United Electronic Industries

The High-Performance Alternative

DNx-AO-308-352
User Manual

8-Channel, 16-bit, ±13.5V,
±13.5mA Analog Output Board

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Specifications in this document are subject to change without notice. Check with UEI for current status.

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Chapter 1 Introduction

This document outlines the feature set and use of the DNx-AO-308-352, an 8-channel, medium voltage analog output board.

This following product versions are described in this manual:

- DNx-AO-308-352 16-bit, 8-channel, ±13.5V Analog Output Layer buffered output, excellent linearity, and low output noise

The following sections are provided in this chapter:

- Organization of this Manual (Section 1.1)
- AO-308-352 Board Overview(Section 1.2)
- DAC Output Capabilities (Section 1.3)
- DNx-AO-308 Board Series (Section 1.4)
- Device Architecture (Section 1.5)
- Layer Connectors and Wiring (Section 1.6)

1.1 Organization of this Manual

This AO-308-352 User Manual is organized as follows:

- **Introduction**

Chapter 1 provides an overview of the AO-308-352 features, device architecture, connectivity and logic.

- **Programming with the High-Level API**

Chapter 2 provides an overview of how to create a session, configure the session, and interpret results with the Framework API

- **Programming with the Low-Level API**

Chapter 3 is an overview of low-level API commands for configuring and using the AO-308-352 series board.

- **Appendix A - Accessories**

This appendix provides a list of accessories available for use with the AO-308-352 board

- **Index**

This is an alphabetical listing of the topics covered in this manual.

NOTE: A glossary of terms used with the PowerDNA Cube/RACK and I/O boards can be viewed or downloaded form www.ueidaq.com

Manual Conventions

To help you get the most out of this manual and our products, please note that we use the following conventions:

Tips are designed to highlight quick ways to get the job done or to reveal good ideas you might not discover on your own.

NOTE: Notes alert you to important information.

CAUTION! *Caution advises you of precautions to take to avoid injury, data loss, and damage to your boards or a system crash.*

Text formatted in **bold** typeface generally represents text that should be entered verbatim. For instance, it can represent a command, as in the following example: “You can instruct users how to run setup using a command such as **setup.exe**.”

Bold typeface will also represent field or button names, as in “Click **Scan Network**.”

Text formatted in `fixed` typeface generally represents source code or other text that should be entered verbatim into the source code, initialization, or other file.

Examples of Manual Conventions

Before plugging any I/O connector into the Cube or RACKtangle, be sure to remove power from all field wiring. Failure to do so may cause severe damage to the equipment.

Usage of Terms

Throughout this manual, the term “Cube” refers to either a PowerDNA Cube product or to a PowerDNR RACKtangle™ rack mounted system, whichever is applicable. The term DNR is a specific reference to the RACKtangle, DNA to the PowerDNA I/O Cube, and DNx to refer to both.

1.2 AO-308-352 Board Overview

The DNx-AO-308-352 boards are high-precision, medium voltage, 8-channel analog output boards.

DNA-AO-308-352, DNR-AO-308-352, and DNF-AO-308-352 board versions are compatible with the UEI cube, RACKtangle, and FLATRACK chassis respectively. These board versions are electronically identical and differ only in mounting hardware. The DNA version is designed to stack in a Cube chassis. The DNR/F versions are designed to plug into the backplane of a RACK chassis.

1.3 DAC Output Capabilities

The DNx-AO-308-352 board offers full 16-bit resolution and guarantees monotonicity over the entire operating range. The output voltage range of ±13.5V makes the AO-308-352 ideal for applications needing a little extra outside the standard ±10V. If your application requires voltage/current ranges outside of these specifications please review the next section detailing the DNx-AO-308 board series.

1.4 DNx-AO-308 Board Series

The DNx-AO-308 series of analog output boards includes the following products:

- DNx-AO-308 16-bit, 8-channel, ±10V Analog Output Board
- DNx-AO-308-350 16-bit, 8-channel, ±10V, High Current Analog Output Board
- DNx-AO-308-352 16-bit, 8-channel, ±13.5V Medium Voltage Analog Output Board
- DNx-AO-308-353 16-bit, 8-channel, ±40V, High Voltage Analog Output Board
- DNx-AO-308-420 16-bit, 8-channel, 4-20 mA Current Analog Output Board
- DNx-AO-308-020 16-bit, 8-channel, 0-20 mA Current Analog Output Board

This manual describes the DNx-AO-308-352 Medium Voltage, 16-bit, 8-channel, ±13.5V Analog Output Board only. The other products in the series are described in separate documents.

