Multi-Range High Precision Thermocouple Signal Data Acquisition Module

J/K/T/E/R/S/B Types Thermocouple Signal Data Acquisition Isolated Transmitter
SY AD08T Series

Features：

- 8 Channels thermocouple signal data acquisition, isolates and converts into RS485/RS232 output.
- Measurement accuracy is better than 0.5%. programmable calibration of module precision is available.
- One-channel DS18B20 Temperature sensor inside is used to compensate the thermocouple cold junction.
- Low cost, small size module, easy to use in installation
- J/ K/ T/ E/ R/ S/ B types thermocouple signal input
- User can programme and set input range
- Wide range input power: 8---50V DC
- Isolation between signal input and output: 3000VDC
- Support MODBUS RTU communication protocol

Applications:

- measure,monitor and control temperature signals
- Intelligent building control, Security and engineering application
- RS-232/485-bus industrial automation control system
- Industrial field signal isolation and long-term transmission
- Thermocouple signal isolated conversion and long-term transmission
- Analogue signal A/D conversion, adjustment and long-term transmission
- Small signal measurement
- Industrial field data acquisition and record
- Application in medical, industrial products development

I Generalization

SY AD 08TSeries products achieve the signal data acquisition between sensor and host which are used to measure analog signal or control remote equipments. And through the configuration of software, they can be used in various types of sensors including: analog signal input, analog signal output and digital signal input and output.SY AD 08T Series products can also be used in industrial automation RS232/485-bus system, thermocouple signal measurement, monitoring and control, small signal measurement and industrial-site signal isolation and long-term transmission.

The products include power supply isolation, signal isolation between input and output, A/D conversion and RS485 series communication circuit module. Each port can connect maximum 256 pieces of SYAD08T series modules, and adopts ASCII character communication protocol or MODBUS RTU communication protocol in communication whose instructions set compatible with ADAM module, the baud rate set by user. And the product can hang in the same RS-485 bus with control model from other manufactures to facilitate host programming.

SYAD08T Series products are the intelligent monitoring and control system based on MCU. All the configuration information set by user includes calibration value, address, baud rate, data format, calibration and status are all deposit in nonvolatile storage device--EEPROM.

SYAD08T Series products can be used to measure varies models of sensor signal includes thermocouple, thermal resistance, strain gauge and others, the specific model selection should be done by reference to the model code supported by different models of products.

SYAD08T Series products are designed on the industrial standard, there is isolation between input and output, the isolation is 3000VDC, high reliability and strong resistance to interference. Industrial operating temperature: -45℃～+85℃

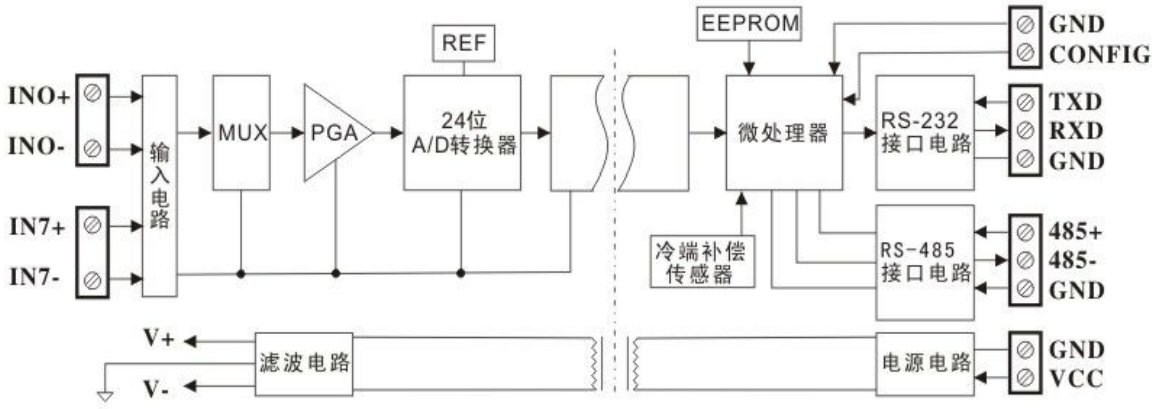


Fig.1 SYAD08T Thematic and External Terminal Diagram

SYAD08T Function

SYAD08T Series Products is 8 Channel Signal Isolated Data Acquisition Module can measure signals from J/ K/ T/ E/ R/ S/ B types Thermocouple.

