eDAM-8018
8-channel Thermocouple
Input Module
User’s manual

Web site: www.inlog.com.tw

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Chapter 1 Introduction

1.1 Overview

The eDAM-*8000* analog 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 analog I/O lines for controlling and monitoring analog signals.

1.2 Communication and Programming

eDAM modules can connect to and communicate with all computers and terminals. They use RS-485 transmission standards, and communicate with ASCII format commands. All communications to and from the module are performed in ASCII, which means that eDAM modules can be programmed in virtually any high-level language.
Up to 256 eDAM modules may be connected to an RS-485 multi-drop network by using the eDAM RS-485 repeater, extending the maximum communication distance to 4,000 ft.

1.3 Software Configuration and Calibration

EDAM modules contain no pots or switches to set. By merely issuing a command from the host computer, you can change an analog input module to accept several ranges of voltage input.
Remote configuration can be done by using the command set's configuration and calibration commands.
By storing configuration and calibration parameters in a nonvolatile EEPROM, modules are able to retain these parameters in case of power failure.

1.4 Watchdog Timer

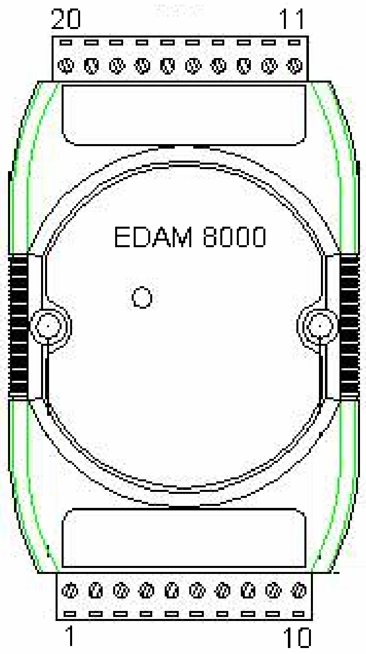
A watchdog timer supervisory function will automatically reset the eDAM modules in the event of system failure. Maintenance is thus simplified.

1.5 Power Requirements

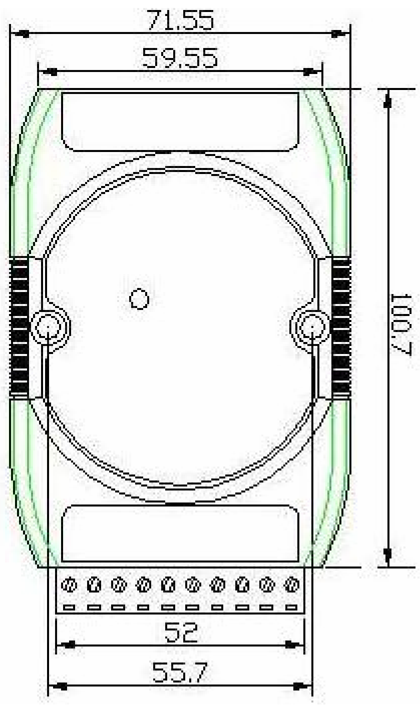
Although the modules are designed for standard industrial unregulated 24V DC power supply , they accept any power unit that supplies power within the range of +10 to +30 V DC . The power supply ripple must be limited to 5 V peak-to-peak, and the immediate ripple voltage should be maintained between +10 and +30 V DC .

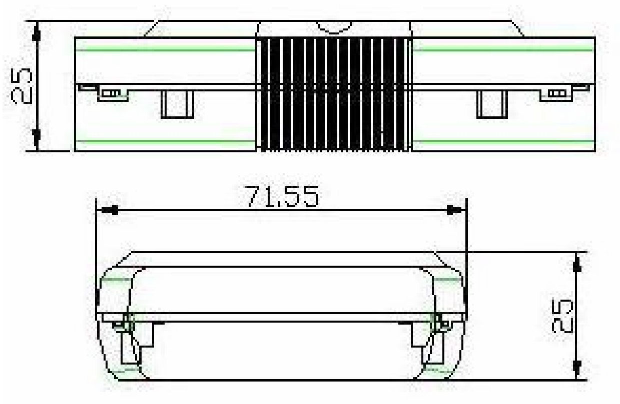
Chapter 2 About the eDAM Analog Modules

2.1 Outline of eDAM Analog modules



2.2 Module Dimension

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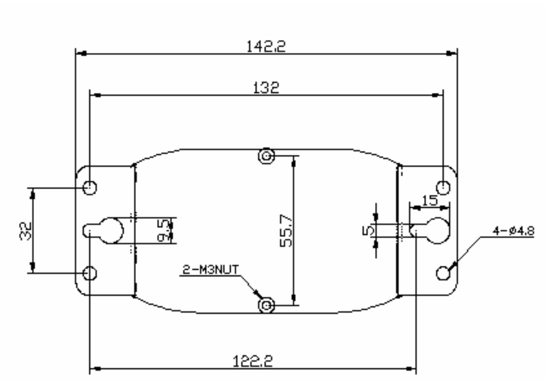
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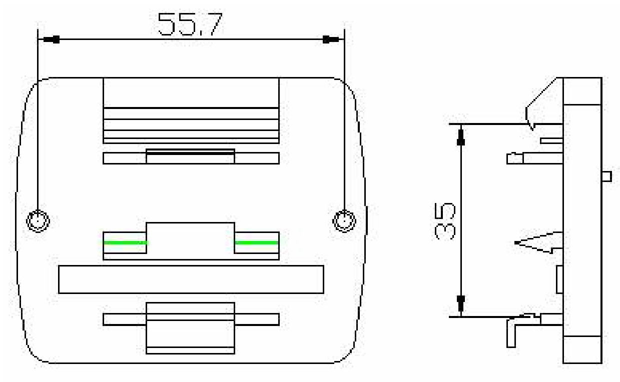
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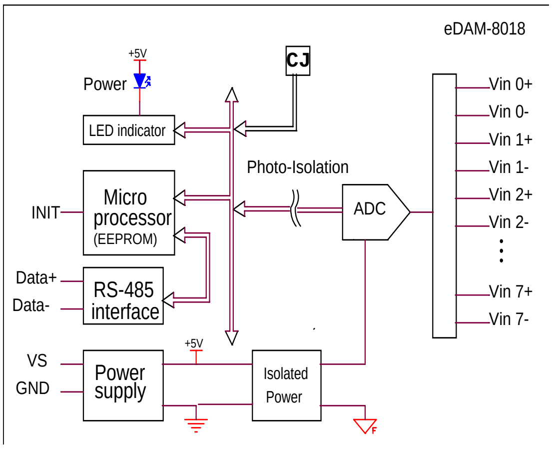
2.3 eDAM-8018 module

