MSXB084 / MSXB085 / MSXB086 Signal Interface Module Manual

Isolated Analog Input/Output Module

Version 1.01

Microstar Laboratories, Inc.

Contents

Introduction

The Isolated Analog Input Expansion Modules, part numbers MSXB084, MSXB085, and MSXB086, have the following features:

- sixteen differential voltage inputs of +/-10V at 16-bit resolution for MSXB084 and MSXB085, current inputs of 4 – 20 mA at 16-bit resolution for MSXB086

- 300V channel-to-ground isolation

- maximum aggregate sample rate of 333k samples per second

- software selectable gains of 1, 2, 5, and 10 per channel

- two isolated analog outputs on the MSXB085

A maximum of eight isolated modules can be connected to one DAP board for 128 inputs and 16 outputs.

The MSXB084/MSXB085/MSXB086 modules are part of the signal interface modules by Microstar Laboratories. The other modules include isolated digital I/O and isolated analog outputs. Contact your Microstar Laboratories representative for more details.

Hardware Architecture

System Configuration

The backplane model of the isolated module connects directly to the digital backplane (MSXB034 or MSXB035) of an industrial enclosure or a DAPserver. This allows one or more MSXB084/MSXB085 modules, or other signal interface modules, to be installed in an industrial enclosure and be connected to one DAP board. The digital interface board (MSXB033) in the enclosure then connects to the DAP board via a MSCBL076-01 and MSCBL054.

Other models may be available. Contact your Microstar Laboratories representative to determine all available models.

Note: The backplane model of the module should not be connected or disconnected to the digital backplane while the digital backplane is powered.

Power Requirements

The isolated analog module typically requires 30 mA at +5 Volts DC. The Data Acquisition Processor can typically supply 1.5A to 2.0A at +5 Volts. The total power consumption of all expansion modules must not exceed the power availability of the Data Acquisition Processor. Please refer to the hardware documentation of the Data Acquisition Processor for more specific power availability information. If the total power consumption exceeds the power availability of the Data Acquisition Processor, then external power must be used.

Isolation

The design of the isolated analog module specifies 300V of board-to-ground isolation. The inputs and outputs of the module are isolated from the ground of the DAP board. The isolation better protects the analog inputs from noise and eliminates ground loops.

Input and Output Specifications

The input range to the MSXB084 and MSXB085 is +/-10V and to the MSXB086 is 4 – 20 mA. For the MSXB085 with two analog outputs, the default range is +/-10V. The output current should not exceed 1mA per channel. If the output range of +/-5V is selected (via the utility program), the resolution is reduced to 15-bit.

Note: If the output current exceeds maximum ratings, damage to the signal interface module may occur.

