

# **MSXB078 Signal Interface Module Manual**

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*Isolated Digital I/O Module*

*Version 1.11*

**Microstar Laboratories, Inc.**

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Part Number MSXB078M111

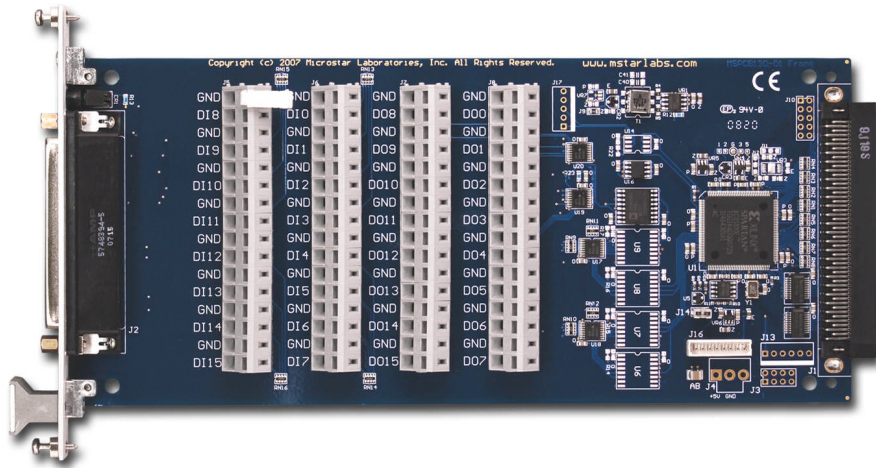
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## Introduction

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The Isolated Digital Input/Output Module, part number MSXB078, provides the Data Acquisition Processor (DAP) with sixteen digital inputs and sixteen digital outputs that are isolated from the ground of the DAP board.

Multiple MSXB078 modules can be connected to one DAP board to support up to 128 digital inputs and 1008 digital outputs. Input expansion is at a maximum eight MSXB078 modules. Output can be expanded to 1008 lines with 63 MSXB078 modules.

The MSXB078 module is one of the signal interface modules by Microstar Laboratories. Other modules include isolated analog inputs and isolated analog outputs. Contact your Microstar Laboratories representative for more details.

## Hardware Architecture

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### System Configuration

The backplane model of the MSXB078 connects directly to the digital backplane (MSXB034 or MSXB035) of an industrial enclosure or a DAPserver. This allows one or more MSXB078 modules, or other digital expansion boards, 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 are available. Contact your Microstar Laboratories representative to determine all available models.

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Note: The backplane model of the MSXB078 module should not be connected or disconnected to the digital backplane while the digital backplane is powered.

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### Power Requirements

The MSXB078 board 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 boards 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.

No more than 10 mA of current may be drawn from the +5V power supply or returned to ground through J2.

### Isolation

The design of the MSXB078 specifies 300V of channel-to-ground isolation. The inputs and outputs of the board are isolated from the ground of the DAP board. The block diagram is shown below. Contact Microstar Laboratories for higher isolation requirements.

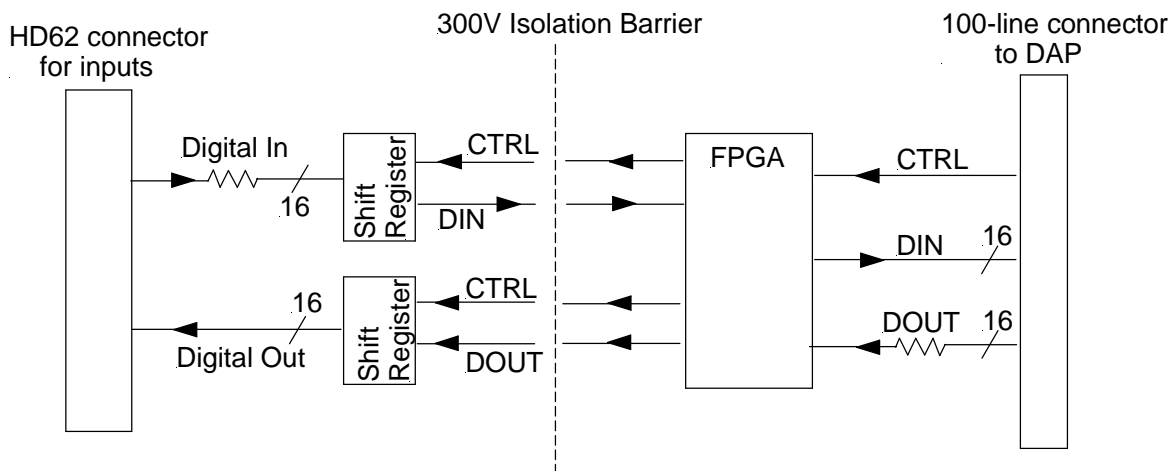


Figure 1. Block diagram of MSXB078

## Board Layout

The MSXB078 is a 3U board measuring 100 mm by 220 mm, or 3.93" by 8.78". The following diagrams show the layout of the module.

