



User Manual

DeviceNet™
Voltage and Current Analog Input Module
“DN” - Harsh Environment Series

Model DN002

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1. Module Description

The Electronic Innovation Inc. “DN” line of modules are intended to provide rugged, reliable, *DeviceNet*[™] I/O capability in unusually harsh environments. These include applications such as on-board control of heavy underground mobile mining equipment or armoured military vehicles.

The DN line has been designed from the ground up to survive these environments with special attention in the following areas:

- a) Mechanical design for high shock, vibration, and concussion tolerance, resistance to liquids such as water or oil, and most forms of corrosion, along with wide operating temperatures.
- b) Electrical design to exceed Mil-Spec. standard reliable operation in the face of severe electrical transients such as the load-dump transient which can occur on heavy vehicle electrical systems.
- c) Electronic design to minimize electromagnetic emissions and provide low susceptibility to external electromagnetic interference.
- d) Extensive design effort has been expended to ensure that hardware, software, or network faults, if and when they occur, will result in a predictable and timely transition of the module to the safest achievable state.

The DN002 *DeviceNet*[™] Voltage and Current Analog Input Module provides four input channels each of which has the choice of either a voltage or a current input. These are well suited to monitor key analog sensor values in a harsh mobile environment. Samples from all inputs are available at up to the maximum network scan rate allowing effective use of these inputs for closed-loop control applications. The inputs have extensive protection circuitry to provide tolerance to electrical transients.

2. Module Configuration

The DN002 module must be configured for proper operation on the DeviceNet network. This module operates as a Group 2 Only Server, UCMM Incapable Device, and therefore communicates using the Predefined Master/Slave Connection Set. Supported message types include I/O Poll, Bit Strobe, and Explicit. Change of State and Cyclic message types are not supported in this version of the DN002.

The baud rate and MAC ID may need to be changed from their default shipping values before the module will operate properly on the target network. For the DN002, the only way to change these values is with software using

any DeviceNet compliant configuration tool capable of allocating the module and accessing its attributes.

The Input Range may be individually adjusted for each input if desired.

All of the above configurations, when changed, are automatically stored in a non-volatile EEPROM. The configuration of the module is not lost when the module is powered down, or, if the module undergoes a reset.

3. Module Operation

Once configured, the DN002 is ready to start collecting data to be sent to the master. The DN002 is factory calibrated; no further calibration is necessary.

The master obtains input values using either I/O Poll, Bit Strobe, or Explicit message types. These message types are described below.

3.1 I/O Poll Messages

The master issues I/O Poll Request messages to the DN002. The data portion of the slave I/O Poll Response message contains channel information in ascending channel order. All data channels are contained in every I/O Poll Response message. There are two bytes per channel as shown below.

1	2	3	4	5	6	7	8
AN1L	AN1H	AN2L	AN2H	AN3L	AN3H	AN4L	AN4H

where ANxL is the Least Significant Byte of Channel “x” and
 ANxH is the Most Significant Byte of Channel “x” x = 1..4

3.2 Bit-Strobe Poll Messages

The master may issue a Bit-Strobe Request message soliciting data from more than one module in a single request message. If the bit number corresponding to the module’s MAC ID is set, the module will respond with a packet containing the same information as provided to an I/O Poll Response. The data portion of the slave message contains channel information in ascending channel order. All data channels are contained in every Response message. There are two bytes per channel as shown below.

1	2	3	4	5	6	7	8
AN1L	AN1H	AN2L	AN2H	AN3L	AN3H	AN4L	AN4H

where ANxL is the Least Significant Byte of Channel “x” and
 ANxH is the Most Significant Byte of Channel “x” x = 1..4

3.3 Explicit Messages

The master can also get the measured data from each input individually by getting attribute 3 (Value) from the corresponding AIP object.

4 Module Calibration

The DN002 module is shipped fully calibrated. Should calibration be lost, the DN002 should be returned to the factory for inspection and recalibration.