Board Layout

The isolated analog modules are 3U modules measuring 100 mm by 220 mm, or 3.93" by 8.78". The following diagrams show the layout of the signal interface modules.
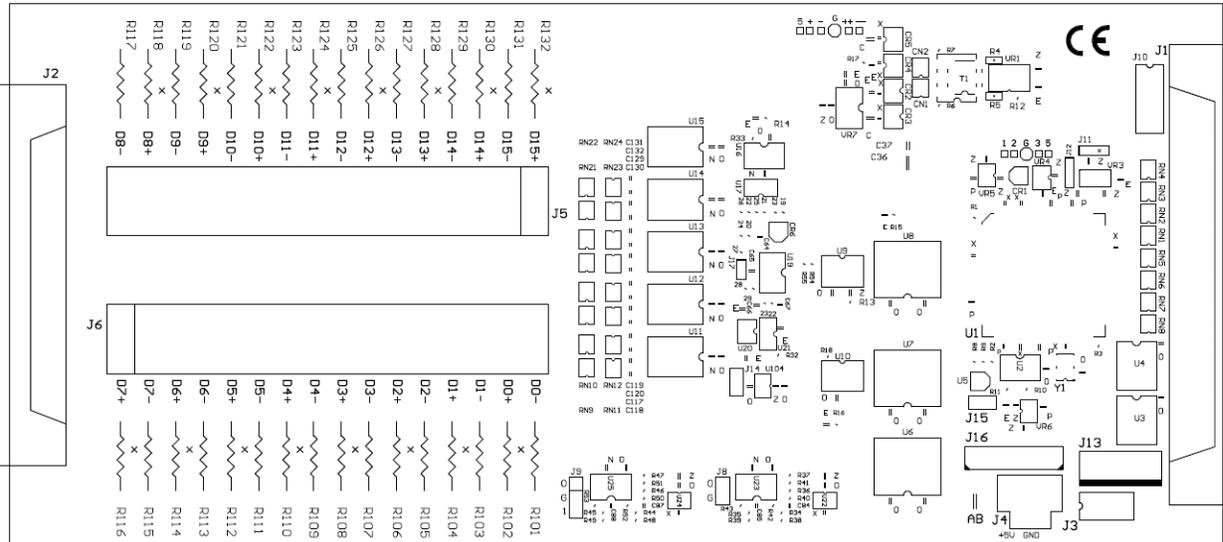
Figure 1. Layout of the isolated analog module
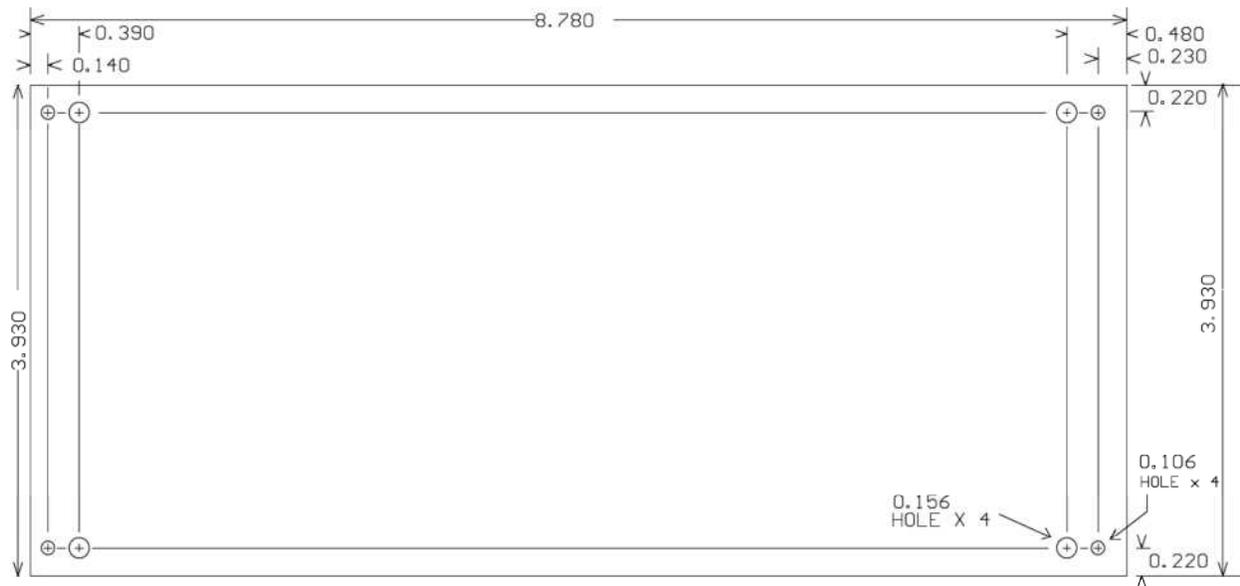
Figure 2. Dimensions of the module

Input/Output Connector Options

Input/output signals can be connected to the isolated analog module via the DB37 male connector at J2 or two Wago terminal blocks J5 and J6. Each module is built with either option. The pinout of the DB37 input/output connector (looking into the connector) is shown below. For the MSXB084 and MSXB086, pins 17, 18, 36, and 37 for the two outputs are not connected.

The DB37 male connector mates with the discrete wire cable kit, part number MSCBL092-01K.