1. Analog signal input

24 bit acquisition accuracy, all the signal input range have been calibrated before ex-factory.

User can also programme himself in usage. Thermocouple Input detection of disconnection command, linearity compensation and cold port temperature compensation. User can detect whether the line is disconnected or not through sending a simple open line detection command. Inside the module, there are linear data of various thermocouples, in the acquisition of thermocouple signals, the modules can do linearity compensation based on the types of thermocouple, and can also do cold port temperature compensation based on the current environment temperature. If necessary, user can programme to calibrate the cold port temperature.

2. Communication Protocol

Communication Interface: one standard RS-485 communication interface and one RS-232 communication interface
Communication Protocol: support two types of protocols, ASII Character protocol and MODBUS RTU communication protocol. Users can select which protocol to use by programming. The modules could have network communication with supervisory computer control system or various types of PLC,RTU.
Data Format: 10 bit. One standard bit, eight data bit, one stop bit.
Communication Address: (00H-FFH)and baud rate (300bps、600 bps、1200 bps、2400 bps、4800 bps、9600 bps、19200 bps、38400bps) can be set. The network communication distance is up to 1200 meters, the connection is realized by double ground shield cable.
High anti-interference of the communication interface: ±15KV ESD protection, and the response time is less than 70ms.

3. Anti-interference

Available to set checksum according to requirement. TVS inside the module can actively restrain all kinds of surge pulse and protect the module, and the digital filter inside can also restrain the power frequency interference from power grid.

Model Selection Guide:

SY AD08T - □

Thermocouple Types

J: J type	R: R type
K: K type	S: S type
T: T type	B: B type
E: E type	

Remarks:

① The model selection of SYAD08T series is just initial type of thermocouple which supports by the module. User can change the types of thermocouple by re-configurating the module through ASCII character command, then calibrate it.

② SYAD08T series modules support both RS232 and RS485 communication interface. User can choose the communication interface according to the application environment, and at the same time only one interface works, otherwise it may interference with each other.

SY AD08T Series Technical Parameter:

(typical @ +25℃，Vs is rated value)

Input: Thermocouple: J type: 0℃～760℃，K type: 0℃～1000℃，T type:-100℃～400℃，
E type:0℃～1000℃，R type: 500℃～1750℃，S type:500℃～1750℃，B type: 500℃～1800℃
(Input type can be set through software)
Accuracy: @+25℃ as shown in Table 1.
Input Imbalance: ±0.02 uV/℃
Temperature Drift: ±1 ppm/℃(±3 ppm/℃, Max.)
Input Resistance: 100 M Ω
Band width: thermocouple -3 dB 3.27 Hz
Switching rate: thermocouple 3.76 Sps

Common mode restraint (CMR): 120 dB(1kΩ Source Imbalance @ 50/60 Hz)
Normal mode restraint (NMR): 60 dB (1kΩ Source Imbalance @ 50/60 Hz)
Input terminal protection: 240Vrms, sustainable
ANSI/IEEE C37.90.1-1989 transient protection