Appendix A: Statement of Compliance

A.1 General Device Data

Conforms to DeviceNet Specification	Volume I, Release 2.0 Volume II, Release 2.0
Vendor Name	Electronic Innovation Inc.
Device Profile Name	General Purpose Analog I/O
Product Catalog Number	DN002
Product Revision	Hardware Ver. 1.2 Software Ver. 2.1

A.2 DeviceNet Physical Conformance Data

Max. Network Power Consumption	0.15A @ 11 VDC (worst case)
Connector Style	
DN002-OF	Open-Pluggable
DN002-SSE	Sealed-Mini
LED Supported	Combo Mod/Net Status
MAC ID Setting	Software Selectable
Default MAC ID	63
Communication Rate Setting	Software Selectable
Communication Rates Supported	125 kbps, 250 kbps, 500 kbps

A.3 DeviceNet Communications Data

Predefined Master/Slave Connection Set	Supported, Group 2 Only Server
Dynamic Connections Supported (UCMM)	None
Fragmented Explicit Messaging Supported	No

A.4 DeviceNet Information

The DN002 operates as a slave device on a DeviceNet network. It supports Explicit Messages, Bit Strobe Messages, and Polled I/O Messages of the Predefined Master/Slave Connection Set. It does not support the Explicit Unconnected Message Manager (UCMM)

DeviceNet Message Types

As a Group 2 Slave device the DN002 supports the following incoming message types

CAN Identifier Field	Group 2 Message Type
10yyyyyy000	Master I/O Bit-Strobe Command Msg
10xxxxxx100	Master Explicit Request Message
10xxxxxx101	Master I/O Poll Command Message
10xxxxxx110	Group 2 Only Unconnected Explicit Request Message
10xxxxxx111	Duplicate MAC ID Check Messages

xxxxxx = DN002 Node Address (0..63)

yyyyyy = Master Address (0..63)

DeviceNet Class Services

As a Group 2 Slave device, the DN002 module supports the following class and instance services.

Service Code	Service Name
0x05 _{HEX}	Reset
0x0E _{HEX}	Get_Attribute_Single
0x10 _{HEX}	Set_Attribute_Single
0x4B _{HEX}	Allocate_Master/Slave_Connection_Set
0x4C _{HEX}	Release_Master/Slave_Connection_Set

DeviceNet Object Classes

The DN002 module supports the following DeviceNet Object classes

Class Code	Service Name
0x01 _{HEX}	Identity Object
0x02 _{HEX}	Message Router Object
0x03 _{HEX}	DeviceNet Object
0x04 _{HEX}	Assembly Object
0x05 _{HEX}	Connection Object
0x0A _{HEX}	Analog Input Point Object

A.5 DeviceNet Required Object Implementation

Identity Object

Class Code: 01_{HEX}

The Identity Object is required on all devices and provided identification and general information about the device.

Object Class

Attribute ID	Access Rule	Name	DeviceNet Data Type	Value
1	Get	Revision	UINT	1

Number of Instances: 1

Object Instance

Attribute ID	Access Rule	Name	DeviceNet Data Type	Value
1	Get	Vendor ID	UINT	285
2	Get	Device Type	UINT	0
3	Get	Product Code	UINT	2
4	Get	Revision Major Revision Minor Revision	STRUCT of: USINT USINT	2 1
5	Get	Status	WORD	see DeviceNet Specification
6	Get	Serial Number	UDINT	32 bit serial number
7	Get	Product Name	SHORT_STRING	DN002

Common Services

Service Code	Implemented for:		Service Name
	Class	Instance	
5 (05 _{HEX})	No	Yes	Reset
14 (0E _{HEX})	Yes	Yes	Get_Attribute_Single

Message Router Object

Class Code: 02_{HEX}

The Message Router Object provides a messaging connection point through which a Client may address a service to any object class or instance residing in the physical device.

Object Class

Attribute ID	Access Rule	Name	DeviceNet Data Type	Value
1	Get	Revision	UINT	1

Number of Instances: 1

Object Instance

Attribute ID	Access Rule	Name	DeviceNet Data Type	Value
2	Get	Number of Connections	UINT	2

Common Services

Service Code	Implemented for:		Service Name
	Class	Instance	
14 (0E _{HEX})	Yes	Yes	Get_Attribute_Single

DeviceNet Object

Class Code: 03_{HEX}

The DeviceNet Object is required on all devices and is used to provide the configuration and status of a physical attachment to DeviceNet.

Object Class

Attribute ID	Access Rule	Name	DeviceNet Data Type	Value
1	Get	Revision	UINT	2

Number of Instances: 1

Object Instance

Attribute ID	Access Rule	Name	DeviceNet Data Type	Value
1	Get/Set	MAC ID	USINT	Range 0 to 63*
2	Get/Set	Data Rate	USINT	0* = 125 kbps 1 = 250 kbps 2 = 500 kbps
3	Get/Set	Bus-Off Interrupt (BOI)	BOOL	0* = Hold CAN chip in Bus off (default) 1 = Reset CAN chip if possible
4	Get/Set	Bus-Off Counter	USINT	Range 0 to 255
5	Get	Allocation Information Alloc. Choice Byte Master's MAC ID	STRUCT of: BYTE USINT	Alloc. Choice Table Range 0..63, 255 255 = not allocated

