United Electronic Industries

The High-Performance Alternative

DNx-AI-248-230

—

User Manual

24-Channel Analog Input Layer
for the PowerDNA Cube, PowerDNR RACKtangle, and PowerDNF FLATRACK

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PN Man-DNx-AI-248-230

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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 DNR- and DNA-AI-248-230 layer. The AI-248-230 is a four-channel strain gauge input module for the PowerDNA I/O Cube (DNA-AI-248-230) and the PowerDNR HalfRACK, RACKtangle, and the FlatRACK chassis (DNR-AI-248-230).

1.1 Organization of Manual

This AI-248-230 User Manual is organized as follows:

- **Introduction**
  This chapter provides an overview of DNx-AI-248-230 Analog Input 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 interpret results with the Framework API.
- **Programming with the Low-Level API**
  This chapter is an overview of low-level API commands for configuring and using the AI-248-230 series layer.
- **Appendix A - Accessories**
  This appendix provides a list of accessories available for use with the DNx-AI-248-230 board.
- **Index**
  This is an alphabetical listing of the topics covered in this manual.

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 AI-248-230 Interface Board

The DNA/DNR/DNF-AI-248-230 are 24 channel differential analog input boards for use in UEI's Cube/RACKtangle/FLATRACK I/O chassis respectively. The high channel count allows a single six slot "Cube" to monitor up to 144 analog inputs in a single 4.0" by 4.1" by 5.8" package while the 12-slot RACKtangle chassis monitors up to 288 channels in a 3U rack.

The -2 to +31 Volt input range makes the AI-248-230 an ideal measurement solution in a host of automotive, aerospace and power generation applications where most DAQ product's 10 volts maximum input range cannot be used without external signal conditioning. Programmable gains of between 1 and 1000 combined with the board's 18-bit A/D converter provides resolution as low as 0.25 microvolt.

The AI-248-230 provides sample rates as high as 250 samples per second on each channel (6 k/s aggregate). Another great feature, the oversampling engine, allows AI-248-230 to automatically acquire as many samples as possible for the given gain/speed and average them, thus dramatically improving noise immunity.

One of the most powerful features of the DNx-AI-248-230 is automated offset compensation which can remove offset fluctuations over the temperature and/or time. This allows reduction of the temperature drift to a few microvolts over the full specified range.

The AI-248-230 offers 350 Vrms of isolation between itself and other I/O boards as well as between the I/O connections and the chassis. Like all UEI "Cube" compatible I/O boards, the AI-248 offers operation in extreme environments and has been tested to 5g vibration, 100g shock, from -40 to +85 °C temperatures and at altitudes up to 70,000 feet.

The board is supported by a variety of cable and screw terminal options certain to meet the needs of almost all users. For those wishing to create their own cables, all connections are through a standard 62-pin "D" connector allowing OEM users to build custom cabling systems with standard, readily available components.

The AI-248-230 is supported by a complete software "suite" including support for Windows, Linux and all popular RTOS. Windows support is provided by the UEIDAQ Framework which includes a simple and complete software interface to all popular Windows programming languages and DAQ applications including LabVIEW, MATLAB and DasyLAB. An extensive factory written software suite is also provided for all popular "non-Windows" operating systems including Linux, VXworks, QNX, RTX, INtime and more. All software support includes extensive example programs that make it easy to cut-and-paste the I/O software into your applications.

1.3 Features

The AI-248-230 layer has the following features:

- 24 differential analog input channels
- Maximum sampling rate of 250 Hz per channel
- 18-bit resolution
- Wide input range:
  - -2 V to +31 V full scale inputs at Gain=1
  - -0.002V to 0.032V at Gain=1000 unipolar
  - ±31V referenced differential (-4/+31V common signal mode range)
- Dynamic autozero support
- Embedded averaging engine
- 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

1.4 Specification

The technical specification for the DNx-AI-248-230 board are listed in **Table 1-1**.

