INSTRUCTION MANUAL

Sensoray Model 7405
STDbus Analog Output Card

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M A N U A L 4 2 6

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A Return Material Authorization (RMA) number must be obtained from the factory and clearly marked on the outside of the package before any equipment will be accepted for warranty work. Sensoray will pay the shipping costs of returning to the owner parts which are covered by warranty.

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Special Handling Instructions

The Model 7405 board contains CMOS circuitry that is sensitive to Electrostatic Discharge (ESD). Special care should be taken in handling, transporting, and installing the 7405 to prevent ESD damage to the board. In particular:

1. Do not remove the 7405 from its protective antistatic bag until you are ready to install it in your computer.
2. Handle the 7405 only at grounded, ESD protected stations.
3. Always turn off the computer before installing or removing the 7405 board.

Introduction

The Model 7405 board interfaces eight analog output channels directly to the STDbus. Each channel may be independently configured for either voltage or current output. The voltage or current output from each channel is a linear function of that channel's applied digital value.

When programmed for voltage output, a channel will generate a voltage between -10 and +10 volts. Careful attention to circuit design on the Model 7405 makes this voltage range possible, even when powering the STDbus from ±12 volt power supplies.

Upon board reset, all channels are automatically initialized to their appropriate zero-output conditions. Voltage-mode channels default to zero volts out, and current-mode channels reset to four milliamps out.

A 40-pin flat cable connector is provided for making connections to the analog output channels. The connector may be wired to an optional Sensoray Model 7409TB or 7409TC screw termination board, or to a termination system customized for the target application.

Two STDbus I/O addresses are occupied by the Model 7405. These two consecutive addresses may be mapped anywhere in the STDbus eight-bit I/O address space.

Specifications

Specification	Value
Input power (excluding output drive)	±12.0 to ±15VDC, 80mA max. +5.0VDC, 100mA max.
Operating temperature	-25°C to +85°C
D/A resolution	12 bits
Channel update rate	20KHz, min. (single channel rate)
Output linearity error	0.03%, max.
Analog output modes	Voltage out: ±10V Current out: 4 to 20 mA

Hardware Configuration

The Model 7405 requires the installation of programming shunts to select various options such as I/O port addresses and channel operating modes. This section describes these configuration options.

After configuring the option shunts, the Model 7405 may be installed in your STDbus backplane and programmed as explained in the *Programming* section of this manual.

Both *board address* and *channel output types* are established by installing programming shunts at various locations on the board. In all of the following discussions of shunt programming, *I* denotes an installed programming shunt and *R* indicates that no shunt is installed:

Symbol	Meaning
I	Shunt installed
R	Shunt removed

Defaults

All option jumpers are set to a standard default configuration at the factory. If the default configuration is consistent with your application, you may be able to use the board without having to reconfigure any jumpers.

Attribute	Default
I/O base address	0xB2
I/O Space	Primary
Analog channel mode	Voltage out

I/O Space

Two separate I/O spaces exist on the STDbus: *primary* and *expanded*. Option jumper **E8** selects which I/O space the Model 7405 board will reside in. E8 is factory set to map the board into primary space.

E8	I/O Address Space
I	Primary
R	Expanded

I/O Port Mapping

The Model 7405 occupies two consecutive 8-bit addresses in the selected STDbus I/O address space. These ports may be mapped to any even address from 0x00 to 0xFE. Jumpers are factory installed to locate the board at ports 0xB2 and 0xB3.

The following tables show the jumper configurations for all possible board addresses. Use the table on the left for the most significant address nibble, and the table on the right for the least significant address nibble.

E7	E6	E5	E4	Val
I	I	I	I	0
I	I	I	R	1
I	I	R	I	2
I	I	R	R	3
I	R	I	I	4
I	R	I	R	5
I	R	R	I	6
I	R	R	R	7
R	I	I	I	8
R	I	I	R	9
R	I	R	I	A
R	I	R	R	B
R	R	I	I	C
R	R	I	R	D
R	R	R	I	E
R	R	R	R	F

E3	E2	E1	Val
I	I	I	0
I	I	R	2
I	R	I	4
I	R	R	6
R	I	I	8
R	I	R	A
R	R	I	C
R	R	R	E

Channel Mode

Each channel has three *mode control* option jumpers, used to select either voltage or current output mode. A channel's mode control jumpers work as a set. For any given channel, either *all* jumpers should be installed or *all* should be removed. A jumper set should be <u>installed</u> to configure the associated channel for current output. Conversely, the jumper set should be <u>removed</u> to configure the channel for voltage output.

