NuDAM-6100 Series

User's Manual

Data Acquisition Modules

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Revision Date:	November 23, 2020
Part Number:	50-12126-1000

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Preface

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Revision History

Revision	Description	Date	By
1.0	Initial release	2020-11-23	JC

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1. Introduction

1.1. Overview

The NuDAM-6100 DIO modules is a set of intelligent sensor to computer interface modules containing built-in microprocessor. They provide data comparison, and digital communication functions. Some modules provide digital I/O lines for controlling relays and TTL devices.

1.2. Module Compatibility

The NuDAM-6100 series are fully compatible to Advantech® ADAM-4000 series and ICP® I-7000 series.

1.3. Communication and Programming

NuDAM modules can connect to and communicate with all computers and terminals. They use RS-485 transmission standards, and communicate with ASCII format protocol(default) or Modbus-RTU protocol(for firmware version D02.01 and later), which means that NuDAM modules can be programmed in virtually any high-level language. Up to 256 NuDAM modules may be connected to an RS-485 multi-drop network by using the NuDAM RS-485 repeater, extending the maximum communication distance to 4,000 ft.

1.4. Common Specifications for the NuDAM-6100 I/O Series

1.4.1. Communications

- RS-485 (2-wire) to host
- Speeds: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps
- Max. communication distance: 4000 feet (1.2 km)
- Power and communication LED indicator
- ASCI I/ Modbus RTU command / response protocol
- Communication error checking with checksum
- Async. data format: 1 start bit, 8 data bits, 1 stop bit, no parity (N, 8, 1)
- Up to 256 multidrop modules per serial port
- Online module insertion and removal
- Transient suppression on RS-485 communication lines

1.4.2. Power

- Unregulated +10 to +30VDC

1.4.3. Environment

- Operating Temperature: -10°C to 70°C (14°F to 158° F)
- Storage Temperature: -25°C to 85° C (-13°F to 185° F)
- Humidity: 5% to 95%, non-condensing

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2. About NuDAM DIO Modules

2.1. Outline

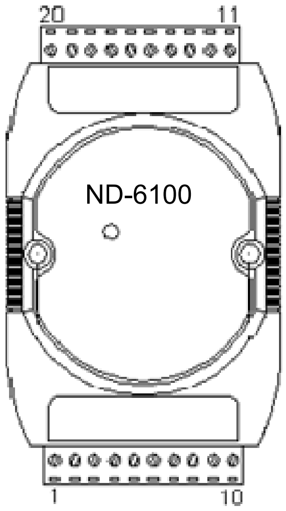


Figure 1: ND-6100 Outline

2.2. Dimensions

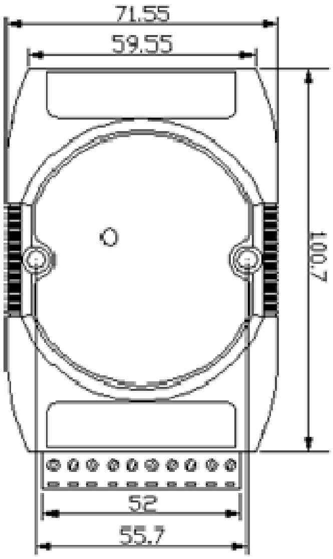


Figure 2: ND-6100 Dimensions (1)

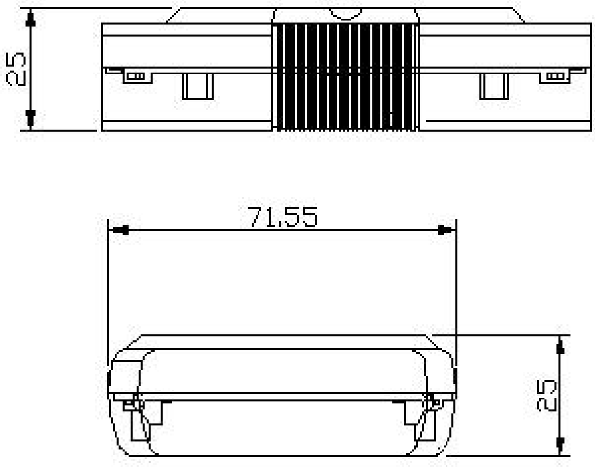


Figure 3: ND-6100 Dimensions (2)

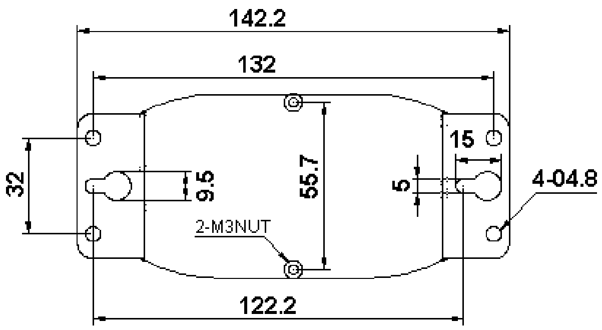


Figure 4: ND-6100 Dimensions (3)

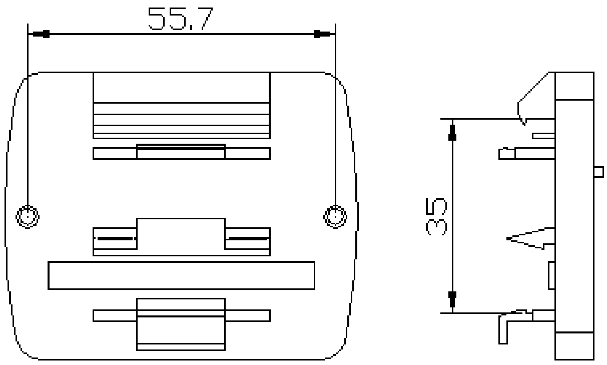


Figure 5: ND-6100 Dimensions (4)

2.3. Summary of Modules

The NuDAM provides a series of digital input or output modules to sense the digital signal or to control the remote devices.

2.3.1. Communication Modules

Module	Description
6520	Isolated RS-232 to RS-422/485 converter
6510	Isolated RS-422/485 repeater
6530	Isolated USB to RS-232 / RS-422 / RS-485 Converter

2.3.2. DC Input and Output Modules

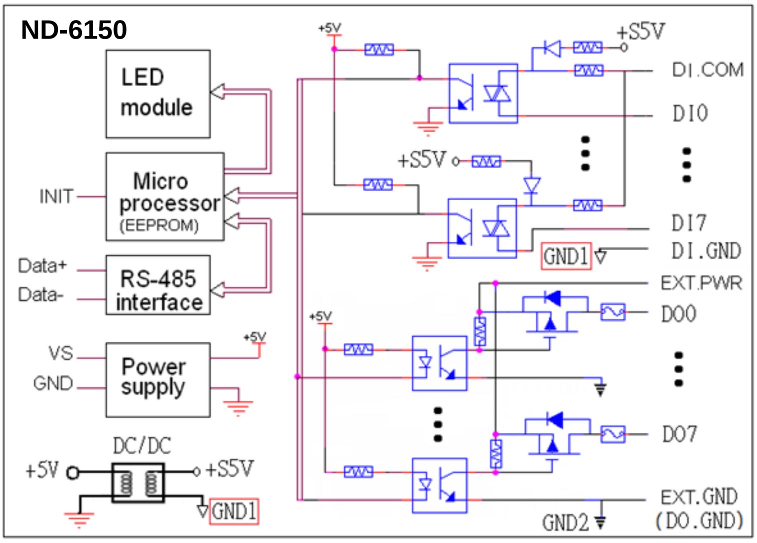
Module	Input Channel	Input Type	Output Channel	Output Type
6150	8	Isolated single-ended with common source	8	Isolated with open drain (source/1.0A/P-MOSFET)

2.3.3. Relay Output and DC Input Modules

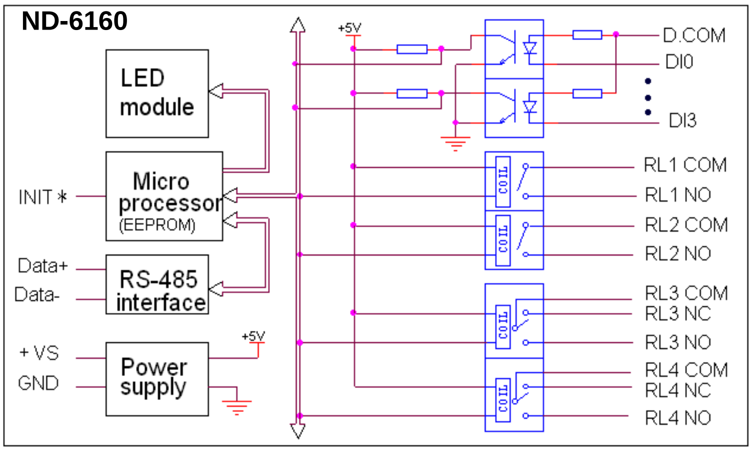
Module	Output Channel	Output Type	Contact Rating	Input Channel	Input Type
6160	4	RL1,RL2 Form A RL3,RL4 Form C	0.6A@125VAC 2A@30VDC	4	Isolation with common source

2.4. Block Diagrams

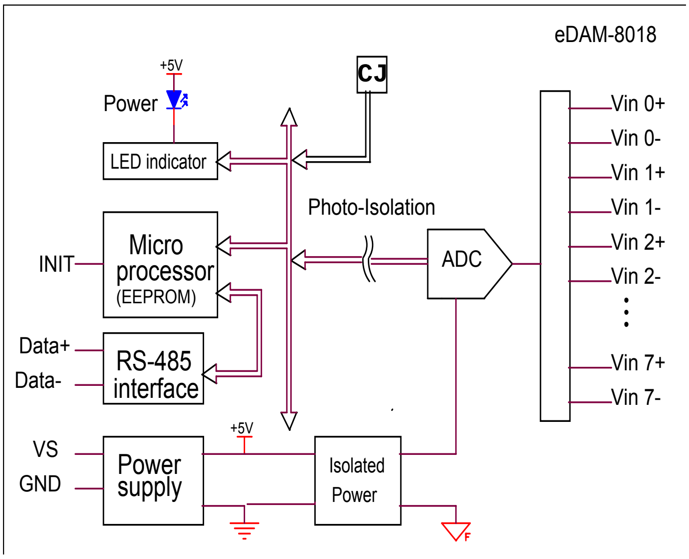
2.4.1. ND-6150 Block Diagram



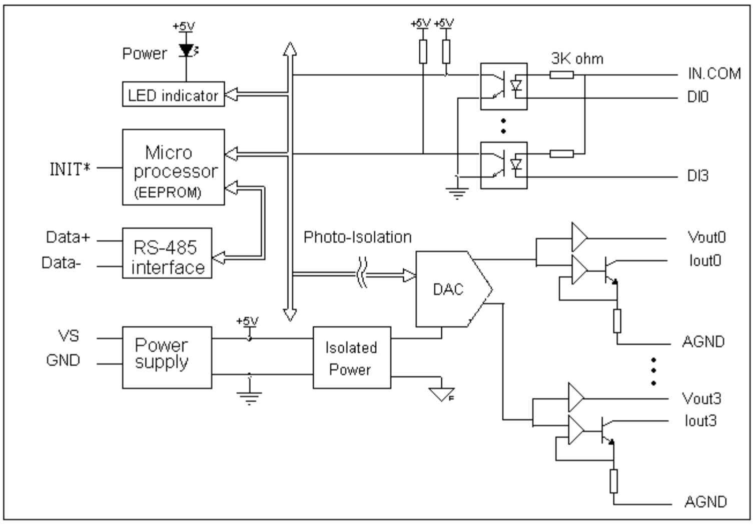
2.4.2. ND-6160 Block Diagram



2.4.3. ND-6117 Block Diagram

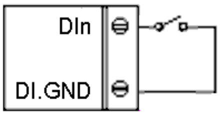


2.4.4. ND-6124 Block Diagram



2.5. Wire Connections

2.5.1. ND-6150 Wire Connections

<table>
<tr><th colspan="4">Dry Contact Signal Input</th></tr>
<tr><td colspan="4">
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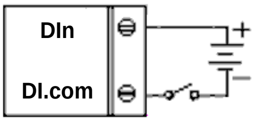
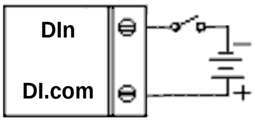
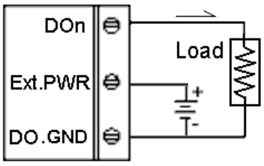
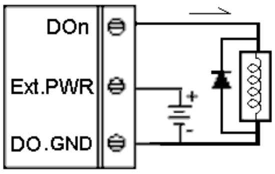
<tr><th colspan="4">Wet Contact Signal Input</th></tr>
<tr><td>
</td><td><b>Note:</b> To use wet contact, the DI.GND pin must be opened.</td><td>
</td><td><b>Note:</b> To use wet contact, the DI.GND pin must be opened.</td></tr>
<tr><th colspan="4">Digital Output</th></tr>
<tr><td colspan="2">
</td><td colspan="2">
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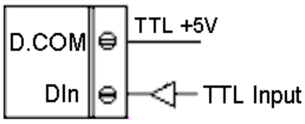
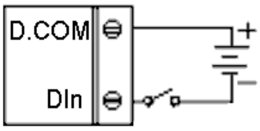
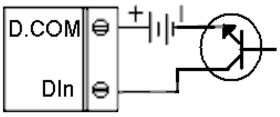
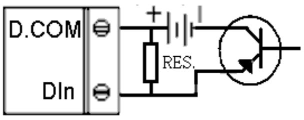
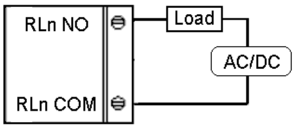
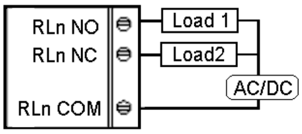
2.5.2. ND-6160 Wire Connections

<table>
<tr><th>TTL/COMS Signal Input</th><th>Contact Closure Input</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><th>NPN Output Signal Input</th><th>PNP Output Signal Input</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><th>Relay Output in RL1 and RL2</th><th>Relay Output in RL3 and RL4</th></tr>
<tr><td>
</td><td>
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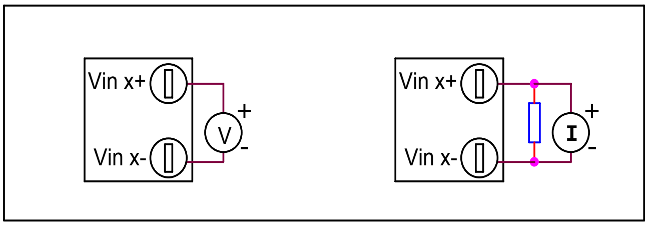
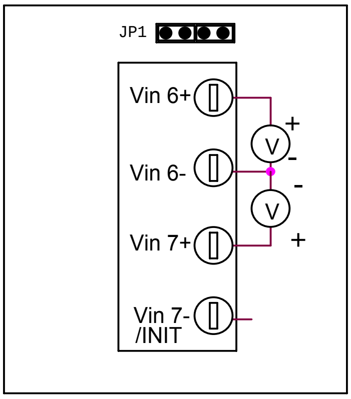
2.5.3. ND-6117 Wire Connections

2.5.3.1. Differential Analog Inputs for Channels 0–7

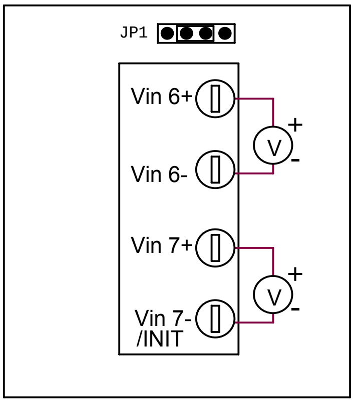


Analog input mode for channels 6 and 7 can be selected by setting JP1 on the board:

2.5.3.2. Differential Inputs for Channels 6 and 7



2.5.3.3. Single-ended Inputs for Channels 6 and 7



2.5.3.4. ND-6117 Pin Assignments

Pin	Name	Description
1	Vin5+	Differential positive input channel 5
2	Vin5-	Differential negative input channel 5
3	Vin6+	Differential/single-ended input channel 6
4	Vin6-/AGND*	Differential negative ground of channel 6 or AGND for single-ended input channels 6 & 7
5	Vin7+	Differential/single-ended input channel 7
6	Vin7-/INIT**	Differential negative ground of channel 7 or Initial state setting
7	DATA+	signal, positive

8	DATA-	signal, negative
9	+VS	+10V – +30Vdc
10	GND	Ground
11	Vin0+	Differential positive input channel 0
12	Vin0-	Differential negative input channel 0
13	Vin1+	Differential positive input channel 1
14	Vin1-	Differential negative input channel 1
15	Vin2+	Differential positive input channel 2
16	Vin2-	Differential negative input channel 2
17	Vin3+	Differential positive input channel 3
18	Vin3-	Differential negative input channel 3
19	Vin4+	Differential positive input channel 4
20	Vin4-	Differential negative input channel 4

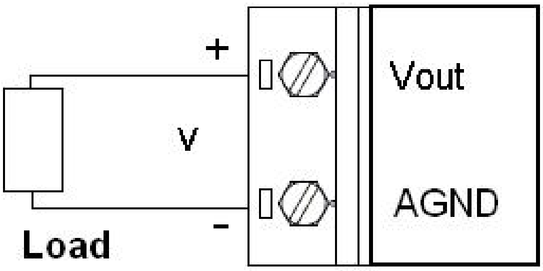
*Negative input of channel 6 or common AGND of channel 6 and 7 depend on JP1 setting

**Negative input of channel 7 or INIT (Initial state setting) pin

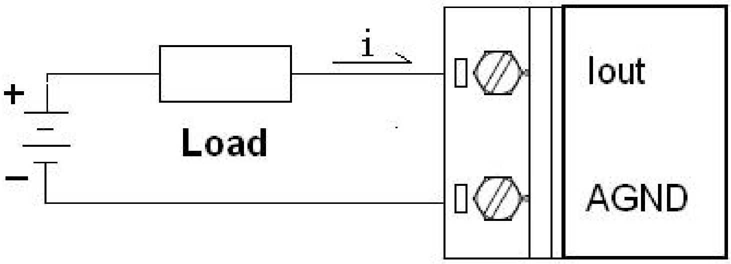
2.5.4. ND-6124 Wire Connections

2.5.4.1. Analog Output Wire Connection

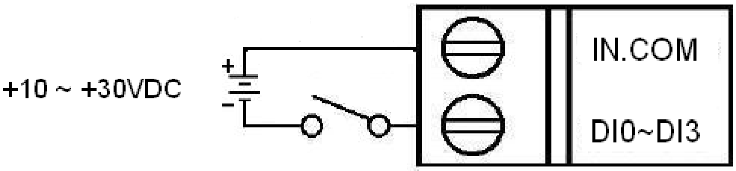
Voltage output:

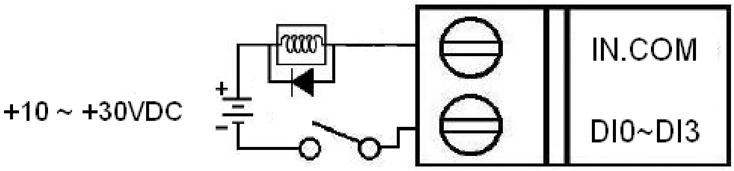


Current output:

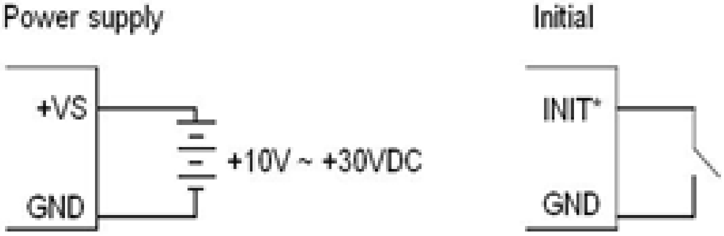


2.5.4.2. Isolation Digital Input Wire Connection





2.5.4.3. Power and Initial Wire Connection



2.5.4.4. ND-6124 Pin Assignments

Pin	Name	Description
1	DI0	Digital Input Channel 0
2	DI1	Digital Input Channel 1
3	DI2	Digital Input Channel 2
4	DI3	Digital Input Channel 3
5	IN.COM	Digital common source (+10V – +30VDC)
6	INIT*	Initial state setting
7	DATA+	RS-485 series signal, positive
8	DATA-	RS-485 series signal, negative
9	+Vs	Power supply, +10V–+30V
10 11 12 13 14 15 16 17 18 19 20	GND Vout0 Vout1 Vout2 Vout3 AGND AGND Iout3 Iout2 Iout1 Iout0	Ground Voltage output channel 0 Voltage output channel 1 Voltage output channel 2 Voltage output channel 3 Analog output ground Analog output ground Current output channel 3 Current output channel 2 Current output channel 1 Current output channel 0

* The module accepts baud rate, checksum, and communication protocol configuration settings under **INIT*** mode. (**INIT*** connects to the ground.)

2.6. Specifications

2.6.1. ND-6150

The ND-6150 provides 8 isolated digital output (source) channels and 8 isolated digital input (sink/source) channels with common source. All output channels are open drain (P-MOSFET). (See 2.4.1)

Specifications

- Interface: RS-485, 2 wires
- Speed: 1200, 2400, 4800, 9600, 19.2K, 38.4K, 57.6K,115.2K
- Digital output:
  - Output channels: 8 isolated output channels (source)
  - Output type: Open drain (P-MOSFET)
  - Output load voltage: +10V to +30Vdc
  - Max. load current: 650mA per channel

- Short-circuit protection: Yes
- Output isolation Voltage: 3750Vrms

- Digital input:
  - Input channels: 8 isolated input channels (sink/source)
  - Input type: Isolated single-ended with common source or common ground
  - Dry Contact Input:
    - Logic level 0: open
    - Logic level 1: close to DI.GND
  - Wet Contact Input: To use wet contact, the DI.GND pin must be opened
    - Logic level 0: 1VDC max.
    - Logic level 1: 10 to 30VDC
  - Input impedance: 5.6K ohms
  - Input isolation Voltage: 3750Vrms
- LED: 16 digital input/output status LED
- Power input: +10V to +30VDC
- Power consumption: 0.8W

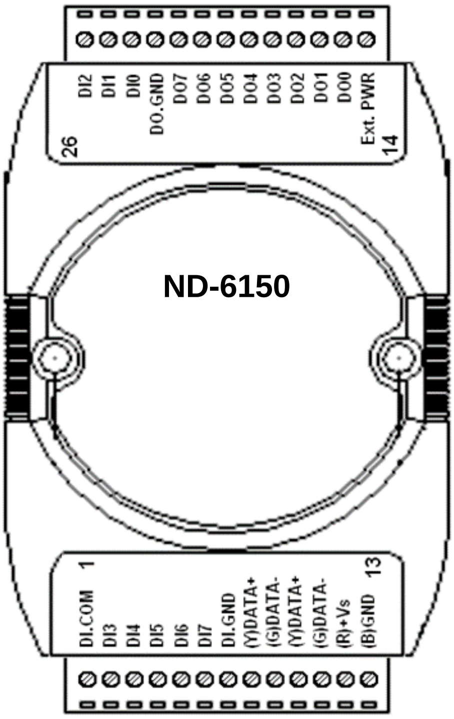


Figure 6: ND-6150 DIO

Note: To use wet contact, the DI.GND pin must be opened (disconnected).

2.6.2. ND-6160

The ND-6160 provides 4 isolated digital input channels and 4 relay output channels. All relay output channels are differential with individually common. (See 2.4.2)

Specifications

- Interface: RS-485, 2 wires
- Speed: 1200, 2400, 4800, 9600, 19.2K, 38.4K, 57.6K,115.2K
- Relay output:
  - Output channels: 4 relay output channels.
    (RL1,RL2: Form A, RL3,RL4 Form C).
  - Relay contact rating: 0.6A/125Vac, 2A/30Vdc
  - Surge strength: 500V
  - Operate Time: 3ms max.
  - Release Time: 2ms max.
  - Min Life: 5*105 ops.

