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Series 9210/9215
Analog Output Board

USER'S MANUAL

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1.0 GENERAL INFORMATION

1.1 INTRODUCTION

The Series AVME9210/9215 Analog Output Boards provide a means for connecting analog outputs to a VMEbus-based computer. The Analog Output Board is available in two variations.

Each Board has 8 output channels, each with 12 bit resolution. A DAC per channel is used to provide maximum signal accuracy and to minimize output transients. The DACs may be set up to accept either straight binary or two's complement data.

The AVME9210 Voltage Output Board has five jumper-programable output ranges (±10v, ±5v, ±2.5v, 0-5v, and 0-10v). Each channel can be individually set for a specific range.

The AVME9215 Current Output Board has an output range of 4-20mA and can drive up to a 500 ohm load. By using an external power supply, an output range of 4-20mA with a 1300 ohm load is possible. The external supply is jumper-selectable and is connected from the field via the P2 connector.

The series AVEM9210-9215 Analog Output Boards conform to the standard Euroboard physical and electrical requirements as described in the VME Specification (REV.C).

Power, ground, and all VMEbus signal lines are connected via the P1 connector. Analog output connections and external power connections are made via the P2 connector.

1.2 THE AVME9210 VOLTAGE OUTPUT BOARD

- 12 bit output resolution.
- Individual DAC per channel design approach.
- 8 channels of output.
- Five jumper programmable output voltage ranges.
- Positioned on 1k byte boundaries in the VME short I/O space.
- BYTE or WORD data transfers.
- Jumper selectable straight binary or two's complement.
- Meets all VME physical and electrical requirements.
- Output can withstand a continuous short circuit.
- Board Identification PROM.
- Pass/Fail status indicators on the front panel.
- Power-Up/Reset to 0 Volts or minus full scale (jumper selectable).
- Compatible with all bus masters (A32,A24,A16) that support A16 slaves.
- Compatible with all bus masters (D32,D16,D08(E0)) that support D16 or D08(E0) slaves.

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1.3 THE AVME9215 CURRENT OUTPUT BOARD

- 12 bit output resolution.
- Individual dac per channel approach.
- 8 channels of current output.
- Configurable for a user-provided external supply to drive up to 1300 ohm loads.
- BYTE or WORD data transfers.
- Meets all VME physical and electrical requirements.
- Power-Up/Reset to 4mA output.
- PASS/ FAIL status indicators on the front panel.
- Card Identification PROM.
- Jumper selectable straight binary or two's complement.
- Compatible with all bus masters (A32,A24,A16) that support A16 slaves.
- Compatible with all bus masters (D32,D16,D08(EO)) that support D16 or D08(EO) slaves.

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2.0 PREPARATION FOR USE

This Chapter provides information about preparing the Analog Output Board for system operations.

2.1 UNPACKING AND INSPECTION

Inspect the shipping carton immediately upon receipt for evidence of mishandling during transit. If the shipping carton is severely damaged or water stained, request that the carrier's agent be present when the carton is opened. If the carrier's agent is absent when the carton is opened and the contents of the carton are damaged, keep the carton and packing material for the agent's inspection.

For repairs to a product damaged in shipment, refer to the Acromag Service Policy to obtain return instructions. It is suggested that salvageable shipping cartons and packing material be saved for future use in the event the product must be shipped.

The board is physically protected with foam and electrically protected with an antistatic bag during shipment. It is advisable to visually inspect the board for evidence of mishandling prior to applying power.

CAUTION
SENSITIVE ELECTRONIC DEVICES
USE ANTI-STATIC HANDLING PROCEDURES

2.2 CARD CAGE CONSIDERATIONS

Refer to the specifications for bus loading and power requirements. Be sure that the system power supplies are able to accommodate the additional requirements within the voltage tolerances specified.

Adequate air circulation must be provided to prevent a temperature rise above the maximum operating temperature. Large and continuing fluctuations in ambient air temperature should be avoided. If the installation is in an industrial environment and the board is exposed to environmental air, careful consideration should be given to air filtering.

2.2.1 Installation

NOTE: Always turn off power to the card cage before installing or removing a Board or cables. Also turn power off when moving configuration jumpers. Failure to do so can result in damage to the Board.

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2.2.2 Field Wiring

Field wiring is connected to the Analog Output Boards via the P2 connector:

ANALOG OUTPUT CONNECTOR P2

PIN NUMBER	SIGNAL	PIN NUMBER	SIGNAL	PIN NUMBER	SIGNAL
1A		1B		1C	
2A		2B		2C	
3A		3B		3C	
4A		4B		4C	
5A		5B		5C	
6A		6B		6C	
7A		7B		7C	
8A		8B		8C	
9A	EXT SUPPLY GND	9B		9C	EXT SUPPLY GND
10A		10B		10C	
11A		11B		11C	
12A	+EXT. SUPPLY	12B		12C	+EXT. SUPPLY
13A		13B		13C	
14A		14B		14C	
15A		15B		15C	
16A		16B		16C	
17A		17B		17C	
18A		18B		18C	
19A		19B		19C	
20A		20B		20C	
21A		21B		21C	
22A	-CHAN 6	22B		22C	-CHAN 7
23A	+CHAN 6	23B		23C	+CHAN 7
24A		24B		24C	
25A	-CHAN 4	25B		25C	-CHAN 5
26A	+CHAN 4	26B		26C	+CHAN 5
27A		27B		27C	
28A	-CHAN 2	28B		28C	-CHAN 3
29A	+CHAN 2	29B		29C	+CHAN 3
30A		30B		30C	
31A	-CHAN 0	31B		31C	-CHAN 1
32A	+CHAN 0	32B		32C	+CHAN 1

The Analog Output Board is connected to the Acromag 6935 Field Termination Panel via Acromag Analog Signal Cable Model 9940. The Model 6935 Field Termination Panel has transient protection circuitry to guard the outputs from damage due to the effects of electrostatic discharge.

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2.2.3 Loading

The model AVME9210 Voltage Output Board can drive capacitive loads up to 0.01uF without any overshoot or ringing in the output voltage. When capacitive loads in excess of 0.01uF are present, a slight overshoot occurs when the output changes. With a 0.5uF load on the output, the overshoot is less than 100 mV and will settle out within 175 uSec. to provide a clean, stable output. If this brief overshoot cannot be tolerated, place a resistor between the "+" output terminal and the load to decouple the capacitive load from the output circuitry. A minimum value for this resistor is 50 ohms. The output impedance will now be equal to the value of this external resistor.

When using the model AVME9215 Current Output Board to drive inductive loads, it is recommended that a 1uF capacitor be placed across the load to reduce any ripple or ringing that may occur. Provisions for this capacitor are made on the Model 6935 Field Termination Panel.

2.3 CONFIGURATION INFORMATION

The AVME921X Analog Output Boards are tested and shipped from the factory per the following configuration.

```
Base Address.......Address 0000H Of The Short I/O Space
Address Modifier....Both (2DH) Short Supervisory Access
                    and (29H) Short Non-Privileged Access
DAC Data Type.....................Two's Complement Binary

AVME9210 Voltage Output:
     Voltage Output Range.............................±10v

AVME9215 Current Output:
     Current Output Range..........................4 - 20MA
     Output Power Supply.....................Internal 15V
```

NOTE: Numbers with an H suffix are hexadecimal numbers.

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2.3.1 Address Decode Jumper J5

The AVME9215 Analog Output Boards are located in the VME short I/O Memory Map.

From Address 0000H of the Short I/O Space to Address FFFFH of the Short I/O Space, each Output Board occupies a 1k byte segment of memory. The base address of an individual Board is determined by Jumper J5. See Figure 2.1 for the location of J5 on the Analog Output Board.

ADDRESS DECODE JUMPER J5						
1&2	3&4	5&6	7&8	9&10	11&12	BASE ADDRESS WITHIN THE SHORT I/O SPACE
OUT	OUT	OUT	OUT	OUT	OUT	0000H
OUT	OUT	OUT	OUT	OUT	IN	0400H
OUT	OUT	OUT	OUT	IN	OUT	0800H
OUT	OUT	OUT	OUT	IN	IN	0C00H
OUT	OUT	OUT	IN	OUT	OUT	1000H
OUT	OUT	OUT	IN	OUT	IN	1400H
			.			.
			.			.
			.			.
			.			.
IN	IN	IN	OUT	IN	IN	EC00H
IN	IN	IN	IN	OUT	OUT	F000H
IN	IN	IN	IN	OUT	IN	F400H
IN	IN	IN	IN	IN	OUT	F800H
IN	IN	IN	IN	IN	IN	FC00H

("In" means that the pins are shorted together with a shorting clip. "Out" indicates that the clip has been removed.)

2.3.2 Address Modifier

The Series AVME921X Analog Output Cards are designed to recognize two address modifier codes, SHORT SUPERVISORY ACCESS (2DH), and SHORT NON-PRIVILEGED ACCESS(29H). Jumper J2 may be programmed as follows...

Jumper IN.....Both SHORT NON-PRIVILEGED ACCESS(29H) and SHORT SUPERVISORY Access(2DH) are valid.

Jumper OUT.....Only SHORT SUPERVISORY ACCESS (2DH) is valid.

