United Electronic Industries

The High-Performance Alternative

DNA/DNF/DNR-DIO-463 Guardian™

—

User Manual

12-Channel Solid-State Relay Output Board
with Guardian functionality
for the PowerDNA Cube and PowerDNR RACKtangle

Release 4.7

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Chapter 1 Introduction

This document outlines the feature-set and use of the DIO-463 layer. This layer is a solid-state relay output interface module for the PowerDNA I/O Cube and RACKtangle.

1.1 Organization of Manual

This DIO-463 User Manual is organized as follows:

- **Introduction**
  This section provides an overview of DIO-463 solid-state relay output board features, the various models available and what you need to get started.
- **The Guardian-series DNA/DNF/DNR-DIO-463 Layer**
  This chapter provides an overview of the device architecture, connectivity, and logic of the DIO-463 layer.
- **Programming with the High-Level API**
  This chapter provides an overview of the how to create a session, configure the session, and interpret results on the DIO-463 series layer.
- **Programming with the Low-Level API**
  Low-level API commands for configuring and using the DIO-463 series layer.
- **Appendix A - Accessories**
  This appendix provides a list of accessories available for use with the DIO-463 layer.
- **Appendix B - Precautions**
  This appendix provides a list of precautions for solid-state relays.
- **Index**
  This is an alphabetical listing of the topics covered in this manual.

1.2 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.

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.

1.3 The DIO-463 Layer

The DNA-DIO-463, DNR-DIO-463, DNF-DIO-463 are 12-channel, solid-state relay boards designed for use with UEI's "Cube", RACKtangle and FlatRACK chassis, respectively. Electronically, they are identical. Relays are in a Form A (SPST) configuration and are rated for continuous operation at 2A at 51 VDC, Solid state contacts ensure many more operations than electromechanical relays and are also silent. The board provides an ON resistance of less than 150 milliohms and update rates up to 125 Hz.

The DIO-463 is part of UEI's Guardian series. It not only controls the relay outputs, it also provides a powerful output monitoring capability. An onboard A/D converter allows you to monitor DC output voltages (relative to the common terminal) and DC output current. This allows the application to detect short and open circuits as well as other "suspicious behavior". The monitoring capability is also a powerful diagnostic tool that allows a repair technician to quickly and accurately identify damaged or mis-wired channels.

The Guardian advantage also includes programmable overcurrent protection – the user may select the overload current up to one second before the channel is shut down. Each board provides 350 Vrms isolation between channels, as well as between the board, cube, and other installed I/O boards.

All connections are made through 37-pin D connectors that ensure that mating cables or connectors are readily available. Users may also use the DNASTP-37 screw terminal panel via DNA-CBL-37 or -37S series cables.

The DNx-DIO-463 includes software drivers supporting all popular operating systems including: Windows, Linux, QNX, VXWorks, RTX,and other popular Real-Time Operating Systems. Our UEIDAQ Framework provides Windows users a simple and complete software interface to all popular programming languages and data acquisition and control applications (e.g., LabVIEW, DASYLab, MATLAB).

1.4 Features

The DIO-463 layer has the following features:

- 2 A continuous output current at 48 VDC or 35 VAC
- Fully solid state contacts
- 150 milliohm "ON" resistance
- Output throughput rate of 125 updates per second
- Guardian-series Diagnostics
  - Programmable overcurrent protection (50 mA to 2 A)
  - Programmable overcurrent duration limits
  - Monitors each channel's output voltage and current allowing automatic detection of shorts/open and other system failures
- Weight of 120 g / 4.24 oz for DNA-DIO-463; 630 g / 22.2 oz with PPC5
- 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

1.5 Specification

The technical specifications for the DIO-463 are listed in the table below:

Table 1-1. DNx-DIO-463 Technical Specifications

Output specifications	
Rated Load (< 50 °C)	2 A at 48 VDC or 35 VAC continuous
Rated Load (85 °C)	1 A at 48 VDC or 35 VAC continuous
Rated Load (50 - 85 °C)	derate linearly between 2A and 1A
Max Operating Voltage	51 VDC (DC voltage or peak AC)
Min Permissible Load	none
Contact ON impedance	150 mOhm max (at the I/O connector)
Contact OFF impedance	>2 MOhm
Off Leakage Current	< 50 µA
Turn-On Time	6 mS max
Turn-Off Time	2 mS max
Max Operating Freq.	125 operations/second (36000/hour limit)
Monitor/circuit breaker specs	(see note 1 below)
Resolution	16 bits
Range	±55 VDC
	0 - 2 A DC
	0.3-2 A AC
	-55/+100 °C
Accuracy	
DC Voltage	5% of measurement + 0.25% of the full scale
DC Current	5% of measurement + 0.25% of the full scale
Relay Temperature	±2 °C typ
Protection	(only one type activated per channel)
DC Voltage	±5 V to ±51 V
DC Current	50 mA to 2 A
Relay Temperature	0 - 85 °C
Disconnection Time	1 sec
Power up / reboot state	Off
Power dissipation	< 2.5 W
Isolation	350 Vrms
Operating Temp. Range	Tested -40 to +85 °C
Operating Humidity	95%, non-condensing
Vibration *IEC 60068-2-6*	5 g, 10-500 Hz, sinusoidal
IEC 60068-2-64	5 g (rms), 10-500 Hz, 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
MTBF	260,000 hours

NOTE: 1: The DNx-DIO-463 is targetted at DC applications. Though the solid state relay used allows for AC operation, the automatic, programmable output protection mode is only supported in DC applications when the NO input (see connector pinout) is used as the + (positive) terminal, while the COM terminal is connected at the - (negative). DC users should pay careful attention to the polarities. AC users are advised to insert external current protection if the application requires it.

1.6 Device Architecture

The DIO-463 is similar to the DIO-462, but uses solid-state relays that are Form A (normally open) instead of Form C (transfer) electromechanical relays, thus allowing longer, silent, bounceless, spark-less switching in exchange for semi-conductor characteristics like non-linearity, higher “on” resistance, “off” reverse leakage current, “shorted” on fail, and vulnerability to overloads. The DIO-462 and DIO-463 are pin-compatible (the 462’s normally-closed line is ignored).

An architecture block diagram is shown in **Figure 1-1**:

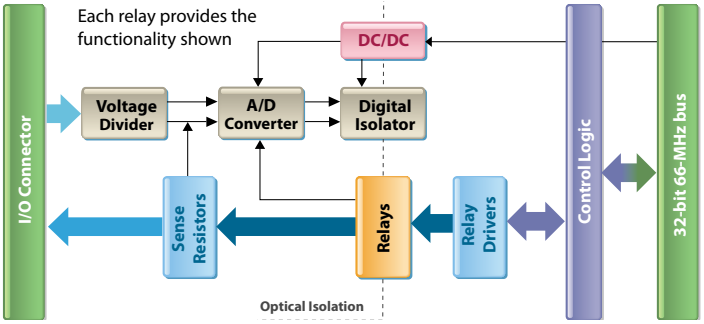

Figure 1-1. Architecture Block Diagram of DNA-DIO-463

Note that the I/O part of the layer is isolated from the logic interface and that overload protection is provided on all output lines.

1.6.1 Guardian Feature

As shown in **Figure 1-1** the Guardian feature of the DIO-463 monitors the voltage drop across a series resistor in the circuit of each output relay, continuously sensing AC current, DC current, and output voltage relative to the COM terminal. An on-board ADC detects undercurrent, overcurrent, shorts, opens, and other off-normal conditions (such as high/low temperature), all of which are user-programmable as to magnitude and/or duration.

The Guardian feature is a valuable diagnostic and troubleshoooting tool for ensuring system uptime.

1.6.2 Circuit Breaker Function

The DIO-463 can be programmed to provide a circuit breaker function when any of the measurements exceeds a user-defined limit.

After a fault is detected, this circuit breaker function can be set to re-connect in either of 2 ways:

- **Auto reconnect:** In this mode, the board will reconnect after a 1 second delay and test the limit again. This will result in the relay continually cycling on and off until the overlimit condition is resolved.
- **User re-enable:** In this mode, the relay will be set to the OFF state and remain there until the user software re-writes the ON command to the relay.

