Document PAS008
Revision B – 7/15/2002

PAS 9716/AO
ENGINEERING SPECIFICATION

16 CHANNEL, 16 BIT
VME ANALOG OUTPUT CARD
Revision B (08/27/1997)

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16 Channel 16 Bit
VME Analog Output Card

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I. INTRODUCTION

GENERAL DESCRIPTION

The PAS 9716/AO provides sixteen channels of sixteen-bit Analog Output. The card can be used in VME systems with A16, A24, or A32 addressing, and data writes of 16 and 32 bits are supported. Pluggable jumpers are used to configure the width of the address bus and the data bus width is specified by the instruction. High-speed voltage output DAC's, with 6 uSec typical settling times are used on this card .The DAC output signals are available on a 37 pin D connector mounted through the front panel. Two digital output signals are also provided on the output connector. A board identifier PROM, control and status register, and a 32-bit test register are also provided.

Card Features: PAS 9716/AO

- 16 channels ,16 bit voltage outputs
- +/- 10 Volt @ 5 mAmp output
- Binary Two's Complement Data Format
- DAC's reset to bipolar zero during power up reset
- Output impedance of 0.1 ohm
- Output short circuit proof to analog ground
- Output slew rate of 10 Volts per uSec
- Settling time of 6 uSec to 0.003% FSR (5K ohm parallel with 500 pF load)
- VME 6U form factor; 233 mm x 160 mm card size
- VME access: D32, D16; A32, A24, A16 Slave
- No VME Interrupts
- Optional VME SYSFAIL assert on power up, jumper selectable
- SYSFAIL LED and board access LED on front panel
- Board Identifier PROM (Board ID is VMEID PAS9716/AO B0)
- Simultaneous DAC update feature is program selectable
- 2 Digital Output channels
- Output signals on DB 37 connector at the front panel
- Loop back test registers allow verification of the VME bus interface
- 32-bit VME interface allows two channels to be written with one transfer and provides twice the data transfer rate of 16 bit interfaces. 16-bit VME transfers are also supported
- DAC's are powered by the +/- 12 Volts from the VME bus
- Operating temperature range 0 to 55 degrees Celsius

II. SPECIFICATIONS

Electrical Specifications

Number of Channels	16 Analog Outputs, 2 Digital Outputs
Resolution	16 bits
Output Voltage	+/- 10 Volts
LSB bit weight	305 uVolt
Output Current	+/- 5 mAmps
Settling Time	6 uSec (typ), 10 uSec (max.)
Integral Nonlinearity	+/- 2 LSB (max.)
Differential Nonlinearity	+/- 4 LSB (max.)
Zero Error	+/- 2 LSB (adjustable to zero)
Gain Error	+/- 0.1 % FS (adjustable to zero)
Digital Outputs	2 Outputs, 74F125 Output Drivers
Low Level Output Voltage	0.40 V (typ), 0.55 V (max.) @ I out = 64mA
High Level Output Voltage	3.1 V (typ), 2.0 V (min.) @ I out + -15mA
Card Power Requirements	5 Volts @ 1 Amp, (typ)
(Backplane supplies +/- 12 V)	+12 Volts @ 350 mAmps, -12 Volts @ 500 mAmps

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)
Connectors	2 ea. 96 position, (VME bus connectors) 1 ea. DB37 female, (Analog Output connector)

Jumpers and Indicators

The 9716/AO card contains 28 Pluggable jumpers and two LED indicators. The first 24 jumpers are used to set the board's VME base address, and are defined in the table 1 on page 8. When a jumper is installed, the corresponding address bit must be low to select the card's address, and when a jumper is removed, the corresponding address bit must be high. The card is shipped configured for address F0000000, so that 20 of the possible 24 address jumpers are installed.

Jumpers J25 and J26 are used to select the boards operating environment, either A16, A24 or A32, and the installation of these jumpers is defined in table 1.

Jumper J27 is used to set the function of the Pass/Access LED. When it is installed in position 1-2, the LED is controlled by bit 1 in the control register. When J27 is in position 2-3 the LED indicates the board is being accessed.

Jumper J28 allows the SYSFAIL line to be driven with bit 0 of the control register when it is installed.

