United Electronic Industries

The High-Performance Alternative

DNx-AO-358

—

User Manual

8-Channel, 4- and 6-wire, 120- 350- and 1000-ohm
Strain Gauge Simulator Layer
for the PowerDNA Cube and PowerDNR RACKtangle

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Chapter 1 Introduction

This document outlines the feature set and use of the DNR- and DNA-AO-358 layer. The AO-358 is a 8-channel strain gauge simulation module for the PowerDNA I/O Cube (DNA-AO-358) and the DNR-1G HalfRACK and RACKtangle chassis (DNR-AO-358). The DNR version is identical to the DNA version except that the DNR version is designed to plug into a RACKtangle backplane instead of a Cube chassis.

This manual describes the following products:

- DNA/DNR-AO-358-xxx 8-channel strain gauge simulator board(s where:
  xxx = 120 for versions fabricated with 120-ohm bridge resistors
  xxx = 350 for versions fabricated with 350-ohm bridge resistors
  xxx = 1k for versions fabricated with 1000-ohm bridge resistors
  -QH = suffix indicates a quarter/half bridge configuration
- Accessory products such as cables.

1.1 Organization of Manual

This AO-358 User Manual is organized as follows:

- **Introduction**
  This chapter provides an overview of DNx-AO-358 Strain Gauge Analog Output Board features, device architecture, connectivity, and logic.
- **Programming with the High-Level API**
  This chapter provides an overview of the how to create a session, configure the session, and generate output on the DNx-AO-358 with the UEIDAQ High-level Framework API.
- **Programming with the Low-Level API**
  This chapter is an overview of low-level API commands for configuring and using the AO-358 series layer.
- **Appendix A - Accessories**
  This appendix provides a list of accessories available for use with the DNx-AO-358 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 layers can be viewed and/or downloaded from 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**.”

Text formatted in `fixed` typeface generally represents source code or other text that should be entered verbadim 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 The AO-358 Interface Board

The DNA-AO-358 and DNR-AO-358 are 8 channel, strain gauge simulators designed for use in UEI's popular Cube and RACKTangle chassis respectively. The boards are based on actual variable resistors and will precisely duplicate the behavior of the gauges simulated.

The boards are an ideal solution for simulator applications where an on-board system device is expecting a strain gauge as an input. The boards are also an excellent solution for testing and diagnosing errors in a variety of strain gage based systems.

The boards are available in two configurations. The standard board supports simulation of full bridge strain gauges while the -QH versions support quarter and half bridge configurations. Both are available in standard 120, 350 and 1 kOhm configurations. Other resistance values are available on a special order basis. The DNx-AO-358 series is compatible with both DC and AC excitations and offers AC throughput bandwidth greater than 250 kHz.

All connections are made through a convenient 62-pin D connector ensuring OEMs may easily obtain mating cables or connectors. Users may also connect the DNx-AO-358 boards to our popular DNA-STP-62 screw terminal panel via the DNA-CBL-62 cable. The cables are fully shielded and are available in 2.5, 10 and 20 foot lengths.

As with all UEI PowerDNA boards, the DNx-AO-358 can be operated in harsh environments and has been tested at 5*g* vibration, 50*g* shock, -40 to +85°C temperature, and altitudes up to 70,000 feet or 21'000 meters. Each board provides 150 V_{rms} isolation between channels and also between the board and its enclosure or any other installed boards.

Software for the DNA/DNR-AO-358 is provided as part of the UEI Framework. The framework provides a comprehensive yet easy to use API that supports all popular Windows programming languages as well as supporting programmers using Linux and most real-time operating systems including QNX, VxWorks, RTX, RT-, Linux and more. Finally, the framework supplies complete support for those creating applications in LabVIEW, MATLAB/Simulink, DASYLab or any application supporting ActiveX or OPC servers.