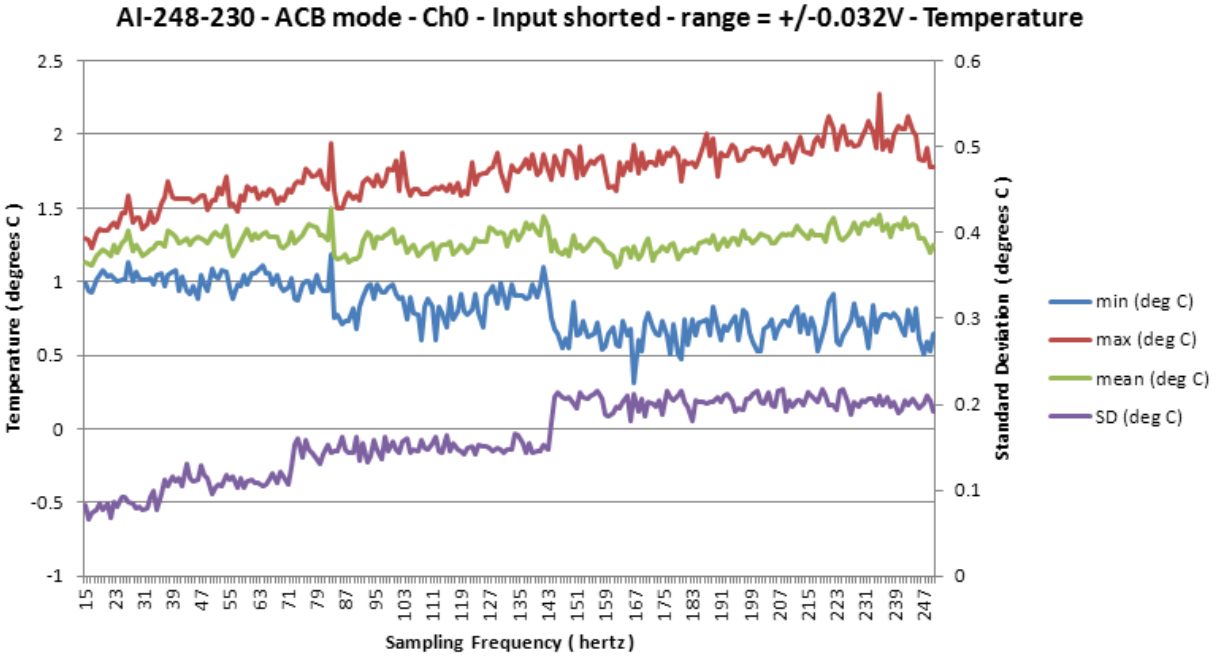
Table 1-1. DNx-AI-248-230 Technical Specifications

Technical Specifications:

Analog Inputs	
Number of channels	24 fully differential inputs plus 1 single-ended dedicated CJC channel
Input configuration	Multiplexed
ADC resolution	18 bits
Sampling rate	250 samples/s per channel, maximum (6 kS/s aggregate)
Input Ranges	-2 Volt to + 31 Volt (G=1)
Gains	1, 10, 100 or 1000
Minimum resolution	0.25 µV (Gain = 1000)
Input bias current	±5 nA max, ±0.5 nA typical
Input impedance	10MΩ
Common mode rejection	100 dB typical
Power supply rejection	> 120 dB
Accuracy (25 °C)	
Gain = 1	± 1.47 mV
Gain = 10	± 0.293 mV
Gain = 100	68 µV
Thermocouple (Type/Acc)	K / ±1.25 °C, J / ±1.9 °C, T / ±1.9 °C (using DNA-STP-AI-U for CJC measurement)
Isolation	350 Vrms
Overvoltage protection	-40V to +55V
General Specificationsvv	
Operating temperature	tested -40 °C to +85 °C
Vibration *IEC 60068-2-6* *IEC 60068-2-64*	5 g, 10-500 Hz, sinusoidal 5 g (rms), 10-500 Hz, broad-band random
Shock *IEC 60068-2-27*	100 g, 3 ms half sine, 18 shocks @ 6 orientations 30 g, 11 ms half sine, 18 shocks @ 6 orientations
Humidity	0 to 95%, non-condensing
Power consumption	3.0 W max
Altitide	120,000 ft
MTBF	550,000 hours