Using a DNx-AO-308-352 instead of a DNx-AO-308 boosts voltage capability to ±13.5V per channel and current output up to ±13.5mA per channel.

The technical specifications for the DNx-AO-308-352 Medium Voltage Analog Output Board are listed in **Table 1-1**.

Table 1-1. DNx-AO-308-352 Technical Specifications

Number of Channels	8
Resolution	16 bits
Max Update Rate: @ 16-bit resolution @ 12-bit resolution @ 9-bit resolution	 100 kHz/chan (800 kHz max aggregate) 200 kHz/chan (800 kHz max aggregate) 400 kHz/chan (800 kHz max aggregate)
Buffer Size	1 K samples
Type of D/A	double-buffered
INL (no load)	±1 LSB (0.003%)
DNL (no load)	±1 LSB (0.003%)
Monotonicity Over Temperature	16 bits
Gain Linearity Error	0.002%
Gain Calibration Error	±1 mV
Offset Calibration Error	±1 mV
Offset Drift	5 ppm/°C
Gain Drift	5 ppm/°C
Output Range	±13.5 V
Output Coupling	DC
Output Impedance	0.1Ω max
Current Drive	±13.5 mA/channel
Capacitive Loads	500 pF
Settling Time	10 µs to 16 bits
Slew Rate	10 V/µs
Isolation	350 Vrms
Power Consumption[1]	2.2 W - 5 W
Physical Dimensions	3.875″ x 3.875″ (98 x 98 mm)
Operating Temp. (tested)	-40 °C to +85 °C
Operating Humidity	0 to 95%, non-condensing

[1] If the total power consumption of the layer is over 4.5W, a DNA-FANx rear-mount cooling fan is required. Refer to the Typical Performance Characteristics for more detail.

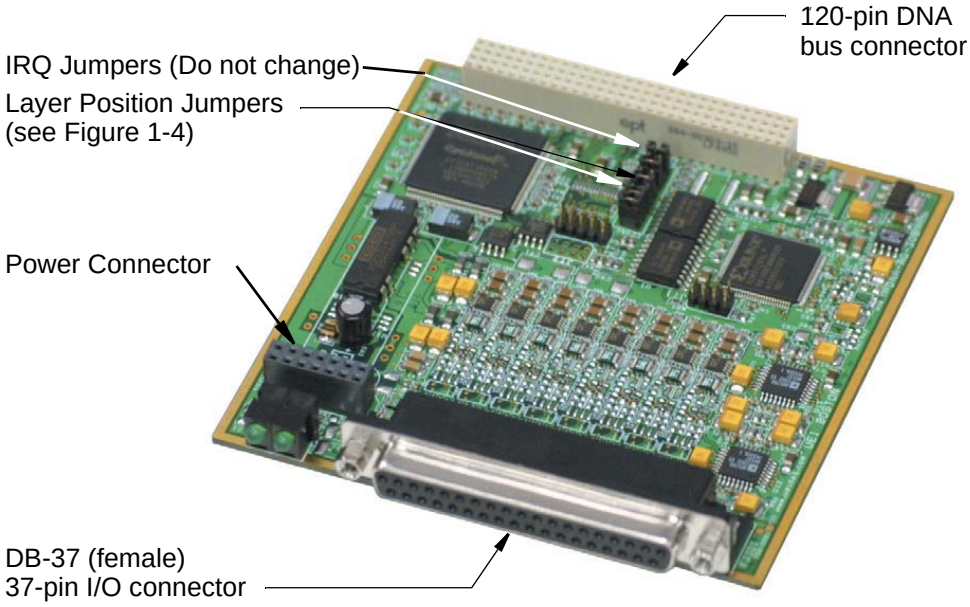

Figure 1-1. DNA-AO-308-352 Board

1.5 Device Architecture

The AO-308-352 Medium Voltage Analog Output board has eight individual analog output channels. **Figure 1-2** is a block diagram of the architecture of the AO-308-352 board