eDAM-8018 is a thermocouple input module with 8 input channels. Six of the eight channels are differential type and the other two are single ended type.

Specifications of eDAM-8018+

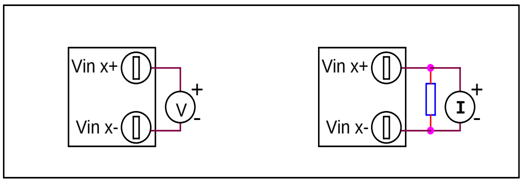
- Interface: RS-485, 2 wires
- Speed (bps): 1200, 2400, 4800, 9600, 19.2K, 38.4K , 115.2K
- Analog Input type: Differential input
- Analog Channels Numbers: 8
- Analog Resolution: 16 bits
- Unit Conversion: Thermocouple, mV, V or mA
- Thermocouple Type: J, K, T, E, R, S, B, N, C
- Sampling Rate :10 Samples/Second
- 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
- Voltage Range: ±2.5V, ±1V,±500mV,±100mV, ±50mV, ±15mV
- Current Measurement: ±20mA (with external 125W resistor)
- Power supply: +10V to +30V

2.4 Block diagram of modules



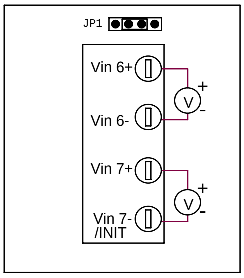
2.5 EDAM-8018 wire connection

Differential analog input for channel 0 to channel 7

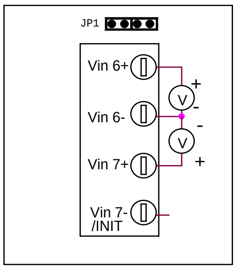


Analog input mode for channel 6 can channel 7 can be selected by setting JP1 on the board

Differential input channel 6 and 7



Single-ended input channel 6 and 7



2.6 EDAM8018 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 channel 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 depended on JP1 setting (see page 8)

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

2.7 Installation

This chapter provides guidelines to what is needed to set up and install an eDAM network. A quick hookup scheme is provided that lets you configure modules before they are installed in a network.
To help you to connect eDAM modules with sensor inputs, several wiring examples are provided. Finally, you will find at the end of this chapter a programming example using the eDAM command set.
Be sure to carefully plan the layout and configuration of your network before you start. Guidelines regarding layout are given in Appendix E: RS-485 Network.
NOTICE: Except for changing eDAM to other compatible modules, which have on-board switches for their baud rate setting, eDAM modules should not be opened. There is no need to open the eDAM modules: all configuration is done remotely and there are no user serviceable parts are inside. Opening the cover will therefore void the warranty.

2.8 Set up an eDAM network

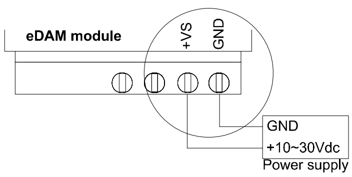
The following list gives an overview of what is needed to setup, install and configure an eDAM environment.
A host computer that can output ASCII characters with an RS-232C or RS-485 port.
Power supply for the eDAM modules (+10 to +30 V DC)
eDAM Series Utility software

2.9 Host computer

Any computer or terminal that can output in ASCII format over either RS-232 or RS-485 can be connected as the host computer. When only RS-232 is available, an eDAM-8520 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 eDAM modules are designed to accept industry standard +24 VDC unregulated power. Operation is guaranteed when using any power supply between +10 and +30 VDC. 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.

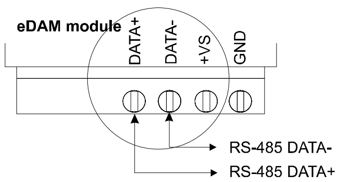
2.10 Power supply

All modules use on-board switching regulators to sustain good efficiency over the 10-30V 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.



2.11 Communication Wiring

We recommend that shielded-twisted-pair cables that comply with the EIA RS-485 standard be used with the eDAM network to reduce interference.



2.12 eDAM Utility Software

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

2.13 eDAM Isolated RS-232/RS485 Converter

When the host computer or terminal has only a RS-232 port, an eDAM-8520 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

2.14 Initializing Module

All eDAM modules in a RS-485 network must have an *unique* address ID. Therefore, to configure the brand-new 8012/D, 8014/D, 8017 before using is necessary

- **Factory default settings:**

  Address ID is 01
  Baud rate is 9600 bps, check-sum disable
  Analog input type: Type 0F (T/C K type)
  60Hz filter rejection mode
  Normal operation mode
  Eight differential input modes

- **INIT* State settings:**

  The eDAM I/O modules must be set at *INIT* State* when you want to change the default settings, such as the *ID address, baud rate, check-sum status* etc. All eDAM I/O modules have an special pin labeled as INIT***. The module will be in *Default State* if the** INIT* **pin is shorted to ground when power ON. Under this state, the default configuration is set as following:**
  Address ID is 00
  Baud rate is 9600 bps
  Check-sum disable
  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.