TABLE 1

PLUGGABLE JUMPER DEFINITIONS

Jumper #	Function
J1	A8
J2	A9
J3	A10
J4	A11
J5	A12
J6	A13
J7	A14
J8	A15
J9	A16
J10	A17
J11	A18
J12	A19
J13	A20
J14	A21
J15	A22
J16	A23
J17	A24
J18	A25
J19	A26
J20	A27
J21	A28
J22	A29
J23	A30
J24	A31
J25 IN, J26 IN	A32 Addressing
J25 IN, J26 OUT	A24 Addressing
J25 OUT, J26 X	A16 Addressing
J27 (1-2)	LED2 indicates board passed
J27 (2-3)	LED2 indicates board accessed
J28 IN	SYSFAIL controlled by control register

LED’s

Two LED’s are provided at the front panel to indicate the board's status. The upper LED is the FAIL LED, and powers up on. This LED is controlled with bit 0 of the control register, and can be turned off by writing a one to that bit. The SYSFAIL line will also be driven when the FAIL LED is on, if J28 is installed.

The lower LED is the PASS/ACCESS LED, and its function is selected with J27. When it is configured for the pass function, it is controlled by bit 1 of the control register. LED2 can be turned on by writing a one to bit 1, and it will power up turned off. This LED can be used to indicate the board has passed some initial power up tests when it is configured for the pass function. When configured for the access function, LED2 will turn on any time the board is accessed. A one-shot is used to drive this LED, so that it will be visible on single cycle accesses.

Connector Definitions

Two 96 position DIN connectors are installed on the back plane end of the board to make the standard VME bus connection. A DB37 female connector is installed through the board's front panel to provide access to the sixteen analog output channels and the two digital outputs. The pin out of this connector is defined on the following page.

TABLE 2

DB37 CONNECTOR

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

III. PROGRAMMING INFORMATION

The 9716/AO card responds to word and longword writes to the sixteen Digital to Analog Converters (DAC's). The card also supports word writes and reads to the control and status register, and word reads of the board identifier PROM. A thirty two-bit test register is provided, and it responds to word and longword transfers. This register is useful for verifying the functionality of the VME bus interface. The card's memory map is shown below.

TABLE 3

PAS 9716/AO MEMORY MAP

BASE + 00	Reserved	Reserved	BASE + 01
02	Reserved	Control/Status Register	03
04	Reserved	Reserved	05
06	Reserved	2nd CSR	07
08	Test Register	Test Register	09
0A	Test Register	Test Register	0B
0C	2nd Test Reg.	2nd Test Reg.	0D
0E	2nd Test Reg.	2nd Test Reg.	0F
10	Reserved	Reserved	11
12	Reserved	3rd CSR	13
14	Reserved	Reserved	15
16	Reserved	4th CSR	17
18	3rd Test Reg.	3rd Test Reg.	19
1A	3rd Test Reg.	3rd Test Reg.	1B
1C	4th Test Reg.	4th Test Reg.	1D
1E	4th Test Reg.	4th Test Reg.	1F
20	FF	V (56)	21
22	FF	M (4D)	23
24	FF	E (45)	25
26	FF	I (49)	27
28	FF	D (44)	29
2A	FF	P (50)	2B
2C	FF	A (41)	2D
2E	FF	S (53)	2F
30	FF	9 (39)	31
32	FF	7 (37)	33
34	FF	1 (31)	35
36	FF	6 (36)	37
38	FF	A (41)	39
3A	FF	O (4F)	3B
3C	FF	B (42)	3D
3E	FF	0 (30)	3F
40	CH 0	CH 0	41
42	CH 1	CH 1	43
5E	CH 2	CH 2	45

TABLE 3 CONT.

PAS 9716/AO MEMORY MAP

44	CH 3	CH 3	47
46	CH 4	CH 4	49
48	CH 5	CH 5	4B
4A	CH 6	CH 6	4D
4C	CH 7	CH 7	4F
4E	CH 8	CH 8	51
50	CH 9	CH 9	53
52	CH 10	CH 10	55
54	CH 11	CH 11	57
56	CH 12	CH 12	59
58	CH 13	CH 13	5B
5A	CH 14	CH 14	5D
5C	CH 15	CH 15	5F

Control and Status Register

The Control and Status Register is located at the cards base address plus 2. Writes to the Control register are used to set the states of the LED's and the SYSFAIL line, to control the Digital Output lines, and to control the simultaneous update function.