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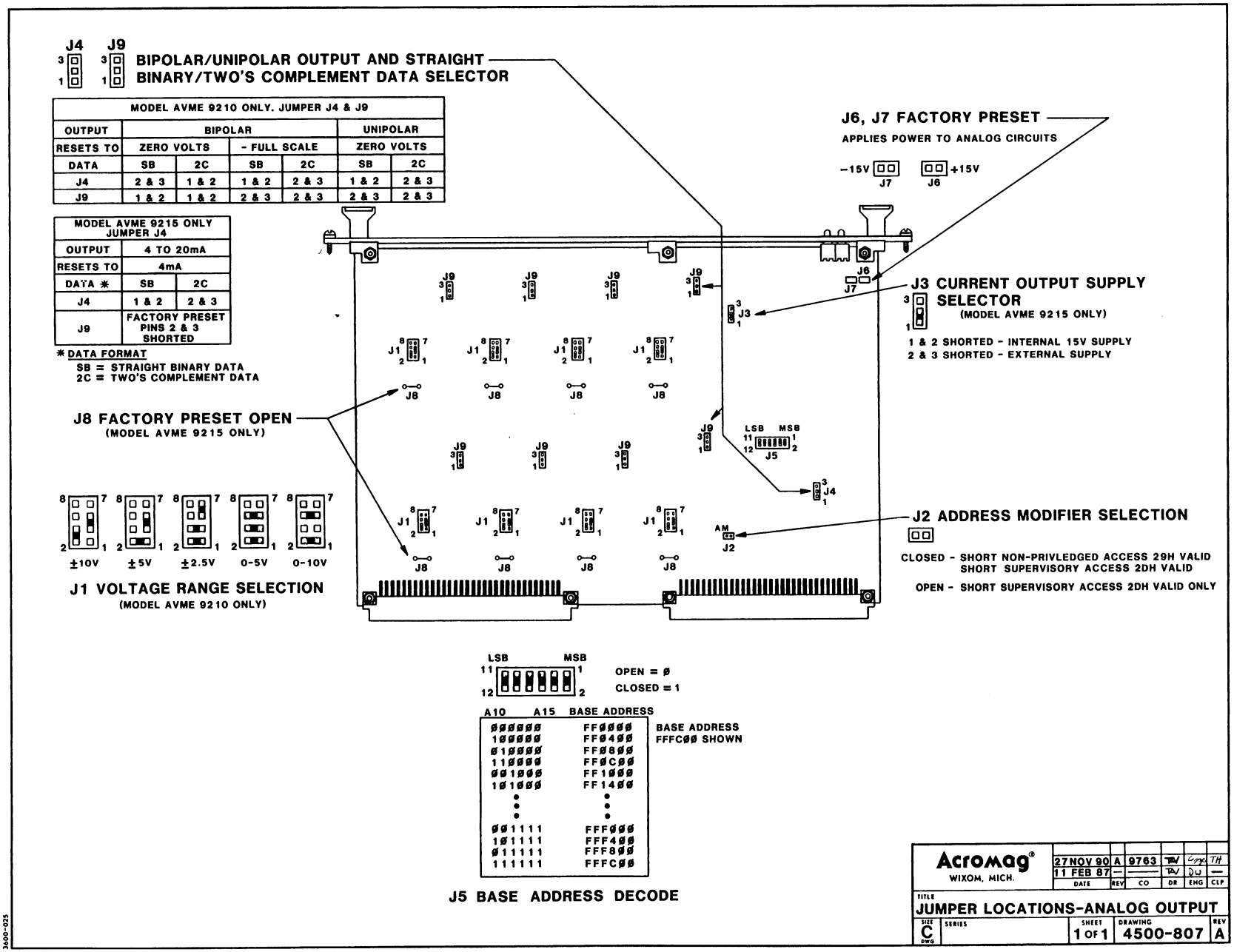


FIGURE 2.1

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2.3.3 Bipolar/unipolar Output and Straight Binary/Two's Complement Data Jumper J4 & J9

Using Jumper J4 & J9, the Analog Output Cards may be programmed such that the Digital to Analog Converters (DACS) will respond to either TWO'S COMPLEMENT OR STRAIGHT BINARY DATA for BIPOLAR or UNIPOLAR OUTPUTS. See Figure 2.1 for jumper location.

MODEL AVME 9210 ONLY, JUMPER J4 & J9

JUMPER	BIPOLAR OUTPUT				UNIPOLAR OUTPUT	
	RESETS TO ZERO VOLTS		RESETS TO MINUS FULL SCALE		RESETS TO ZERO VOLTS	
	SB	2C	SB	2C	SB	2C
J4	2&3	1&2	1&2	2&3	1&2	2&3
J9	1&2	1&2	2&3	2&3	2&3	2&3

MODEL AVME 9215 ONLY JUMPER J4

JUMPER	OUTPUT 4-20mA RESETS TO 4mA	
	SB	2C
J4	1&2	2&3
J9	FACTORY PRESET PINS 2&3 SHORTED	

* DATA FORMAT
SB = STRAIGHT BINARY DATA
2C = TWO'S COMPLEMENT DATA

MODEL AVME 9210

DATA		BIPOLAR OUTPUT (VOLTS)			UNIPOLAR OUTPUT (VOLTS)	
STRAIGHT BINARY	TWO'S COMPLEMENT	-10 TO +10	-5 TO +5	-2.5 TO +2.5	0-10V	0-5V
FFFH	7FFH	9.9951	4.9976	2.4988	9.9976	4.9988
C00H	400H	5.0000	2.5000	1.2500	7.5000	3.7500
800H	000H	0.0000	0.0000	0.0000	5.0000	2.5000
7FFH	FFFH	-0.0049	-0.0024	-0.0012	4.9976	2.4988
400H	C00H	-5.0000	-2.5000	-1.2500	2.5000	1.2500
000H	800H	-10.0000	-5.0000	-2.5000	0.0000	0.0000

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MODEL AVME9215 4-20 mA OUTPUT		
DATA STRAIGHT BINARY	TWO'S COMPLEMENT	OUTPUT CURRENT (mA)
FFFH	7FFH	19.996
C00H	400H	16.000
800H	000H	12.000
7FFH	C00H	11.996
400H	C00H	8.000
000H	800H	4.000

2.4 OPTIONAL EXTERNAL POWER SUPPLY JUMPER J3 (AVME9215 only)

The AVME9215 Current Output Card can support up to 500 ohm loads using the internal power supply to power the output driver. Larger loads can be supported by using a higher voltage external supply to power the output driver. The external supply is provided by the user and is connected via the P2 connector. By configuring Jumper J3, the user may select either INTERNAL or EXTERNAL power supply configurations. See Figure 2.1 for jumper location.

OPTIONAL EXTERNAL POWER SUPPLY JUMPER J3		
1&2	2&3	POWER SUPPLY
IN	OUT	INTERNAL
OUT	IN	EXTERNAL

("In" means that the pins are shorted together with a shorting clip. "Out" indicates that the clip has been removed.)

NOTE: IF THE CAGE POWER IS TURNED OFF AND THE EXTERNAL SUPPLY IS LEFT ON, ALL THE OUTPUTS GO TO + FULL SCALE.

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2.5 VOLTAGE OUTPUT RANGE JUMPER J1 (AVME9210 ONLY)

The AVME9210 Voltage Output Card has eight output channels and each channel may be individually programmed to output a specific voltage range. By using jumper J1 on each channel, the user may select any one of five possible ranges. See Figure 2.1 for jumper location.

VOLTAGE OUTPUT RANGE SELECTION JUMPER 1

1&2	2&4	3&4	3&5	5&7	5&6	RANGES
OUT	IN	OUT	IN	OUT	OUT	+-10V
IN	OUT	OUT	IN	OUT	OUT	+-5V
IN	OUT	IN	OUT	IN	OUT	+-2.5V
IN	OUT	IN	OUT	OUT	IN	0-5V
IN	OUT	OUT	OUT	OUT	IN	0-10V

("In" means that the pins are shorted together with a shorting clip. "Out" indicates that the clip has been removed.)

2.6 POWER SUPPLY JUMPERS J6 AND J7

The Analog output cards have two jumpers, J6 and J7, which interconnect power outputs to the analog circuitry. These jumpers are used for testing and are installed at the factory. They should not be removed. See Figure 2.1 for jumper location.

2.7 JUMPER J8

This jumper is preset open at the factory. No further adjustment is necessary.

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3.0 PROGRAMMING INFORMATION

This section is intended to provide all of the necessary information for communicating with the VME ANALOG OUTPUT BOARDS.

3.1 MEMORY MAP

The Analog Output Boards connect to the VMEbus via the P1 connector. They respond as a non-intelligent slave and reside in the VME SHORT I/O memory space. All Acromag VMEbus non-intelligent slaves have a standard interface configuration which consists of a 32 byte Board I.D. Prom and a STATUS/CONTROL register. The rest of the 1k byte block contain registers specific to the operation of the board. Both double byte and single byte data transfers are valid, but quad byte transfers are not. The Memory Map is shown in Table 3.1.