Cold Junction Compensation Sensor
Accuracy： @+25℃ ±0.25℃ (±0.75℃, Max.)
Accuracy： +5℃～+45℃ ±0.5℃ (Non-linearity ±0.0125℃/℃)
Communication: RS-485 interface or RS-232 interface；ASCII character protocol and MODBUS RTU communication protocol. Baud rage(300bps、600 bps、1200 bps、2400 bps、4800 bps、9600 bps、19200 bps、38400bps)(can be set through software).
Address (00H~FFH)can be set through software
Response time: 100 ms Max.
Operation Power Supply：+8 ～ 50 VDC wide range power，internal anti-inverse connection and over-voltage protection circuit.
Power Consumption：≤1W
Operation Temperature：- 45 ~ +85℃
Operation Humidity：10 ~ 90% (no condensation)
Storage Temperature：- 45 ~ +85℃
Storage Humidity：10 ~ 95% (no condensation)
Isolation Withstand Voltage： 3KVDC between input and output，1 minute，stray current 1mA, Output and power are common-ground
Endure Impact Voltage： 3KVAC， 1.2/50us(peak value)
Dimension：101 mm x 23 mm x 116.5 mm
Weight：about 120g

SY AD08T Electrical Parameter Vs is rated value

Input Range Description	Accuracy (Typical)	Accuracy (Maximum)	Noise (Peak-to-Peak)
Type J thermocouple,0℃～760℃	±0.2℃	±0.4℃	±0.12℃
Type K thermocouple,0℃～1000℃	±0.25℃	±0.5℃	±0.2℃
Type T thermocouple,-100℃～400℃	±0.2℃	±0.35℃	±0.15℃
Type E thermocouple,0℃～1000℃	±0.18℃	±0.4℃	±0.1℃
Type R thermocouple,500℃～1750℃	±0.3℃	±0.8℃	±0.22℃
Type S thermocouple,500℃～1750℃	±0.3℃	±0.75℃	±0.2℃
Type B thermocouple,500℃～1800℃	±0.4℃	±0.9℃	±0.3℃

Note: The error value of thermocouple accuracy in the table above not include the temperature error value of cold junction sensor.
Table 1 SYAD08T Measuring Accuracy

Initialization of SYAD08T Module

For all the SYAD08T series modules, it must be allocate a unique address code when connecting to RS232/RS-485 network, and the value range of address code should be 00H-FFH.
All the SYAD08T series modules have one set of initial setting from factory, as below:
Address code is 01H
Baud rate: 9600bps
Checksum: disable
ASCII character communication protocol

As the new module code is the same, their addresses will be contradictory with other modules, so when users set up the system, the re-configuration for each analog output module address must be done. Users can modify SYAD08T series module's address through configuration commands after connecting SYAD08T series module power cable and RS485/RS-232 communication cable.

Baud rate, parity, status, and communication protocols can also be adjusted according to user's requirements. Before the adjusting process, one must set the module to be the default state firstly; otherwise it can not be modified.SYU AD08T series module has a Pin marked CONFIG. Connect CONFIG Pin to the ground (GND) and then connect power supply. In this way, the module is in default status.

Let the modules be in default status, under default status, the module setting is as following：
Address code: 00H
Baud rate: 9600 bps
Checksum: disable
ASCII Character communication protocol

At this time, users can modify the baud rate, checksum state and other parameters by configuring the command and select the means of communication by setting the module's communication protocol command. If the exact configuration of a module is uncertain, the module could be in default state by installing the jumper and then reconfigure the module. If user requires the module to be set to MODBUS RTU communication protocol, see introduction of MODBUS communication protocol section for reference.

Pin Definition

Pin	Name	Description
1	IN0+	Input 0 +
2	IN0-	Input 0 -
3	IN1+	Input 1+
4	IN1-	Input 1-
5	IN2+	Input 2+
6	IN2-	Input 2-
7	IN3+	Input 3+
8	IN3-	Input 3-
9	IN4+	Input 4+
10	IN4-	Input 4-
11	IN5+	Input 5+
12	IN5-	Input 5-
13	IN6+	Input 6-
14	IN6-	Input 6-
15	VCC	Power supply +
16	GND	Power ground
17	EGND	-
18	NC	Null，maintain
19	NC	Null，maintain
20	485-	RS485 -
21	485+	RS485 +
22	GND	RS232 serial port GND
23	RXD	RS232 RXD
24	TXD	RS232 TXD
25	CONGFIG	Configuration pin
26	GND	GND
27	IN7+	Input 7+
28	IN7-	Input 7-