2.15 Initialization Procedure

1. Power off the host computer and the installed eDAM-xxxx to COM port of host computer.
2. Connect a brand new eDAM module with the RS-485. Set the module in *Default State* by shorting the **INIT*** pin to GND. Refer to Figure 4.1 for detailed wiring.
3. Power on the power supply for eDAM modules.
4. Use the eDAM utility to configure the address ID, baud rate, check-sum status and command sets of the module.

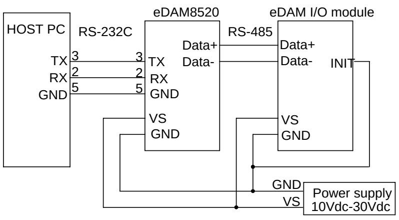


Figure 4.1

2.16 Install a New eDAM to a Existing Network

1. Equipments for Install a New Module
2. A existing eDAM network
3. New eDAM modules.
4. Power supply (+10 to +30 VDC)
5. Installing Procedures
6. Configure the new eDAM module according to the initialization procedure in section 2.14
7. 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 eDAM modules on the network.
8. Power off the eDAM power supply of the existing RS-485 network.
9. Wire the power lines for the new eDAM with the existing network. Be careful about the signal polarity as wiring.
10. Wire the RS-485 data lines for the new eDAM with the existing network. Be careful about the signal polarity as wiring.
11. Wire to the input or output devices.
12. Power on the eDAM local power supply.
13. Use the eDAM utility to check entire network.

Chapter 3 ASCII Command Set

3.1 Introduction

The eDAM command is composed by numbers of 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 only one eDAM module except those synchronized commands with wildcard address command "#**".
The eDAM may or may not give response to the command. The host should check the response to handshake with the modules.

3.2 Format of eDAM 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 ,a wave sign '~' ,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 command is terminated by a carriage return (cr).

Conventions

Leading Code	The first characteristic of the eDAM 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 ASCII uppercase characters. There is no spacing between characters.	

3.3 Calculate Checksum:

Calculate ASCII sum of all characters of command (or response) string except the character return(cr)

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)

3.4 Response of Commands

The response message depends on eDAM 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 is not exist.
- Syntax error.
- Communication error
- Some special commands do not have response.

3.5 Summary of Command Set

There are four categories of eDAM commands. The first is the ***eDAM special command***s. The second is the ***general command*****s**

3.6 Host Watchdog Command Sets

Command	Response	Description	Page
~**	no response	Host OK	28
~AA0	!AASS	Read Module Status	28
~AA1	!AA	Reset Module Status	29
~AA2	!AAVV	Read Host watchdog Timeout Value	29
~AA3EVV	!AA	Set Host Watchdog Timeout Value	30

3.7 General Command Sets

Command	Response	Description	Page
%AANNTTCCFF	!AA	Set Module Configuration	16
#AA	>(Data)	Read Analog Input	18
#AAN	>(Data)	Read Analog Input from channel N	19
$AA0	!AA	Perform Span Calibration	19
$AA1	!AA	Perform Zero Calibration	20
$AA2	!AATTCCFF	Read Configuration	20
$AA3	> (Data)	Read CJC Temperature	21
$AA5VV	!AA	Set Channel Enable	21
$AA6	!AAVV	Read Channel Status	22
$AA9SNNNN	!AA	Set CJC Offset Value	22
$AAF	!AA(Data)	Read Firmware Version	25
$AAB	!AA(Data)	Read burnout status	
$AAM	!AA(Data)	Read Module Name	26
~AAC	!AAN	Read the CJC status	27
~AACN	!AA	Enable/disable CJC	27
~AAEV	!AA	Enable/Disable Calibration	31
~AAO(Data)	!AA	Set Module Name	31
~AAM	~AA	Read MODBUS data format	24
~AAMD	~AAM(Data)	Set MODBUS data format	24
~AABO	!AA(Data)	Read Burnout detection enable/disable status	23
~AABON	!AA	Set Burnout detection enable/disable	23

3.8 Set Module configuration

Modules:	**8017,8018**	
Description:	**Set module configuration**	
Command:	**%AANNTTCCFF[CHK](cr)**	
Syntax:	**%**	**Command leading code**
	AA	**Module address ID (00 to FF)**
	NN	**New eDAM address ID (00 to FF)**
	TT	**Analog input range (See *)**
	CC	**Set new baud rate of module (See **)**
	FF	**Data format (See ***)**
	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**

***: Data format settings (FF)

Bit	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**

Bit7: =0 for 60 Hz (default)
=1 for 50 Hz

Bit6: =1 Enable checksum
=0 Disable checksum (default setting)

Bit5: =0 for normal operation mode (Default setting)
=1 for fast operation mode (8017 only)

Bit4~bit2: No used

Bit1~bit0: =00 Engineer unit format (default setting)
=01 Percent format
=11 2's complement Hex format

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

Command: %0103080600(cr)
Response: !03(cr)
Response new module ID address 03 (change ID address only)

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

Command: %0003080700(cr)
Response:!03(cr)
Response module ID address 03

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

Command: %0003080640(cr)
Response: !03(cr)
Response module ID address 03

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

Command: %0003080740(cr)
Response:!03(cr)
Response module ID address 03
It is recommended to use the setup utility to configure the module (see section 2.14 and 2.15)

*Analog Input type and range (TT)

