run in both an ONLINE and OFFLINE mode. When OFFLINE no attempt is made to access the hardware. This mode can be used to setup and save multiple configurations with or without physical hardware present.

The OASIS Configuration Editor - OFFLINE MODE



All the functions of the Model 436 are remotely programmable through the configuration editor. The same set of functions and modes are available for each channel.

H. Functional Characteristics

Model 436 is fully compatible with the 400-series specifications, i.e. it is designed to operate in both the Model 4990-2 (via a standard RS-232 serial interface) and the Model 4990-1 Rack (via Ethernet).

The ENDEVCO Model 436 can be programmed via the serial interface (RS-232) or Ethernet port of any PC connected to the Model 4990 Rack. All settings, such as gain and output scaling, and all status information, such as faults, operating modes etc. are accessible via remote control.

When the Model 436 is not accessed by the remote control software for the setting of parameters or for the report of status information it will enter a low-power/low-noise mode. This design feature, along with the optimized layout and the low number of amplifier and buffering stages allows for extremely low noise operation.

The card will automatically restore at power-up all the settings stored in its internal non-volatile memory. The same set of programmable functions are available for each channel.

I. Sensor Connections

The Model 436 is shipped with one Shunt Calibration & Bridge Completion Adapter EX84 per channel plugged into the 18-pin sockets close to the sensor connectors.

Positions 9 and 16 are occupied by a pre-installed resistor that is used for automated test of the Model 436. This resistor may be removed or replaced.

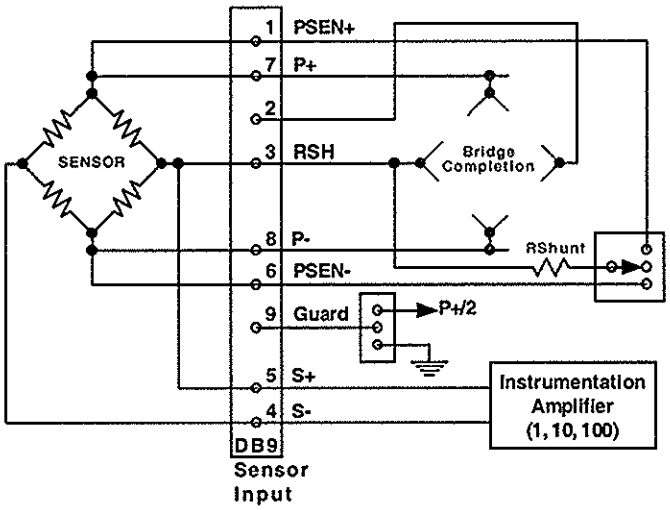
The bifurcated terminals of the adapter EX84 can be used to attach bridge completion and shunt calibration resistors. It is recommended to remove the adapter EX84 prior to soldering resistors to the terminals.

The pin positions for the resistors are:

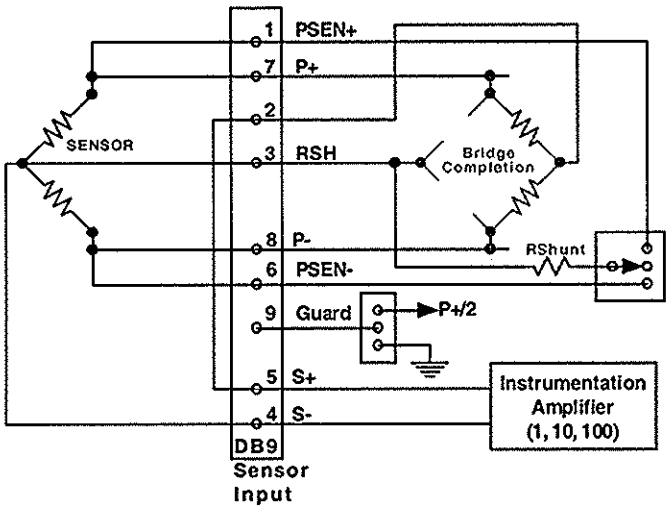
Pin 1-24: Bridge completion resistor A (Ra)
Pin 3-22: Bridge completion resistor B (Rb)
Pin 5-20: Bridge completion resistor C (Rc)
Pin 7-18: Bridge completion resistor D (Rd)
Pin 9-16: Shunt calibration resistor (Rsh)

No connections should be made to the remaining pins.

