Revision A – 05/12/15

PAS 9406/AMP ENGINEERING SPECIFICATION

24 CHANNEL, +/- 30 VOLT, +/- 200 mAMP, AMPLIFIER CARD
Rev A (05/12/15)

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24 Channel, +/- 30Volt,
+/- 200 mAmp Amplifier Card

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24 Channel, +/- 30 Volt, +/- 200 mAmp Amplifier Card

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I. INTRODUCTION

GENERAL DESCRIPTION

The PAS 9406/AMP provides twenty four channels of voltage amplification on a 1U x 19” rack mountable panel. Two PCBs with 12 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 OPA551 by Texas Instruments. This amplifier can use power supply voltages from +/- 4 Volts to +/- 30 Volts. The output current rating is 200 mAmps continuous. These amplifiers can be used to significantly boost the output voltage and current drive capability of a standard analog output card.

The board provides an offset voltage that can be connected to specific channels to give them a different voltage transfer characteristic. In one case a speed sensor was being simulated with the amplifier. When 0.0 Volts was input to the card, the amplifier would output 1.4 Volts. When 3.8 Volts was input to the card, the amplifier would output 2.8 Volts. This type of transfer function is only possible by adjusting both the gain and offset of the amplifier circuit. Not all of the amplifier circuits need to be connected to the offset voltage. Jumpers are used to either select the offset voltage or 0.0 volts of offset. Custom versions of the card are available, so the customer can select any gain and offset required for each channel.

The amplifiers on this board use solder on heat sinks to increase the power dissipation. The OPA551 provides thermal shutdown and 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 9406/AMP

- 24 Channels of voltage amplification with optional offset voltage
- Mounts on standard 19” cabinet rails and requires 1 ¾ “ of vertical rack space
- Each panel mounts 2 amplifier boards with 12 channels each
- Input and Output signals available on DB37 connectors
- Thermal shut down and over current protection provided by the OPA551 op-amp.
- Custom versions available

II. SPECIFICATIONS

Electrical Specifications

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

PAS 9406/AMP-000 Specifications

Number of channels	12
Transfer characteristics	
CH 0-3	Gain = 1
CH 4	Speed Sensor
CH 5	Gain = 1
CH 6-8	Speed Sensor
CH 9-11	Gain = 2.7
Speed Sensor Characteristics	0.0 Volts In = 1.4 Volts Out 3.8 Volts In = 2.8 Volts Out
Amplifier Type	OPA551
Maximum Output Current	200 mAmps
Maximum Power Supply	+/- 30 Volts Typical, 60 Volt Spread

PAS 9406/AMP-000 Specifications

Number of channels	2
Transfer characteristics	
CH 0-1	Gain = 2.8
Amplifier Type	OPA551
Maximum Output Current	200 mAmps
Maximum Power Supply	+/- 30 Volts Typical, 60 Volt Spread

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	
Input	2 Ea, DB37 Female
Output	2 Ea, DB37 Male

TABLE 1
P1 Connector Definitions

IN0LO	20	1	IN0HI
IN1LO	21	2	IN1HI
IN2LO	22	3	IN2HI
IN3LO	23	4	IN3HI
IN4LO	24	5	IN4HI
IN5LO	25	6	IN5HI
IN6LO	26	7	IN6HI
IN7LO	27	8	IN7HI
IN8LO	28	9	IN8HI
IN9LO	29	10	IN9HI
IN10LO	30	11	IN10HI
IN11LO	31	12	IN11HI
AGND	32	13	AGND
AGND	33	14	AGND
AGND	34	15	AGND
-PS	35	16	GND
GND	36	17	GND
+PS	37	18	GND
		19	GND

TABLE 2
P2 Connector Definitions

AGND	20	1	OUT0
AGND	21	2	OUT1
AGND	22	3	OUT2
AGND	23	4	OUT3
AGND	24	5	OUT4
AGND	25	6	OUT5
AGND	26	7	OUT6
AGND	27	8	OUT7
AGND	28	9	OUT8
AGND	29	10	OUT9
AGND	30	11	OUT10
AGND	31	12	OUT11
AGND	32	13	AGND
AGND	33	14	AGND
AGND	34	15	AGND
-PS	35	16	GND
GND	36	17	GND
+PS	37	18	GND
		19	GND

III. CIRCUIT DESCRIPTION

The PAS 9406/AMP-000 card contains 12 high power amplifier circuits. Channels are configured to provide a gain of 1.0, 2.7 or a gain used to simulate a speed sensor, with an output current drive of 100 mAmps. 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 OPA551, and they are built by Texas Instruments. Other versions of this card can be built with the OPA458. The OPA551 has a maximum power supply voltage of +/- 30 Volts, and a maximum output current of 200mA. The OPA458 has a maximum power supply voltage of +/- 40 Volts, and a maximum output current of 50mA.

The OPA551 and OPA458 are packaged in TI's DDPAC-7 and mounted with heat sinks. This package with the heat sink has a typical thermal resistance of 25 °C per Watt from junction to air, and the device has a maximum junction temperature of 125° 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 +/- 30 Volts. The amplifiers quiescent current is 8 mA which will produce 60 Volts x 8 mA = 480 mW of quiescent power. When the amplifiers are operated with +/- 15 Volt power supplies, the quiescent power is 30 Volts x 8 mA = 240 mW.

The maximum load current the amplifier is guaranteed to output is 200 mA. In this example, we will use 100 mAmp of load current. With +/- 30 Volt power supplies and a 4 Volt drop across the output stage, the output voltage is +/- 26 Volts. The minimum load resistance is 26 Volts divided by 100 mA = 260 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 26 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; 15 Volts x 15 Volts divided by 260 Ohms = 865 mWatts. In this example the total power in the amplifier is 480 mW + 865 mW = 1345 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° + (1.345 Watts x 25° C/W) = 94° C. This is below the maximum junction temperature, so it is safe to operate the amplifier under these conditions.

When the amplifiers are operated from +/- 15 Volt power supplies, the maximum output voltage is approximately +/- 11 Volts. At 100 mAmps of output current, this translates into a minimum load resistance of 110 Ohms. At half the power supply voltage, the output power in the amplifier is 7.5 Volts x 7.5 Volts divided by 110 Ohms = 511 mW. The total power is 511 mW + 240 mW = 751 mW. This puts the maximum junction temperature at about 18.7° above ambient.