Channel	Jumper Set		
0	A0	B0	D0
1	A1	B1	D1
2	A2	B2	D2
3	A3	B3	D3
4	A4	B4	D4
5	A5	B5	D5
6	A6	B6	D6
7	A7	B7	D7

For example, jumpers A3, B3 and D3 must all be installed to configure channel 3 for the 4-20mA current output mode. Jumpers A7, B7 and D7 must all be removed to configure channel 7 for the ±10 volt output mode.

Programming

Programming of the Model 7405 is accomplished by means of three STDbus interface registers. One register is used to let the host processor know when new data may be sent to the board. The other two registers receive a combination of channel number and analog channel data from the host.

Programming Model

The Model 7405 board occupies two contiguous I/O ports in the STDbus I/O space. Both ports may be written to, and the base port has a read function as well.

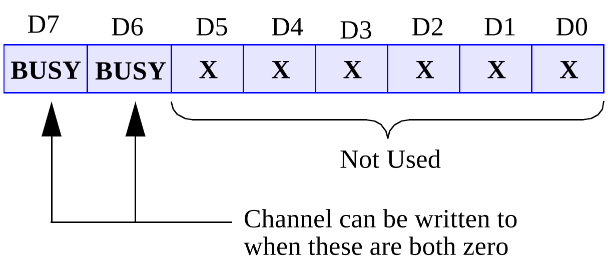
I/O Address	Function	
	Read	Write
Base Address + 0	Status Register	A Register
Base Address + 1	(not used)	B Register

Analog output data and channel number is written to the A and B registers, while the status register is used by the host processor for handshake control.

Note that the status register and A register share the same I/O port address. This is possible because the status register is *read only* while the A register is *write only*.

Status Register

The status register provides the host with a means for monitoring Model 7405 handshake status. When the host reads from the status port, a byte with the following form is returned:



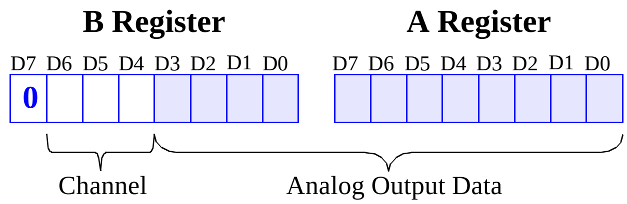
The status register contains two **BUSY** bits that are used to handshake data onto the Model 7405 board. When both bits are reset to logic 0, the board is ready to accept new data. The remaining six bits are not used and should be ignored.

Prior to writing new data to the board, the host must read and test the two BUSY bits. The host should write data to the board <u>only</u> when both BUSY bits contain logic 0.

Although this handshake rule is simple, *failure to observe it will most likely result in communication errors*.

Data Registers

Analog channel data may be written into the A and B registers after ensuring that the status register handshake bits are both reset to logic 0.



First the low data byte is written into the A register. Then the B register is loaded with the high data nibble and channel number.

Data Format

The analog channel data format is a function of the selected output mode. Voltage mode employs a format different from that of current mode. This table illustrates the relationship between channel data value and signal output:

Data Value (Hexadecimal)	Voltage Mode Output (V)	Current Mode Output (mA)
000	-10.000	4.0000
001	-9.9951	4.0039
002	-9.9902	4.0078
...		
7FF	-0.0049	11.996
800	0.0000	12.000
801	+0.0049	12.004
...		
FFE	+9.9902	19.996
FFF	+9.9951	20.000

Connections

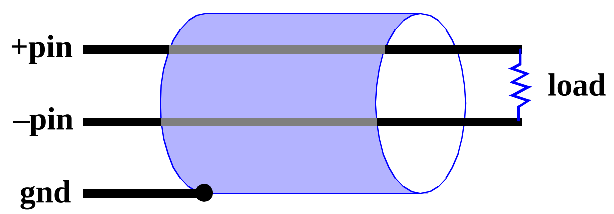
All output loads are connected to the Model 7405 through 40-pin flat cable connector P1. Optionally, loads may be connected to the Model 7405TB screw termination board, which in turn connects to P1 by means of flat ribbon cable.

Each channel has four dedicated pins on connector P1. Two of the pins are used only in the voltage output mode, and the other two only in current output mode. In addition, ground is supplied on connector P1 pin 38 for use as a cable shield.

