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The Microstar Laboratories MSXB 032 Analog Output Expansion Board converts digital inputs from a Data Acquisition Processor into four separate analog outputs. Up to 16 Analog Output Expansion Boards can be connected to a Data Acquisition Processor for a maximum expansion of 64 additional analog output channels.™

Hardware Configuration

Connecting to a Data Acquisition Processor

The Analog Output Expansion Board connects to the Data Acquisition Processor's digital connector. If digital input/output is needed in addition to analog output expansion, a Digital Expansion Board is required. If more than one expansion board is to be connected to the digital port of a Data Acquisition Processor, either an unshielded daisy-chain cable must be used, or the expansion boards may reside in an industrial enclosure.

The recommended cabling method employs the MSCBL 046-01, a 100-line cable adapter board. Of particular interest to customers wishing to build CE-compliant systems, this adapter occupies a slot adjacent to the Data Acquisition Processor. The MSCBL 046-01 permits the MSCBL 054-01, a shielded cable, to be easily routed from the MSCBL 046-01's connector at the back of the PC case to an Analog Output Expansion Board or digital Backplane.

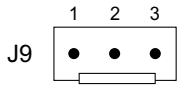
When less stringent requirements apply, the MSCBL 046-01 can be connected to an expansion board or Backplane interface with a MSCBL 056-01, an unshielded ribbon cable. The Analog Output Expansion Board may also be connected directly to the Digital Input/Output Port of the Data Acquisition Processor with an unshielded 100-line ribbon adapter cable, part number MSCBL 058-01.

Warning: Never connect or disconnect the Analog Output Expansion Board while the Data Acquisition Processor is powered.

Power Requirements and External Power

The Analog Output Expansion Board typically requires 0.9 Amps at 5 VDC. The total power consumption of all expansion boards must not exceed the 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 of the exceeds the power availability of the Data Acquisition Processor, then external power must be used.

The Analog Output Expansion Board allows an external 5-volt power supply to be connected through connector J9. Connector J9 is a male Molex connector part number 26-60-4030 and mates with the Molex connector part number 09-50-3031. A mating connector is included with the Microstar Laboratories cable kit MSCBL 035-01K.



Pin	Signal
1	+5 Volts
2	Ground
3	No Connect

When an external +5 Volts power supply is connected to the board, all shunts on jumper header J15 must be removed. Jumper header J15 is located to the right of J1. Removing all the shunts from J15 disconnects the Data Acquisition Processor's +5V power supply from the board's +5V power supply.

Warning: When using an external power supply, all shunts on J15 must be removed. Otherwise the external power supply or the host PC power supply could be damaged.

Note: When using external power, it is best to power the Analog Output Expansion Board from the host PC's power supply so that both the Analog Output Expansion Board and the Data Acquisition Processor are powered on and off at the same time. If this is not practical, then external power to the MSXB 032 should be applied before powering on the DAP and should be disconnected after powering off the DAP.

Address Range Selection

Digital outputs from a Data Acquisition Processor may be expanded into 64 ports, shared among Analog Output Expansion Boards, Digital Output Expansion Boards, Counter-Timer Boards, etc. The MSXB 032 divides this digital port address space into 16 contiguous ranges of 4 ports each. Address jumpers located on the Analog Output Expansion Board's J2 header provide the means to select the address range. The pin numbering of header J2 is:

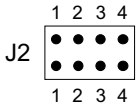


Figure 2. Address Range Selection Header

The address range is selected by installing jumpers on header J2 as shown in the following table:

Table 1. Address Range Configuration

Output Address	Jumpers	DACOUT Port Address
0 - 3	1, 2, 3, 4	2 - 5
4 - 7	1, 2, 3	6 - 9
8 - 11	1, 2, 4	10 - 13
12 - 15	1, 2,	14 - 17
16 - 19	1, 3, 4	18 - 21
20 - 23	1, 3	22 - 25
24 - 27	1, 4	26 - 29
28 - 31	1	30 - 33
32 - 35	2, 3, 4	34 - 37
36 - 39	2, 3	38 - 41
40 - 43	2, 4	42 - 45
44 - 47	2	46 - 49
48 - 51	3, 4	50 - 53
52 - 55	3	54 - 57
56 - 59	4	58 - 61
60 - 63	none	62 - 65

Notice that corresponding "Output Addresses" (digital port numbers) and "DACOUT Port Addresses" differ numerically by 2. Analog output ports 0 and 1 are driven by DACs on the Data Acquisition Processor. Digital output expansion maps the single 16-bit digital output port onto 64 additional ports. Analog output expansion merely piggybacks on the digital expansion scheme, augmenting rather than consuming the Data Acquisition Processor's analog output capability.

Analog Outputs

There are four digital-to-analog converters on the Analog Output Expansion Board. These digital-to-analog converters are identical to those on most Data Acquisition Processors. The digital-to-analog converters have voltage outputs with typical output impedance of 0.2 Ω and maximum output current of 5 mA. It is recommended, however, that the output current not exceed 1 mA.