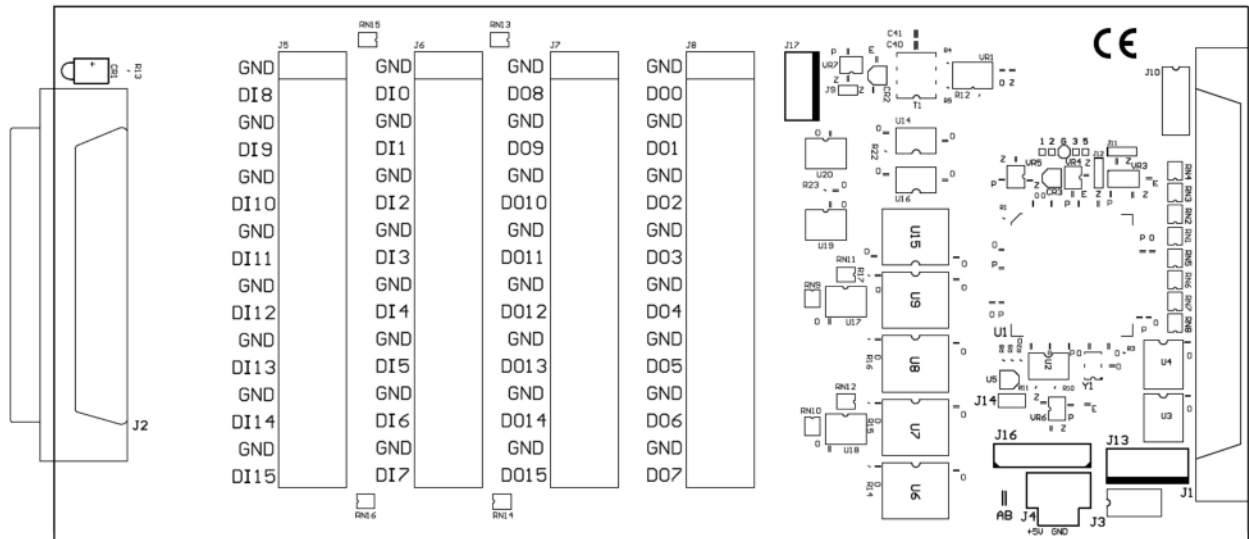


Figure 2. Layout of the MSXB078

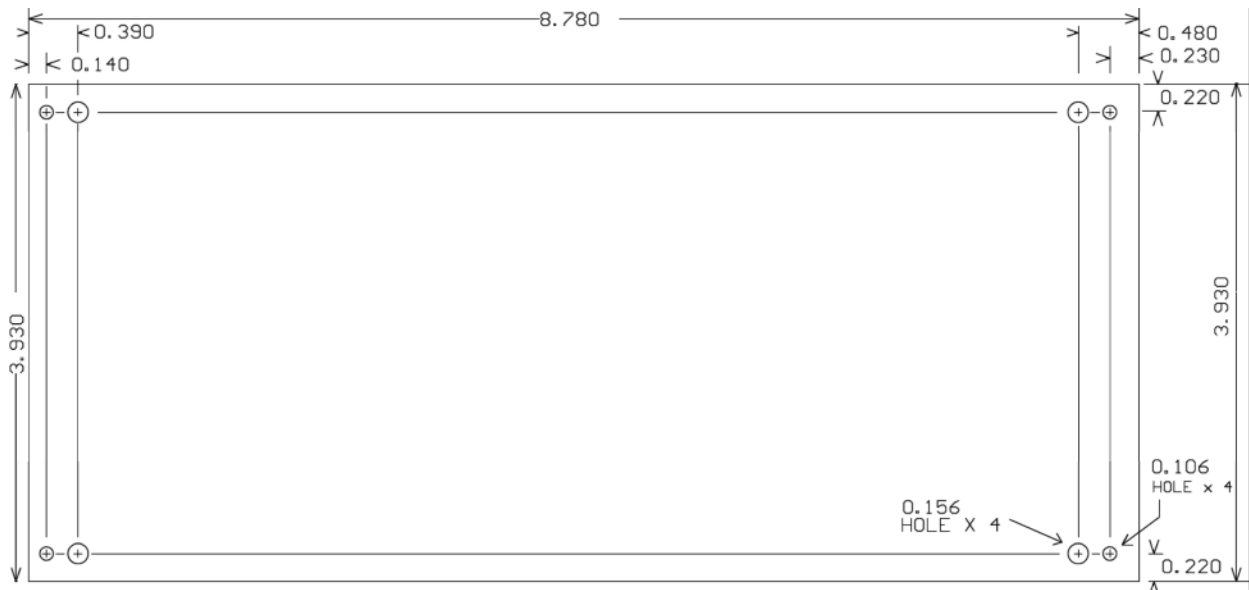


Figure 3. Dimensions of the module

## Input/Output Connector Options

Input/output signals can be connected to the MSXB078 via the HD-62 connector at J2 or four Wago terminal strips at J5–J8. Each MSXB078 is built with either option. The pinout of the 62-pin input/output connector (looking into the connector) is shown below. The cable kit for the HD-62 connector is part number MSCBL109-01K.

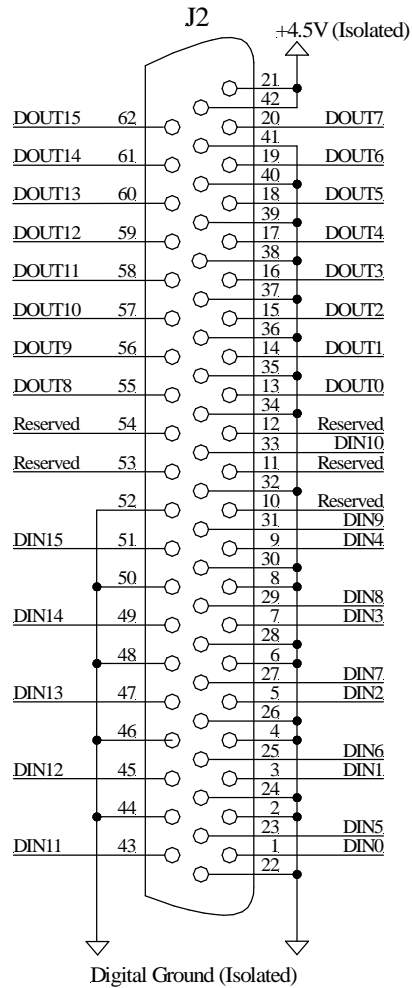


Figure 4. Pinout of the 62-pin I/O connector

## Input and Output Specifications

The inputs are LV TTL. The input current is specified at +/-1 microamps. An input voltage greater than 2 volts is interpreted as a “1” and an input voltage less than 0.8 volts is interpreted as a “0.” The inputs are protected by 330-Ohm resistors in series, with 10k Ohms to ground. The DAP board reads “0” for all unconnected inputs.

Digital input pins may have signals applied when the Data Acquisition Processor is off.

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Note: If a voltage greater than 5 volts or less than 0 volts is applied to an input, damage to the MSXB078 module may occur.

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The outputs are LV TTL. The output current is specified at 16 milliamps per digital line and 32 milliamps over all 16 lines.

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Note: If the output current exceeds maximum ratings, damage to the MSXB078 module may occur.

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## Software Configuration

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The MSXB078 module is configured by the Signal Interface Module configuration utility. The parameters are listed below:

- Module ID
- Input and sampling addresses
- Output and update addresses
- Initial output state

The utility is available for download at [www.mstarlabs.com](http://www.mstarlabs.com). Refer to the utility manual for more information on the interface.

### Hardware Setup

To configure a MSXB078, it should be connected to a DAP board that has been installed with Accel32 or DAPcell Server. A new MSXB078 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 MSXB078 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 be initialized before it is detected. If two or more modules have the same Module ID, the results are unspecified.

## Input and Sampling Addresses

Each MSXB078 module should have a unique input address between B0 and B7. No more than eight Digital Input/Output Expansion modules (MSXB078 or other digital expansion boards) can be used for digital input expansion. If more than eight digital expansion boards are connected to the DAP board, the boards not being used for input expansion must have their input expansion disabled in the configuration utility program.

The module also has a sampling address between 0 and 7 for simultaneous sampling. Reading from the sampling address causes the digital input values to be read by the MSXB078; sampling the input address causes the most-recently sampled inputs to be made available to be read by the DAP board.