A channel circuit may be wired in one of two ways, depending on the selected output mode (voltage versus current). The following table specifies the proper connector P1 pins to be used:

Chan	Voltage Mode Pin		Current Mode Pin	
	+	-	+	-
0	2	4	1	3
1	6	8	5	7
2	10	12	9	11
3	14	16	13	15
4	18	20	17	19
5	22	24	21	23
6	26	28	25	27
7	30	32	29	31

Channel connections should be made as illustrated in the following diagram, regardless of the selected channel output mode.



Calibration

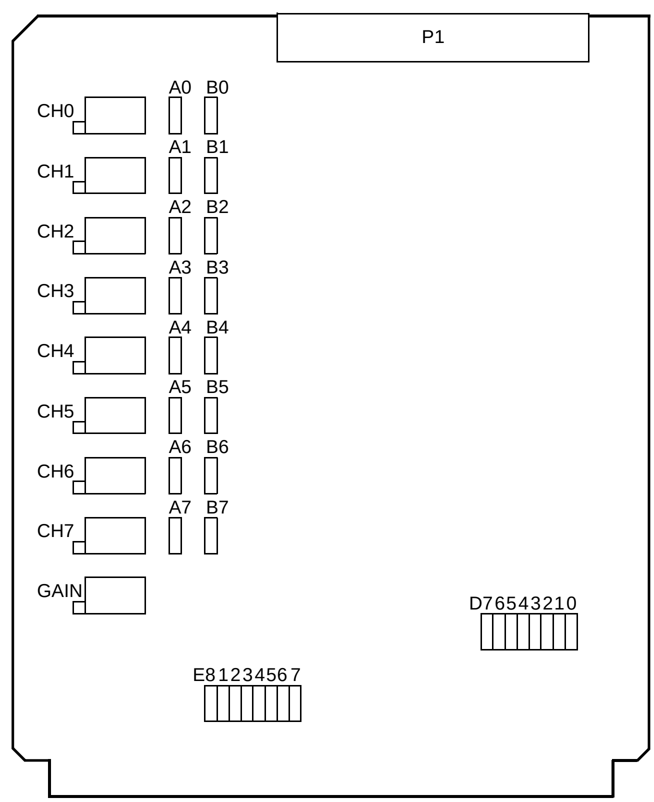
Although the 7405 analog section is factory calibrated at Sensoray, you may find that a periodic calibration is in order to compensate for circuit drift over time. The board contains nine trimpots in all, one offset trim for each channel and one gain trim that is common to all channels.

The general strategy for board calibration is to first adjust the gain trimpot, followed by the individual channel offset adjustments. It is important that the final offset adjustments be performed *after* configuring the channels for their target operating modes.

Procedure

1. Configure analog channel 0 for voltage output mode by removing programming shunts at A0, B0 and D0.
2. Connect a precision voltmeter to the channel 0 voltage outputs. Connect the positive lead to P1 pin 2, and the negative lead to P1 pin 4.
3. Set analog channel 0 output to 0 volts by programming the channel data value to 800 hex.
4. Adjust the channel 0 offset trimpot until the voltmeter reads 0 volts.
5. Set analog channel 0 output to -10 volts by programming the channel data value to 000 hex.
6. Adjust the gain trimpot until the voltmeter reads -10 volts.
7. Configure the output modes of all eight channels as required by your application.
8. For each voltage channel, connect the meter to the channel *voltage* output pins on connector P1. Set the output to 0 volts by programming the channel data value to 800 hex. Adjust the channel offset trimpot until the meter displays 0 volts.
9. For each current channel, connect a precision milliammeter across the channel's *current* output pins on connector P1. Set the output to 4 mA by programming the channel data value to 000 hex. Adjust the channel offset trimpot until the meter displays 4 mA.

