ZT-2024
User Manual

Warranty

All products manufactured by ICP DAS are under warranty regarding defective materials for a period of one year, beginning from the date of delivery to the original purchaser.

Warning

ICP DAS assumes no liability for any damage resulting from the use of this product. ICP DAS reserves the right to change this manual at any time without notice. The information furnished by ICP DAS is believed to be accurate and reliable. However, no responsibility is assumed by ICP DAS for its use, nor for any infringements of patents or other rights of third parties resulting from its use.

Copyright

Trademarks

Names are used for identification purposes only and may be registered trademarks of their respective companies.

Technical Support

If you have any problems, please feel free to contact us via email at service@icpdas.com.

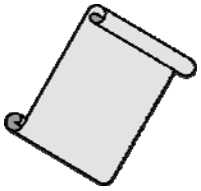
Table of Contents

What's in the Shipping Package?

The shipping package contains the following items:

ZT-2024 Module

ANT-124-05



Quick Start

CD

If any of these items are missing or damaged, please contact your local distributor for more information. Save the shipping materials and cartons in case you need to ship the module in the future.

More Information

- Documentation:

  All documentation related to the ZT Series of devices can be found on the companion CD at:

  `CD:\Napdos\ZigBee\ZT_Series\Document`

  Or can be downloaded from:

  http://ftp.icpdas.com/pub/cd/usbcd/napdos/zigbee/zt_series/document

- Software:

  Utility software for the ZT Series of devices can be found on the companion CD at:

  `CD:\Napdos\ZigBee\ZT_Series\Utility`

  Or can be download from:

  http://ftp.icpdas.com/pub/cd/usbcd/napdos/zigbee/zt_series/utility

1 Introduction

1.1 Introduction to ZigBee

ZigBee is a specification for a suite of high-level communication protocols using small, low-power digital radios based on the IEEE 802.15.4 standard for personal area networks. ZigBee devices are often used in mesh network form to transmit data over longer distances, passing data through intermediate devices to reach more distant ones. This allows ZigBee networks to be formed ad-hoc, with no centralized control or high-power transmitter/receiver required in order to reach all of the devices. Any ZigBee device can be tasked with running the network.

ZigBee is targeted at applications that require a low data rate, long battery life, and secure networking. ZigBee has a defined rate of 250 kbit/s, best suited for periodic or intermittent transmission of data, or for a single signal transmission from a sensor or input device. Applications include wireless light switches, electrical meters with in-home-displays, traffic management systems, and other consumer and industrial equipment that requires short-range wireless transfer of data at relatively low rates. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other WPANs.

1.2 Introduction to the ZT-2000 I/O Series

The ZT-2000 I/O series of devices are small wireless ZigBee I/O modules based on the IEEE802.15.4 standard that allow data acqusition and control via personal area ZigBee networks. See Section 3.1 for more detailed information.

The ZT-2000 I/O series is a wireless data acquisition-based client/server system. Accordingly, a Net Server for the ZigBee (ZT-2570/ZT-2550) is essential in such systems. For more information regarding any configuration issues related to the ZigBee Coordinator, refer to the “ZT-25XX ZigBee Converter Quick Start” document, which can be found at:

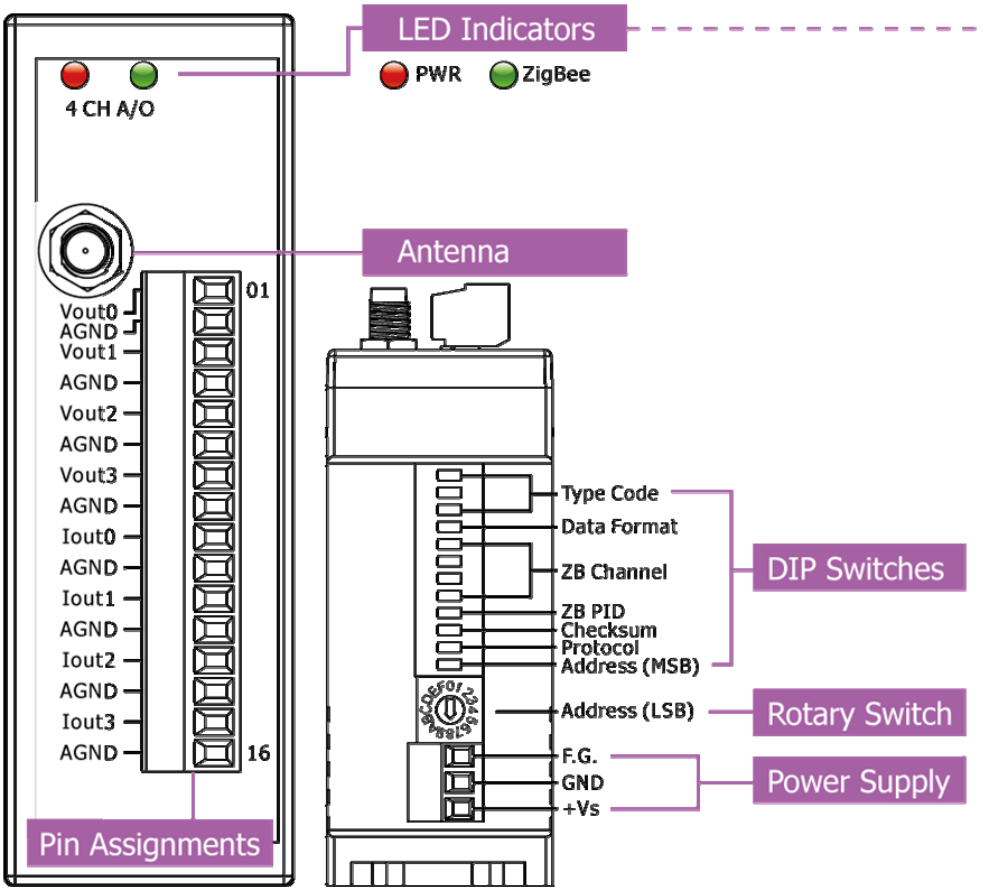
http://ftp.icpdas.com/pub/cd/usbcd/napdos/zigbee/zt_series/document/

2 Hardware Information

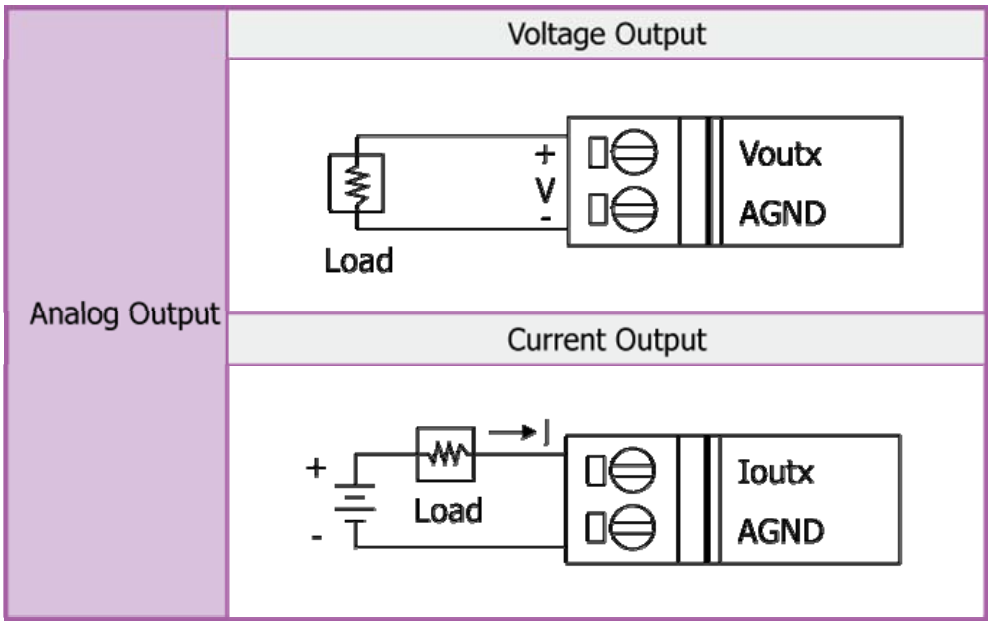
2.1 Specifications

Analog Output	
Output Channels	4
Output Type	+/-10 V_{DC}, +/-5 V_{DC}, 0 - 10 V_{DC}, 0 - 5 V_{DC}, 0 – 20mA, 4 – 20mA
Resolution	12-bit
Accuracy	+/-0.1% of FSR
Zero Drift	+/-30 μV/°C
Span Drift	+/-25 ppm/°C
Programmable Output Slope	0.0625 ~ 1024 V/Sec.
Voltage Capability	20 mA@10 V
Power-on and Safe Value	Yes
LED Indicators	
ZigBee PWR	ZigBee Device Power
ZigBee Net	ZigBee Communication Indicator
Power	
Power Consumption	1.7 W (Max.)
Environment	
Operating Temperature	-25 to +75°C
Storage Temperature	-30 to +80°C
Humidity	10 to 90%, Non-condensing
Wireless	
RF Channels	16
RF Transmit Power	11 dBm
Antenna (2.4 GHz)	5 dBi Omni directional
Transmission Range (LOS)	700 m (Typical)
Max. Slaves Supported	255
EMI Certification	CE/FCC, FCC ID

2.2 Pin Assignments



2.3 Wire Connections



3 Setting up the ZT-2000 I/O Device

3.1 Introduction to the Configuration Parameters

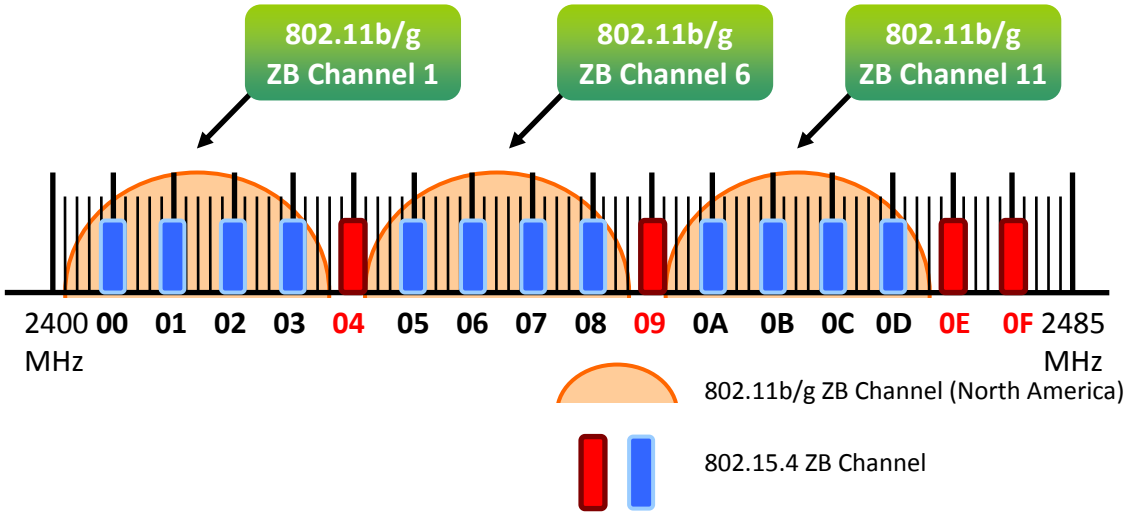
A. The **"ZB PID"** parameter is the group identity for a ZigBee network, and must be the same for all devices in the same ZigBee network.