Code	Range	Format	+F.S.	zero	-F.S
00	-15~+15mV	Engineer unit	+15.000	+00.000	-15.000
		% of F.S.R	+100.00	+000.00	-100.00
		2's complement	7FFF	0000	8000
01	-50~+50mV	Engineer unit	+50.000	+00.000	-50.000
		% of F.S.R	+100.00	+000.00	-100.00
		2's complement	7FFF	0000	8000
02	-100~+100mV	Engineer unit	+100.00	+000.00	-100.00
		% of F.S.R	+100.00	+000.00	-100.00
		2's complement	7FFF	0000	8000
03	-500~+500mV	Engineer unit	+500.00	+000.00	-500.00
		% of F.S.R	+100.00	+000.00	-100.00
		2's complement	7FFF	0000	8000
04	-1~+1V	Engineer unit	+1.0000	+0.0000	-1.0000
		% of F.S.R	+100.00	+000.00	-100.00
		2's complement	7FFF	0000	8000
05	-2.5~+2.5V	Engineer unit	+2.5000	+0.0000	-2.5000
		% of F.S.R	+100.00	+000.00	-100.00
		2's complement	7FFF	0000	8000
06	-20~+20mA	Engineer unit	+20.000	+00.000	-20.000
		% of F.S.R	+100.00	+000.00	-100.00
		2's complement	7FFF	0000	8000
OE	Type J T/C -210~760˚C	Engineer unit	+760.00	+00.000	-210.00
		% of F.S.R	+100.00	+000.00	-027.63
		2's complement	7FFF	0000	DCA2
0F	Type K T/C -270~1372˚C	Engineer unit	+1372.0	+00.000	-0270.0
		% of F.S.R	+100.00	+000.00	-019.68
		2's complement	7FFF	0000	E6D0
10	Type T T/C -270~400˚C	Engineer unit	+400.00	+00.000	-270.00
		%of F.S.R	+100.00	+000.00	-067.50
		2's complement	7FFF	0000	DCA2
11	Type E T/C -270~1000˚C	Engineer unit	+1000.0	+0000.0	-0270.0
		% of F.S.R	+100.00	+000.00	-027.00
		2's complement	7FFF	0000	DD71
12	Type R T/C 0~1768˚C	Engineer unit	+1768.0	+00.000	-0000.0
		% of F.S.R	+100.00	+000.00	-100.00
		2's complement	7FFF	0000	0000
13	Type S T/C 0~1768˚C	Engineer unit	+1768.0	+00.000	-0000.0
		% of F.S.R	+100.00	+000.00	-100.00
		2's complement	7FFF	0000	0000
14	Type B T/C 0~1820˚C	Engineer unit	+1820.0	+00.000	-0000.0
		% of F.S.R	+100.00	+000.00	-100.00
		2's complement	7FFF	0000	0000
15	Type N T/C -270~1300˚C	Engineer unit	+1300.0	+0000.0	-0270.0
		% of F.S.R	+100.00	+000.00	-020.77
		2's complement	7FFF	0000	E56B
16	Type C T/C -270~2320˚C	Engineer unit	+2320.0	+0000.0	-0000.0
		% of F.S.R	+100.00	+000.00	-100.00
		2's complement	7FFF	0000	F54D

** Baud Rate settings (CC)

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

3.9 Read analog data

Modules:	**For,8017,8018**	
Description:	**Read the ANALOG input value**	
Command:	**#AA[CHK](cr)**	
Syntax:	**#**	**Command leading code**
	AA	**Module address ID (00 to FF)**
	CHK	**Check sum**
	(cr)	**Carriage return**
Response: (see Note)	**>(data)[CHK](cr)**	**Valid command**
	?AA[CHK](cr)	**Invalid command**
	>	**Delimiter for valid command**
	?	**Delimiter for invalid command**
	(data)	**Analog input data(see *)**
	CHK	**Check sum**
	(cr)	**Carriage return**

*: **If analog data of eDAM-8018 module be read by using this command, data of all channels are responded as follows:**
>(chan.0 data) (chan.1 data) …… (chan.7 data) [CHK](cr)

Example: Read analog input data from eDAM8018 at addr.=05

Command: #05(cr)
Response: +02.645-01.001+03.023+00.321+08.123-03.333+09.210-06.000(cr)

3.10 Read data from channel N

Modules:	For 8017,8018	
Description:	Read the analog input value of a specified AD channel from an analog input module	
Command:	#AAN[CHK](cr)	
Syntax:	#	Command leading code
	AA	Module address ID (00 to FF)
	N	Command for reading analog input value
	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
	(data)	Analog input data
	CHK	Check sum
	(cr)	Carriage return

Example: Read the analog input channel 1 of AD module at address 06 in the network. (Data format is engineering unit)

User command: #061<CR>

Response: >+1.6888<CR>

3.11 Perform Span calibration

Modules:	For 88017,8018	
Description:	To correct the gain errors of AD converter by using the span calibration.	
Command:	$AA0[CHK](cr)	
Syntax:	$	Command leading code
	AA	Module address ID (00 to FF)
	0	Command for span calibration
	CHK	Check sum
	(cr)	Carriage return
Response: (see Note)	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID (00 to FF)
	CHK	Check sum
	(cr)	Carriage return

Note: **To perform the calibration, a proper input signal should be connected to the analog input module. Different input range have different input voltage, detail refer** “**Calibration chapter”.**

Example: Perform span calibration of module with address=06

Command: $060<CR>

Response:!06<CR>

3.12 Perform Offset calibration

Modules:	**For 8017,8018**	
Description:	**To correct the offset errors of AD converter by using the offset calibration**	
Command:	**$AA1[CHK](cr)**	
Syntax:	**$**	**Command leading code**
	AA	**Module address ID (00 to FF)**
	1	**Command for offset calibration**
	CHK	**Check sum**
	(cr)	**Carriage return**
Response: (see Note)	**!AA[CHK](cr)**	**Valid command**
	?AA[CHK](cr)	**Invalid command**
	!	**Delimiter for valid command**
	?	**Delimiter for invalid command**
	AA	**Module address ID (00 to FF)**
	CHK	**Check sum**
	(cr)	**Carriage return**

Note: To perform the calibration, a proper input signal should be connected to the analog input module. Different input range have different input voltage, detail refer "Calibration chapter".