- Digital input:
    - Input channels: 4 isolated input channels with common source
    - Isolation Voltage: 3750Vrms.
    - Input impedance: 3K ohms
    - Input logical level 0: +1V Max.
    - Input logical level 1: +10V to +30V
- LED: 8 digital input/output status LED
- Power input: +10V to +30VDC
- Power consumption: 1.2W (8060)

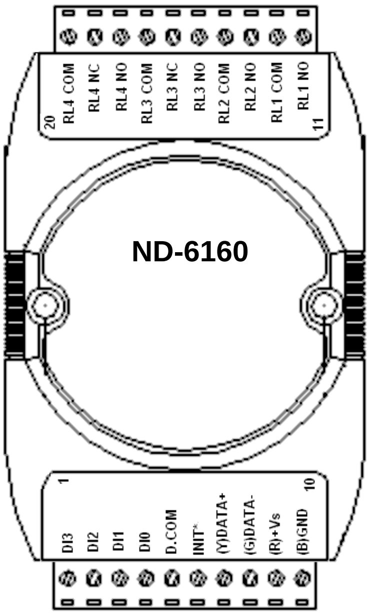


Figure 7: ND-6160 DIO

Note: NO: Normal open; NC: Normal close

2.6.3. ND-6117

The ND-6117 is an analog input module with 8 input channels. Six of the eight channels are differential type and the remaining two are single-ended type.

Specifications

- Interface: RS-485, 2 wires
- Speed (bps): 1200, 2400, 4800, 9600, 19.2K, 38.4K , 115.2K
- Analog input type: Differential input
- Analog channels Numbers: 8
- Analog resolution: 16 bits
- Unit conversion: mV, V or mA
- Voltage range: +/-10V,+/-5V,+/-1V,+/-500mV,+/-150mV,+/-20mA
- Sampling rate :10 Samples/Second
- Bandwidth: 15.7 Hz
- Accuracy: ±0.1%
- Zero drift: 0.5µV/°C
- Span drift: 25ppm/°C
- CMR@50/60Hz: 150dB
- NMR@50/60Hz: 100dB
- Input impedance: 20M Ohms
- Current measurement: ±20mA (with external 125 ohm resistor)
- Power supply: +10V to +30V

2.6.4. ND-6124

The ND-6124 is a 4-channel analog output module with mixed-type I/O. Under some circumstances, it is demanding for multiple analog outputs to fulfill particular applications without many duplicate modules. The ND-6124 is designed to achieve this by integrating four A/O channels and four isolated D/I channels into one module. Both NuDAM ASCII and Modbus-RTU protocols are supported.

The ND-6124 provides multi-range A/O support: its four A/O channels can work at the same time at different output ranges and with additional output ranges. For example, it can have 0–20 mA and ±10 V at its output. To ensure the operation of machines and facilities, the ND-6124 has the functionality of slew rate control. The output slope is programmable through ramping/clamping the slew rate. Unlike traditional mechanisms, the ND-6124 permits users to substitute its default value upon startup. Users can easily set up and configure the module to be more adaptive.

Specifications

- Support Protocol: MODBUS-RTU (default) and NuDAM-ASCII
- Interface: RS-485, 2 wires
- Speed (bps): 1200, 2400, 4800, 9600, 19.2K, 38.4K , 115.2K
- Analog output:
  - Output type: mA, V
  - Analog channels: 4
  - Analog resolution: 14 bits
  - Output range: 0–20 mA, 4–20 mA, 0–+5V, ±5V, 0–+10V and ±10V
  - Programmable output slope: 0.125 to 2048 mA/Second
    0.0625 to 1024 V/Second
  - Current load resistor: External 24V/1050 ohms
  - Current Output: 5mA max.
  - Accuracy: ±0.1% of FSR for current output
    ±0.02% of FSR for voltage output
  - Zero Drift: Voltage output: ±30μV/°C
    Current output: ±0.2μA/°C
  - Span temperature coefficient: ±25 ppm/°C
  - Isolation voltage : 3000VDC
- Isolation Digital Input:
  - Channel: 4
  - Logical level 0: +1V max.
  - Logical level 1: +10 – +30Vdc
  - Isolation voltage: 3750Vrms
- LED display: 5 1/2 digits display (6124 only)
- Watchdog function:
  - Module internal watchdog timer: 200 ms
  - Power failure threshold: 4.65 V
  - Host programmable watchdog: 100 ms – 25.500 sec
- Overvoltage protection: ±35V
- Power input: +10V to +30VDC
- Consumption: 2.4W(E-8024)

3. Installation

This chapter provides guidelines to what is needed to set up and install an NuDAM network. A quick hookup scheme is provided that lets you configure modules before they are installed in a network.

To help you to connect NuDAM modules with sensor inputs, several wiring examples are provided. The end of this chapter also provides a programming example using the NuDAM command set.

Be sure to carefully plan the layout and configuration of your network before you start. Guidelines regarding layout are provided in Appendix A.

3.1. Setting Up a NuDAM Network

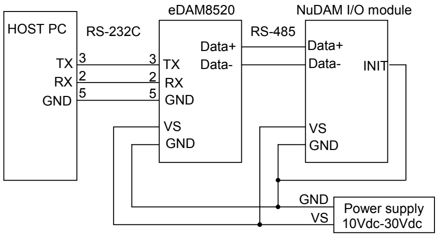
The following list gives an overview of what is needed to setup, install and configure a NuDAM environment.

- NuDAM modules
- A host computer that can output characters with an RS-232C or RS-485 port.
- Power supply for the NuDAM modules (+10 to +30 VDC)
- NuDAM Series Utility software
- NuDAM Isolated RS-232/RS-485 Converter (optional)
- RS-232/RS-485 NuDAM Repeater (optional)

3.2. Host Computer

Any computer or terminal that can output characters over either RS-232 or RS-485 can be connected as the host computer. When only RS-232 is available, an ND-6520 module (RS-232/RS-485 converter) is required to transform the host signals to the correct RS-485 protocol. The converter also provides opto-isolation and transformer-based isolation to protect your equipment.

For the ease of use in industrial environments the NuDAM modules are designed to accept industry standard +24VDC unregulated power. Operation is guaranteed when using any power supply between +10 and +30VDC. Power ripples must be limited to 5 V peak to peak while the voltage in all cases must be maintained between +10 and +30 VDC . All power supply specifications are referenced at module connector. When modules are powered remotely, the effects of line voltage drops must be considered.

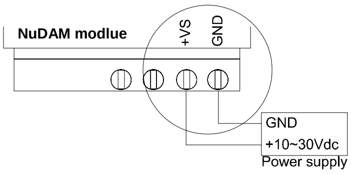


3.3. Power Supply

All modules use on-board switching regulators to sustain good efficiency over the +10 ~ +30VDC input range, therefore we can assume that the actual current draw is inversely proportional to the line voltage. The following example shows how to calculate the required current that a power supply should be able to provide.

We advise the following standard colors (as indicated on the modules) for each power line:

+Vs	(R)	Red
GND	(B)	Black



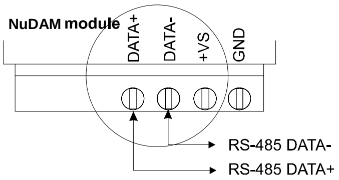
3.4. Communication Wiring

We recommend that shielded-twisted-pair cables that comply with the

EIA RS-485 standard be used with the NuDAM network to reduce interference.

We advise the following standard colors (as indicated on the modules) for each power line:

DATA+	(Y)	Yellow
DATA-	(G)	Green



3.5. NuDAM Utility Software

A menu-driven utility program for DOS or Windows is provided for NuDAM module configuration, monitoring and calibration. It also includes a terminal emulation program that lets you easily communicate through the NuDAM command set.

3.6. NuDAM Isolated RS-232/RS485 Converter (Optional)

When the host computer or terminal has only a RS-232 port, an ND-6520 Isolated RS-232/RS-485/422 converter connected to the host’s RS-232 port is required.

This module equips a “Auto baud rate detector” inside, therefore it can detect the baud rate and data format automatically and control the direction of RS-485 precisely.

3.7. Initializing a Module

All NuDAM modules in a RS-485 network must have an unique address ID. Therefore, to configure the brand-new NuDAM before using is necessary.

Factory default settings:

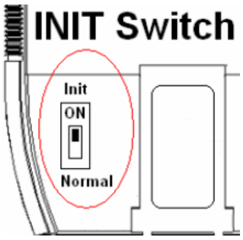
- Address ID is 01
- Baud rate is 9600 bps (N,8,1)
- Check-sum disable
- Modbus-rtu protocol

INIT* State Settings:

The NuDAM I/O modules must be set at INIT* State when you want to change the default settings, such as the ID address, baud rate, edam-ascii protocol, check-sum status etc. All NuDAM I/O modules have an special pin labeled as INIT* (see Appendix A). The module will be in Default State if the INIT* pin is shorted to ground(or INIT switch ON) when power ON. Under this state, the default configuration is set as following :

- Address ID is 00
- Baud rate is 9600 bps (N,8,1)
- Check-sum disable
- Modbus-rtu protocol

Therefore, the communication between host and the module will can be easily set as the same configuration, the initialization of a module will be possible no matter what configuration is set under operating state.



3.8. Initialization Procedure

1. Connect a brand new NuDAM module with the RS-485. Set the module in Default State by Sliding the INIT switch to the Init position (see Appendix A).
2. Power on the power supply for NuDAM modules.
3. Use the NuDAM utility to configure the address ID, baud rate, check-sum status and command sets of the module.

3.9. Changing the protocol from ASCII to Modbus-RTU

Changing the protocol from ASCII to Modbus Some NuDAM-6100 modules support both NuDAM ASCII and Modbus protocols, and the factory default setting of these modules is ASCII protocol. If you would like to configure the modules to Modbus protocol, please refer to Appendix G, which describes how to change the protocol in NuDAM utility.

To switch to the Modbus RTU protocol: (see Appendix G)

1. Sends the $AAPN command and set N to a value of 1.

Note: It is necessary to short the pin INIT* to ground (see 3.7).

2. After a power-on reset, the communication protocol will be changed to the Modbus-RTU protocol.

To switch to the ASCII format protocol:

1. Uses address 00257 of Modbus function and set to a value of 0.
2. After a power-on reset, the communication protocol will be changed to NuDAM-ASCII format protocol.

3.10. Install a New NuDAM on an Existing Network

Requirements:

- Equipment for installing a new module
- An existing NuDAM network
- New NuDAM modules

Installation Procedures:

1. Configure the new NuDAM module according to the initialization procedure in Appendix A.
2. The baud rate and check-sum status of the new module must be identity with the existing RS-485 network. The address ID must not be conflict with other NuDAM modules on the network.
3. Power off the NuDAM power supply of the existing RS-485 network.
4. Wire the power lines for the new NuDAM with the existing network. Be careful about the signal polarity as wiring.
5. Wire the RS-485 data lines for the new NuDAM with the existing network. Be careful about the signal polarity as wiring.
6. Wire to the input or output devices.
7. Power on the NuDAM local power supply.
8. Use the NuDAM utility to check entire network.

3.11. NuDAM DIO Module Configuration Tables (ND-6150 & ND-6160)

3.11.1. Baud Rate Settings (CC)

Code	03	04	05	06	07	08	09	0A
Baud rate	1200	2400	4800	9600	19200	38400	57600	115200

Note: The data bits are fixed at one start bit, eight data bits, no parity, and one stop bit.

3.11.2. Data Format Settings (FF)

Bit	7	6	5	4	3	2	1	0

Bit 7: Input counter update direction: (see "#AAN" and "%AANNTTCCFF")

0=Falling edge (default)

1=Rising edge

Bit 6: checksum:

1=Enable

0=Disable (default)

Bit 5–Bit 0: Reserved must be 0

Note: You must short the INIT* pin to ground while changing baud rate and/or enable/disable checksum.

3.11.3. Digital Input/Output Data Format Table

The data format of the response of the $AA4, $AA6 and $AALS commands is: (the First Data)(the Second Data)00.

The data format of the response of the @AA command is: (the First Data)(the Second Data).

Note: Both the First Data and the Second Data are in two hexadecimal digits format.

Module	First Data		Second Data	
ND-6150	DO0–DO7	00–FF	DI0–DI7	00–FF
ND-6160	RL1–RL4	00–0F	DI0–DI3	00–0F

3.11.4. DIO Active Status

The DIO read value of the NuDAM -6100 is as follows:

Module	DIO	Inactive	Active
ND-6150	8 DO	OFF	ON
	8 DI	OFF	ON
ND-6160	4 RO	OFF	ON
	4 DI	ON	OFF
• ON: The DIO read value is 1. • OFF: The DIO read value is 0.			

3.12. NuDAM AI Module Configuration Tables (ND-6117)

3.12.1. Baud Rate Settings (CC)

Code (CC)	03	04	05	06	07	08	09	0A
Baud rate	1200	2400	4800	9600	19200	38400	57600	115200

Note: The data bits are fixed at one start bit, eight data bits, no parity, and one stop bit.

3.12.2. Analog Input Settings (TT)

Input Range Type (Hex)	Input Range
00	No change
08	± 10 V
09	± 5 V
0A	± 1 V
0B	± 500 mV
0C	± 150 mV
0D	± 20 mA

3.12.3. Data Format Settings (FF)

7	6	5	4	3	2	1	0
FS	CS	MS	reserved			DF	

Key	Description
DF	Data format 00: Engineer unit 01: % of FSR (full scale range) 10: 2's complement hexadecimal
MS	Mode settings 0: normal mode (16 bit) 1: fast mode (12 bit)
CS	Checksum 0: disabled 1: enabled
FS	Filter settings 0: 60 Hz rejection 1:50 Hz rejection

3.12.4. Analog Input Type and Data Format Table

Type Code	Input Type	Data Format	+Full Scale	-Full Scale
08	-10V–+10V	Engineering	+10.000	-10.000
		% of Full scale	+100.00	-100.00
		2's Complement	7FFF	8000
09	-5V–+5V	Engineering	+5.0000	-5.000
		% of Full scale	+100.00	-100.00
		2's Complement	7FFF	8000
0A	-1V–+1V	Engineering	+1.0000	-1.0000
		% of Full scale	+100.00	-100.00
		2's Complement	7FFF	8000
0B	-500mV–+500mV	Engineering	+500.00	-500.00
		% of Full scale	+100.00	-100.00
		2's Complement	7FFF	8000
0C	-150mV–+150mV	Engineering	+150.00	-150.00
		% of Full scale	+100.00	-100.00
		2's Complement	7FFF	8000
0D	-20mA–+20mA	Engineering	+20.000	-20.000
		% of Full scale	+100.00	-100.00
		2's Complement	7FFF	8000

3.13. NuDAM AO Module Configuration Table (ND-6124)

3.13.1. Baud Rate Settings (CC)

Code	03	04	05	06	07	08	09	0A
Baud rate	1200	2400	4800	9600	19200	38400	57600	115200

3.13.2. Analog Output Settings (TT)

Type Code	30 hex	31 hex	32 hex	33 hex	34 hex	35 hex
Min. Input	0mA	4mA	0V	-10V	0V	-5V
Max. Input	20mA	20mA	+10V	+10V	+5V	+5V

3.13.3. Data Format Settings (FF)

ND-6124 analog output modules can be configured to transmit data to the module in engineering units and hexadecimal binary data format.

Bit	7	6	5	4	3	2	1	0

Bit 7: - reserved
= 0

Bit 6: - Checksum Bit
= 0 - Disable checksum/CRC (default)
= 1 - Enable checksum/CRC

Bit 5–bit 2: - reserved
= 0

Bit 1–bit 0: - Data format
= 00 - Engineer unit format (default)
= 10 - 2's complement hexadecimal format

3.13.4. Slew Rate (SS)

The slew rate is defined as the discrepancy between the present number of milliamps (or volts) per second and the required output currents (or voltages). A single ND-6124 analog output module may be configured for a specific slew rate.

Slew Rate	V/Sec.	mA/Sec.	Slew Rate	V/Sec.	mA/Sec.
00	Immediate		08	8.0	16.0
01	0.0625	0.125	09	16.0	32.0
02	0.125	0.25	0A	32.0	64.0
03	0.25	0. 5	0B	64.0	128.0
04	0.5	1.0	0C	128.0	256.0
05	1.0	2.0	0D	256.0	512.0
06	2.0	4.0	0E	512.0	1024.0
07	4.0	8.0	0F	1024.0	2048.0

Note:

1. Type and slew rate are set by the command "$AA9NTTSS"
2. The analog output value is 100 conversions per second.
3. You must short the **INIT*** pin to ground while changing the baud rate and/or enabling/disabling the checksum.

3.13.5. ND-6124 Default Settings

ND-6124 factory default settings:

- Address ID: 01
- Baud rate : 9600 bps, (no parity, 8 data bits, 1 stop bit)
- Check-sum is disabled
- Host Watchdog timer is disabled
- Engineer unit format
- Analog output type: type 32 hex (0V – +10V)
- Analog output slew rate is immediate
- Protocol: Modbus-rtu format protocol

4. NuDAM-6100 Utility Guide

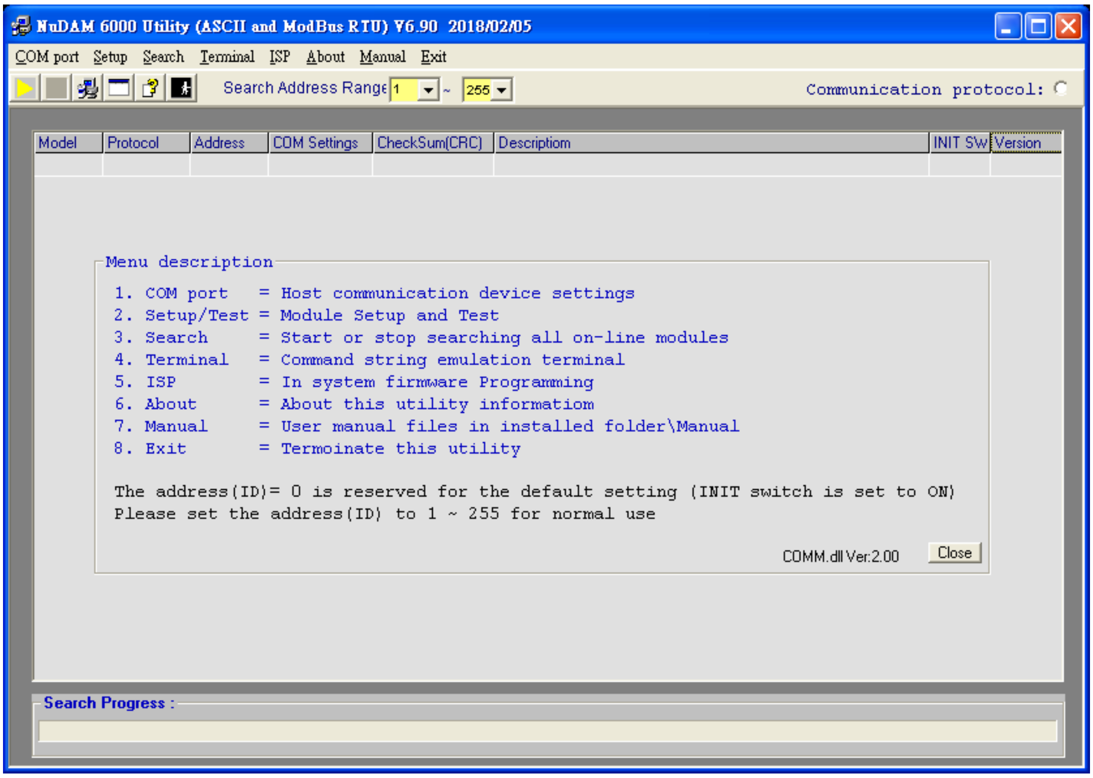
4.1. NuDAM-6100 I/O Utility Overview

The NuDAM-6100 Utility software offers a graphical interface that helps you configure NuDAM-6100 modules. The software also makes it easy to test and monitor your remote DAQ system. This section demonstrates the following elements of the NuDAM-6100 Utility software.

- Main menu
- Module Address settings
- Baudrate settings
- Checksum settings
- Mosbus RTU/ASCII protocol settings
- I/O module configuration
- WDT settings

4.2. Main Menu

The top of the operation screen consists of a function menu and a tool bar for users commonly operating functions. Double Click the icon of NuDAM I/O Utility shortcut and press 'search' icon it will search all NuDAM -6100 I/O modules on the host PC's domination RS-485 network automatically. Then the tree-structure display area will appeal with the searched units and the relative module address.



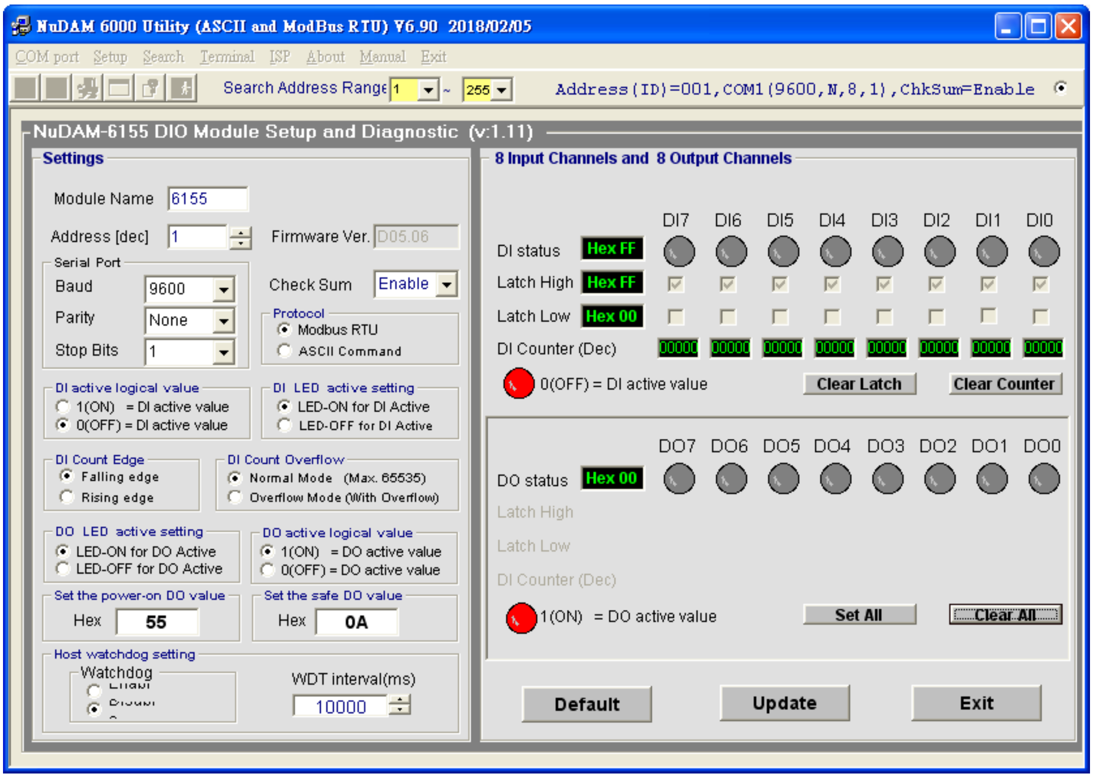
```
Menu description
 1. COM port   = Host communication device settings
 2. Setup/Test = Module Setup and Test
 3. Search     = Start or stop searching all on-line modules
 4. Terminal   = Command string emulation terminal
 5. ISP        = In system firmware Programming
 6. About      = About this utility information
 7. Manual     = User manual files in installed folder\Manual
 8. Exit       = Termoinate this utility

 The address(ID)= 0 is reserved for the default setting (INIT switch is set to ON)
 Please set the address(ID) to 1 ~ 255 for normal use
```

4.3. Function Menu

- **COM port:** COM port and baudrate selection
- **Search:** Search installed modules
- **Terminal:** Call up the operation screen of Terminal emulation to execute request/response commands
- **ISP:** Firmware update
- **Setup:** Setting functions. Please perform a search before using this function.
- **Manual:** Contains documentation to help with user operation
- **About:** Contains information about the software version, release date, and support modules
- **Exit:** Exit the Utility program

4.4. Module Setup

After pressing the **Search** button, the program will automatically search all NuDAM-6100 I/O modules on the host PC's domination RS-485 network. Then, the tree-structure area will display all units and their respective module addresses. After finding all connected units, you can start setting up each unit. Choose any one I/O module listed on the tree-structure display area. The following image shows the basic module configuration table and related settings.