B. The **"Node ID"** parameter is the individual identity of the specific ZigBee module, and must be unique for each device connected to the same ZigBee network.

C. The **"ZB Channel"** parameter indicates the radio frequency channel, and must be set to the same value as other modules on the same ZigBee network.

ZB Channel	0x00	0x01	……	0x0F
Frequency (MHz)	2405	2410	……	2480

※ **ZB channels 0x04, 0x09, 0x0E or 0x0F are recommended because they do not overlap with the Wi-Fi frequency band.**



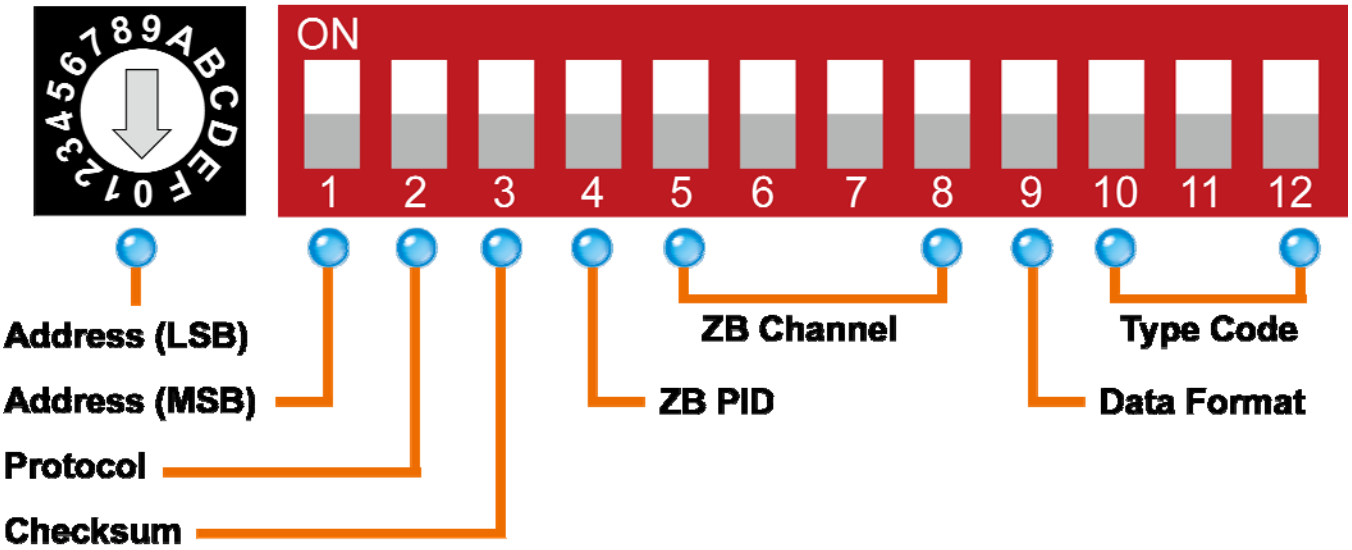
D. Protocol/Application Mode:

When implementing custom programs based on different protocols, the following application mode(s) are recommended in order to ensure optimal performance.

User Program Protocol	ZT-2000	ZT-2550	ZT-2570
DCON	DCON	Transparent	Transparent
Modbus RTU	Modbus RTU	Transparent Modbus Gateway	Transparent Modbus Gateway
Modbus TCP	Modbus RTU	------	Modbus Gateway

3.2 Introduction to the Rotary and DIP Switches

The configuration of the ZT-2024 can be adjusted using a combination of the external rotary switch and the DIP switches. The ZT-2000 device should only be rebooted once the configuration is complete.



➢ Rotary Switch

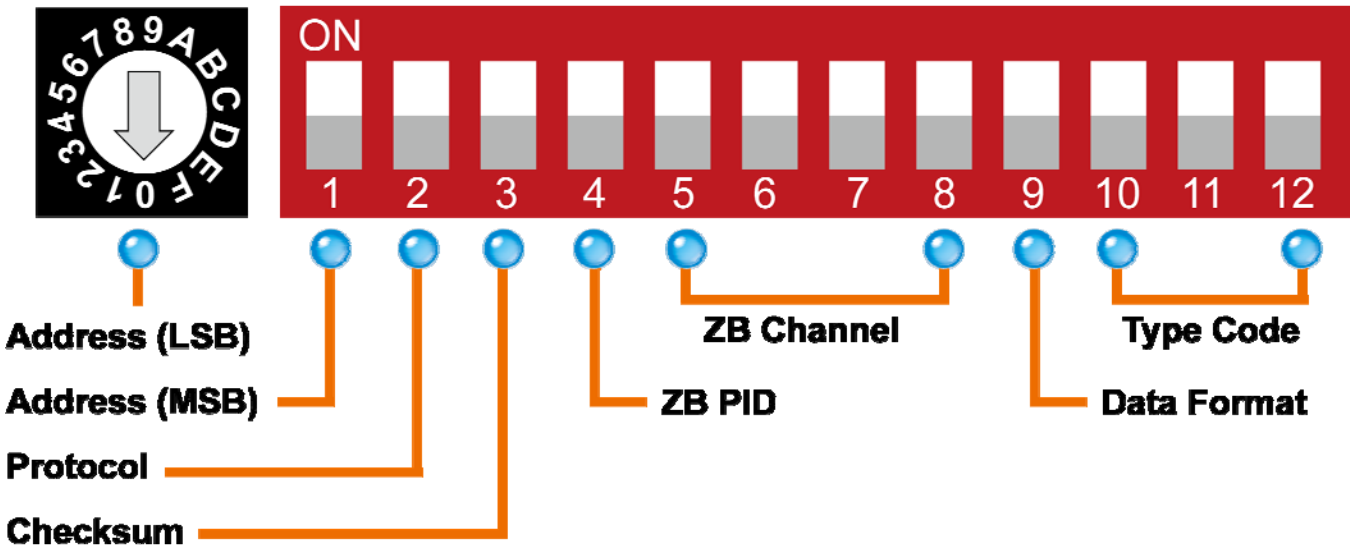
Case 1: Address MSB = 0

	0	1	2	3	4	5	6	7
Address	***Note 1**	01	02	03	04	05	06	07
Node ID	***Note 1**	0x0001	0x0002	0x003	0x0004	0x0005	0x0006	0x0007
	8	9	A	B	C	D	E	F
Address	08	09	0A	0B	0C	0D	0E	0F
Node ID	0x008	0x0009	0x000A	0x000B	0x000C	0x000D	0x000E	0x000F

Case 2: Address MSB = 1

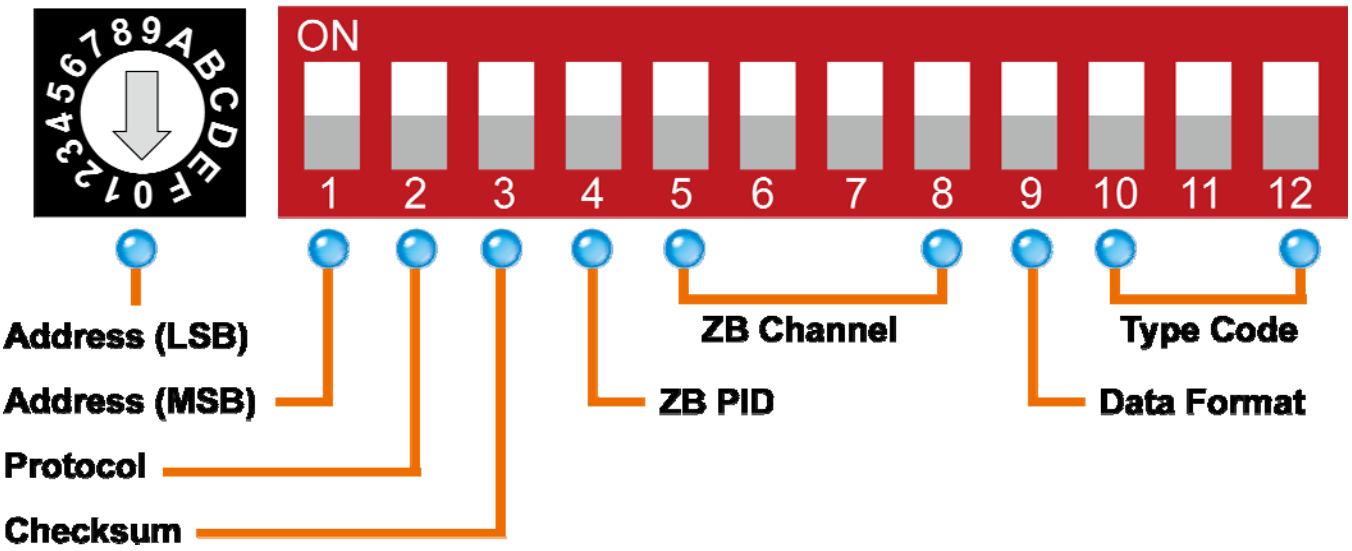
	0	1	2	3	4	5	6	7
Address	10	11	12	13	14	15	16	17
Node ID	0x0010	0x0011	0x0012	0x013	0x0014	0x0015	0x0016	0x0017
	8	9	A	B	C	D	E	F
Address	18	19	1A	0B	0C	1D	1E	1F
Node ID	0x018	0x0019	0x001A	0x001B	0x001C	0x001D	0x001E	0x001F

***Note 1: The "Address" and "Node ID" values are defined via the $AANNTTCCFF command. In software configuration mode, the DIP switches for "Address", "Data Format" and "Type Code" are ignored and can also be set via the %AANNTTCCFF and $AACiRrr commands.**



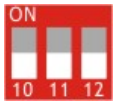
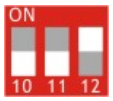
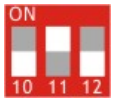
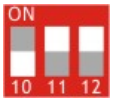
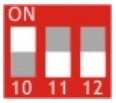
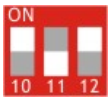
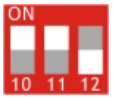
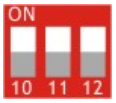
➢ DIP Switches

Number	Item	Status	Description
1	Address MSB	OFF	Valid Address (Node ID) from 0x01 to 0x0F
		ON	Valid Address (Node ID) from 0x10, 0x01 to 0x1F
2	Protocol	OFF	DCON Protocol
		ON	Modbus RTU Protocol
3	Checksum	OFF	Disabled (DCON Protocol)
		ON	Enabled (DCON Protocol)
4	ZB PID	OFF	ZigBee Pan ID = 0x0000
		ON	ZigBee Pan ID = 0x0001
5	ZB Channel	OFF	------
		ON	0x08
6		OFF	------
		ON	0x04
7		OFF	------
		ON	0x02
8		OFF	------
		ON	0x01
9	Data Format	OFF	Engineering Units Format
		ON	Hexadecimal Format



➢ Type Code

DIP switches 10-12 are used to define the input type code for the ZT-2024, as shown below.

Switch Position	Type Code	Switch Position	Type Code	Switch Position	Type Code
	0x00		0x01		0x02
	0x03		0x04		0x05
	0x05		0x05		

3.3 Starting the ZT-2000 I/O Device

As the ZigBee network is controlled by the ZigBee Coordinator, the ZT-2550/ZT-2570 (ZigBee Coordinator) must be configured first. Refer to the documents section below for full details of how to configure these devices.