1.3 Features

The AO-358 layer has the following features:

- 8 simulated strain gages
- 18-bit resolution
- ±15 V excitation range (3W max bridge power)
- Full, half, and quarter-bridge strain gauge simulator outputs
- 120*, 350-ohm, and 1000*-ohm standard configurations
- ±1.5% variable range
- 250 kHz minimum system bandwidth
- Weight of 136 g or 4.79 oz for DNA-AO-358; 817 g or 28.8 oz with PPC5.
- Tested to withstand 5g Vibration, 50g Shock, -40 to +85°C Temperature, and Altitude up to 70,000 ft or 21’000 meters.
- UEI Framework Software API may be used with all popular Windows programming languages and most real time operating systems such as RT Linux, RTX, or QNX and graphical applications such as LabVIEW, MATLAB, DASYLab and any application supporting ActiveX or OPC.

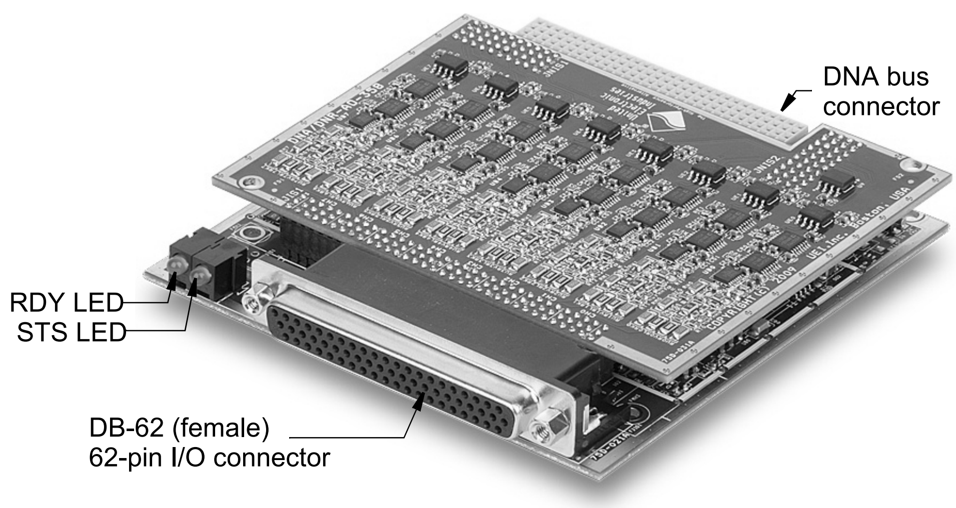
* by special order; see technical specification document. Please call for quantity, pricing, and delivery information.

1.4 Indicators

A photo of the DNx-AO-358 unit is illustrated below.

The front panel has two LED indicators:

- RDY: indicates that the layer is receiving power and operational.
- STS: can be set by the user using the low-level framework.



The DNA-AO-358 Analog-Input Layer

1.5 Specification

The technical specification for the DNx-AO-358 board are listed in **Table 1-1**.

Table 1-1. DNx-AO-358 Technical Specifications

Configuration	
Number of Channels	8
Bridge configurations	Full or Half/Quarter bridge
Strain Resistances	120, 350 and 1k Ω standard, other resistances available as special orders
Max / Min Excitation Voltage	+15 / -15 VDC (3 W max bridge power *Note 1* below/left)
Resistance Specifications	
Nominal resistance	
Variable resistor	± 1.0 %
Bridge completion resistors	± 0.1 %
Full scale resistance range	±1.5%
Resolution	
120 Ω gauges	0.46 mΩ
350 Ω gauges	1.33 mΩ
1 kΩ gauges	3.82 mΩ
Output resistance non-linearity	0.005% max
Dynamic Specifications	
Excitation frequency	DC to 25 kHz
System bandwidth	250 kHz, minimum
Resistance change update rate	0 - 5 kHz
Excitation Monitor Specifications	
Monitor Accuracy	±10 mV
General	
Power consumption	<3W, not including bridge IR dis
Operating range	Tested -40 to +85 °C
Humidity range	0-95%, non-condensing
Vibration *IEC 60068-2-6* *IEC 60068-2-64*	5 g, 10-500 Hz, sinusoidal 5 g (rms), 10-500Hz, broad-band random
Shock *IEC 60068-2-27*	50 g, 3 ms half sine, 18 shocks @ 6 orientations 30 g, 11 ms half sine, 18 shocks @ 6 orientations
Altitude	to 70,000 feet
MTBF	greater than 250,000 hours