Fig.2 SYAD08T Module Effect Drawing

Table 2 Pin Definition

Ⅱ ASCII Character Communication Protocol

Brief Introduction

When the controller communicates on the MODBUS under ASCII character protocol mode, every 8-bit of a message is transmitted as two ASCII bytes. E.g.: Transmit the number 34: it transmits 0x33 (ASCII code of 3) and 0x34 (ASCII code of 4) separately. The advantage is that the interval of sending the bytes is only 1s without error.

Character Protocol Command Set

The command is formed by a series of characters, e.g.: first code, address ID, variable,selectable calibration and byte and one end fent mark **(cr)** shows the end of command. SYAD08T series module is not support broadcast address, so the host only control one module one time.

Format of each ASCII code's byte: (Leading Code)(Addr)(Command)[data][checksum](cr)

Leading code)	the first letter of a command,every command requires a leading code as %,$,#,@,etc.	**1-C**
(Addr)	address code of module, the default value range in the following is 00～FF (hexadecimal system).	**2- C**
(Command)	command code/variable value	**1- C**
[data]	command parameter	variable length
[checksum]	calibration value，selectable parameter，it requires only in the operation of checksum	**2- C**
(cr)	a control code character used as the end code. **(cr)** as end code of the enter the value is 0x0D	**1- C**

Calibrate and check the communication between host and module is correct or not. When checksum is enabled, both command and response must be added additional checksum parameter which occupies 2 bytes.The checksum and characters should be before enter key mark after command or response character.

Calculation method: Get the sum of ASCII code value of all the prior issued bytes. This sum and hexadecimal digits 0xFF is two characters (the hexadecimal number).

E.g.: Prohibit checksum

User command **$022(cr)**

Module response **!02000600 (cr)**

Enable checksum

User command **$022B8 (cr)**

Module response **!02000640AD (cr)**

'$' = 0x24 '0' = 0x30 '2' = 0x32

B8=(0x24+0x30+0x32+0x32) AND 0xFF

'**!**' = 0x21 '0' = 0x30 '2' = 0x32 '4'=0x34 '6' = 0x36

AD=(0x21+0x30+0x32+0x30+0x30+0x30+0x36+0x34+0x30) AND 0xFF

Commonly Used Analog Input Command

1. Read analog input module data
2. Read the analog output value of channel N
3. CJC status command
4. CJC offset adjustment
5. Module allocation
6. Read allocation state
7. Offset calibration
8. Full span calibration
9. Enable or prohibit channel command
10. Read the Channel Status
11. Set communication protocol
12. Thermocouple disconnection checking command
13. Read module name

Response of Commands

Response message depends on a variety of commands. Response also consists of several characters, including leading code, variables and end tags. There are two leading codes of response signal: '!' or '>' indicates a valid command and '?' means invalid. By checking the response information, user can monitor whether the command is valid or not.

Note: 1. User needs to ensure the address he uses is correct in a command. If one use the wrong address, the object module will not response

2.The command must be entered in capital letters.

1. Read Analog Input Module Data

Description：Based on the current data format, the command is to read analog input value of all channels from the module.

Command Syntax：**#AA(cr)**

Parameter Description：**#** delimiter character

AA module address, value range 00H～FFH(hexadecimal)

(cr) end character, carriage return(0DH)

Response：**>(data)(cr)** command is valid.

?AA(cr) invalid command or illegal operation

Parameter Description：**>** delimiter character

(data) represent the data of all channels which been read by the command. The data format is in Engineering Units, PERCENT OF FSR, complement of hexadecimal or ohms. For details, refer to Chapter 4 Command Set.

