United Electronic Industries

The High-Performance Alternative

DNx-AO-308-353

—

User Manual

8-Channel, 16-bit, High Voltage
Analog Output Board, up to ±40V, ±5mA,
for the PowerDNA Cube and RACK Series Chassis

April 2020

PN Man-DNA-AO-308-353-0910

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Chapter 1 Introduction

This document outlines the feature set and use of the DNx-AO-308-353, an 8-channel, high voltage, analog output board.

1.1 Organization

This DNx-AO-308-353 User Manual is organized as follows:

1.1.1 Introduction

This chapter provides an overview of DNx-AO-308-353 board features, accessories, and what you need to get started.

1.1.2 DNx-AO-308-353 Board

This chapter provides an overview of the device architecture, connectivity, logic, and accessories for the DNx-AO-308-353 board.

1.1.3 Programming with the High-Level API

This chapter provides a general overview of procedures that show how to create a session, configure the session, and generate output on a DNx-AO-308-353 board, working with the UEIDAQ Framework High-Level API.

1.1.4 Programming with the Low-Level API

This chapter describes the Low-Level API commands for configuring and using a DNx-AO-308-353 board.

Appendices

A. Accessories

This appendix provides a list of accessories available for use with a DNx-AO-308-353 board.

Index

This is an alphabetical index of topics covered in this manual.

NOTE: A glossary of terms used with the PowerDNA Cube and Boards 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 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**.”

1.2 The DNA-AO-308 Series Analog Output Boards

The DNx-AO-308 series of Analog Output boards includes the following products:

- AO-308 16-bit, 8-channel, ±10V Analog Output board
- AO-308-350 16-bit, 8-channel, ±10V, High Current Analog Output board
- AO-308-353 16-bit, 8-channel, ±40V, High Voltage Analog Output board
- AO-308-420 16-bit, 8-channel, 4-20 mA Current Analog Output board

The DNA-AO-308-353, DNR-AO-308-353, and DNF-AO-308-353 boards are compatible with the UEI Cube, RACKtangle, and FLATRACK chassis respectively. These board versions are electrically identical and only differ 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. For brevity we will refer to all form factors of the board simply as the AO-308-353 throughout the rest of the manual.

This manual describes the AO-308-353 High Voltage, 16-bit, 8-channel, ±40V Analog Output board only The other products in the series are described in separate documents.

Using an AO-308-353 instead of an AO-308 boosts voltage capability to ±40V per channel. It uses a ±45V source, supplied from an external supply or internally by the addition of a DNA-PC-913 Power Conversion board mounted in the UEI chassis.

The technical specifications for the AO-308-353 High Voltage Analog Output board are listed in **Table 1-1**.

Table 1-1. DNA-AO-308-353 Technical Specifications

Number of Channels	8
Resolution	16 bits
Max Update Rate: @ 16-bit resolution @ 12-bit resolution @ 9-bit resolution	 100 kHz/channel (800kHz max aggregate) 200 kHz/channel (800kHz max aggregate) 400 kHz/channel (800kHz max aggregate)
Buffer Size	1K 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	5ppm/°C
Gain Drift	5ppm/°C
Output Range	±40V
Output Coupling	DC
Output Impedance	0.1Ω max
Current Drive	±5mA/channel
Capacitive Loads	500 pF
Settling Time	10 µs to 16 bits
Slew Rate	10 V/µs
Isolation	350Vrms
Power Consumption[2]	1.8W - 5W
Physical Dimensions	3.875" x 3.875" (98 x 98 mm)
Operating Temp. (tested)	-40°C to +85°C
Operating Humidity	90%, non-condensing

[1] If the total power consumption of the board 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 is a photo of the DNA-AO-308-353 board.

