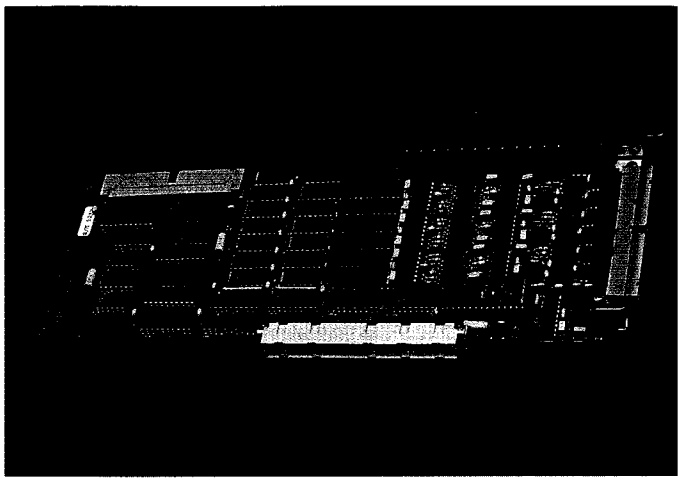
Analog Output Board for the Macintosh NuBus

NB-AO-6



NB-AO-6

Related Products		
Hardware	**Software**	**Accessories**
3-117, 3-141, 3-145	1-15, 1-38, 3-127	3-175, 3-190

Features

- 6 high-speed, high-accuracy, 12-bit DACs
- Unipolar and bipolar outputs available from each converter
- Voltage output from each converter
- 4 to 20 mA current sink to ground from each converter
- Onboard references of 2.5 V and 10 V
- 1 µV/°C offset temperature stability
- External bipolar reference input for each converter
- Double-buffered D/A latches with simultaneous update capability
- High-performance RTSI bus interface
  - DMA operation with an NB-DMA2800 board
  - Waveform generation with sample rates up to 350 kHz
- Includes NI-DAQ for Macintosh
- Programmed with LabVIEW

Overview

The National Instruments NB-AO-6 is a high-performance analog output interface for the Macintosh NuBus. It consists of six identical DAC channels, each of which has a 4 to 20 mA current output and a voltage output. The voltage output of each channel is either bipolar or unipolar and is derived from one of the onboard references (2.5 V and 10 V) or from an external reference. When DMA control is implemented via the Real-Time System Integration (RTSI) bus and an NB-DMA2800 board, the NB-AO-6 can operate at conversion rates up to 350 kHz.

Applications

The NB-AO-6 is useful in many Macintosh data acquisition and control applications. The high accuracy of the voltage outputs makes them suitable as a programmable voltage source or for generating test signals in automated equipment. In conjunction with the NB-DMA2800, the NB-AO-6 can generate multiple-channel simultaneous waveforms. The high-compliance 4 to 20 mA current outputs can also be used in process control loops in industrial applications.

Hardware

Figure 1 is the block diagram of the NB-AO-6. Its major functions are described in the following paragraphs.

ANALOG OUTPUT CHANNELS – All six of the analog output channels are identical. Each is equipped with the PM7645HP multiplying DAC. Each channel can generate fast and accurate voltage and current outputs. The voltage outputs typically settle to within 0.5 least significant bit (LSB) of full-scale (10 V) within 3 µsec. The factory-calibrated error is under 0.5 LSB at 25 °C. Offset and gain drift are typically 1 µV/°C and 10 ppm/°C, respectively.

The current outputs settle within 5 µsec and are accurate within 0.1%. They sink current to ground when given an external voltage supply in the range of 7 to 40 VDC.

Each channel has four jumper-selectable options: (1) internal (10 V) or external reference voltage; (2) straight binary or two's-complement data coding; (3) unipolar or bipolar output voltage swing; and (4) local or remote sensing. To implement the 0 to 2.5 V or -2.5 to +2.5 V output range on a channel, you jumper select the external reference voltage option for that channel and externally wire the 2.5 V onboard reference to the appropriate external reference input.

Remote sensing takes voltage feedback at the load rather than at the board output. Thus, remote sensing can compensate for voltage drops due to long lead lengths and low load impedance. It also makes possible the use of offboard analog power buffers without degraded accuracy.