Once configuration of the ZigBee Coordinator has been completed, set the "ZB PID" and "ZB Channel" values for the ZT-2000 I/O device to the same values as the network, and then reboot the device. The module will automatically start to function on the ZigBee network using the default protocol.

※ **Documents**

http://ftp.icpdas.com.tw/pub/cd/usbcd/napdos/zigbee/zt_series/document/zt-255x/
http://ftp.icpdas.com.tw/pub/cd/usbcd/napdos/zigbee/zt_series/document/zt-257x/

※ **Configuration Utility** (Used to configure the ZT-2000 I/O device Coordinator)

http://ftp.icpdas.com.tw/pub/cd/usbcd/napdos/zigbee/zt_series/utility/

3.4 Communications Testing

Once the ZT-2000 I/O device has joined the ZigBee network, the signal quality can be confirmed by monitoring the status of the ZigBee Net LED indicators. If the LED indicator shows a steady light, communication with the ZT-2000 I/O device has been successfully established for data acquisition and control.

ICP DAS provides the “DCON Utility” which can be used to simulate DCON/Modbus communication. This software can also be used to verify the device settings and the ZigBee I/O functions.

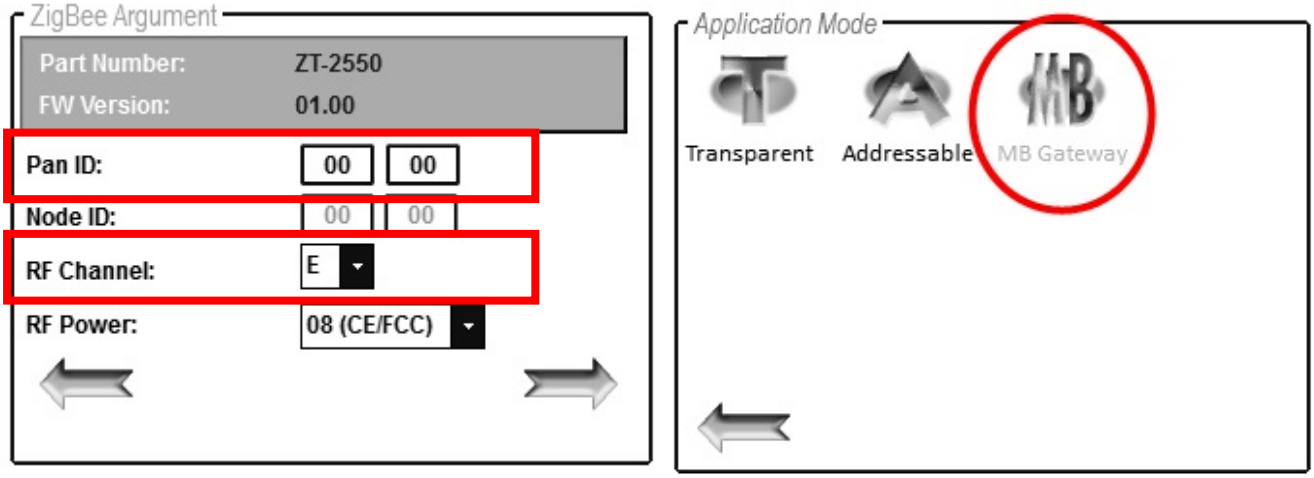
The DCON Utility can be downloaded from:

http://ftp.icpdas.com/pub/cd/8000cd/napdos/driver/dcon_utility/

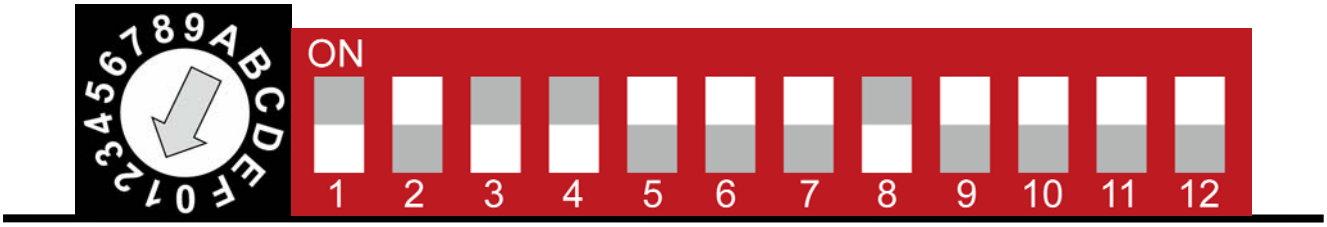
3.5 Examples

➢ Architecture Diagram

➢ Configuring the ZT-2550/ZT-2570



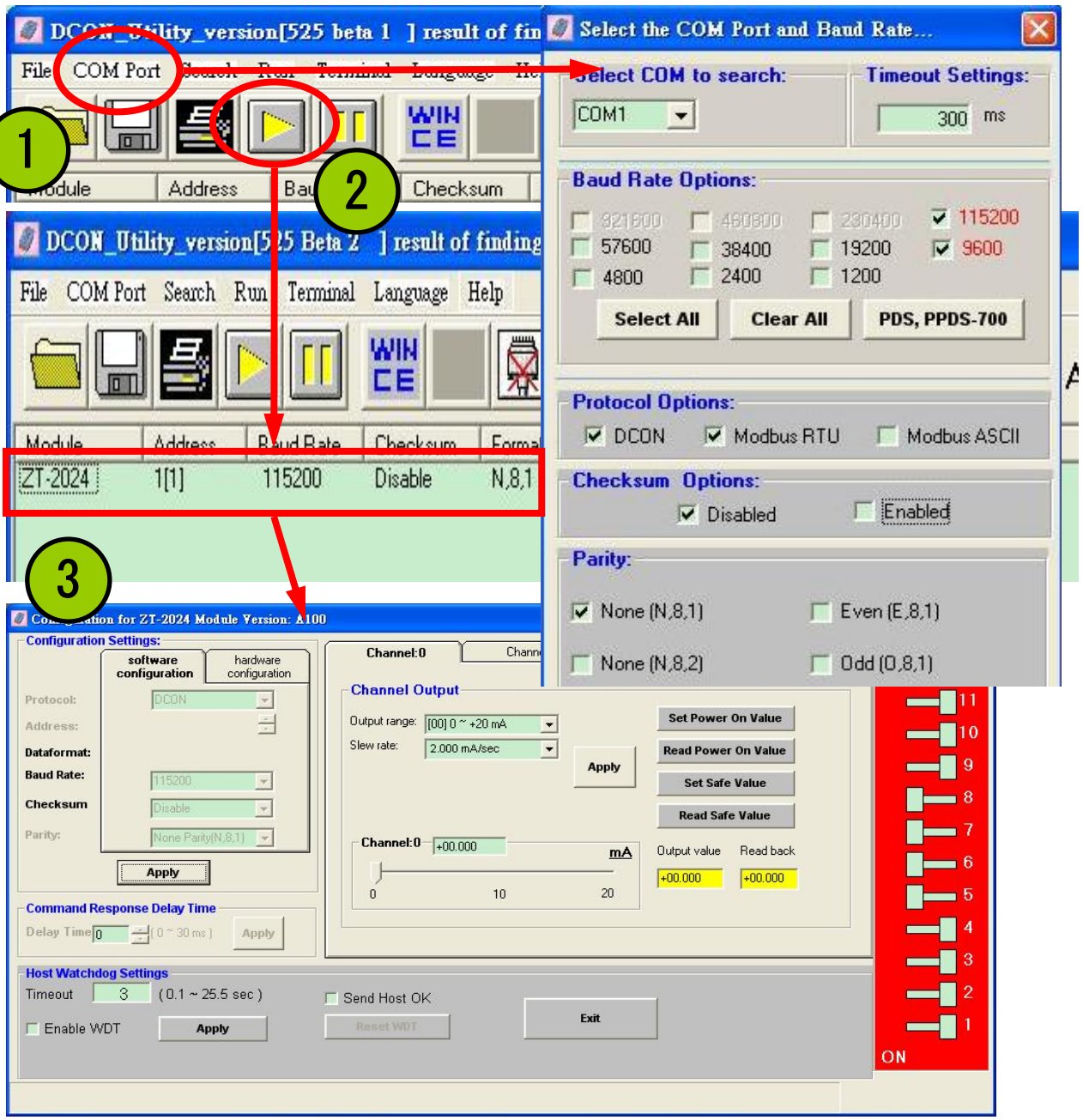
➢ Configuring the ZT-2000 I/O device



Number	Item	Status	Description	
1	Address MSB	OFF	Address/Node ID is **01** (Rotary Switch=1)	
2	Protocol	ON	Use the **Modbus RTU** Protocol	
3	Checksum	OFF	Disabled	
4	ZB PID	OFF	ZigBee Pan ID = **0x0000**	
5	ZB Channel	ON	0x08	ZigBee RF Channel = **0x0E**
6		ON	0x04	
7		ON	0x02	
8		OFF	------	

➢ Simulating I/O channel operation via the DCON Utility

1. Launch the DCON Utility and select the appropriate COM Port settings to connect to the ZigBee Coordinator (ZT-2550/ZT-2570).
2. Click the “Search” button to start searching for ZT-2000 I/O devices connected to the same ZigBee network.
3. If any ZT-2000 I/O devices are found, they will be displayed in the device list window. Double-click the name of the module to start the operation.



4 Analog Output Type, Data Format and Slew Rate

Type Code	Input Type	Data Format	+F.S.	-F.S.
0	+0 to +20 mA	Engineering Units	+20.000	+0.000
		% of FSR*1	+100.00	+000.00
		2's Comp. Hex	FFFF	0000
1	+4 to +20 mA	Engineering Units	+20.000	+4.000
		% of FSR*1	+100.00	+000.00
		2's Comp. Hex	FFFF	0000
2	+0 to +10 V	Engineering Units	+10.000	+0.000
		% of FSR*1	+100.00	+000.00
		2's Comp. Hex	FFFF	0000
3	-10 to +10 V	Engineering Units	+10.000	-10.000
		% of FSR*1	+100.00	-100.00
		2's Comp. Hex	7FFF	8000
4	+0 to +5 V	Engineering Units	+05.000	+00.000
		% of FSR*1	+100.00	+000.00
		2's Comp. Hex	FFFF	0000
5	-5 to +5 V	Engineering Units	+05.000	-05.000
		% of FSR*1	+100.00	-100.00
		2's Comp. Hex	7FFF	8000
*1: FSR (Full Scale Range)				

➢ Data Format Settings (FF)

7	6	5	4	3	2	1	0
Reserved						DF	

Key	Description
DF	Data Format

	00: Engineering Units 01: % of FSR 10: 2’s Complement Hexadecimal

- Slew Rate Control

0 Immediate Change
1 0.0625 V/Second or 0.125 mA/Second
2 0.125 V/Second or 0.25 mA/Second
3 0.25 V/Second or 0.5 mA/Second
4 0.5 V/Second or 1.0 mA/Second
5 1.0 V/Second or 2.0 mA/Second
6 2.0 V/Second or 4.0 mA/Second
7 4.0 V/Second or 8.0 mA/Second
8 8.0 V/Second or 16 mA/Second
9 16 V/Second or 32 mA/Second
A 32 V/Second or 64 mA/Second
B 64 V/Second or 128 mA/Second
C 128 V/Second or 256 mA/Second
D 256 V/Second or 512 mA/Second
E 512 V/Second or 1024 mA/Second
F 1024 V/Second or 2048 mA/Second

5 Calibration

➢ Warning

Performing calibration is not recommended until the process is fully understood.