With only one MSXB078 in the system, the module must have the same address for both input and sampling. If there is more than one module and no simultaneous sampling is required among the modules, the input and sampling addresses must be the same on each module.

With more than one module, the modules with the same sampling address (but different input addresses) are sampled simultaneously. The sampling address should be the same value as the first input address of the modules used. This allows simultaneous sampling of groups of modules in a system. The DAPL Configuration section has examples on various configurations.

### Using the MSXB078 with Analog Input Boards

If the MSXB078 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.

With B0 not available as an input address, the MSXB078 can be configured for an address between B1 and B7. That allows a total of seven modules for 112 digital inputs. Contact us if you need more than 112 digital inputs.

## Output and Update Addresses

Each MSXB078 module should have a unique output address between B0 and B62. A maximum of 63 modules can be connected to a DAP for 1008 output lines. Port 63 is reserved as the broadcast port. In addition to the output address, the module also has an update address between 0 and 62 for simultaneous update. The output and update addresses are similar to the input and sampling addresses.

With only one MSXB078 in the system, the module must have the same address for both output and update. If there is more than one board and no simultaneous update is required among the modules, the output and update addresses must be the same on each module.

With more than one module, the modules with the same update address (but different output addresses) are updated simultaneously. The update address should be the same value as the last output address of the modules that is used. This allows simultaneous update of groups of modules in a system. The DAPL Configuration section has examples on various configurations.

## DAPL Configuration

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The digital outputs of a DAP board can be updated asynchronously or synchronously. Different DAPL commands are used for the two cases. This section discusses the special command for synchronous outputs and shows examples on configuring the DAP board to work with a MSXB078 module for digital I/O.

## TWOWRITE Command for Output Expansion

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TWOWRITE encodes multiple channels for synchronized output expansion. It is used by signal interface module part numbers MSXB075 and higher. For older expansion boards, use DEXPAND.

The command module TWOWRTM.DLM has to be downloaded to the DAP board before TWOWRITE can be used. The module can be downloaded from Control Panel | Data Acquisition Processor | Modules | Add or by using the DAPIO32 function DapModuleLoad or DapModuleInstall in a PC program. Go to [www.mstarlabs.com](http://www.mstarlabs.com) to download a copy of the module.

**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 #3 under Digital Outputs 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 – No Simultaneous Sampling

The system has two MSXB078 modules with the following addresses:

<i>Board</i>	<i>Input Address</i>	<i>Sampling Address</i>
MSXB078 #1	1	1
MSXB078 #2	2	2

With no simultaneous sampling or output update, the MSXB078 behaves as a MSXB038. Shown below is an example for two MSXB078 modules.

```
RESET
IDEF A 2
  SET IPIPE0 B1
  SET IPIPE1 B2
  TIME 5000
END
PDEF B
  MERGE(IPIPE0, IPIPE1, $BINOUT)
END
START A, B
```

The input and sampling addresses are the same on each module. Since the sampling address is different between the two modules, the digital lines are not sampled simultaneously among the modules. The DAP board samples the two modules sequentially at an interval of 5000 microseconds, or 5 milliseconds. The sixteen digital inputs on each board are sampled every 10 milliseconds; the sample rate per channel is 100 samples per second.

## Example #2 – Simultaneous Sampling

Consider the hardware setting below for two MSXB078 modules:

<i>Board</i>	<i>Input Address</i>	<i>Sampling Address</i>
MSXB078 #1	1	1
MSXB078 #2	2	1

Each module has a unique input address. Since the sampling addresses are the same, the digital lines on the two modules are simultaneously sampled. The DAPL configuration is shown here:

```
RESET
IDEF A 2
  SET IPIPE0 B1
  SET IPIPE1 B2
  TIME 5000
END
PDEF B
  SKIP(IPIPE(0..1), 2, 1, 0, $BINOUT)
END
START A, B
```

Note that the input definition “A” in this example is the same as that in example #1 with no simultaneous sampling. For a system with simultaneous sampling, the sampling address must be sampled first in the input pipe list. In this case, the sampling address for the two boards is 1 (B1 in DAPL), which is also the input address of board #1. Even though the port B1 is declared as both a sampling and an input address, it only has to be sampled once in the list. The sample rate is the same as that in example #1, at 100 Hz per channel.

With the MSXB078, there is always a pipeline delay of 1 sample, whether or not simultaneous sampling is enabled. The data returned from the first scan of the input pipe list is invalid due to the pipeline delays. No valid data are lost; they are returned in the next scan. The `SKIP` command can be used to take an initial skip of two samples (one sample from each input pipe) and then transfer data continuously to `$BINOUT`.