Table 3.1 Memory Map

Address Base +	Even	Odd	Address Base +
00 3E	Undefined	Module ID Prom	01 3F
40 7E	UNDEFINED		41
80	Undefined	STATUS/CONTROL REGISTER	81
82	CHANNEL 0 DATA REGISTER		83
84	CHANNEL 1 DATA REGISTER		85
86	CHANNEL 2 DATA REGISTER		87
88	CHANNEL 3 DATA REGISTER		89
8A	CHANNEL 4 DATA REGISTER		8B
8C	CHANNEL 5 DATA REGISTER		8D
8E	CHANNEL 6 DATA REGISTER		8F
90	CHANNEL 7 DATA REGISTER		91
92 3FE	UNDEFINED		93 3FF

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3.2 BOARD IDENTIFICATION PROM (read only)

The Analog Output Cards are equipped with a PROM that contains information about the Board model number and the manufacturer. The identification information is 32 bytes in length, and is addressed on every odd byte starting at BASE ADDRESS +01H. Tables 3.2 and 3.3 show the ID PROM contents for the AVME9215 Voltage Output Board and the AMVE9215 Current Output Board respectively.

Table 3.2 VOLTAGE OUTPUT CARD
AVME9210
ID INFORMATION

BASE ADDRESS OFFSET	HEX DATA	ASCII DATA	DESCRIPTION
01H	56H	V	"VMEID"
03H	4DH	M	
05H	45H	E	
07H	49H	I	
09H	44H	D	
0BH	41H	A	"ACR" ACROMAG
0DH	43H	C	
0FH	52H	R	
11H	39H	9	MODEL NUMBER
13H	32H	2	
15H	31H	1	
17H	30H	0	
19H	20H		SPACE
1BH	20H		SPACE
1DH	20H		SPACE
1FH	31H	1	KILOBYTES USED
21H	20H		SPACE
23H			UNDEFINED
25H			
27H			
29H			
2BH			
2DH			
2FH			
31H			
33H			
35H			
37H			
39H			
3BH			
3DH			
3FH			

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Table 3.3 AVME9215
CURRENT OUTPUT BOARD
ID INFORMATION

BASE ADDRESS OFFSET	HEX DATA	ASCII DATA	DESCRIPTION
01H	56H	V	"VMEID"
03H	4DH	M	
05H	45H	E	
07H	49H	I	
09H	44H	D	
0BH	41H	A	"ACR" ACROMAG
0DH	43H	C	
0FH	52H	R	
11H	39H	9	MODEL NUMBER
13H	32H	2	
15H	31H	1	
17H	35H	5	
19H	20H		SPACE
1BH	20H		SPACE
1DH	20H		SPACE
1FH	31H	1	KILOBYTES USED
21H	20H		SPACE
23H			UNDEFINED
25H			
27H			
29H			
2BH			
2DH			
2FH			
31H			
33H			
35H			
37H			
39H			
3BH			
3CH			
3FH			

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3.3 STATUS/CONTROL REGISTER

The Analog Output Cards reserve a memory location for Board status indicator flags and reset control. This memory location is one byte in length and is located at BASE ADDRESS +81H. The STATUS/CONTROL Register controls the front panel status indicators, and provides a means to perform a local reset under software control. Reset responses described below also apply to a system reset from the VMEbus. Figure 3.4 describes the Board STATUS/CONTROL Register.

Figure 3.4 ANALOG OUTPUT BOARD
STATUS/CONTROL REGISTER
BASE ADDRESS +81H

7	6	5	4	3	2	1	0
UDF	UDF	UDF	SOFTWARE RESET	UDF	UDF	GREEN LED	RED LED

D7,D6,D5,D3,D2
UDF= Undefined, reserved for future use, always reads 0.

D4: Software reset.

Writing a 1 to this bit causes a local reset on the Analog Output Board. Writing 0 or reading this bit has no effect. This bit always reads 0. A software reset, resets all DACS according to jumper selection J4 & J9 (See section 2.3.3) and resets status/control register.

D1: Green LED.

This bit when written to will control the state of the green LED on the front panel. Writing a 1 will turn it on and writing a 0 will turn it off. Reading it reflects the present state. Upon application of a software or system reset, D1 is set to 0 and the GREEN LED is off.

D0: Red LED.

This bit when written to will control the state of the red LED on the front panel and drives the SYSFAIL line. Writing a 1 turns the red LED off and disables the SYSFAIL line. Writing a 0 turns the red LED on and enables the SYSFAIL line. Reading will reflect its current state. Upon application of a software or system reset, D0 is set to 0 and the RED LED is on.

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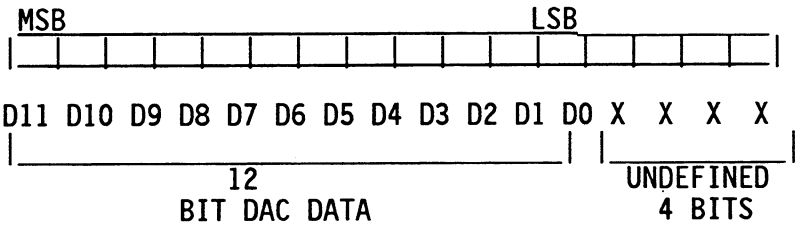
3.4 DAC DATA REGISTER (write only)

The Analog Output Cards have 8 channels of output. Each channel has one 12 bit digital to analog converter. A two byte address location is reserved for each channels' data register. Every card has eight two-byte data registers.

DATA REGISTER	BASE ADDRESS OFFSET
CHANNEL 0	+82H
CHANNEL 1	+84H
CHANNEL 2	+86H
CHANNEL 3	+88H
CHANNEL 4	+8AH
CHANNEL 5	+8CH
CHANNEL 6	+8EH
CHANNEL 7	+90H

Each of the 8, two byte data registers is set up as:

DAC DATA REGISTER



Note that the least significant 4 bits in the DAC DATA REGISTER are ignored when writing to the DAC. Only the upper twelve bits are used.

Note that both double byte and single byte writes are valid when writing to this register. However, one should consider that when using two single byte writes, the DAC output may be briefly set to an unintended value between data transfers.

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3.5 GENERAL PROGRAMMING CONSIDERATIONS

3.5.1 Board Diagnostics

The Analog Output Board is a non-intelligent slave and does not perform self diagnostics. It does, however, provide a standard interface architecture which includes a Board Status Register useful in system diagnostics. Refer to Paragraph 3.3: Board Status Register.

Status bits, control of front panel LEDs, and control of the SYSFAIL* signal are provided through the Board Status Register. Bits 0 and 1 may be used as follows:

Board Status Register bit 1	bit 0	LEDs Green	Red	SYSFAIL* Signal	Condition
0	0	Off	On	On	Board failed test or has not been tested
1	0	On	On	On	Board is being tested
1	1	On	Off	Off	Board has passed test
0	1	Off	Off	Off	Board is inactive

At power up, the system diagnostic software can test each non-intelligent slave, sequencing the status bits to indicate "undergoing test" and then to "passed" or "failed".

After testing each board the system software records which boards have failed and sets their status to indicate "inactive". By setting the boards status to inactive, the SYSFAIL* signal is released and may then be useful for an on-line indication of failure by other boards.

Alternatively the system software could simply set the bits and therefore front panel LEDs, to "passed test" as a visual indication that the presence of the board is recognized.

3.5.2 Treatment of Data

The input and output data is 12 bit left justified. When working with bipolar signals, the user may find it advantageous to treat the data as 16 bit two's complement numbers. In that way future products with higher resolution D/A converters may use the same software drivers. Similarly, unipolar data may best be treated as 16 bit unsigned numbers.

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4.0 THEORY OF OPERATION

This section provides a functional description of the Analog Output Board. This board contains six functional blocks.

- VME bus interface
- STATUS/CONTROL circuitry
- Card identification circuitry
- Digital to Analog converter
- Voltage to current conversion blocks (AVME9215 only)
- DC to DC converter circuitry

Block diagrams are shown in figure 4.1 and 4.2. Refer to the schematic and parts location diagrams in Chapter 7 for other items referenced in this section.

