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**PAS 9416/AO  
ENGINEERING SPECIFICATION**

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**+/- 35 VOLT AMPLIFIER CARD  
Revision A (11/09/2001)**

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# 16 Channel High Power Amplifier VME Analog Output Card

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# 16 Channel High Power Amplifier VME Analog Output Card

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# I. INTRODUCTION

## GENERAL DESCRIPTION

The PAS 9416/AO provides sixteen amplifiers and offset voltage circuits on a 6U format card. This amplifier is pin compatible with the PAS 9716/AO, 16 channel, 16-bit Analog Output card. By using the combination of these two cards, a VME based Analog Output system can be constructed that will supply up to +/- 35 volts and up to 20 mAmps of output current.

External power supplies can be used to power the amplifiers, and a front panel connector is provided for wiring to these supplies. As an option, on board DC-to-DC converters can be provided to power the amplifiers. The front panel also provides two DB37 connectors. One terminates the input signals and the other provides the amplified output signals. Both of these connectors have the same pin out as the PAS 9716 analog output card.

The offset voltage is applied to all channels, and can either be provided by an external source or by the on board reference circuit. This circuit provides two adjustable reference voltages and a relay for selecting one of them. The relay can either be controlled by an external signal or by one of the PAS 9716/AO card's Digital Outputs. Custom versions of this board can be provided with gain and offset voltage tailored to the application. These cards are described in Section V of the specification.

### Card Features: PAS 9416/AO

Number of Channels	16
Output Voltage	+/- 20 Volts (typ.), +/- 35 Volts (max.)
Output Current	+/- 15 mAmps (min.), +/- 20 mAmps (max.)
Input Voltage	+/- 10 Volts (typ.), +/- 35 Volts (max.)
Gain	1 or 2, jumper selectable
External Power Supply	+/-15 VDC (min.), +/- 45 VDC (max.)
On Board Supply Options	+/- 18 VDC, +/- 24 VDC, +/- 30 VDC
Slew Rate	10 Volts / uSec. (typ.)
Full Power Bandwidth	55 KHz (typ) @ V out 35 V pk-pk
Status LEDs	2 front panel LEDs are driven by the PAS 9716/AO digital outputs
Size	6U format, 160 mm x 233 mm
Input / Output Connectors	2 ea. DB 37 female
Power Supply Connector	6 pin shrouded header (Molex)

## II. SPECIFICATIONS

### Electrical Specifications

Number of Channels	16 Analog Outputs
Output Voltage	+/- 20 Volts (typ.) +/- 35 Volts (max.)
Output Current	+/- 15 mAmps (min.), +/-20 mAmps (typ.)
Input Voltage	+/- 10 Volts (typ.), +/- 35 Volts (max.)
Gain	1 or 2, jumper selectable
Zero Error	+/- 5 mV, (adjustable to zero)
Gain Error	+/- 0.1 % FS, (adjustable to zero)
Slew Rate	5 V / uSec (min.), 10 V / uSec (typ.) V out = +/- 35 Volts, 5 K ohm load
Full Power Bandwidth	45 KHz (min.), 55 KHz (typ.) V out = 35 Vpk-pk, 5 K ohm load
Offset Voltage Range	+/- 35 Volts (max.) Signal plus offset
On Board Offset Range	0 Volts, + 2.5 Volts to +7.5 Volts (adjustable), +5 Volts to + 15 volts (adjustable)
Card Power Requirements (With On Board Power Supplies)	5 Volts @ 4.5 Amps (max.) Full Load on DC-to-DC Converter Outputs
(With External Power Supplies)	+/- 15 VDC to +/- 45 VDC @ +/- 100 mAmp (No Load) @ +/- 420 mAmp (Full Load)

### Environmental Specifications

Operating Temperature Range	0 to 55 degrees C.
Storage Temperature Range	-20 to 85 degrees C.
Relative Humidity Range	20% to 80%, non-condensing

### Physical Specifications

Dimensions	Form factor: Double (160 mm x 233 mm)
Weight	12 oz. (typ), no power supplies
Connectors	2 ea. DB37 female, (Analog Input and Output connectors)  1 ea. 6 pin shrouded header (External power connector) Mating connector, Molex P/N 50-57-9406

## Jumpers and Indicators

The 9416/AO card contains 20 Pluggable jumpers and two LED indicators. All of the jumpers have three pins, and provide two possible jumper locations. Pin 1 of each jumper strip is defined with a square pad in the PC board layout.

The first 16 jumpers, (JP1- JP16), are used to set each channels gain to either one or two. When gain of one is selected, the offset voltage is summed with the input voltage. Gain of one is selected by installing the jumpers from pin 1 to 2. This is the lower position for the jumpers.

When gain of two is selected, no offset voltage is summed with the input voltage. Gain of two is selected by installing the jumpers from pin 2 to 3. This is the upper position for the jumpers.