5.1 Analog Output

The Analog Output calibration procedure is as follows:

1. Warm up the module for at least 30 minutes.
2. Set the Type Code to the type you wish to calibrate. Refer to Section 4 and Section 6.4.13 for details.
3. Enable calibration. Refer to Section 6.4.26 for details.
4. Set the zero Analog Output voltage/current. Refer to Section 6.4.2 for details.
5. Check the meter and trim the output until zero output is achieved. Refer to Section 6.4.6 for details.
6. Send the Analog Output zero calibration command. Refer to Section 6.4.3 for details.
7. Set the span Analog Output voltage/current. Refer to Section 6.4.2 for details.
8. Check the meter and trim the output until span output is achieved. Refer to Section 6.4.6 for details.
9. Send the Analog Output span calibration command. Refer to Section 6.4.4 for details.

➢ Notes

1. For Analog Output channels, calibration must be performed for each channel individually, so the calibration voltage/current should be connected to the specific channel to be calibrated.
2. Calibration voltages/current are shown below.

➢ Calibration Voltage Type used by the ZT-2024

Type Code	0	1	2	3	4	5
Zero Output	0 mA	4 mA	0 V	0 V	0 V	0 V
Span Output	20 mA	20 mA	+10 V	+10 V	+5 V	+5 V

6 The DCON/Modbus RTU Command Sets

6.1 Communicating with the ZT-2000 I/O Device

ICP DAS ZT-2000 I/O devices can be operated using either the DCON or the Modbus RTU protocol, which can be selected by adjusting the position of DIP Switch 2 to OFF (DCON) or ON (Modbus RTU) and then rebooting the ZT-2000 I/O device to use the new protocol.

6.2 The DCON Protocol Command Set

All ZT-2000 I/O series devices are controlled via wireless broadcast commands, so each device must have a unique address that is saved in the EEPROM of the device.

Consequently, all command and response formats contain the address of the destination module. When an I/O device receives a command, it will determine whether or not to respond based on the address contained in the command. However, there are two exceptions to this, the #** and ~** commands.

➢ DCON Command Format

Delimiter Character	Module Address	Command	[CHECKSUM]	CR

➢ DCON Response Format

Delimiter Character	Module Address	Data	[CHECKSUM]	CR

※ **Note: 'CR' is the end of command (carriage return) character used to end a frame.**

※ **Note: All characters should be expressed in capital letters.**

6.3 Checksum

➢ Calculating the Checksum:

Sum the ASCII codes of all the characters contained in the command in addition to the 'CR' terminator. The Checksum is the sum value expressed in Hexadecimal format.

➢ Example: Command "$012(CR)"

Sum = '$' + '0' + '1' + '2' = 24h + 30h + 31h + 32h = B7h

Checksum = "B7"

DCON Command with Checksum ="$012B7(CR)"

➢ Example: Response "!01200600(CR)"

Sum = '!' + '0' + '1' + '2' + '0' + '0' + '6' + '0' + '0'

= 21h+30h+31h+32h+30h+30h+36h+30h+30h

= 1AAh

Checksum = "AA"

DCON Response with Checksum = "!01200600AA(CR)"

※ **Note: The Checksum is the sum value expressed in capital letters.**

6.4 Overview of the DCON Command Set

General Command Set			
Command	Response	Description	Section
%AANNTTCCFF	!AA	Sets the Configuration of the Module	6.4.1
#AAN(Data)	>	Sets the Analog Output for a Specific Channel	6.4.2
$AA0N	!AA	Performs a Zero Calibration on a Specific Analog Output Channel	6.4.3
$AA1N	!AA	Performs a Span Calibration on a Specific Analog output Channel	6.4.4
$AA2	!AANNTTCCFF	Reads the Configuration of the Module	6.4.5
$AA3NVV	!AA	Trims the Calibration for a Specific Analog Output Channel	6.4.6
$AA4N	!AA	Sets the Power-on Value for a Specific Analog Output Channel	6.4.7
$AA5	!AAS	Reads the Reset Status of the Module	6.4.8
$AA6N	!AA(Data)	Reads the last Value received by a Specific Analog Output Channel	6.4.9
$AA7N	!AA(Data)	Reads the Power-on Value for a Specific Analog Output Channel	6.4.10
$AA8N	!AA(Data)	Reads the Current Value for a Specific Analog Output Channel	6.4.11
$AA9N	!AATTS	Reads the Configuration for a Specific Analog Output Channel	6.4.12
$AA9NTS	!AA	Sets the Configuration for a Specific Analog Output Channel	6.4.13
$AAF	!AA(Data)	Reads the Firmware Version of the Module	6.4.14
$AAM	!AA(Data)	Reads the Name of the Module	6.4.15
$AAS1	!AA	Reloads the Default Calibration Parameters	6.4.16
~AA4N	!AA(Data)	Reads the Safe Value for a Specific Analog Output Channel	6.4.22
~AA5N	!AA	Sets the Safe Value for a Specific Analog Output Channel	6.4.23
~AAEV	!AA	Enables or Disables Calibration for the Module	6.4.26
~AAO(Name)	!AA	Sets the Name of the Module	6.4.27

Host Watchdog Command Sets			
Command	Response	Description	Section
~**	No Response	The command to inform all modules that the Host is OK	6.4.17
~AA0	!AASS	Reads the Status of the Host Watchdog	6.4.18
~AA1	!AA	Resets the Status of the Host Watchdog Timeout	6.4.19
~AA2	!AAETT	Reads the Timeout Settings for the Host Watchdog	6.4.20
~AA3ETT	!AA	Enables or Disables the Host Watchdog and Sets the Host Watchdog Timeout Value	6.4.21
~AA6PN(Data)	!AA	Sets the Analog Output Power-on Value for a Specific Channel	6.4.24
~AA6SN(Data)	!AA	Sets the Analog Output Safe Value for a Specific Channel	6.4.25

6.4.1 %AANNTTCCFF

Description
This command is used to set the configuration of a specific module.

Syntax	
%AANNTTCCFF[CHECKSUM](CR)	
%	Delimiter character
AA	The address of the module to be configured in hexadecimal format (00 to FF)
NN	The new address of the module in hexadecimal format (00 to FF)
TT	00 (Reserved)
CC	0A (Reserved)
FF	The command used to set the data format, checksum, and filter settings. See Section 4 for details of the data format.

Response	
Valid Command	!AA[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
AA	The address of the responding module in hexadecimal format (00 to FF)
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	%0320000A00
Response	!03
In Normal mode, the address 0x20 is saved to the EEPROM and the data format for module 03 is set to 00 (Engineering Units). The module returns a response indicating that the command was successful.	

Command	%0320000A02
Response	!20
In Software Configuration mode, the address 0x20 is saved to the EEPROM and the data format for module 03 is set to 02 (2's Complement Hexadecimal). The module returns a response indicating that the command was successful.	

Command	%0303000000
Response	?03
Attempts to set the configuration for module 03, but returns a response indicating that an error occurred because the "CC"parameter must be 0A.	

※Related Commands: Section 6.4.5 $AA2

※Related Topics: Section 4 Analog Output Type, Data Format and Slew Rate

6.4.2 #AAN(Data)

Description
This command is used to set the Analog Output value for Analog Output channel N of a specified module.

Syntax	
#AAN(Data)[CHECKSUM](CR)	
#	Delimiter character
AA	The address of the module to be set in hexadecimal format (00 to FF)
N	The Analog Output channel to be set, zero based
(Data)	The Analog Output value. See the Section 4 for details of the data format.

Response	
Valid Command	>[CHECKSUM](CR)
Invalid Command	?[CHECKSUM](CR)
Ignored Command	![CHECKSUM](CR)
>	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command because the Analog Output value (Data) is out of range. The Analog Output value will be restored to the closest value defined in the range settings for the module.
!	Delimiter character to indicate that the module's Host Watchdog flag is set. The command will be ignored and the Analog Output value will be set to the configured Safe value.
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	$039050
Response	!03
Sets the output range for Analog Output channel 0 of module 03 to -5 to +5 V and sets the slew rate to change immediately, and returns a response indicating that the command was successful.	

Command	#030+05.000
Response	>
Sets the output value for Analog Output channel 0 of module 03 to +05.000 (+5.0 V) and returns a response indicating that the command was successful.	

Command	#030+25.000
Response	?
Attempts to set the output value for Analog Output channel 0 of module 03 to +25.000 (+25 V), but returns a response indicating that the command was unsuccessful because the output value of +25.000 (+25 V) is not within the valid range. The Analog Output value will be restored to the closest value of +05.000(+5V) defined in the range settings for the module.	

※Related Commands: Section 6.4.1 %AANNTTCCFF, Section 6.4.12 $AA9N, Section 6.4.13 $AA9NTS

※Related Topics: Section 4 Analog Output Type, Data Format and Slew Rate

6.4.3 $AA0N

Description
The command is used to performan an Analog Output zero calibration on Analog Output channel N of a specified module.

Syntax	
$AA0N[CHECKSUM](CR)	
$	Delimiter character
AA	The address of the module to be calibrated in hexadecimal format (00 to FF)
0	The command to perform the Analog Output zero calibration
N	The Analog Output channel to be calibrated, zero based

Response	
Valid Command	!AA[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command.
AA	The address of the responding module in hexadecimal format (00 to FF)
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	$0301
Response	?03
Attempts to perform an Analog Output zero calibration on Analog Output channel 1 of module 03, but a response indicating that the command was unsuccessful is returned because the “Enable Calibration” command (~AAEV, see Section 6.4.26) was not sent in advance.	

Command	~03E1
Response	!03
Enables calibration on module 03 and returns a response indicating that the command was successful.	

Command	$0301
Response	!03
Performs an Analog Output zero calibration on Analog Output channel 1 of module 03 and returns a response indicating that the command was successful.	

Command	$0309
Response	?03
Attempts to perform an Analog Output zero calibration on Analog Output channel 9 of module 03, but returns a response indicating that the command was unsuccessful because Analog Output channel 9 does not exist.	

※Related Commands: Section 6.4.4 $AA1N, Section 6.4.6 $AA3NVV, Section 6.4.26 ~AAEV

※Related Topics: Section 5 Calibration

※Notes:

1. The “Enable Calibration” command, ~AAEV, must be sent before this command is used. See Section 6.4.26 for details.
2. This command must be sent before the Analog Output “Span Calibration” command, $AA1N, is used. See Section 6.4.4 for details.
3. For Analog Output channels, calibration must be performed for each channel individually.

6.4.4 $AA1N

Description
The command is used to perform an Analog Output span calibration on Analog Output channel N of a specified module.

Syntax	
$AA1N[CHECKSUM](CR)	
$	Delimiter character
AA	The address of the module to be calibrated in hexadecimal format (00 to FF)
1	The command to perform the Analog Output span calibration
N	The Analog Output channel to be calibrated, zero based

Response	
Valid Command	!AA[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command.
AA	The address of the responding module in hexadecimal format (00 to FF)
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	$0311
Response	?03
Attempts to perform an Analog Output span calibration on Analog Output channel 1 of module 03, but a response indicating that the command was unsuccessful is returned because the “Enable Calibration” command (~AAEV, see Section 6.4.26) was not sent in advance.	