A ‘1’ written to the digital output for any given relay will switch the relay ON, which allows current to flow from COM (-) to the N.O. (+) contact. The circuit breaker function always acts to return the relay to the ‘0’ or OFF state, which will prevent current from flowing between the COM and the N.O. contact. The user program can always read the voltage across the relay regardless of which state the relay is in because it flows through a parallel voltage sensing circuit. Note however that the circuit breaker function only works for DC (not AC).

The limit set function used by the circuit breaker always assumes that a direct current (DC) farther from zero is greater than one that is closer to zero. For example, a current limit of +200mA will disconnect when a current of +201mA is detected and a current limit of negative 200mA will disconnect with a current of -201mA.

1.6.3 Operating Precautions

Do not apply current or voltage exceeding the maximum rated range:

- Load voltage (AC peak or DC): 51 V
- Continuous load current (AC peak or DC): 2 A

Do not apply a short-circuit current to the load side (this is a common error) as this may cause the relay to blow (fail permanently). A bi-directional 51V TSV should prevent this much damage to the relays, but note that solid-state relays can fail in a permanently “ON” state. See “Precautions for MOS FET Relays” on page 11 of the Appendix for more precautions for Solid State Relays.

1.7 Layer Connectors and Wiring

Figure 1-2 shows the pinout of the 37-pin female connector of the DIO-463:

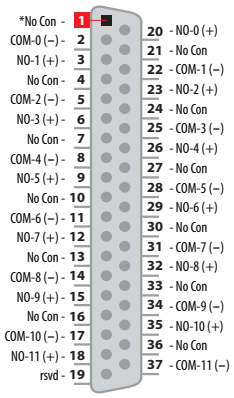

Figure 1-2. DB-37 I/O Connector Pinout for DIO-463

1.7.1 Indicators

A photo of the DIO-463 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.

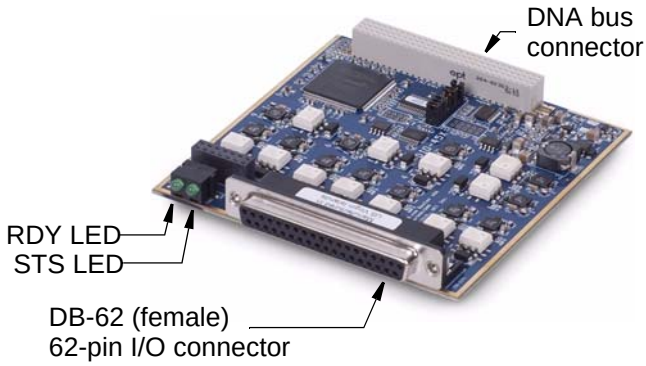

Figure 1-3. Photo of DIO-463 Digital Input Layer

Chapter 2 Programming with the High Level API

This section describes how to control the DNx-DIO-463 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

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 digital output lines 0,1,2,3 on device 1 at IP address 192.168.100.2: “pdna://192.168.100.2/Dev1/Do0,1,2,3”

NOTE: In Framework, a digital channel corresponds to a physical port on the device. You cannot configure a session only to access a subset of lines within a digital port.

NOTE: Sessions are unidirectional. The DIO-463 is also unidirectional and you only need to configure one session for output.

2.3 Configuring for Digital I/O

The DIO-463 is known as an intelligent digital output device. It can monitor the current flowing through each of its digital lines and open or close a line when the current goes above or below specified current limits.

You can configure the device to attempt to close the connection after a programmed delay whenever an over- or under-current condition occurs.

The following call configures the digital output port of a DIO-463 set as device 1::

```
// Configure session to write to port 0 on device 1

session.CreateDOProtectedChannel("pdna://192.168.100.2/Dev1/Do0",
                                 -0.01,
                                  0.01,
                                  200.0,
                                  false,
                                  50.0);
```

It configures the following parameters:

- **Under-current limit:** when the current goes below this limit, the line opens.
- **Over-current limit:** when the current goes above this limit, the line opens.
- **Current sampling rate:** the rate at which the DIO-463 monitors current. This rate has a direct influence on how fast the DIO-463 reacts to an under or over-current condition.
- **The retry status:** specifies whether the DIO-463 attempts to close the circuit after an over or under current condition.
- **The retry rate:** specifies how often the DIO-463 attempts to close the circuit.