Product	Description
DNx-AO-358-120*	8-Channel, 120 Ohm Full Bridge Strain Gauge simulator board (Order DNR-AO-series for RACKtangle chassis, DNA-AO-series for Cube chassis)
DNx-AO-358-120-QH*	8-Channel, 120 Ohm Quarter/Half Bridge Strain Gauge simulator board (Order DNR-AO-series for RACKtangle chassis, DNA-AO-series for Cube chassis)
DNx-AO-358-350	8-Channel, 350 Ohm Full Bridge Strain Gauge simulator board (Order DNR-AO-series for RACKtangle chassis, DNA-AO-series for Cube chassis)
DNx-AO-358-350-QH*	8-Channel, 350 Ohm Quarter/Half Bridge Strain Gauge simulator board (Order DNR-AO-series for RACKtangle chassis, DNA-AO-series for Cube chassis)
DNx-AO-358-1k*	8-Channel, 1000 Ohm Full Bridge Strain Gauge simulator board (Order DNR-AO-series for RACKtangle chassis, DNA-AO-series for Cube chassis)
DNx-AO-358-1k-QH*	8-Channel, 1000 Ohm Quarter/Half Bridge Strain Gauge simulator board (Order DNR-AO-series for RACKtangle chassis, DNA-AO-series for Cube chassis)
DNA-CBL-62	3 foot shielded cable connects DNx-AO-358 series boards to DNA-STP-62 screw terminal panels. (available in 2.5, 10 and 20 foot lengths)
DNA-STP-62	62-connection screw terminal panel

*Special order product, minimum purchase may be required. Please call for quantity, pricing and delivery information.

1.6 Device Architecture

Figure 1-1 is a block diagram of the architecture of the AO-358 layer.