*Factory default

Alloc. Choice Table

Bit	Service	Value
0	Explicit Message	Supported. Set to 1 to allocate
1	I/O Poll	Supported. Set to 1 to allocate
2	Bit Strobe	Supported. Set to 1 to allocate
3	-	Reserved. Always 0
4	Change of State	Not Supported. Always 0
5	Cyclic	Not Supported. Always 0
6	Acknowledge Suppression	Always 0
7	-	Reserved. Always 0

Common Services

Service Code	Implemented for:		Service Name
	Class	Instance	
14 (0E _{HEX})	Yes	Yes	Get_Attribute_Single
16 (10 _{HEX})	No	Yes	Set_Attribute_Single
75 (4B _{HEX})	No	Yes	Allocate_Master_Slave_Connection_Set
76 (4C _{HEX})	No	Yes	Release_Master_Slave_Connection_Set

Assembly Object

Class Code: 04_{HEX}

The Assembly Object binds attributes of multiple objects which allows data to or from each object to be sent or received over a single connection.

Object Class

Attribute ID	Access Rule	Name	DeviceNet Data Type	Value
1	Get	Revision	UINT	2

Number of Instances: 1

Object Instance

Attribute ID	Access Rule	Name	DeviceNet Data Type	Value
3	Get	Data	BYTE Array	<i>Output Status Byte</i>

Common Services

Service Code	Implemented for:		Service Name
	Class	Instance	
14 (0E _{HEX})	Yes	Yes	Get_Attribute_Single

Connection Object

Class Code: 05_{HEX}

The Connection Object manages the characteristics of each communication connection. As a Group 2 Only Slave device, the module supports one Explicit Message connection and one I/O Poll Message connection.

Object Class

Attribute ID	Access Rule	Name	DeviceNet Data Type	Value
1	Get	Revision	UINT	1

Number of Instances: 3

Object Instance 1 – Explicit Messaging

Attribute ID	Access Rule	Name	DeviceNet Data Type	Value
1	Get	State	USINT	0 = Non-existent 3 = Established 5 = Deferred Delete
2	Get	Instance Type	USINT	0 = Explicit Messaging
3	Get	Transport Class Trigger	BYTE	83 _{HEX}
4	Get	Produced Connection ID	UINT	10xxxxxx011 _{BIN} xxxxxx = DN002 MAC ID
5	Get	Consumed Connection ID	UINT	10xxxxxx100 _{BIN} xxxxxx = DN002 MAC ID
6	Get	Initial Comm. Characteristics	BYTE	21 _{HEX}
7	Get	Produced Connection Size	UINT	7
8	Get	Consumed Connection Size	UINT	7
9	Get/Set	Expected Packet Rate	UINT	2500 ms
12	Get/Set	Watchdog Timeout Action	USINT	1 (Auto Delete) 3 (Deferred Delete)
13	Get	Produced Connection Path Length	UINT	0
14	Get	Produced Connection Path	Array of USINT	Null (no data)
15	Get	Consumed Connection Path Length	UINT	0
16	Get	Consumed Connection Path	Array of USINT	Null (no data)
17	Get	Production Inhibit Time	UINT	0 (no inhibit time)

Object Instance 2 – I/O Poll

Attribute ID	Access Rule	Name	DeviceNet Data Type	Value
1	Get	State	USINT	0 = Non-existent 1 = Configuring 3 = Established 4 = Timed Out
2	Get	Instance Type	USINT	1 = I/O Messaging
3	Get	Transport Class Trigger	BYTE	82 _{HEX}
4	Get	Produced Connection ID	UINT	01111xxxxxx _{BIN} xxxxxx = DN002 MAC ID
5	Get	Consumed Connection ID	UINT	10xxxxxx101 _{BIN} xxxxxx = DN002 MAC ID
6	Get	Initial Comm. Characteristics	BYTE	01 _{HEX}
7	Get	Produced Connection Size	UINT	8
8	Get	Consumed Connection Size	UINT	1 (or 0)
9	Get/Set	Expected Packet Rate	UINT	200 ms
12	Get/Set	Watchdog Timeout Action	USINT	0* (Timeout) 1 (Auto Delete) 2 (Auto Reset)
13	Get	Produced Connection Path Length	UINT	6
14	Get	Produced Connection Path	Array of USINT	{20, 04, 24, 64, 30, 03} _{HEX}
15	Get	Consumed Connection Path Length	UINT	6
16	Get	Consumed Connection Path	Array of USINT	{20, 04, 24, 64, 30, 03} _{HEX}
17	Get	Production Inhibit Time	UINT	0 (no inhibit time)