Command	~03E1
Response	!03
Enables calibration on module 03 and returns a response indicating that the command was successful.	

Command	$0311
Response	!03
Performs an Analog Output span calibration on Analog Output channel 1 of module 03 and returns a response indicating that the command was successful.	

Command	$0319
Response	?03
Attempts to perform an Analog Output span calibration on Analog Output channel 9 of module 03, but returns a response indicating that the command was unsuccessful because the Analog Output channel 9 does not exist.	

※Related Commands: Section 6.4.3 $AA0N, Section 6.4.6 $AA3NVV, Section 6.4.26 ~AAEV

※Related Topics: Section 5 Calibration

※Notes:

1. The “Enable Calibration” command, ~AAEV, and the Analog Output “Zero Calibration” command, $AA0N, must be sent before this command is used. See Sections 6.4.3 and 6.4.26 for details.
2. For Analog Output channels, calibration must be performed for each channel individually.

6.4.5 $AA2

Description
This command is used to read the configuration of a specified module.

Syntax	
$AA2[CHECKSUM](CR)	
$	Delimiter character
AA	The address of the module to be read in hexadecimal format (00 to FF)
2	The command to read the configuration of the module

Response	
Valid Command	!NNTTCCFF[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
NN	The address of the module that is saved in the EEPROM in hexadecimal format (00 to FF)
TT	00 (Reserved)
CC	0A (Reserved)
FF	The data format, checksum settings and filter settings for the module. See Section 4 for details of the data format
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	$032
Response	!FF000A00
In Normal mode, reads the configuration of module 03. The response indicates that the command was successful and shows that the address stored in the EEPROM is 0xFF, that the filter is set to 60 Hz rejection, and that the data format is Engineering Units.	

Command	$FF2
Response	!FF000A00
In Software Configuration mode, reads the configuration of module FF. The response indicates that the command was successful, and shows that the address stored in the EEPROM is 0xFF, that the filter is set to 60 Hz rejection, and that the data format is Engineering Units.	

※Related Commands: Section 6.4.1 %AANNTTCCFF

※Related Topics: Section 4 Analog Output Type, Data Format and Slew Rate
Section 7.1 Software Configuration Mode

6.4.6 $AA3NVV

Description
The command is used to trim the calibration for Analog Output channel N of a specified module.

Syntax	
$AA3NVV[CHECKSUM](CR)	
$	Delimiter character
AA	The address of the module to be trimmed in hexadecimal format (00 to FF)
3	The command to trim the calibration
N	The Analog Ouptput channel to be trimmed, zero based
VV	Two hexadecimal digits to represent the trim calibration value. Use 00 to 5F to increase the voltage in increments from 0 to 95, and use FF to A1 to decrease the voltage in increments from 1 to 95.

Response	
Valid Command	!AA[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command.
AA	The address of the responding module in hexadecimal format (00 to FF)
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	$03301F
Response	!03
Increases the voltage of the Analog Output for channel 0 of module 03 by an increment of 31, and returns a response indicating that the command was successful.	

Command	$033060
Response	?03
Attempts to increase the voltage of the Analog output for channel 0 of module 03 by an increment 96, but returns a response indicating that the command was unsuccessful because the increment value is not within the valid range.	

※Related Commands: Section 6.4.3 $AA0N, Section 6.4.4 $AA1N, Section 6.4.26 ~AAEV

※Related Topics: Section 5 Calibration

6.4.7 $AA4N

Description
This command is used to store the current Analog Output value as the Analog Output power-on value for Analog Output channel N of a specific module.

Syntax	
$AA4N[CHECKSUM](CR)	
$	Delimiter character
AA	The address of the module to be set in hexadecimal format (00 to FF)
4	The command to store the current Analog Output value as the power-on value
N	The Analog Output channel to be set, zero based

Response	
Valid Command	!AA[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
AA	The address of the responding module in hexadecimal format (00 to FF)
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	#032+00.000
Response	>
Sets the Analog Output value for channel 2 of module 03 to +00.000 (0.0 V) and returns a response indicating that the command was successful.	

Command	$0342
Response	!03
Stores the current Analog Output as the Analog Output power-on value for Analog Output channel 2 of module 03 and returns a response indicating that the command was successful.	

Command	$0349
Response	?03
Attempts to store the current Analog Output as the Analog Output power-on value for Analog Output channel 9 of module 03, but returns a response indicating that the command was unsuccessful because Analog Output channel 9 does not exist.	

※Related Commands: Section 6.4.2 #AAN(Data), Section 6.4.10 $AA7N, Section 6.4.24 ~AA6PN(Data)

6.4.8 $AA5

Description
This command is used to read the reset status of a specified module.

Syntax	
$AA5[CHECKSUM](CR)	
$	Delimiter character
AA	The address of the module to be read in hexadecimal format (00 to FF)
5	The command to read the reset status of the module

Response	
Valid Command	!AAS[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
AA	The address of the responding module in hexadecimal format (00 to FF)
S	The reset status of the module: 0: This is NOT the first time the command has been sent since the module was powered on, which denotes that there has been no module reset since the last $AA5 command was sent. 1: This is the first time the command has been sent since the module was powered on.
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	$035
Response	!031
Reads the reset status of module 03. The module returns a response indicating that the command was successful and that it is the first time the $AA5 command has been sent since the module was powered on.	

Command	$035
Response	!030
Reads the reset status of module 03. The module returns a response indicating that the command was successful and that there has been no module reset since the last $AA5 command was sent.	

6.4.9 $AA6N

Description
This command is used to read the Analog Output requisition for channel N of a specified module.

Syntax	
$AA6N[CHECKSUM](CR)	
$	Delimiter character
AA	The address of the module to be read in hexadecimal format (00 to FF)
6	The command to read the output value requisition
N	The Analog Output channel to be read, zero based

Response	
Valid Command	!AA(Data)[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
AA	The address of the responding module in hexadecimal format (00 to FF)
(Data)	The output requistion value. See Section 4 for details of the data format.
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	#031+10.000
Response	!03
Sets the Analog Output requisition value for Analog Output channel 1 of module 03 to +10.000(+10 V) and returns a response indicating that the command was successful.	

Command	$0361
Response	!03+10.000
Reads the Analog Output requisition value for Analog Output channel 1 of module 03 and returns a response indicating that the command was successful, with a value of +10.000 (+10.0 V).	

Command	$0369
Response	?03
Attempts to read the Analog Output value from the last command received by Analog Output channel 9 of module 03, but returns a response indicating that the command was unsuccessful because Analog Output channel 9 does not exist.	

※Related Commands: Section 6.4.1 %AANNTTCCFF, Section 6.4.2 #AAN(Data), Section 6.4.11 $AA8N, Section 6.4.13 $AA9NTS

※Related Topics: Section 4 Analog Output Type, Data Format and Slew Rate

6.4.10 $AA7N

Description
This command is used to read the Analog Output power-on value for channel N of a specified module.

Syntax	
$AA7N[CHECKSUM](CR)	
$	Delimiter character
AA	The address of the module to be read in hexadecimal format (00 to FF)
7	The command to read the Analog Output power-on value
N	The Analog Output channel to be read, zero based

Response	
Valid Command	!AA(Data)[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
AA	The address of the responding module in hexadecimal format (00 to FF)
(Data)	The Analog Output power-on value for the specified Analog Output channel
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	#032+00.000
Response	>
Sets the Analog Output value for Analog Output channel 2 of module 03 to +00.000 (0.0 V) and returns a response indicating that the command was successful.	

Command	$0342
Response	!03
Stored the current Analog Output as the power-on value for Analog Output channel 2 of module 03 and returns a response indicating that the command was successful.	

Command	$0372
Response	!03+00.000
Reads the Analog Output power-on value for Analog Output channel 2 of module 03 and returns a response indicating that the command was successful, with a value of +00.000 signifying that the Analog Output power-on value is 0.0 V.	

Command	$0379
Response	?03
Attempts to read the Analog Output power-on value for Analog Output channel 9 of module 03, but returns a response indicating that the command was unsuccessful because Analog Output channel 9 does not exist.	

※Related Commands: Section 6.4.1 %AANNTTCCFF, Section 6.4.2 #AAN(Data), Section 6.4.7 $AA4N, Section 6.4.24 ~AA6PN(Data)

※Related Topics: Section 4 Analog Output Type, Data Format and Slew Rate

6.4.11 $AA8N

Description
This command is used to read the current Analog Output value for Analog Output channel N of a specified module.

Syntax	
$AA8N[CHECKSUM](CR)	
$	Delimiter character
AA	The address of the module to be read in hexadecimal format (00 to FF)
8	The command to read the current Analog Output value
N	The Analog Output channel to be read, zero based

Response	
Valid Command	!AA(Data)[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
AA	The address of the responding module in hexadecimal format (00 to FF)
(Data)	The current Analog Output value for the specified Analog Output channel. See Section 4 for details of the data format.
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	$039051
Response	!03
Sets the configuration for Analog Output channel 0 of module 03 to an output range of -5 to +5 V and a slew rate of 0.0625 V/Second, and returns a response indicating that the command was successful.	

Command	#030+05.000
Response	>
Sets the Analog Output value for Analog Output channel 0 of module 03 to +05.000 (+5.0 V) and returns a response indicating that the command was successful.	

Command	$0380
Response	!03+02.500
Reads the current Analog Output value for Analog Output channel 0 of module 03 and returns a response indicating that the command was successful, with a value of +02.500 (+2.5 V).	

Command	$0389
Response	?03
Attempts to read the current Analog Output value for Analog Output channel 9 of module 03, but returns a response indicating that the command was unsuccessful because Analog Output channel 9 does not exist.	

※Related Commands: Section 6.4.2 #AAN(Data), Section 6.4.9 $AA6N, Section 6.4.13 $AA9NTS

※Related Topics: Section 4 Analog Output Type, Data Format and Slew Rate

6.4.12 $AA9N

Description
This command is used to read the Analog Output configuration for Analog Output channel N of a specified module.

Syntax	
$AA9N[CHECKSUM](CR)	
$	Delimiter character
AA	The address of the module to be read in hexadecimal format (00 to FF)
9	The command to read the Analog Output configuration
N	The Analog Output channel to be read, zero based

Response	
Valid Command	!AATS[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
AA	The address of the responding module in hexadecimal format (00 to FF)
T	The Analog Output type. See Section 4 for details of the data format.
S	The Analog Output slew rate. See Section 4 for details of the data format.
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	$039051
Response	!03
Sets the configuration for Analog Output channel 0 of module 03 to an output range of -5 to +5 V and a slew rate of 0.0625 V/Second and returns a response indicating that the command was successful.	

Command	$0390
Response	!0351
Reads the configuration for Analog Output channel 0 of module 03 and returns a response indicating that the command was successful, with a value of 51, meaning that the output range is -5 to +5 V and the slew rate is 0.0625 V/Second.	

Command	$0399
Response	?03
Attempts to read the configuration for Analog Output channel 9 of module 03, but returns a response indicating that the command was unsuccessful because Analog Output channel 9 does not exist.	