4.1 VME BUS INTERFACE

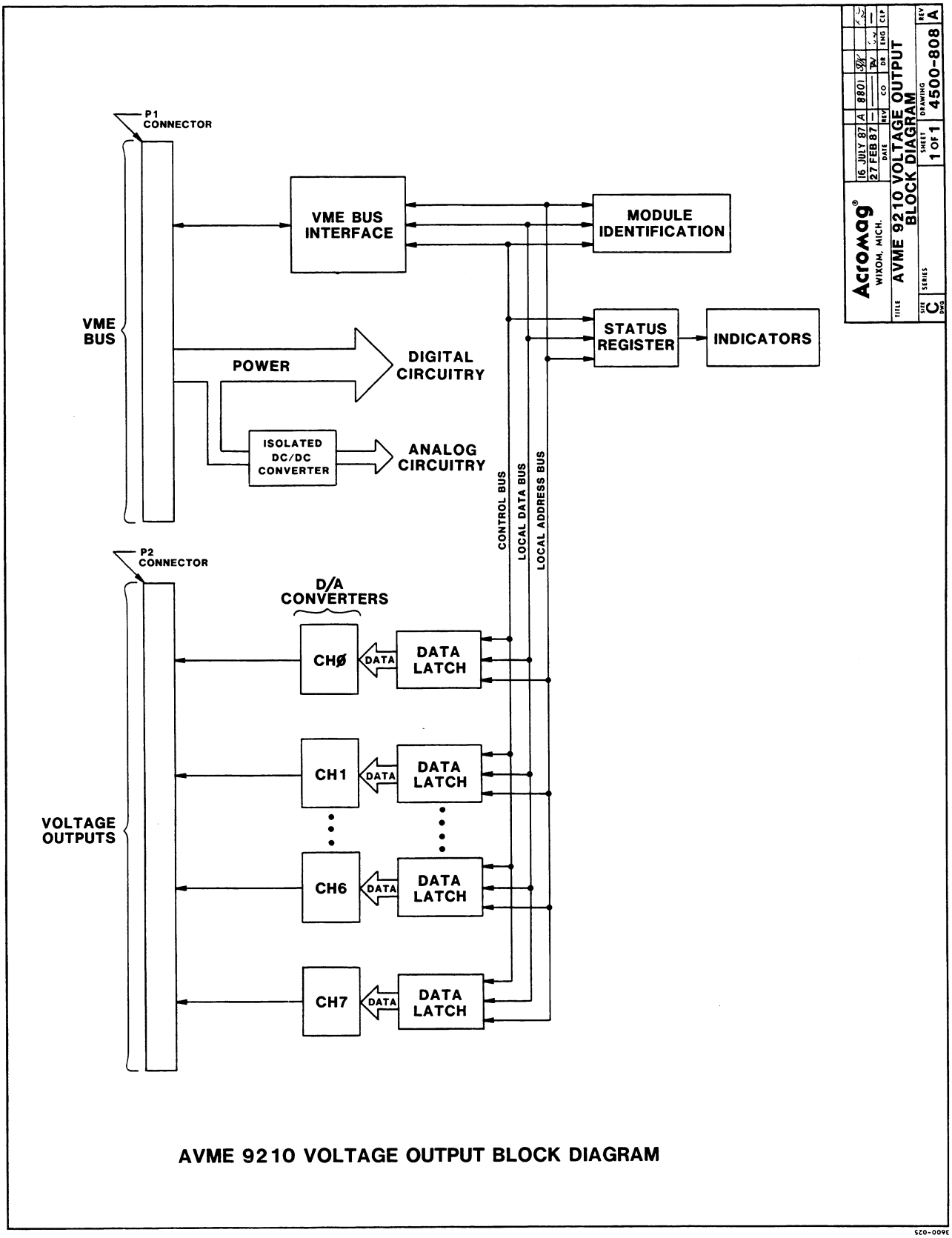
The Analog Output Boards interface to the VMEbus as a 1 kilobyte block of contiguous address locations in the VMEbus I/O address space. The starting address of this block is determined by jumpers on pins 1 through 12 of J5. Integrated circuit U16 compares the Jumper J5 with the VMEbus address lines to produce a valid address enable EN* signal for the programmable logic device U7.

The Analog Output Boards respond to two address modifier codes. They are 29H SHORT NON-PRIVILEGED ACCESS and 2DH SHORT SUPERVISORY ACCESS. The address modifier code selected is determined by the jumper on pins 1&2 of J2. Programmable logic device U7 compares the VMEbus address modifier lines with Jumper J2 and the result is gated with the valid address enable EN* signal from U16 to produce a valid address signal VCD. When valid, the board is then free to communicate on the bus.

Once the board has been addressed correctly, device U7 initiates BDTACK on the falling edge of either DS0 or DS1. The rising edge of BDTACK starts counter U14. After a specified delay, U14 enables RDDLY and WRTDLY. WRTDLY latches in data from the bus on the rising edge. It is delayed to allow the local data bus to settle. After additional delay, counter U14 enables the DTACK data transfer acknowledge signal. On a write cycle, DTACK tells the host that data has been received. On a read cycle, DTACK tells the host that data on the bus is valid and may be read at this time. DTACK is connected to the bus via U18.

Programmable logic devices U8,U9,and U17 perform the local address decode and produce all the necessary logic for data transfer timing.

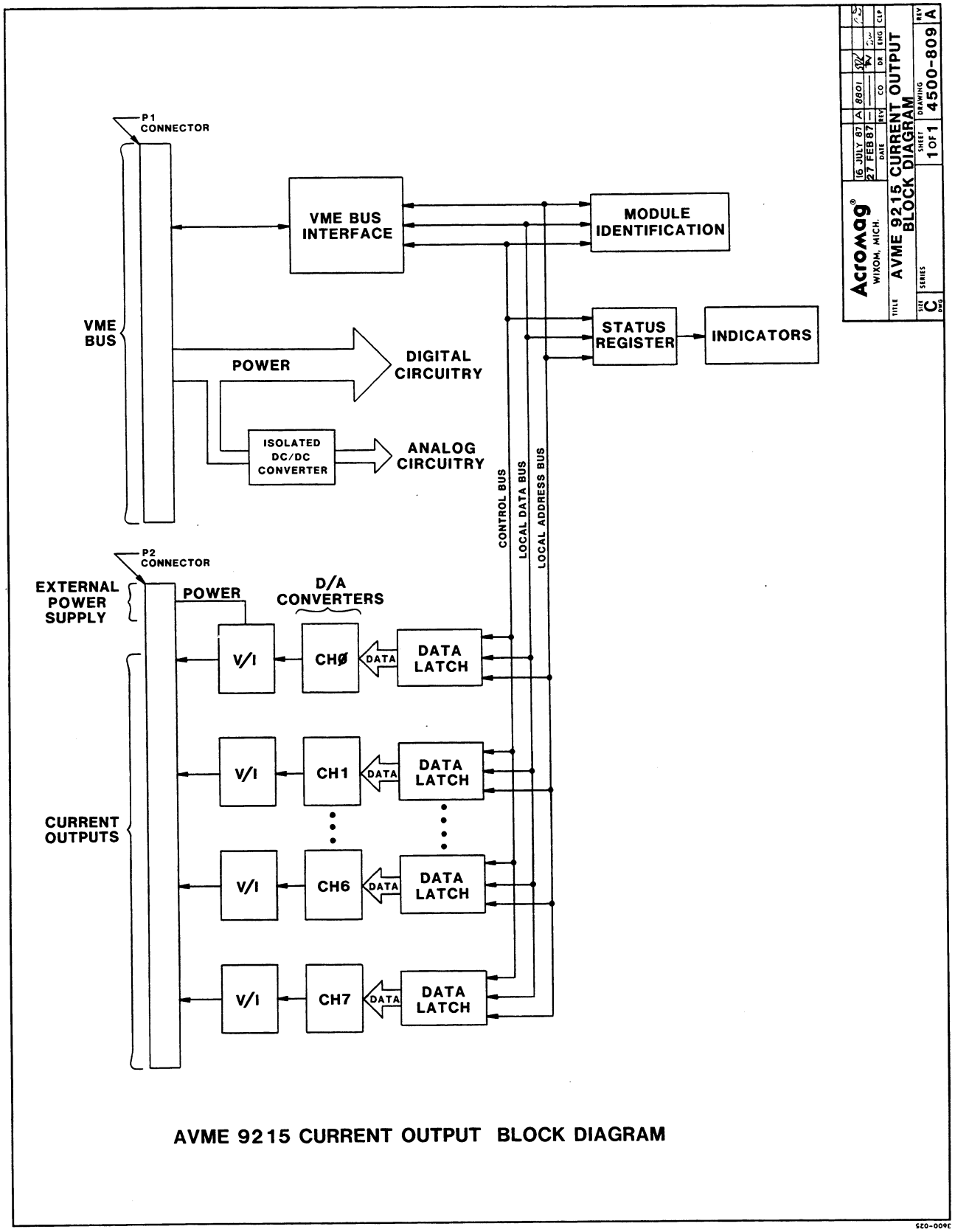
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AVME 9210 VOLTAGE OUTPUT BLOCK DIAGRAM

FIGURE 4.1

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AVME 9215 CURRENT OUTPUT BLOCK DIAGRAM

FIGURE 4.2

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4.2 BOARD IDENTIFICATION CIRCUITRY

The Board identification prom U15 is a read only device. It stays in a high impedance output state until it receives a low signal on chip select pin 15. At that point, it drives the lower eight bits of the local data bus.

4.3 STATUS/CONTROL CIRCUITRY

The Status/Control circuitry is made up of ICs U12 and U13. On a write cycle to the status register, delay flip flop U12 clocks in new data from the local data bus. On a read cycle, the tri-state buffer U13 drives the local data bus with the output of U12. Delay flip flop U12 also provides control lines for the red and green LEDS via programmable logic device U17.

4.4 DIGITAL TO ANALOG CONVERTER

Every analog output board has eight channels of output. Each channel has a D/A converter U2 and three 4 bit data latches U3,U4,U5. the data latches clock in Data from the local data bus on a rising edge on pin 9 and are cleared on a low level on pin 1. The D/A converter uses an internal resistor ladder network to control the voltage output level on pin 15. Pins 1 through 8 of jumper J1 select the output voltage range for the AVME9210 Voltage Output Board. On the Current Output Board AVME9215, J1 is preset for the 0-10v range and this output is used to drive the voltage-to-current converter.

4.5 THE VOLTAGE TO CURRENT CONVERTER

The voltage to current converter is made up of a level shifter and an output driver stage. The level shifter is a voltage follower which produces a constant current through transistor Q3 proportional to the output voltage from the DAC. The current is sensed by resistor R5. The output driver is a voltage follower which produces a constant current through transistors Q1 and Q2.