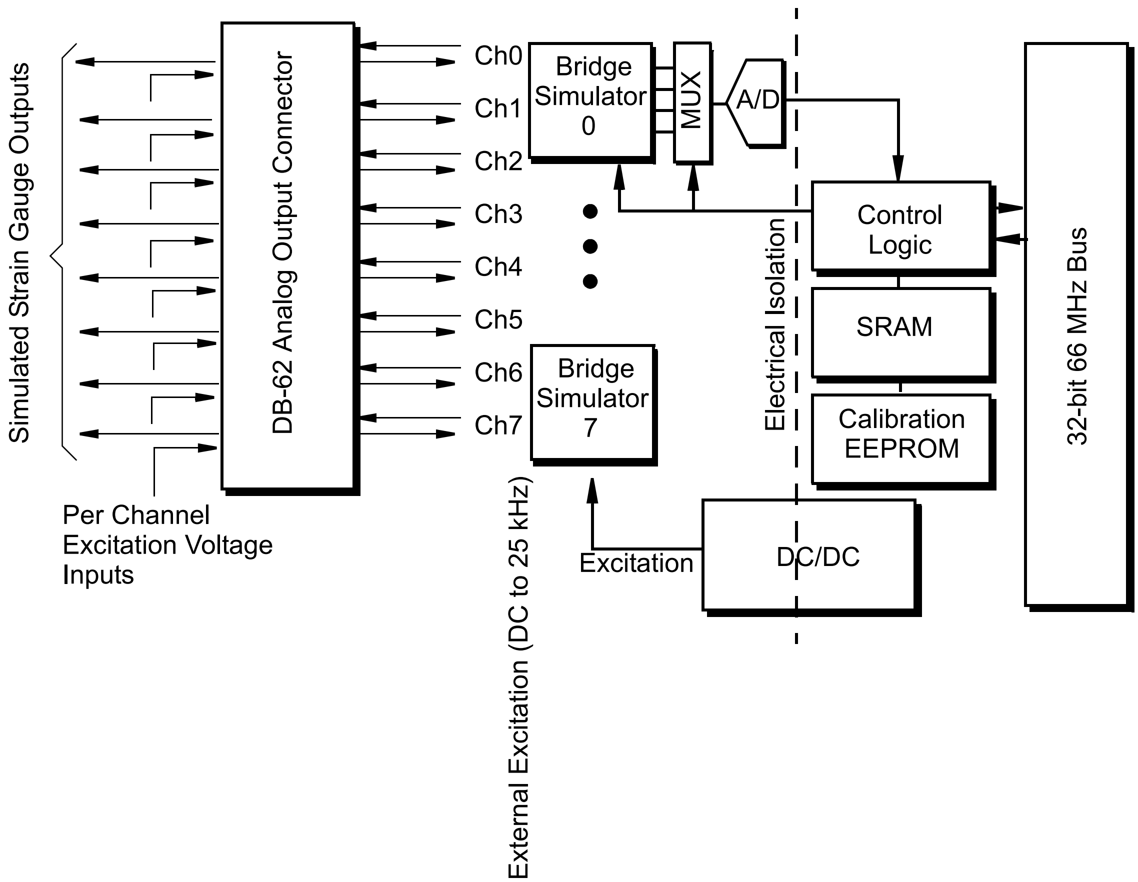
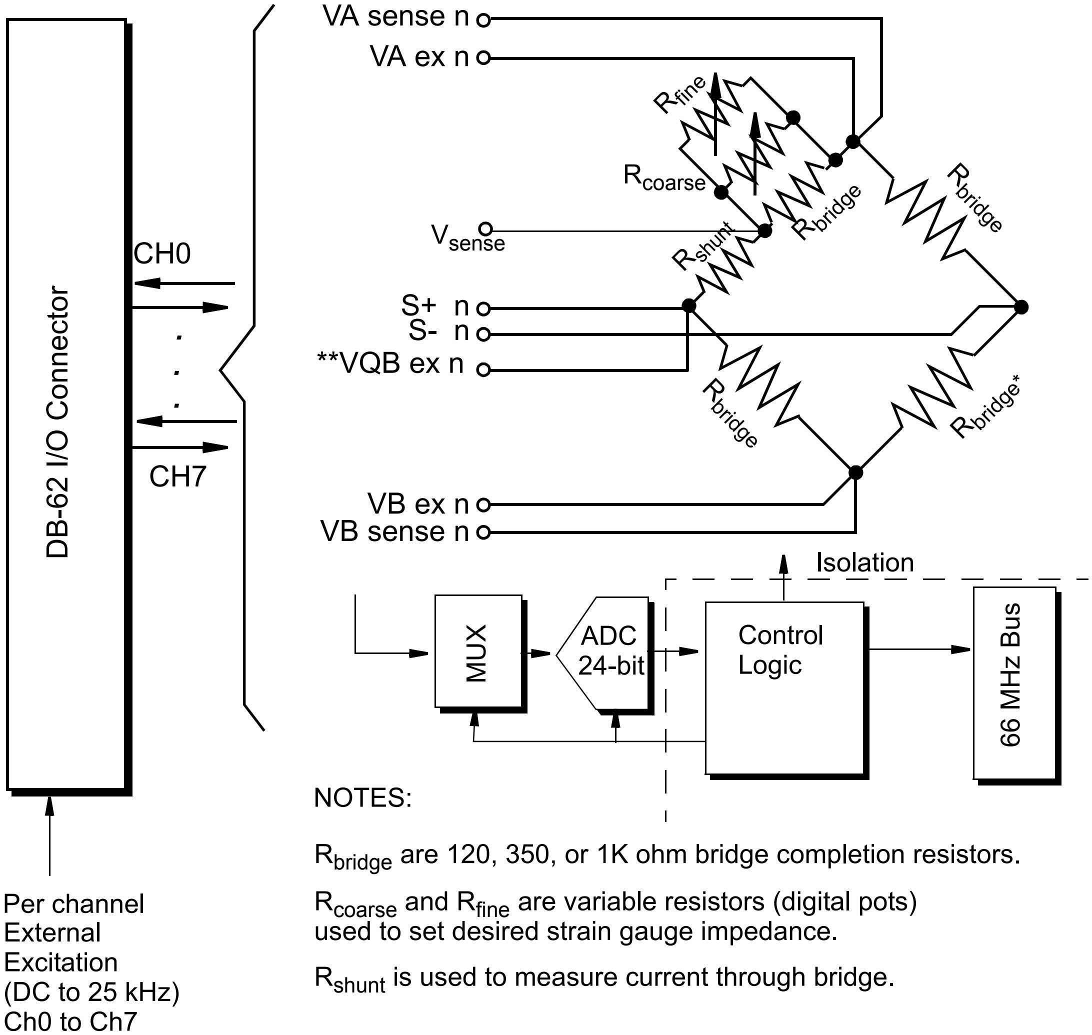