The DAC outputs are available on two connectors on the Analog Output Expansion Board. One connector is an 8-point quick connect terminal block and the other is a 10-pin shrouded header. There is a ground return for each output. It is recommended that these grounds be paired with their respective outputs to minimize noise. The connections on the 10-pin shrouded header are:

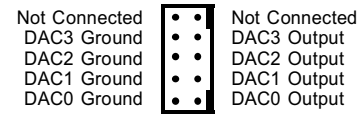


Figure 3. DAC Output 10-Pin Connector

Each digital-to-analog converter has an eight-pin header with three jumpers to select the output voltage range. J3 controls DAC0, J4 controls DAC1, J5 controls DAC2, and J6 controls DAC3. The pin numbering of the headers are as follows:

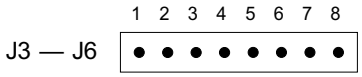


Figure 4. Voltage Range Selection Header

Pin 1 is closest to the J1 end of the board and to the header label.

Three jumpers are placed on each header, as follows:

Jumpers	Range
3 to 4, 5 to 6, 7 to 8	0 volts to +10 volts
1 to 2, 4 to 5, 7 to 8	-5 volts to +5 volts
1 to 2, 4 to 5, 6 to 7	-10 volts to +10 volts

The Analog Output Expansion Board is shipped with the -5 volts to +5 volts range selected.

Note: Using the 0 to +10 volt unipolar output selection requires special software support. Contact Microstar Laboratories for more information.

Software Configuration

The Analog Output Expansion Board is controlled through DAPL in the same way as output expansion is controlled with the Digital Expansion Board. To use the Analog Output Expansion Board, the DAPL `OUTPORT` command is required. The output port type of the Analog Output Expansion Board is "1".

The command `DACOUT` uses "0" and "1" for the Data Acquisition Processor onboard analog outputs. For the Analog Output Expansion Board, `DACOUT` uses "2" for analog output expansion port 0, "3" for output expansion port 1, and so on.

The following DAPL listing generates +5 volts DC on DAC0, 0 volts DC on DAC1, -2.5 volts DC on DAC2, and +2.5 volts DC on DAC3, provided that the DAC output control jumpers are in the ±5 volt range as shipped from the factory:

```
OUTPORT 0..3 TYPE=1

RESET
PIPES P0, P1, P2, P3
PDEF A
   DACOUT(P0,2)
   DACOUT(P1,3)
   DACOUT(P2,4)
   DACOUT(P3,5)
   END
START A
FILL P0 32767
FILL P1 0
FILL P2 -16384
FILL P3 16384
```

In real applications, the values in pipes `P0`, `P1`, `P2` and `P3` typically come from other procedures instead of from `FILL` commands.

Synchronous Analog Output Expansion

Synchronous analog output expansion uses a special protocol that is implemented by the DAPL command DEXPAND. For each word of output, the data and address are encoded into four words that are sent to the digital output port. If DEXPAND is used, DAC outputs occur one-after-the-other, synchronously with the Data Acquisition Processor's Internal Output Clock. See the description of DEXPAND in the DAPL manual for more information. Also see the Applications Manual for an example of synchronous analog output expansion.

Simultaneous Update of Outputs

In addition to the serial, synchronous update regime provided by the DEXPAND command, the MSXB 032 Analog Output Expansion Board can update all DACs on all installed MSXB 032's at the same instant. Like DEXPAND, the simultaneous update protocol operates synchronously with the Data Acquisition Processor's Internal Output Clock. This protocol is not part of DAPL but is implemented by a custom command. Please contact Microstar Laboratories for additional information and to obtain this software.

External Enclosure Option

The MSXB 032 Analog Output Expansion Board is available with a single-board external enclosure option. The external enclosure provides shielding and is compatible with the European Community directive 89/336/EEC.

The single-board enclosure has several possible end panels that allow for different connection points to the Analog Output Expansion Board. Contact Microstar Laboratories for more information on available end panels for the MSXB 032.

Backplane Connector Option

A MSXB 032 Analog Output Expansion Board is available with a Backplane connector installed in J1 instead of a cable connector. This allows the MSXB 032 to be used with a Digital Backplane. Connector J1 of the Analog Output Expansion Backplane Board plugs directly into an empty slot on the Digital Backplane. See the Digital Backplane manual for more information on how to install Backplane boards into a Digital Backplane and how to connect the Digital Backplane to the Data Acquisition Processor.

Warning:

Never connect or disconnect the Analog Output Expansion Backplane Board while the Digital Backplane is powered.

The MSXB 032 Analog Output Expansion Backplane Board has several possible front panels that allow for different connection points to the board. Contact Microstar Laboratories for more information on available front panels for the MSXB 032.