**Revision A – 05/13/15**

# PAS 9405/AMP
# ENGINEERING SPECIFICATION

**16 CHANNEL, +/- 175 VOLT,**
**+/- 60 mAmp, AMPLIFIER CARD**
**Rev A (05/13/15)**

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# 16 Channel, +/- 175Volt, +/- 60 mAmp Amplifier Card

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# 16 Channel, +/- 175 Volt,
# +/- 60 mAmp Amplifier Card

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# I. INTRODUCTION

## GENERAL DESCRIPTION

The PAS 9405/AMP provides sixteen channels of voltage amplification or attenuation on a 1U x 19” rack mountable panel. Two PCBs with 8 channels each are mounted on the panel. Different types of amplifier boards can be mounted in the different locations on the panel to tailor the amplifier to your application.

The integrated circuit amplifier used in this design is the PA341DF by Apex Microtechnology. This amplifier can use power supply voltages from +/- 10 Volts to +/- 175 Volts. The output current rating is 60 mAmps continuous. These amplifiers can be used to significantly boost the output voltage and current drive capability of a standard analog output card. The attenuator versions of the card use the AD8510 operational amplifier with +/- 15 Volt power supplies. Individual offset and gain potentiometers are provided for each channel.

When the board is used to amplify analog output signals, the analog output card will be cabled to P1 of the amplifier card. The amplifier card will use a DB37 male connector for P1. The amplified signals will be available on P2, and this will be a DB37 female connector. When the board is used as a buffered attenuator, then the board is turned around on the mounting bracket. This allow the field signals to connect through the front on the mounting bracket, and the I/O card signals to connect to the rear of the bracket. The analog input card will be cabled to P2, and this will be a DB37 male connector. The field input signals will connect to P1, and this will be a DB37 female connector. The definition of the signals for P1 and P2 are shown in tables 1 and 2.

The amplifiers on this board use heatslugs that are soldered to the foil on the PCB to increase the power dissipation. The PA341DF provides output current limiting to fully protect the amplifier. Each application that involves high current and voltage needs to be evaluated to make sure the amplifiers power dissipation is not exceeded. See the power dissipation calculation section near the end of this manual.

**Card Features: PAS 9405/AMP**

- 16 Channels of voltage amplification or attenuation
- Mounts on standard 19” cabinet rails and requires 1 ¾ “ of vertical rack space
- Each panel mounts 2 amplifier boards with 8 channels each
- Input and Output signals available on DB37 connectors
- Over current protection provided by the PA341DF op-amp
- Each channel provides gain and offset adjustment potentiometers
- Custom versions available

# II. SPECIFICATIONS

**Electrical Specifications**

Each panel provides mounting locations for two boards. These electrical specifications are for one board.

PAS 9405/AMP-001 Specifications

| | |
|---|---|
| Number of channels | 8 |
| Transfer characteristics<br>CH 0-7 | Gain = 6.2 |
| Amplifier Type | PA341DF |
| Output Current Limit | 6 mAmps Typical |
| Typical Power Supply | +/- 75 Volts this application |
| Maximum Power Supply | +/- 175 Volts |

PAS 9406/AMP-002 Specifications

| | |
|---|---|
| Number of channels | 8 |
| Transfer characteristics<br>CH 0-7 | Attenuation = 13 to 1<br>65 Volts In = 5 Volts Out |
| Amplifier Type | AD8510 |
| Power Supply Voltage | +/- 15 Volts Typical |

**Environmental Specifications**

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

**Physical Specifications**

| | |
|---|---|
| Length | 19.0” |
| Height | 1.75” |
| Depth | 4.00” |
| Weight | 2 lbs |

| | |
|---|---|
| Connectors when used as a Voltage Attenuator | |
| Input | 2 Ea, DB37 Female |
| Output | 2 Ea, DB37 Male |

| | |
|---|---|
| Connectors when used as a Voltage Amplifier | |
| Input | 2 Ea, DB37 Male |
| Output | 2 Ea, DB37 Female |

## TABLE 1
### P1 Connector Definitions
### When used to amplify an analog output

| | | | |
|---|---|---|---|
| GND | 37 | 19 | IN0HI |
| GND | 36 | 18 | IN0LO |
| GND | 35 | 17 | IN1HI |
| GND | 34 | 16 | IN1LO |
| GND | 33 | 15 | IN2HI |
| GND | 32 | 14 | IN2LO |
| GND | 31 | 13 | IN3HI |
| GND | 30 | 12 | IN3LO |
| GND | 29 | 11 | IN4HI |
| GND | 28 | 10 | IN4LO |
| GND | 27 | 9 | IN5HI |
| GND | 26 | 8 | IN5LO |
| GND | 25 | 7 | IN6HI |
| GND | 24 | 6 | IN6LO |
| GND | 23 | 5 | IN7HI |
| -PS | 22 | 4 | IN7LO |
| GND | 21 | 3 | -15VPS |
| +PS | 20 | 2 | +15VPS |
| | | 1 | +5V |