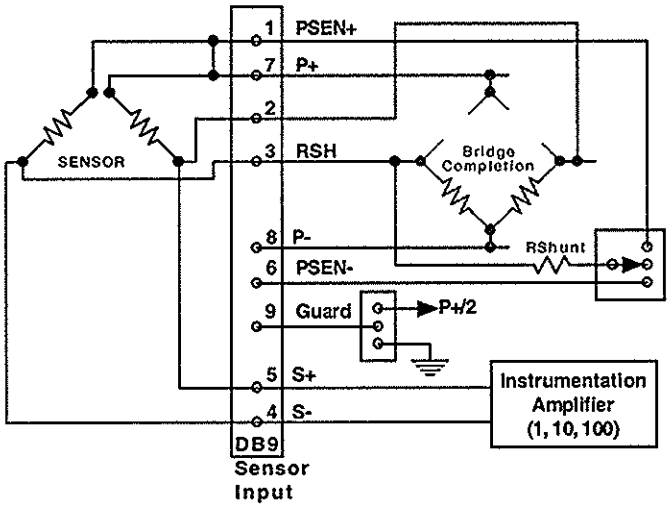
One Remote PR Sensor (Full Bridge), 6-Wire Connection



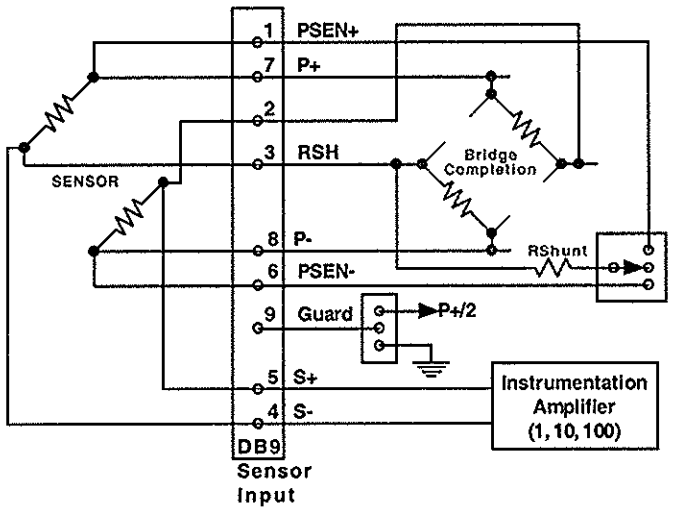
Two Remote PR Sensors (Half Bridge), 3-Wire Connection



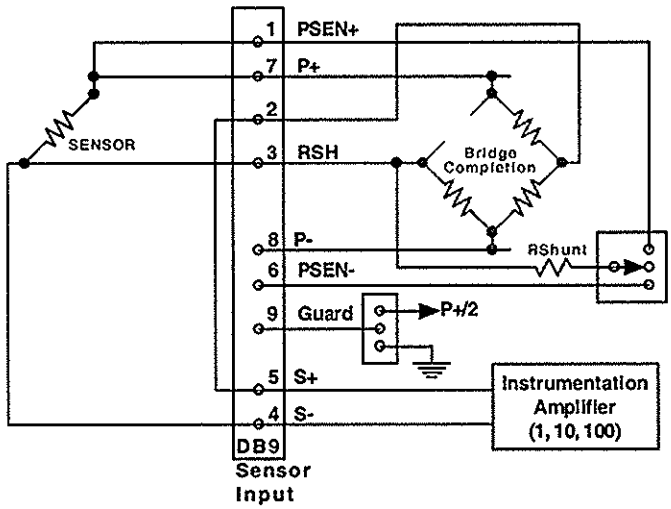
Two Remote PR Sensors (Half Bridge), 2 Sets of 3-Wire Connection