J2

D0-	20	
D1-	21	
D2-	22	
D3-	23	
D4-	24	
D5-	25	
D6-	26	
D7-	27	
D8-	28	
D9-	29	
D10-	30	
D11-	31	
D12-	32	
D13-	33	
D14-	34	
D15-	35	
DAC1G	36	
DAC0G	37	

1	D0+
2	D1+
3	D2+
4	D3+
5	D4+
6	D5+
7	D6+
8	D7+
9	D8+
10	D9+
11	D10+
12	D11+
13	D12+
14	D13+
15	D14+
16	D15+
17	DAC1
18	DAC0
19	Reserved
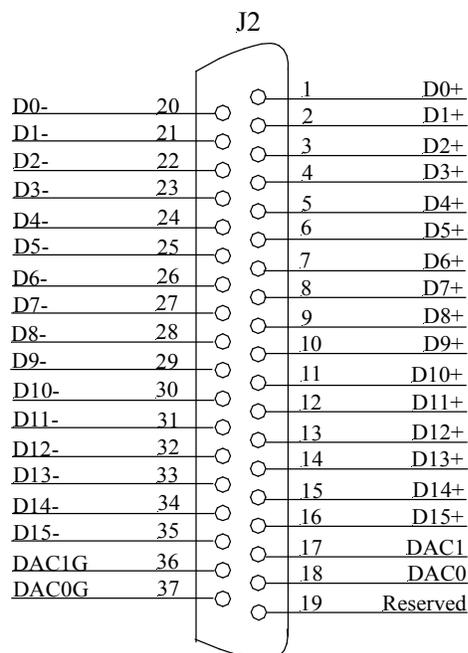
Figure 3. Pinout of the 37-pin input/output connector

Software Configuration

The isolated analog modules are configured by the configuration utility. The parameters are listed below:

- Module ID

- Gains

- Channel list

- Addresses – input, scan, sampling, and output

The utility is available for download at www.mstarlabs.com. Refer to the utility manual for more information on the interface.

Hardware Setup

To configure an isolated analog module, it should be connected to a DAP board that has been installed with Accel32 or DAPcell Server. A new module needs to be initialized by using the configuration utility to add it by its serial number. Refer to the utility manual for instructions.

Module ID

Each module must have a unique Module ID ranging from 1 to 254. The Module ID is used to configure the input and output addresses with the utility program. It can be changed using the utility program. The default Module ID is 255 and the module needs to initialized before it is detected. If two or more modules have the same Module ID, the results are unspecified.

Gains

The isolated analog modules have a gain amplifier for each of the eight inputs; the gain is selectable per input. The valid gains are 1, 2, 5, and 10, with the unity gain as the default. The gains are specified at the configuration utility. Each input can be sampled at different gains if it is specified multiple times in the channel list. See the next section on channel list.

Channel List

A channel list is the list of selected inputs in the sequence at which they should be sampled. By default, each read operation of the input address of an isolated analog module returns a value from one input in the channel list in sequence, as long as the scan address (described later) has not been read. The configuration utility allows the selection of only the inputs that should be returned to the PC. **The number of input pipes sampled in the DAPL configuration must be the same as the number of channels in the channel list.**

The configuration utility in Figure 4 shows a channel list of 15 channels and the sampling sequence.
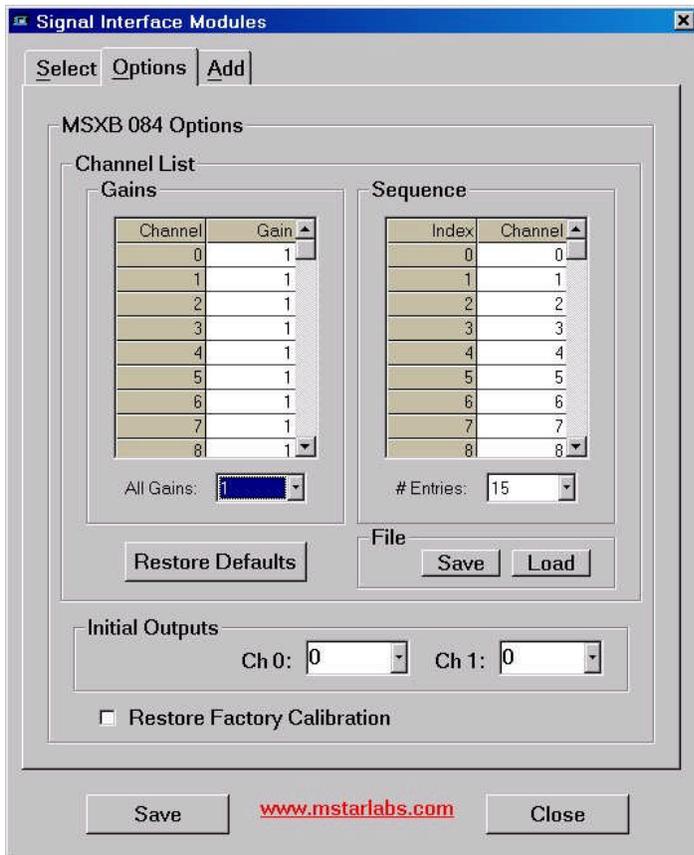
Figure 4. Channel list of a MSXB085 module.