### When used to attenuate an analog input

| | | | |
|---|---|---|---|
| GND | 20 | 1 | IN0HI |
| GND | 21 | 2 | IN0LO |
| GND | 22 | 3 | IN1HI |
| GND | 23 | 4 | IN1LO |
| GND | 24 | 5 | IN2HI |
| GND | 25 | 6 | IN2LO |
| GND | 26 | 7 | IN3HI |
| GND | 27 | 8 | IN3LO |
| GND | 28 | 9 | IN4HI |
| GND | 29 | 10 | IN4LO |
| GND | 30 | 11 | IN5HI |
| GND | 31 | 12 | IN5LO |
| GND | 32 | 13 | IN6HI |
| GND | 33 | 14 | IN6LO |
| GND | 34 | 15 | IN7HI |
| -PS | 35 | 16 | IN7LO |
| GND | 36 | 17 | -15VPS |
| +PS | 37 | 18 | +15VPS |
| | | 19 | +5V |

## TABLE 2

### P2 Connector Definitions

### When used to amplify an analog output

| | | | |
|---|---|---|---|
| GND | 37 | 19 | OUT0 |
| GND | 36 | 18 | GND |
| GND | 35 | 17 | OUT1 |
| GND | 34 | 16 | GND |
| GND | 33 | 15 | OUT2 |
| GND | 32 | 14 | GND |
| GND | 31 | 13 | OUT3 |
| GND | 30 | 12 | GND |
| GND | 29 | 11 | OUT4 |
| GND | 28 | 10 | GND |
| GND | 27 | 9 | OUT5 |
| GND | 26 | 8 | GND |
| GND | 25 | 7 | OUT6 |
| GND | 24 | 6 | GND |
| GND | 23 | 5 | OUT7 |
| N/C | 22 | 4 | GND |
| GND | 21 | 3 | -15VPS |
| N/C | 20 | 2 | +15VPS |
| | | 1 | +5V |

### When used to attenuate an analog input

| | | | |
|---|---|---|---|
| GND | 20 | 1 | OUT0 |
| GND | 21 | 2 | GND |
| GND | 22 | 3 | OUT1 |
| GND | 23 | 4 | GND |
| GND | 24 | 5 | OUT2 |
| GND | 25 | 6 | GND |
| GND | 26 | 7 | OUT3 |
| GND | 27 | 8 | GND |
| GND | 28 | 9 | OUT4 |
| GND | 29 | 10 | GND |
| GND | 30 | 11 | OUT5 |
| GND | 31 | 12 | GND |
| GND | 32 | 13 | OUT6 |
| GND | 33 | 14 | GND |
| GND | 34 | 15 | OUT7 |
| N/C | 35 | 16 | GND |
| GND | 36 | 17 | -15VPS |
| N/C | 37 | 18 | +15VPS |
| | | 19 | +5V |

# III. CIRCUIT DESCRIPTION

The PAS 9405/AMP-001 card contains 8 high power amplifier circuits. All channels are configured to provide a gain of 6.2. An input voltage of 10 Volts will produce a 62 Volt output. The output current is limited to 6 mAmps with a current limit resistor. Output current and voltage range will be increased significantly when compared with a standard analog output card. Versions of this card with other gain values are also available.

The amplifiers used on this card are high voltage monolithic MOSFET operational amplifiers. They deliver performance features previously only found in hybrid designs, while increasing reliability. The amplifier part number is PA341DF, and they are built by Apex Microtechnology

The PA341DF is packaged in a 24 pin PSOP with a heatslug and soldered to the PCB's foil. This package has a typical thermal resistance of 25 °C per Watt from junction to air, and the device has a maximum junction temperature of 150° C. Based on these parameters, the amplifier will dissipate a maximum of 2.6 Watts, and should typically be operated at 2.00 Watts or less.

# IV. POWER DISSIPATION AND POWER SUPPLY REQUIREMENTS

In order to calculate the power dissipated by the amplifiers, the quiescent power is added to the power dissipated by the output driver circuit; as shown in the following expression; P (Total) = P (Quiescent) + P(Output Stage)

The maximum power will occur when the power supply voltage is at its maximum of +/- 175 Volts. The amplifiers quiescent current is 2.2 mA which will produce 350 Volts x 2.2 mA = 770 mW of quiescent power. When the amplifiers are operated with +/- 75 Volt power supplies, the quiescent power is 150 Volts x 2.2 mA = 330 mW.

The maximum load current the amplifier is guaranteed to output is 60 mA. In this example, we will use 40 mAmp of load current. With +/- 75 Volt power supplies and a 10 Volt drop across the output stage, the output voltage is +/- 65 Volts. The minimum load resistance is 65 Volts divided by 40 mA = 1625 Ohms. The maximum power dissipation in the amplifier occurs at half the power supply voltage. As the output voltage increases from this point, the voltage across the amplifier decreases. As the output voltage decreases from this point, the current through the amplifier and the load decreases.

When the amplifier is driving this load to 65 Volts, it is delivering 2.6 Watts of power to the load, and the amplifier is dissipating 400 mW. When the amplifier is driving the load to half the power supply voltage, both the amplifier and the load are dissipating 865 mWatts of power. This calculation is shown in the following equation; 37.5 Volts x 37.5 Volts divided by 1625 Ohms = 865 mWatts. In this example the total power in the amplifier is 330 mW + 865 mW = 1195 mW.

The output amplifiers use heat sinks that provide a junction to air thermal resistance of 25° C/W. The junction temperature of the amplifier should never exceed 125° C, and is calculated by adding the ambient temperature to the temperature rise caused by the power dissipation. The following expression defines this temperature: $T_J = T_A + P_D \Theta_{JA}$. In the case of this example with an ambient temperature of 60° C, the junction temperature would be; $T_J$ = 60° + (1.195 Watts x 25° C/W) = 90° C. This is below the maximum junction temperature, so it is safe to operate the amplifier under these conditions.