Two Remote PR Sensors (Half Bridge), 2 Sets of 4-Wire Connection



One Remote PR Sensor (Quarter Bridge), 4-Wire Connection



J. Status Indication

A fault indicator on the front panel will emit green light if the unit is operating normally. It will turn red if there is a hardware problem, a digital communication problem or if any of the 3 inputs fails auto-zero or auto-balance. The user can make the card ignore faults in any of the channels if the card will be operated with less than 3 sensors.

K. Communication with the OASIS 2000 Software

Model 436 is fully compatible with the 400-series specifications, i.e. it is designed to operate in a Model 4990-2 Rack (via a standard RS-232 serial interface) or in a Model 4990-1 Rack (via Ethernet).

L. Serial Communication between Model 4990 Rack and PC

In both the Model 4990-1 and 4990-2 Racks, the Model 436 is capable of communicating the following parameters to the OASIS 2000 Software:

1. Identification of the Card Model Number, firmware revision, bus address.
2. Configuration of the rack (number of installed cards)
3. Read/Write settings for all of the programmable functions.
4. Read/Write calibration constants. The new calibration constant will take effect immediately and it will be stored into non-volatile memory.
5. Query error/status
6. Reset the unit.

M. Select Input

This function is used for connecting the input of the front-end Instrumentation Amplifier to one of the following options:

1. "DC": PR sensor DC signals S+ and S- selected.
2. "AC": DC components removed from PR sensor signal
3. "Ext. Cal": External Calibration Signal from 4990 Rack.
4. "Ground": Differential Input is grounded.

N. Excitation Voltage

This function is used to enable/disable the excitation voltage and also to set the amplitude of the excitation voltage as monitored by the excitation sense lines (±PSEN). The following options are available:

1. "0.00": Set excitation voltage level to 0 VDC.
2. "5.00": Set excitation voltage level to 5 VDC.
3. "10.00": Set excitation voltage level to 10 VDC.
4. "15.00": Set excitation voltage level to 15 VDC.

O. Sensor Sensitivity (mV/EU)

Sensor's sensitivity is entered in mV/EU. The card uses this information to determine the gain needed to achieve the required output scaling. The user can enter four significant digits ranging from 0.001 to 9999.

If the sensitivity is decreased to the point where the amplifier's gain is greater than 1000, then the card will send an error message indicating that the Output Scaling setting has been modified to meet the Gain $\leq$ 1000 constraint.