4.6 DC TO DC CONVERTER

The DC to DC converter changes the 5V digital supply into dual $\pm$15V outputs and provides power for the analog output circuitry. Astable multivibrator U20 provides drive signals for transistors Q4 and Q5. Transistors Q4 and Q5 are turned on and off alternately providing current switching through the windings of transformer T1. The secondary signals are then rectified by diode bridge D17-D20 and regulated via regulators U22 and U23. Inductor L1 makes up an input pi-filter to protect the cage supply from switching transients.

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5.0 SERVICE AND REPAIR INFORMATION

The Chapter provides calibration procedures, service diagrams, and instructions on how to obtain service and repair assistance.

5.1 SERVICE AND REPAIR ASSISTANCE

It is highly recommended that a non-functioning board be returned to Acromag for repair. Acromag uses tested and burned-in parts, and in some cases, parts that have been selected for characteristics beyond that specified by the manufacturer. Acromag has automated test equipment that thoroughly checks the performance of each board. When a board is first produced and when any repair is made, it is tested, placed in a burn-in room at elevated temperature, and retested before shipment.

Please refer to Acromag's Service Policy Bulletin, or contact Acromag for complete details on how to obtain parts and repair information.

5.2 PRELIMINARY SERVICE PROCEDURE

Before beginning calibration or repair, be sure that all of the procedures in Chapter 2, Preparation For Use, have been followed. The procedures are necessary since the board has jumpers that must be properly configured.

CAUTION
POWER MUST BE OFF BEFORE REMOVING OR INSERTING BOARDS

Note: It has been observed that on occasion, a "boot" program for a disk operating system will "hang" waiting for the VMEbus SYSFAIL* signal to be released by an intelligent disk controller board. Acromag's non-intelligent slave boards assert the SYSFAIL* signal as described to the VMEbus Specification Rev. C.1 and therefore, the disk operating system will remain "hung". The best solution to this problem is to correct the boot program so that it is no longer dependent upon the SYSFAIL* signal. When this solution is not practical, it is possible to disconnect the SYSFAIL* from the circuitry on the Acromag board by cutting pin 8 of U18 on the component side. Discard pin. Caution should be exercised so as not to cut any other foils nor damage the board in any other way. Call Acromag's Applications Engineering Department for assistance.

5.3 CALIBRATION PROCEDURE

The Analog Output Board is calibrated at the factory and, under normal circumstances, additional adjustment in the field should not be required, reasonable care should be taken to insure the quality and integrity of the adjustments.

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The following equipment is required to perform the calibration procedures.

A. Precision Digital Voltmeter
B. Precision 500 ohm (±.012%) resistor

For calibrating a AVME9215 Current Output Board, a 500 ohm load resistor should be placed across the output and the voltage across the load should be measured with a precision digital voltmeter.

For calibrating a AVME9210 Voltage Output Board, no load resistor is required. Simply connect the digital voltmeter across the output of the channel to be calibrated. The voltage output Board comes calibrated from the factory in the bipolar, ±10v, range. Some users may wish to operate in one of the four other output ranges. Set the range select jumper in the range desired before calibration.

Configure the Analog Output Board for straight binary. Write 0000H to the DAC and, using the table below, adjust the offset potentiometer until the correct OFFSET value is obtained. Write FFFH to the DAC and, using the table below, adjust the span potentiometer until the correct SPAN value is obtained. Repeat both adjustments until the correct values are obtained.

RANGE	OFFSET	SPAN	TOLERANCE
+-10V	-10.0V	9.9951V	0.00244V
+-5V	-5.0V	4.9976V	0.00122V
+-2.5V	-2.5V	2.4988V	0.00061V
0-10V	0.0V	9.9976V	0.00122V
0-5V	0.0V	4.9988V	0.00061V
4-20MA	4mA	19.9961MA	1.95uA

5.4 REPLACEMENT PARTS

The replacement parts list is provided as an aid to the user in troubleshooting the board. Replacement parts and repair services are available from Acromag. If parts are replaced in the analog circuitry, recalibration may be required. If repair is necessary in this circuitry, it is highly recommended that the board be returned to Acromag for repair and recalibration.

Changes are sometimes made to improve the product, to facilitate delivery or to control cost. It is therefore important to include the reference number, the card model number, the Acromag part number, and the card serial number when providing information to order parts. Table 5.1 is a Replacement Parts list for both Analog Output Board models. Table 5.2 covers only those parts specific to the AVME9210 Voltage Output Board and Table 5.3 covers only those parts specific to the AVME9215 Current Output Board.

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TABLE 5.1
REPLACEMENT PARTS LIST (BOTH MODELS)

REFERENCE NUMBER	ACROMAG PART NO.	DESCRIPTION
R12	1006-518	15 OHM
R14	1006-943	402K OHM
R15	1000-869	1.5M OHM
R16,17	1100-145	10K OHM
R20,22	1000-839	4.7K OHM
R21	1100-490	1K NETWORK
R23,24	1100-493	68 OHM NETWORK
R25,26	1100-492	33 OHM NETWORK
R27,28	1006-051	33.2 OHM
R29,30	1000-802	3.9 OHM
R31	1006-765	5.62K OHM
R32	1000-811	22 OHM
C4	1002-442	0.01uF
C5	1002-428	100pF
C6,51,52	1002-319	3.3uF
C9-18,24-39, 48,49,55-59	1002-530	0.1uF
C19,20	1002-430	220pF
C22	1002-313	68uF
C47	1002-438	0.001uF
C50	1002-312	22uF
C53,54	1002-321	10uF
C60	1002-320	1uF

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CONTINUED TABLE 5.1
REPLACEMENT PARTS LIST (BOTH MODELS)

U2	1033-656	DAC80-CBI-V
U3,4,5,12	1033-657	74LS175
U7	5016-247	PROGRAMMED PART
U8	5016-248	PROGRAMMED PART
U9	5016-249	PROGRAMMED PART
U10	1033-297	74LS645
U11,13	1033-273	74LS244
U14	1033-658	74LS164
U16	1033-626	25LS2521
U17	5016-250	PROGRAMMED PART
U18	1033-623	74F38
U19	1033-670	74LS174
U20	1033-323	4047
U21	1033-146	4069
U22	1033-222	78M15
U23	1033-234	79M15
D11	1001-165	GREEN LED
D12	1001-166	RED LED
D15,16	1001-091	1N4744
D17-20	1001-167	FAST RECOVERY DIODE
Q4,5	1023-116	BUZ71A
Q6	1023-094	TIP30
Q7	1023-087	TIP31
F1	1030-471	10 AMP
L1	1016-061	1uH
T1	1014-092	POWER XFMR

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TABLE 5.2 AVME9210
VOLTAGE OUTPUT BOARD SPECIAL PARTS

REFERENCE NUMBER	ACROMAG PART NO.	DESCRIPTION
R11	1100-334	ZERO OHM
C7	1002-428	100pF

TABLE 5.3 AVME9215
CURRENT OUTPUT SPECIAL PARTS

REFERENCE NUMBER	ACROMAG PART NO.	DESCRIPTION
R1	1100-338	50 OHM
R2	1006-693	1K OHM
R3	1006-722	2K OHM
R4	1006-769	6.19K OHM
R5	1110-271	232 OHM
R6	1008-831	27.4K OHM
R7	1100-446	2.8K OHM
R8	1006-760	4.99K OHM
R9	1110-585	9.09K OHM
R10	1006-896	130K OHM
R13	1006-909	178K OHM
R18	1100-105	130 OHM
R19	1006-701	1.21K OHM
R33	1000-831	1K OHM
C1	1002-430	220pF
C2,3	1002-428	100pF
C41,42,45,46	1002-530	0.1uF
C8,43	1002-319	3.3uF
C23	1002-297	4.7uF
C40	1002-438	0.001uF
C61,62	1002-442	0.01uF
U1	1033-519	LF412
U6	1033-512	LM329
U15	5016-246	PROGRAMMED PART
Q1	1023-046	2N4036
Q2	1023-089	MPS6534
Q3	1023-109	VN10KM
D1,6	1001-113	1N914B
D2-5	1001-116	RED LED
D9	1001-083	1N823

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5.5 SERVICE AND REPAIR ASSISTANCE

If it is determined that parts need to be replaced, it is highly recommended that the card be returned to Acromag for repair. Acromag uses tested and burned-in parts, and in some instances, parts have been selected for characteristics beyond that specified by the manufacturer. Acromag has automated test equipment that thoroughly checks the performance of each card. When a card is first produced and when any repair is made , it is tested, placed in a burn-in room at elevated temperatures , and retested before shipment.

Please refer to Acromag's Service Policy Bulletin or contact the factory for complete details on how to obtain parts and service.

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6.0 SPECIFICATIONS

The following specifications are for 25C ambient temperature and nominal power supply levels unless otherwise noted.

6.1 GENERAL SPECIFICATIONS

Operating Temperature	0 to 70C
Storage temperature	-25 to 85C

Physical Characteristics

Length	9.187in.(223.3mm)
Width	6.299in.(160mm)
Board Thickness	0.062in.(1.59mm)
Component height	0.55in. (13.97mm)
Recommended Board Spacing	0.8in.(20.32mm)

Mating Connectors

P1	IEC type 603-2 -6096mx-xxx or equiv.
P2	-6064mx-xxx or equiv.