The selection for '# Entries' specifies the number of channels in the sequence. The isolated analog I/O module has sixteen inputs in hardware and it can sample an input more than once through the channel list. The figure above shows a list of fifteen channels. The '# Entries' can go up to 64.

Note that some inputs are sampled multiple times at different gains. The corresponding values are returned according to the sequence specified in the channel list.

Input Address

Each isolated analog input module should have a unique input address; no two modules can have the same input address. The input address is used for the sixteen inputs per module. In a DAPL configuration, each operation reading from the input address obtains one data value from the channel list specified in the configuration utility. The default input address is B1.

A maximum of eight modules can be connected to one DAP. If more than eight MSXB085 modules are connected to the DAP board, the modules not being used for inputs must have their input expansion disabled in the configuration utility program.

Using the module with older analog input boards

If the isolated analog module is used in a system with analog input board(s) connected to the analog I/O port of the same DAP board, avoid using the address B0 as the input or sampling address. When the DAP board samples the analog port, it clears the digital input expansion lines, which causes B0 to sample its inputs.

Scan Address

An isolated analog input module should have a scan address between B1 and B7. When the DAP reads the scan address, the module resets its channel list. The scan address should be read at a minimum time interval of 3.0 microseconds. The default scan address is B7.

When the system has only one module, the scan address must be different from the input address because it is the transition to the scan address that causes the reset. If the two addresses are the same, there is no transition to the scan address and thus no reset of the channel list. The single module must be selected to return an input channel for the scan address (i.e. Sample Returns Input checked). If the system has multiple modules, the modules should have the same scan address and the scan address can be the same as one of the input addresses.

For the module that is selected to return an input channel for the scan address (i.e. Sample Returns Input checked), it returns a data value to the DAP board when the scan address is read, as well as when its input address is read. Since reading the scan address returns one channel for that module, its input address should be read one time fewer than the number of channels in the channel list. The examples in the DAPL Configuration section illustrate the different hardware settings.

The module has a pipeline delay of one to two scan. The data from the first two passes through the input pipe list in the DAPL input definition should be discarded because they might not be valid data. See example #1 in the DAPL Configuration section.

Sampling Address

If the system has more than one isolated analog input module, the modules with the same sampling address are sampled simultaneously. Assuming the channel lists have the same number of channels, the nth channels on the lists are sampled simultaneously. The default value is OFF.

Output Address for MSXB085

Each MSXB085 module should have a unique output address range. It uses two ports (e.g. B0 to B1) per module. A maximum of 32 MSXB085 modules can be connected to a DAP for 63 outputs between B0 and B62. Port 63 is reserved as the broadcast port.

When using the DACOUT command to asynchronously update the outputs, the port addresses specified for the command differ from the output addresses numerically by two because DACOUT uses ports 0 and 1 for the DACs onboard of the DAP board. For example, if the MSXB085 is configured for ports B4 and B5, the DACOUT port addresses are 6 and 7. Table 1 shows the correspondence between the output and DACOUT port addresses.