※Related Commands: Section 6.4.2 #AAN(Data), Section 6.4.13 $AA9NTS
※Related Topics: Section 4 Analog Output Type, Data Format and Slew Rate

6.4.13 $AA9NTS

Description
This command is used to set the configuration for Analog Output channel N of a specified module.

Syntax	
$AA9NTS[CHECKSUM](CR)	
$	Delimiter character
AA	The address of the module to be set in hexadecimal format (00 to FF)
9	The command to set the Analog Output configuration
N	The Analog Output channel to be set, zero based
T	The Analog Output type. See Section 4 for details of the data format.
S	The Analog Output slew rate. See Section 4 for details of the data format.

Response	
Valid Command	!AA[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
AA	The address of the responding module in hexadecimal format (00 to FF)
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	$039051
Response	!03
Sets the configuration for Analog Output channel 0 of module 03 to an output range of -5 to +5 V and a slew rate of 0.0625 V/Second, and returns a response indicating that the command was successful.	

Command	$0390
Response	!0351
Reads the configuration for Analog Output channel 0 of module 03 and returns a response indicating that the command was successful, with a value of 51, meaning that the output range is -5 to +5 V and the slew rate is 0.0625 V/Second.	

Command	$039951
Response	?03
Attempts to set the configuration for Analog Output channel 9 of module 03 to an output range of -5 to +5 V and a slew rate of 0.0625 V/Second, but returns a response indicating that the command was unsuccessful because Analog Output channel 9 does not exist.	

※Related Commands: Section 6.4.2 #AAN(Data), Section 6.4.12 $AA9N, Section 6.4.24 ~AA6PN(Data)

※Related Topics: Section 4 Analog Output Type, Data Format and Slew Rate

6.4.14 $AAF

Description
This command is used to read the firmware version of a specified module.

Syntax	
$AAF[CHECKSUM](CR)	
$	Delimiter character
AA	The address of the module to be read in hexadecimal format (00 to FF)
F	The command to read the firmware version information

Response	
Valid Command	!AA(Data)[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
AA	The address of the responding module in hexadecimal format (00 to FF)
(Data)	The firmware version of the module as a string value
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	$03F
Response	!03A1.0
Reads the firmware version of module 03 and returns a response indicating that the command was successful, and showing that the firmware is version A1.0.	

6.4.15 $AAM

Description
This command is used to read the name of a specified module.

Syntax	
$AAM[CHECKSUM](CR)	
$	Delimiter character
AA	The address of the module to be read in hexadecimal format (00 to FF)
M	The command to read the name of the module

Response	
Valid Command	!AA(Data)[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
AA	The address of the responding module in hexadecimal format (00 to FF)
(Data)	The name of the module as a string value
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	~03OZT-2024
Response	!03
Sets the name of module 03 to “ZT-2024” and returns a response indicating that the command was successful.	

Command	$03M
Response	!03ZT-2024
Reads the name of module 03 and returns a response indicating that the command was successful, and that the name of the module is “ZT-2024”.	

※Related Commands: Section 6.4.27 ~AAO(Name)

6.4.16 $AAS1

Description
This command is used to reload the factory default calibration parameters for a specified module, including the internal calibration parameters.

Syntax	
$AAS1[CHECKSUM](CR)	
$	Delimiter character
AA	The address of the module where the default parameters are to be reloaded in hexadecimal format (00 to FF)
S1	The command to reload the factory default calibration parameters

Response	
Valid Command	!AA[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
AA	The address of the responding module in hexadecimal format (00 to FF)
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	$03S1
Response	!03
Sends a command to reload the factory default calibration parameters for module 03 and returns a response indicating that the command was successful.	

Command	$03S0
Response	?03
Attempts to send a command to reload the factory default calibration parameters for module 03, but returns a response indicating that the command was unsuccessful because the command was incorrect.	

※Related Commands: Section 6.4.3 $AA0N, Section 6.4.4 $AAA1N, Section 6.4.26 ~AAEV

※Related Topics: Section 5 Calibration

6.4.17 ~**

Description
This command is used to inform all modules that the Host is OK.

Syntax	
~**[CHECKSUM](CR)	
~	Delimiter character
**	The “Host OK” command

Response
There is no response to this command.

Examples	
Command	~**
Response	No response
Sends a “Host OK” command to all modules.	

※Related Commands: Section 6.4.18 ~AA0, Section 6.4.19 ~AA1, Section 6.4.20 ~AA2, Section 6.4.21 ~AA3ETT

※Related Topics: Section 7.2 Dual Watchdog Operation.

6.4.18 ~AA0

Description
This command is used to read the status of the Host Watchdog for a specified module.

Syntax	
~AA0[CHECKSUM](CR)	
~	Delimiter character
AA	The address of the module to be read in hexadecimal format (00 to FF)
0	The command to read the status of the Host Watchdog

Response	
Valid Command	!AASS[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
AA	The address of the responding module in hexadecimal format (00 to FF)
SS	Two hexadecimal digits that represent the status of the Host Watchdog, where: Bit 2: 0 indicates that no Host Watchdog timeout has occurred, and 1 indicates that a Host Watchdog timeout has occurred. Bit 7: 0 indicates that the Host Watchdog is disabled, and 1 indicates that the Host Watchdog is enabled. The status of the Host Watchdog is stored in the EEPROM, and can only be reset by using the ~AA1 command. See Section 6.4.19 for more details.
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	~030
Response	!0380
Reads the status of the Host Watchdog for module 03 and returns a response indicating that the command was successful, with a value of 00, meaning that	

the Host Watchdog is enabled and no Host Watchdog timeout has occurred.

Command	~030
Response	!0304
Reads the status of the Host Watchdog for module 03 and returns a response indicating that the command was successful, with a value of 04, meaning that a Host Watchdog timeout has occurred.	

※Related Commands: Section 6.4.18 ~**, Section 6.4.19 ~AA1, Section 6.4.20 ~AA2, Section 6.4.21 ~AA3ETT

※Related Topics: Section 7.2 Dual Watchdog Operation

6.4.19 ~AA1

Description
This command is used to reset the status of the Host Watchdog timeout for a specified module.

Syntax	
~AA1[CHECKSUM](CR)	
~	Delimiter character
AA	The address of the module to be reset in hexadecimal format (00 to FF)
1	The command to reset the status of the Host Watchdog timeout

Response	
Valid Command	!AA[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
AA	The address of the responding module in hexadecimal format (00 to FF)
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	~030
Response	!0304
Reads the status of the Host Watchdog for module 03 and returns a response indicating that the command was successful, and that a Host Watchdog timeout has occurred.	

Command	~031
Response	!03
Resets the status of the Host Watchdog timeout for module 03 and returns a response indicating that the command was successful.	

Command	~030
Response	!0300
Reads the status of the Host Watchdog for module 03 and returns a response indicating that the command was successful, and showing that no Host Watchdog timeout has occurred.	

※Related Commands: Section 6.4.17 ~**, Section 6.4.18 ~AA0, Section 6.4.20 ~AA2, Section 6.4.21 ~AA3ETT

※Related Topics: Section 7.2 Dual Watchdog Operation

6.4.20 ~AA2

Description
This command is used to read the Host Watchdog timeout value for a specified module.

Syntax	
~AA2[CHECKSUM](CR)	
~	Delimiter character
AA	The address of the module to be read in hexadecimal format (00 to FF)
2	The command to read the Host Watchdog timeout value

Response	
Valid Command	!AAETT[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
AA	The address of the responding module in hexadecimal format (00 to FF)
E	The status of the Host Watchdog 0: The Host Watchdog is disabled 1: The Host Watchdog is enabled
TT	Two hexadecimal digits to represent the timeout value in tenths of a second. For example, 01 denotes 0.1 seconds and FF denotes 25.5 seconds.
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	~033164
Response	!03
Enables the Host Watchdog for module 03 and sets the Host Watchdog timeout value to 64 (10.0 seconds). The module returns a response indicating that the command was successful.	

Command	~032
Response	!03164
Reads the Host Watchdog timeout value for module 03 and returns a response indicating that the command was successful, with a value of 164, which denotes that the Host Watchdog is enabled and the Host Watchdog timeout value is 10.0 seconds.	

※Related Commands: Section 6.4.17 ~**, Section 6.4.18 ~AA0, Section 6.4.19 ~AA1, Section 6.4.21 ~AA3ETT

※Related Topics: Section 7.2 Dual Watchdog Operation

6.4.21 ~AA3ETT

Description
This command is used to enable or disable the Host Watchdog for a specified module, and sets the Host Watchdog timeout value.

Syntax	
~AA3ETT[CHECKSUM](CR)	
~	Delimiter character
AA	The address of the module to be configured in hexadecimal format (00 to FF)
3	The command to enable or disable the Host Watchdog
E	The command to set the Host Watchdog: 0: Disables the Host Watchdog 1: Enables the Host Watchdog
TT	Two hexadecimal digits to represent the Host Watchdog timeout value in tenths of a second. For example, 01 denotes 0.1 seconds and FF denotes 25.5 seconds.

Response	
Valid Command	!AA[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
AA	The address of the responding module in hexadecimal format (00 to FF)
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	~033164
Response	!03
Enables the Host Watchdog for module 03 and sets the Host Watchdog timeout value to 64 (10.0 seconds). The module returns a response indicating that the command was successful.	

Command	~032
Response	!03164
Reads the Host Watchdog timeout value for module 03. The module returns a response indicating that the command was successful, with a value of 164, which denotes that the Host Watchdog is enabled and that the Host Watchdog timeout value is 10.0 seconds.	

※Related Commands: Section 6.4.17 ~**, Section 6.4.18 ~AA0, Section 6.4.19 ~AA1, Section 6.4.20 ~AA2, Section 6.4.22 ~AA4N, Section 6.4.23 ~AA5N

※Related Topics: Section 7.2 Dual Watchdog Operation

※Note: When a Host Watchdog timeout occurs, the Host Watchdog is disabled. In this case the ~AA3ETT command should be sent again to re-enable the Host Watchdog.

6.4.22 ~AA4N

Description
This command is used to read the safe value for Analog Output channel N of a specified module.

Syntax	
~AA4N[CHECKSUM](CR)	
~	Delimiter character
AA	The address of the module to be read in hexadecimal format (00 to FF)
4	The command to read the Analog Output safe value
N	The Analog Output channel to be read, zero based

Response	
Valid Command	!AA(Data)[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
AA	The address of the responding module in hexadecimal format (00 to FF)
(Data)	The Analog Output safe value. See Section 4 for details of the data format
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	#030+06.000
Response	>
Sets the Analog Output value for Analog Output channel 0 of module 03 to +06.000 (+6.0 V) and returns a response indicating that the command was successful.	

Command	~0350
Response	!03
Sets the current Analog Output value for Analog Output channel 0 as the Analog Output safe value and returns a response indicating that the command was successful.	

Command	~0340
Response	!03+06.000
Reads the Analog Output safe value for Analog Output channel 0 of module 03 and returns a response indicating that the command was successful, with a value of +06.000 (+6.0 V).	

Command	~0349
Response	?03
Attempts to read the Analog Output safe value for Analog Output channel 9 of module 03, but returns a response indicating that the command was unsuccessful because Analog Output channel 9 does not exist.	

※Related Commands: Section 6.4.2 #AAN(Data), Section 6.4.21 ~AA3ETT, Section 6.4.23 ~AA5N

※Related Topics: Section 4 Analog Output Type, Data Format and Slew Rate

6.4.23 ~AA5N

Description
This command is used to set the safe value for Analog Output channel N of a specified module.