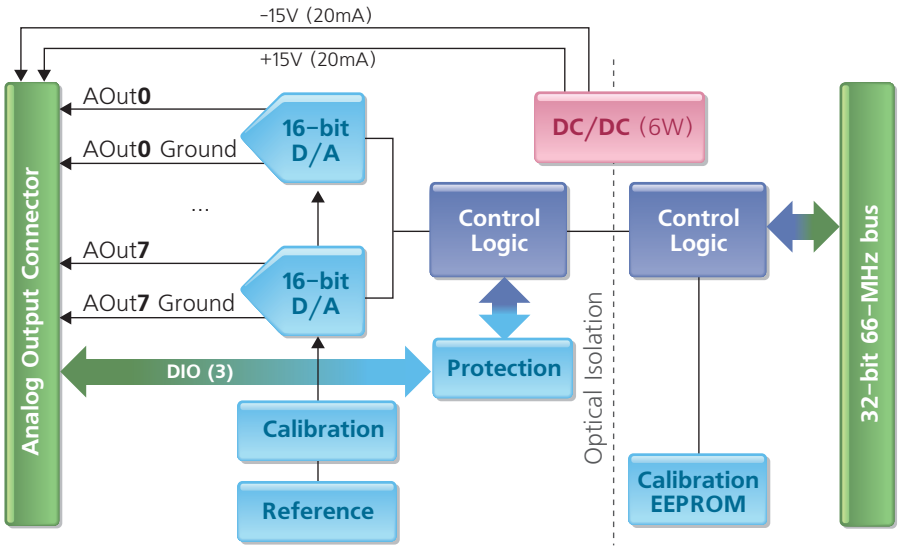

Figure 1-2. Block Diagram of DNA-AO-308-352 Device Architecture

1.6 Layer Connectors and Wiring

Since the DNx-AO-308-352 board is designed with output buffers, separate sense lines are not provided. To minimize error due to differences in lead resistance, be sure to use equal length signal and return lines.

1.6.1 Connectors

The pinout of the 37-pin connector for the DNx-AO-308-352 Layer board is shown in **Figure 1-3**. .

DB-37 (female)
37-pin connector:

AOUT0 GND	37	19	AGND
AGND	36	18	AOUT0
AOUT1	35	17	AOUT1 GND
AOUT2 GND	34	16	AGND
AGND	33	15	AOUT2
AOUT3	32	14	AOUT3 GND
AOUT4 GND	31	13	AGND
AGND	30	12	AOUT4
AOUT5	29	11	AOUT5 GND
AOUT6 GND	28	10	AGND
AGND	27	9	AOUT6
AOUT7	26	8	AOUT7 GND
+VEXT (140mA fused)	25	7	AGND
AGND	24	6	**–VEXT** (140mA fused)
AGND	23	5	AGND
DIO2	22	4	DIO1
AGND	21	3	DIO0
–15V (20mA) OUT	20	2	+15V (20mA) OUT
		1	AGND

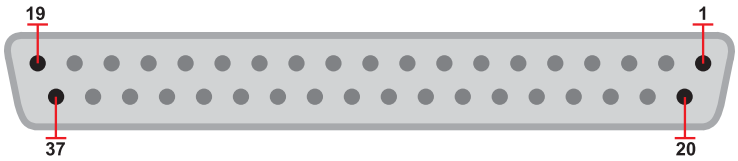

Figure 1-3 DB-37 I/O Connector Pinout of DNx-AO-308-352

Chapter 2 Programming with the High-Level API

This chapter provides the following information about using the UeiDaq high-level Framework API to program the AO-308-352:

- About the High-level Framework (Section 2.1)
- Creating a Session (Section 2.2)
- Configuring the Resource String (Section 2.3)
- Configuring the Timing (Section 2.4)
- Writing Data (Section 2.5)
- Cleaning-up the Session (Section 2.6)

2.1 About the High-level Framework

UeiDaq Framework is object oriented and its objects can be manipulated in the same manner from different development environments, such as Visual C++, Visual Basic, or LabVIEW.

UeiDaq Framework is bundled with examples for supported programming languages. Examples are located under the UEI programs group in:

- *Start » Programs » UEI » Framework » Examples*

The following sections focus on the C++ API, but the concept is the same no matter which programming language you use.

Please refer to the “UeiDaq Framework User Manual” for more information on use of other programming languages.

2.2 Creating a Session

The Session object controls all operations on your PowerDNx device. Therefore, the first task is to create a session object:

```
// create a session object for input

CUeiSession aoSession;
```

2.3 Configuring the Resource String

UeiDaq Framework uses resource strings to select which device, subsystem, and channels to use within a session. The resource string syntax is similar to a web URL:

```
<device class>://<IP address>/<Device Id>/<Subsystem><Channel list>
```

For PowerDNA Cubes and RACKs, the device class is **pdna**.

For example, the following resource string selects analog output lines 0,1,2,3 on device 1 at IP address 192.168.100.2: “pdna://192.168.100.2/Dev1/Ao0:3” as a range, or as a list “pdna://192.168.100.2/Dev1/Ao0,1,2,3”.

2.4 Configuring the Timing

You can configure the AO-308-352 to run in simple mode (point by point) or high-throughput buffered mode (ACB mode), or high-responsiveness (DMAP) mode.