Example: Perform offset calibration of module with address=06

Command: $061<CR>
Response: !06<CR>

3.13 Read Configuration

Modules:	**For eDAM modules**	
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	**Analog input type and range (see sec.3.8)**
	CC	**Baud rate (see sec.3.8)**
	FF	**Data format of module (see sec.3.8)**
	CHK	**Check sum**
	(cr)	**Carriage return**

Example: Read configuration of module with ID address=05

Command: $052(cr)
Response: !05080600(cr)
Read address ID=05 module configuration
08=Analog input range ±10 V
06=9600 baud rate
00=no checksum,

3.14 Read CJC temperature

Modules:	For 8018 only	
Description:	Read CJC temperature.	
Command:	$AA3[CHK](cr)	
Syntax:	$	Command leading code
	AA	Module address ID (00 to FF)
	3	Command for reading CJC temp.
	CHK	Check sum
	(cr)	Carriage return
Response: (see Note)	>AA(data) [CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	>	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID
	data	CJC temperature in degree Celsius, including a sign byte, ’+’ or ‘-‘, and followed by 5 decimal digital with fixed decimal point in tenths of a degree
	CHK	Check sum
	(cr)	Carriage return

Example: Read CJC temperature at address ID=03

Command: $013<cr>
Response: >+0028.5<cr> CJC temperature is +28.5℃

3.15 Enable/disable channel for multiplexing

Modules:	For 8017,8018	
Description:	Enable/Disable multiplexing simultaneously for individual channel.	
Command:	$AA5VV[CHK](cr)	
Syntax:	$	Command leading code
	AA	Module address ID (00 to FF)
	5	Command for reading digital I/O status
	VV	bit 3~0 of 1st character control channel 7-4 bit 3~0 of 2nd character control channel 3-0 bit value 0: Disable channel bit value 1: Enable channel
	CHK	Check sum
	(cr)	Carriage return
Response: (see Note)	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID (00 to FF)
	CHK	Check sum
	(cr)	Carriage return

Example: Enable channel 3 and channel 6, the other channels are all disable of eDAM-8018.

Command: $06548<cr>
‘48’ is 01001000 that means enable channel 3 and channel 6, the other channels are all disabled.
Response: !06<cr>

3.16 Read channel status

Modules:	For eDAM 8017/8018	
Description:	Read the enable/disable status the channels of eDAM-8017	
Command:	$AA6[CHK](cr)	
Syntax:	$	Command leading code
	AA	Module address ID (00 to FF)
	6	Command for reading channel status
	CHK	Check sum
	(cr)	Carriage return
Response: (see Note)	!AAVV[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID (00 to FF)
	VV	Channel status (See sec 3.15)
	CHK	Check sum
	(cr)	Carriage return

Example: Read channel status of eDAM-8017 with address=06.

Command: $066<CR>

Response: !0648<CR>

4 is equals binary 0100 that means enable channel 6 and disable channel 7, 5, 4.

8 is equals binary 1000 that means enable channel 3 and disable channel 2, 1, 0.

3.17 Set CJC offset value

Modules:	For eDAM 8018 only	
Description:	Set Cold junction offset of eDAM-8018	
Command:	$AA9SNNNN[CHK](cr)	
Syntax:	$	Command leading code
	AA	Module address ID (00 to FF)
	9	Command for setting CJC offset value
	SNNNN	CJC offset value including a sign and 4 hexadecimal digits from –1000 to +1000, each count is 0.01℃
	CHK	Check sum
	(cr)	Carriage return
Response: (see Note)	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID (00 to FF)
	CHK	Check sum
	(cr)	Carriage return

Example: Set Address 01 CJC offset to increase 16 counts(+0.16℃).

Command: $019+0010<CR>

Response: !01<CR>

3.18 Read Burn out detection

Modules:	For eDAM 8018 only	
Description:	Set burn out detection of eDAM-8018	
Command:	~AABO[CHK](cr)	
Syntax:	~	Command leading code
	AA	Module address ID (00 to FF)
	BO	Command for setting burnout detection
	CHK	Check sum
	(cr)	Carriage return
Response: (see Note)	!AAN[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID (00 to FF)
	N	N=1 burn out detection enabled N=0 burn out detection disabled
	CHK	Check sum
	(cr)	Carriage return

Example: Read Address 01 burnout detection status

Command: ~01BO<CR>

Response:!011<CR> **Burnout function is enabled**

3.19 Set Burn out detection

Modules:	For eDAM 8018 only	
Description:	Set burn out detection of eDAM-8018	
Command:	~AABON[CHK](cr)	
Syntax:	~	Command leading code
	AA	Module address ID (00 to FF)
	BO	Command for setting burnout detection
	N	N=0 Disable burn out detection N=1 Enable burn out detection
	CHK	Check sum
	(cr)	Carriage return
Response: (see Note)	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID (00 to FF)
	CHK	Check sum
	(cr)	Carriage return

Example: Enable Address 01 burnout detection

Command: ~01BO1<CR>

Response: !01<CR>

3.20 Read MODBUS data format

Modules:	For eDAM 8018 only~AAM	
Description:	Read MODBUS data format	
Command:	~AAM[CHK](cr)	
Syntax:	~	Command leading code
	AA	Module address ID (00 to FF)
	M	Command for reading MODBUS data format
	CHK	Check sum
	(cr)	Carriage return
Response: (see Note)	!AAN[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID (00 to FF)
	N	N=0 engineering data format N=1 2's complement data format
	CHK	Check sum
	(cr)	Carriage return