Jumper 17 is used to select the gain of the reference buffer amplifier. When it is in position 1 to 2, the gain is two, in position 2 to 3 the gain is one.

Jumper 18 is used to select the output source of the offset voltage. When it is in position 2 to 3, (the upper position), the offset is ground. In position 1 to 2, (the lower position), the offset is supplied by the reference buffer.

Jumper 19 is used to select the input source of the reference buffer. When it is in position 1 to 2, (the left position), the source is from the on board reference circuit. In position 2 to 3, (the right position), the source is an external reference, connected to pin 2 of P4.

Jumper 20 is used to select the source that drives the reference select relay. When it is in position 1 to 2, (the left position), the relay is switched by digital output 2 on the PAS 9716 analog output card. In position 2 to 3, (the right position), the relay is switched by an externally supplied signal, connected to pin 1 of P4.

**TABLE 1**  
**PLUGGABLE JUMPER DEFINITIONS**

<b><u>Jumper #</u></b>	<b><u>Function</u></b>
J1	Gain CH 0
J2	Gain CH 1
J3	Gain CH 2
J4	Gain CH 3
J5	Gain CH 4
J6	Gain CH 5
J7	Gain CH 6
J8	Gain CH 7
J9	Gain CH 8
J10	Gain CH 9
J11	Gain CH 10
J12	Gain CH 11
J13	Gain CH 12
J14	Gain CH 13
J15	Gain CH 14
J16	Gain CH 15
J17	Gain Reference Buffer
J18	Offset = GND or Reference Buffer
J19	Reference Input Source
J20	Reference Select Source

Two LEDs are provided at the front panel to indicate the board's status. These LEDs are steered by the DO1 and DO2 signals from the 9716 Analog Output card. If the amplifier is not wired directly to the AO card, then these LEDs will be driven by the signals that are wired to pins 1 and 2 of P3.

## Connector Definitions

Two 96 position DIN connectors are installed on the back plane end of the board and connect to the VME bus to bring in +5 Volts. This voltage is used to power the on board DC to DC converters. If the board is powered by the front panel connector, then no current is drawn from the VME bus power supplies.

Two DB37 female connectors are installed through the board's front panel to provide access to the sixteen analog output channels and the two digital outputs. The pin outs of these connectors are defined on the following page.

A six-position Molex header is provided at the front panel, and located between the two DB37 connectors. This connector is used to bring in external power to the amplifiers, if the on board DC-to-DC converters are not used. When the DC-to-DC converters are used, their outputs are available at this connector, through 400 mAmp solid state fuses.

The mating connector to this header is Molex P/N 50-57-9406, and crimp on pin P/N 16-02-1114 or 16-02-1125. The pin out of this connector is defined below.

**TABLE 2**

### **6 Position Molex Header**

1	Positive Power Supply
2	Power Supply Ground
3	Negative Power Supply
4	N/C
5	N/C
6	N/C

**TABLE 3**  
**DB37 Connectors (P3 and P4)**

AGND	37	19	AGND (REF)
AGND	36	18	CH1H
AGND	35	17	CH3H
AGND	34	16	CH5H
AGND	33	15	CH7H
AGND	32	14	CH9H
AGND	31	13	CH11H
AGND	30	12	CH13H
AGND	29	11	CH15H
AGND	28	10	CH0H
AGND	27	9	CH2H
AGND	26	8	CH4H
AGND	25	7	CH6H
AGND	24	6	CH8H
AGND	23	5	CH10H
AGND	22	4	CH12H
AGND	21	3	CH14H
AGND	20	2	DO1 (REFIN)
		1	DO2 (REFSEL)

P3 is the input connector, P4 is the output connector. Signal names in ( ) are used on P4. Signal names that are not in ( ) are used in the input and output connectors. Example; CH0H input is P3 pin 10, and CH0H output is P4 pin 10. The REF signal is the offset voltage that is supplied to all channels, REFIN is a user supplied offset voltage, and REFSEL is a user supplied reference selection signal.

### III. CIRCUIT DESCRIPTION

The PAS 9416/AO card contains 16 amplifier circuits and a selectable reference / offset circuit. Cards can be configured to either provide a gain of two, or to sum an offset signal with the input signal. In either case, the output current and voltage range will be increased when compared with a standard analog output card.

In the offset configuration, a reference signal is summed with the input signal to provide the buffered output signal. The reference or offset signal can come from several different sources. The source of the offset is configured with Pluggable jumpers, as defined in section II.

The simplest case is to connect the reference signal to ground using JP18 from pin 2 to 3. In this configuration, no offset voltage is added to the input voltage.