Search Address Range 1 ~ 255

Address(ID)=001,COM1(9600,N,8,1),ChkSum=Enable

NuDAM-6155 DIO Module Setup and Diagnostic (v:1.11)

Settings

Module Name: 6155

Address [dec]: 1

Firmware Ver.: D05.06

Serial Port

Baud: 9600

Parity: None

Stop Bits: 1

Check Sum: Enable

Protocol
● Modbus RTU
○ ASCII Command

DI active logical value
○ 1(ON) = DI active value
● 0(OFF) = DI active value

DI LED active setting
● LED-ON for DI Active
○ LED-OFF for DI Active

DI Count Edge
● Falling edge
○ Rising edge

DI Count Overflow
● Normal Mode (Max. 65535)
○ Overflow Mode (With Overflow)

DO LED active setting
● LED-ON for DO Active
○ LED-OFF for DO Active

DO active logical value
● 1(ON) = DO active value
○ 0(OFF) = DO active value

Set the power-on DO value: Hex 55

Set the safe DO value: Hex 0A

Host watchdog setting

Watchdog
○ Enabl
● Disabl

WDT interval(ms): 10000

8 Input Channels and 8 Output Channels

		DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0
DI status	Hex FF	●	●	●	●	●	●	●	●
Latch High	Hex FF	☑	☑	☑	☑	☑	☑	☑	☑
Latch Low	Hex 00	□	□	□	□	□	□	□	□
DI Counter (Dec)		00000	00000	00000	00000	00000	00000	00000	00000

0(OFF) = DI active value

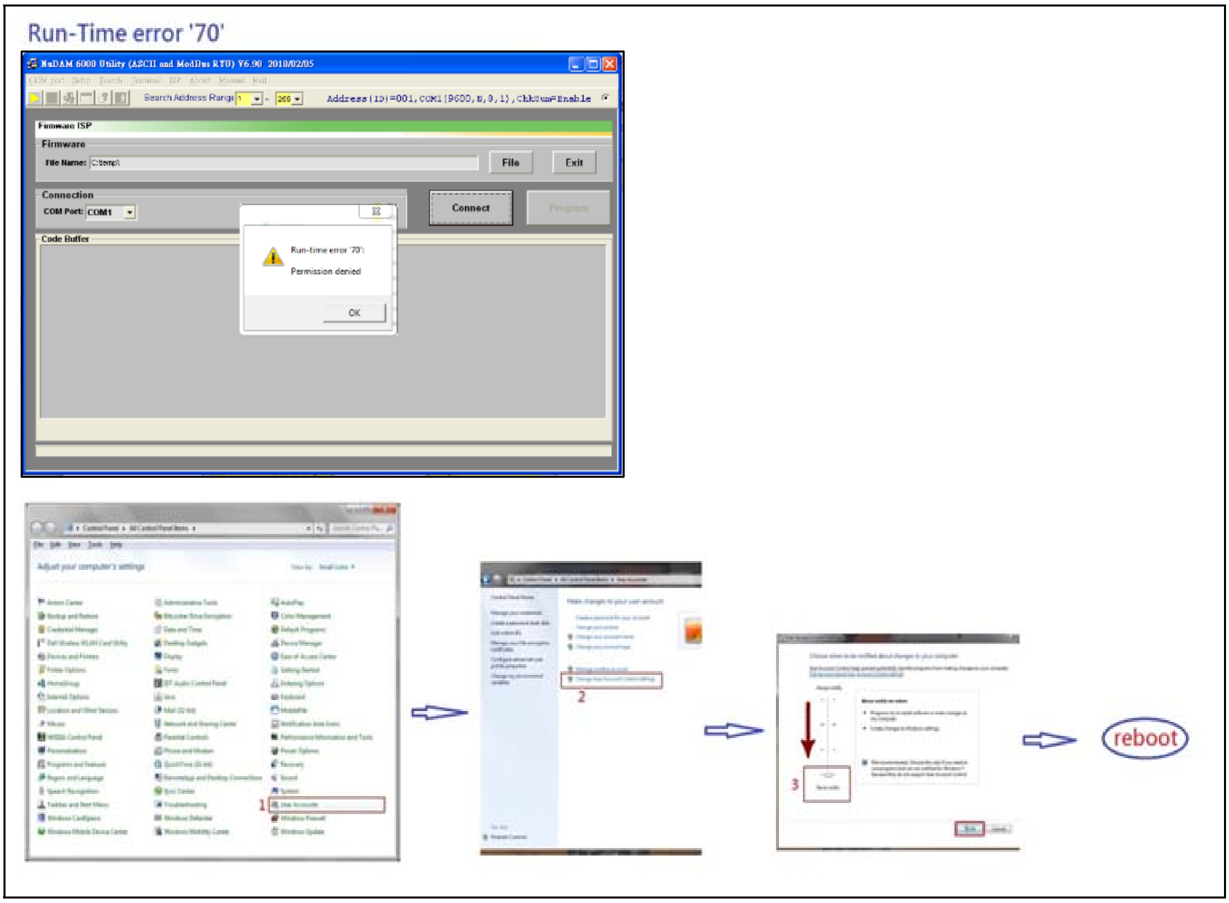
		DO7	DO6	DO5	DO4	DO3	DO2	DO1	DO0
DO status	Hex 00	●	●	●	●	●	●	●	●
Latch High									
Latch Low									
DI Counter (Dec)									

1(ON) = DO active value

4.5. NuDAM-6100 Utility Runtime Error

An runtime error sometimes occurs when running the Utility software on Windows 7 or later. The following guidelines provide instructions on how to fix this problem.

1. In Windows 7, go to **Control Panel > User Accounts > Change User Account Control Settings**.
2. Drag the slider all the way to the bottom (**Never notify**).
3. Click **OK**.
4. Restart your computer.



Run-Time error '70'

NuDAM 6000 Utility (ASCII and ModBus RTU) V6.90 2018/02/05

Address(ID)=001,COM1(9600,N,8,1),ChkSum=Enable

File Name: C:\temp\

COM Port: COM1

Run-time error '70':

Permission denied

5. ASCII Protocol Command Sets

5.1. Introduction

The ASCII command is composed of many characteristics, including the leading code, address ID, the variables, the optional check-sum byte, and a carriage return to indicate the end of a command.

The host computer can only command one NuDAM module, except those synchronized commands with wildcard address commands “#**” and “~**”. The NuDAM may or may not give response to the command. The host should check the response to handshake with the modules.

5.2. Format of NuDAM ASCII Commands

Syntax: (Leading code)(Addr)(Command)[Data] <Cksum><CR>

Every command begins with a delimiter character. There are five valid characters: a dollar sign $, a pound sign #, a percentage sign %, a wave sign ~ and an at sign @.

The delimiter character is followed by a two-character address (hexadecimal) that specifies the target module. The actual two character command follows the address. Depending on the command, an optional data segment follows the command string. An optional two character checksum may be appended to the total string. Every commands is terminated by a carriage return (cr).

Conventions:

- **Leading Code:** The first characteristic of the NuDAM command, such as %, $, #, ~, @, ...etc(1- character)
- **Addr:** Module’s address ID, the value is in the range of 00 – FF (Hex) 2- character
- **Command:** Command codes or value of variables
- **Data:** Data needed by some output command
- **Checksum:** Checksum in brackets indicate optional parameter, only checksum is enable then this field is required (2- character)
- **<CR>:** carriage return (0x0D)

Note:

- All commands should be issued in UPPERCASE characters.
- Do not put spaces between characters.

Calculate Checksum:

1. Calculate ASCII sum of all characters of command (or response) string except the character return(cr)
2. Mask the sum of string with 0ffh
   [Checksum] = {(Leading code)+(addr)+(command)+[data]} MOD 0x100

Example:

Command string : $012(cr)

Sum of string = ’$’+’0’+’1’+’2’=24h+30h+31h+32h=B7h

The checksum is B7h, and [CHK] = ”B7”

Command string with checksum = $012B7(cr)

Response string : !01400600(cr)

Sum of string = ’!’+’0’+’1’+’4’+’0’+’0’+’6’+’0’+’0’

= 21h+30h+31h+34h+30h+30h+36h+30h+30h=1ACh

The checksum is ACh, and [CHK] = ”AC”

Response string with checksum = !01400600AC(cr)

5.3. Command Responses

The response message depends on NuDAM command. The response is also composed with several characteristics, including leading code, variables, and carriage return for ending. There are two kinds of leading code for response message, ”!“ or ”>“ means valid command and ”?“ means invalid. By checking the response message, user can monitor the command is valid or invalid. But under the following conditions, there will have no response message.

- The specified address ID does not exist
- Syntax error
- Communication error
- Some special commands do not have a response

5.4. ND-6150 & ND-6160 Command Sets

Table 1: General Commands

Syntax	Description	Modules
%AANNTTCCFF	Sets the module configuration	All NuDAM modules
$AA2	Reads the module configuration	All NuDAM modules
~AAI	Soft INIT command	All NuDAM modules
~AATnn	Sets the soft INIT timeout value	All NuDAM modules
$AA5	Reads the Reset Status of a module	All NuDAM modules
$AAF	Read the firmware version of a module	All NuDAM modules
$AAM	Reads the module name	All NuDAM modules
~AAO(data)	Sets the module name	All NuDAM modules
$AAPN	Sets the communication protocol	All NuDAM modules
$AAP	Reads the communication protocol information	All NuDAM modules
$AARS	Reboot the module to power-on state	All NuDAM modules
$AAS1	Reloads the module factory default	All NuDAM modules
~AAX3IO	DIO LED ON/OFF Configuration	For 61xxD DIO modules
~AAX3	Read DIO LED ON/OFF	For 61xxD DIO modules

Table 2: DIO Function Commands

Syntax	Description	Modules
#**	Synchronized Sampling	For NuDAM DIO modules
$AA4	Read synchronized data	For NuDAM DIO modules
$AA6	Reads the Digital I/O Status (see "@AA")	For NuDAM DIO modules
#AA00DD	Sets the digital output value of the lower eight channels (same as "#AA0ADD")	For 61xx D/O modules
#AA00DDDD	Sets the digital output value for channel(0–15), (same as ADAM-4000 "#AABB")	For 61xx D/O modules
#AA0ADD	Sets the digital output value of the lower eight channels. (same as "#AA00DD")	For 61xx D/O modules
#AA0BDD	Sets the digital output value of the upper eight channels	For 61xx D/O modules
#AA1CDD	Sets a single digital output for channel N (see "#AAACDD" and “#AABCDD”)	For 61xx D/O modules
#AAACDD	Sets a single digital output channel of the lower eight channels. (see "#AA1CDD”)	For 61xx D/O modules

#AABCDD	Sets a single digital output channel of the upper eight channels. (see "#AA1CDD")	For 61xx D/O modules
@AA	Reads the status of the digital input/output ports. (see "$AA6")	For NuDAM DIO modules
@AA(data)	Sets the digital output channels	For 61xx D/O modules
@AADO(data)	Sets digital output value	For 61xx DIO modules
@AADO	Reads the status of the digital output ports	For 61xx DIO modules
@AADOCCS	Sets a single digital output for channel N	For 61xx DIO modules
@AADOCC	Reads a single digital output for channel N	For 61xx DIO modules
@AADICC	Read a single digital input for channel N	For NuDAM DIO modules
@AADI	Reads the status of the digital input ports	For 61xx DIO modules
$AAC	Clear latched digital input	For 61xx D/I modules
$AALS	Read latched digital input	For 61xx D/I modules
~AACPSS	To change the polarity state of digital inputs and outputs of the module.	For 61xx DIO modules
~AACR	To read the polarity state of digital inputs and outputs of the module.	For 61xx DIO modules

Table 3: Watchdog Commands

Syntax	Description	Modules
~**	Informs all modules that the host is OK	All NuDAM modules
~AA0	Reads the host watchdog status of a module	All NuDAM modules
~AA1	Resets the host watchdog timeout status of a module	All NuDAM modules
~AA2	Read Host WatchDog / Safe Value	All NuDAM modules
~AA3EVVSS	set host wdt Enable(1)/disable(0) , host wdt timeout value (0.1sec) and safe value(8 ch)	All NuDAM modules
~AA5V	Set Power-On & Safe Value	All NuDAM modules
~AA4V	Read Power-On & Safe Value	All NuDAM modules

5.4.1. ASCII Command Descriptions

5.4.1.1. %AAANNTTCCFF

Description	Set module configuration	
Command	%AANNTTCCFF[CHK](cr)	
Syntax	%	Command leading code
	AA	Module address ID (00 to FF)
	NN	New address of the module (00 to FF)
	TT	Type code, should be hex 40 for DIO module
	CC	New baud rate code (see 3.11.1)
	FF	Data format (see 3.11.2)
	CHK	Check sum
	(cr)	Carriage return
Response	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	New Module address ID
	CHK	Check sum
	(cr)	Carriage return

Note: When you want to change the checksum or baud rate, the INIT* pin must be grounded at first (see Appendix A), or use the Soft INIT* command (see ~AAI , ~AATnn).

- **Example 1:** Change ID address from 01 to 03 (assume current baud rate is 9600 and checksum is disabled), response new module ID address 03 (change ID address only).

  Command: %0103400600(cr)

  Response: !03(cr)

- **Example 2:** Change baud rate from 9600 to 19200(Assume current ID is 03, baud rate is 9600, and checksum disabled).

  Because the baud rate is changed from 9600 to 19200, the following procedures should be performed before sending the command:

1. Power off the module.
2. Short INIT* pin to Ground.
3. Power on the module.
4. Send command string.

   Command: %0003400700(cr)

5. Response module ID address 03.

   Response: !03(cr)

6. Power off the module.
7. Open INIT* pin and power on the module again.

- **Example 3:** Enable checksum (Assume current ID is 03, baud rate is 9600 and checksum disabled).

  Because the checksum is changed from disable to enable, the following procedures should be performed before sending the command:

1. Power off the module.
2. Short INIT* pin to Ground (see Appendix A).
3. Power on the module.
4. Send command string.

   Command: %0003400640(cr)

5. Response module ID address 03.

   Response: !03(cr)

6. Power off the module.
7. Open INIT* pin and power onthe module again (checksum enabled).

- **Example 4:** Change baud rate from 9600 to 19200 and enable checksum (Assume current ID is 03, baud rate is 9600 and checksum disabled).

  Because both the baud rate and checksum is changed, the following procedures should be performed before sending this command:

1. Power off the module
2. Short INIT* pin to Ground (see Appendix A).
3. Power on the module.
4. Send command string.

   Command: %0003400740(cr)

5. Response module ID address 03

   Response: !03(cr)

6. Response module ID address 03
7. Power off the module.
8. Open INIT* pin and power on module again (baud rate changed to 19200 and checksum enabled).

Note: We recommend using the setup utility to configure the module.

Related topics: $AA2, ~AAI, ~AATnn

5.4.1.2. $AA2

Description	Read module configuration	
Command	$AA2[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	2	Command for reading configuration
	CHK	Check sum
	(cr)	Carriage return
Response	!AATTCCFF[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	TT	Type code
	CC	Baud rate (see 3.11.1)
	FF	Data format of module (see 3.11.2)
	CHK	Check sum
	(cr)	Carriage return

Example: For the NuDAM-6150(ID=01), read configuration of module with ID address=01 and returns “400600” (TT=40, baud rate=9600, no checksum)

Command: $012(cr)
Response: !01400600(cr)

Related command: %AANNTTCCFF

5.4.1.3. ~AAI

Description	The Soft INIT* command is used to enable modification of the Baud Rate, checksum and communication protocol settings using software only. (The command is for firmware version D02.01 and later.)	
Command	~AAI[CHK](cr)	
Syntax	~	Command leading code
	AA	Module address ID (00 to FF)
	I	Command to set the Soft INIT*
	CHK	Check sum
	(cr)	Carriage return
Response	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Note: The “~AATnn” command should be sent prior to sending this command.

Example: Sets the soft INIT* of module 01 and returns a valid response.
Command: ~01I(cr)
Response: !01(cr)

Related commands: %AANNTTCCFF, ~AATnn, ~AAI, $AAPN

5.4.1.4. ~AATnn

Description	Sets the soft INIT* timeout value. (The command is for firmware version D02.01 and later.)	
Command	~AATnn[CHK](cr)	
Syntax	~	Command leading code
	AA	Module address ID (00 to FF)
	T	Command to set the soft INIT time out value
	nn	Two hexadecimal digits representing the timeout value in seconds. The maximum timeout value is 60 seconds. When changing the Baud Rate or checksum settings without altering the INIT* pin, the ~AAI and %AANNTTCCFF(or $AAPN) commands should be sent consecutively and the time interval between the two commands should be less than the soft INIT* timeout. If the soft INIT* timeout is 0, then the Baud Rate and checksum settings cannot be changed using software only. The power-on reset value of the soft INIT* timeout is 0.
	CHK	Check sum
	(cr)	Carriage return
Response	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Example 1:

(1) Sets the soft INIT* of module 01 and returns a valid response.

Command: ~01I (cr) **Response:** !01(cr)

(2) Attempts to change the Baud Rate of module 01 to 19200 without first altering the INIT * pin. The module returns an invalid response because the soft INIT timeout value is 0.

Command: %0101000700 (cr) **Response:** ?01(cr)

(3) Sets the soft INIT* timeout value of module 01 to 32 seconds and returns a valid response.

Command: ~01T20 (cr) **Response:** !01(cr)

(4) Sets the soft INIT* of module 01 and returns a valid response.

Command: ~01I (cr) **Response:** !01(cr)

(5) Changes the Baud Rate of module 01 to 19200 without first altering INIT * pin. The module returns

Command: %0101000700 (cr) **Response:** !01(cr)

Example 2:

(1) Sets the soft INIT* of module 01 and returns a valid response.

Command: ~01I (cr) **Response:** !01(cr)

(2) Attempts to change the protocol of module 01 to modbus-rtu without first altering the INIT * pin. The module returns an invalid response because the soft INIT timeout value is 0.

Command: $01P1 (cr) **Response:** ?01(cr)

(3) Sets the soft INIT* timeout value of module 01 to 32 seconds and returns a valid response.

Command: ~01T20 (cr) **Response:** !01(cr)

(4) Sets the soft INIT* of module 01 and returns a valid response.

Command: ~01I (cr) **Response:** !01(cr)

(5) Changes the protocol of module 01 to modbus-rtu without first altering INIT * pin. The module returns

Command: $01P1 (cr) **Response:** !01(cr)

Related command: %AANNTTCCFF, ~AAI, $AAPN

5.4.1.5. $AA5

Description	Reads the Reset Status of a module	
Command	$AA5[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	5	Command for read reset status
	CHK	Check sum
	(cr)	Carriage return
Response	!AAS[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	S	= 0 - the module is not been reseted
		= 1 - the module is been reseted
	CHK	Check sum
	(cr)	Carriage return

Example: Read address 01, read reset status, and return module has been reset

Command: $015(cr)
Response: !011(cr) - the module has been reset

Command: $015(cr)
Response: !010(cr) - the module has not been reset

Related command: $AARS

5.4.1.6. $AAF

Description	Read the firmware version of a module	
Command	$AAF[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	F	Command for Read Firmware Version
	CHK	Check sum
	(cr)	Carriage return
Response	!AA(data)[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID

	(data)	firmware version of module(max. 6 chars.)
	CHK	Check sum
	(cr)	Carriage return

Example: Read address 01 Read Firmware Version and return version D02.01

Command: $01F(cr)
Response: !01D02.01 (cr) - BIOS version D02.01

Related command:

5.4.1.7. $AAM

Description	Read the module name	
Command	$AAM[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	M	Command for Read Module Name
	CHK	Check sum
	(cr)	Carriage return
Response	!AA(data)[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	(data)	A string showing the name of the module (max. 6 chars.)
	CHK	Check sum
	(cr)	Carriage return

Example: Read name of module 01 and return the module name “6150”

Command: $01M(cr)
Response: !016150(cr)

Related command: ~AAO(data)

5.4.1.8. ~AAO (Data)

Description	Sets the module name	
Command	~AAO(data)[CHK](cr)	
Syntax	~	Command leading code
	AA	Module address ID (00 to FF)
	O	Command to Sets the name of a module
	(data)	New name of the module (max. 6 characters).
	CHK	Check sum
	(cr)	Carriage return
Response	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Note: The new name is saved in the EEPROM.

Example:

(1) Read name of module 01 and return the module name “610”
Command: $01M(cr)
Response: !016160 (cr)

(2) Sets the name of the module 01 to be “NuDAM " and returns a valid response.
Command: ~01ONuDAM (cr)
Response: !01 (cr)

(3) Read address 01 Read the module name, return the module name “NuDAM”
Command: $01M(cr)
Response: !01NuDAM(cr)

Related command: $AAM

5.4.1.9. $AAPN

Description	Sets the communication protocol (The command is for firmware version D02.01 and later.)	
Command	$AAPN[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	P	Command to Set the communication protocol
	N	The protocols supported by the module = 0 - NuDAM-ASCII format protocol (default) = 1 - Modbus-RTU protocol
	CHK	Check sum
	(cr)	Carriage return
Response	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Note:

1. Before the command is issued, the INIT* pin should be connected to GND or use Soft INIT* command (see ~AAI , ~AATnn).
2. The new protocol is saved in the EEPROM and will be effective after the next power on reset (Open INIT* pin).

Example: Sets the communication protocol of module 01 to Modbus-RTU and returns an valid response

Command: $01P1 (cr)
Response: !01(cr)

Related command: ~AAP, ~AAI, ~AATnn

5.4.1.10. $AAP

Description	Reads the communication protocol information (The command is for firmware version D02.01 and later.)	
Command	$AAP[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	P	Command for Read protocol information
	CHK	Check sum
	(cr)	Carriage return
Response	!AASC[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	S	The protocols supported by the module = 0 - Only ASCII protocol is supported = 1 - Both the NuDAM ASCII and Modbus RTU protocols are supported
	C	The protocols supported by the module = 0 - NuDAM -ASCII format protocol = 1 - Modbus-RTU protocol
	CHK	Check sum
	(cr)	Carriage return

Example: Reads the communication protocol of module 01 and returns a response of “10” meaning that it supports both the NuDAM ASCII and Modbus RTU protocol and the protocol that will be used at the next power on reset is NuDAM ASCII.

Command: $01P(cr)
Response: !0110(cr)

Related command: $AAPN

5.4.1.11. $AARS

Description	Reboot the module to the power-on state (The command is for firmware version D02.01 and later.)	
Command	$AARS[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	RS	Reset command
	CHK	Check sum
	(cr)	Carriage return
Response	No response	

Note: Reset command will reset module to reboot.
(This command has no response from module.)

Example: Reset module with ID address is 02

Command: $02RS (cr)
Response: No response

Related command: $AA5

5.4.1.12. $AAS1

Description	Reloads the module factory default (The command is for firmware version D02.01 and later.)	
Command	$AAS1[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	S1	Command to reload the factory default
	CHK	Check sum
	(cr)	Carriage return
Response	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Note: Before the command is issued, the **INIT*** pin should be connected to GND and after response command is issued, the module will be rebooted.

Example: Reloads the module factory default setting and return valid.

Command: $05S1(cr)
Response: !05(cr)

Related commands: %AANNTTCCFF, $AA2

5.4.1.13. ~AAX3IO

Description	Set DIO module LED display panel on/off	
Command	~AAX3IO[CHK](cr)	
Syntax	~	Command leading code
	AA	Module address ID (00 to FF)
	X3	Status LED control command.
	I	Digital input status LED control, = 1 - Turn-ON,if digital input active(default) = 0 - Turn-OFF, if digital input active Note: input disconnected(open) = inactive.
	O	Digital output status LED control = 1 - Trun-ON LED, if output active(default) = 0 - Trun-OFF LED, if output active
	CHK	Check sum
	(cr)	Carriage return
Response	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Example: Set module with ID=02 to turn-on the LED when relative input channels are active and output channels are active.

Command: ~02X311 (cr)
Response: !02 (cr)

Related command: ~AAX3

5.4.1.14. ~AAX3

Description	Read status LED display panel control settings	
Command	~AAX3[CHK](cr)	
Syntax	~	Command leading code
	AA	Module address ID (00 to FF)
	X3	Read LED setting command.
	CHK	Check sum
	(cr)	Carriage return
Response	!AAIO[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	I	Input status LED control, = 1 - Turn-ON,if input active = 0 - Turn-OFF, if input active Note: input disconnected(open) = inactive.
	O	Output status LED control = 1 - Trun-ON LED, if output active = 0 - Trun-OFF LED, if output active
	CHK	Check sum
	(cr)	Carriage return

Example: Read LED control settings of module with ID=02.