Object Instance 2 – I/O Bit-Strobe

Attribute ID	Access Rule	Name	DeviceNet Data Type	Value
1	Get	State	USINT	0 = Non-existent 1 = Configuring 3 = Established 4 = Timed Out
2	Get	Instance Type	USINT	1 = I/O Messaging
3	Get	Transport Class Trigger	BYTE	82 _{HEX}
4	Get	Produced Connection ID	UINT	01110xxxxxx _{BIN} xxxxxx = DN002 MAC ID
5	Get	Consumed Connection ID	UINT	10xxxxxx000 _{BIN} xxxxxx = Master MAC ID

6	Get	Initial Comm. Characteristics	BYTE	02 _{HEX}
7	Get	Produced Connection Size	UINT	8
8	Get	Consumed Connection Size	UINT	8
9	Get/Set	Expected Packet Rate	UINT	200 ms
12	Get/Set	Watchdog Timeout Action	USINT	0* (Timeout) 1 (Auto Delete) 2 (Auto Reset)
13	Get	Produced Connection Path Length	UINT	6
14	Get	Produced Connection Path	Array of USINT	{20, 04, 24, 64, 30, 03} _{HEX}
15	Get	Consumed Connection Path Length	UINT	6
16	Get	Consumed Connection Path	Array of USINT	{20, 04, 24, 64, 30, 03} _{HEX}
17	Get	Production Inhibit Time	UINT	0 (no inhibit time)

Common Services

Service Code	Implemented for:		Service Name
	Class	Instance	
5 (05 _{HEX})	No	Yes	Reset
14 (0E _{HEX})	Yes	Yes	Get_Attribute_Single
16 (10 _{HEX})	No	Yes	Set_Attribute_Single

A.6 DeviceNet Open Object Implementation

Analog Input Point Object

Class Code: 0A_{HEX}

The Analog Input Point (AIP) models the point level attributes and services of the analog outputs in the DN002.

Object Class

Attribute ID	Access Rule	Name	DeviceNet Data Type	Value
1	Get	Revision	UINT	2
2	Get	Max. Object Instance	UINT	4

Number of Instances: 4

Object Instances 1 to 4

Attribute ID	Access Rule	Name	DeviceNet Data Type	Value
3	Get	Value	Based on attribute 8	Measured Value
7	Get/Set	Input Range	USINT	0 (-10V to +10 V) 1 (0V to +5V) 2 (0V to +10V) 6* (-5V to +5V) 8 (0mA to +20mA) 100 (-20mA to +20mA)
8	Get/Set	Value Data Type	USINT	0* = INT 6 = UINT

*Factory default

Common Services

Service Code	Implemented for:		Service Name
	Class	Instance	
14 (0E _{HEX})	Yes	Yes	Get_Attribute_Single
16 (10 _{HEX})	No	Yes	Set_Attribute_Single

Appendix B: Electronic Data Sheet (EDS) Listing

```

$ Electronic Innovation Inc.
$ DN002 - 4 Analog (Voltage/Current) Input Module - EDS

[File]
DescText=   "DN002 EDS";
CreateDate= 8-11-2000;
CreateTime= 10:00:00;
ModDate=    8-11-2000;
ModTime=    10:00:00;
Revision=   2.0;

[Device]
VendCode=   285;
ProdType=   0;
ProdCode=   2;
MajRev=     2;
MinRev=     1;
VendName=   "Electronic Innovation Inc.";
ProdTypeStr="Generic Device";
ProdName=   "DN002";
Catalog=    "DN002";

[IO_Info]
Default=    0x0001;
PollInfo=   0x0003,1,1;
StrobeInfo= 0x0003,1,2;

Input1=     8,0,0x0003,"Producing IO/Data",6,"20 04 24 64 30 03","Poll & BitS Prod";
Output1=    1,0,0x0003,"Consuming Poll/Data",6,"20 04 24 64 30 03","Poll Cons";
Output2=    8,0,0x0003,"Consuming BitS/Data",6,"20 04 24 64 30 03","Bits Cons";

[ParamClass]
MaxInst=4;
Descriptor=0;
CfgAssembly=0;

[Params]
$ ----- $
$                                     CHANNEL 1                                     $
$ ----- $
Param1=
  0,                                     $ reserved
  6, "20 0A 24 1 30 7",                 $ link size and path
  0x02,                                  $ descriptor
  0xC6, 1,                               $ data type, data size (in bytes)
  "Input Range 1",                       $ parameter name
  "N/A",                                  $ units string
  "Input Range in V or mA",              $ help string
  0,102,6,                                $ minimum, maximum and default values
  , , , , , , , ;                       $ optional fields

$ ----- $
$                                     CHANNEL 2                                     $
$ ----- $
Param2=
  0,                                     $ reserved
  6, "20 0A 24 2 30 7",                 $ link size and path
  0x02,                                  $ descriptor
  0xC6, 1,                               $ data type, data size (in bytes)
  "Input Range 2",                       $ parameter name
  "N/A",                                  $ units string