(cr) end character ， carriage return (0DH).

More instructions：If there is a syntax error or communication error or address does not exist, the object module does not respond. When the input is thermocouple, if the thermocouple is disconnected, the output is maximum value (full span value). Can send disconnection checking command $AAB(cr) to check whether it is disconnected or not.(check command set the 12th chapter for reference)

E.g.: User command **#23(cr)**

Module response **>+4.7653+4.7653+4.7653+4.7653+4.7653+4.7653+4.7653+4.7653(cr)**

Description ： On the module with address 23H, input is +4.7653V(data format is the engineering unit)：

Channel 0-7：+04.7653V

2. Read the Data of Analog Input Module in Channel N

Description ： Read the analog input data of channel N from the module at the current allocated data format.

Command Syntax ： **#AAN(cr)**

Parameter Description ： **#** delimiter character

AA module address，value range 00H～FFH

N channel 0 or 1

(cr) end character，carriage return(0DH)

Response：**>(data)(cr)** command is valid.

?AA(cr) invalid command or illegal operation or channel is closed.

Parameter Description ： **>** delimiter character

(data) data read in channel N. The data format is in Engineering Units，PERCENT OF FSR, complement of hexadecimal, Or ohms. Refer to Article 3 Command Set.

(cr) end character，carriage return(0DH)

More instructions： If there is a syntax error or communication error or address does not exist, the module does not respond.

E.g.: User command **#230(cr)**

Module response **>+04.632 (cr)**

Description：The input current of channel 0 on address 23H module is +04.632mA (data format is engineering unit)

3. CJC Status Command

Description: Read CJC value of sensor,the unit of returning value is℃.

Parameter Description: **$** delimiter character

AA module address，value range 00H～FFH

3 indicate CJC status

(cr) end character ， host machine return key(0DH)

Response：**>(data)(cr)** command is valid.

?AA(cr) invalid command or illegal operation or channel is closed.

Parameter Description ： **>** delimiter character means the command is valid

? delimiter character means the command is invalid

(data) the value represented CJC sensor, the unit is ℃. Format: one character“+”or “-” and the following 5 decimal digit position and one decimal point position. The position of decimal point is fixed, the resolution definition is 0.1℃.

AA module address

(cr) end character, host machine enter key(0DH)

More instructions： If there is a syntax error or communication error or address does not exist, the module does not respond.

E.g.: User command **$233(cr)**

Module response **>+0024.9(cr)**

Description ： The temperature of CJC sensor in module on address 23H is 24.9℃

4. CJC Offset Calibration

Description: CJC offset calibration (cold-junction compensation) can be used to proofread the CJC offset error.

Command Syntax: **$AA9(Counts)(cr)**

Parameter Description: **$** delimiter character

AA module address，value range 00H～FFH

(Counts) CJC offset value, the default is 0000. The command is four character(hexadecimal system) with "+" or "-", the range is 0000-FFFF. Each cunt equals about 0.125℃.

(cr) end character，host machine return key(0DH)

Response： **!AA(cr)** command is valid.

?AA(cr) invalid command or illegal operation or channel is closed or haven't set to thermocouple signal input

E.g.: User command **%239+0028(cr)**

Module response **!23(cr)**

Description：do CJC offset compensation of the module on address 23H, the offset temperature +0028= 2 * 16 + 8 = 40，40 * 0.125℃ = 5℃

5. Module Allocation

Description：Set address, input range, baud rate, data format, checksum status for an analog input module. Configuration information is stored in nonvolatile memory EEPROM.

Syntax：**%AANNTTCCFF(cr)**

Parameter Description：**%** delimiter character

AA module address, value range 00H～FFH

NN hexadecimal address, NN is from 00 to FF

TT hexadecimal represents type code. Type code shows input range. Table 4 is the type code of analog input modules.