Command: ~02X3 (cr)
Response : !0210 (cr)

Note: Input LED will turn on when input channels are active and output LED will turn off when output channels are active.

Related command: ~AAX3IO

5.4.1.15. #**

Description:	Synchronize all modules to sample input values and store the values in the module's register at the same time and use "$AA4"(Read Synchronized Data) command to read the data and process it one by one.	
Command:	#**[CHK](cr)	
Syntax:	#	Command leading code
	**	Synchronized Sampling command
	CHK	Check sum
	(cr)	Carriage return
Response:	No response	

Example: Synchronized sampling command has no response

Command: #**<CR>
Response:
Related command: $AA4

5.4.1.16. $AA4

Description	Read synchronized data	
Command	$AA4[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	4	Command for reading synch. data
	CHK	Check sum
	(cr)	Carriage return
Response	!SDDDD00[CHK](cr)	Valid command
	? AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	S	Data status, S=1 first read, S=0 been readed
	DDDD	Data (4 characters) (see 3.11.3)
	00	The value is always 00
	CHK	Check sum
	(cr)	Carriage return

Related command: #**

5.4.1.17. $AA6

Description	Read the digital input channel value and readback the digital output channel value. (see "@AA")	
Command	$AA6[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	6	Command for reading digital I/O status
	CHK	Check sum
	(cr)	Carriage return
Response	!DDDD00[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	DDDD	A four-digit hexadecimal I/O value (see 3.11.3).
	00	The value is always 00
	CHK	Check sum
	(cr)	Carriage return

Example: For the ND-6160(ID=02), Reads the digital input/output port status of module and returns 0F00h, which denotes that RL1,RL2, RL3 and RL4 are ON(1) and DI0,DI1, DI2 and DI3 are OFF(0).

Command: $026(cr)
Response: !0F0000 (cr)

Related commands: @AA, @AA(data) ,#AA0ADD, #AA0BDD

5.4.1.18. #AA00DD

Description	Sets the digital output value of the lower eight channels (This command is the same with "#AA0ADD" command)	
Command	#AA00DD [CHK](cr)	
Syntax	#	Command leading code
	AA	Module address ID (00 to FF)
	00	Output command type
	DD	A two-digit hexadecimal value, where bit 0 corresponds to DO0, bit 1 corresponds to DO1, etc. When the bit is 1, it denotes that the digital output channel is ON, and 0 denotes that the digital output channel is OFF. (see 3.11.3)
	CHK	Check sum
	(cr)	Carriage return
Response	>[CHK](cr)	Valid command
	?[CHK](cr)	Invalid command
	![CHK](cr)	Ignored command
	>	Delimiter for valid command
	?	Delimiter for invalid command
	!	Delimiter for ignore command (The watchdog timeout status is set)
	CHK	Check sum
	(cr)	Carriage return

Related commands: #AA0ADD, #AA00DDDD, @AA(data)

5.4.1.19. #AA00DDDD

Description	Sets the digital output value for channel(0~15), (This command is the for compatible with ADAM-4000 "#AABB")	
Command	#AA00DDDD [CHK](cr)	
Syntax	#	Command leading code
	AA	Module address ID (00 to FF)
	00	Output command type
	DDDD	A four-digit hexadecimal value, where bit 0 corresponds to DO0, bit 1 corresponds to DO1, etc. When the bit is 1, it denotes that the digital output channel is ON, and 0 denotes that the digital output channel is OFF (see 3.11.3).
	CHK	Check sum
	(cr)	Carriage return
Response	>[CHK](cr)	Valid command
	?[CHK](cr)	Invalid command
	![CHK](cr)	Ignored command
	>	Delimiter for valid command
	?	Delimiter for invalid command

	!	Delimiter for ignore command (The watchdog timeout status is set)
	CHK	Check sum
	(cr)	Carriage return

Related command: #AA0ADD, @AA(data), #AA00DD

5.4.1.20. #AA0ADD

Description	Sets the digital output value of the lower eight channels (This command is the same with "#AA00DD" command)	
Command	#AA0ADD [CHK](cr)	
Syntax	#	Command leading code
	AA	Module address ID (00 to FF)
	0A	Output command type
	DD	A two-digit hexadecimal value, where bit 0 corresponds to DO0, bit 1 corresponds to DO1, etc. When the bit is 1, it denotes that the digital output channel is ON, and 0 denotes that the digital output channel is OFF. (see 3.11.3)
	CHK	Check sum
	(cr)	Carriage return
Response	>[CHK](cr)	Valid command
	?[CHK](cr)	Invalid command
	![CHK](cr)	Ignored command
	>	Delimiter for valid command
	?	Delimiter for invalid command
	!	Delimiter for ignore command (The watchdog timeout status is set)
	CHK	Check sum
	(cr)	Carriage return

Example: For the ND-6160(ID=05), Sets RL2,RL3 to ON, and RL1, RL4 to OFF, and the module returns a valid response.

Command: #050A06<cr>
Response: >(cr)

Related command: #AA00DD, @AA(data)

5.4.1.21. #AA0BDD

Description	Sets the digital output value of the upper eight channels	
Command	#AA0BDD [CHK](cr)	
Syntax	#	Command leading code
	AA	Module address ID (00 to FF)
	0B	Output command type
	DD	A two-digit hexadecimal value, where bit 0 corresponds to DO8, bit 1 corresponds to DO9, etc. When the bit is 1, it denotes that the digital output channel is ON, and 0 denotes that the digital output channel is OFF. (see 3.11.3)
	CHK	Check sum
	(cr)	Carriage return

Response:	>[CHK](cr)	Valid command
	?[CHK](cr)	Invalid command
	![CHK](cr)	Ignored command
	>	Delimiter for valid command
	?	Delimiter for invalid command
	!	Delimiter for ignore command (The watchdog timeout status is set)
	CHK	Check sum
	(cr)	Carriage return

Related commands: #AA00DDDD, @AA(data)

5.4.1.22. #AA1CDD

Description	Sets a single digital output for channel N (see "AAACDD" and "#AABCDD")	
Command	#AA1CDD [CHK](cr)	
Syntax	#	Command leading code
	AA	Module address ID (00 to FF)
	1	Command to set a single digital output channel
	C	Specifies the digital output channel to be set (0 to F)
	DD	output ON/OFF state = 00 - set the digital output channel to OFF. = 01 - set the digital output channel to ON.
	CHK	Check sum
	(cr)	Carriage return
Response	>[CHK](cr)	Valid command
	?[CHK](cr)	Invalid command
	![CHK](cr)	Ignored command
	>	Delimiter for valid command
	?	Delimiter for invalid command
	!	Delimiter for ignore command (The watchdog timeout status is set)
	CHK	Check sum
	(cr)	Carriage return

Example: For the ND-6160(ID=05), Set RL3 to OFF and the module returns a valid response.

Command: #051200<cr>
Response: >(cr)

Related commands: #AAACDD, #AABCDD, @AADOCCS

5.4.1.23. #AAACDD

Description	Sets a single digital output channel of the lower eight channels (see "#AA1CDD")	
Command	#AAACDD [CHK](cr)	
	#	Command leading code
	AA	Module address ID (00 to FF)

Syntax	A	Command to set a single digital output channel of the lower eight channels
	C	Specifies the digital output channel to be set (0 to 7)
	DD	output ON/OFF state = 00 - set the digital output channel to OFF. = 01 - set the digital output channel to ON.
	CHK	Check sum
	(cr)	Carriage return
Response	>[CHK](cr)	Valid command
	?[CHK](cr)	Invalid command
	![CHK](cr)	Ignored command
	>	Delimiter for valid command
	?	Delimiter for invalid command
	!	Delimiter for ignore command (The watchdog timeout status is set)
	CHK	Check sum
	(cr)	Carriage return

Example: For the ND-6160(ID=05), Set RL3 to OFF and the module returns a valid response.

Command: #05A200<cr>
Response: >(cr)

Related commands: #AA1CDD, #AABCDD

5.4.1.24. #AABCDD

Description	Sets a single digital output channel of the upper eight channels (see "#AA1CDD")	
Command	#AABCDD [CHK](cr)	
Syntax	#	Command leading code
	AA	Module address ID (00 to FF)
	B	Command to set a single digital output channel of the upper eight channels.
	C	Specifies the digital output channel to be set (0 to 7) where 0 stands for channel 8, 1 stands for channel 9, etc.
	DD	output ON/OFF state = 00 - set the digital output channel to OFF. = 01 - set the digital output channel to ON.
	CHK	Check sum
	(cr)	Carriage return
Response	>[CHK](cr)	Valid command
	?[CHK](cr)	Invalid command
	![CHK](cr)	Ignored command
	>	Delimiter for valid command
	?	Delimiter for invalid command
	!	Delimiter for ignore command (The watchdog timeout status is set)
	CHK	Check sum

	(cr)	Carriage return

Related commands: #AA1CDD , #AABCDD, #AAACDD

5.4.1.25. @AA

Description	Reads the status of the digital input/output ports (see "$AA6")	
Command	@AA [CHK](cr)	
Syntax	@	Command leading code
	AA	Module address ID (00 to FF)
	CHK	Check sum
	(cr)	Carriage return
Response	>DDDD[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	![CHK](cr)	Ignored command
	>	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	DDDD	A four-digit hexadecimal I/O value (see 3.11.3)
	CHK	Check sum
	(cr)	Carriage return

Example: For the ND-6160(ID=02), Reads the digital input/output port status of module and returns 0F00h, which denotes that RL1, RL2, RL3 and RL4 are ON(1) and DI0,DI1, DI2 and DI3 are OFF(0).

Command: @02(cr)
Response: >0F00 (cr) (see 3.11.3 and 3.11.4)

Related commands: $AA6, @AA(data), ~AADMN

5.4.1.26. @AA(data)

Description	Sets the digital output channels	
Command	@AA(data)[CHK](cr)	
Syntax	@	Command leading code
	AA	Module address ID (00 to FF)
	(data)	Data to be written to the digital output channels. it is a one,two or four-digit hexadecimal value. where bit 0 corresponds to DO0, bit 1 corresponds to DO1, etc. When the bit is 1, it denotes that the digital output channel is ON, and 0 denotes that the digital output channel is OFF (see 3.11.3 and 3.11.4). (data) = 0–F (one character) for 6160
	CHK	Check sum
	(cr)	Carriage return
	>[CHK](cr)	Valid command
	?[CHK](cr)	Invalid command
	![CHK](cr)	Ignored command
	>	Delimiter for valid command

Response	?	Delimiter for invalid command
	!	Delimiter for ignore command (The watchdog timeout status is set)
	CHK	Check sum
	(cr)	Carriage return

Example: For the ND-6160(ID=05), Sets RL2,RL4 to ON, and RL1,RL3 to OFF, and the module returns a valid response.

Command: @05A<cr>
Response: >(cr)

Related commands: #AA0ADD, #AA0BDD, @AA(data), #AA00DD

5.4.1.27. @AADO(data)

Description	Sets the digital output value for channels (0–31) (for Firmware version D04.01 and later)	
Command	@AADO(data) [CHK](cr)	
Syntax	@	Command leading code
	AA	Module address ID (00 to FF)
	DO	Specifies the digital output channels (0–31)
	(data)	Data to be written to the digital output channels(0~31). it is eight-digit hexadecimal value. where bit 0 corresponds to DO0, bit 1 corresponds to DO1, etc. When the bit is 1, it denotes that the digital output channel is ON, and 0 denotes that the digital output channel is OFF.
	CHK	Check sum
	(cr)	Carriage return
Response	>[CHK](cr)	Valid command
	?[CHK](cr)	Invalid command
	![CHK](cr)	Ignored command
	>	Delimiter for valid command
	?	Delimiter for invalid command
	!	Delimiter for ignore command (The watchdog timeout status is set)
	CHK	Check sum
	(cr)	Carriage return
	>[CHK](cr)	Valid command

Example: For the ND-6160(ID=05), Sets RL2,RL4 to ON, and RL1,RL3 to OFF, and the module returns a valid response.

Command: @05DO0000000A<cr>
Response: >(cr)

Related command: @AADO

5.4.1.28. @AADO

Description	Reads the status of the digital output ports. (ch. 0–31) (for Firmware version D04.01 and later)
Command	@AADO [CHK](cr)

Syntax	@	Command leading code
	AA	Module address ID (00 to FF)
	DO	Specifies read the digital output channels (0~31)
	CHK	Check sum
	(cr)	Carriage return
Response	>DDDDDDDD[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	![CHK](cr)	Ignored command
	>	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	DDDDDDD D	A eight-digit hexadecimal output value (ch 0~31)
	CHK	Check sum
	(cr)	Carriage return

Related commands: @AADO(data), @AA

5.4.1.29. @AADOCCS

Description	Sets a single digital output for channel N (0–31) (for Firmware version D04.01 and later)	
Command	@AADOCCS [CHK](cr)	
Syntax	@	Command leading code
	AA	Module address ID (00 to FF)
	DO	Specifies the digital output channels (0~31)
	CC	Channel number (00h~1Fh)
	S	output ON/OFF state = 0 - set the digital output channel to OFF. = 1 - set the digital output channel to ON.
	CHK	Check sum
	(cr)	Carriage return
Response	>[CHK](cr)	Valid command
	?[CHK](cr)	Invalid command
	![CHK](cr)	Ignored command
	>	Delimiter for valid command
	?	Delimiter for invalid command
	!	Delimiter for ignore command (The watchdog timeout status is set)
	CHK	Check sum
	(cr)	Carriage return
	>[CHK](cr)	Valid command

Example 2: For the ND-6160(ID=05), set RL3 to OFF and the module returns a valid response.

Command: @05DO020<cr>
Response: >(cr)

Related commands: #AA00DD, @AA(data)

5.4.1.30. @AADOCC

Description	Reads a single digital output for channel N (0–31) (for Firmware version D04.01 and later)	
Command	@AADOCC[CHK](cr)	
Syntax	@	Command leading code
	AA	Module address ID (00 to FF)
	DO	Specifies read the digital output channels (0~31)
	CC	Channel number (00h~1Fh)
	CHK	Check sum
	(cr)	Carriage return
Response	>S[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	![CHK](cr)	Ignored command
	>	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	S	output ON/OFF state = 0 - the digital output channel OFF. = 1 - the digital output channel ON.
	CHK	Check sum
	(cr)	Carriage return

Related command: @AADOCCS

5.4.1.31. @AADICC

Description	Reads a single digital input for channel N (0–31) (for Firmware version D04.01 and later)	
Command	@AADICC[CHK](cr)	
Syntax	@	Command leading code
	AA	Module address ID (00 to FF)
	DI	Specifies read the digital input channels (0~31)
	CC	Channel number (00h~1Fh)
	CHK	Check sum
	(cr)	Carriage return
Response	>S[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	![CHK](cr)	Ignored command
	>	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	S	input ON/OFF state = 0 - the digital input channel OFF. = 1 - the digital input channel ON.
	CHK	Check sum
	(cr)	Carriage return

Related command: @AADI

5.4.1.32. @AADI

Description	Reads the status of the digital input ports. (ch. 0–31) (for Firmware version D04.01 and later)	
Command	@AADI[CHK](cr)	
Syntax	@	Command leading code
	AA	Module address ID (00 to FF)
	DI	Specifies read the digital input channels (0~31)
	CHK	Check sum
	(cr)	Carriage return
Response	>DDDDDDDD[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	![CHK](cr)	Ignored command
	>	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	DDDDDDDD	A eight-digit hexadecimal input value (ch. 0–31)
	CHK	Check sum
	(cr)	Carriage return

Related command: @AA

5.4.1.33. $AAC

Description	Clears the status of the latched digital input channels	
Command	$AAC[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	C	Command for clearing latched digital input
	CHK	Check sum
	(cr)	Carriage return
Response	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Example: Clear latched input of module address ID=06

Command: $06C<CR>
Response: !06<CR>

Related command: $AALS

5.4.1.34. $AALS

Description	Reads the status of the latched digital input channels	
Command	$AALS[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	L	Command to read the latched status
	S	= 0 - Read the low latched status = 1 - Read the high latched status
	CHK	Check sum
	(cr)	Carriage return
Response	!DDDD00[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	DDDD	Status of the latched digital input channels, a four digit hexadecimal value (see 3.11.3). When the bit is 1, it denotes that the input channel is latched, and 0 denotes that the input channel is not latched.
	00	The value is always 00
	CHK	Check sum
	(cr)	Carriage return

Related command: $AAC

5.4.1.35. ~AACPSS

Description	Changes the polarity state of digital inputs and outputs of the module.	
Command	~AACPSS [CHK](cr)	
Syntax	~	Command leading code
	AA	Module address ID (00 to FF)
	CP	Command to Set DIO active status
	SS	Polarity state of digital inputs and outputs (2 characters) = 00 - set di/do to default active value = 01 - Change the polarity of default digital inputs = 02 - Change the polarity of default digital outputs = 03 - Change the polarity both the default digital inputs and outputs.
	CHK	Check sum
	(cr)	Carriage return
Response	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Example:

# Read ND-6150 active status, Response: Polarity was not changed

Command: ~06CR(cr)
Response: !0600(cr)

# For the ND-6150 (ID=06), Reads the status of the DIO

Command: @06(cr)
Response: >00FF (cr)

# For the ND-6150 (ID=06), Changes the polarity of default digital inputs

Command: ~06CP01(cr)
Response: !06 (cr)

# For the ND-6150 (ID=06), Reads the status of the DIO

Command: @06(cr)
Response: >0000 (cr)

Related command: ~AACR, @AA

5.4.1.36. ~AACR

Description	Reads the polarity state of digital inputs and outputs of the module	
Command	~AACR[CHK](cr)	
Syntax	~	Command leading code
	AA	Module address ID (00 to FF)
	CR	Command to readDIO active status
	CHK	Check sum
	(cr)	Carriage return
Response	!AAMN[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	SS	Polarity state of digital inputs and outputs (2 characters) = 00 - set di/do to default active value = 01 - Change the polarity of default digital inputs = 02 - Change the polarity of default digital outputs = 03 - Change the polarity both the default digital inputs and outputs.
	CHK	Check sum
	(cr)	Carriage return

Example:

# For the ND-6150 (ID=06), Set input active value to 1 (ON) and output active value to 0 (OFF).

# For the ND-6150 (ID=06), Changes the polarity of default digital outputs

Command: ~06CP02(cr)
Response: !06 (cr)

# Read ND-6150 active status, Response: DO Polarity was changed

Command: ~06CR(cr)
Response: !0602(cr)

Related commands: ~AACPSS, @AA

5.4.1.37. ~**

Description	Host sends this command to all modules for send the information "Host OK"	
Command	~**[CHK](cr)	
Syntax	~	Command leading code
	**	For all modules
	CHK	Check sum
	(cr)	Carriage return
Response	No response	

Note: When the host watchdog timer is enabled, the host computer must send this command to all modules before timeout; otherwise, the "Host watchdog timer enabled" module's output value will go to the safety state output value.

Related commands: ~AA0, ~AA1, ~AA2, ~AA3EVV, ~AA4V, ~AA5V

5.4.1.38. ~AA0

Description	Reads watchdog timeout status	
Command	~AA0[CHK](cr)	
Syntax	~	Command leading code
	AA	Module address ID (00 to FF)
	0	Command for reading timeout status
	CHK	Check sum
	(cr)	Carriage return
Response	! AASS[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	SS	Two hexadecimal digits that represent the host watchdog status. bit(7) - Host watchdog enable/disable , = 0 - Disable. */ = 1 - Enable. */ bit(2) - Host watchdog timeout status, */ = 0 - indicates that no host watchdog timeout has occurred. = 1 - indicates that a host watchdog timeout has occurred. bit(6,5,4,3,1,0) - reserved(=0) The host watchdog status is stored in EEPROM and can only be reset by using the ~AA1 command.
	CHK	Check sum
	(cr)	Carriage return

Example 1: Reads the host watchdog status of module 02 and returns 00, meaning that the host watchdog is disabled and no host watchdog timeout has occurred.

Command: ~020(cr)
Response: !0200(cr)
Example 2: Reads the host watchdog status of module 02 and returns 04, meaning that a host watchdog timeout has

occurred.

Command: ~020(cr)
Response: !0204(cr)

Related commands: ~AA1, ~AA2, ~AA3EVV, ~AA4V, ~AA5V

5.4.1.39. ~AA1

Description	Resets watchdog timeout status	
Command	~AA1[CHK](cr)	
Syntax	~	Command leading code
	AA	Module address ID (00 to FF)
	1	Command for resetting watchdog timeout status
	CHK	Check sum
	(cr)	Carriage return
Response	! AA [CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Example 1: Reads the host watchdog status of module 03 and shows that a host watchdog timeout has occurred.

Command: ~030 (cr)
Response: !0304 (cr)

Resets the host watchdog timeout status of module 03 and returns a valid response.

Command: ~031 (cr)
Response: !03 (cr)

Reads the host watchdog status of module 03 and shows that no host watchdog timeout has occurred.

Command: ~030 (cr)
Response: !0300 (cr)

Related commands: ~AA0, ~AA2, ~AA3EVV, ~AA4V, ~AA5V

5.4.1.40. ~AA2

Description	Reads host watchdog timeout value	
Command	~AA2[CHK](cr)	
Syntax	~	Command leading code
	AA	Module address ID (00 to FF)
	2	Command for reading watchdog timeout value
	CHK	Check sum
	(cr)	Carriage return
Response	! AAEVV[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command

	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID

	E	Host watchdog enabled status
		E = 1 – Enable
		E = 0 – Disable

	VV	Timeout value in hex format from 01 to FF (01 denotes 0.1 seconds and FF denotes 25.5 seconds)
	CHK	Check sum
	(cr)	Carriage return

Example: Reads the host watchdog timeout value of module 03 and returns FF, which denotes that the host watchdog is enabled and the host watchdog timeout value is 25.5 seconds.

Command: ~032 (cr)
Response: !031FF(cr)

Related commands: ~AA0, ~AA1, ~AA3EVV, ~AA4V, ~AA5V

5.4.1.41. ~AA3EVV

Description	Enables/disables the host watchdog and sets the host watchdog timeout value of a module.		
Command	~AA3EVV[CHK](cr)		
Syntax	~	Command leading code	
	AA	Module address ID (00 to FF)	
	3	Command for setting watchdog timeout value	
	E	1= enable, 0= disable Host watchdog	
	VV	Timeout value (01~FF, each for 0.1 second)	
	CHK	Check sum	
	(cr)	Carriage return	
Response	! AA [CHK](cr)	Valid command	
	?AA[CHK](cr)	Invalid command	
	!	Delimiter for valid command	
	?	Delimiter for invalid command	
	AA	Module address ID	
	CHK	Check sum	
	(cr)	Carriage return	

Note:

If host watchdog timer is enabled, the host should send *Host OK* (see "~**") command periodically within Timeout value to refresh the timer, otherwise the module will be forced to the safety state (see "~AA5V")

Example:
Sets module (ID=04) to have watchdog timeout value 20.0 seconds and enable host watchdog.

Command: ~0431C8(cr)
Response: !04(cr)

Reads the watchdog timeout value form module (ID=04).
The module returns 1C8, which denotes that the host watchdog is enabled and the host watchdog timeout value is 20.0 seconds.

Command: ~042(cr)

Response: !041C8(cr)

Host sends this command to all modules for send the information "Host OK"

Command: ~**(cr)

Stops sending any command string to modules for at least 20.0 seconds. The LED on the module will go to flash. The flash LED indicates the host watchdog is timeout and timeout status is set.

Reads watchdog timeout status, The module returns 04, which denotes that a host watchdog timeout has occurred.

Command: ~040(cr)
Response: !0404(cr)

Resets watchdog timeout status. Watchdog timeout is cleared and LED stop flashing, and host watchdog is disabled

Command: ~041(cr)
Response: !04 (cr)

Reads the host watchdog status of module 04 and returns 00, meaning that the host watchdog is disabled and no host watchdog timeout has occurred.