Syntax	
~AA5N[CHECKSUM](CR)	
~	Delimiter character
AA	The address of the module to be set in hexadecimal format (00 to FF)
5	The command to set the Analog Output safe value
N	The Analog Output channel to be set, zero based

Response	
Valid Command	!AA[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
AA	The address of the responding module in hexadecimal format (00 to FF)
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	#030+06.000
Response	>
Sets the Analog Output value for Analog Output channel 0 of module 03 to +06.000 (+6.0 V) and returns a response indicating that the command was successful.	

Command	~0350
Response	!03
Sets the current Analog Output value for Analog Output channel 0 of module 03 as the Analog Output safe value and returns a response indicating that the command was successful.	

Command	~0340
Response	!03+06.000
Reads the Analog Output safe value for channel 0 of module 03 and returns a response indicating that the command was successful, with a value of +06.000 (+6.0 V).	

Command	~0359
Response	?03
Attempts to set the current Analog Output value for Analog Output channel 9 of module 03 as the Analog Output safe value, but returns a response indicating that the command was unsuccessful because Analog Output channel 9 does not exist.	

※Related Commands: Section 6.4.2 #AAN(Data), Section 6.4.21 ~AA3ETT, Section 6.4.22 ~AA4N

※Related Topics: Section 4 Analog Output Type, Data Format and Slew Rate

6.4.24 ~AA6PN(Data)

Description
This command is used to set the power-on value for Analog Output channel N of a specified module.

Syntax	
~AA6PN(Data)[CHECKSUM](CR)	
~	Delimiter character
AA	The address of the module to be set in hexadecimal format (00 to FF)
6P	The command to set the Analog Output power-on value
N	The Analog Output channel to be set, zero based
(Data)	The Analog Output value. See the Section 4 for details of the data format.

Response	
Valid Command	!AA[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
AA	The address of the responding module in hexadecimal format (00 to FF)
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	~036P0+05.000
Response	!03
Sets the Analog Output power-on value for Analog Output channel 0 of module 03 to +05.000 (+5.0 V) and returns a response indicating that the command was successful.	

Command	~036P0+25.000
Response	?03
Attempts to set the Analog Output power-on value for Analog Output channel 0 of module 03 to +25.000 (+25.0 V), but returns a response indicating that the command was unsuccessful because the value is not within the valid output range.	

※Related Commands: Section 6.4.2 #AAN(Data), Section 6.4.7 $AA4N, Section 6.4.10 $AA7N, Section 6.4.13 $AA9NTS

※Related Topics: Section 4 Analog Output Type, Data Format and Slew Rate

6.4.25 ~AA6SN(Data)

Description
This command is used to set the safe value for Analog Output channel N of a specified module.

Syntax	
~AA6SN(Data)[CHECKSUM](CR)	
~	Delimiter character
AA	The address of the module to be set in hexadecimal format (00 to FF)
6S	The command to set the Analog Output safe value
N	The Analog Output channel to be set, zero based
(Data)	The Analog Output value. See Section 4 for details of the data format.

Response	
Valid Command	!AA[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
AA	The address of the responding module in hexadecimal format (00 to FF)
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	~036S0+05.000
Response	!03
Sets the Analog Output safe value for Analog Output channel 0 of module 03 to +05.000 (+5.0 V), and returns a response indicating that the command was successful.	

Command	~036S0+25.000
Response	?03
Attempts to set the Analog Output safe value for Analog Output channel 0 of module 03 to +25.000 (+25.0 V), but returns a response indicating that the command was unsuccessful because the value is not within the valid output range.	

※Related Commands: Section 6.4.2 #AAN(Data), Section 6.4.13 $AA9NTS, Section 6.4.21 ~AA3ETT, Section 6.4.22 ~AA4N, Section 6.4.23 ~AA5N

※Related Topics: Section 4 Analog Output Type, Data Format and Slew Rate

6.4.26 ~AAEV

Description
This command is used to enable or disable calibration for a specified module.

Syntax	
~AAEV[CHECKSUM](CR)	
~	Delimiter character
AA	The address of the module where calibration is to be enabled or disabled in hexadecimal format (00 to FF)
E	The command to enable or disable calibration
V	The command to enable or disable calibration 0: Disables calibration 1: Enables calibration

Response	
Valid Command	!AA[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
AA	The address of the responding module in hexadecimal format (00 to FF)
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	$030
Response	?03
Attempts to send a command to perform a span calibration on module 03, but returns a response indicating that the command was unsuccessful because the “Enable Calibration” command (~AAEV) has not yet been sent.	

Command	~03E1
Response	!03
Enables calibration on module 03 and returns a response indicating that the command was successful.	

Command	$030
Response	!03
Sends a command to perform a span calibration on module 03 and returns a response indicating that the command was successful.	

※Related Commands: Section 6.4.3 $AA0N, Section 6.4.4 $AA1N, Section 6.4.16 $AAS1

※Related Topics: Section 5 Calibration

※Note: This command must be sent before any other calibration commands can be used.

6.4.27 ~AAO(Name)

Description
This command is used to set the name of a specified module.

Syntax	
~AAO(Name)[CHECKSUM](CR)	
~	Delimiter character
AA	The address of the module to be set in hexadecimal format (00 to FF)
O	The command to set the name of the module
(Name)	The new name of the module (Max. 8 characters)

Response	
Valid Command	!AA[CHECKSUM](CR)
Invalid Command	?AA[CHECKSUM](CR)
!	Delimiter character to indicate a valid command
?	Delimiter character to indicate an invalid command
AA	The address of the responding module in hexadecimal format (00 to FF)
There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.	

Examples	
Command	~03OZT-2024
Response	!03
Sets the name of module 03 to “ZT-2024” and returns a response indicating that the command was successful.	

Command	$03M
Response	!03ZT-2024
Reads the name of module 03 and returns a response indicating that the command was successful, with the name “ZT-2024”.	

Command	~03O123456789ABCDEF
Response	?03
Attempts to set the name of module 03 to “123456789ABCDEF”, but returns a response indicating that the command was unsuccessful, because the name is longer than 8 characters..	

※Related Commands: Section 6.4.15 $AAM

6.5 Modbus RTU Protocol Command set

The Modbus Protocol was developed by Modicon Inc., and was originally designed for Modicon controllers. Detailed information regarding the Modbus RTU Protocol can be found at:
http://www.modicon.com
and http://www.modbus.org

- Modbus RTU Command Format

Field 1	Field 2	Field 3	Field 4~n	Field n+1~n+2
Module Address	Function Code	Sub Function	Configuration Field	CRC16

Function Code	Description
0x04	Reads the input channels
0x46	Reads/writes the module settings

Examples:

A. To read the Analog Input value for module 01, the following command should be sent:
01 04 00 00 00 08 F1 CC

B. To read the name of the module, the following command should be sent:
01 46 00 12 60

6.5.1 Modbus Address Mapping

Address Mapping		
Address	Description	Attribute
00260	The Modbus Host Watchdog mode: 0: The same as the I-7000 series modules 1: The Analog Output commands can be used to clear the status of the Host Watchdog timeout	R/W
00261	Enables or disables the Host Watchdog: 0: Disable 1: Enable	R/W
00269	The Modbus Data Format: 0: Hexadecimal 1: Engineering Units	R/W
00270	The status of the Host Watchdog timeout. Write 1 to clear.	W
00272	The factory calibration parameters. Write 1 to load.	W
00273	The Reset status: 0: This is NOT the first time the module has been read after being powered on 1: This is the first time the module has been read after being powered on	R
00284	Enables or disables calibration: 0: Disable 1: Enable	R/W
30065 ~ 30066	The current Analog Output value	R
40033 ~ 40036	The Analog Output value for Analog Output channels 0 to 3	R/W
40097 ~ 40100	The Analog Output safe value for Analog Output channels 0 to 3	R/W
40193 ~ 40196	The Analog Output power-on value for Analog Output channels 0 to 3	R/W
40289 ~ 40292	The slew rate for Analog Output channels 0 to 3	R/W

40417 ~ 40420	The Type Code for Analog Output channels 0 to 3	R/W
40481 ~ 40482	The Firmware Version	R
40483 ~ 40484	The Module Name	R
40485	The Module Address. The valid range is 1 ~ 247	R
40486	The Baud Rate: Bit 5:0 Baud Rate. Always set to 0x0A Bit 7:6 Reserved	R
40489	The Host Watchdog timeout value. The valid range is 0 ~ 255, in 0.1 second intervals	R/W
40492	The Host Watchdog timeout counter value. Write 0 to clear.	R/W
40673 ~ 40676	Trims the Analog Output for Analog Output channels 0 to 3	W
40801 ~ 40802	The Analog Output calibration type: 0x5A45: Zro Calibration 0x5350: San Calibration	W

6.5.2 PLC Address Mapping

Function Code	Description	Section
0x01	Reads the Coils	6.5.3
0x02	Reads the Discrete Inputs	6.5.4
0x03	Reads Multiple Registers	6.5.5
0x04	Reads Multiple Input Registers	6.5.6
0x05	Writes a Single Coil	6.5.7
0x06	Writes Multiple Registers	6.5.8
0x0F	Writes Multiple Coils	6.5.9
0x46	Reads/Writes the Module Settings	6.5.10

If the function specified in the message is not supported, then the module will respond with an error code as per the tablk below. Note that the address mapping for the Modbus protocol is Base 0.

Error Response

Number	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	Function code + 0x80
02	Exception Code	1	01

Note: If a CRC mismatch occurs, the module will not respond.

6.5.3 01 (0x01) Reading the Coils

Description
This function code is used to read the current Digital Output values from the ZT-2000 I/O module.

Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x01
02~03	Starting Channel Number or Address Mapping	2	See Section 6.5.1 for details
03~05	Output Channel Number or Bit Count	2	0x0001 to 0x0020

Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x01
02	Byte Count	1	Byte Count of the Response (B=(Bit Count + 7)/8)
03	Bit Values	B	(Bit Values)

Error Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x81
02	Exception Code	1	Refer to the Modbus standard for more details

6.5.4 02 (0x02) Reading the Discrete Inputs

Description
This function code is used to read the current Digital Input values from the ZT-2000 I/O module.

Request			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x02
02~03	Starting Channel Number or Address Mapping	2	See Section 6.5.1 for details
04~05	Input Channel Number or Bit Count	2	0x0001 to 0x0020

Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x02
02	Byte Count	1	Byte Count of the Response (B=(Bit Count + 7)/8)
03	Bit Values	B	(Bit Values)

Error Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x82
02	Exception Code	1	Refer to the Modbus standard for more details

6.5.5 03 (0x03) Reading Multiple Registers

Description
This function code is used to read the current Digital Input counter values from the ZT-2000 I/O module.

Request			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x03
02~03	Starting Channel Number or Address Mapping	2	See Section 6.5.1 for details
04~05	Input Channel Number or Bit Count	2	0x0001 to 0x0020

Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x03
02	Byte Count	1	Byte Count of the Response (B=2 * Word Count)
03~	Register Values	B*2	Register Values

Error Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x83
02	Exception Code	1	Refer to the Modbus standard for more details

6.5.6 04 (0x04) Reading Multiple Input Registers

Description
This function code is used to read the current Analog Input values from the ZT-2000 I/O module.