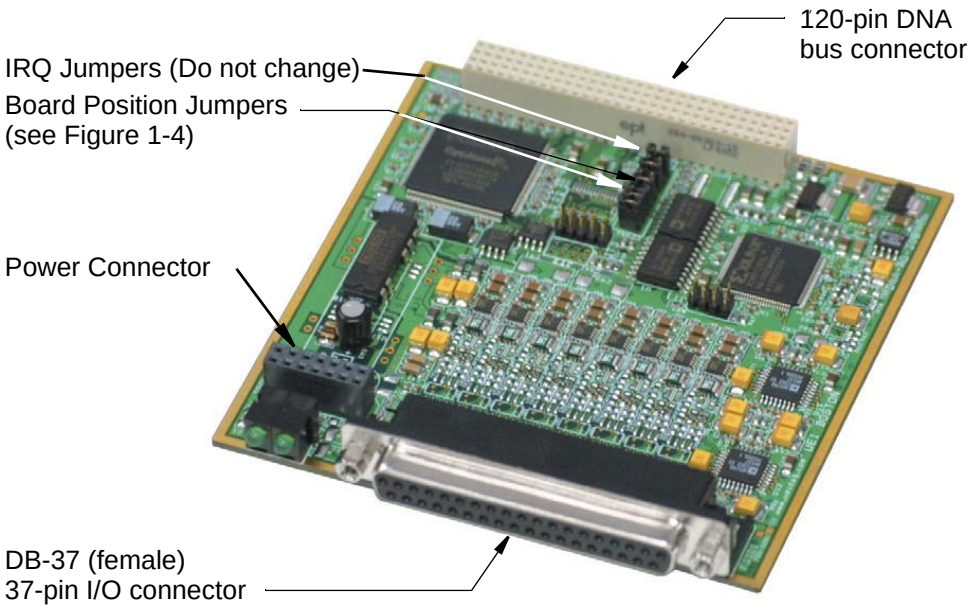

Figure 1-1. DNA-AO-308-353 Board

1.3 Device Architecture

The AO-308-353 High Voltage Analog Output board has eight individual analog output channels. A Block Diagram of the board is shown in **Figure 1-2**.

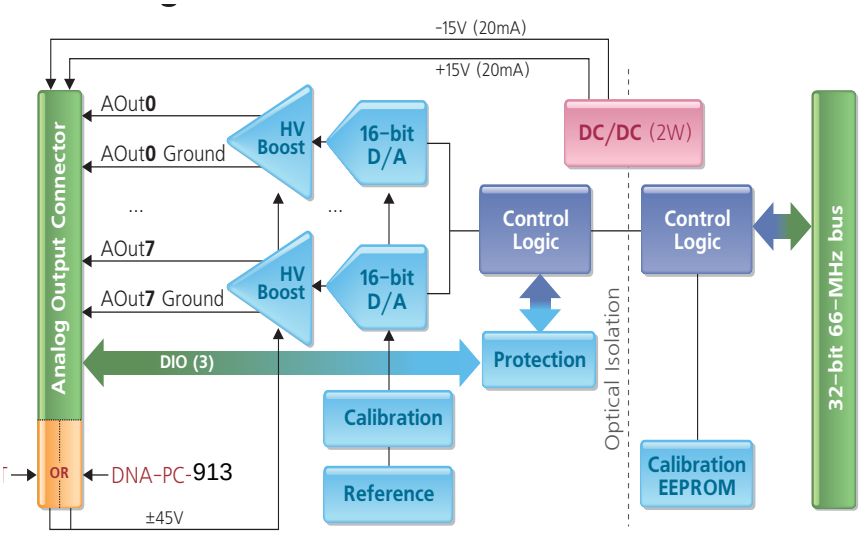

Figure 1-2. Block Diagram of* AO-308-353 *Device Architecture

1.4 Board Connectors and Wiring

Since the AO-308-353 High Voltage Analog Output 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.

1.4.1 Connectors

The pinout of the 37-pin connector for the AO-308-353 board is shown in **Figure 1-3**. A diagram for using the PC-913 for supplying external power to the AO-308-353 is shown in **Figure 1-6**.