Command: ~040(cr)
Response: !0400(cr) Timeout status is cleared

Related commands: ~AA0, ~AA1, ~AA2, ~AA4V, ~AA5V

5.4.1.42. ~AA5V

Description	Sets the current DO value as the power-on DO value or the safe DO value.	
Command	~AA5V[CHK](cr)	
Syntax	~	Command leading code
	AA	Module address ID (00 to FF)
	5	Command for Sets power on and safe value
	V	V= P – Set power on value V= S – Set safe value
	CHK	Check sum
	(cr)	Carriage return
Response	! AA [CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Related commands: ~AA0, ~AA1, ~AA2, ~AA3EVV, ~AA4V

5.4.1.43. ~AA4V

Description	Reads the power-on DO value or the safe DO value of a module	
Command	~AA4V[CHK](cr)	
	~	Command leading code
	AA	Module address ID (00 to FF)
	4	Command for reading power on and safe value

Syntax	V	V= P – Read power on value V= S – Read safe value
	CHK	Check sum
	(cr)	Carriage return
Response	! AA(data)[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	(data)	For the DO channels > 8 mdules, they are four hexadecimal digits. For other modules, they are two hexadecimal digits followed by 00. (data) = xxxx - for EDAM-8042,804,8045….. (data) = xx00 - for other modules
	CHK	Check sum
	(cr)	Carriage return

Related commands: ~AA0, ~AA1, ~AA2, ~AA3EVV, ~AA5V

5.5. ND-6117 Command Sets

There are five categories of ND-6117 commands: special commands, general commands, analog commands, digital commands, and linear mapping commands. All commands used in the ND-6117 analog input module are listed in the following tables.

5.5.1. Host Watchdog Commands

Command	Response	Description
~**	no response	Host OK
~AA0	!AASS	Read Module Status
~AA1	!AA	Reset Module Status
~AA2	!AAVV	Read Host watchdog Timeout Value
~AA3EVV	!AA	Set Host Watchdog Timeout Value

5.5.2. General Commands

Command	Response	Description
%AANNTTCCFF	!AA	Set Module Configuration
#AA	>(Data)	Read Analog Input
#AAN	>(Data)	Read Analog Input from channel N
$AA0	!AA	Perform Span Calibration
$AA1	!AA	Perform Zero Calibration
$AA2	!AATTCCFF	Read Configuration
$AA5VV	!AA	Set Channel Enable
$AA6	!AAVV	Read Channel Status
$AA7CiRrr	!AA	Set channel type individually
$AA8Ci	!AACiRrr	Read individual channel type
$AAF	!AA(Data)	Read Firmware Version
$AAM	!AA(Data)	Read Module Name
~AAEV	!AA	Enable/Disable Calibration
~AAO(Data)	!AA	Set Module Name

5.5.3. Command Descriptions

5.5.3.1. %AANNTTCCFF Set Module Configuration

Description	Sets the configuration of the module at address AA	
Syntax	%AANNTTCCFF (cr)	
	%	delimiter character
	AA	(range 00-FF) represents the 2-character hexadecimal address of module
	NN	new module address (00–FF)
	TT	represents the type code. Type code determines the input range. If TT=00 or FF the type of all
	CC	represents the baud rate code
	FF	hexadecimal number that equals the 8-bit parameter that represents the data format,
	(cr)	terminating character, carriage return (0Dh)
Response	!AA (cr)	the command is valid

	?AA (cr)	the command is invalid
	!	delimiter character indicates a valid command was received
	?	delimiter character indicates the command was invalid
	AA	(range 00-FF) represents the 2-character hexadecimal address of an analog input module
	(cr)	terminating character, carriage return (0Dh)
Example	Command	%0203080602
	Response	!02
	Result	new module address=03
		Analog input type code=08(-10V–+10V) for all channels
		baud rate=06 (9600)
		data format =02 (2's complement hexadecimal)

Note: This command will set all channels to have the same type code (TT) if TT >0

5.5.3.2. #AA Read Analog Data

Description	Returns the input value from a specified (AA) module in the currently configured data format	
Syntax	#AA(cr)	
	#	delimiter character
	AA	(range 00-FF) represents the 2-character hexadecimal address of an analog input module
	(cr)	terminating character, carriage return (0Dh)
Response	>(data)(cr)	the command is valid
	?AA (cr)	the command is invalid
	There is no response if the module detects a syntax error or communication error.	
	>	delimiter character
	(data)	input value in the configured data format of the module
	(cr)	terminating character, carriage return (0Dh)
Example	Command	#21(cr)
	Response	>+7.2111+7.2567+7.3125+7.1000+7.4712+7.2555+7.1234+7.5678(cr)
	The command responds to the analog input module at address 21h for its input values of all channels. The analog input module responds with channels from 0 to 7 with +7.2111 volts, +7.2567 volts, +7.3125 volts, +7.1000 volts, +7.4712 volts, +7.2555 volts, +7.1234 volts, and +7.5678 volts.	
	Command	#DE(cr)
	Response	>FF5D(cr)
	The analog input module at address DEh has an input value of FF5D. (The configured data format of the analog input module is two's complement.)	

5.5.3.3. #AAN Read Analog Input from Channel N

Description	Returns the input value from one of the eight channels of a specified (AA) module in the currently configured data format	
Syntax	#AAN(cr)	
	#	delimiter character
	AA	(range 00-FF) represents the 2-character hexadecimal address of the analog input module

	(cr)	terminating character, carriage return (0Dh)
Response	>(data)(cr)	the command is valid
	?AA (cr)	the command is invalid
	There is no response if the module detects a syntax error or communication error.	
	>	delimiter character
	(data)	input value in the configured data format of the module
	(cr)	terminating character, carriage return (0Dh)
Example	Command	#120(cr)
	Response	>+1.4567(cr)
	The command requests the analog input module at address 12h to return the input value of channel 0. The analog input module responds that the input value of channel 0 is equal to +1.4567 volts.	

5.5.3.4. $AA0 Span Calibration

Description	Calibrates an analog input module to correct for gain errors	
Syntax	$AA0(cr)	
	$	delimiter character
	AA	(range 00-FF) represents the 2-character hexadecimal address of the module to be calibrated
	0	Span calibration command
	(cr)	terminating character, carriage return (0Dh)
Response	!AA(cr)	the command is valid
	?AA (cr)	the command is invalid
	There is no response if the module detects a syntax error or communication error.	
	!	delimiter character indicating a valid command was received
	?	delimiter character indicating the command was valid
	AA	(range 00-FF) represents the 2-character hexadecimal address of the module
	(cr)	terminating character, carriage return (0Dh)

Note: To successfully calibrate an analog input module's input range, a proper calibration input signal must be connected to the analog input module before and during calibration

5.5.3.5. $AA1 Offset Calibration

Description	Calibrates an analog input module to correct for offset errors	
Syntax	$AA1(cr)	
	$	delimiter character
	AA	(range 00-FF) represents the 2-character hexadecimal address of the module to be calibrated
	0	Span calibration command
	(cr)	terminating character, carriage return (0Dh)
Response	!AA(cr)	the command is valid
	?AA (cr)	the command is invalid
	There is no response if the module detects a syntax error or communication error.	
	!	delimiter character indicating a valid command was received
	?	delimiter character indicating the command was valid

	AA	(range 00-FF) represents the 2-character hexadecimal address of the module
	(cr)	terminating character, carriage return (0Dh)

Note: To successfully calibrate an analog input module's input range, a proper calibration input signal must be connected to the analog input module before and during calibration

5.5.3.6. $AA2 Read Configuration Status

Description	Requests the return of the configuration data from the module at address AA	
Syntax	$AA2(cr)	
	$	delimiter character
	AA	(range 00-FF) represents the 2-character hexadecimal address of a module
	2	Configuration Status command
	(cr)	terminating character, carriage return (0Dh)
Response	!AATTCCFF(cr)	the command is valid
	?AA (cr)	the command is invalid
	There is no response if the module detects a syntax error or communication error.	
	!	delimiter character indicating a valid command was received
	?	delimiter character indicating the command was valid
	AA	(range 00-FF) represents the 2-character hexadecimal address of an analog input module
	TT	the type code of channel 0; see $AA8Ci
	CC	represents the baud rate code
	FF	a hexadecimal number that equals the 8-bit parameter that represents the data format, checksum status, and integration time. Bits 2 to 5 are not used, and are set to 0.
	(cr)	terminating character, carriage return (0Dh)
	Note: Refer to 3.12 for TT, CC, and FF parameter definitions.	
Example	Command	$452(cr)
	Response	!45050600(cr)
	The command asks the analog input module at address 45h to send its configuration data. The analog input module at address 45h responds with an input range of 2.5 volts, a baud rate of 9600 bps, and an integration time of 50 ms (60 Hz); engineering units are the currently configured data format, and there is no checksum function or checksum generation.	

5.5.3.7. $AA5VV Enable/Disable Channels for Multiplexing

Description	Enables/disables multiplexing simultaneously for separate channels of a specified input module	
Syntax	$AA5VV(cr)	
	$	delimiter character
	AA	(range 00-FF) represents the 2-character hexadecimal address of a module
	5	Enable/Disable Channels command

	VV	Two hexadecimal values. The values are interpreted by the module as two binary words (4-bit). The first word represents the status of channels 4–7, and the second word represents the status of channels 0–3. Value 0 means the channel is disabled, and value 1 means the channel is enabled.
	(cr)	terminating character, carriage return (0Dh)
Response	!AA(cr)	the command is valid
	?AA (cr)	the command is invalid
	There is no response if the module detects a syntax error or communication error.	
	!	delimiter character indicating a valid command was received
	?	delimiter character indicating the command was valid
	AA	(range 00-FF) represents the 2-character hexadecimal address of the module
	(cr)	terminating character, carriage return (0Dh)
Example	Command	$00581(cr)
	Response	!00(cr)
	Hexadecimal 8 equals binary 1000, which enables channel 7 and disables channels 4, 5, and 6. Hexadecimal 1 equals binary 0001, which enables channel 0 and disables channels 1, 2, and 3.	

5.5.3.8. $AA6 Read Channel Status

Description	Asks a specified input module to return the status of all channels	
Syntax	$AA6(cr)	
	AA	(range 00-FF) represents the 2-character hexadecimal address of the module that you want to send the channel status for. The channel status defines whether a channel is enabled or disabled.
	6	Read Channel Status command
	(cr)	terminating character, carriage return (0Dh)
Response	!AAVV(cr)	the command is valid
	?AA (cr)	the command is invalid
	There is no response if the module detects a syntax error or communication error.	
	!	delimiter character indicating a valid command was received
	?	delimiter character indicating the command was valid
	AA	(range 00-FF) represents the 2-character hexadecimal address of the module
	VV	Two hexadecimal values. The values are interpreted by the module as two binary words (4-bit). The first word represents the status of channels 4–7, and the second word represents the status of channels 0–3. Value 0 means the channel is disabled, and value 1 means the channel is enabled.
	(cr)	terminating character, carriage return (0Dh)
Example	Command	$026(cr)
	Response	!02FF(cr)

	The command asks the analog input module at address 02 to send the status of it input channels. The analog input module at address 02 responds that all its multiplex channels are enabled (FF equals 1111 and 1111).

5.5.3.9. $AA7CiRrr Set Channel Type Individually

Description	Sets the channel type individually	
Syntax	$AA7CiRrr(cr)	
	$	delimiter character
	AA	(range 00-FF) represents the 2-character hexadecimal address of a module
	7C	Set Channel Type command
	i	channel number
	rr	channel type code
	(cr)	terminating character, carriage return (0Dh)
Response	!AA	the command is valid
	?AA (cr)	the command is invalid
	There is no response if the module detects a syntax error or communication error.	
	!	delimiter character indicating a valid command was received
	AA	(range 00-FF) represents the 2-character hexadecimal address of the module
	(cr)	terminating character, carriage return (0Dh)
Example	Command	$017C3R08(cr)
	Response	!01(cr)
	Set type code 08 (+/-10V) to channel 3.	

5.5.3.10. $AA8Ci Read Individual Channel Type

Description	Reads the individual channel type	
Syntax	$AA8Ci (cr)	
	$	delimiter character
	AA	(range 00-FF) represents the 2-character hexadecimal address of a module
	8C	Read Channel Type command
	i	channel number
	(cr)	terminating character, carriage return (0Dh)
Response	!AACiRrr	the command is valid
	?AA (cr)	the command is invalid
	There is no response if the module detects a syntax error or communication error.	
	!	delimiter character indicating a valid command was received
	AA	(range 00-FF) represents the 2-character hexadecimal address of the module
	i	channel number (0–7)
	rr	type of channel i
	(cr)	terminating character, carriage return (0Dh)
Example	Command	$018C3(cr)
	Response	!01C3R08(cr)
	The type code of channel 3 is 08 (+/-10V).	

5.5.3.11. $AAF Read Firmware Version

Description	Requests the module at address AA to return the version code of its firmware	
Syntax	$AAF (cr)	
	$	delimiter character
	AA	(range 00-FF) represents the 2-character hexadecimal address of a module
	F	Read Firmware Version command
	(cr)	terminating character, carriage return (0Dh)
Response	!AA(Version)(cr)	the command is valid
	?AA (cr)	the command is invalid
	There is no response if the module detects a syntax error or communication error.	
	!	delimiter character indicating a valid command was received
	AA	(range 00-FF) represents the 2-character hexadecimal address of the module
	(Version)	version code of the modules firmware at address AA
	(cr)	terminating character, carriage return (0Dh)

5.5.3.12. $AAM Read Module Name

Description	Requests the analog output module at address AA to return its name	
Syntax	$AAM (cr)	
	$	delimiter character
	AA	(range 00-FF) represents the 2-character hexadecimal address that you want to access
	M	Read Module Name command
	(cr)	terminating character, carriage return (0Dh)
Response	!AA(Module Name)(cr)	the command is valid
	?AA (cr)	the command is invalid
	There is no response if the module detects a syntax error or communication error.	
	!	delimiter character indicating a valid command was received
	AA	(range 00-FF) represents the 2-character hexadecimal address of the module
	(Module Name)	name of the module at address AA
	(cr)	terminating character, carriage return (0Dh)

5.5.3.13. ~AAEV Enable/Disable Module Calibration

Description	Enables or disables module calibration	
Syntax	~AAEV	
	~	delimiter character
	AA	address of the module
	E	Enable/Disable Module Calibration command
	V	1: Enable calibration; 0: Disable calibration
Response	!AA (cr)	the command is valid
	?AA (cr)	the command is invalid

	There is no response if the module detects a syntax error or communication error.	
	!	delimiter character for a valid response
	?	delimiter character for an invalid response
	AA	address of the responding module (00-FF)
Example	Command	$010
	Response	?01
	Sends the command to perform a span calibration on module 01. It returns an invalid response because the “enable calibration command” was not sent in advance.	
	Command	~01E1
	Response	!01
	Enables calibration on module 1	
	Command	$010
	Response	!01
	Sends the command to perform a span calibration on module 01 and returns a valid response.	

5.5.3.14. ~AAO(name) Set Module Name

Description	Sets the module name	
Syntax	~AAO(name)(cr)	
	~	delimiter character
	AA	address of the module to be set (00-FF)
	O	Set Module Name command (max. 6 characters)
Response	!AA (cr)	the command is valid
	?AA (cr)	the command is invalid
	There is no response if the module detects a syntax error or communication error.	
	!	delimiter character indicating a valid command was received
	?	delimiter character indicating an invalid response was received
	AA	address of the responding module (00-FF)

5.5.3.15. ~AA0 Read Host Watchdog Status

Description	Reads the host watchdog status of a module	
Syntax	~AA0(cr)	
	~	delimiter character
	AA	address of the module to be read (00-FF)
	0	Read Host Watchdog Status command
Response	!AASS (cr)	the command is valid
	?AA (cr)	the command is invalid
	There is no response if the module detects a syntax error or communication error.	
	!	delimiter character indicating a valid command was received
	?	delimiter character indicating an invalid response was received
	AA	address of the responding module (00-FF)

	SS	Two hexadecimal digits that represent the host watchdog status, where: Bit 7: =0 indicates that the host watchdog is disabled and =1 indicates the host watchdog is enabled, Bit 2: =1 indicates watchdog time out has occurred. The host watchdog status is stored in EEPROM and can only be reset using the ~AA1 command.

5.5.3.16. ~AA1 Reset Host Watchdog Timeout Status

Description	Reads the host watchdog timeout status of a module	
Syntax	~AA1 (cr)	
	~	delimiter character A
	AA	address of the module to be set (00-FF)
	1	Read Host Watchdog Timeout Status command
Response	!AA (cr)	the command is valid
	?AA (cr)	the command is invalid
	There is no response if the module detects a syntax error or communication error.	
	!	delimiter character indicating a valid command was received
	?	delimiter character indicating an invalid response was received
	AA	address of the responding module (00-FF)

5.5.3.17. ~AA2 Read Host Watchdog Timeout Value

Description	Reads host watchdog timeout value	
Syntax	~AA2(cr)	
	~	delimiter character
	AA	address of the module to be read
	2	Read Host Watchdog Timeout Value command
Response	!AAEVV(cr)	the command is valid
	?AA (cr)	the command is invalid
	There is no response if the module detects a syntax error or communication error.	
	!	delimiter character for a valid response
	?	delimiter character for an invalid response
	AA	address of the responding module
	E	1: host watchdog is enabled; 0: host watchdog is disabled
	VV	two hexadecimal digits to represent the value in tenths of a second
Example	Command	~012(cr)
	Response	!011FF(cr)
	Reads the host watchdog time out value of module 01 and returns FF, meaning that the host watchdog is enabled and watchdog timeout value is FF(hex)=255.5 seconds	

5.5.3.18. ~AA3EVV Enable/Disable Host Watchdog

Description	Enables or disables the host watchdog and sets the host watchdog timeout value of a module	
Syntax	~AA3EVV(cr)	
	~	delimiter character
	AA	address of the module to be read
	3	Set Host Watchdog Timeout Value command
	E	1: enables host watchdog; 0: disables host watchdog
	VV	two hexadecimal digits to represent timeout value in tenths of second; for example, 01 means 0.1 seconds, and FF means 25.5 seconds
Response	!AA(cr)	the command is valid
	?AA (cr)	the command is invalid
	There is no response if the module detects a syntax error or communication error.	
	!	delimiter character for a valid response
	?	delimiter character for an invalid response
	AA	address of the responding module
Example	Command	~013164(cr)
	Response	!01(cr)
	Enables the host watchdog of module 01 and sets the host watchdog timeout value to 10.0 seconds.	

5.5.3.19. ~** Send “Host OK”

Description	Informs all modules that the host is OK	
Syntax	~**(cr)	
	~	delimiter character A
	**	Host OK command
Response	No response	

5.6. ND-6124 Command Sets

There are four categories of ND-6124 commands: general commands, analog commands, digital input commands, and host watchdog command sets. All the commands used in the ND-6124 analog output module are list in the following tables.

5.6.1. General Commands

Command	Response	Description
%AANNTTCCFF	!AA	Set Module Configuration
$AA2	!AATTCCFF	Read Configuration
$AA5	!AAS	Read Reset Status
$AAF	!AA(data)	Read Firmware Version
$AAM	!AA(Data)	Read Module Name
~AAO(Data)	!AA	Set Module Name
$AAPN	!AA	Sets the communication protocol.

$AAP	! AASC	Reads the communication protocol information.
~AAI	!AA	Soft INIT
~AATnn	!AA	Sets the Soft INIT Time-out
$AAS1	!AA	Reloads the module factory default
$AARS	!AA	Reset the module to initial power on state.

5.6.2. Analog Commands

Command	Response	Description
#AAN(data)	>	Output Analog Value(for engineer format)
$AA0N	!AA	0mA/-10V Calibration
$AA1N	!AA	20mA/10V Calibration
$AA3NVV	!AA	Trim Calibration for Channel N
$AA4N	!AA	Set Power-On Value for Channel N
$AA6N	!AA(Data)	Last Value of Channel N Readback
$AA7N	!AA	Read Power-On Value
$AA8N	!AA(Data)	Current Value Readback
$AA9N	!AATTSS	Read DA Configuration of channel N
$AA9NTTSS	!AA	Set DA Configuration of channel N

5.6.3. Digital Input Commands

Command	Response	Description
#**	No response	Synchronized Sampling
$AA9	>SDD	Reads the synchronized data that was retrieved by the last "#**" command.
$AA8	!DD0000	Digital Input
@AA	>(Data)	Read Emergency DI Input port
~AA8NE	!AA	Enable/Disable channel(N) Emergency DI
~AA8N	!AA	Clear Emergency DI active flag

5.6.4. Host Watchdog Commands

Command	Response	Description
~**	No Response	Host OK
~AA0	!AASS	Reads the watchdog status & Emergency input flag.
~AA1	!AA	Reset Module Status
~AA2	!AAVV	Read host watchdog timeout interval
~AA3EVV	!AA	Set Host Watchdog Timeout interval
~AA4N	!AA(Data)	Read Safe Value
~AA5N	!AA	Set Safe Value

5.6.5. Command Descriptions

5.6.5.1. Set Module Configuration

Modules	For 6124 module

Description	Configure the basic setting of NuDAM, including the address ID, input range, baud rate, and data format.	
Command	%AANNTTCCFF[CHK](cr)	
Syntax	%	Command leading code
	AA	Module address ID (00 to FF)
	NN	New NuDAM address ID (00 to FF)
	TT	= 00 - Reserved
	CC	Set new baud rate of module
	FF	Data format
	CHK	Check sum
	(cr)	Carriage return
Response	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	New Module address ID
	CHK	Check sum
	(cr)	Carriage return

Note: When you want to change the checksum or baud rate, the INIT* pin must be grounded first.

Example 1: Change ID address from 01 to 03 (Assume current baud rate is 9600 and checksum disabled)

Command: %0103000600(cr)
Response: !03(cr)

Response new module ID address 03 (change ID address only)

Example 2: Change baud rate from 9600 to 19200(Assume current ID is 03, baud rate is 9600, and checksum disabled).

Because the baud rate is changed from 9600 to 19200, the following procedures should be done before sending this command:

1. Power off the module
2. Short INIT* pin to Ground
4. Power on the module
5. Send command string
6. Command: %0003000700(cr)
7. Response: !03(cr)
8. Response module ID address 03
9. Power off the module
10. Open the INIT* pin and power on module again

Example 3: Enable checksum (Assume current ID is 03, baud rate is 9600 and checksum disabled).

Because the checksum is changed from disable to enable, the following procedures should be done before sending this command:

1. Power off the module
2. Short INIT* pin to Ground
3. Power on the module
4. Send command string

5. Command: %0003000640(cr)
6. Response: !03(cr)
7. Response module ID address 03
8. Power off the module
9. Open INIT* pin and power on module again (checksum enabled)

Example 4: Change baud rate from 9600 to 19200 and enable checksum (Assume current ID is 03, baud rate is 9600 and checksum disabled). Because that both the baud rate and checksum is changed , the following procedures should be done before sending this command:

1. Power off the module
2. Short INIT* pin to Ground
3. Power on the module
4. Send command string
5. Command: %0003000740(cr)
6. Response: !03(cr)
7. Response module ID address 03
8. Power off the module
9. Open INIT* pin and power on module again (Baud rate changed to 19200 and checksum enabled)

Note: It is recommended to use the setup utility to configure the module

Related commands: $AA2

5.6.5.2. Read Configuration

Modules	For 6124 module	
Description	Read module configuration	
Command	$AA2[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	2	Command for reading configuration
	CHK	Check sum
	(cr)	Carriage return
Response	!AATTCCFF[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	TT	= 00
	CC	Baud rate
	FF	Data format of module
	CHK	Check sum
	(cr)	Carriage return

Example 1: Read configuration of module with ID address=01

Command: $012(cr)
Response: !01000600(cr)

Read address ID=01 module configuration

= 00 - TT
= 06 - 9600 baud rate

= 00 - no checksum,

Related commands: %AANNTTCCFF , $AA9NTTSS, $AA9N

5.6.5.3. Read Reset Status

Modules	For all modules	
Description	Read reset status	
Command	$AA5[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	5	Command for read reset status
	CHK	Check sum
	(cr)	Carriage return
Response	!AAS[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	S	= 0 - the module is not been reseted
		= 1 - the module is been reseted
	CHK	Check sum
	(cr)	Carriage return

Example: Read address 01 Read reset status and return module is bee reseted

Command: $015(cr)
Response: !011(cr) - the module is been reset

Command: $015(cr)
Response: !010(cr) - the module is not been reset

Related command: $AARS

5.6.5.4. Read Firmware Version

Modules	For all modules	
Description	Read Firmware Version	
Command	$AAF[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	F	Command for Read Firmware Version
	CHK	Check sum
	(cr)	Carriage return
Response	!AA(data)[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	(data)	firmware version of module(max. 6 chars.)
	CHK	Check sum
	(cr)	Carriage return

Example: Read address 01 Read Firmware Version and return version A00.02

Command: $01F(cr)
Response: !01A00.02 (cr)   - BIOS version A00.02

5.6.5.5. Read Module Name

Modules	For all modules	
Description	Read Module Name	
Command	$AAM[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	M	Command for Read Module Name
	CHK	Check sum
	(cr)	Carriage return
Response	!AA(data)[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	(data)	A string showing the name of the module (max. 6 chars.)
	CHK	Check sum
	(cr)	Carriage return

Example: Read name of module 01 and return the module name “6124”

Command: $01M(cr)
Response: !016124(cr)

Related command: ~AAO

5.6.5.6. Set Module Name

Modules	For all modules	
Description	Sets the name of a module	
Command	~AAO(data)[CHK](cr)	
Syntax	~	Command leading code
	AA	Module address ID (00 to FF)
	O	Command to Sets the name of a module
	(data)	New name of the module (max. 6 characters).
	CHK	Check sum
	(cr)	Carriage return
Response	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Example:

(1) Reads the name of module 01 and returns the module name “6124”

Command: $01M(cr)
Response: !016124(cr)

(2) Sets the name of the module 01 to be “NuDAM" and returns a valid response.