Request			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x04
02~03	Starting Channel Number or Address Mapping	2	See Section 6.5.1 for details
04~05	Input Channel Number or Bit Count	2	0x0001 to 0x0020

Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x04
02	Byte Count	1	Byte Count of the Response (B=2 * Word Count)
03~	Register Values	B*2	Register Values

Error Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x84
02	Exception Code	1	Refer to the Modbus standard for more details

6.5.7 05 (0x05) Writing a Single Coil

Description
This function code is used to write the Digital Output value for the ZT-2000 I/O module.

Request			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x05
02~03	Starting Channel Number or Address Mapping	2	See Section 6.5.1 for details
04~05	Output Value	2	A value of 0xFF00 sets the output to ON. A value of 0x0000 sets the output to OFF.

Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x05
02~03	Output Channel Number	2	This value is the same as bytes 02 and 03 of the Request
04~05	Output Value	2	This value is the same as bytes 04 and 05 of the Request

Error Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x85
02	Exception Code	1	Refer to the Modbus standard for more details

6.5.8 06 (0x06) Writing Multiple Registers

Description
This function code is used to configurethe settings for the ZT-2000 I/O module.

Request			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x06
02~03	Address Mapping	2	See Section 6.5.1 for details
04~05	Register Value	2	Register Value

Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x06
02~03	Address Mapping	2	The value is the same as bytes 02 and 03 of the Request
04~05	Register Value	2	Register value

Error Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x86
02	Exception Code	1	Refer to the Modbus standard for more details

6.5.9 15 (0x0F) Writing Multiple Coils

Description
This function code is used to write the Digital Output values for the ZT-2000 I/O module.

Request			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x0F
02~03	Starting Cchannel Number	2	See Section 6.5.1 for details
04~05	Output Channel Number	2	0x0001 to 0x0020
06	Byte Count	1	B=(Bit Count + 7)/8
07	Output Value	2	A bit corresponds to a channel. When the bit is '0', it denotes that the channel that was set is OFF or Disabled. If the bit is '1', it denotes that the channel that was set is ON or Enabled.

Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x0F
02~03	Starting Channel Number	2	The value is the same as bytes 02 and 03 of the Request
04~05	Output Channel Number	2	0x0001 ~ 0x0020

Error Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x8F
02	Exception Code	1	Refer to the Modbus standard for more details

6.5.10 70 (0x46) Reading/Writing the Module Settings

Description		
This function code is used to read the configuration settings from the module or to change the settings for the module. The following sub-function codes are supported.		
Sub-function Code	**Description**	**Section**
00 (0x00)	Reads the Name of the Module	A.1
04 (0x04)	Sets the Address of the Module	A.2
07 (0x07)	Reads the Type Code	A.3
08 (0x08)	Sets the Type Code	A.4
32 (0x20)	Reads the Firmware Version	A.5
37 (0x25)	Reads whether a Specific Channel is Enabled or Disabled	A.6
38 (0x26)	Sets a Specific Channel to Enabled or Disabled	A.7
41 (0x29)	Reads the Miscellaneous Settings	A.8
42 (0x2A)	Writes the Miscellaneous Settings	A.9

If the sub-function code specified in the message is not supported, then the module will respond with an error code as per the table below:

Error Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0xC6
02	Exception Code	1	Refer to the Modbus standard for more details

A.1 00 (0x00) Reading the Name of a Module

Description
This sub-function code is used to read the name of a module.

Request			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x46
02	Sub-function Code	1	0x00

Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x46
02	Sub-function Code	1	0x00
03~06	Module Name	4	0x54 0x20 0x26 0x00

Error Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0xC6
02	Exception Code	1	Refer to the Modbus standard for more details

Example	
Command	01 46 00 [12 60]
Response	01 46 00 54 20 26 00 [0E FC]

A.2 04(0x04) Setting the Address of the Module

Description
This sub-function code is used to set the address fo the module.

Request			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x46
02	Sub-function Code	1	0x04
03	New Address	1	1 to 247
04~06	Reserved	3	0x00 0x00 0x00

Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x46
02	Sub-function Code	1	0x04
03	New Address	1	1 to 247
04~06	Reserved	3	0x00 0x00 0x00

Error Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0xC6
02	Exception Code	1	Refer to the Modbus standard for more details

Example	
Command	01 46 04 02 00 00 00 [F5 1E]
Response	01 46 04 00 00 00 00 [F4 A6]

A.3 07 (0x07) Reading the Analog Input Type Code

Description
This sub-function code is used to read the Type Code information for a specific Analog Input channel of a module.

Request			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x46
02	Sub-function Code	1	0x07
03	Reserved	1	0x00
04	Channel Number	1	0x00 to 0x07

Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x46
02	Sub-function Code	1	0x07
03	Type Code	1	The Type Code. See Section 4 for details of the data format.

Error Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0xC6
02	Exception Code	1	Refer to the Modbus standard for more details

Example	
Command	01 46 07 00 01 [7C 89]
Response	01 46 07 08 [E3 FB]

A.4 08 (0x08) Setting the Analog Input Type Code

Description
This sub-function code is used to set the Type Code for a specific Analog Input channel of a module.

Request			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x46
02	Sub-function Code	1	0x08
03	Reserved	1	0x00
04	Channel Number	1	0x00 ~ 0x07
05	Type Code	1	The Type Code. See Section 4 for details of the data format.

Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x46
02	Sub-function Code	1	0x08
03	Type Code	1	0: OK Others: Error

Error Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0xC6
02	Exception Code	1	Refer to the Modbus standard for more details

Example	
Command	01 46 20 [13 B8]
Response	01 46 20 01 00 00 [D2 05]

A.5 32 (0x20) Reading the Firmware Version Information

Description
This sub-function code is used to read the firmware version information for a module.

Request			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x46
02	Sub-function Code	1	0x20

Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x46
02	Sub-function Code	1	0x20
03	Major Version	1	0x00 to 0xFF
04	Minor Version	1	0x00 to 0xFF
05	Reserved	1	0x00
06	Build Version	1	0x00 to 0xFF

Error Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0xC6
02	Exception Code	1	Refer to the Modbus standard for more details

Example	
Command	01 46 20 [13 B8]
Response	01 46 20 0A 01 00 00 [D6 B9]

A.6 37 (0x25) Reading whether a Analog Input Channel is Enabled or Disabled

Description
This sub-function code is used to read whether each Analog Input channel of a module is enabled or disabled.

Request			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x46
02	Sub-function Code	1	0x25

Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x46
02	Sub-function Code	1	0x25
03	Enabled/Disabled Status	1	0x00 to 0xFF. The enabled/disabled status of each Analog Input channel, where bit 0 corresponds to Analog Input channel 0, and bit 1 corresponds to Analog Input channel 1, etc. When the bit is 0, it denotes that the Analog Input channel is disabled, and 1 denotes that the Analog Input channel is enabled.

Error Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0xC6
02	Exception Code	1	Refer to the Modbus standard for more details

Example	
Command	01 46 25 [D3 BB]
Response	01 46 25 07 [BB 5F]

A.7 38 (0x26) Enabling or Disabling a Analog Input Channel

Description
This sub-function code is used to specify which Analog Input channels of a module are to be enabled.

Request			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x46
02	Sub-function Code	1	0x26
03	Enabled/Disabled Settings	1	0x00 to 0xFF. The enabled/disabled settings for each Analog Input channel, where bit 0 corresponds to Analog Input channel 0, and bit 1 corresponds to Analog Input channel 1, etc. When the bit is 0, it denotes that the Analog Input channel is disabled, and 1 denotes that the Analog Input channel is enabled.

Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x46
02	Sub-function Code	1	0x26
03	Enabled/Disabled Settings	1	0: OK Others: Error

Error Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0xC6
02	Exception Code	1	Refer to the Modbus standard for more details

Example	
Command	01 46 26 01 [3B AD]
Response	01 46 26 00 [FA 6D]

A.8 41 (0x29) Reading the Miscellaneous Settings

Description
This sub-function code is used to read the miscellaneous settings for a module.

Request			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x46
02	Sub-function Code	1	0x29

Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x46
02	Sub-function Code	1	0x29
03	Miscellaneous Settings	1	The data format. See Section 4 for details of the format.

Error Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0xC6
02	Exception Code	1	Refer to the Modbus standard for more details

Example	
Command	01 46 29 [D3 BE]
Response	01 46 29 02 [7E 5C]

A.9 42(0x2A) Writing the Miscellaneous Settings

Description
This sub-function code is used to configure the miscellaneous settings for a module.

Request			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x46
02	Sub-function Code	1	0x2A
03	Miscellaneous Settings	1	The data format. See Section 4 for details of the format.

Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0x46
02	Sub-function Code	1	0x2A
03	Miscellaneous Settings	1	0: OK Others: Error

Error Response			
Byte	Description	Length	Value
00	Address	1	1 to 247
01	Function Code	1	0xC6
02	Exception Code	1	Refer to the Modbus standard for more details

Example	
Command	01 46 2A 00 [FF 6D]
Response	01 46 2A 00 [FF 6D]

7 Appendix

7.1 Software Configuration Mode

Each ZT-2000 I/O device contains a built-in EEPROM memory that is used to store configuration information, such as the address, the data format, the Analog Input Type Code and other information. When the module is powered on with the Address (Node ID) set to 0x00, the ZT-2000 I/O device will be set to software configuration mode. In this mode, the configuration details (Address (Node ID), data format and Analog Input Type Code) are loaded from the EEPROM. The settings can then be changed using the %AANNTTCCFF and $AA9NTS commands. When the ZT-2000 I/O device is set to software configuration mode, the switch settings are ignored.

7.2 Dual Watchdog Operation

Dual Watchdog = Module Watchdog + Host Watchdog

The Module Watchdog is a hardware reset circuit that monitors the operating status of the module. While working in harsh or noisy environments, the module may be shut down by external signals. The Watchdog circuit allows the module to operate continuously without disruption.

The Host Watchdog is a software function that monitors the operating status of the host. Its purpose is to prevent problems due to network/communication errors or host malfunctions. When a Host Watchdog timeout occurs, the module will reset all outputs to a safe state in order to prevent any erroneous operations of the controlled target.

ZT-2000 series devices include an internal Dual Watchdog, making the control system more reliable and stable.

7.3 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, and is cleared after responding to the first $AA5 command. This can be used to check whether the module has been previously reset. When the response to the $AA5 command indicates that the reset status has been cleared, it means that the module has not been reset since the last $AA5 command was sent. When the response to the $AA5 command indicates that the reset status has been set and it is not the first time the $AA5 command has been sent, it means that the module has been reset and the Digital Output value has been changed to the power-on value.

8 Troubleshooting

A. Technical Support.

If you have any difficulties using your ZT-2000 series I/O device, please send a description of the problem to service@icpdas.com

Include the following items in your email:

- *A description or diagram of the current DIP switch positions.*
- *A copy of the configuration file for the ZT-2000 coordinator. This file can be obtained using the procedure outlined below and should be attached to your email.*

B. Set the DIP switch for the ZT-255x device to the [ZBSET] position then reboot the device. Launch the ZT Configuration Utility and select the [Save Log] icon to save the configuration of the ZT-255x as a file.

C. After clicking the [Save Log] icon, enter the "File Name" and the "File Path" in the Windows "Save" dialog box. Once the configuration has been successfully saved, the following message will be displayed.