NuBus INTERFACE – The NuBus interface circuitry makes programming the outputs of the board very easy. You can write data to any combination of DACs simultaneously, with or without updating enabled. The board is memory mapped, which means that no special instructions are required to access it. Standard 16-bit write operations are all that is required. Fast interface circuitry yields a 300 nsec write-cycle time. This feature, coupled with the high slew rate of the analog outputs, makes possible high-speed waveform generation.

CALIBRATION – The board is shipped fully calibrated. Its very low time and temperature coefficients, which are implemented with flying-capacitor and chopper-stabilizing techniques, ensure that recalibration is seldom necessary. Moreover, *changing jumper setting does not affect calibration.* Should recalibration ever be necessary, there are only two adjustments to make for each channel, and one adjustment will calibrate both the 10 V and the 2.5 V references to within a few parts per million.

RTSI INTERFACE – The NB-AO-6 can receive update commands from the RTSI bus. This means that waveform generation can run in the background if an NB-DMA2800 is available in the system. The NB-AO-6 also makes the NuBus-generated and externally triggered update signals available to the RTSI bus, enabling synchronization with processes on other NB Series boards.

WAVEFORM GENERATION – When used in conjunction with an NB-DMA2800, the NB-AO-6 can provide 2, 4, or 6 channels of simultaneous waveform generation, with separate buffers for each channel so that all of the waveforms can be independent of each other. Each waveform is stored in a contiguous memory block isolated from the other waveforms. In addition, the update rate is fully user-programmable. Flexible waveform generation can thus be implemented in a very

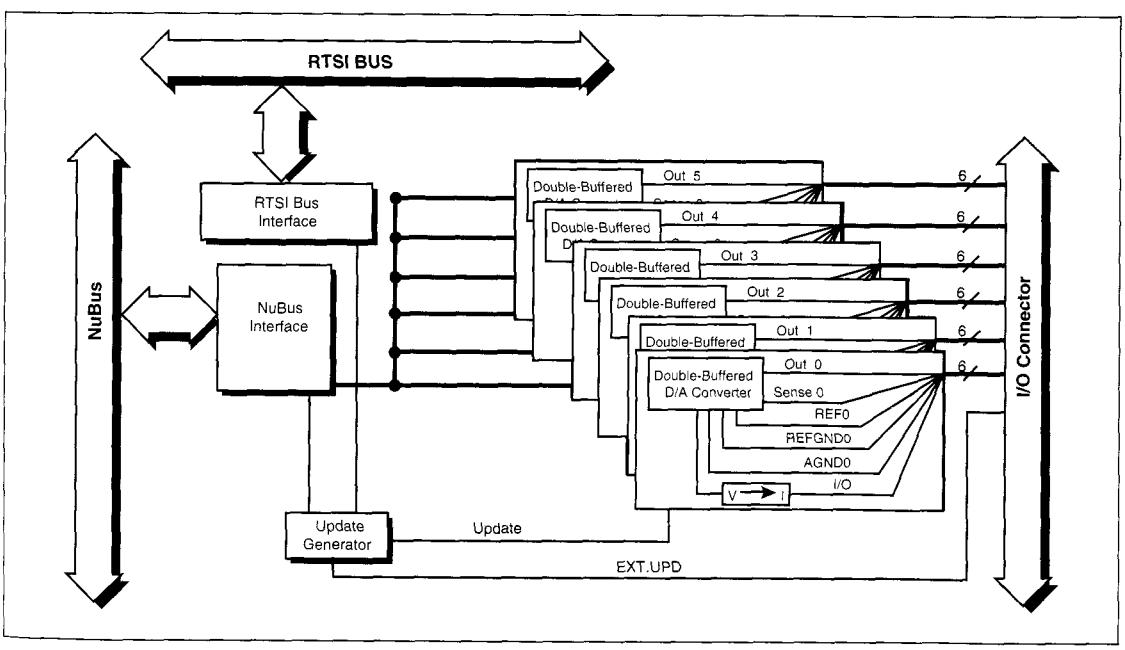


Figure 1. NB-AO-6 Block Diagram

straightforward manner. The amount of NuBus bandwidth used will be proportional to the waveform update rate.