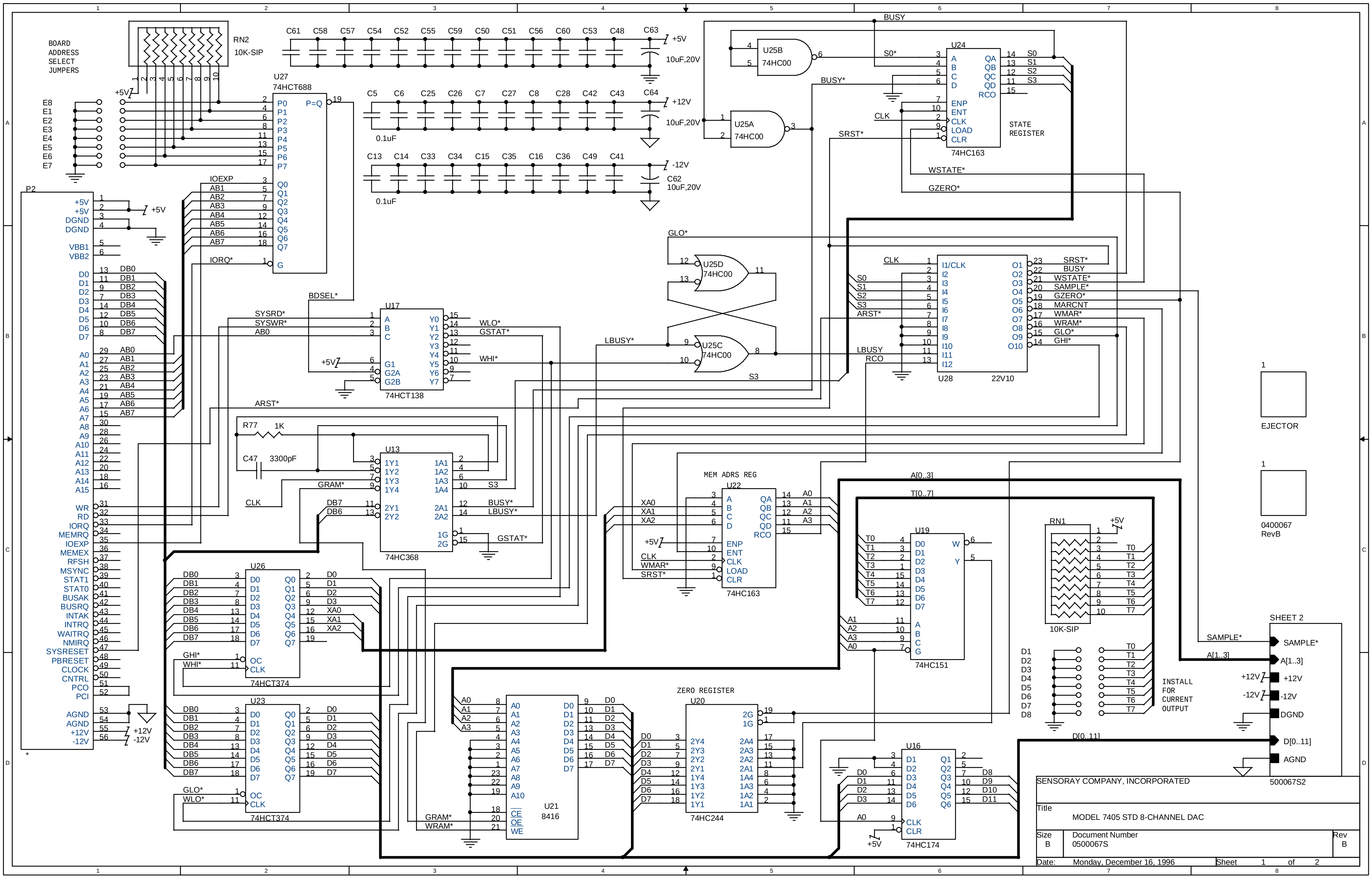
Board Layout



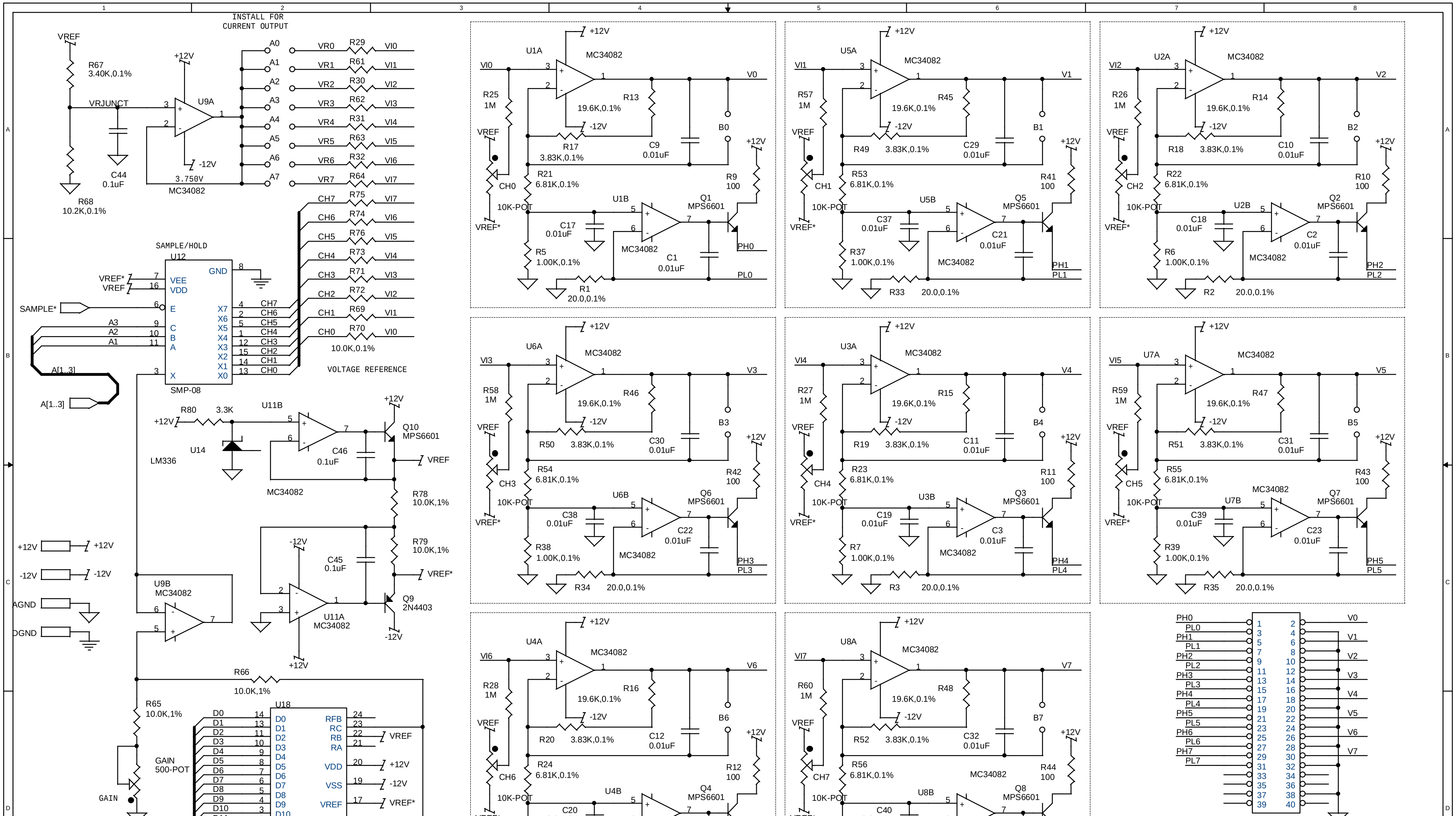
Sample Drivers

These sample driver functions, written in C/C++, assume that all channels are configured for the voltage output mode. With minor modification, these drivers can be made to work with channels that are set up for current output mode operation.

```
#define BUSY 0xC0        // Handshake status bit mask

typedef unsigned char UCHAR;

UCHAR InByte( UCHAR address )
{
     // INSERT CODE HERE THAT WILL RETURN A VALUE FROM AN 8-BIT I/O PORT
}

void OutByte( UCHAR address, UCHAR value )
{
     // INSERT CODE HERE THAT WILL WRITE A VALUE TO AN 8-BIT I/O PORT
}

void WriteVoltage( UCHAR baseport, UCHAR channel, double volts )
{
     // Limit voltage to legal values.
     double voltage = (volts > 9.995) ? 9.995 : ( (volts < -10.0) ? -10.0 : volts );

     // Convert voltage value to binary value suitable for DAC.
     short value = (short)( 2048 + voltage * 204.8 );

     // Wait until Model 7405 board is ready to accept data.
     do {} while ( InByte(baseport) & BUSY );

     // Write binary value to Model 7405 board.
     OutByte( baseport, value & 0xFF );
     OutByte( baseport + 1, ((channel << 4) & 0x70) | ((value >> 8) & 0x0F) );
}
```



SENSORAY COMPANY, INCORPORATED
Title
MODEL 7405 STD 8-CHANNEL DAC
Size B
Document Number 0500067S
Rev B
Date: Monday, December 16, 1996
Sheet 1 of 2
BOARD ADDRESS SELECT JUMPERS
RN2 10K-SIP
U27 74HCT688
P2
U17 74HCT138
U13 74HC368
U26 74HCT374
U23 74HCT374
U21 8416
MEM ADRS REG U22 74HC163
ZERO REGISTER U20 74HC244
U19 74HC151
U16 74HC174
RN1 10K-SIP
INSTALL FOR CURRENT OUTPUT
U25A 74HC00
U25B 74HC00
U25C 74HC00
U25D 74HC00
U24 74HC163 STATE REGISTER
U28 22V10
EJECTOR
0400067 RevB
SHEET 2
500067S2



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Title	MODEL 7405 STD 8-CHANNEL DAC		
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