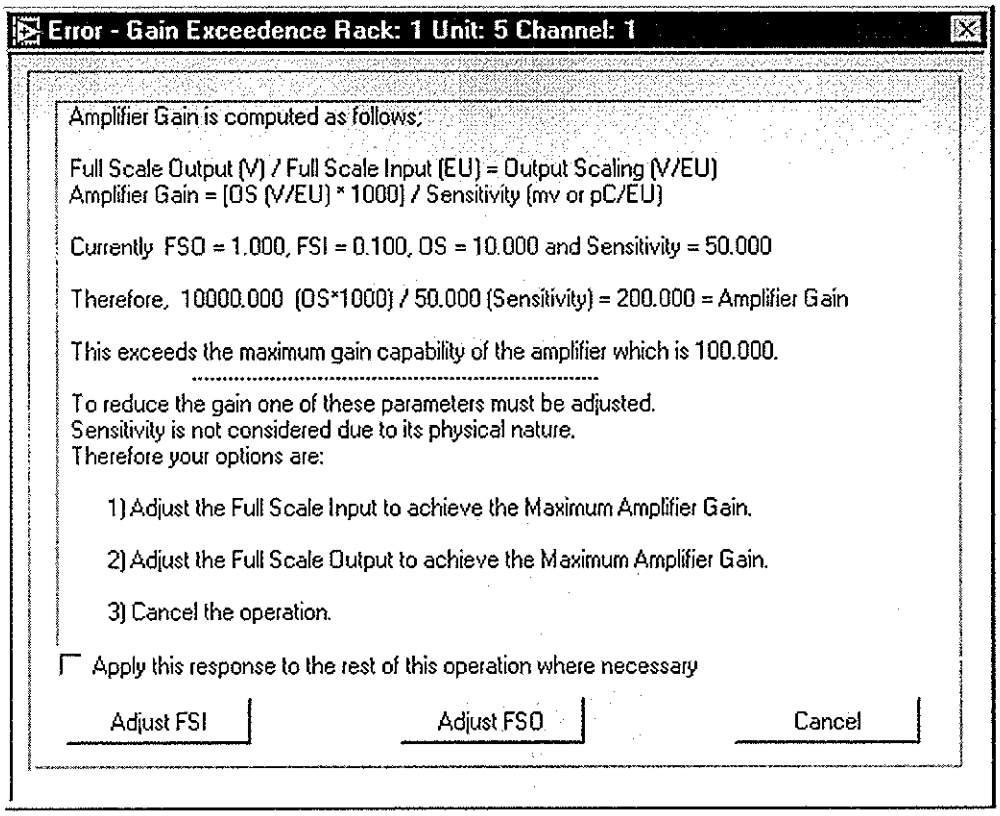
P. Output Scaling

This function selection provides for programming the desired scaling of the amplifier's output (in mV/EU). The Endevco Model 436 determines the gain needed to achieve the required output scaling by using the following equation:

$$\text{Amplifier's Gain} = \frac{\text{Output Scaling}}{\text{Sensor Sensitivity}}\ ;\ \text{Output Scaling} = \frac{\text{Full Scale Output Range}}{\text{Full Scale Input Range (EU)}}$$

The entry in Output Scaling depends on the Sensor Sensitivity setting and it will automatically change to the lowest or highest limit if the current entry violates the following constraint:

$$0 \leq \frac{\text{Output Scaling}}{\text{Sensor Sensitivity}} \leq 1000$$



If the Full Scale Output Range is incremented to the point where Amplifier's Gain is greater than 10000, then the 436 amplifier will temporarily set an error message to indicate that the Full Scale Input Range has been modified to meet the Gain < 10000 constraint (Maximum Gain Limit Error).

Q. Lowpass Filter (LPF)

This function selection provides for enabling or disabling the built-in 4-pole Lowpass filter (filter type and corner set by module 31875). The following options are available:

1. "OFF": Lowpass filter disabled.
2. "On": Lowpass filter enabled.

The corner frequency can be set from 0.01 kHz (10 Hz) to 60.00 kHz by using the 31875 lowpass filter module. The card will read at power-up the -3dB frequency corner of the installed module in each channel and transmit it on command to the host computer.

R. Operation Modes (OFF, Auto-Zero, Auto-Balance, Out-Cal)

The following options for mode selection are available:.