In simple mode, the delay between output samples is determined by software on the host computer. In buffered mode, the delay between samples is determined by the AO-308-352 on-board clock (programmable) and data is transferred in blocks between PowerDNA and the host PC.

The following sample shows how to configure the simple mode. Please refer to the “UeiDaq Framework User’s Manual” to learn how to use other timing modes.

```
// configure timing of input for point-by-point (simple mode)
aoSession.ConfigureTimingForSimpleIO();
```

2.5 Writing Data

Writing data is accomplished using a *writer* object.

You can create a writer object that writes raw data straight to the D/A converter. You can also create a writer object that writes data scaled as volts or amps. Framework automatically performs a conversion to binary code before sending the data to the D/A converter.

The following sample code shows how to create a scaled writer object and write a sample:

```
// create a writer and link it to the session’s stream
CueiAnalogScaledWriter writer(aoSession.GetDataStream());
// the buffer must be big enough to contain one value per channel
double data[2] = {0.0, 0.0};
// write one scan, where the buffer will contain one value per channel
writer.WriteSingleScan(data);
```

Or you can create a writer object that writes raw data straight to the DAC.

```
// create a writer and link it to the session’s stream
CueiAnalogRawWriter writer(session.GetDataStream());
// the buffer must be big enough to contain one value per channel
uint16 data[2] = {0x1234, 0x5678};
// write one scan, where the buffer will contain one value per channel
writer.WriteSingleScan(data);
```

All the AO-308x analog output layers are programmed the same way.

2.6 Cleaning-up the Session

The session object will clean itself up when it goes out of scope or when it is destroyed. To reuse the object with a different set of channels or parameters, you can manually clean up the session with the `CleanUp` call as follows:

```
// clean up the sessions
aoSession.CleanUp();
```

Chapter 3 Programming with the Low-Level API

This chapter provides the following information about programming the AO-308-352 using the low-level API:

- About the Low-level API (Section 3.1)
- Low-level Functions (Section 3.2)
- Data Transfer Modes (Section 3.4)
- Programming the AO-308-352 (Immediate Mode) (Section 3.5)

3.1 About the Low-level API

The low-level API provides direct access to the DAQBIOS protocol structure and registers in C. The low-level API is intended for speed-optimization, when programming unconventional functionality, or when programming under Linux, Windows, or real-time operating systems.

When programming in Windows OS, however, we recommend that you use the UeiDaq high-level Framework API (see **Chapter 2**). The Framework simplifies the low-level API that makes programming easier and faster while still providing access to the majority of low-level API features. Additionally the Framework supports a variety of programming languages and the use of scientific software packages such as LabVIEW and Matlab.

For additional information regarding low-level programming, refer to the “PowerDNA API Reference Manual” located in the following directories:

- On Linux systems:
  <PowerDNA-x.y.z>/docs
- On Windows systems:
  Start » All Programs » UEI » PowerDNA » Documentation

3.2 Low-level Functions

Table 3-1 provides a summary of AO-308-352 functions, which are shared amongst the AO-308 series boards. All low-level functions are described in detail in the PowerDNA API Reference Manual.

Table 3-1 Summary of Low-level API Functions for DNx-AO-308-352

Function	Description
`DqAdv3xxWrite`	Write either floating point or raw values to AO-308 output.
`DqAdv3xxSetWForm`	Configure board for continuous waveform operation.
`DqAdv3xxWriteWFormCL`	Load repetitive waveform in to analog output board memory.
`DqAdv3xxEnableWForm`	Enable continuous waveform output.

3.3 Low-level Programming Techniques

Application developers are encouraged to explore existing source code examples when first programming the AO-308-352. Sample code provided with the installation is self-documented and serves as a good starting point.

Code examples are located in the following directories:

- On Linux systems: <PowerDNA-x.y.z>/src/DAQLib_Samples
- On Windows: *Start » All Programs » UEI » PowerDNA » Examples*

Sample code has the name of the I/O boards being programmed embedded in the sample name. For example, SampleVMap3xx contains sample code for running an AO-308-352 (and other AO-3xx products) in VMap mode. Refer to the low-level sample code `Sample30x` for an example of how to use the board in Immediate mode operation.

3.4 Data Transfer Modes

The AO-308-352 supports the following acquisition modes.

Immediate (point-to-point): Transfers a single data point per channel of a single I/O board at a non-deterministic pace. Runs at a maximum of 100 Hz.

RtDMap/RtVMap: Transfers samples as specified in a user-defined map of I/O boards and channels. The timebase is maintained by the host application. Designed for closed-loop (control) applications.