CC hexadecimal represents baud rate code. **Refer to table 3**

Baud Rate Code	Baud Rate
01	300bps
02	600bps
03	1200bps
04	2400bps
05	4800bps
06	9600bps
07	19200bps
08	38400bps

Table 3 Baud Rate Code

Module	Type Code(TT)	Input Range
SY AD08T	0E	Type J thermocouple,0℃～760℃
	0F	Type K thermocouple,0℃～1000℃
	10	Type T thermocouple,-100℃～400℃
	11	Type E thermocouple,0℃～1000℃
	12	Type R thermocouple,500℃～1750℃
	13	Type S thermocouple,500℃～1750℃
	14	Type B thermocouple,500℃～1800℃

Table 4 Analog Input Module Type Code

FF The 8-bit of hexadecimal is used to represent data format and checksum. (Note: From bits2 to bits 5 is unnecessary to be set to 0.)

Bit7	Bit 6	Bit 5	Bit 4	Bit 3	Bit2	Bit 1	Bit 0

Table 5 Data Format, Checksum Code

Bit7：Reserved bits should be set to 0
Bit6：checksum status: 0 represents prohibit; 1 represents permission
Bit5-bit2：it's unnecessary and used to be set to 0
Bit1-bit0：data format bit
00： Engineering Units
01： % of FSR
10：complement of hexadecimal (Twos complement)
11： ohms(only the thermal resistance could be set)
(cr) end character, carriage return(0DH).

Response：**!AA(cr)** command is valid.
?AA(cr) invalid command or illegal operation, no jumper allocation before baud rate checksum status.
Parameter Description：**!** delimiter code indicates valid command.
? delimiter code indicates invalid command.
AA indicates input Module address
(cr) end character, carriage return(0DH)
More instructions：1.If need to reallocate module, user should install jumper to let the module be in default status. Now Module address is 00H，that is AA=00H，NN = new address. Otherwise it will respond error signal.
Once the command is executed, the new address will be set as response information and be send back to the host machine by the module after reallocation.
If there is a syntax error or communication error or address does not exist, the module does not respond.

E.g.: User command **%0011050600(cr)**
Module response **!11(cr)**
Description：**%** Delimiter character
00 Indicate the analog module original address which user wants to allocate is 00H.
11 Indicate the hexadecimal address of the new address is 11H.
05 Means input range +/-2.5V
06 Means baud rate 9600 bps
00 Indicate data format is engineering unit and the checksum is forbidden.

6. Read the Allocation Status

Description：Read the configuration information of the specified module
Command Syntax：**$AA2(cr)**
Parameter Description：
$ delimiter character
AA module address,value range 00H～FFH
2 read the configuration status
(cr) end character, carriage return(0DH)
Response：**!AATTCCFF(cr)** command is valid.
?AA(cr) invalid command or illegal operation
Parameter Description ：
! delimiter character
AA input module address
TT Type code (see table 4)
CC baud rate code, (see table 3)
FF table 5 for reference
(cr) end character，upper machine enter key(0DH)
More instructions： If there is a syntax error or communication error or address does not exist, the module does not respond.

E.g.: User command **$302(cr)**
Module response **!300F0600(cr)**
Description：**!** delimiter character

30 analog input module address is 30H
0F input K type thermocouple, measurement range:0℃～1000℃
06 baud rate 9600 bps.
00 data format is engineering unit and the checksum is forbidden.

7. Offset Calibration

Description：Adjust the zero offset of channel N
Command Syntax ： **$AA1N(cr)**
Parameter Description ：
$ Delimiter character
AA Module address，value range 00H～FFH
1 Offset calibration
N Channel code 0～7
(cr) End character，upper computer enter key(0DH).
Response：**!AA(cr)** command is valid.
?AA(cr) invalid command or illegal operation
Parameter Description：**!** delimiter code means valid command
? delimiter code means invalid command
AA input Module address
(cr) end character，upper computer enter key(0DH).