Table 1. Output and DACOUT Port Addresses for MSXB085

Output Address	DACOUT Port Address	Output Address	DACOUT Port Address
0 – 1	2 – 3	32 – 33	34 – 35
2 – 3	4 – 5	34 – 35	36 – 37
4 – 5	6 – 7	36 – 37	38 – 39
6 – 7	8 – 9	38 – 39	40 – 41
8 – 9	10 – 11	40 – 41	42 – 43
10 – 11	12 – 13	42 – 43	44 – 45
12 – 13	14 – 15	44 – 45	46 – 47
14 – 15	16 – 17	46 – 47	48 – 49
16 – 17	18 – 19	48 – 49	50 – 51
18 – 19	20 – 21	50 – 51	52 – 53
20 – 21	22 – 23	52 – 53	54 – 55
22 – 23	24 – 25	54 – 55	56 – 57
24 – 25	26 – 27	56 – 57	58 – 59
26 – 27	28 – 29	58 – 59	60 – 61
28 – 29	30 – 31	60 – 61	62 – 63*
30 – 31	32 – 33	62 – 63*	64

*Port 63 (and DACOUT port address 65) is reserved as the broadcast port.

DAPL Configuration

This section shows several DAPL configurations for input sampling with the isolated analog module and using the analog outputs on the MSXB085. It also discusses the special command for synchronous outputs for the MSXB085. The examples shown describes the MSXB084. They also work for the MSXB085 and MSXB086.

TWOWRITE Command for Output Expansion

TWOWRITE encodes multiple channels for synchronized output expansion. It is used by output modules part numbers MSXB075 and higher. For each word of output, the data and address are encoded into two words that are sent to the digital output port for TWOWRITE. With DEXPAND, the data and address are encoded into four words. The MSXB075 and MSXB076 are compatible with both commands. For older expansion boards, use DEXPAND only. See the description of DEXPAND in the DAPL manual for more information.

The command module TWOWRTM.DLM has to be downloaded to the DAP board before TWOWRITE can be used. The module can be downloaded from the Control Panel | Data Acquisition Processor | Modules | Add or by using the DAPIO32 function DapModuleLoad or DapModuleInstall in a PC program.

TWOWRITE *(<in_pipe>, <output_vector>, <out_pipe>)*

Parameters

<in_pipe>
  Input word pipe.
  WORD PIPE

<output_vector>
  A vector containing a list of the output ports to which data should be sent.
  VECTOR

<out_pipe>
  Output channel pipe.
  WORD PIPE

Description

TWOWRITE encodes data and address information for transfer to a digital or analog expansion module through the Data Acquisition Processor digital port. *<output_vector>* is a vector containing a list of the expanded output ports to which data should be sent. *<in_pipe>* is a word pipe that contains data to be sent. Data must appear in the order of the list in *<output_vector>*. For each data value read from *<in_pipe>*, two encoded words specifying the output pin number and the data are written to *<out_pipe>*, which is typically an output channel pipe assigned to digital output port B0.

The encoding generates a data stream in groups of two WORD values. The data values from *<in_pipe>* are in every other value in *<out_pipe>*. The *<output_vector>* specifies a list of output ports. The port numbers must be within the range 0 through 62 as supported by the expansion modules. TWOWRITE is used only for synchronous output expansion. See example #5 for more information.

Example

TWOWRITE(P1, (4, 5, 6, 7), OPIPE0)

Prepare multiplexed data from pipe P1 for synchronized digital updating. Encode the data to send it through the digital port to converter ports 4, 5, 6, and 7 on the expansion card. Transfer the data to the Data Acquisition Processor's digital connector through output channel pipe OPIPE0.

Example #1 – One MSXB084 Module

The system has one MSXB084 connected to a DAP board with the default settings:

Module	Input Address	Scan Address	Sampling Address	Sample Returns Input
MSXB084	1	7	OFF	YES

Assume that the channel list has eight channels D0 to D7 at unity gain. Consider the following DAPL configuration:

```
RESET

IDEFINE MslInputs
   CHANNELS 9
   SET IPIPE0 B7          // resets the channel list and returns data for D0
   SET IPIPE1 B1          // D1
   SET IPIPE2 B1          // D2
   SET IPIPE3 B1          // D3
   SET IPIPE4 B1          // D4
   SET IPIPE5 B1          // D5
   SET IPIPE6 B1          // D6
   SET IPIPE7 B1          // D7
   TIME 100               // sample clock at 100 microseconds, or 900 microseconds per channel
   END

PDEFINE MslProc
   SKIP(IPIPE(0..7), 16, 1, 0, $BINOUT)          // or COPY(IPIPE(0..7), $BINOUT)
   END
```