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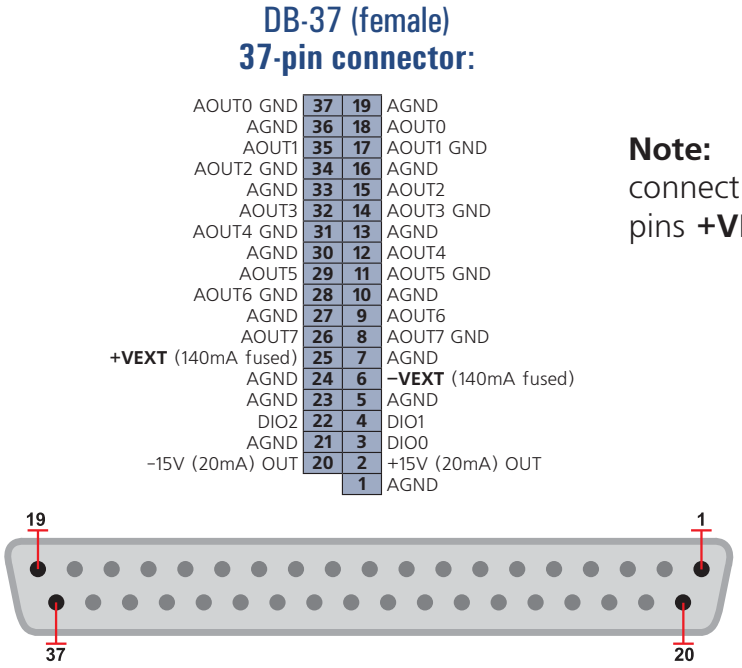


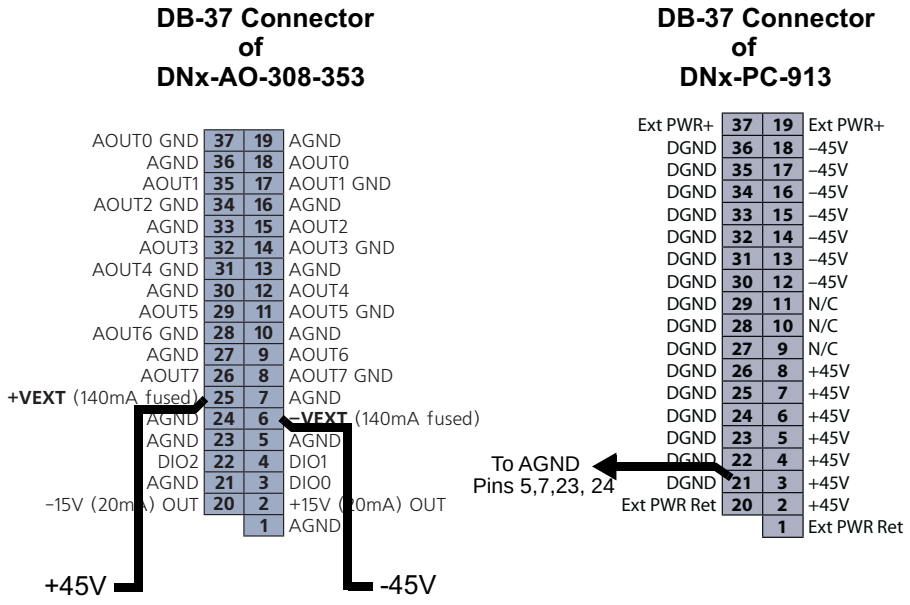
Note: If powering externally, connect ±45V power supply to pins **+VEXT** (25) and **−VEXT** (6).

***Figure 1-3 DB-37 I/O Connector Pinout of the* AO-308-353**

1.4.2 Interconnecting a DNx-AO-308-353 and a DNx-PC-913

Using an AO-308-353 with a DNx-PC-913 as the ±45V external power supply requires interconnections between the two boards as shown in **Figure 1-4** below.