Figure 1-1. Block Diagram of the AO-358 Layer

The DNA/DNR-AO-358 Strain Gauge Simulator board has eight individual analog output channels. Each channel has its own MUX and sigma/delta A/D converter for the diagnostic and each channel is fully isolated from the others. A diagram of a typical strain gauge simulator (one of eight channels) is shown in **Figure 1-2**.

As shown in **Figure 1-1** and **Figure 1-2** show a MUX connects a 24-bit, slow A/D converter to various points in the associated strain gauge bridge simulator, which allows the AO-358 under software control to sense externally supplied excitation voltages (DC or AC), strain gauge and bridge resistances (both variable and fixed), current flow through the variable part of the bridge, and simulated bridge output voltage. For added accuracy, it also measures the ADC die temperature.

Digital potentiometers that form the variable resistances in the bridge may be accessed from registers or from the output channel list. Use of the channel list allows dynamic simulation of strain gauges, fast enough to allow simulation of vibration and other dynamic physical phenomena by the AO-358. Offset and gain adjustment of the digital pots are handled in the FPGA.



NOTES:

R_{bridge} are 120, 350, or 1K ohm bridge completion resistors.

R_{coarse} and R_{fine} are variable resistors (digital pots) used to set desired strain gauge impedance.

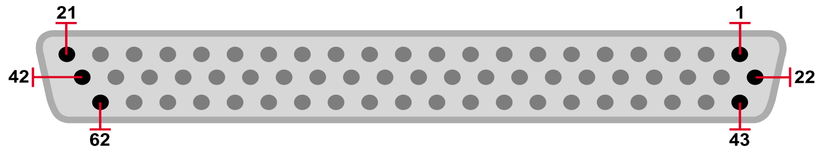
R_{shunt} is used to measure current through bridge.

*not installed on -QH versions of boards.
**provides excitation for Quarter Bridge configuration

Figure 1-2. Diagram of DNx-AO-358 Simulated Strain Gauge

1.7 Layer Connectors and Wiring

Figure 1-3 below illustrates the pinout of the AO-358.



Pin	Signal	Pin	Signal	Pin	Signal
1	VB ex 0	22	VQB ex 0	43	S– 0
2	VA sense 0	23	VB sense 0	44	S+ 0
3	n/c	24	VA ex 0	45	VQB ex 1
4	S+ 1	25	S– 1	46	n/c
5	VA sense 1	26	VB sense 1	47	VB ex 1
6	VQB ex 2	27	VA ex 1	48	VB ex 2
7	S+ 2	28	S– 2	49	n/c
8	VA sense 2	29	VB sense 2	50	VA ex 2
9	S+ 3	30	S– 3	51	VQB ex 3
10	VA sense 3	31	VB sense 3	52	VB ex 3
11	VQB ex 4	32	VA ex 3	53	S– 4
12	VA sense 4	33	VB sense 4	54	S+ 4
13	VB ex 4	34	VA ex 4	55	VQB ex 5
14	S+ 5	35	S– 5	56	VB ex 5
15	VA sense 5	36	VB sense 5	57	n/c
16	VQB ex 6	37	VA ex 5	58	VB ex 6
17	S+ 6	38	S– 6	59	n/c
18	VA sense 6	39	VB sense 6	60	VA ex 6
19	VB ex 7	40	VQB ex 7	61	S– 7
20	VA sense 7	41	VB sense 7	62	S+ 7
21	VA ex 7	42	n/c		

Figure 1-3. Pinout Diagram of the AO-358 Layer

The following table is provided as a convenient reference for connecting the various simulator I/O signals.