Example: Read Address 01 MODBUS data format

Command: ~01M<CR>

Response: !011<CR> **MODBUS data is engineering data format**

3.21 Set MODBUS data format

Modules:	For eDAM 8018 only	
Description:	Set MODBUS data format of eDAM-8018	
Command:	~AAMN[CHK](cr)	
Syntax:	~	Command leading code
	AA	Module address ID (00 to FF)
	M	Command for setting MODBUS data format
	N	N=0 engineering data format N=1 2's complement data format
	CHK	Check sum
	(cr)	Carriage return
Response: (see Note)	!AA[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID (00 to FF)
	CHK	Check sum
	(cr)	Carriage return

Example: Set Address 01 MODBUS data to engineering data format

Command: ~01M0<CR>

Response: !01<CR>

3.22 Read firmware version

Modules:	**For all eDAM modules**	
Description:	**Read module's firmware version.**	
Command:	**$AAF[CHK](cr)**	
Syntax:	**$**	**Command leading code**
	AA	**Module address ID (00 to FF)**
	F	**Command for reading firmware version.**
	CHK	**Check sum**
	(cr)	**Carriage return**
Response: (see Note)	**!AA(data)[CHK](cr)**	**Valid command**
	?AA[CHK](cr)	**Invalid command**
	!	**Delimiter for valid command**
	?	**Delimiter for invalid command**
	AA	**Module address ID**
	data	**Module's firmware version.**
	CHK	**Check sum**
	(cr)	**Carriage return**

Example: Read firmware version of module address ID=30

Command: $30F<CR>
Response: !30A1.04<CR>
! Command is valid, Address ID=30, Firmware Version=A1.04

3.23 Read Burnout status

Modules:	**For eDAM -8018 modules**	
Description:	**Read channel burnout status.**	
Command:	**$AAB[CHK](cr)**	
Syntax:	**$**	**Command leading code**
	AA	**Module address ID (00 to FF)**
	B	**Command for reading burnout status.**
	CHK	**Check sum**
	(cr)	**Carriage return**
Response: (see Note)	**!AA(data)[CHK](cr)**	**Valid command**
	?AA[CHK](cr)	**Invalid command**
	!	**Delimiter for valid command**
	?	**Delimiter for invalid command**
	AA	**Module address ID**
	data	**Channel burnout status**
	CHK	**Check sum**
	(cr)	**Carriage return**

Example: Read burnout status of module address ID=30

Command: $30B<CR>
Response: !3003<CR>
! Command is valid, Address ID=30, Channel 0 and channel 1 are open wired

3.24 Reset module

Modules:	**All eDAM modules**	
Description:	**Reset all existing eDAM modules**	
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 default settings. This command has no response from module**

Example: Reset module with ID address is 02

Command: $02RS(cr)

Response: No response

3.25 Read module name

Modules:	**For all eDAM modules**	
Description:	**Read module's name**	
Command:	**$AAM[CHK](cr)**	
Syntax:	**$**	**Command leading code**
	AA	**Module address ID (00 to FF)**
	M	**Command for reading module's name**
	CHK	**Check sum**
	(cr)	**Carriage return**
Response: (see Note)	**!AA(data)[CHK](cr)**	**Valid command**
	?AA[CHK](cr)	**Invalid command**
	!	**Delimiter for valid command**
	?	**Delimiter for invalid command**
	AA	**Module address ID**
	data	**Module's name**
	CHK	**Check sum**
	(cr)	**Carriage return**

Example: Read module's name of address ID=30

Command: $30M<CR>

Response: !308014<CR>

! Command is valid, Address ID=30, module's name=8014

3.26 Read CJC status

Modules:	For eDAM 8018 only	
Description:	Read Cold junction status of eDAM-8018	
Command:	~AAC[CHK](cr)	
Syntax:	~	Command leading code
	AA	Module address ID (00 to FF)
	C	Command for reading CJC status
	CHK	Check sum
	(cr)	Carriage return
Response:	!AAN[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID (00 to FF)
	N	0: CJC disabled 1: CJC enabled
	CHK	Check sum
	(cr)	Carriage return

Example: Read Address 01 CJC status and response CJC enabled

Command: ~01C<CR>
Response: !011<CR>

3.27 Enable/disable CJC

Modules:	For eDAM 8018 only	
Description:	Enable/disbale Cold junction of eDAM-8018	
Command:	~AACN[CHK](cr)	
Syntax:	~	Command leading code
	AA	Module address ID (00 to FF)
	C	Command for reading CJC status
	N	0: disable CJC 1: enable CJC
	CHK	Check sum
	(cr)	Carriage return
Response:	!AAN[CHK](cr)	Valid command
	?AA[CHK](cr)	Invalid command
	!	Delimiter for valid command
	?	Delimiter for invalid command
	AA	Module address ID (00 to FF)
	CHK	Check sum
	(cr)	Carriage return

Example: Enable Address 01 CJC

Command: ~01C1<CR>
Response: !01<CR>

3.28 Host OK

Modules:	**For all eDAM modules**	
Description:	**Host send 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 host watchdog timer is enable, host computer must send this command to all module before timeout otherwise "Host watchdog timer enabled" **module's output value will go to safety state output value.**

3.29 Read module status

Modules:	**For all eDAM modules**	
Description:	**Read 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	**SS=00 - watchdog timeout is cleared** **SS=04 - watchdog timeout is set**
	CHK	**Check sum**
	(cr)	**Carriage return**