1. "OFF": The unit sets all of the internal DC offset adjustments to neutral.
2. "Execute Zero": The unit short its inputs to ground and sets the DC output voltage to zero to within ±10 mVDC (zero will depend on the DC voltage imbalance present at the input of the amplifier). If the unit is unable to set the DC output voltage to zero, the setting will revert back to "OFF". This setting will change to "OFF" if Auto-Zero is set to "On" and the user makes a change in any of the following functions: Excitation Voltage, Sensor Sensitivity, Output Scaling, and Lowpass Filter. After successful execution of auto-zero, the unit will report that the operation mode is "Auto-Zero".
3. "Auto-Zero": The unit automatically executes auto-zero whenever there is a change in any of the following functions: Excitation Voltage, Sensor Sensitivity, Output Scaling, and Lowpass Filter. After successful execution of auto-zero, the unit will report that the operation mode is "Auto-Zero".
4. "Auto-Zero": The unit reports this setting after a successful execution of auto-zero.
5. "Execute Balance": The unit leaves its input connected to the sensor and sets the DC output voltage to zero to within ±10 mVDC (zero will depend on the DC voltage imbalance present at the input of the amplifier). If the unit is unable to set the DC output voltage to zero, the setting will revert back to "OFF". This setting will change to "OFF" if Auto-Balance is set to "On" and the user makes a change in any of the following functions: Excitation Voltage, Sensor Sensitivity, Output Scaling, and Lowpass Filter. After successful execution of auto-balance, the unit will report that the operation mode is "Balance".
6. "Balance": The unit automatically executes auto-balance whenever there is a change in any of the following functions: Excitation Voltage, Sensor Sensitivity, Output Scaling, and Lowpass Filter. After successful execution of auto-balance, the unit will report that the operation mode is "Balance". If the unit settings are saved into non-volatile memory when in "Balance" mode, the unit will re-apply the balance settings when power is cycled.
7. "Balance": The unit reports this setting after a successful execution of auto-balance.
8. "Out Cal": This will cause the unit to quit auto-balance or auto-zero mode and emit a calibration signal of 50 to 60 Hz at the signal output. The amplitude of this signal can be selected with the Full-Scale Output field.

S. Shunt Calibration

This function selection provides for connecting the shunt calibration resistor to either the positive (PSEN+) or negative (PSEN-) terminals. The choices are:.

"OFF": The shunt calibration resistor is disconnected from the sensor.

"RSH+": The shunt calibration resistor is connected to the PSEN+ line.

"RSH-": The shunt calibration resistor is connected to the PSEN- line.

T. Auto-Range

This function is used to initiate auto-ranging. The amplifier will auto-range for the duration specified in the command. Auto-ranging is done by adjusting "Output Scaling" so that the maximum RMS voltage detected at the output during the specified duration is within 50% to 80% of 3.5 VRMS. The user can stop auto-ranging any time by selecting "OFF" in the front panel display. Valid duration times are from 0 (OFF) to 120 seconds, in steps of 10 seconds.

U. Reset

This special mode selection allows the user to reset the card (equivalent to a power-up initialization).

V. Store Settings in EEPROM (Non-Volatile Memory)

This special function allows the user to force the card to store all of the function settings into non-volatile memory.

W. Recall Default Setup

This special mode selection allows the user to recall the default function settings.

Function	Factory Default Setting
1. Excitation Voltage	0.00 (off)
2. Sensor Sensitivity	1.000
3. Output Scaling	1.000
4. Lowpass Filter	ON
5. Auto-Balance/Zero	OFF
6. Shunt Calibration	OFF
7. Auto-Range	OFF
8. Adjust Gain	0

X. Calibration

This procedure defines the manual calibration to be conducted upon the ENDEVCO® Model 436 Signal Conditioner to establish conformance to the functional requirement of Endevco PS436. Each card must be calibrated in accordance with this procedure and a data calibration report sheet must be completed.

Calibration Constants

A table of all calibration constants used by the 436 firmware is shown below. The calibration constants are stored in the EEPROM of the unit.

A checksum for the calibration constants is stored in non-volatile memory. The card will use this checksum at power up to verify that all calibration constants are good. The card will declare an error if the checksum test for the calibration constants fails.

Calibration Constant	Name
for $100 \leq$ Gain ≤ 1000	K1
for $10 \leq$ Gain < 100	K2
for $0 \leq$ Gain < 10	K3
slope of ADC	-
offset of ADC	-

The ADC slope and offset calibration constants are determined automatically by the unit on power-up. They do not have to be calibrated manually.

Calibration Procedure

Each Model 436 unit shipped by ENDEVCO® has been calibrated in the factory. The calibration of the unit can easily be checked by applying a known input voltage at a given gain and measuring the output voltage. If the gain is not within the limits specified by the 436 Performance Specification, a calibration procedure can be performed.