1.4.1 Characteristic Graphs

The following chart shows the thermocouple accuracy statistic over the -0.002 to 0.032V range at 1000x gain which represents a range of 800°C. The Type K thermocouple is wired into a DNA-STP-AI-U terminal panel connected to the DNR-AI-248-230 analog input board (see Appendix for terminal panel).



1.5 Device Architecture

Figure 1-1 is a block diagram of the architecture of the AI-248 layer.

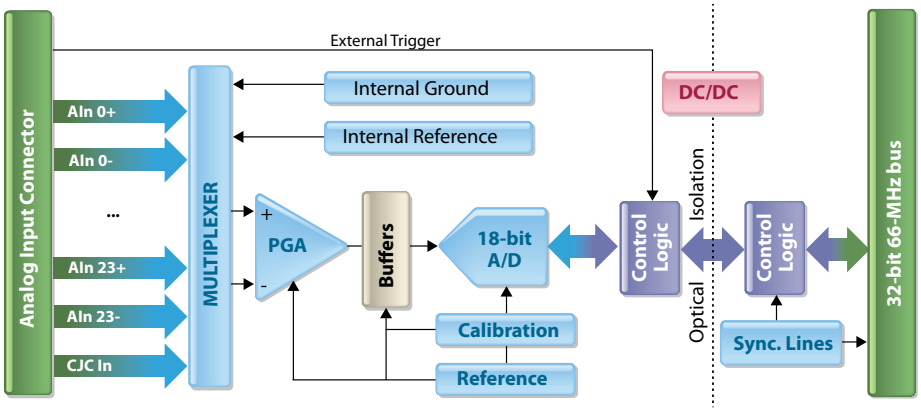


Figure 1-1. Block Diagram of the AI-248 Layer

The analog measurement voltages from each channel, as shown in **Figure 1-1**, are fed through input multiplexers to a programmable gain amplifier, buffered, then passed to the A/D converter. The A/D converter is a successive approximation 18-bit device, which also performs signal averaging for further noise reduction. The result is then processed and buffered in the control logic and provided across the 32-bit PowerDNx bus to the CPU layer to be transmitted over the network to the host in the normal manner.

1.6 Indicators

A photo of the DNx-AI-248-230 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.

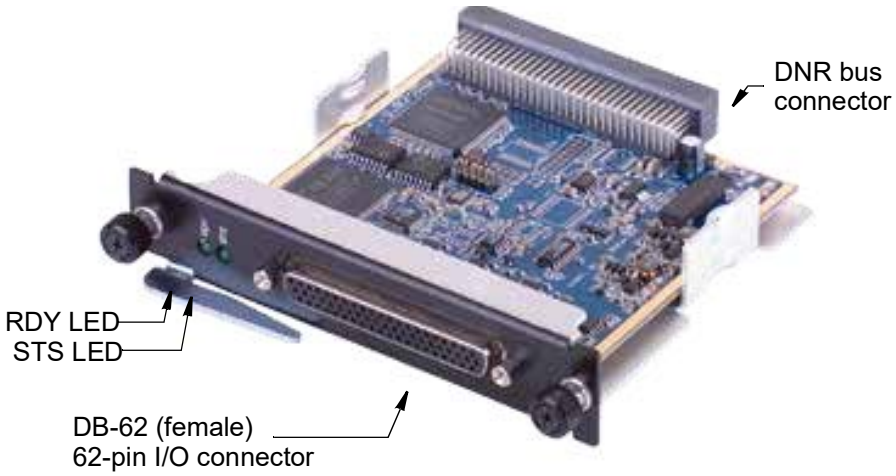
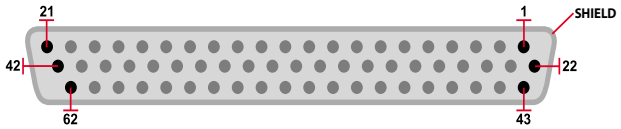


Figure 1-2. The DNA-AI-248-230 Analog-Input Layer

1.7 Layer Connectors and Wiring

Figure 1-3 below illustrates the pinout of the AI-248-230. The pinout is pin-compatible with the AI-225 and can be used with the DNA-STP-AI-U.