Command: ~01ONuDAM (cr)

Response: !01 (cr)

(3) Reads address 01 Read Firmware Version, returns the module name “NuDAM”

Command: $01M(cr)
Response: !01NuDAM(cr)

Related command: $AAM

5.6.5.7. Set Communication Protocol

Modules	For all modules	
Description	Set the communication protocol	
Command	$AAPN[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	P	Command to Set the communication protocol
	N	The protocols supported by the module = 0 - NuDAM-ASCII format protocol (default) = 1 - Modbus-RTU protocol
	CHK	Check sum
	(cr)	Carriage return
Response	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Note:

1. Before the command is issued, the INIT* pin should be connected to GND.
2. The new protocol is saved in the EEPROM and will be effective after the next power on reset.

Example: Sets the communication protocol of module 01 to Modbus-RTU and returns an valid response

Command: ~01P1 (cr)
Response: !01(cr)

Related command: ~AAP

5.6.5.8. Read Communication Protocol Information

Modules	For all modules	
Description	Reads the communication protocol information	
Command	$AAP[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	P	Command for Read protocol information
	CHK	Check sum
	(cr)	Carriage return
Response	!AASC[CHK](cr)	Valid command

	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	S	The protocols supported by the module = 0 - only ASCII protocol is supported = 1 - both the ASCII and Modbus RTU protocols are supported
	C	The protocols supported by the module = 0 - NuDAM-ASCII format protocol = 1 - Modbus-RTU protocol
	CHK	Check sum
	(cr)	Carriage return

Example: Reads the communication protocol of module 01 and returns a response of “10” meaning that it supports both the ASCII and Modbus RTU protocol and the protocol that will be used at the next power on reset is ASCII.

Command: $01P(cr)
Response: !0110(cr)

Related command: $AAPN

5.6.5.9. Soft INIT* Command

Modules	For all modules	
Description	The Soft INIT* command is used to enable modification of the Baud Rate and checksum settings using software only.	
Command	~AAI[CHK](cr)	
Syntax	~	Command leading code
	AA	Module address ID (00 to FF)
	I	Command to set the Soft INIT
	CHK	Check sum
	(cr)	Carriage return
Response	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Note: The ~AATnn command should be sent prior to sending this command.

Example: Sets the soft INIT* of module 01 and returns a valid response.
Command: ~01I(cr)

Response: !01(cr)

Related commands: %AANNTTCCFF, ~AATnn

5.6.5.10. Set Soft INIT* Timeout Value

Modules	For all modules	
Description	Sets the soft INIT* timeout value.	
Command	~AATnn[CHK](cr)	
	~	Command leading code

Syntax	AA	Module address ID (00 to FF)
	T	Command to set the soft INIT time out value
	nn	Two hexadecimal digits representing the timeout value in seconds. The maximum timeout value is 60 seconds. When changing the Baud Rate or checksum settings without altering the INIT* pin, the ~AAI and %AANNTTCCFF commands should be sent consecutively and the time interval between the two commands should be less than the soft INIT timeout. If the soft INIT timeout is 0, then the Baud Rate and checksum settings cannot be changed using software only. The power-on reset value of the soft INIT timeout is 0.
	CHK	Check sum
	(cr)	Carriage return
Response	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Example:

(1) Sets the soft INIT* of module 01 and returns a valid response.

Command: ~01I (cr)
Response: !01(cr)

(2) Attempts to change the Baud Rate of module 01 to 19200 without first altering the INIT * pin. The module returns an invalid response because the soft INIT timeout value is 0.

Command: %0101000700 (cr)
Response: ?01(cr)

(3) Sets the soft INIT* timeout value of module 01 to 16 seconds and returns a valid response.

Command: ~01T10 (cr)
Response: !01(cr)

(4) Sets the soft INIT* of module 01 and returns a valid response.

Command: ~01I (cr)
Response: !01(cr)

(5) Changes the Baud Rate of module 01 to 19200 without first altering INIT * pin. The module returns

Command: %0101000700 (cr)
Response: !01(cr)

Related commands: %AANNTTCCFF, ~AATI

5.6.5.11. Reload Factory Default

Modules	For all modules	
Description	Reloads the module factory default setting.	
Command	$AAS1[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	S1	Command to reload the factory default

	CHK	Check sum
	(cr)	Carriage return
Response	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Note: Before the command is issued, the INIT* pin should be connected to GND and after response command is issued, the module will be rebooted.

Example: Reloads the module factory default setting and return valid.

Command: $05S1(cr)
Response: !05(cr)

Related command: %AANNTTCCFF, $AA2

5.6.5.12. Reset Module to Initial Power-on State

Modules	For all modules	
Description	To stop current operation , reset the module to initial power on state.	
Command	$AARS[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	RS	Command for reset the module
	CHK	Check sum
	(cr)	Carriage return
Response	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Example: To stop current operation and reset the module to power-on state or safe output.

Command: $05RS(cr)
Response: !05(cr)

5.6.5.13. Output Analog Value

Modules	For 6124	
Description	Output Analog Value for channel N	
Command	#AAN(data) [CHK](cr)	
Syntax	#	Command leading code
	AA	Module address ID (00 to FF)
	N	Analog output channel (0 to 3)

	(data)	analog output value, **Engineering format:** This data format including three components. 1. sign (+ or -) 2. digits 3. decimal point Data is composited with a sign (+ or -) followed with 5-digits and a decimal point. It does not exceed 7-characters. Over Range(+9999.9) , Under Range(-9999.9). Example: #AAN+99.999 or #AAN-99.999 **Hexadecimal format:** Twos Complement Hexadecimal format presents the data in ASCII hexadecimal Example: #AANFFFF
	CHK	Check sum
	(cr)	Carriage return
Response	>[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!AA[CHK](cr)	Ignore Command
	>	Delimiter for valid command
	?	Delimiter for Invalid command
	!	Delimiter for the module's host watchdog status is set or Emergency input is active and the output command will be ignored.
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

For Engineering format: #AAN+99.999 or #AAN-99.999

Example: Output address 01 value +02.456V for channel 0 and return success.

Command: #010+02.456
Response: > (cr)

Example: Output address 01 value -03.456V for channel 0 and return success.

Command: #010-03.456
Response: > (cr)

Example: Output address 01 value +12.456mA for channel 2 and return success.

Command: #012+12.456
Response: > (cr)

Example: Output address 01 value +02.456V for channel 2 and return emergency input is active(low) and the output command will be ignored.

Command: #012+02.456
Response: ! (cr)

For Hexadecimal format: #AANFFFF

Example: Output address 01 value +02.456V for channel 0 and return success.

Command: #0100998
Response: > (cr)

Example: Output address 01 value -03.456V for channel 0 and return success.

Command: #010F280

Response: > (cr)

Example: Output address 01 value +12.456mA for channel 2 and return success.

Command: #01230A8
Response: > (cr)

Related commands: $AA9, $AA9NTTSS, $AA6N, $AA8N

5.6.5.14. Perform 0mA/-10V Calibration

Modules	For 6124	
Description	Tells the module to store parameters for channel(N) 0mA/-10V calibration.	
Command	$AA0N [CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	0	Command for performing 0mA/-10V calibration
	N	Channel to calibrate (0 to 3)
	CHK	Check sum
	(cr)	Carriage return
Response	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Example: Perform 0mA/-10V Calibration for Channel 3

Command: $0203(cr)
Response: !02 (cr)

Related commands: $AA3NVV, $AA1N, #AAN(data)

5.6.5.15. Perform 20mA/+10V Calibration

Modules	For 6124	
Description	Tells the module to store parameters for channel(N) 20mA/+10V calibration.	
Command	$AA1N [CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	1	Command for performing 20mA/+10V calibration
	N	Channel to calibrate (0 to 3)
	CHK	Check sum
	(cr)	Carriage return
Response	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Example: Perform 20mA/+10V Calibration for Channel 3 and return valid.

Command: $0213(cr)
Response: !02 (cr)

Related command: $AA3NVV, $AA0N, #AAN(data)

5.6.5.16. Trim Calibration

Modules	For 6124	
Description	Trim Calibration for Channel N Note: Before start please set Analog output Type Code to 0x30 or 0x33.	
Command	$AA3NVV [CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	3	Command for trimming calibration
	N	Channel to trim (0 to 3)
	VV	2's complement hexadecimal to trim the analog output value. 00 to 5F to increase 0 to 95 counts, and FF to A1 to decrease 1 to 95 counts. Each count indicates 2.44μA or 1.22mV.
	CHK	Check sum
	(cr)	Carriage return
Response	!AA [CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	delimiter for invalid command or the calibration is not enabled
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Example: Trim address 02 channel 1 output 52 counts and return success.

Command: $023134(cr)
Response: !02 (cr)

Related commands: $AA0N, $AA1N, #AAN(data)

5.6.5.17. Set Power-on Value for Channel N

Modules	For 6124	
Description	Stores a default output value in a specified module. The output value will take effect upon startup.	
Command	$AA4N[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	4	command for setting Power-On Value
	N	Channel to set (0 to 3)
	CHK	Check sum
	(cr)	Carriage return
Response	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command

	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Example:

(1) Sets address 02 channel 1 output +01.50, returns success.

Command: #021+01.500 (cr)
Response: >(cr)

(2) Sets address 02 channel 1 power-on Value, returns success. The Power-On Value of channel 1 is set to 01.50 now

Command: $0241(cr)
Response: >(cr)

Related command: #AAN(data)

5.6.5.18. Read Back Last Value of Channel N

Modules	For 6124	
Description	Returns either last value sent to specified module by #AAN command.	
Command	$AA6N[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	6	command for reading last output value
	N	Channel to readback (0 to 3)
	CHK	Check sum
	(cr)	Carriage return
Response	!AA(data)[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	(data)	the last output command value.
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Example:

(1) Sets address 02 channel 1 output +02.567, returns success.

Command: #021+02.567(cr)
Response: !02 (cr)

(2) Reads address 02 channel 1 last output value, returns +02.567

Command: $0261
Response: !00+02.567(cr)

Related command: #AAN(data)

5.6.5.19. Read Power-on Value of Channel N

Modules	For 6124	
Description	Reads power-on value of channel N	
Command	$AA7N[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)

	7	command for reading Power-On Value
	N	Channel to readback (0 to 3)
	CHK	Check sum
	(cr)	Carriage return
Response	!AA(data)[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	(data)	Power-on value
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Example: Read address 02 channel 1 power-on Value, returns +05.000.

Command: $0271(cr)
Response: !02+05.000 (cr)

Related commands: $AA4N, #AAN(data)

5.6.5.20. Read Back Current Value

Modules	For 6124	
Description	Reads back the current analog output value for channel N.	
Command	$AA8N[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	8	command for read current output value
	N	Channel to readback (0 to 3)
	CHK	Check sum
	(cr)	Carriage return
Response:	!AA(data)[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	(data)	current analog output value.
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Example:

(1) Reads address 01 configuration, return output type 0 to 10V, and slew rate is 1.0V/Second.

Command: $0190(cr)
Response: !013205 (cr)

(2) Reads address 01 channel 0 current value, returns 0.0V.

Command: $0180 (cr)
Response: !01+00.000 (cr)

(3) Sets address 01 channel 0 output 10.0V, returns success.

Command: #010+10.000 (cr)

Response: > (cr)

(4) Reads address 01 channel 0 last output command value, returns +10.000V.

Command: $0160 (cr)
Response: !01+10.000 (cr)

(5) Waits 1 second and reads address 01 channel 0 current value, returns 9.0V.

Command: $0180 (cr)
Response: !01+09.000 (cr)

(6) Waits 6 seconds, reads address 01 channel 0 current value, returns 3.0V.

Command: $0180 (cr)
Response: !01+03.000 (cr)

Related commands: #AAN(data), $AA9, $AA9N

5.6.5.21. Read DA Configuration of Channel N

Modules	For 6124	
Description	Reads type and slew rate of Channel N	
Command	$AA9N[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	9	command for reading DA configuration
	N	channel to read DA configuration (0 to 3)
	CHK	Check sum
	(cr)	Carriage return
Response	!AATTSS[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	TT	Analog output type.
	SS	Analog output slew rate.
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Example: Read address 01 channel 2 DA configuration, return +/-10V output and slew rate is 5 (1.0V/Second).

Command: $0192(cr)
Response: !013305 (cr)

Related command: $AA9NTTSS

5.6.5.22. Set DA Configuration of Channel N

Modules	For ND-6124 modules	
Description	Sets type and slew rate for Channel N	
Command	$AA9NTTSS[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	9	command for set DA configuration
	N	channel to set DA configuration (0 to 3)
	TT	Analog output type.
	SS	Analog output slew rate.
	CHK	Check sum
	(cr)	Carriage return

Response	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Note: After the command is issued, the module must be rebooted.

Example: Set address 01 channel 2 type to 30 (0 to 20mA) and slew rate is 5 (1.0V/Second).

Command: $01923005 (cr)
Response: !01(cr)

Related command: $AA9N

5.6.5.23. Read Emergency Digital Input Ports

Modules	For 6124	
Description	Reads emergency digital input ports	
Command	@AA[CHK](cr)	
Syntax	@	Command leading code
	AA	Module address ID (00 to FF)
	CHK	Check sum
	(cr)	Carriage return
Response	>(data)[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	>	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	(data)	Status of the digital input ports, a four-digit hexadecimal value. The first word represents the status of DI(15~8) and the second word represents the status of DI(7~0). Value 0 of bit means the channel is input low level, value 1 of bit means the channel is input high level.
	CHK	Check sum
	(cr)	Carriage return

Example: Read address 01 digital input status and returns DI(0,2) high level and DI(1,3) low level.

Command: @01(cr)
Response: >0005(cr)

Related commands: ~AA0, ~AA8E

5.6.5.24. Host OK

Modules	For all modules	
Description	Host sends this command to all modules for broadcasting the information “Host OK”	
Command	~** [CHK](cr)	
Syntax	~	Command leading code
	**	command for all modules
	CHK	Check sum
	(cr)	Carriage return

Response	No response.

Example: Send Host OK to all modules.

Command: ~** (cr)
Response: No response

Related command: ~AA0, ~AA1, ~AA2, ~AA3EVV, ~AA4N, ~AA5N

5.6.5.25. Read Module Status

Modules	For 6124	
Description	Reads the watchdog status & emergency input flag.	
Command	~AA0[CHK](cr)	
Syntax	~	Command leading code
	AA	Module address ID (00 to FF)
	0	Command for reading module status
	CHK	Check sum
	(cr)	Carriage return
Response	! AASS[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	SS	Module Status(hex ascii). bit(7) - Host watchdog enable flag, = 0 - Disable. = 1 - Enable. bit(6~3) - Emergency input E/Disable flag, one channel per bit of bit(3~6) for channel(0~3) and status is indicated as: = 0 - Disable. = 1 - Enable. bit(2) - Host watchdog timeout flag, = 0 - No host watchdog timeout has occurred. = 1 - Host watchdog timeout has occurred. bit(1~0) - reserved.
	CHK	Check sum
	(cr)	Carriage return

Note:

(1) The watchdog timeout status will be stored in EEPROM of the module and can only be cleared by issuing ~AA1 command.

(2) The emergency input(DI) enable/disable flag will be stored in EEPROM of the module and can only be set by issuing ~AA8NE command.

Example:

(1) Reads the host watchdog status of module 01 and returns 00, meaning that the host watchdog is disabled and no host watchdog time out has occurred.

Command: ~010<cr>
Response: !0100

(2): Reads the host watchdog status of module 02 and returns 84, meaning that a host watchdog timeout has occurred.

Command: ~010<cr>
Response: !0184

(3): Reads the host watchdog status of module 01 and returns 04, meaning that the host watchdog is disabled and host watchdog time out has occurred.

Command: ~010<cr>
Response: !0104

(4): Reads the status of module 01 and returns 09, meaning that channel(0) emergency Input is enable.

Command: ~010<cr>
Response: !0109

Related commands: ~**, AA1, ~AA2, ~AA3EVV, ~AA4N, ~AA5N, ~AA8E

5.6.5.26. Reset Module Status

Modules	For 6124	
Description	Resets the watchdog active status of a module	
Command	~AA1[CHK](cr)	
Syntax	~	Command leading code
	AA	Module address ID (00 to FF)
	1	Command for resetting watchdog active status
	CHK	Check sum
	(cr)	Carriage return
Response	! AA [CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Note: The module’s watch dog active status will be cleared after this command issued.

Example: Resets the host watchdog time out status of module 01 and returns a valid response.

Command: ~011<cr>
Response: !01

Related commands: ~**,AA0,~AA2,~AA3EVV,~AA4N, ~AA5N

5.6.5.27. Read Host Watchdog Timer Timeout Value

Modules	For 6124	
Description	Reads the host watchdog time out value of a module.	
Command	~AA2[CHK](cr)	
Syntax	~	Command leading code
	AA	Module address ID (00 to FF)
	2	Command for reading watchdog timeout value
	CHK	Check sum
	(cr)	Carriage return
Response	! AAEVV[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	E	Host watchdog Enable/Disable status = 0 - Disable = 1 - Enable

	VV	Timeout value in Hex format from 01 to FF(=25.5 seconds), one unit is 0.1 sec
	CHK	Check sum
	(cr)	Carriage return

Example: Reads the host watchdog time out value of module 01 and returns FF, meaning that the host watchdog time out value is 25.5 seconds.

Command: ~012 (cr)
Response: !01FF (cr)

Related commands: ~**, AA0, ~AA1, ~AA3EVV, ~AA4N, ~AA5N

5.6.5.28. Set Host Watchdog Timeout Value

Modules	For 6124	
Description	Enables/disables the host watchdog and set the host watchdog time out value of a module.	
Command	~AA3EVV[CHK](cr)	
Syntax	~	Command leading code
	AA	Module address ID (00 to FF)
	3	Command for setting watchdog timeout value
	E	Enables/disables the host watchdog: = 0 - disable = 1 - enable
	VV	Timeout value in Hex format from 01 to FF(=25.5 seconds), one unit is 0.1 sec
	CHK	Check sum
	(cr)	Carriage return
Response	! AA [CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Note: If the host watchdog timer is enabled, the host should send Host OK command periodically within the timeout value to refresh the timer; otherwise, the module will be forced to the safety state.

Example:

(1) Sets module (ID=04) to have watchdog timeout value 10.0 seconds and enable host watchdog.

Command: ~043164(cr)
Response: !04 (cr)

(2) Read watchdog timeout value form module (ID=04) and returns watchdog timeout value=10.0 seconds, and host watchdog is enabled.

Command: ~042(cr)
Response: !04164 (cr)

(3) Host OK

Command: ~**(cr)

;

wait…………

;

Stops sending any command string to modules for at least 10.0 seconds. The LED on the module will flash. The flashing LED indicates the host watchdog has timed out and the timeout status is set.

(4) Reads watchdog timeout status, and returns that the timeout status is set.

Command: ~040(cr)
Response: !0484(cr)

(5) Resets the host watchdog time out counter register of module 04 and returns a valid response.

Command: ~041<cr>
Response: !01

Related commands: ~**, ~AA0, ~AA1, ~AA2, ~AA4N, ~AA5N

5.6.5.29. Read Safe Value

Modules	For 6124	
Description	Read back safe value for watchdog timeout and Emergency input.	
Command	~AA4N[CHK](cr)	
Syntax	~	Command leading code
	AA	Module address ID (00 to FF)
	4	command for Read Safe Value
	N	channel number (0 to 3)
	CHK	Check sum
	(cr)	Carriage return
Response	!AA(data)[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	(data)	Safe Value of module.
	CHK	Check sum
	(cr)	Carriage return

Example: Reads address 01 channel 2 Safe Value, return +02.500 Safe Value

Command: ~0142 (cr)
Response: !01+02.500(cr)

Related commands: ~**, AA0, ~AA1, ~AA2, ~AA3EVV, ~AA5N

5.6.5.30. Set Safe Value

Modules	For 6124	
Description	Command for setting safe value for watchdog timeout and emergency Input, store the current output value as safe value.	
Command	~AA5N[CHK](cr)	
Syntax	~	Command leading code
	AA	Module address ID (00 to FF)
	5	command for set Safe Value
	N	channel number (0 to 3)
	CHK	Check sum
	(cr)	Carriage return
Response	!AA [CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command

	?	Delimiter for invalid command
	CHK	Check sum
	(cr)	Carriage return

Example:

(1) Outputs address 01 value +01.000V for channel 2, return success.

Command: #012+01.000
Response: > (cr)

(2) Sets address 01 channel 2 Safe Value, return success.

Command: ~0152(cr)
Response: !01 (cr)

(3) Reads address 01 channel 2 Safe Value, return +01.000 Safe Value

Command: ~0142 (cr)
Response: !01+01.000(cr)

Related commands: ~**, AA0, ~AA1, ~AA2, ~AA3EVV, ~AA4N

5.6.5.31. Enable/Disable Emergency Input (DI)

Modules	For 6124	
Description	Enables or disables emergency input (DI)	
Command	~AA8NE [CHK](cr)	
Syntax	~	Command leading code
	AA	Module address ID (00 to FF)
	8	command for Set Emergency DI Inputs
	N	channel number (0 to 3)
	E	Enables/disables emergency inputs (DI): = 0 - disable = 1 - enable
	CHK	Check sum
	(cr)	Carriage return
Response	! AA [CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Note:

1. When an emergency input (DI) is active (low), the module will be forced to the safety output state for channel N of A/O.
2. If disable is selected, then th emergency input (DI) is the same as standard digital input.
3. Read Emergency Input (DI) Enable/Disable by command "~AA0"

Example:

(1) Outputs address 04 value +01.000V for channel 1, return success.

Command: #041+01.000
Response: > (cr)

(2) Sets address 04 channel 1 Safe Value, returns success.

Command: ~0451(cr)
Response: !01 (cr)

(3) Sets module (ID=04) to enable channel (1) emergency inputs.

Command: ~04181 (cr)
Response: !04 (cr)

(4) Reads module status from module (ID=04) and returns the channel(1) emergency input is enabled.

Command: ~040(cr)
Response: !0410 (cr)

wait………
;
The module's emergency input (DI) channel (1) is active (low) and the AO channel N of the module is put into safe output mode.
;
(5) Reads emergency input port status from module (ID=04) and returns that the emergency input channel (1) is active(low).

Command: @040(cr)
Response: !040D(cr)

(6) Outputs address 04 value +01.000V for channel 1, returns that emergency input is active and the output command will be ignored.

Command: #041+01.000
Response: ! (cr)

(7) Clears emergency input (DI) active flag for channel 1.

Command: ~041(cr)
Response: !04 (cr)

(8) Outputs address 04 value +01.000V for channel 1, returns successful.

Command: #041+01.000
Response: >AA (cr)

Related commands: ~AA8, ~AA8N, ~AA0, @AA, ~AA5N, #AAN

5.6.5.32. Clear Emergency DI Active Flag

Modules	For 6124	
Description	Clears emergency DI active flag	
Command	~AA8N [CHK](cr)	
Syntax	~	Command leading code
	AA	Module address ID (00 to FF)
	8	command for Clear Emergency DI Active Flag
	N	Channel number (0–3)
	CHK	Check sum
	(cr)	Carriage return
Response	! AA [CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	CHK	Check sum
	(cr)	Carriage return

Example: Clears emergency DI active flag for channel 1.