Note:

the watchdog timeout status will be stored in EEPROM of the module and can only be cleared by issuing ~AA1 command (see ~AA1 and ~AA3EVV commands)

When the module's watchdog timeout value is reached, this command will be responded with SS=04 otherwise SS=00

Example:

Command: ~010<cr>
Response: !0104
The host watchdog timeout status is set

3.30 Reset module status

Modules:	For all eDAM modules	
Description:	Reset 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

Note:
The module's watch dog status will be cleared after this command issued
(Reference to ~AA3EVV command)

3.31 Read host watchdog timeout value

Modules:	For all eDAM modules	
Description:	Read 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 enable/disable status E=1 – Enabled E=0 – Disabled
	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

(also see sec 3.32)

3.32 Set host watchdog timeout value

Modules:	For all eDAM modules	
Description:	Set host watchdog timeout value	
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 section 3.28) command periodically within Timeout value to refresh the timer, otherwise the module will be forced to safety state

Example: Set module (ID=04) to have watchdog timeout value 10.0 seconds and enable host watchdog

Command: ~043164<cr> **Set watchdog timeout value 10.0 sec and enable host watchdog**
Response: !04<cr> **Valid command**

Example: Read watchdog timeout value form module (ID=04)

Command: ~042<cr> **Read watchdog timeout value**
Response: !04164 **Watchdog timeout value=10.0 seconds, and host watchdog is enabled**

Example: Reset watchdog timer

Command: ~<cr>** **Read host watchdog timer**

Stop sending any command string to modules for at least 10.0 seconds. The LED on the module will go to flash. The flash LED indicates the host watchdog is timeout and timeout status is set

Example: Read watchdog timeout status

Command: ~040<cr> **Read module (ID=04) watchdog timeout status**
Response: !0404<cr> **Timeout status is set**

Example: Read watchdog timeout value form module (ID=04)

Command: ~042<cr> **Read watchdog timeout value**
Response: !04164 **Watchdog timeout value=10.0 seconds, and host watchdog is** enabled

Example: Reset watchdog timeout status

Command: ~041<cr> **Reset watchdog timeout status**
Response: !04<cr> **Watchdog timeout is cleared and LED stop flashing, and host watchdog is disabled**

Example: Read watchdog timeout status

Command: ~040<cr> Read module (ID=04) watchdog timeout status
Response: !0400<cr> Timeout status is cleared

3.33 Enable/disable calibration

Modules:	**For 8017,8018 modules**	
Description:	**Enable or disable Span calibration.**	
Command:	**~AAEV[CHK](cr)**	
Syntax:	**!**	**Command leading code**
	AA	**Module address ID (00 to FF)**
	E	**Enable/disable calibration command**
	V	**0=Disable span calibration** **1=Enable span calibration**
	CHK	**Check sum**
	(cr)	**Carriage return**
Response: **(see Note)**	**!AA[CHK](cr)**	**Valid command**
	?AA[CHK](cr)	**Invalid command**
	!	**Delimiter for valid command**
	?	**Delimiter for invalid command**
	AA	**Module address ID (00 to FF)**
	CHK	**Check sum**
	(cr)	**Carriage return**

Note: **send enable calibration command before performing the calibration,**

Example: Perform span calibration of module with address=06

Command: $06E1<CR> **Enable calibration**
Response: !06<CR>
Command: $060<CR> **Perform span calibration**
Response: !06<CR>

3.34 Set module name

Modules:	**For all eDAM modules**	
Description:	**Set new module name.**	
Command:	**~AAO(data)[CHK](cr)**	
Syntax:	**$**	**Command leading code**
	AA	**Module address ID (00 to FF)**
	O	**Command for setting new name**
	(data)	**Module name, Max. 6 characters**
	CHK	**Check sum**
	(cr)	**Carriage return**
Response: **(see Note)**	**!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 new module name at address ID=30

Command: ~30O4012<CR> **Set new name 4012 to the module at address ID=30**
Response: !30<CR> **Command is valid.,**

Chapter 4 MODBUS RTU Command structure

EDAM-8018+ system accept a command/response form with the host computer. When systems are not transmitting they are in listen mode. The host issues a command to a system with a specified address and waits a certain amount of time for the system to respond. If no response arrives, a time-out aborts the sequence and returns control to the host. This chapter explains the structure of the commands with Modbus RTU protocol, and guides to use these command sets to implement user's programs.

4.1 ModBus Function code introductions

Code (Hex)	Name	Usage
02	Read Input Status	Read Discrete Input Bit
03	Read Holding Registers	Read 16-bit register. Used to read integer or floating point process data.
04	Read Input Registers	
06	Preset Single Register	Write data in 16-bit integer format
10	Preset Multiple Registers	Write multiple data in 16-bit integer format

4.2 MODBUS Discrete address mapping

ADDR 0+/1+	Channel	Item	Attribute	Memo
X+0201	0	Burn-out Signal	R	1:Burn-out
X+0202	1	Burn-out Signal	R	
X+0203	2	Burn-out Signal	R	
X+0204	3	Burn-out Signal	R	
X+0205	4	Burn-out Signal	R	
X+0206	5	Burn-out Signal	R	
X+0207	6	Burn-out Signal	R	
X+0208	7	Burn-out Signal	R	
X+0269		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