Pin	*Signal*	*Pin*	*Signal*	*Pin*	*Signal*
1	Rsvd	22	Rsvd	43	Gnd
2	Rsvd	23	Gnd	44	DIO 2
3	Rsvd	24	Gnd	45	Gnd
4	CJC In	25	CJC Ret	46	AIN 23-
5	AIN 22-	26	AIN 23+	47	AIN 22+
6	AIN 21+	27	AIN 21-	48	AIN 20-
7	AIN 19-	28	AIN 20+	49	AIN 19+
8	AIN 18+	29	AIN 18-	50	AIN 17-
9	AIN 16-	30	AIN 17+	51	AIN 16+
10	AIN 15+	31	AIN 15-	52	AIN 14-
11	AIN 13-	32	AIN 14+	53	AIN 13+
12	AIN 12+	33	AIN 12-	54	AIN 11-
13	AIN 10-	34	AIN 11+	55	AIN 10+
14	AIN 9+	35	AIN 9-	56	AIN 8-
15	AIN 7-	36	AIN 8+	57	AIN 7+
16	AIN 6+	37	AIN 6-	58	AIN 5-
17	AIN 4-	38	AIN 5+	59	AIN 4+
18	AIN 3+	39	AIN 3-	60	AIN 2-
19	AIN 1-	40	AIN 2+	61	AIN 1+
20	AIN 0+	41	AIN 0-	62	DIO 0
21	Rsvd	42	Rsvd		

Figure 1-3. Pinout Diagram of the AI-248-230 Layer

Chapter 2 Programming with the High Level API

This section describes how to control the DNx-AI-248-230 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 aiSession;
```

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 input 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 for Input

The AI-248-230 can be configured for strain gauge input.

The gain to be applied on each channel is specified with low and high input limits.

For example, the AI-248 available gains are 1, 10, 100, 1000 and the maximum input range is -2V to 31V differential span.

To select a gain of 1, you must specify input limits of [-2V, 31V]:

```
// Configure channels 0,1 to use gain 128 in differential mode

aiSession.CreateAIChannel(“pdna://192.168.100.2/Dev0/Ai0,1”,
                          -2,
                           31,
                          UeiAIChannelInputModeDifferential);
```

Be mindful of your gain setting. Note that when reading any of the channels, that saturation or clipping can occur if the gain is too high, making the value appear stuck at the highest or lowest value. Try a lower gain value, or begin with one.

2.4 Configuring the Timing

You can configure the AI-248-230 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 samples is determined by software on the host computer. In DMAP mode, the delay between samples is determined by the AI-248-230 on-board clock and data is transferred one scan at a time between PowerDNA and the host PC. In buffered mode, the delay between samples is determined by the AI-248-230 on-board clock 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)
aiSession.ConfigureTimingForSimpleIO();
```