2.4 Configuring the Timing

You can configure the DIO-463 to run in simple mode (point by point) only.

Use of ACB mode is not currently supported.

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 the other timing modes.

```
// configure timing for point-by-point (simple mode)

session.ConfigureTimingForSimpleIO();
```

2.5 Writing Data

Writing data is done using a writer object. The following sample shows how to create a writer object and write data:

```
// Create a writer and link it to the session’s stream

CUeiDigitalWriter writer(session.GetDataStream());

// write one scan, the buffer must contain one value per channel

uInt32 data = 0xFEFE;
writer.WriteSingleScan(&data);
```

2.6 Monitoring the Current

You can monitor the current measured at each digital line.

Use an Analog Input session the same way you would measure voltage from an Analog Input device.

The following code shows how to measure current out of the first 4 digital lines:

```
// Create an Analog Input reader to read with

CUeiSession aiSs;
aiSs.CreateAIChannel("pdna://192.168.100.2/Dev1/Ai0:3"
                     -10.0, 10.0,
                     UeiAIChannelInputModeDifferential);
                     aiSs.ConfigureTimingForSimpleIO();

CUeiAnalogScaledReader aiReader(aiSs.GetDataStream());

// Measure current out of the first 4 digital lines

double currents[8];
aiReader.ReadSingleScan(currents);
```

2.7 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();
aiSs.CleanUp();
```

Chapter 3 Programming with the Low Level API

The low-level API offers direct access to PowerDNA DAQBios protocol and allows you to directly access device registers.

Where possible, we recommend that you use the UeiDaq Framework (*see Chapter 2*), which is easier to use.

You should need to use the low-level API only if you are using an operating system other than Windows.

Please refer to the `API Reference Manual` document under:

Start » Programs » UEI » PowerDNA » Documentation

for pre-defined types, error codes, and functions for use with this layer.

For a good starting point, please consider reviewing the examples for DIO layers that are under:

Start » Programs » UEI » PowerDNA » Examples

The following examples are recommended:

- Sample462 - configure, read and write in “immediate” mode

Appendix

A. Accessories

The following cables and STP boards are available for the DIO-463 layer.

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 DNA and DNR 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 series cables. 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.

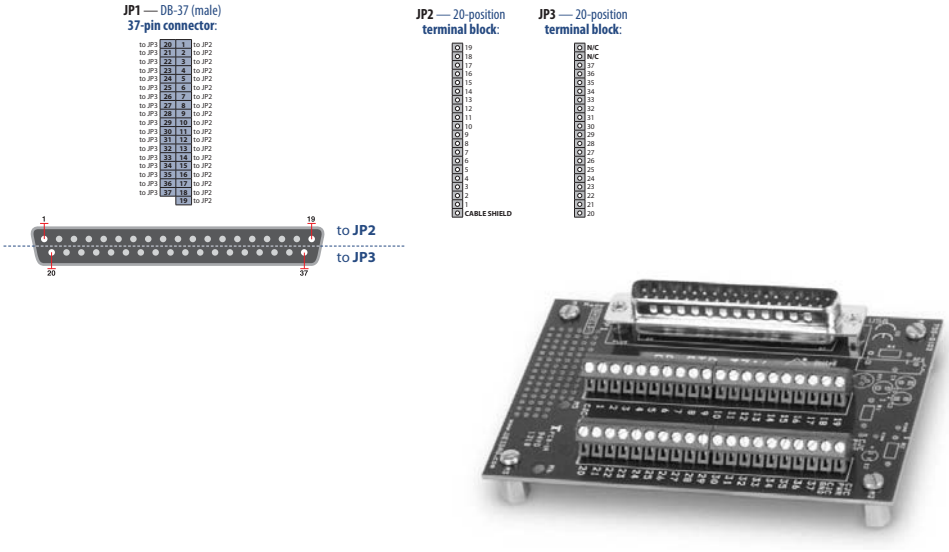

Figure A-1. Pinout and photo of DNA-STP-37 screw terminal panel

B. Precautions for MOS FET Relays

The Omron G3VM-61ER1 MOS FET relay documentation used by the DIO-463 layer recommends that the following precautions are followed by systems using this part: http://www.omron.com/ecb/products/pdf/precautions_ssr.pdf

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