Command: ~041(cr)
Response: !04 (cr)

Related commands: ~AA8NE, ~AA8N, ~AA0, @AA, ~AA5N, #AAN

5.6.5.33. #**

Modules	For 6124	
Description	Synchronize all modules to sample input values and store the values in the module's register at the same time and use "$AA9"(Read Synchronized Data) command to read the data and process it one by one.	
Command	#**[CHK](cr)	
Syntax	#	Command leading code
	**	Synchronized Sampling command
	CHK	Check sum
	(cr)	Carriage return
Response	No response	

Example 1: Synchronized sampling command has no response

Command: #**(cr)
Response: // No response

Example 2: Reads synchronized data from ND-6155 (ID=05), and returns S = 1 – first read, Synchronized data = 0E (DI0 active)

Command: $059(cr)
Response: >10E(cr)

Related command: ~AA9

5.6.5.34. $AA9

Description	Read synchronized data	
Command	$AA9[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	9	Command for reading synch. data
	CHK	Check sum
	(cr)	Carriage return
Response	>SDD [CHK](cr)	Valid command
	? AA[CHK](cr)	Invalid command
	>	Delimiter for valid command
	?	Delimiter for invalid command
	S	Data status, S=1 first read, S=0 been readed
	DD	Data (2 characters)
	CHK	Check sum
	(cr)	Carriage return

Example 1: Synchronized sampling command has no response

Command: #**(cr)
Response: // No response

Example 2: Reads synchronized data from ND-6155 (ID=05), and returns S = 1 – first read, synchronized data = 0E (DI0 active)

Command: $059(cr)

Response: !10E(cr)

Example 3: Reads synchronized data from ND-6155 (ID=05), and returns S = 0 – been readed, synchronized data = 0E (DI0 active)

Command: $059(cr)
Response: >00E(cr)

Related command: #**

5.6.5.35. Read Digital Input Ports

Modules	For 6124	
Description	Reads digital input ports.	
Command	$AA8[CHK](cr)	
Syntax	$	Command leading code
	AA	Module address ID (00 to FF)
	8	Command for Read Digital Input Ports
	CHK	Check sum
	(cr)	Carriage return
Response	!DD0000[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	DD	Status of the digital input ports, a two-digit hexadecimal value. Value 0 of bit means the channel is input low level, value 1 of bit means the channel is input high level.
	CHK	Check sum
	(cr)	Carriage return

Example: Reads address 01 digital input status and return DI(0,2) high level and DI(1,3) low level.

Command: $058(cr)
Response: !050000(cr)

Related commands: ~AA9, #**, @AA

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6. Modbus RTU Protocol Command Sets

6.1. Introduction

The Modbus protocol is a messaging structure developed by Modicon in 1979 for establishing master-slave/client-server communication between intelligent devices. Detailed information can be found at http://www.modbus.org.

NuDAM-6100 series modules support the Modbus RTU protocol **via firmware version D02.01 and later**.

The communication BaudRates range from 1200bps to 115200bps. The parity, data bits, and stop bits are fixed as no parity, 8 data bits and 1 stop bit. The following Modbus functions are supported.

6.2. Modbus Data Model

MODBUS bases its data model on a series of tables that have distinguishing characteristics.

The four primary tables are as follows:

Primary	Object Type	Access	Comments
Discrete Input	Single bit	Read-Only	This type of data can be provided by an I/O system.
Coils	Single bit	Read-Write	This type of data can be alterable by an application
Input Reg.	16 bit word	Read-Only	This type of data can be provided by an I/O system
Holding Reg.	16 bit word	Read-Write	This type of data can be alterable by an application program.

6.3. Modbus Function Code Definitions

Function Code	Description
01 (0x01)	Read coils
02 (0x02)	Read Discrete Inputs
03 (0x03)	Read multiple Holding registers
04 (0x04)	Read multiple input registers
05 (0x05)	Write single coil
06 (0x06)	Write single register
15 (0x0F)	write Multiple coils
16 (0x10)	Write Multiple register
70 (0x46)	Read/write module settings

Error Response:
If the function specified in the message is not supported, then the module Response is as follows:

Offset	Function	Length	Description
00	Address	1 Byte	1 to 247
01	Function code	1 Byte	Function code | 0x80
02	Exception code	1 Byte	= 0x01 -invalid function code. = 0x02 -invalid data address. = 0x03 -invalid data value. = 0x04 - host WDT timeout

Note: If a CRC mismatch occurs, the module will not respond (see “02208”).

6.4. Modbus Standard Register Designation

0xxxx - Coils access (for 0x01, 0x05, 0x0F function codes)
1xxxx - Reads discrete inputs (for 0x02 function code)
3xxxx - Reads input register (for 0x04 function code)
4xxxx - Holding register access (for 0x03, 0x06, 0x10 function codes)

xxxx - Element address of a data block, In the MODBUS data model each element within a data block is numbered from 1 to n.

Example:
00005 - Coils access and Starting address = 0004 (0005-1)
10002 - Read discrete inputs and Starting address = 0001 (0002-1)
30257 - Read input register and Starting address = 0256 (0257-1)
40001 - Access holding register and Starting address = 0000 (0001-1)

6.5. Modbus Address Mapping Tables (ND-6150 and ND-6160)

There are three categories of NuDAM module commands: general commands, watchdog commands, and DIO function commands. This section contains all commands used in NuDAM DIO input/output modules ND-6150 and ND-6160).

6.5.1. General Commands

Address Mapping			
Address	Item	Attr.	Sec.
00257	Protocol, NuDAM ASCII & Modbus select. = 1 (W/0xFF00) - Modbus RTU = 0 (W/0x0000) - NuDAM ASCII	R/W	6.5.6.1
00272	Load factory DIO module parameters = 0xFF00 - Enable	W	6.5.6.2
02208	CRC checking enable / disable = 1 (W/0xFF00) - Enable = 0 (W/0x0000) - Disable (default)	R/W	6.5.6.3
02210	Reset(reboot) the module to initial power-on status = 0xFF00 - Enable	W	6.5.6.4
00273	Read module reset status = 1 - first read after powered on = 0 - not the first read after powered on	R	6.5.6.5
40481	Firmware version (32 bits)	R	6.5.6.6
40483	Module name (32 bits)	R	6.5.6.7
40485	Module address, valid range: 1–247	R/W	6.5.6.8
40486	Baudrate setting, valid range: 3–10 for Baudrate (1200,2400,4800,9600,19200,38400,57600,115200)	R/W	3.11.1
42201	Digital input/output LED Configuration (for 80xxD) bit(1) - for digital output LED control: = 0 - Turn-OFF LED when output active = 1 - Turn-ON LED when output active bit(0) - for digital input LED control: = 0 - Turn-OFF LED when input active = 1 - Trun-ON LED when input active	R/W	6.5.8.7
42209	DIO active status (see 3.11.4) bit(0) - DI active status: = 0 - 0 for digital input active value = 1 - 1 for digital input activel value,	R/W	6.5.8.8

	(DI disconnect(OPEN) mean DI inactive) bit(1) - DO active status(OAS): = 0 - 0 for digital output active value = 1 - 1 for digital output active value		

6.5.2. Watchdog Commands

Address Mapping			
Address	Item	Attr.	Sec.
412345	Informs all modules that the host is OK(no response)	R	6.5.7
40489	Host watchdog timeout value, 0–255, in 0.1 seconds	R/W	6.5.7
40492	Inform the module that the host is OK	R	6.5.7
00261	Host watchdog enable/disable = 1 (W/0xFF00) - Enable = 0 (W/0x0000) - Disable	R/W	6.5.7
00270	Host watchdog timeout status, and write 0xFF00 (or 1) to clear host watchdog timeout status.	R/W	6.5.7
00129–00160	Host timeout Safe value for DO0–DO31	R/W	6.5.8.5

6.5.3. Digital Input/Output Function Commands

Address Mapping			
Address	Item	Attr.	Sec.
00161~00192	Power-on DO value for DO0–DO31	R/W	6.5.8.6
00001~00032	Digital output channel for DO0–DO31	R/W	6.5.8.1
00033~00064	Digital input channel for DI0–DI31	R	6.5.8.2

6.5.4. DI Latch Function Commands

Address Mapping			
Address	Item	Attr.	Sec.
00065–00096	DI Latch high value for DI0–DI31	R	6.5.8.3
00097–00128	DI Latch low value for DI0–DI31	R	6.5.8.3
00264	Clear the latch value for all DI (0–31) = 1 (or 0xFF00) - Clear all DI (0–31)	W	6.5.8.3

6.5.5. Examples of Modbus RTU General Commands

6.5.5.1. (00257) Protocol, NuDAM, ASCII, & Modbus Selection

- (00257) Read protocol and return modbus RTU is selected (01)

  Request: 01 01 01 00 00 01 [FC 36]
  Response: 01 01 01 01 [90 48]

- (00257) Set to NuDAM ASCII protocol and return successful

  Request: 01 05 01 00 00 00 [CC 36]
  Response: 01 05 01 00 00 00 [CC 36]

- (00257) Read protocol and return (0x00) NuDAM ASCII is select

  Request: 01 01 01 00 00 01 [3D F6]

Response: 01 01 01 00 [51 88]

6.5.5.2. (00272) Load Factory Calibration Parameters

- (00272) Load factory calibration parameters and wait 1 second for response

  Request: 01 05 01 0F FF 00 [BD C5]
  Response: 01 05 01 0F FF 00 [BD C5]

6.5.5.3. (02208) CRC Checking Status

- (02208) Read CRC checking status and return CRC disable (00)

  Request: 01 01 08 9F 00 01 [CF 84]
  Response: 01 01 01 00 [51 88]

- (02208) Set CRC checking to enable and return successful

  Request: 01 05 08 9F FF 00 [BE 74]
  Response: 01 05 08 9F FF 00 [BE 74]

- (02208) Set CRC checking to disable and return successful

  Request: 01 0F 08 9F 00 01 01 00 [BB C3]
  Response: 01 0F 08 9F 00 00 [A6 45]

6.5.5.4. (02210) Reset Module to Initial Power-on Status

- (02210) Reset the module to initial power-on status and return successful

  Request: 01 05 08 A1 FF 00 [DF B8]
  Response: 01 05 08 A1 FF 00 [DF B8]

6.5.5.5. (00273) Read Module Reset Status

- (00273) Read module reset status and return first read after powered on (01)

  Request: 01 01 01 10 00 01 [FD F3]
  Response: 01 01 01 01 [90 48]

- (00273) Read module reset status and return not first read (00)

  Request: 01 02 01 10 00 01 [B9 F3]
  Response: 01 02 01 00 [A1 88]

6.5.5.6. (40481) Read Firmware Version

- (40481) Read firmware version and return version D02.01(00 0D 02 01)

  Request: 01 03 01 E0 00 02 [C4 01]
  Response: 01 03 04 00 0D 02 01 [AB 50]

6.5.5.7. (40483) Module Name

- (40483) Read module name and return module name 8050 (00 80 50 00)

  Request: 01 03 01 E2 00 02 [65 C1]
  Response: 01 03 04 00 80 50 00 [C7 DB]

6.5.5.8. (40485) Module Address

- (40485) Read module address and return module address 01 (00 01)

  Request: 01 03 01 E4 00 01[C5 C1]
  Response: 01 03 02 00 01[79 84]

- (40485) Set new module address to 05 and return successful

  Request: 01 06 01 E4 00 05 [08 02]

Response: 01 06 01 E4 00 05 [08 02]

- (40485) Read module address and return module address 01 (00 01)

  Request: 01 03 01 E4 00 01[C5 C1]
  Response: 01 03 02 00 05[78 47]

- (40485) Set new module address to 01 and return successful

  Request: 01 10 01 E4 00 01 02 00 01 [60 B4]
  Response: 01 10 01 E4 00 01 [40 02]

6.5.5.9. (40486) Baud Rate Settings

- (40486) Read baud rate and return baud rate 9600 (00 06)

  Request: 01 03 01 E5 00 01 [94 01]
  Response: 01 03 02 00 06 [38 46]

- (40486) Set baud rate to 115200 (0A) and return successful (the **INIT*** pin must be grounded at first)

  Request: 01 06 01 E5 00 0A [19 C6]
  Response: 01 06 01 E5 00 0A [19 C6]

- (40486) Read baud rate and return baud rate 115200 (00 0A)

  Request: 01 03 01 E5 00 01 [94 01]
  Response: 01 03 02 00 0A [38 43]

- (40486) Set baud rate to 9600(06) and return successful (the **INIT*** pin must be grounded at first)

  Request: 01 10 01 E5 00 01 02 00 06 [20 A7]
  Response: 01 10 01 E5 00 01 [11 C2]

6.5.6. Examples of Modbus RTU Watchdog Commands

Host Watchdog Timeout Operation

- (00129) Set output channel(0,2,4,5,9) to ON(0000 0010 0011 0101) for write safe value and return successful.

  Request: 01 0F 00 80 00 0A 02 35 02 [6C 69]
  Response: 01 0F 00 80 00 0A [D4 24]

- (40489) Write host watchdog timeout value (20 sec) return valid

  Request: 01 06 01 E8 00 C8 [09 94]
  Response: 01 06 01 E8 00 C8 [09 94]

- (40489) Read host watchdog timeout value return (00 C8) watchdog timeout value (20 sec)

  Request: 01 03 01 E8 00 01 [05 C2]
  Response: 01 03 02 00 C8 [B9 D2]

- (00270) Clear host watchdog timeout status, return watchdog timeout status is cleared

  Request: 01 05 01 0D FF 00 [1C 05]
  Response: 01 05 01 0D FF 00 [1C 05]

- Set DO output channel(0~12) to 0 and return successful

  Request: 01 0F 00 00 00 0D 02 00 00 [E4 4C]
  Response: 01 0F 00 00 00 0D [94 0E]

- (00261) Set host watchdog timeout enable, return valid

  Request: 01 05 01 04 FF 00 [CC 07]
  Response: 01 05 01 04 FF 00 [CC 07]; wait 15 seconds

- (412345) Informs all modules that the host is OK and no response

  Request: 01 04 30 38 00 00 [7E C7]

Response: no response; wait 15 seconds

- (40492) Inform the module (ID=0x01) that the host is OK

  Request: 01 03 01 EB 00 00 [34 02]
  Response: 01 03 02 00 00 [B8 44]; wait 25 seconds; watchdog timeout and into safe output mode

- (00270) Read host watchdog timeout status, return host watchdog timeout flag is set

  Request: 01 01 01 0D 00 01 [6D F5]
  Response: 01 01 01 01 [90 48]

- Read output channel (0–12) and return safe value (2F 6D)

  Request: 01 01 00 00 00 0D [FD CF]
  Response: 01 01 02 35 02 [2F 6D]

- (00270) Clear host watchdog timeout status, return host watchdog timeout flag is set

  Request: 01 05 01 0D FF 00 [1C 05]
  Response: 01 05 01 0D FF 00 [1C 05]

6.5.7. Examples of Modbus RTU DIO Function Commands

6.5.7.1. (00001) Digital Output Channel for DO0–DO31

- (00001) Set output channel (0,2,4,5,9) to ON (0000 0010 0011 0101) and return successful

  Request: 01 0F 00 00 00 0D 02 35 02 [E4 4C]
  Response: 01 0F 00 00 00 0D [94 0E]

- (00001) Read output channel (0–12) and return safe value (35 03)

  Request: 01 01 00 00 00 0D [FD CF]
  Response: 01 01 02 35 02 [2F 6D]

- (00001) Set DO11 output channel ON and return successful

  Request: 01 05 00 0B FF 00 [FD F8]
  Response: 01 05 00 0B 00 0D [FD F8]

- (00001) Read output channel (11) and return (01) ON

  Request: 01 01 00 0B 00 01 [8C 08]
  Response: 01 01 01 01 [90 48]

6.5.7.2. (00033) Digital Input Channel for DI0–DI31

- (00033) Read input channel (0–13) and return all ON (FF 3F)

  Request: 01 01 00 20 00 0E [BC 04]
  Response: 01 01 02 FF 3F [B8 1C]

6.5.7.3. (00065, 00097,00264) DI Latch for DI0–DI31

- (00065) Read DI(0–14) Latch high value and return (FF 3F)

  Request: 01 01 00 40 00 0F [BC 1A]
  Response: 01 01 02 FF 3F [B8 1C]

- (00097) Read DI(0–14) Latch low value and return (00 00)

  Request: 01 01 00 60 00 0F [BD D0]
  Response: 01 01 02 00 00 [B9 FC]

- (00264) Clear DI channels latch value and return successful

  Request: 01 05 01 07 FF 00 [3C 07]
  Response: 01 05 01 07 FF 00 [3C 07]

6.5.7.4. (00129) Safe Value for DO0–DO31

- (00129) Set output channel (0,2,4,5,9) to ON(0000 0010 0011 0101) for write safe value and return successful

  Request: 01 0F 00 80 00 0F 02 35 02 [6C A5]
  Response: 01 0F 00 80 00 0F [14 27]

- (00129) Read safe value for output channel (0–12) and return safe value (35 02)

  Request: 01 01 00 80 00 0F [7D E6]
  Response: 01 01 02 35 02 [2F 6D]

6.5.7.5. (00161) Power-on Value for DO0–DO31

- (00161) Set output channel(0,2,4,5,9) to ON(0000 0010 0011 0101) for write power-on value and return successful

  Request: 01 0F 00 A0 00 0F 02 35 02 [6B C5]
  Response: 01 0F 00 A0 00 0F [15 ED]

- (00161) Read power-on value for output channe l (0–12) and return value (35 02)

  Request: 01 01 00 A0 00 0F [7C 2C]
  Response: 01 01 02 35 02 [2F 6D]

- (00161) Set output channel (0) to ON and return successful

  Request: 01 05 00 A0 FF 00 [8C 18]
  Response: 01 05 00 A0 FF 00 [8C 18]

6.5.7.6. (42201) Digital Input/Output LED Configuration (for 80xxD)

- (42201) Set Digital input/output LED to turn-ON LED when output active (bit-1=0) and turn-ON LED when input high (bit-0=1) and return successful

  Request: 01 06 08 98 00 01 [CB 85]
  Response: 01 06 08 98 00 01 [CB 85]

- (42201) Read Digital input/output LED configuration and return (00 01) turn-ON LED when output active and turn-ON LED when input high

  Request: 01 03 08 98 00 01 [07 85]
  Response: 01 03 02 00 01 [79 84]

- (42201) Set Digital input/output LED to turn-ON LED when input high (bit-1=1) and turn-ON LED when output inactive (bit-0=1) and return successful.

  Request: 01 10 08 98 00 01 02 00 03 [73 89]
  Response: 01 10 08 98 00 01 [82 46]

6.5.7.7. (42209) DIO Active Status

- (42209) Set DIO input value 1 for non-signal or the low voltage (bit-0=0) and output value 1 for output inactive (bit-1=1) and return successful

  Request: 01 06 08 A0 00 02 [0A 49]
  Response: 01 06 08 A0 00 02 [0A 49]

- (42209) Read DIO active status and return (00 02) , output value 1 for output inactive (bit-1=1) and input value 1 for non-signal (bit-0=0)

  Request: 01 03 08 A0 00 01 [86 48]
  Response: 01 03 02 00 02 [39 85]

- (42209) Set input value 1 for high voltage, input value 0 for non-signal (bit-0=1) and output value 1 for output active (bit-1=0) and return successful.

Request: 01 03 08 A0 00 01 [86 48]
Response: 01 03 02 00 02 [39 85]

6.6. Modbus Address Mapping Tables (ND-6117)

6.6.1. Discrete Coil Address

Discrete coil addresses are available for Modbus function codes 0x01, 0x05, and 0x0F.

Address	Channel	Item	Attribute
00201	0	Channel active status	R/W
00202	1	Channel active status	R/W
00203	2	Channel active status	R/W
00204	3	Channel active status	R/W
00205	4	Channel active status	R/W
00206	5	Channel active status	R/W
00207	6	Channel active status	R/W
00208	7	Channel active status	R/W
00269		Set MODBUS data format	R/W (*) 1=Hex 2's format 0=engineering format

(*):

1. Modbus data format of analog input value is 2's complement format or engineering format.
2. Factory default: Engineering format

6.6.2. Discrete Input Address

Discrete input addresses are available for Modbus function code 0x02.

Address	Channel	Item	Attribute
10201	0	Channel active status	R
10202	1	Channel active status	R
10203	2	Channel active status	R
10204	3	Channel active status	R
10205	4	Channel active status	R
10206	5	Channel active status	R
10207	6	Channel active status	R
10208	7	Channel active status	R
10269		Set MODBUS data format	R 1=Hex 2's format 0=engineering format

(*):

1. Modbus data format of analog input value is 2's complement format or engineering format.
2. Factory default: Engineering format

6.6.3. Input Register Address

Input register addresses are available for Modbus function code 0x04.

Address	Channel	Item	Attribute	Memo
30001	0	Analog input Value	R	
30002	1	Analog input Value	R	
30003	2	Analog input Value	R	

30004	3	Analog input Value	R	
30005	4	Analog input Value	R	
30006	5	Analog input Value	R	
30007	6	Analog input Value	R	
30008	7	Analog input Value	R	
30201	0	Input range Code	R	0x08–0x0d
30202	1	Input range Code	R	0x08–0x0d
30203	2	Input range Code	R	0x08–0x0d
30204	3	Input range Code	R	0x08–0x0d
30205	4	Input range Code	R	0x08–0x0d
30206	5	Input range Code	R	0x08–0x0d
30207	6	Input range Code	R	0x08–0x0d
30208	7	Input range Code	R	0x08–0x0d
30211		Module Name 1	R	0x8017
30212		Module Name 2	R	0x8017
30213		Version 1	R	
30214		Version 2	R	
30221		Channel Enable	R	0x00–0xFF
30269		Set MODBUS data format	R	0x0001=Hex 2’s format 0x0000=engineering format

6.6.4. Holding Register Address

Holding register addresses are available for Modbus function codes 0x03, 0x06, and 0x10.

Address	Channel	Item	Attribute	Memo
40001	0	Analog input Value	R	
40002	1	Analog input Value	R	
40003	2	Analog input Value	R	
40004	3	Analog input Value	R	
40005	4	Analog input Value	R	
40006	5	Analog input Value	R	
40007	6	Analog input Value	R	
40008	7	Analog input Value	R	
40201	0	Input range Code	R/W	0x08–0x0d
40202	1	Input range Code	R/W	0x08–0x0d
40203	2	Input range Code	R/W	0x08–0x0d
40204	3	Input range Code	R/W	0x08–0x0d
40205	4	Input range Code	R/W	0x08–0x0d
40206	5	Input range Code	R/W	0x08–0x0d
40207	6	Input range Code	R/W	0x08–0x0d
40208	7	Input range Code	R/W	0x08–0x0d
40211		Module Name 1	R	0x8017
40212		Module Name 2	R	0x8017
40213		Version 1	R	
40214		Version 2	R	
40221		Channel Enable	R/W	0x00–0xFF
40269		Set MODBUS data format	R/W	0x0001=Hex 2’s format 0x0000=engineering format

6.6.5. Modbus Engineering Data Format Table

Type Code	Input Type	Min.	Max.	Formula	Unit
08	-10V – +10V	-10000	+10000	Volt=(MODBUS data) /1000	V
09	-5V – + 5V	-5000	+5000	Volt=(MODBUS data) /1000	V
0A	-1V – +V	-10000	+10000	Volt=(MODBUS data) /10000	V
0B	-500 mV – +500 mV	-5000	+5000	Volt=(MODBUS data) /10	mV
0C	-150m V – +150mV	-15000	+15000	Volt=(MODBUS data) /100	mV
0D	-20 mA – +20 mA	-20000	+20000	Volt=(MODBUS data) /1000	mA

- **Example:** Assume type of channel 2 is +/-10V and MODBUS data=0x2030(Hex)=8240(Dec)

  The voltage of channel 2 is 8240/1000=8.24V.
- **Example:** Assume type of channel 1 is +/-500mV and MODBUS data=0xEF1B(Hex)=-4325(Dec)

  The voltage of channel 2 is -4235/10=423.5mV.
- **Example:** Assume type of channel 1 is +/-20mA and MODBUS data=0x3B84(Hex)=15236(Dec)

  The current of channel 2 is 15236/1000=15.236mA.