Interconnection Between DNx-PC-913 and DNx-AO-308-353



Connect -45V external power to Pin 6 of DNx-308-353 DB-37 connector. Connect +45V external power to Pin 25 of DNx-AO-308-353 DB-37 connector.

Connect any DGND pin of DNx-PC-913 to AGND Pins 5, 7, 23, and 24 of the DB-37 connector of the DNx-AO-308-353 DB-37 connector.

Figure 1-4. DNx-PC-913 and AO-308-353 Interconnection Diagram

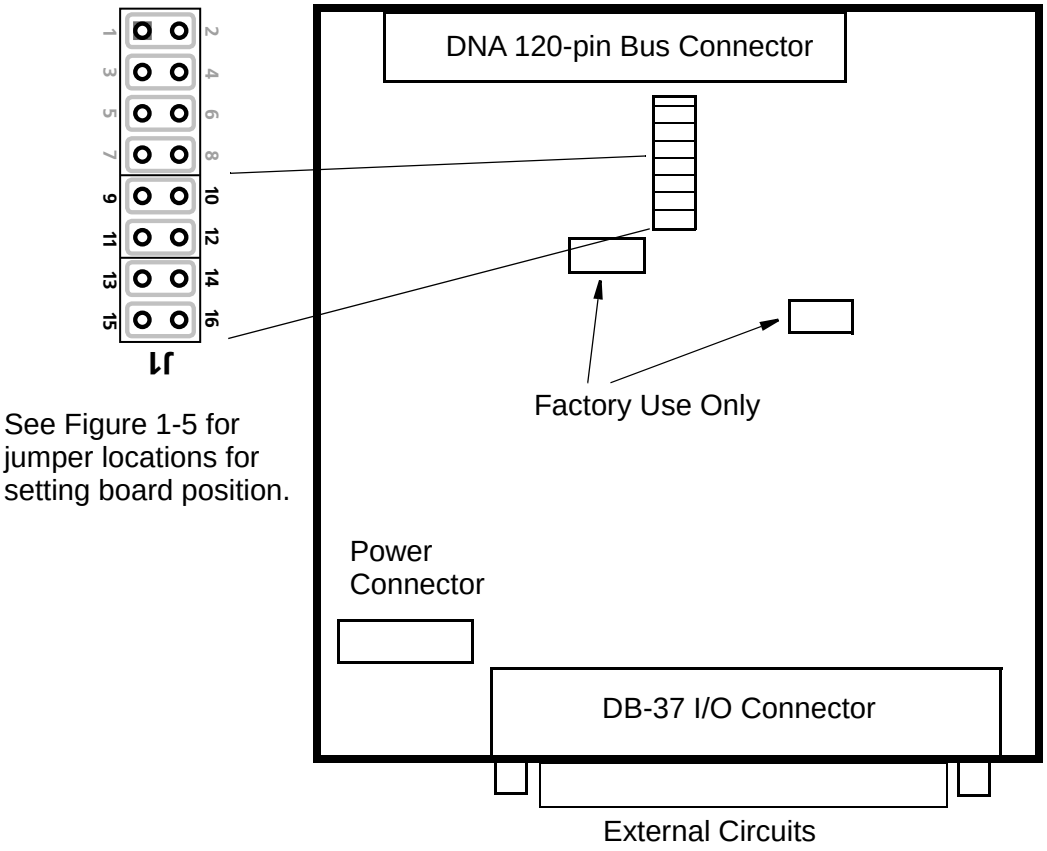


Figure 1-5. Physical Layout of* AO-308-353 *Board

1.4.2.1 Jumper Settings

A diagram of the jumper block is shown in **Figure 1-5**. 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	●	○	●	○	●	○
	11-12	●	●	○	○	●	●
	13-14	●	●	●	●	○	○
	15-16	●	●	●	●	●	●

* *All I/O Layers are sequentially enumerated from top to the bottom of the Cube*

○ - **Open** ● - **Closed**

Figure 1-6. Diagram of* AO-308-353 *Board Position Jumper Settings

Chapter 2 Programming with the High-Level API

2.1 Programming with the Ueidaq Framework API

This section describes how to program the AO-308x family of boards (AO-308, AO-308-350, AO-308-353, AO-308-420) using the UeiDaq Framework High-Level API.