2.5 Read Data

Reading data is done using *reader* object(s). The following sample code shows how to create a scaled reader object and read samples.

```
// create a reader and link it to the analog-input session’s stream
CUeiAnalogScaledReader aiReader(aiSession.GetDataStream());
// the buffer must be big enough to contain one value per channel
double data[2];
// read one scan, where the buffer will contain one value per channel
aiReader.ReadSingleScan(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
aiSession.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 AI-248-230, 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 AI-248-230, as well as others related to cube operation:

Function	Description
`DqAdv248Read`	Returns continously sampled data from input channel.

Appendix A

A. Accessories

The following cables and STP boards are available for the AI-248-230 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) and 20ft (610cm).

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.

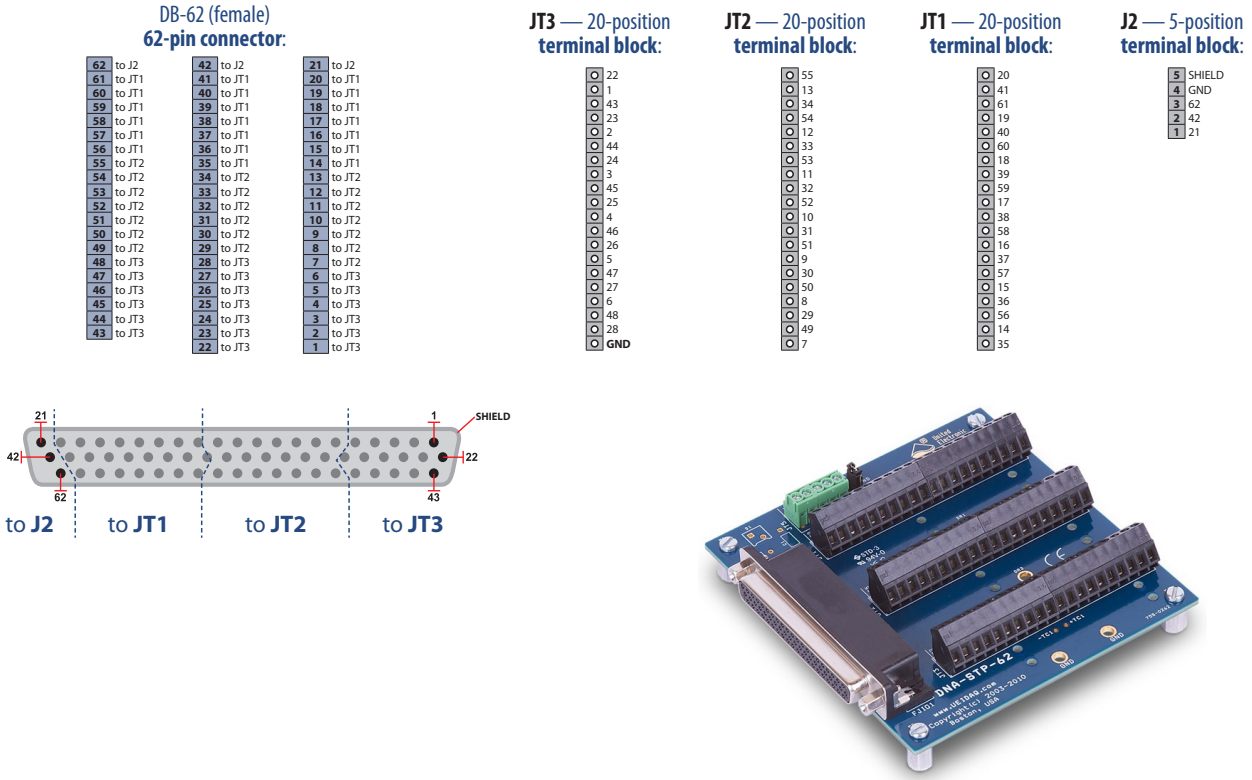
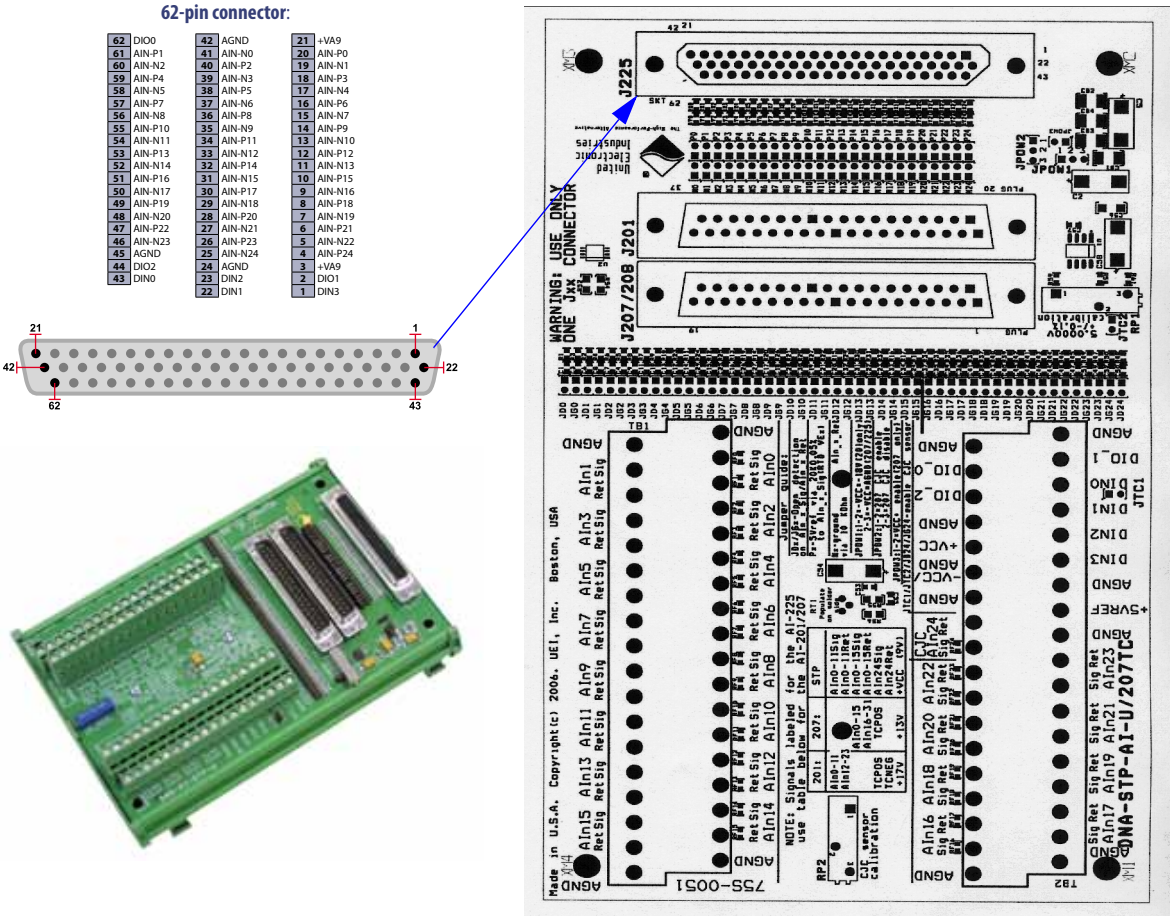


Figure A-1. Pinout and photo of DNA-STP-62 screw terminal panel

DNA-STP-AI-U

The STP-AI-U is a Screw Terminal Panel with built-in cold-junction compensation (CJC) designed to connect to the AI-248 with the DNA-CBL-62 cable. The STP-AI-U is connected to an AI-248 like the AI-225, they are pin-compatible.

Unlike most conventional STP panels, the DNA-STP-AI-U uses a 4-layer PCB design which ensures the highest quality low-level analog signals. This terminal panel features per-channel jumper-selectable configuration including voltage RTD (resistance temperature device) excitation, 10MΩ or 10kΩ pull-down resistors, as well as 10MΩ pull-up resistors to 1/101 of the power supply rail. In addition to that, all input signals may be filtered with the simple RC (22.1Ω / 0.1µF) filter. The terminal also incorporates an isothermal block and calibratable CJC (cold-junction compensation) sensor mounted directly on the panel. For the precision sensors and RTD devices, the panel offers 3ppm/°C stable 5.000V reference with calibration range ±0.2%.



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