Bit 0 of the Control Register steers the Fail LED, and the SYSFAIL line on the backplane, if J28 is installed. When the card is reset the Fail LED will come on, and the SYSFAIL line will be driven true. The LED and the SYSFAIL line can be turned off by writing a one to bit 0.

Bit 1 of the Control Register will control the Pass LED if this function is selected with J27. This LED will be turned off when the board is reset or when a zero is written to bit 1. The LED can be turned on by writing a one to bit 1.

Bit 2 of the Control Register controls the simultaneous update feature. This function is disabled when the board is reset or when a zero is written to bit 2. When simultaneous update is disabled, the DAC's will be updated whenever they are written. Simultaneous update can be enabled by writing a one to bit 2, as part of the sequence described below on writing to the DAC's.

Bit 3 of the Control Register is used to enable the digital output drivers. The drivers are disabled when the board is reset or when a zero is written to bit 3. This puts the outputs in a high impedance state. The drivers are enabled by writing a one to bit 3.

Bits 4 and 5 of the Control Register control the state of Digital Outputs 1 and 2 respectively. The outputs will be low whenever a zero is written to these bits, and the outputs are enabled. When the card is reset, the outputs are disabled. The outputs will be driven high by writing ones to bits 4 or 5 with the outputs enabled.

Bits 6 and 7 in the Control Register do not have any function, however they are returned in the status register.

The status register is accessed by reading the card's base address plus 2. This register returns the state of the control register.

TABLE 4

Control and Status Register

7	6	5	4	3	2	1	0
Loop Back HT	Loop Back HT	Dig Out 2 HT	Dig Out 1 HT	Out Enbl HT	Sim Updat HT	Pass LED HT	Fail LED LT

LT = Low True
HT = High True

The power up or reset condition of the Control and Status Register is FF00, and indicates the Digital Outputs are disabled, simultaneous update is disabled, the PASS LED is off, (if selected with J27), and the FAIL LED is on.

32 Bit Test Register

The 32-bit Test Register can be written to and read at the card's base address plus 8. This register supports word and long word transfers, and is useful for verifying the proper operation of the VME bus interface. Reading the register will return the value that was last written to it.

Board Identifier PROM

The board identifier PROM is located at an offset of 20 (hex) from the base address, and can be read with word reads only. The least significant byte of the word will contain valid data, and the most significant byte will contain FF. The ID PROM contains 16 ASCII characters that specify the board's model number and revision level. A write to the ID PROM will handshake, but not transfer any data.

16 Bit Digital to Analog Converters

The sixteen D to A converters can be written to starting at the board's base address plus 40 (hex). Binary Two's Complement data is the format of data written to the DAC's. For the bipolar Analog Output configuration of this card, a digital word of 7FFF gives positive full scale output, 8000 hex gives negative full scale output, and 0000 hex gives bipolar zero output.

Dual rank registers are used in the DAC's and data is always written into the DAC's input register. If simultaneous update is disabled, the DAC register will also be updated during this write. If the DAC's are to be updated simultaneously, then the following sequence should be performed;

1) Bit 2 in the Control Register is set to a 1 to disable the DAC registers from tracking the input registers,
2) all of the DAC's but one are written to,
3) Bit 2 in the Control Register is set to zero,
4) The final DAC is written to. This will cause all of the DAC's to be updated on the final write.

The Digital to Analog Converters can be written to individually using word transfers, or in pairs using longword transfers. During a power up reset, the output voltage of all of the DAC's will set to 0.000 Volts.

IV. CALIBRATION PROCEDURE

Install the 9716/AO card in a VME chassis, and allow the card to stabilize for approximately five minutes. A meter with five digits of resolution and accuracy is required to perform these adjustments.

Offset Adjustment

The offset adjustment should be performed before the gain adjustment to avoid interaction of adjustments. Write the hex value 8001 to the channel to be adjusted, and adjust the zero potentiometer for a value of – 9.9996 Volts. The zero adjustments are the even numbered pots R10 through R40, and they are the lower pot on each channel.

Gain Adjustment

Write a hex value of 7FFF to the channel to be adjusted, and adjust the gain potentiometer for a value of + 9.9996 Volts. The gain adjustments are the odd numbered pots R9 through R39, and they are the upper pot on each channel.