Gain accuracy calibration is best done using the low-level command utility command accessible from the matrix view in the OASIS 2000 Program (type <CTRL><SHIFT><F12> on the keyboard). The procedure involves reading the calibration constants currently stored in the unit. This is done by selecting the command "Read Cal Constants" from the scroll-down menu and activating the "Send Command" button. The low-level command utility will display a matrix of the current calibration constants, as shown in the following table (example of a factory-calibrated unit):

	chan 1	chan 2	chan 3
Gain 100 to 1K	0.9984	0.9815	0.9901
Gain 10 to 100	0.9892	0.9826	0.9925
Gain 0 to 10	0.9952	0.9855	0.9906
ADC slope (read only)	0.996	0.996	0.996
ADC offset (read only)	4.25	4.25	4.25

When determining the applicable calibration command, the existing calibration constant (K_n) has to be taken into account. With a gain of 2, 20, or 200 selected, the output voltage V_m (in RMS) is measured and compared to the expected (ideal) output voltage V_{id}. If the existing calibration constant is 1.000 (which is only true for uncalibrated units), the applicable calibration constant is:

$$K = V_{id} / V_m$$

With an existing calibration (K_n) constant other than 1.000 (which will be true for most shipped units), the applicable calibration constant is calculated as follows:

$$K = K_n * V_{id} / V_m$$

Adjusting Calibration Constant: K3 (Gain=0...10)

1. Set channel 1's Gain=2, LPF off
2. Read the current calibration constant for this gain range and this channel (K_n).
3. Apply input voltage Vin=3.5Vrms @ 300 Hz
4. Measure output voltage V_m
5. Determine ratio V_{id} / V_m and calculate $K3 = K_n * V_{id} / V_m$
6. Enter K3 into field labeled "gain 0...10" of channel 1
7. Select "Write Calibration Constants" from the scroll-down command menu and activate the "Send Command" button
8. This will adjust the output of channel 1 to exactly 7.00Vrms
9. If the output voltage of channel 1 is still not within the desired range, the value for K3 can be re-entered. This can be done by either using the number keys on the keyboard or by placing the cursor in the K3 field at the desired digit and using the UP and DOWN keys to scroll the value for K3 up or down. After this, "Write Calibration Constants" must be selected and the "Send Command" button must be pressed. This step can be repeated as many times as necessary until the output voltage is within the desired range.
10. Repeat 1 through 9 for channels 2 and 3.

Adjusting Calibration Constant: K2 (Gain=10...<100)

1. Set channel 1's Gain=20, LPF off
2. Read the current calibration constant for this gain range and this channel (K_n).
3. Apply input voltage Vin=350mVrms @ 300 Hz
4. Measure output voltage V_m
5. Determine ratio V_{id} / V_m and calculate $K2 = K_n * V_{id} / V_m$
6. Enter K2 into field labeled "gain 0...10" of channel 1
7. Select "Write Calibration Constants" from the scroll-down command menu and activate the "Send Command" button
8. This will adjust the output of channel 1 to exactly 7.00Vrms
9. If the output voltage of channel 1 is still not within the desired range, the value for K2 can be re-entered. This can be done by either using the number keys on the keyboard or by placing the cursor in the K2 field at the desired digit and using the UP and DOWN keys to scroll the value for K2 up or down. After this, "Write Calibration Constants" must be selected and the "Send Command" button must be pressed. This step can be repeated as many times as necessary until the output voltage is within the desired range.
10. Repeat 1 through 9 for channels 2 and 3.