The UeiDaq Framework is object-oriented. Its objects can be manipulated in the same manner within various development environments, such as Visual C++, Visual Basic, or LabVIEW.

Although the following section focuses on the C++ API, the concept is the same for any programming language you use.

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

Please refer to the examples that come with the UeiDaq Framework. They contain detailed and commented code that can be compiled and executed.

2.1.1 Creating a Session

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

```
CUeiSession session;
```

2.1.2 Configuring the Channels

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

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

For PowerDNA, the device class is **pdna**.

For example, the following resource string selects analog output channels 0,1 on device 1 at IP address 192.168.100.2: “pdna:// 192.168.100.2/Dev1/Ao0:1”

```
// Configure channels 0,1 with an output
// range of ±40V
session.CreateAOChannel("pdna://192.168.100.2/
Dev0/ao0:1",-40.0, 40.0);
```

2.1.3 Configuring the Timing

You can configure the AO-308-353 series boards to run either in simple mode (point by point) or buffered mode (ACB mode).

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

In buffered mode, the delay between samples is determined by the AO-308-353 on-board clock.

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

```
session.ConfigureTimingForSimpleIO();
```

2.1.4 Writing Data

Writing data to the AO-308-353 board is done with 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 to volts. 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 reader and link it to the
// session’s stream
CueiAnalogScaledWriter
writer(session.GetDataStream());

// write one scan, the buffer must contain
// one value
// for each channel
double data[2] = {0.0, 0.0};
writer.WriteSingleScan(data);
```

Similarly, you can create a raw writer object by entering the following:

```
// Create a reader and link it to the session’s stream
CUeiAnalogRawWriter writer(session.GetDataStream());
// write one scan, the buffer must contain one value
// for each channel
uInt16 data[2] = {0x1234, 0x5678};
writer.WriteSingleScan(data);
```

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

2.1.5 Cleaning-up the Session

The session object cleans itself up when it goes out of scope or when it is destroyed. If you want to reuse the object with a different set of channels or parameters, you can manually clean up the session with the following:

```
session.CleanUp();
```

Chapter 3 Programming with the Low-Level API

This section describes how to program the PowerDNA cube 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.

We recommend that, where possible, you use the UeiDaq Framework high-level API (*see* “Programming with the Ueidaq Framework API” on page 8), which is easier to use than the low-level API.

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

3.1 Configuration Settings

Configuration settings are passed in `DqCmdSetCfg()` and `DqAcbInitOps()` functions.

Not all configuration bits apply to DNA-AO-308x series (AO-308, AO-308-350, AO-308-353, AO-308-420) boards, however. The following bits make sense:

```
#define DQ_FIFO_MODEFIFO (2L << 16)
    // continuous acquisition with FIFO
#define DQ_LN_MAPPED     (1L<<15)
    // For WRRD (DMAP) devices
    //(automatically selected)
#define DQ_LN_STREAMING  (1L<<14)
   // For RDFIFO devices - stream the FIFO data
   //(automatically selected) For WRFIFO - do NOT
   //send reply to WRFIFO unless needed
#define DQ_LN_IRQEN    (1L<<10) //enable  irqs
#define DQ_LN_PTRIGEDGE1 (1L<<9)
   // stop trigger edge MSB
#define DQ_LN_PTRIGEDGE0 (1L<<8)
    // stop trigger edge: 00 - software,
    // 01 - rising, 02 – falling
#define DQ_LN_STRIGEDGE1 (1L<<7)
   // start trigger edge MSB
#define DQ_LN_STRIGEDGE0 (1L<<6)
   // start trigger edge: 00 - software,
  //01 -rising, 02 - falling
#define DQ_LN_CVCKSRC1   (1L<<5)
  // CV clock source MSB
#define DQ_LN_CVCKSRC0   (1L<<4)
  // CV clock source 01 - SW,10 -  HW, 11 –EXT
#define DQ_LN_CLCKSRC1   (1L<<3)
  // CL clock source MSB
#define DQ_LN_CLCKSRC0   (1L<<2)
 // CL clock source 01 - SW,10 - HW,11 –EXT
#define DQ_LN_ACTIVE     (1L<<1)
```