VME BUS LOADING

	input low	output low
A10-A15	-.36mA	20uA
D0-D7	-.1mA	20uA
AM0-AM5,A6-A9,LWORD* IACK*,DS0*,DS1*,WRITE*		
SYSRESET*	-.1mA	40uA
A1-A5, SYSCLK	-.4mA	20uA
D8-D15	-.2mA	20uA

VME BUS DRIVE

DTACK*,SYSFAIL*	64mA(MAX)	----
D0-D7	48mA	-15mA

VME BUS ACCESS TIME . . . . . 390nS typical

(Measured from the falling edge of $\overline{DSx}$ to the falling edge of $\overline{DTACK}$.)

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6.2 AVME9210 VOLTAGE OUTPUT BOARD SPECIFICATIONS

OUTPUT TYPE	NON-ISOLATED
OUTPUT RANGES	±10V, ±5V, ±2.5V, 0-10, 0-5V
NUMBER OF CHANNELS	8 CHANNELS
RESOLUTION	12 BITS
MONOTONICITY OVER TEMP.	12 BITS
NON-LINEARITY	ACCURACY (+10V RANGE) . . 0.025% OF SPAN (max)
(OTHER RANGES)	0.45% OF SPAN (max)**
OUTPUT NOISE	1.5 mVrms in 20MHZ. bandwidth, typical.
OUTPUT DRIVE CURRENT	+5mA
OUTPUT IMPEDENCE	<1 OHM
CAPACITIVE DRIVE CAPABILITY	< 0.01uF without overshoot or ringing

POWER SUPPLY REJECTION

DC	0.0002% FSR/%Vcc
60hz	0.0005% FSR/%Vcc

CHANNEL TO CHANNEL REJECTION	93db

SETTLING TIME TO 1/2 LSB

(20V STEP)	6.0uS
(5V STEP)	1.2uS

RFI/EMI	<0.25% OF FSR @ 27,151, and 467 MHZ (AT 10V/M FIELD INTENSITY)

DEFAULT ON RESET

(unipolar)	0V
(bipolar)	0V or minus full scale

POWER REQUIREMENTS

+5V	3.3A(max)
+12V	0.6mA
-12V	NO LOAD

GAIN TEMPERATURE COEF.	30PPM/C max 15PPM/C typ.
OFFSET TEMPERATURE COEF	10PPM/C max 5 PPM/C typ.

** NOTE: THIS ERROR IS ADJUSTABLE TO 0.025% OF SPAN (see calibration section)

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6.3 AVME9215 CURRENT OUTPUT BOARD SPECIFICATION

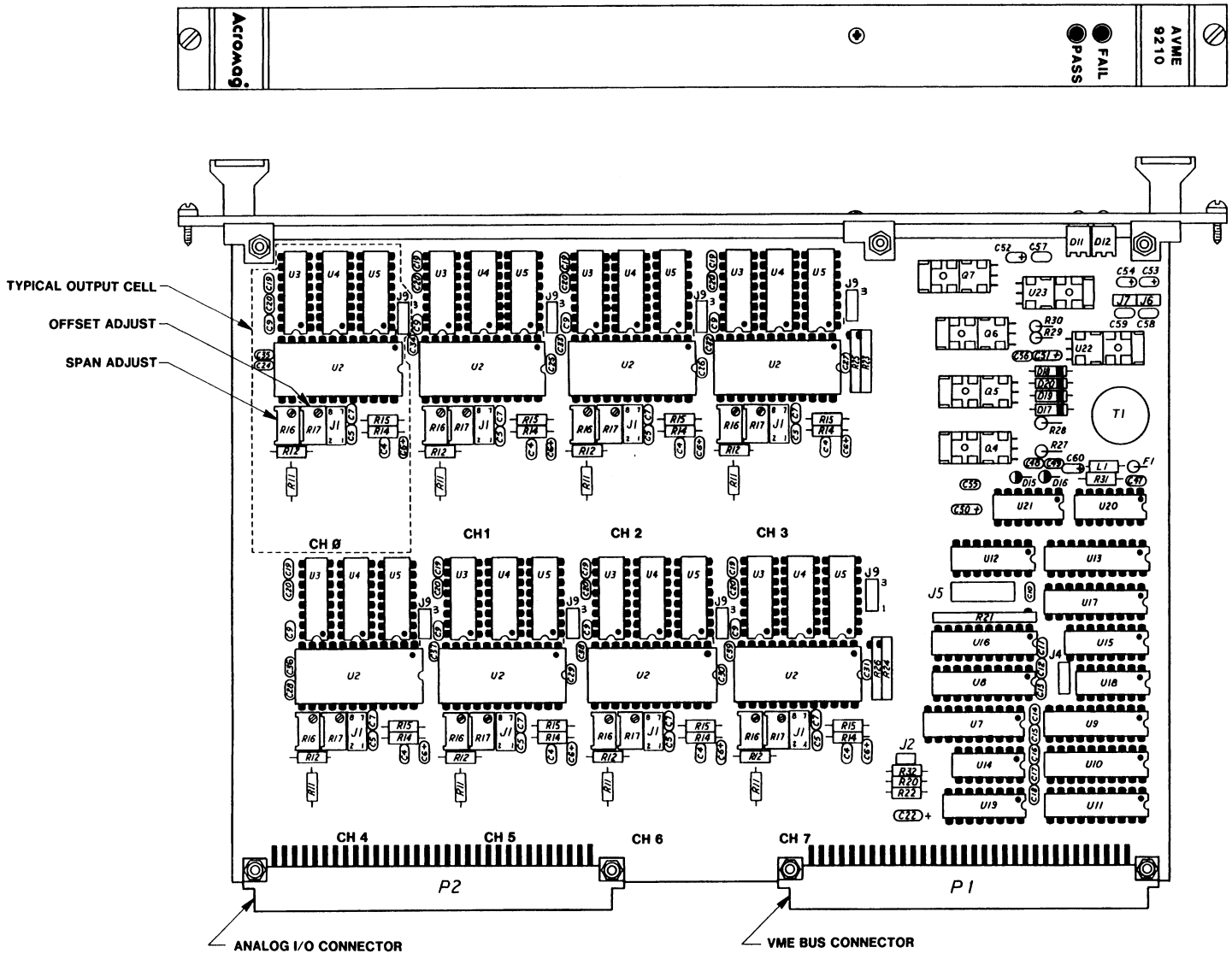
OUTPUT TYPE	NON-ISOLATED
NUMBER OF CHANNELS	8 CHANNELS
RESOLUTION	12 BITS
MONOTONIC OVER TEMPERATURE	12 BITS
OUTPUT RANGES	4 TO 20mA
NON-LINEARITY	0.013% of SPAN
ACCURACY	0.025% of SPAN
OUTPUT NOISE	2uArms in 20MHZ. bandwidth, typical.
SETTLING TIME TO 1/2 LSB (FULL SCALE STEP, 250 OHM LOAD)	25uS
INTERNAL DC SUPPLY	
LOAD VOLTAGE COMPLIANCE	10.5 Volts
LOAD RESISTANCE RANGE	0 TO 525 OHM
EXTERNAL DC SUPPLY (user provided)	
SUPPLY RANGE	15V to 30V
LOAD VOLTAGE COMPLIANCE(SUPPLY=30V)	26V max.
LOAD RESISTANCE RANGE(SUPPLY=30V)	0 TO 1300 OHMS
EXTERNAL POWER SUPPLY REJECTION	0.0018% FSR/%Vcc
ZERO OHM LOAD PROTECTION	CONTINUOUS
DEFAULT ON RESET	4mA
GAIN TEMPERATURE COEF	35PPM/C max. 18PPM/C typ.
OFFSET TEMPERATURE COEF	18PPM/C max. 9 PPM/C typ.
POWER SUPPLY REJECTION	
DC	0.00064% FSR/%Vcc
60Hz	0.00074% FSR/%Vcc
CHANNEL TO CHANNEL REJECTION	81DB (500 ohm load)
POWER REQUIREMENTS	
+5V	4A
+12V	0.6mA
-12V	NO LOAD
EXTERNAL SUPPLY POWER REQUIREMENTS	
MAX 420mA (with cage power off)	
MAX 250mA (with cage power on)	
RFI/EMI	<0.25% OF FSR @ 27,151, & 467 MHZ (at 10V/m field intensity)

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7.0 SCHEMATIC AND PART LOCATION DRAWINGS