The MSXB084 module samples each channel at an interval of 900 microseconds, or 1111 samples per second per channel. There are eight input pipes, which equals to the number of channels in the channel list. Since there is only one MSXB084 module in the system, it must be selected to return an input channel for the scan address. That means reading the scan address B7 returns the first channel in the channel list, which is D0 in this example. Note that the input address B1 is read seven times, which is one fewer than what you would expect for reading eight channels in the channel list. By reading address B1 repeatedly, the DAP board polls data from the MSXB084 module one channel at a time in the sequence specified by the channel list. In this example, the order is D0, D1, D2, D3, D4, D5, D6, and then D7.

Due to the delay in the input pipeline, the first two samples from each channel can be ignored. If each and every sampled value from the channels is important, the data from the first two passes of the input pipes should be discarded. The SKIP command shown makes an initial skip of eight samples, or two samples per channel for the four data channels, and then passes data continuously from the input pipes to the PC via the communication pipe $BINOUT. If the channels are monitored continuously and the first two samples from each channel can be ignored, the channels can be passed to the PC directly using the MERGE or COPY command.

Example #2 – Two MSXB084 Modules

Consider a system with two MSXB084 modules with the following settings:

Module	Input Address	Scan Address	Sampling Address	Sample Returns Input
MSXB084 #1	1	1	OFF	YES
MSXB084 #2	2	1	OFF	NO

The two modules have unique input addresses. The scan addresses should be the same and are equal to one of the two input addresses. MSXB084 #1 is specified to return an input channel for the scan address, which means reading the scan address will return the first channel on its channel list.

Assume that the channel list for each module has the first four channels D0 to D3. The DAPL configuration for sampling the eight channels is shown below.

```
RESET

IDEFINE MslInput
  CHANNELS 8
  SET IPIPE0 B1          // resets the list and returns D0 on module #1
  SET IPIPE1 B1          // D1 on module #1
  SET IPIPE2 B1          // D2 on module #1
  SET IPIPE3 B1          // D3 on module #1
  SET IPIPE4 B2          // D0 on module #2
  SET IPIPE5 B2          // D1 on module #2
  SET IPIPE6 B2          // D2 on module #2
  SET IPIPE7 B2          // D3 on module #2
  TIME 10                // sample clock at 10 microseconds, or 80 microseconds per channel
  END

PDEFINE MslProc
  SKIP(IPIPE(0..7), 16, 1, 0, $BINOUT)
  END
```

The channels are sampled at 12.5 kHz per channel. As in example #1, the SKIP command discards data from the first two passes of the input pipe list.

Example #3 – Eight MSXB084 Modules

Consider the hardware setting below for a system with eight MSXB084 modules connected to one DAP board.

Module	Input Address	Scan Address	Sampling Address	Sample Returns Input
MSXB084 #1	0	0	OFF	Yes
MSXB084 #2	1	0	OFF	No
MSXB084 #3	2	0	OFF	No
MSXB084 #4	3	0	OFF	No
MSXB084 #5	4	0	OFF	No
MSXB084 #6	5	0	OFF	No
MSXB084 #7	6	0	OFF	No
MSXB084 #8	7	0	OFF	No