Adjusting Calibration Constant: K1 (Gain=100...<1000)

1. Set channel 1's Gain=200, LPF off
2. Read the current calibration constant for this gain range and this channel (K_n).
3. Apply input voltage Vin=35.0mVrms @ 300 Hz

4. Measure output voltage V_m
5. Determine ratio V_{id} / V_m and calculate $K1 = K_n * V_{id} / V_m$
6. Enter K1 into field labeled "gain 0...10" of channel 1
7. Select "Write Calibration Constants" from the scroll-down command menu and activate the "Send Command" button
8. This will adjust the output of channel 1 to exactly 7.00Vrms
9. If the output voltage of channel 1 is still not within the desired range, the value for K1 can be re-entered. This can be done by either using the number keys on the keyboard or by placing the cursor in the K1 field at the desired digit and using the UP and DOWN keys to scroll the value for K1 up or down. After this, "Write Calibration Constants" must be selected and the "Send Command" button must be pressed. This step can be repeated as many times as necessary until the output voltage is within the desired range.
10. Repeat 1 through 9 for channels 2 and 3.

Y. Status/Error List

The possible errors reported by the card are:

- auto-balance failure
- auto-zero failure
- calibration constant format error
- calibration constant check sum error

Z. Fault/Status Indication

There is one (1) fault/status indicator (green/red LED) located on the front panel. This indicator will be red if any of the error bits are set. A catastrophic malfunction of the unit such as missing microcontroller, corrupted program code, failure of the clock crystal etc., will likewise be indicated by a red fault indicator.

If the unit is set to download mode (expecting code to be downloaded through the serial interface), the LED will flash briefly every five seconds.

GREEN - 1 time every 5 seconds:	boot loader is waiting for program download
RED - 1 time every 5 seconds:	boot loader found SRAM error
RED - 2 times every 5 seconds:	boot loader found check sum error over boot code
RED - 3 times every 5 seconds:	serial communications error while handling program download
RED - 4 times every 5 seconds:	error while erasing FLASH memory during program download
RED - 5 times every 5 seconds:	error while writing to FLASH memory during program download

Combinations of flashes (e.g. 2 times plus three times) may also occur to signal multiple errors.

AB. Code Download

The Model 436 is capable of downloading new operational code via the serial interface. This is achieved through a bootloader program implemented in the EEPROM section of the PSD813F1 memory device. It is strongly recommended to perform a complete automatic test procedure (ATP) on calibrated automated test equipment (ATE) after each code download.

5. Troubleshooting Tips

Refer to IM4990 and IM2000 for additional information.

To aid in troubleshooting the rack, access to the power supply and module interconnect PCB is gained with the rear panel dropped down to the open position.

If 4990 or 436 do not respond, check:

- Power applied to 4990 rack. Check fuse. Fan must be audible, air flow must be present.

WARNING

LETHAL VOLTAGES ARE PRESENT AT THE POWER ENTRY MODULE. USE EXTREME CAUTION WHEN PERFORMING THE NEXT STEPS

- Check DC voltages inside on back plane. Jumpers W2/W4/W7/W8/W9 are labeled with their appropriate voltages.
- Serial cable/Ethernet cable connected?
- Serial cable connected from DB9 connector on rear panel to W1 on back plane for 4990-2, serial cable connected from EDAS serial port to W1 on back plane for 4990-1?
- Type of Ethernet cable to RJ-45 connector on rear panel (must be crossover when connecting PC, straight when connecting to in-house net.
- Type of serial cable (straight TX = 2, RX = 3 at 4990 end), if null-modem cable is used, change DIP switch settings (see 4990 Instruction Manual)
- Baud rate identical for OASIS 2000 software and for 4990 rack?
- Check if card is plugged in properly. Connector must latch, LED must be on (blinking when powering up).
- Check card function. When powered on, LED must go from OFF --> red --> green/red (depending on fault status). Reset of all cards can be initiated by briefly connecting pins 1 and 2 of J31 (RESET)
- Cards will blink upon receiving serial data in the proper format!

If 436 displays/reports fault status, check:

- Is a channel fault enabled for an unused channel?
- Are all inputs of enabled channels connected to a sensor?
- Check sensor cable!
- Check voltage across sensor, must be roughly the selected excitation voltage!
- Obtain fault status in OASIS 2000 software menu

If no signal appears on outputs, check:

- Check if proper channel is selected in OASIS 2000 menu
- Is the proper input selected for the unit and channel?
- Is the output cable connected?