3. See sec.4.4 And sec.4.5

4.3 MODBUS Register address mapping

ADDR 4+/3+	Channel	Item	Attribute	Memo
X+0001	0	Analog input Value	R	
X+0002	1	Analog input Value	R	
X+0003	2	Analog input Value	R	
X+0004	3	Analog input Value	R	
X+0005	4	Analog input Value	R	
X+0006	5	Analog input Value	R	
X+0007	6	Analog input Value	R	
X+0008	7	Analog input Value	R	
X+0101	0~7	Read burnout status	R	
X+0129	CJC	CJC temperature		In 0.01C
X+0201	0	Type Code	R/W	See page 37
X+0202	1	Type Code	R/W	
X+0203	2	Type Code	R/W	
X+0204	3	Type Code	R/W	
X+0205	4	Type Code	R/W	
X+0206	5	Type Code	R/W	
X+0207	6	Type Code	R/W	
X+0208	7	Type Code	R/W	
X+0211		Module Name 1	R	0x80 0x18
X+0212		Module Name 2	R	0x80 0x00
X+0213		Version 1	R	0xB2 0x00
X+0214		Version 2	R	0x00 0x00
X+0221		Channel Enable	R/W	0x00 0xff
X+0269		Set MODBUS data format	R/W	0x0001=hex 2's format 0x0000=engineering format (**)

(**):

1. MODBUS data format of analog input value is 2's complement format or engineering format

2. Factory default: engineering format

3. See sec.4.4 And sec.4.5

4.4 MODBUS Engineering Data Format Table

Type Code	Input Type	Min.	Max.	Formula
00	-15 mV ~ +15 mV	-15000	15000	Volt=(MODBUS data) /1000 (mV)
01	-50 mV ~ + 50 mV	-5000	5000	Volt=(MODBUS data) /1000 (mV)
02	-100 mV ~ +100 mV	-10000	10000	Volt=(MODBUS data) /100 (mV)
03	-500 mV ~ +500 mV	-5000	5000	Volt=(MODBUS data) /10 (mV)
04	-1 V ~ +1 V	-10000	10000	Volt=(MODBUS data) /10000 (V)
05	-2.5 V ~ +2.5 V	-25000	25000	Volt=(MODBUS data) /10000 (V)
06	-20 mA ~ +20 mA	-20000	20000	Volt=(MODBUS data) /1000 (mA)
0E	Type J Thermocouple -210°C to 760°C	-2100	7600	Temp.=(MODBUS data) /10 (°C)
0F	Type K Thermocouple -270°C to 1372°C	-2700	13720	
10	Type T Thermocouple -270°C to 400°C	-2700	4000	
11	Type E Thermocouple -270°C to 1000°C	-2700	10000	
12	Type R Thermocouple 0°C to 1768°C	0	17680	
13	Type S Thermocouple 0°C to 1768°C	0	17680	
14	Type B Thermocouple 00°C to 1820°C	0	18200	
15	Type N Thermocouple -270°C to 1300°C	-270	13000	
16	Type C Thermocouple -270°C to 2320°C	-270	2320	

4.5 MODBUS Hex 2's Data Format Table

Type Code	Input Type	Min.	Max.	Formula
00	± 15 mV	8000	7FFF	Volt=(MODBUS data *15)/0x7FFF (mV)
01	± 50 mV	8000	7FFF	Volt=(MODBUS data *50)/0x7FFF (mV)
02	± 100 mV	8000	7FFF	Volt=(MODBUS data *100)/0x7FFF (mV)
03	± 500 mV	8000	7FFF	Volt=(MODBUS data *500)/0x7FFF (mV)
04	± 1 V	8000	7FFF	Volt=(MODBUS data *1)/0x7FFF (V)
05	± 2.5 V	8000	7FFF	Volt=(MODBUS data *2.5)/0x7FFF (V)
06	± 20 mA	8000	7FFF	Volt=(MODBUS data *20)/0x7FFF (mA)
0E	Type J Thermocouple -210°C to 760°C	DCA2	7FFF	Temp.=(MODBUS data*760) /0x7FFF (°C)
0F	Type K Thermocouple -270°C to 1372°C	E6D0	7FFF	Temp.=(MODBUS data*1372) /0x7FFF (°C)
10	Type T Thermocouple -270°C to 400°C	A99A	7FFF	Temp.=(MODBUS data*400) /0x7FFF (°C)
11	Type E Thermocouple -270°C to 1000°C	DD71	7FFF	Temp.=(MODBUS data*1000) /0x7FFF (°C)
12	Type R Thermocouple 0°C to 1768°C	0000	7FFF	Temp.=(MODBUS data*1768) /0x7FFF (°C)
13	Type S Thermocouple 0°C to 1768°C	0000	7FFF	Temp.=(MODBUS data*1768) /0x7FFF (°C)
14	Type B Thermocouple 0°C to 1820°C	0000	7FFF	Temp.=(MODBUS data*1820) /0x7FFF (°C)
15	Type N Thermocouple -270°C to 1300°C	E56B	7FFF	Temp.=(MODBUS data*1300) /0x7FFF (°C)
16	Type C Thermocouple -270°C to 2320°C	F54D	7FFF	Temp.=(MODBUS data*2320) /0x7FFF (°C)

Chapter 5 Calibration for eDAM8018

The offset calibration is used to calibrate output offset when the input voltage is 0V

- Calibration procedures

1. **Apply zero voltage to channel 0 of analog module**
2. **Issues configuration command with type=00~06**
3. **Issues enable calibration command**
4. **Issues zero offset calibration command five times**

Code	Type and range
0	**+/-15mV**
1	**+/-50mV**
2	**+/-100mV**
3	**+/-500mV**
4	**+/-1V**
5	**+/-2.5V**
6	**+/-20mA**

Chapter 6 Analog Input Types

Code	Type and range
0	+/-15mV
1	+/-50mV
2	+/-100mV
3	+/-500mV
4	+/-1V
5	+/-2.5V
6	+/-20mA
0x0E	T/C J type
0x0F	**T/C K type**
0x10	**T/C T type**
0x11	**T/C E type**
0x12	**T/C R type**
0x13	**T/C S type**
0x14	**T/C B type**
0x15	**T/C N type**
0x16	**T/C C type**