```

```

    "Input Range in V or mA",      $ help string
    0,102,6,                      $ minimum, maximum and default values
    , , , , , , , , ;           $ optional fields

$ -----
$                               CHANNEL 3
$ -----
Param3=
  0,                              $ reserved
  6, "20 0A 24 3 30 7",          $ link size and path
  0x02,                          $ descriptor
  0xC6, 1,                      $ data type, data size (in bytes)
  "Input Range 3",              $ parameter name
  "N/A",                        $ units string
  "Input Range in V or mA",     $ help string
  0,102,6,                      $ minimum, maximum and default values
  , , , , , , , , ;           $ optional fields

$ -----
$                               CHANNEL 4
$ -----
Param4=
  0,                              $ reserved
  6, "20 0A 24 4 30 7",          $ link size and path
  0x02,                          $ descriptor
  0xC6, 1,                      $ data type, data size (in bytes)
  "Input Range 4",              $ parameter name
  "N/A",                        $ units string
  "Input Range in V or mA",     $ help string
  0,102,6,                      $ minimum, maximum and default values
  , , , , , , , , ;           $ optional fields

[EnumPar]
Param1="-10V-10V", "0-5V", "0-10V", "", "", "", "-5V-5V", "0-20mA", "", "", "", "", "", "", "",
Param2="-10V-10V", "0-5V", "0-10V", "", "", "", "-5V-5V", "0-20mA", "", "", "", "", "", "", "",
Param3="-10V-10V", "0-5V", "0-10V", "", "", "", "-5V-5V", "0-20mA", "", "", "", "", "", "", "",
Param4="-10V-10V", "0-5V", "0-10V", "", "", "", "-5V-5V", "0-20mA", "", "", "", "", "", "", ""

[Groups]
Group1 = "AIP Object", 4,1,2,3,4;

```

Appendix C: Specifications

DeviceNet Power Supply:

Power Supply Voltage:	8.8 V to 65.0 V, continuous operating
Power Supply Isolation:	1.2kVrms
Current Consumption:	200 mA @ 8.8 V Supply 150 mA @ 11.0 V Supply 80 mA @ 25.0 V Supply
Overvoltage Withstand:	120V, 20 seconds
Operation During Overvoltage:	Module operation maintained without disruption throughout transient
Applicable Military Standard:	Exceeds Quadripartite Standardization Agreement 307, Annex B (28VDC Military Vehicles), including Load-Dump Transient protection.

Analog Inputs:

Voltage/Current Selection:	Separate Input Pins
Voltage Input Ranges:	0-5V, 0-10V, $\pm 5V$, $\pm 10V$
Current Input Ranges:	0-20 mA, 0-40mA, $\pm 20mA$, $\pm 40mA$
Sampling:	Inputs are sampled at 8 kHz Poll command returns average of last 8 samples.
Overvoltage withstand:	+35V, indefinite duration +60V, 10 seconds
Input Over-voltage Scan:	Over-voltage inputs will read as full-scale.
Overload Recovery:	Guaranteed by next scan after overload removed
Unconnected Input:	Input reads less than 0.25% of Full Scale

Communications:

Data Rates Supported:	125 kbps, 250 kbps, 500 kbps
Maximum Distances:	500 m (1,640 ft) at 125 kbps 200 m (650 ft) at 250 kbps 100 m (330 ft) at 500 kbps

Electromagnetic Interference Control:

Emissions:	Meets MIL-STD 461D: RE102, Navy Mobile and Army
Susceptibility:	Meets MIL-STD 461D: RS103, Ground Vehicles
Note:	Only –SSE enclosure option is qualified to MIL-STD 461D EMI Limits

Environmental

Operating Temperature:	-40°C to +85°C
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DN002 Voltage and Current Analog Input Module

Storage Temperature: -55°C to +125°C

Shipping Configuration:

MAC ID: 63
Data Rate: 125 kbps

Ordering Information

DN002-OF Potted into Open Frame stainless steel tray,
Terminal block connectors

DN002-SSE Potted into Stainless Steel Enclosure,
sealed stainless steel Mini-style DeviceNet
and Aux. connectors, sealed stainless steel
micro-style connectors for outputs

Appendix D: Mechanical Drawings