ANALOG SIGNAL CONNECTOR – The analog outputs are available at a 50-pin ribbon cable connector, diagrammed in Figure 2. OUT(0:5) are the six analog output channels referenced to AGND(0:5). I(0:5) are six current output channels. SENSE(0:5) are remote sense inputs for each of the channels. REF(0:5) are external reference input pins and REFGND(0:5) are their corresponding ground pins. The analog output signal can be clocked externally by applying a pulse at the external update pin (EXT.UPD). This update signal is referenced to DGND. A 2.5 VDC signal referenced to AGND is available for calibrating the internal 10V reference.

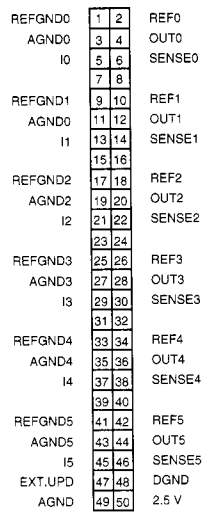


Figure 2.
NB-AO-6 Signal Connector

Software

National Instruments has developed the following software packages to control data acquisition functions on the NB Series boards.

NI-DAQ for Macintosh is a library of functions for controlling National Instruments NB series data acquisition boards that is callable from MPW C, THINK C, THINK Pascal, and Microsoft QuickBASIC. NI-DAQ for Macintosh is shipped with all National Instruments NB series data acquisition boards.

LabVIEW for Macintosh offers a graphical programming environment for application software construction on the Macintosh.

Specifications

Typical for 25° C unless otherwise noted.

ANALOG OUTPUTS

Number of channels	6
Input data coding	Straight binary (unipolar), offset binary or two's complement (bipolar)
Voltage outputs	
Ranges	0 to 10 V, ±10 V, 0 to 2.5 V, ±2.5 V, 0 to V_{ref}, $\pm V_{ref}$
V_{ref} input range	±10 V
V_{ref} input impedance	10 kΩ
Current drive	±5 mA maximum
Output impedance	0.1 Ω maximum
Capacitive drive	500 pF maximum
Protection	Short circuit to ground
Gain error	Adjustable to zero
Unipolar zero error	200 µV maximum
Bipolar zero error	Adjustable to zero
Accuracy	±0.025% FSR
Settling time to 0.5 LSB	
(20 V step)	4 µsec
(10 V step)	3 µsec
(100 mV step)	2 µsec
Slew rate	20 V/µsec minimum, 30 V/µsec typical
Current outputs	
Type	4 to 20 mA current sink to ground
Output resistance	10^9 Ω minimum
Excitation voltage	+7 to +40 VDC (at connector pins)
Accuracy	±0.1% FSR
Slew Rate	7.5 mA/µsec
Protection	Short circuit and open circuit
DAC	
D/A type	PM7645HP
Digital inputs	Double-buffered, with simultaneous update capability
Resolution	12 bits (1 part in 4,096)
Integral nonlinearity	±0.5 LSB
Differential nonlinearity	±1.0 LSB (guaranteed monotonic)
Thermal characteristics	
Unipolar zero drift	1 µV/°C
Bipolar zero drift	±5 ppm of FSR/°C
Gain drift	±5 ppm/°C typical, ±10 ppm/°C maximum (excluding reference drift)
Reference drift	±5 ppm/°C typical, ±8.5 ppm/°C maximum
Monotonicity	Monotonic 0° to 70°C

THROUGHPUT

Single channel	350 kHz maximum
All 6 channels	58 kHz maximum

(limited by Macintosh memory access time)

POWER REQUIREMENTS (from NuBus)

+5 VDC	0.35 A typical
+12 VDC	65 mA typical + load
-12 VDC	60 mA typical + load Load is ±5 mA maximum

PHYSICAL

Dimensions	4.0 by 10.7 in.
I/O connector	50-pin male ribbon-cable connector

OPERATING ENVIRONMENT

Component temperature	0° to 70°C
Relative humidity	5% to 90% noncondensing

STORAGE ENVIRONMENT

Temperature	-55° to 150°C
Relative humidity	5% to 90% noncondensing

Part Numbers

NB-AO-6 and software*	776160-01
CB-50 I/O connector block (50 screw terminals)	
with 0.5 m ribbon-cable	776164-01
with 1.0 m ribbon-cable	776164-02

For NB Series RTSI bus cables refer to page 3-190

* Includes NI-DAQ for Macintosh software on 3.5 in. DS/DD diskettes.