- RtDMap delivers 1 data sample per channel
- RtVMap delivers multiple samples per channel

ACB: Transfers a buffer of samples, where transfers are initiated by IOM firmware issuing event notifications when circular buffer crosses a user-defined frame boundary. Every data point is guaranteed but will have an intrinsic delivery delay. ACB is not appropriate for real-time control applications and is not supported for UEIPAC products.

API that implement data acquisition modes and additional mode descriptions are provided in the PowerDNA API Reference Manual.

3.5 Programming the AO-308-352 (Immediate Mode)

The following sections provide an overview of how to set up and use your AO-308-352 in Immediate Mode using the low-level API.

For best results, use this overview in conjunction with actual sample code, (e.g. Sample30x). This overview does not address all initialization or error handling. Refer to Section 3.3 for sample code location.

3.5.1 Configuring Output Channels

Users initialize a list of AO-308-352 channels to enable and output samples to.

```
uint32 cl[CHANNELS]; // CHANNELS is max of 8
```

You can enable channels sequentially or in whichever order you choose:

```
// to order channels sequentially in the channel list:
for (i = 0; i < CHANNELS; i++) {
      cl[i] = i;
}
```

3.5.2 Writing Output Data

In Immediate mode, use the `DqAdv3xxWrite()` API to write raw or floating point samples to each of the enabled channels (in the order of the channel list):

```
                uint16 data[CHANNELS];
                double fdata[CHANNELS];

while (!stop) {

    //set up data to be output
    for (i = 0; i < CHANNELS; i++) {
          data[i] = 0; // value isn't used, not sending raw data
          fdata[i] = nextSampleToOutput();   // -13.5V through 13.5V for AO-
308-352

    DqAdv3xxWrite(hd,        // handle to IOM
                  DEVN,      // device number of AO-308-352
                  CHANNELS,  // total number of channels enabled
                  cl,        // channel list configured in previous step
                  0,         // RawData flag (0 is FALSE, use floating pt)
                  data,      // array of raw data - not used if RawData==0
                  fdata);    // CHANNELS-size array of floating point data

    UeiPalSleep(500); // controls data output rate

}
```

Appendix A

A.1 Accessories

The following cables and STP boards are available for the AO-308-352 board.

DNA-CBL-37

This is a 37-conductor flat ribbon cable with 37-pin male D-sub connectors on both ends. The length is 3ft and the weight is 3.4 ounces or 98 grams.

DNA-CBL-37S

This is a 37-conductor round shielded cable with 37-pin male D-sub connectors on both ends. It is made with round, heavy-shielded cable; 3 ft (90 cm) long, weight of 10 ounces or 282 grams; also available in 10ft and 20ft lengths.

DNA-STP-37

The DNA-STP-37 provides easy screw terminal connections for all DNx series I/O boards which utilize the 37-pin connector scheme. The DNA-STP-37 is connected to the I/O board via either DNA-CBL-37 or DNA-CBL-37S cable. The dimensions of the STP-37 board are 4.2w x 2.8d x1.0h inch or 10.6 x 7.1 x 7.6 cm (with standoffs). The weight of the STP-37 board is 2.4 ounces or 69 grams.

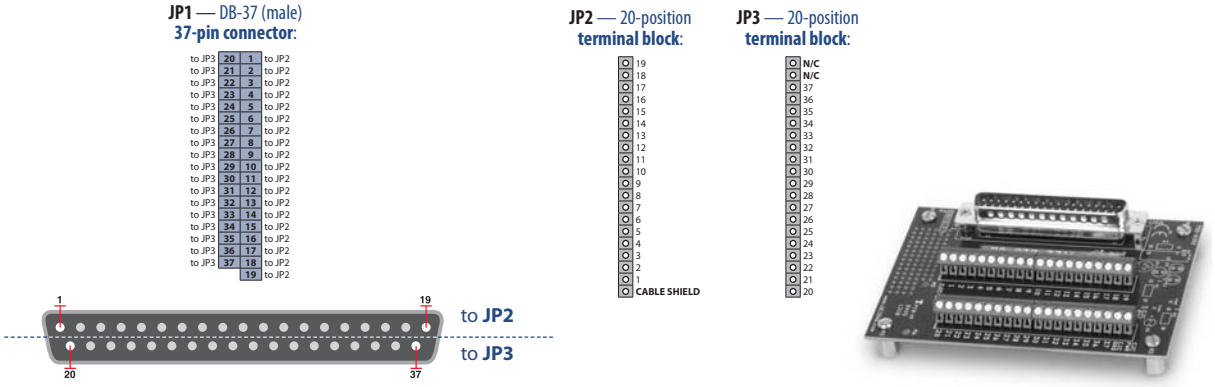

Figure A-1 Pinout and photo of DNA-STP-37 screw terminal panel

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