6.6.6. Modbus Hex 2’s Complement Data Format Table

Type Code	Input Type	Min.	Max.	Formula	Unit
08	-10V – +10V	8000	7FFF	Volt=(MODBUS data *10)/32767	V
09	-5V – + 5V	8000	7FFF	Volt=(MODBUS data *5)/32767	V
0A	-1V – +V	8000	7FFF	Volt=(MODBUS data *1)/32767	V
0B	-500 mV – +500 mV	8000	7FFF	Volt=(MODBUS data *500)/32767	mV
0C	-150m V – +150mV	8000	7FFF	Volt=(MODBUS data *150)/32767	mV
0D	-20 mA – +20 mA	8000	7FFF	Current=(MODBUS data *20)/32767	mA

- **Example:** Assume type of channel 2 is +/-10V and MODBUS data=0x2030(Hex)=8240(Dec)

  The voltage of channel 2 is (8240*10)/32767=2.514V.
- **Example:** Assume type of channel 1 is +/-500mV and MODBUS data=0xEF1B(Hex)=-4325(Dec)

  The voltage of channel 2 is (-4235*500)/32767=-64.622mV.
- **Example:** Assume type of channel 1 is +/-20mA and MODBUS data=0x3B84(Hex)=15236(Dec)

  The current of channel 2 is (15236*20)/32767=9.299mA.

6.7. Modbus Address Mapping Tables (ND-6124)

There are two categories of ND-6124 commands: data access command sets and read/write module command sets. This section includes all commands used in NuDAM analog output module ND-6124.

6.7.1. Analog Output Formats

You can configure ND-6124 analog output modules to receive data from the host in one of the following data formats:

- Engineering units (default)
- Twos complement hexadecimal

Data for ND-6124 modules can be used in any of the following data formats:

6.7.1.1. Engineering Units

This format is chosen by command Address(00269) to setting 0. Data are presented in natural units such as mV/μA.

- **Example 1:** An analog output module (address 01h) is configured for a 0 to 20 mA (type code=0x30) range. If the output value is 3.567 mA, the format of the analog data out command should be “01 06 00 00 0D EF” by command (40001).
- **Example 2:** An analog output module (address 01h) is configured for a +10V to -10V V (type code=0x33) range. If the output value is -4.672 V, the format of the analog data out command should be “01 06 00 00 ED C0” by command (40001).

6.7.1.2. Twos Complement Hexadecimal

Twos Complement Hexadecimal format presents the data in hexadecimal form providing a rapid communication, high resolution, and easy conversion to a computer-compatible integer format. This format is chosen by command address (00269) to setting 1. Data are presented in natural units such as mV/μA. Output ranges with voltage and milliAmp values are used with the full, calibrated voltage range from C000 to 3FFF. For instance, an ND-6124 module is given a ±5 V output range. In this case, -5 V is represented as C000h and +5 V is denoted as 3FFFh (output resolution: 0.3052mV).

- **Example 1:** An analog output module (address 01h) is configured for a 0 to 20 mA (type code=0x30) range (output resolution: 1.2207uA). If the output value is 3.567 mA:
    - This value (0x0B6A) is equivalent to the signed integer 2922.
    - The hexadecimal value is 0x0B6A = 2922 = 3567uA/1.2207uA.
    - The output value is 3.567 mA = 2922 * 1.2207uA.
    - The command should be “01 06 00 00 0B 6A” by address (40001).
- **Example 2:** An analog output module (address 01h) is configured for a +10V to -10V V (type code=0x33) range (output resolution: 0.6104mV). If the output value is -4.673 V:
    - This value (0xE218) is equivalent to the signed integer -7656.
    - The hexadecimal value is 0xE218 = -7656 = -4673mV/0.6014mV.
    - The output value is -4.673 V = -7656 * 0.6104mV.
    - The command should be “01 06 00 00 E2 18” by address (40001).

6.7.2. Analog Output Type and Data Format Table

Type Code	Range	Format	Max.	Min.	Output Resolution
30 hex	0mA – 20mA	Engineer unit	20000	0	1uA
		Hex Binary	3FFF	0	1.2207μA
31 hex	4mA – 20mA	Engineer unit	20000	4000	1uA
		Hex Binary	3FFF	0	0.9766uA
32 hex	0V – +10V	Engineer unit	10000	0	1mV
		Hex Binary	3FFF	0	0.6104mV
33 hex	-10V – +10V	Engineer unit	10000	-10000	1mV
		2’s comp. HEX	3FFF	C000	0.6104mV
34 hex	0V – +5V	Engineer unit	5000	0	1mV
		Hex Binary	3FFF	0	0.3052mV
35 hex	-5V – +5V	Engineer unit	5000	-5000	1mV
		2’s comp. HEX	3FFF	C000	0.3052mV

6.7.3. General Commands

Address	Item	Attrib.
00257	Protocol, ASCII & Modbus select. = 1 - Modbus RTU = 0 - ASCII	R/W
00272	Load factory calibration parameters = 1 - enable.	W
00273	Read module reset status = 1 - first read after powered on. = 0 - not the first read after powered on.	R

02208	CRC checking enable/disable (default) = 1 - enable.	R/W
02210	Reset the module to initial power-on status = 1 - enable.	W
40481–40482	Read Firmware version (version-1,version-2)	R
40483–40484	Read module name(name-1, name-2)	R
40485	Module address, valid range: 1 – 247	R/W
40486	Baudrate & Parity setting. Bits(5:0) - 0x03 ~ 0x0A for baudrate 1200–115200. Bits(7:6) - Parity = 00 - Non-Parity, 1 stop bit (default) = 01 - reserved = 10 - even parity, 1 stop bit = 11 - odd parity, 1 stop bit	R/W

6.7.4. Watchdog Commands

Address	Item	Attrib.
00261	Host watchdog enable/disable = 1 - enable	R/W
00270	Host watchdog timeout status For function (0x01) : = 1 – timeout has occurred. For function (0x05) : 1 = clear flag For function (0x0F) : 1 = clear flag	R/W
40489	Host watchdog timeout value (0–255, in 100ms)	R/W
40492	Host watchdog timeout count, write 0 to clear	R/W
43001–43004	Safe value of analog output for channel(0~3)	R/W
412345	Informs all modules that the host is OK (no response)	R

6.7.5. Emergency Digital Input Commands

Address	Item	Attrib.
00001–00004	Read Emergency digital Input for channel (0–3). 1 = input high level (ON) 0 = input low level (OFF)	R
02241–02244	Enable/Disable Emergency digital input flag for channel(0–3). For function (0x01) : 1 = enable For function (0x05) : 1 = enable For function (0x0F) : 1 = enable. **Note:** The Emergency DI active flag will be cleared after command read.	R/W

6.7.6. Analog Commands

Address	Item	Attrib.

40001– 40004	Analog output value of channel (0–3) Error Response (offset 02): = 0x00 - valid command */ = 0x02 - invalid start address */ = 0x03 - invalid data value */ = 0x04 - host WDT timeout */ = 0x05 - The Emergency DI was activated	R/W
40065– 40068	Read back current analog output for channel(0–3)	R
40193– 40196	Power on analog output value of channel(0–3)	R/W
00269	Analog output data format, = 0 - Hexadecimal, = 1 - Engineering (default)	R/W
40257– 40260	Type code (0x30–0x35) for channel (0–3)	R/W
40289– 40292	Slew rate (0x00–0x0F) control for channel (0–3)	R/W

6.7.7. Examples of Modbus RTU Commands

6.7.7.1. Protocol, NuDAM, ASCII, & Modbus Selection

- (00257) Read protocol and return modbus RTU is selected

  Request: 01 01 01 00 00 01
  Response: 01 01 01 01

- (00257) Set to NuDAM ASCII protocol

  Request: 01 05 01 00 00 00
  Response: 01 05 01 00 00 00

- (00257) Read protocol and return NuDAM ASCII is selected

  Request: 01 01 01 00 00 01
  Response: 01 01 01 00

6.7.7.2. (00272) Load Factory Calibration Parameters

Request: 01 05 01 0F FF 00
Response: 01 05 01 0F FF 00 ;return valid.

6.7.7.3. (40481–40482) Read Firmware Version (Version-1, Version-2)

Request: 01 03 01 E0 00 02
Response: 01 03 04 00 0A 02 00 ; 00 0A 02 00 (version: A02.00)

6.7.7.4. (40486) Set Baud Rate (9600) & Non-Parity

Request: 01 06 01 E5 00 06
Response: 01 06 01 E5 00 06 ;return valid.

6.7.7.5. (40193) Set Power-on Output Value + 7.654V for channel 0

Request: 01 06 00 C0 1D E6 ;for Engineer format
Response: 01 06 00 C0 1D E6 ; return valid.

6.7.7.6. Host Watchdog Timeout Operation

- (43001) Set +1.600V as safe output value of channel(0) return valid.

  Request: 01 06 0B B8 0A 42
  Response: 01 06 0B B8 0A 42

- (40489) Write host watchdog timeout value (20 sec)return valid.

  Request: 01 06 01 E8 00 C8
  Response: 01 06 01 E8 00 C8

- (00261) Set host watchdog timeout enable, return valid.

  Request: 01 05 01 04 FF 00
  Response: 01 05 01 04 FF 00

- (40001) Write +7.373V to analog output of channel(0), return valid.

  Request: 01 06 00 00 2F 34
  Response: 01 06 00 00 2F 34
  ;
  wait 15 sec……
  ;

- (00270) Clear host watchdog timeout counter, return watchdog timeout is set.

  Request: 01 05 01 0D FF 00
  Response: 01 05 01 0D FF 00
  ;
  wait 25 sec……
  watchdog times out and enters safe output mode
  ;

- (00270) Read host watchdog timeout status, return host watchdog timeout flag is set.

  Request: 01 01 01 0D 00 01
  Response: 01 01 01 01

- (40001) Write +7.373V to analog output of channel(0), return host watchdog timeout occur.

  Request: 01 06 00 00 2F 34
  Response: 01 86 04

- (00270) Clear host watch dog timeout status, return host watchdog timeout flag is set.

  Request: 01 05 01 0D FF 00
  Response: 01 05 01 0D FF 00

- (40001) Write +7.373V to analog output of channel (0), return valid.

  Request: 01 06 00 00 2F 34
  Response: 01 06 00 00 2F 34

6.7.7.7. Analog Commands for Engineering Unit Format

- (00269) Set analog output to engineering format

  Request: 01 05 01 0C 00 01
  Response: 01 05 01 0C 00 01 ;return valid.

- (40257) Set D/A type code to 0x33 for channel 0 (+/-10V)

  Request: 01 06 01 00 00 33
  Response: 01 06 01 00 00 33 ;return valid.

- (40260) Set D/A type code to 0x30 for channel 3 (0–20mA)

  Request: 01 06 01 03 00 30
  Response: 01 06 01 03 00 30 ;return valid.

- (40289) Set D/A slew to 0x00 (immediate) for channel 0

  Request: 01 06 01 20 00 00
  Response: 01 06 01 20 00 00 ;return valid.

- (40292) Set D/A slew to 0x00 (immediate) for channel 3

  Request: 01 06 01 23 00 00
  Response: 01 06 01 23 00 00 ;return valid.

- (40001) Output analog +7.654V for channel 0.

  Request: 01 06 00 00 1D E6
  Response: 01 06 00 00 1D E6 ;return valid.

- (40001) Output analog -3.654V for channel 0.

  Request: 01 06 00 00 F1 BA
  Response: 01 06 00 00 F1 BA ;return valid.

- (40004) Output analog +15.654mA for channel 3.

  Request: 01 06 00 03 3D 26
  Response: 01 06 00 03 3D 26 ;return valid.

6.7.7.8. Analog Commands for Hexadecimal Unit Format

- (00269) Set analog output to hexadecimal format

  Request: 01 05 01 0C 00 00
  Response: 01 05 01 0C 00 00 ;return valid.

- (40257) Set D/A type code to 0x33 for channel 0 (+/-10V)

  Request: 01 06 01 00 00 33
  Response: 01 06 01 00 00 33 ;return valid.

- (40260) Set D/A type code to 0x30 for channel 3 (0–20mA)

  Request: 01 06 01 03 00 30
  Response: 01 06 01 03 00 30 ;return valid.

- (40289) Set D/A slew to 0x00 (immediate) for channel 0

  Request: 01 06 01 20 00 00
  Reponse: 01 06 01 20 00 00 ;return valid.

- (40292) set D/A slew to 0x00 (immediate) for channel 3

  Request: 01 06 01 23 00 00
  Reponse: 01 06 01 23 00 00 ;return valid.

- (40001) Output analog +4.672V for channel 0.

  Request: 01 06 00 00 1D E6
  Reponse: 01 06 00 00 1D E6 ;return valid.

- (40001) Output analog -4.680V for channel 0.

  Request: 01 06 00 00 E2 18
  Reponse: 01 06 00 00 E2 18 ;return valid.

- (40004) Output Analog +9.343mA for channel 3.

  Request: 01 06 00 03 3D E6
  Reponse: 01 06 00 03 3D E6 ;return valid.

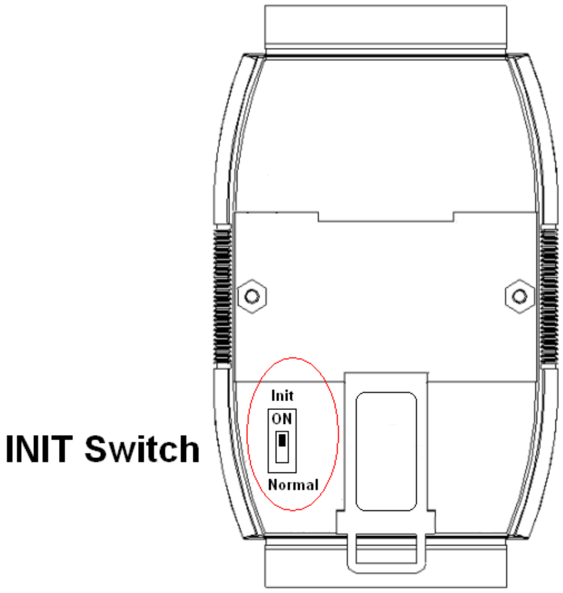
Appendix A: INIT Pin (Switch) Operation

INIT mode has two functions: one for the reading module current configuration, and another for configuring the module baud rate and checksum.

Reading Module Current Configuration

Each NuDAM module has a built-in EEPROM for storing configuration information such as address ID, type, and baud rate. If you forget the configuration of the module, you can use INIT mode to retrieve it. When the module is set to INIT mode, the default settings are ID=00, baud rate=9600, and checksum=disable.

The INIT switch is located on the rear side of NuDAM -6100 modules to allow easier access to INIT mode. For these modules, you can access INIT mode by sliding the **Init** switch to the **Init** (ON) position:



The following steps illustrate how to enable INIT mode and read the current configuration.

1. Power off the module.
2. Slide the INIT switch to the **Init** (ON) position.
3. Power on the module.
4. Send command $002(cr) at 9600 baud rate to read the current configuration stored in the EEPROM.
5. Power off the module again.
6. Open the INIT pin to force the module to normal mode (or, slide the INIT switch to the **Normal** position).

Configuring the Module Baud Rate and Checksum

Now that the module is set to INIT mode, you can change the baud rate or checksum state by sending the “Set module configuration” command (see 3.11).

The following steps show how to enable INIT mode and the change baud rate or checksum state.

1. Power off the module.
2. Slide the INIT switch to the **Init** (ON) position.
3. Power on the module.
4. Send command %AANNTTCCFF at 9600 baud rate to set the baud rate or checksum state (ID should be set to **00** in INIT mode).
5. Power off the module again.
6. Open the INIT pin to force the module to normal mode (or, slide the INIT switch to the **Normal** position).

Appendix B: Module Status

Power-On Reset or **Module Watchdog Reset** will let all output go to **Power-On Value**. The module may also accept the host’s command to change the output value. **Host Watchdog Timeout** will let all digital output go to **Safe Value**.The host watchdog timeout flag is set, and the output command will be ignored. The module’s LED will go to flash and user must reset the **Module Status** via command to restore normal operation.

Appendix C: Dual Watchdog Operation

Dual Watchdog = Module Watchdog + Host Watchdog

The **Module Watchdog** is a hardware reset circuit to monitor the module's operating status. While working in harsh or noisy environments, the module may be down by the external signal. The circuit may let the continue to work without stopping. The **Host Watchdog** is a software function for monitoring the host's operating status. Its purpose is to prevent the network/communication from problem or host halt. When a timeout occurs, the module will turn the all output into safe state to prevent any unexpected problems involving the controlled target. The E-8000 module with **Dual Watchdog** can make control system more stable and reliable.

Appendix D: Reset Status

The reset status of a module is set when the module is powered on or when the module is reset by the module watchdog. It is cleared after the responding of the first $AA5 command. This can be used to check whether the module has been reset. When the $AA5 command responds that the reset status is cleared, that means the module has not been reset since the last $AA5 command was sent. When the $AA5 command responds that the reset status is set and it is not the first time the $AA5 command was sent, it means the module has been reset and the digital output value has been changed to the power-on value.

Appendix E: Input Latch

Input Latch:

Each input channel has an internal latch for latching the pulse signal from the input. This latched state can be read by sending the "*Read latched digital input* " command and cleared by sending the "*Clear latched digital input*" command (see 5.4.1.41).

For example, if the digital input is connected to a key switch. The key switch is a pulse signal.

Note: You may lose strike information by sending command $AA6.

The digital input latch can latch the pulse and be read by sending the "*Read latched digital input* " command. If the latched state=1, then a key strike occurred.

Appendix F: Power-on & Safe Value

Power-on Value:

Power-on values are used to set the module to the default output value when the module is turned on or when the watchdog timeout resets. This function is especially important in applications where the specified initial output states are required. You can set the power-on value by sending the "*Set power-on/safe value*" command (see 5.4.1.49).

Safe Value:

Safe values are used to set the module outputs to the specified values when the host watchdog times out. If the host watchdog timer is enabled by sending the "*Set host watchdog timeout value*" (see 5.4.1.49), the host should send the "*Host OK*: (see 5.4.1.44) command periodically within the timeout value to refresh the timer; otherwise, the module will be forced to the safety state.

Appendix G: Changing to the Modbus Protocol

NuDAM-6100 Modbus modules may come from the factory set with the Modbus RTU protocol set as the default protocol. If the module is connected to an ASCII network, the ASCII network may not recognize the module. This may be caused by incorrect settings. NuDAM-6100 modules should be set up for ASCII protocols instead of Modbus-rtu protocols.

The following steps show how set a NuDAM-6100 module to the Modbus protocol.

1. Configure the NuDAM-6100 Module using the NuDAM-6100 utility.
2. Initialize the NuDAM-6100 on an RS-485 network (we recommend initializing one module at a time).
3. With the module powered off, slide the INIT switch to the **Init** (ON) position.
4. Power on the module.
   Wait 10 seconds for the module to initialize.
5. Use the NuDAM-6100 utility to search for the module and change the protocol (initial COM settings: 9600 baud, N-8-1).
   The utility will identify the module and permit the serial data protocol to be changed to the ASCII protocol.

   Note: You can also change the address and COM port settings at this stage.

6. Click the module icon in the utility to access the module.
7. Update the settings by pressing the **Update** button.
8. Power off the module.
9. Slide the INIT switch to the **Normal** position.
10. Power on the module.

The module is now ready to be placed in the ASCII network.

Appendix H: ND-6117 Calibration

Offset calibration is used to calibrate output offset when the input voltage is 0V.

Calibration procedure:

1. Apply zero voltage to channel 0 of the analog module.
2. Issue configuration command with type=00–06.
3. Issue enable calibration command.
4. Issue zero offset calibration command.

Code	Type and Range
08	+/-10V
09	+/-5V
0A	+/-1V
0B	+/-500mV
0C	+/-150mV
0D	+/-20mA

Appendix I: ND-6124 Calibration

Note: Please read through the instructions carefully and ensure that you fully understand the calibration procedure before attempting to calibrate the ND-6124.

Current Calibration Procedure:

1. Connect the meter and external power source to the module's current output channel N.

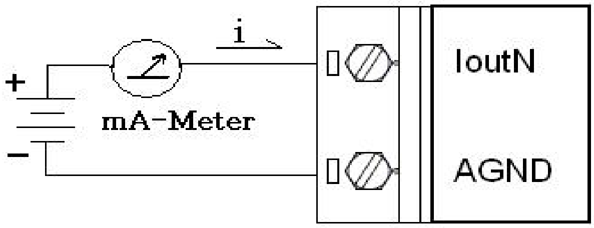


Figure 6: mA-Meter (Current Calibration)

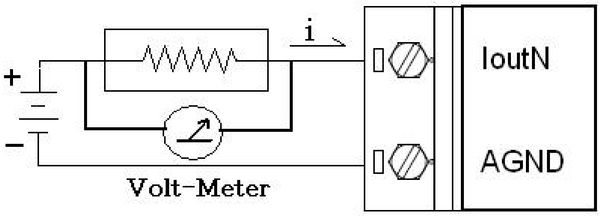


Figure 7: Volt-Meter (Current Calibration)

5. Warm up the module for 30 minutes.
6. Set protocol to ASCII mode using the NuDAM-6000 utility software.
7. Setting type to 30 (0 to 20mA) using the command "$AA9NTTSS".
8. Output 0mA using analog output command "#AAN(data)".
9. Check the meter and trim the output until 0mA matches by applying trim command "$AA3NVV".
10. Repeat step 5 for trim calibration.
11. Perform 0mA calibration command to save min. calibration parameter using command "$AA0N".
12. Output 20mA using analog output command "#AAN(data)".
13. Check the meter and trim the output until 20mA matches by applying trim command "$AA3NVV".
14. Repeat step 9 for trim calibration.
15. Perform 20mA calibration command to save min. calibration parameter using command "$AA1N".
16. Repeat steps 4 to 11 three times.

Voltage Calibration Procedure:

1. Connect the meter to the module's voltage output channel N.

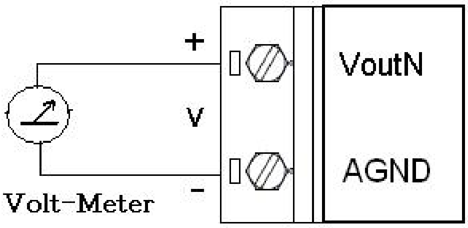


Figure 8: Volt-Meter (Volage Calibration

2. Warm up the module for 30 minutes.
3. Set protocol to ASCII mode by using the NuDAM-6000 utility software.
4. Set type to 33 (-10V to +10V) using command "$AA9NTTSS"4.
    a. Output -10V using analog output command "#AAN(data)".
5. Check the meter and trim the output until -10V matches by applying trim command "$AA3NVV".
6. Repeat step 5 for trim calibration.
7. Perform -10V calibration command to save min. calibration parameter using command "$AA0N".
8. Output +10V by analog output command "#AAN(data)".
9. Check the meter and trim the output until +10V matches by applying trim command "$AA3NVV".
10. Repeat step 9 for trim calibration.
11. Perform +10V calibration command to save min. calibration parameter using command "$AA1N"
12. Repeat steps 4 to 11 three times.

Note: Reload the factory default calibration parameters and clear user calibration using command "$AAS1".

Safety Instructions

Read and follow all instructions marked on the product and in the documentation before you operate your system. Retain all safety and operating instructions for future use.

- Please read these safety instructions carefully.
- Please keep this User‘s Manual for later reference.
- Read the specifications section of this manual for detailed information on the operating environment of this equipment.
- When installing/mounting or uninstalling/removing equipment, turn off the power and unplug any power cords/cables.
- To avoid electrical shock and/or damage to equipment:
    - Keep equipment away from water or liquid sources.
    - Keep equipment away from high heat or high humidity.
    - Keep equipment properly ventilated (do not block or cover ventilation openings).
    - Make sure to use recommended voltage and power source settings.
    - Always install and operate equipment near an easily accessible electrical socket-outlet.
    - Secure the power cord (do not place any object on/over the power cord).
    - Only install/attach and operate equipment on stable surfaces and/or recommended mountings.
    - If the equipment will not be used for long periods of time, turn off and unplug the equipment from its power source.
- Never attempt to fix the equipment. Equipment should only be serviced by qualified personnel.

Getting Service

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