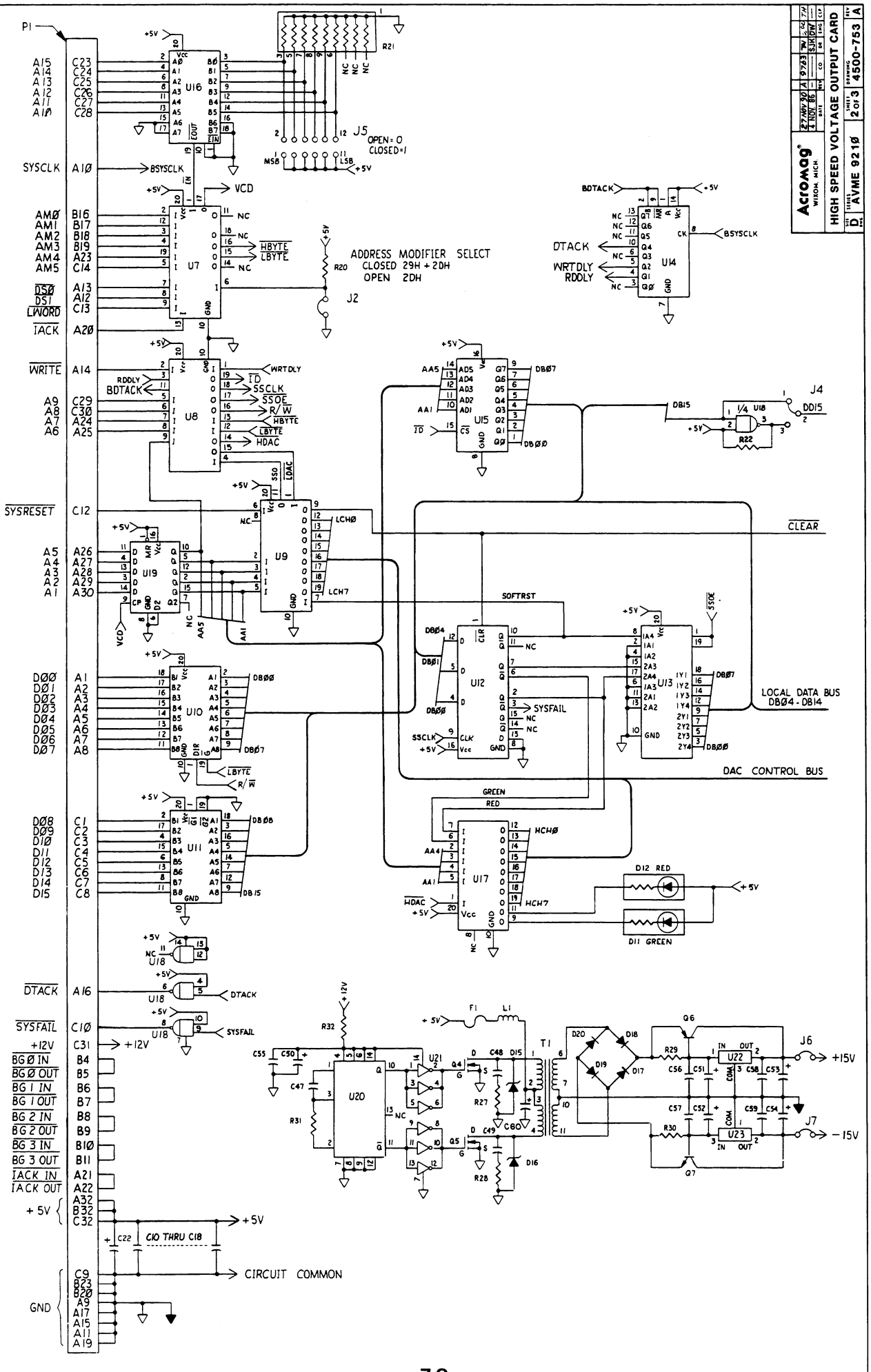
The following sheets contain the schematic and part location drawings for both the 9210 and 9215.

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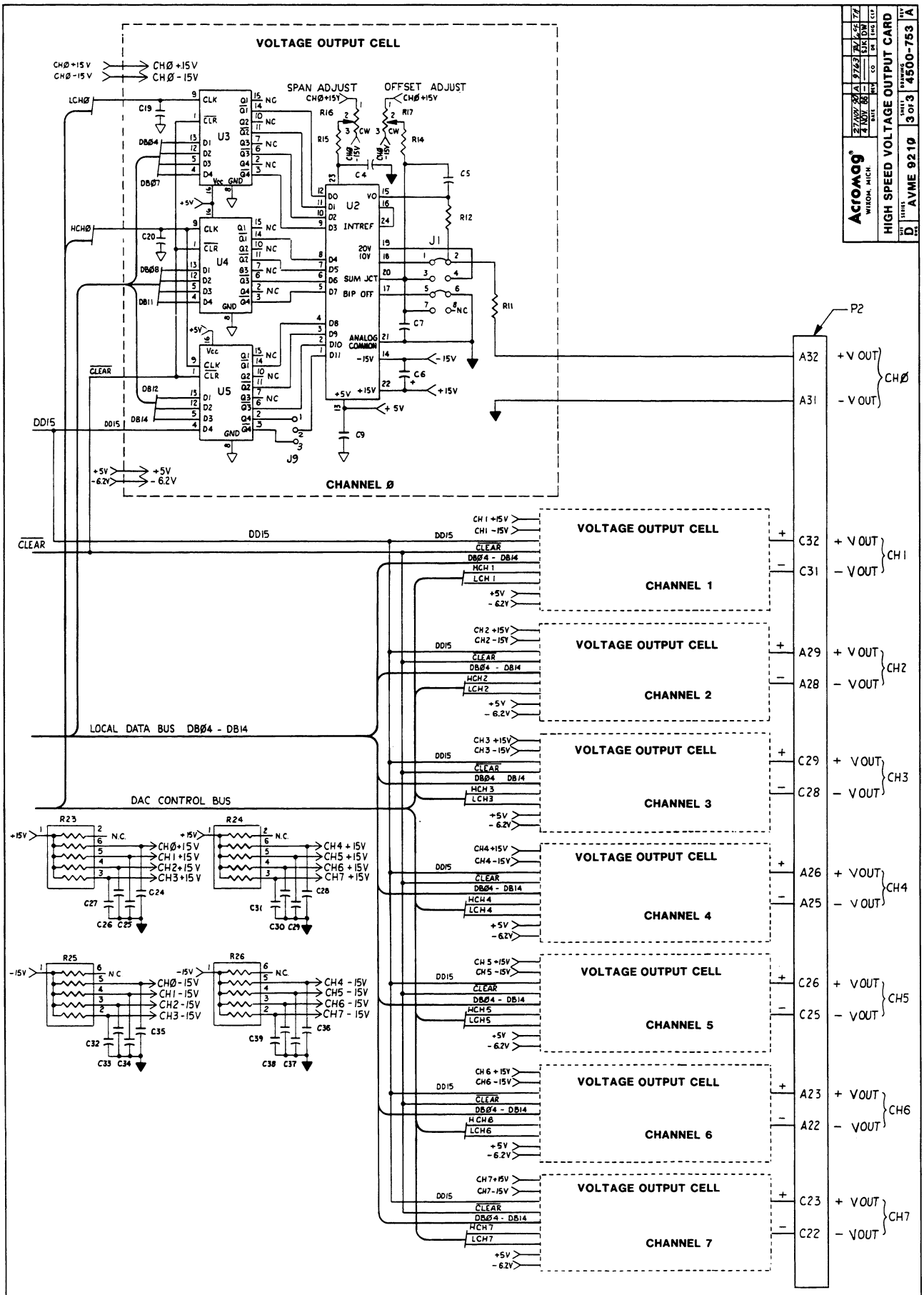


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SIZE D DWG	SCHEM AVME 9210	SHEET 1 OF 3	DRAWING 4500-753	REV A		