A user supplied offset voltage can be supplied on pin 2 on P4. This voltage can be selected to drive the reference buffer amplifier by installing JP19 from pin 2 to 3. The reference amplifier can be set for a gain of 1 or 2, with JP17, and connected to drive the reference input of all the amplifier circuits by installing JP18 from pin 1 to 2. The offset voltage output signal is always available on pin 19 of P4.

A precision 10-volt reference circuit provided on the card is used to drive two adjustable divider circuits. The divider circuits can be adjusted from 2.5 Volts to 7.5 Volts, and selected with an on board relay. The output of the relay can be connected to the input of the reference buffer amplifier by installing JP19 from pin 1 to 2.

The relay can be switched either with digital output 2 from the analog output card, or from an externally provided signal. The external signal is connected to pin 1 of P4, and JP20 is used to select the source of the relay drive.

In the gain only configuration, all of the channels have a gain of 2, and no offset is added. When the amplifier is connected to a +/- 10 Volt analog output card, the combination will provide a +/- 20 Volt, +/- 20-mAmp analog output system.

All of the amplifier circuits have gain and offset adjustments.

## VI. CALIBRATION PROCEDURE

Configure jumpers 1 through 16 on the PAS 9416/AO card to position 1 to 2, (the lower position), and JP 18 to position 2 to 3, (the upper position). Install JP17 from pin 1 to 2, (the right position), JP19 from pin 2 to 3, (the right position) and JP20 from pin 2 to 3, (the right position). This configures the card for the gain of 1 and zero volts offset. Install the card in a VME chassis, and connect external power supplies if required. Allow the card to stabilize for approximately 15 minutes.

### Offset Adjustment

Connect all of the input signals to ground, either using a shorting connector or by connecting the card to a PAS 9716/AO card and driving the outputs to zero Volts. Observe the individual output channels with a Voltmeter and adjust the zero pot on each channel for zero volts. The zero adjustment pots are defined in the table on the following page.

### Gain Adjustment

Drive all of the input signals to 10.00 Volts, and adjust the gain pots on each channel, so that all of the outputs are at 10.00 Volts. The gain adjustment pots are defined in the table on the following page.

### Reference Buffer Adjustment

Move JP 18 to position 1 to 2 (the lower position). This enables the reference buffer to drive the common offset line. Connect the Voltmeter from the output of the reference amplifier, (pin 19 of P 4), to analog ground, (pin 20-37 of P4). Connect a jumper wire from pin 2 of P 4 to analog ground, (pins 20-37 of P4). Adjust R100 for a reading of 0.000 Volts. This adjusts the offset voltage of the reference buffer to zero volts. Remove the jumper wire, and install a jumper plug on JP 19 from pin 1 to 2, (the left position). This selects the on board reference voltages to drive the reference buffer.

Adjust R105 for a reading of 6.000 Volts. Ground pin 1 of P 4 with a jumper wire, and adjust R102 for a reading of 8.000 Volts.

### Offset Check

Connect all of the inputs to 0.000 Volts, and observe that all of the outputs are at 8.000 Volts. Connect all of the inputs to 10.000 Volts and observe that all of the outputs are at 18.000 Volts. If any of the outputs are not at the correct voltage, repeat the offset and gain adjustments.

**TABLE 4**

**Gain and Offset Potentiometer Table**

CH #	Offset Pot	Gain Pot
0	R6	R5
1	R12	R11
2	R18	R17
3	R24	R23
4	R30	R29
5	R36	R35
6	R42	R41
7	R48	R47
8	R54	R53
9	R60	R59
10	R66	R65
11	R72	R71
12	R78	R77
13	R84	R83
14	R90	R89
15	R96	R95
Ref. Buf	R100	R99

## V. CUSTOM GAIN VERSIONS

The PAS 9416/AO is available with customer specified gain and offsets. These versions of the card are described in this section of the manual.

### **PAS 9416-020/AO**

This version of the amplifier card adds a 5.000 volt offset signal to the input signal and multiplies the resultant voltage with a gain of eight. This takes a +/- 5 volt input signal and maps it to a 0-to-40 volt output signal.

External power supplies with +/- 45 volt outputs are required for the -020 version of the card. The jumper plugs are shipped in the following configuration.

**JP1-16**, position 1 to 2. A 5.000 volt offset voltage is summed with the input voltage.

**JP17**, position 2 to 3. Reference buffer gain is one.

**JP18**, position 1 to 2. Offset voltage supplied by the reference buffer.

**JP19**, position 1 to 2. On board reference drivers the reference buffer.

**JP20**, position 2 to 3. Reference select relay is switched by an external signal connected to pin 1 of P4. This pin should be left open.

### **Power Supply Options**

PAS 9416 XY0/AO	Without Power Supply
PAS 9416 XY1/AO	+/- 18 Volt Power Supply
PAS 9416 XY2/AO	+/- 24 Volt Power Supply
PAS 9416 XY3/AO	+/- 30 Volt Power Supply