All the modules have unique input addresses and the same scan address. Since B0 is used, the system should not have any analog input board(s) connected to the DAP via the analog I/O port. Assume that the channel list of each module has two channels. The DAPL configuration for sampling the 16 channels for the eight modules is shown below.

```
RESET
IDEFINE MslInput
    CHANNELS 16
    SET IPIPE0 B0        // 1st channel in channel list on module #1, resets channel lists for all modules
    SET IPIPE1 B0        // 2nd channel in channel list on module #1
    SET IPIPE2 B1        // 1st channel in channel list on module #2
    SET IPIPE3 B1        // 2nd channel in channel list on module #2
    SET IPIPE4 B2        // 1st channel in channel list on module #3
    SET IPIPE5 B2        // 2nd channel in channel list on module #3
    SET IPIPE6 B3        // 1st channel in channel list on module #4
    SET IPIPE7 B3        // 2nd channel in channel list on module #4
    SET IPIPE8 B4        // 1st channel in channel list on module #5
    SET IPIPE9 B4        // 2nd channel in channel list on module #5
    SET IPIPE10 B5       // 1st channel in channel list on module #6
    SET IPIPE11 B5       // 2nd channel in channel list on module #6
    SET IPIPE12 B6       // 1st channel in channel list on module #7
    SET IPIPE13 B6       // 2nd channel in channel list on module #7
    SET IPIPE14 B7       // 1st channel in channel list on module #8
    SET IPIPE15 B7       // 2nd channel in channel list on module #8
    TIME 10              // sample clock at 10 microseconds, or 160 microseconds per channel
    END

PDEFINE MslProc
    SKIP(IPIPE(0..15), 32, 1, 0, $BINOUT)
    END
```

The address B0 is the scan address and it is selected to return an input channel for the scan address, and thus reading it returns the first channel for the MSXB084 module set as B0. Again, the data returned from the first two passes through the input pipe list is invalid due to the pipeline delays. The SKIP command can be used to take an initial skip of 32 samples, or two samples for each input pipe, and then transfer data continuously to $BINOUT. The 16 channels are sampled at 6250 Hz per channel.

Example #4 – Asynchronous Outputs

The following DAPL listing outputs the 16-bit values in two user pipes to one MSXB085.

```
OUTPORT 0..1 TYPE=1

RESET
PIPES P0, P1
PDEF B
   P0 = 16384        // half the full voltage scale, e.g. 5V on a 10V range
   P1 = 32767        // the maximum voltage, e.g. 10V on a 10V range
   DACOUT(P0, 2)
   DACOUT(P1, 3)
   END
START B
```

With asynchronous output updates, the OUTPORT command must be used. The MSXB085 is configured for output addresses 0 and 1. The output port type of an analog output expansion module is 1. The DACOUT command bypasses normal output clocking and sends data directly to the hardware parts. The addresses used in the DACOUT commands differ from the OUTPORT addresses by two. See the section on Output Address for more information.

Example #5 – Synchronous Outputs

Synchronous analog output expansion uses a special protocol which is implemented by the DAPL command TWOWRITE. Refer to an earlier section on TWOWRITE for more information. For this example, we have two MSXB085 modules with different output addresses – one with 0 – 1 and the other 2 – 3. The DAPL configuration for such a system is shown below:

```
OUTPORT 0..3 TYPE=1

RESET
PIPES P0, P1, P2, POUT
PDEF B
   P0 = 16384        // half the full voltage scale, e.g. 5V on a 10V range
   P1 = 32767        // the maximum voltage, e.g. 10V on a 10V range
   P2 = 0
   MERGE(P0,P1,P2, POUT)
   TWOWRITE(POUT, (0,1,2), OP0)
   END
ODEF C 1
   SET OP0 B0
   TIME 1000
   END
START B, C
```

The MERGE command merges three streams of data into pipe POUT. The TWOWRITE command then converts the output data in POUT to the output expansion format of the module and places the result in output channel pipe OP0. The list (0,1,2) specifies that the analog outputs are at addresses 0, 1, and 2, that is the two outputs on the first MSXB085 and the first output on the second MSXB085.

An output procedure sends the data in output channel pipe OP0 to the modules connected to the analog output port every 1000 microseconds, or 1 milliseconds. TWOWRITE produces two output values for every input value. The output channel pipe 0 contains three channels of data and each channel of data has an additional value from TWOWRITE. The effective update interval of each channel is then 6 milliseconds (1 ms * 3 channels * 2 values / channel). The update rate is then 1666 Hz.

The effective update rate of an output channel can be calculated by the following equation:

Update rate per channel = 1 / (TIME value * number of output channels * 2)

If the DEXPAND command is used in place of TWOWRITE, the value "2" should be changed to "4" in the equation above. That means the update rate per channel is halved. For applications that require a high update rate, the TWOWRITE command is recommended.