```
 // "STS" LED status
#define DQ_LN_ENABLED    (1L<<0)
                                  // enable operations
```

For streaming operations with hardware clocking, select the following flags:

```
DQ_LN_ENABLE | DQ_LN_CVCKSRC0 | DQ_LN_STREAMING |
DQ_LN_IRQEN | DQ_LN_ACTIVE | DQ_AO308_BI10
```

AO-308x has a range of -specific settings - as follows:

The following modes are reserved for future use:

```
#define DQ_AO308_MODEFIFO  (1L << 19)
     // continuous output with FIFO
#define DQ_AO308_MODECONT  (2L << 19)
    // waveform mode – continuous
#define DQ_AO308_MODECYCLE (3L << 19)
    // waveform mode – regenerate
#define DQ_AO308_MODEWFGEN (4L << 19)
   // waveform mode - hardware
```

`DQ_LN_ENABLE` enables all operations with the . `DQ_LN_CVCKSRC0` selects the internal channel list clock (CL) source as a timebase. AO-308 supports CV clock.
`DQ_LN_ACTIVE` is needed to switch on “STS” LED on the CPU .

You can select either the CL or CV clock as a timebase. Because of the parallel architecture of AO-308x , either clock triggers all converters.

```
Aggregate rate = Per-channel rate * Number of
channels
```

Note that acquisition rate cannot be selected on per-channel basis.

3.2 Channel List Settings

The AO-308x boards have the following channel list structure:

Bit	Name	Purpose	Comments
31	LNCL_NEXT	Tells firmware that there is a next entry n the channel list	
21	DQ_LNCL_UPDALL	Check update line to update all DACs.	Reserved
20	DQ_LNCL_WRITE	Write data into the DAC, but do not update.	Reserved
7...0		Channel number	

3.3 Data Representation

AO-308x boards have 16-bit straight binary data representation, as shown in below.

Board	Range/ Value	0x0	0x8000	0xFFFF	Span	Offset
AO-308, 350,	±10V	-10V	0	+10V	20V	0
AO-308-353	±40V	-40V	0	+40V	80V	0
AO-308-420	4-20mA	4mA	12mA	20mA	16mA	4mA

To convert voltage into an A/D representation, use the following formula:

```
Raw = (Volt+Offset)/(Span/0xFFFF),
```

where Volt is the desired level in volts.

To convert current into A/D representation (AO-308-420 only), use the following formula:

```
Raw = (mA+Offset)/(Span/0xFFFF),
```

where mA is the desired level in mA.

3.4 Board-specific Commands and Parameters

Board-specific functions are described in the *DaqLibHL.h* file.

`DqAdv30xWrite()`

This function works using underlying `DqCmdIoctl()`. It uses the `DQCMD_IOCTL` command with the `DQIOCTL_CVTCHNL` function.

When this function is called for the first time, the firmware terminates any ongoing operation on the device.

Then, the firmware parses the channel list and writes the passed values one by one.

Therefore, you cannot perform this function call when the is involved in any streaming or data mapping operations.

Every write to the channel takes approximately 3.3µs. Thus, execution time for this function depends on the number of channels in the channel list.

3.5 Using the Board in ACB Mode

This is a pseudo-code example that highlights the sequence of functions needed to use ACB on the 308x boards. A complete example with error checking can be found in the directory *SampleACB30x*.

Note that we use the `#defines` for a 30x for a DNA-AO-308x .