More instructions: The product has been calibrated before delivery, and the user can directly use it without calibration. When calibrating an analog input, offset calibration should be done firstly, and then calibrate the gain. During the calibration, analog input module needs to be connected with the appropriate input signal on the channel which is to be calibrated. Different input range requires different input voltage or current. See the calibration module section for reference.
If there is a command syntax error or communication error or address does not exist, the module does not respond.

E.g.: User command **$2310(cr)**
Module response **!23(cr)**
Description ： Offset calibrating channel 0 of address 23H

8. Gain Calibration

Description：calibrate the gain of channel N
Command Syntax： **$AA0N(cr)**
Parameter Description ：
$ Delimiter character
AA Module address，value range 00H～FFH
0 Gain calibration command
N Channel code 0～1
(cr) End character，host computer enter key(0DH)
Response：**!AA(cr)** command is valid.
?AA(cr) invalid command or illegal operation
Parameter Description：**!** delimiter code means valid command
? delimiter code means invalid command
AA input Module address
(cr) end character, carriage return(0DH)
More instructions：The product has been calibrated before delivery, and the user can directly use it without calibration. When calibrating an analog input, offset calibration should be done firstly, and then calibrate the gain.During the calibration, analog input module needs to be connected with the appropriate input signal on the channel which as to be calibrated. Different input range requires different input voltage or current. See the calibration module section.
If there is a syntax error or communication error or address does not exist, the module does not respond.

E.g.: User command **$2303(cr)**
Module response **!23(cr)**
Description ： gain calibration of channel 3 of address 23H module.

9. Enable or Prohibit Channel

Description ： Enable or prohibit the data acquisition channel of the module

Command Syntax ： **$AA5VV(cr)**

Parameter Description ：

$ Delimiter character

AA Module address，value range:00H～FFH (hexadecimal system)

5 The command means enable or prohibit the data acquisition channel of the module

VV Two bits (hexadecimal)，3~0 at the first bid represents 7~4 channel.
3~0 at the second bid 3~0 channel
Bit is 0：prohibit the channel
Bit is 1：enabled the channel

(cr) end character ，host machine enter key(0DH)

Response：**!AA(cr)** command is valid.

?AA(cr) invalid command or illegal operation

Parameter Description：**!** delimiter character: command is valid.

? delimiter character: command is invalid.

AA input Module address

(cr) end character，host machine enter key(0DH).

More instructions： If there is a syntax error or communication error or address does not exist, the module does not respond.

E.g.: User command **$08537(cr)**
Module response **!08 (cr)**

Description：set object channel value to 0x37
3 is 0011，represents prohibit channel 7, channel6, enable channel 5 and channel 4.
7 is 0111，represents enable channel 2 and channel 1channel 0, prohibit channel 3.

10. Read the Channel Status

Description：Read the channel status command

Command Syntax ： **$AA6(cr)**

Parameter Description：

$ Delimiter character

AA Module address，value range 00H～FFH.

6 Read the channel status

(cr) End character, host machine enter key(0DH)

Response：**!AAVV(cr)** command is valid.

?AA(cr) invalid command or illegal operation

Parameter Description ：

! delimiter character :command is valid.

? delimiter character: command is invalid.

AA input Module address

VV two 16 bits (hexadecimal)
Bit is 0：prohibit the channel
Bit is 1：enabled the channel

(cr) end character，host machine enter key(0DH).

More instructions： If there is a syntax error or communication error or address does not exist, the module does not respond.

E.g.: User command **$186 (cr)**
Module response **!18FF(cr)**

Description ： the current channel status is 0xFF.
0xFF is 1111 and 1111，means all the channels of the module with address 18H have been enabled.

11. Set Communication Protocol

Function: set the communication protocol to ASCII character communication protocol or MODBUS RTU protocol.