Table 1-2. Output Pin Connections by Channel

In/Out	Signal Name	Ch0	Ch1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7
Excitation Inputs	VA (+)	24	27	50	32	34	37	60	21
	VB (–)	1	47	48	52	13	56	58	19
Strain Gauge Outputs	VA sense	2	5	8	10	12	15	18	20
	VB sense	23	26	29	31	33	36	39	41
	VQB ex	22	45	6	51	11	55	16	40
	S+	44	4	7	9	54	14	17	62
	S-	43	25	28	30	53	35	38	61
	NC	3	46	49	--	--	57	59	42

The schematic circuit used for each strain gauge simulator is shown in **Figure 1-2** on page 9, where n indicates the channel number (0 to 7). Excitation voltage is applied between VA ex and VB ex and sensed between VA sense and VB sense. Bridge output is sensed between S+ and S-.

The R_{bridge} resistors form the bridge itself. The DNx-AO-358-350 version is a full bridge fabricated with 350 ohm bridge resistors; the DNx-AO-358-120 with 120-ohm resistors, and the DNx-AO-358-1k with 1000-ohm bridge resistors. The suffix -QH indicates a quarter/half bridge configuration instead of a full bridge.

1.8 Power Dissipation

The table below lists the maximum excitation voltages that may be used with the AO-358 in various types of bridges so as not to exceed power dissipation specs.

Bridge Power Dissipation note:

The total power dissipated by bridge resistors on the DNx-AO-358 board is limited to 3 Watt and no channel may dissipate more than 0.5 Watt. Though the excitation voltage limit is 15 VDC, when using 350 and 120 ohm versions of the board there are conditions when this 3 W limit will be exceeded if all channels are excited with 15 VDC. In addition to the board dissipation rate, no single channel may dissipate greater than 0.5 Watt. The table below describes the maximum excitation voltage that may be used on both a full-board and single channel basis for the three (full/half/quarter) configurations.

DNx-AO-358-120	*Full Bridge*	*Half Bridge*	*Quarter Bridge*
Max Excitation on all 8 channels	6.67 Vrms	9.5 Vrms	13.3 Vrms
Max Channels at 15 Vrms Excitation	n/a	3	6
Max Excitation on a single channel	7.5 Vrms	11 Vrms	15 Vrms

DNx-AO-358-350	*Full Bridge*	*Half Bridge*	*Quarter Bridge*
Max Excitation on all 8 channels	11.5 Vrms	15 Vrms	15 Vrms
Max Channels at 15 Vrms Excitation	4	8	8
Max Excitation on a single channel	13 Vrms	15 Vrms	15 Vrms

DNx-AO-358-1K	*Full Bridge*	*Half Bridge*	*Quarter Bridge*
Max Excitation on all 8 channels	15 Vrms	15 Vrms	15 Vrms
Max Channels at 15 Vrms Excitation	8	8	8
Max Excitation on a single channel	15 Vrms	15 Vrms	15 Vrms