```
#include "PDNA.h"
// unit configuration word
#define CFG308          (DQ_LN_ENABLED \
                        |DQ_LN_ACTIVE \
                        |DQ_LN_GETRAW \
                        |DQ_LN_IRQEN \
                        |DQ_LN_CVCKSRC0 \
                        |DQ_LN_STREAMING \
                        |DQ_AI30x_MODEFIFO
                        |DQ_AO30x_BI10)
                        uint32 Config = CFG30x;
```

STEP 1: Start DQE engine.

```
#ifndef _WIN32
    DqInitDAQLib();
#endif
    // Start engine
    DqStartDQEngine(1000*1, &pDqe, NULL);
    // Open communication with IOM
    hd0 = DqOpenIOM(IOM_IPADDR0, DQ_UDP_DAQ_PORT,
TIMEOUT_DELAY, &RdCfg);
    // Receive IOM crucial identification data
    DqCmdEcho(hd0, DQRdCfg);

    // Set up channel list
    for (n = 0; n < CHANNELS; n++) {
```

```
        CL[n] = n;
    }
```

STEP 2: Create and initialize host and IOM sides.

```
    // Now we are going to test device
    // DqAcbCreate(pDqe, hd0, DEVN, DQ_SS0IN, &bcb);
    // Let's assume that we are dealing with AI-201
      //device
dquser_initialize_acb_structure();
    // Now call the function
    DqAcbInitOps(bcb,
                 &Config,
                 0,      //TrigSize,
                 NULL,   //pDQSETTRIG TrigMode,
                 &fCLClk,
                 0,      //float*  fCVClk,
                 &CLSize,
                 CL,
                 0,      //uint32* ScanBlock,
                 &acb);
    printf("Actual clock rate: %f\n", fCLClk);
    // Now set up events
    DqeSetEvent(bcb,
DQ_eFrameDone|DQ_ePacketLost|DQ_eBufferError|DQ_eP
acketOOB);
    // Allocate data buffer
    datta = dquser_allocatebuffer();
    // Pre-fill ACB with raw data
    dquser_prefillbuffer(data);
    DqAcbPutScansCopy(bcb, data, // buffer
                      bufsize,   // buffer size in
                                 //scans
                      bufsize,   // minimum size
                      &size,     // actual copied
                                 //size (from user
                                // buffer into ACB)
                      &avail);

                               // available free
                                // space in buffer
```

STEP 3: Start operation.

```
    // Start operations
    DqeEnable(TRUE, &bcb, 1, FALSE);
```

STEP 4: Process data.

```
// We will not use event notification at first
// - just retrieve scans
while (keep_looping) {
    DqeWaitForEvent(&bcb, 1, FALSE,
EVENT_TIMEOUT, &events);
    if (events & DQ_eFrameDone) {
        // fill buffer with more data
        dquser_prefillbuffer(data);
        DqAcbPutScansCopy(bcb, data,// buffer
                          bufsize,  // buffer size
                          MINRQ,   // minimum size
                             &size,   // actual
                          //copied size from
                          //user buffer into
                          //ACB &avail);
                          // available free space
                             //in buffer
    }
}
```

STEP 5: Stop operation.

```
DqeEnable(FALSE, &bcb, 1, FALSE);
```

STEP 6: Clean up.

```
    DqAcbDestroy(bcb);
    DqStopDQEngine(pDqe);
    DqCloseIOM(hd0);
#ifndef _WIN32
    DqCleanUpDAQLib();
#endif
```

Appendices

A. Accessories

The following accessory items are available for use with the AO-308-353 .

DNA-CBL-37

This is a 3 ft., 37-way flat ribbon cable with one 37-pin male and one 37-pin D-sub connector. Used to connect the AO-308-353 board to a 37-terminal panel such as the DNA-STP-37.

DNA-STP-37

This is a 37-way screw terminal panel that can be used for making external connections to the AO-308-353 board and DNA-CBL-37 cable.

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

B. Board Calibration

Please note that if you perform calibration yourself, the factory calibration warranty is void.

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