If sensors get burned out when powering up 436 units, check:

- Are signals P+ and PSEN+ connected? Are signals P- and PSEN- connected?
- Does 436 unit have the correct settings for excitation voltage stored in EEPROM?

6. SAFETY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. ENDEVCO assumes no liability for the customer's failure to comply with these requirements.

Ground The Instrument

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

Do Not Operate In An Explosive Atmosphere

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Keep Away From Live Circuits

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages mat exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

Do Not Service Or Adjust Alone

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

Do Not Substitute Parts Or Modify Instrument

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to ENDEVCO for service and repair to ensure that safety features are maintained.

Dangerous Procedure Warnings

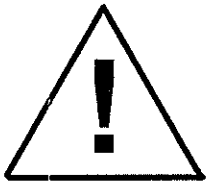
Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

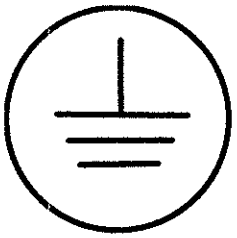
Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

Safety Symbols

General Definitions of Safety Symbols Used On Equipment or In Manuals.



Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating the equipment.

DANGER

The DANGER sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which could result in injury or death to personnel even during normal operation.

WARNING

The WARNING sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

Line Fuse

Verify that the correct line fuse is installed before connecting the line cord.

100/115/230 VAC
50/60 Hz
3/3/1.5 A

250 V, 3A, T

CE

CAUTION: For continuous protection against fire replace with same type of fuse only!

ACHTUNG: Zur Vermeidung von Brandgefahr darf die Sicherung nur durch identischen Typ ersetzt werden!

ATTENTION: Afin d'éviter tous risques de feu, n'utiliser que de fusible du même type!

PRECAUCION: Para proteccion contra fuego remplace fusible con el mismo tipo de fusible solamente!

7. ROUTINE MAINTENANCE AND HANDLING

A. Introduction

The Model 482 is a self-contained electronic instrument that requires minimal maintenance.

The Model 482 is designed to require no component-level repair by the user. However, detailed schematics are available upon request.

The periodic maintenance function performed by the user is quality calibration. Any component failures simply require the user to return the unit to ENDEVCO for repair/replacement.

Should a faulty unit be returned to Endevco, it is suggested that the original or equivalent packaging be used. This will reduce damage to the equipment during shipment.

B. Factory Service

ENDEVCO maintains factory service repair for all ENDEVCO instruments. To obtain repair or replacement of a defective instrument, place a call to ENDEVCO to obtain a return material authorization number (RMA), then return the instrument to the factory at the following address:

ENDEVCO
30700 Rancho Viejo Road
San Juan Capistrano, CA 92675

TEL: +01 949-493-8181
FAX: +01 949-661-7231
email: applications@endevco.com
Web Site: http://www.endevco.com

To return an instrument, please:

1. Ensure proper packaging, preferably the original shipping cartons.
2. Prepay shipping and insurance charges.
3. Attach the Return Material Authorization (RMA) number from ENDEVCO and include any information that may be pertinent to the description of the failure/problem.

C. WARRANTY

ENDEVCO warrants each new electronic instrument to be free from defects in material and workmanship. Please refer to the appropriate Warranty Policies for the terms and warranty period. Instruments returned under warranty will be repaired or replaced at no charge, if the failure is due to defective material or workmanship; and the unit is returned within the time period and conditions of Endevco's warranty policy.

D. OUT-OF-WARRANTY RETURNS

Enclose a purchase order not to exceed $300.00, authorizing repair/calibration along with a full explanation of the failure or symptoms observed to help in fixing the problem. The instrument will be repaired/calibrated, returned and invoiced for the actual repair charges. If the instrument cannot be repaired for $300.00 or less, ENDEVCO will submit a written quotation for the cost of the repair and/or replacement of the unit.

APPENDIX 1 PS436

APPENDIX 2 PS31875