Figure 1-4. Permissible Excitation Voltages for Various Bridge Types

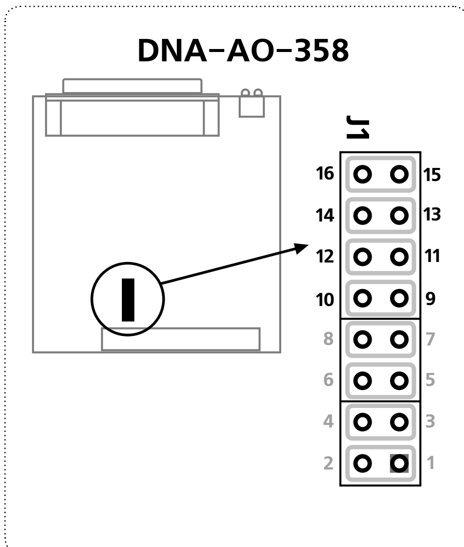
1.9 Jumper Settings for Board Position

This section briefly describes how to change jumper positions that indicate logical layer positioning in the uncommon case that you must physically swap layers on the PowerDNA I/O Cube (not PowerDNR RACKtangle).

All layers are assembled in Cubes before shipment with identifying labels, so you should never have to change a jumper setting unless you have to change a layer from one physical position to another in the field.

Figure 1-5 shows the physical layout of DNA-AO-358 Base Board (DNA-PL-61x), highlighted to show the 16-pin jumper block for setting the board position within the PowerDNA Cube.

NOTE: Board position jumpers are not provided with the DNR versions of AO-358. The physical position of the board within the DNR RACKTangle™ and HalfRACK enclosure is determined automatically by the system.



See Fig. 1-6 for placement of jumpers for various board positions in a Cube.

Figure 1-5. Jumper Block for DNA-AO-358 Board Position

A diagram of the jumper block is shown in **Figure 1-6**. To set the board position jumpers, place jumpers as shown in **Figure 1-6**.

		Layer's Position as marked on the Faceplate*					
		I/O **1**	I/O **2**	I/O **3**	I/O **4**	I/O **5**	I/O **6**
Jx Pins	9-10	Closed	Open	Closed	Open	Closed	Open
	11-12	Closed	Closed	Open	Open	Closed	Closed
	13-14	Closed	Closed	Closed	Closed	Open	Open
	15-16	Closed	Closed	Closed	Closed	Closed	Closed

* *All I/O Layers are sequentially enumerated from top to the bottom of the Cube*
○○ - **Open** ■■ - **Closed**

Figure 1-6. Diagram of DNA-AO-358 Board Position Jumper Settings

Chapter 2 Programming with the High Level API

This section describes how to control the DNx-AO-358 using the UeiDaq Framework High Level API.

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.

The following section focuses on the C++ API, but the concept is the same no matter what programming language you use.

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

2.1 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 session;
```

2.2 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 and RACKtangle, 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/Ai0:3” as a range, or as a list “pdna://192.168.100.2/Dev1/Ai0,1,2,3”.

2.3 Configuring Channels for Output

The AO-358 can be configured for analog output / strain gauge simulation:

```
// Configure channels 0,1 with an output range of ±10V
session.CreateAOChannel("pdna://192.168.100.2/Dev0/ao0:1",
                         -10.0, 10.0);
```

2.4 Configuring the Timing

You can configure the AO-358 to run in simple mode (point by point).

In simple mode, the delay between samples is determined by software on the host computer.

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)
aiSession.ConfigureTimingForSimpleIO();
```

2.5 Write Data

Writing data is done using *writer* object(s). 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(session.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);
```

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 as follows:

```
// clean up the session
session.CleanUp();
```

Chapter 3 Programming with the Low-level API

The PowerDNA cube and PowerDNR RACKtangle and HalfRACK can be programmed using the low-level API. The low-level API offers direct access to PowerDNA DAQBios protocol and also allows you to access device registers directly.

However, we recommend that, when possible, you use the UeiDaq Framework High-Level API (see **Chapter 2**), because it is easier to use. You should need to use the low-level API only if you are using an operating system other than Windows.

For additional information about low-level programming of the AO-358, please refer to the PowerDNA API Reference Manual document under:

Start » Programs » UEI » PowerDNA » Documentation

Refer to the PowerDNA API Reference Manual on how to use the following low-level functions of AO-358, as well as others related to cube operation:

Function	Description
`DqAdv358ExCalAccess`	Retrieves the extended calibration data for the AO-358.
`DqAdv358Write`	Write either floating point or raw values to AO-358 output.
`DqAdv358ReadADC`	Requests conversion results for each channel specified in the channel list and stores them alongside converted data.

Appendix A

A. Accessories

The following cables and STP boards are available for the AO-358 layer.

DNA-CBL-62

This is a 62-conductor round shielded cable with 62-pin male D-sub connectors on both ends. It is made with round, heavy-shielded cable; 2.5 ft (75 cm) long, weight of 9.49 ounces or 269 grams; up to 10ft (305cm) for the DNA-CBL-62-10 and 20ft (610cm) for the DNA-CBL-62-20.

DNA-STP-62

The STP-62 is a Screw Terminal Panel with three 20-position terminal blocks (JT1, JT2, and JT3) plus one 3-position terminal block (J2). The dimensions of the STP-62 board are 4w x 3.8d x1.2h inch or 10.2 x 9.7 x 3 cm (with standoffs). The weight of the STP-62 board is 3.89 ounces or 110 grams.

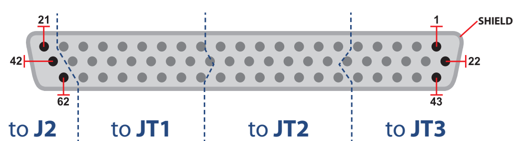
DB-62 (female)
62-pin connector:

62	to J2	42	to J2	21	to J2
61	to JT1	41	to JT1	20	to JT1
60	to JT1	40	to JT1	19	to JT1
59	to JT1	39	to JT1	18	to JT1
58	to JT1	38	to JT1	17	to JT1
57	to JT1	37	to JT1	16	to JT1
56	to JT1	36	to JT1	15	to JT1
55	to JT2	35	to JT1	14	to JT1
54	to JT2	34	to JT2	13	to JT2
53	to JT2	33	to JT2	12	to JT2
52	to JT2	32	to JT2	11	to JT2
51	to JT2	31	to JT2	10	to JT2
50	to JT2	30	to JT2	9	to JT2
49	to JT2	29	to JT2	8	to JT2
48	to JT3	28	to JT3	7	to JT2
47	to JT3	27	to JT3	6	to JT3
46	to JT3	26	to JT3	5	to JT3
45	to JT3	25	to JT3	4	to JT3
44	to JT3	24	to JT3	3	to JT3
43	to JT3	23	to JT3	2	to JT3
		22	to JT3	1	to JT3

JT3 — 20-position terminal block:	JT2 — 20-position terminal block:	JT1 — 20-position terminal block:
22	55	20
1	13	41
43	34	61
23	54	19
2	12	40
44	33	60
24	53	18
3	11	39
45	32	59
25	52	17
4	10	38
46	31	58
26	51	16
5	9	37
47	30	57
27	50	15
6	8	36
48	29	56
28	49	14
GND	7	35

J2 — 5-position terminal block:

5	SHIELD
4	GND
3	62
2	42
1	21



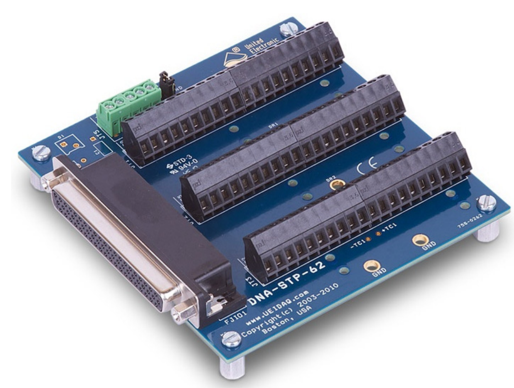


Figure A-1. Pinout and photo of DNA-STP-62 screw terminal panel

NOTE: If the total power consumption of the layer exceeds 4.5W, a rear mount cooling fan such as the DNA-FAN5 (for 3-layer Cube) or DNA-FAN8 (for 5-layer Cube) should be added to the DNA Cube.

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