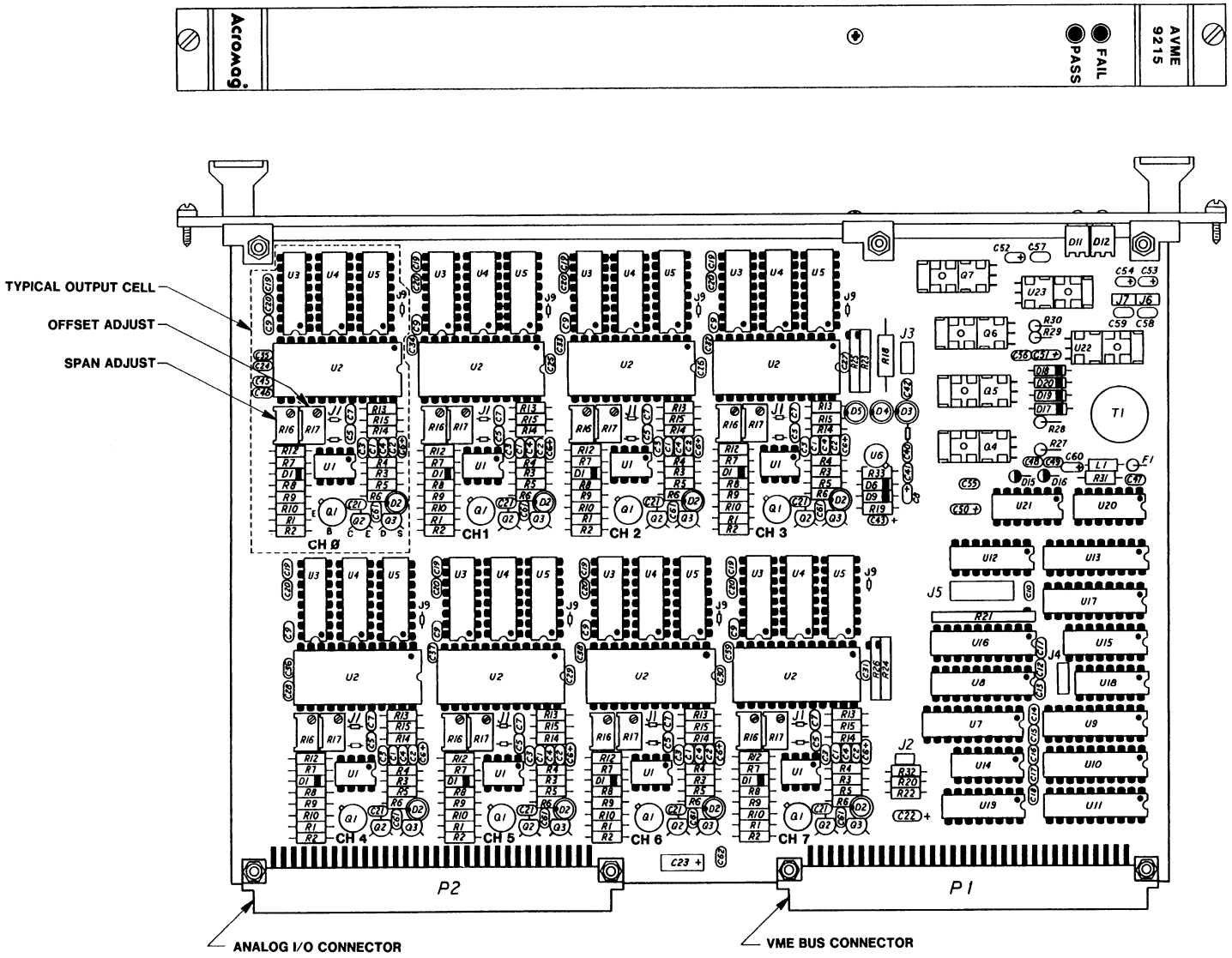
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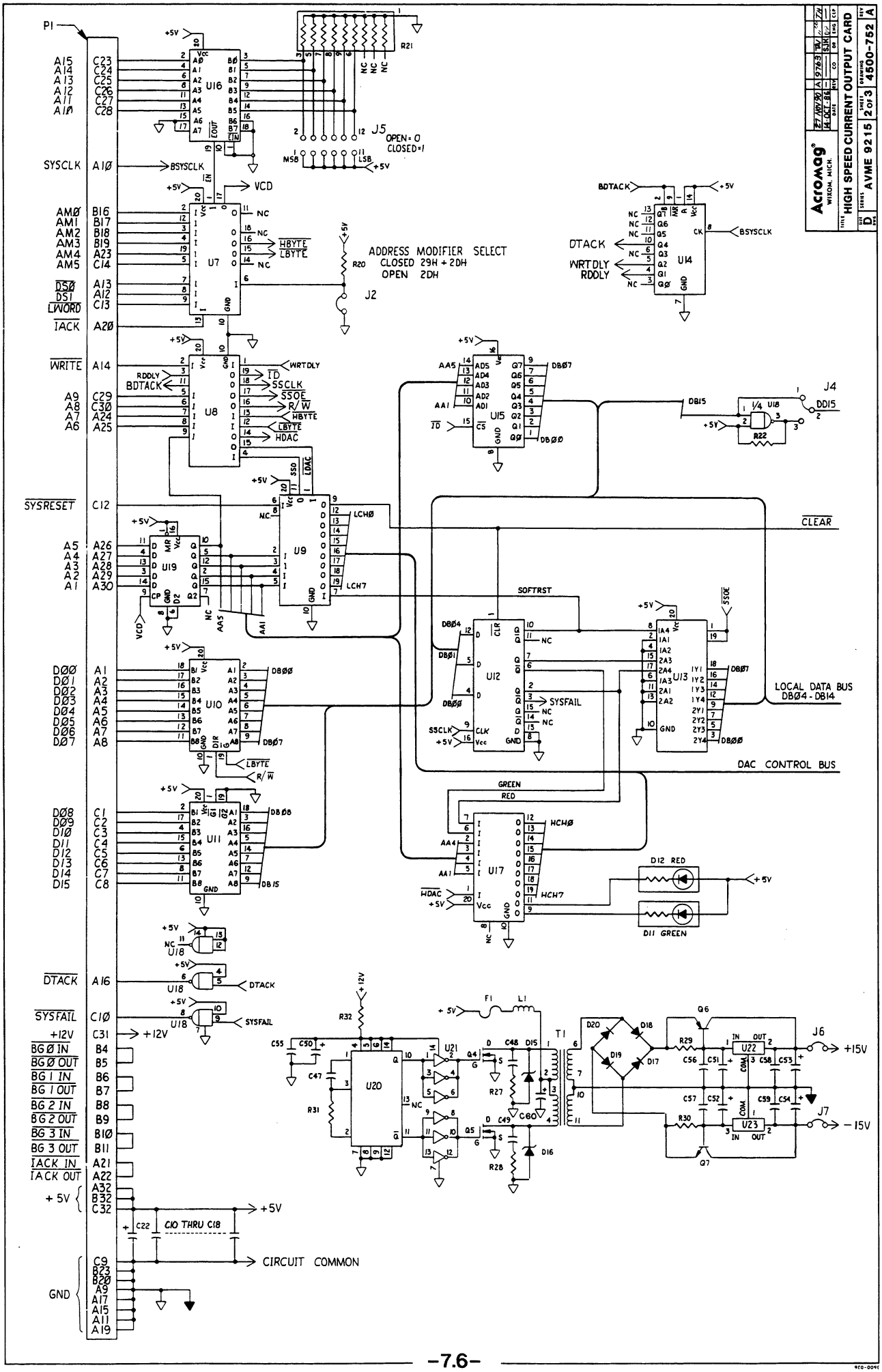


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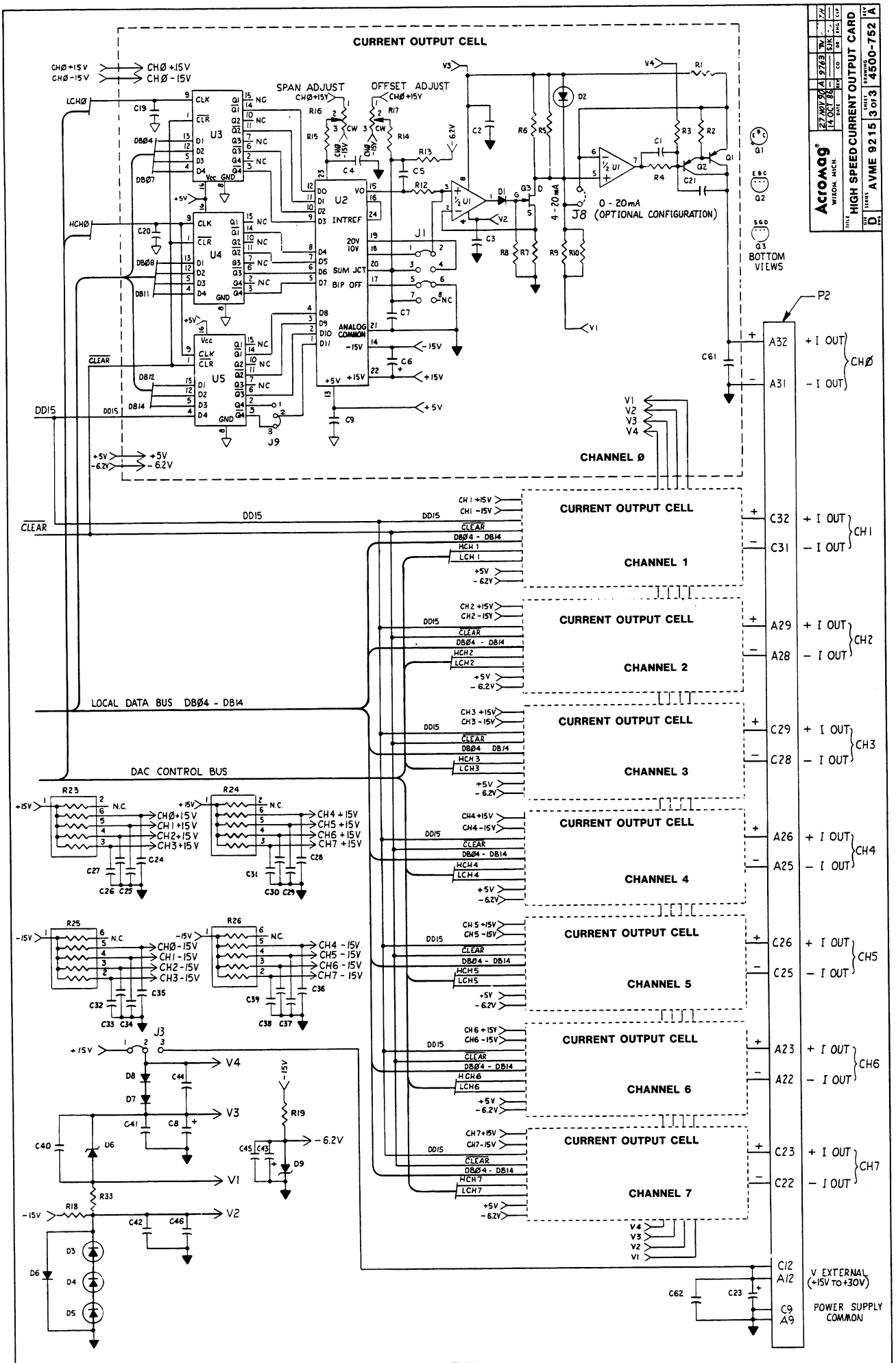


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TITLE: HIGH SPEED CURRENT OUTPUT CARD						
SIZE D	SERIES AVME 9215	SHEET 1 OF 3	DRAWING 4500-752	REV A		

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