The sampling address does not have to be the same as one of the input addresses. Let’s see what the DAPL commands look like when the sampling address for both boards is changed to 7.

```
RESET
IDEF A 3
  SET IPIPE0 B7
  SET IPIPE1 B1
  SET IPIPE2 B2
  TIME 3333
END
PDEF B
  SKIP(IPIPE(1..2), 2, 1, 0, $BINOUT)
END
START A, B
```

Since the sampling address has to be first in the input pipe list and it is different from the input addresses, three input pipes are declared instead of two. To avoid having to declare an extra input pipe for the sampling address, it is good practice to have the sampling address the same as the first digital port to be sampled on the list.

### Example #3 – Simultaneous Sampling in Selected Groups

In this example, there are four boards with the following settings:

<i>Board</i>	<i>Input Address</i>	<i>Sampling Address</i>
MSXB078 #1	1	1
MSXB078 #2	2	1
MSXB078 #3	3	3
MSXB078 #4	4	3

Boards #1 and #2 are to be simultaneously sampled and so are boards #3 and #4.

```
RESET
IDF A 4
  SET IPIPE0 B1
  SET IPIPE1 B2
  SET IPIPE2 B3
  SET IPIPE3 B4
  TIME 1000
END
PDEF B
  SKIP(IPIPE(0..3), 4, 1, 0, $BINOUT)
END
```

To avoid sampling the sampling addresses separately, the sampling address of each pair of boards is the same as the first input address of the pair – B1 and B3. The SKIP command is used to ignore the four samples from the first scan of the input pipes.



## Example #4 – Asynchronous Outputs

Consider a system with three MSXB078 modules configured for the following:

<i>Board</i>	<i>Output Address</i>	<i>Update Address</i>
MSXB078 #1	0	0
MSXB078 #2	1	1
MSXB078 #3	2	2

The DAPL configuration below outputs the 16-bit values in three user pipes P0, P1, and P2 to the three expansion modules.

```
OUTPORT 0..2 TYPE=0

RESET
PIPES P0, P1, P2
PDEF B
  P0 = 1    //bit 0 is on
  P1 = 2    //bit 1 is on
  P2 = 3    //bits 0 and 1 are on
DIGITALOUT(P0, 0)
DIGITALOUT(P1, 1)
DIGITALOUT(P2, 2)
END
START B
```

With asynchronous output updates, the **OUTPORT** command must be used. The output port type of a digital output expansion module is 0. The **DIGITALOUT** command bypasses normal output clocking and sends data directly to the hardware parts.

## Example #5 – Synchronous Outputs

Synchronous digital output expansion uses a special protocol which is implemented by the DAPL command TWOWRITE. The TWOWRITE command is described in an earlier section.

In the hardware settings in Example #4, the output and update addresses are the same on each module. Since the update address is different between the two modules, the digital lines are not updated simultaneously among the modules. The DAPL configuration for such a system is shown below:

```
OUTPUT 0..2 TYPE=0

RESET
PIPES P0, P1, P2, POUT
PDEF B
  P0 = 1      //bit 0 is on
  P1 = 2      //bit 1 is on
  P2 = 3      //bits 0 and 1 are on
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 output expansion module and places the result in output channel pipe OP0. The list (0,1,2) specifies that the digital outputs are at addresses 0, 1, and 2.

An output procedure sends the data in output channel pipe OP0 to the expansion modules connected to the digital output port every 1000 microseconds, or 1 milliseconds. TWOWRITE produces two output values for every input value. The output channel pipe OP0 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:

$$\text{Update rate per channel} = 1 / (\text{TIME value} * \text{number of output channels} * 2)$$

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.

## Example #6 – Synchronous Outputs with Simultaneous Updates

Consider the hardware from the previous two examples with the update addresses changed to 2:

<i>Board</i>	<i>Output Address</i>	<i>Update Address</i>
MSXB078 #1	0	2
MSXB078 #2	1	2
MSXB078 #3	2	2

Each module has a unique output address. Since the update addresses are the same, the digital lines on the three modules are simultaneously updated. The update address should have the same value as the last output address.

The DAPL configuration for this example is the same as that from example #2.

## Appendix A. Changes in manual

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Version 1.00 of the manual describes a MSXB078 that uses a write-protect header. The shunt needs to be removed from the header to configure and save settings such as Module ID and I/O addresses.