Command Syntax: **$AAPV(cr)**

Parameter Description:

$ Delimiter character

AA Module address，value range 00H～FFH.
P Set communication protocol
V Code number of protocol, (0 or 1)
0: Character protocol which defines by command set
1：MODBUS RTU Protocol
(cr) End character, host machine enter key(0DH)

Response：!**AA(cr)** command is valid.
?AA(cr) invalid command or illegal operation

Parameter Description ：
! delimiter character :command is valid.
? delimiter character: command is invalid.
AA input Module address
(cr) end character, host machine enter key(0DH)

More Instructions：If there is a syntax error or communication error or address does not exist, the module does not respond.
The command for setting communication protocol is valid must be in the allocation status.

E.g.: User command **$00P1(cr)**
Module response **!00 (cr)**
Description: set the communication protocol to MODBUS Protocol

E.g.: User command **$00P0(cr)**
Module response **!00 (cr)**
Description: set the communication protocol to character protocol which defines by command set.

12. Check Thermocouple Disconnection

Function: check whether thermocouple disconnected or not.
Command Syntax: **$AAB(cr)**
Parameter Description:
$ Delimiter character
AA Module address，value range 00H～FFH.
B Check the thermocouple disconnection
(cr) End character, host machine enter key(0DH)

Response: **! AAVV(cr)** two hexadecimal characters, the 7-0 represent 7-0 channel
The position is 0: indicate connection
The position is 1: indicate disconnection
?AA(cr) invalid command or illegal operation, or the input has not been set to thermocouple signal input

Parameter Description：
! delimiter character:command is valid.
? delimiter character: command is invalid.
AA input Module address
(cr) end character，host machine enter key(0DH)

E.g.: User command **$06B(cr)**
Module response **!0600 (cr)**
Description: there is no line breaking on the module of the address 06H.

13. Read Module Name

Description：Read module name
Command Syntax：**$AAM(cr)**
Parameter Description：
$ Delimiter character
AA Module address，value range 00～FF
M Read module name
(cr) End character，host machine enter key(0DH)

Response：**!AA(Module Name)(cr)** command is valid.
?AA(cr) invalid command or illegal operation

Parameter Description：
! delimiter character:command is valid.

? delimiter character:command is invalid.
AA input Module address
(Module Name) module name could be SYAD08T etc. Means the module type you used.
(cr) end character, host machine enter key(0DH)

More instructions： If there is a syntax error or communication error or address does not exist, the module does not respond.

E.g.: User command **$08M(cr)**
Module response **!08SYAD08T (cr)**
Description ： Module SY AD08T is a module in address 08H.

Input Range and Data Format

There are 4 output data formats used in analog input module:

00： Engineering Units
01： % of FSR
10： Complement hexadecimal
11: Ohms (only in thermocouple)

Application Case

1.The input range is K type Thermocouple (0℃～1000℃),output is 600℃

User command: **#01(cr)**
Engineering Units: module response **>+0600.0(cr)**
Percent of FSR: module response **>+0600.0(cr)**
Complement code hexadecimal: module response **>4CCCCC(cr)**

Code	Thermocouple Input Range	Data Format	Max.	Min.	Resolution Definition
0E	J(0℃～760℃)	Engineering Unit	+760.00	+000.00	0.01℃
		% of FSR	+100.00	+000.00	0.01%
		complement of hex	7FFFFF	000000	1LSB
0F	K(0℃～1000℃)	Engineering Unit	+1000.0	+0000.0	0.1℃
		% of FSR	+100.00	+000.00	0.01%
		complement of hex	7FFFFF	000000	1LSB
10	T(-100℃～400℃)	Engineering Unit	+400.00	-100.00	0.01℃
		% of FSR	+100.00	-025.00	0.01%
		complement of hex	7FFFFF	DFFFFF	1LSB
11	E(0℃～1000℃)	Engineering Unit	+1000.0	+0000.0	0.1℃
		% of FSR	+100.00	+000.00	0.01%
		complement of hex	7FFFFF	000000	1LSB
12	R(500℃～1750℃)	Engineering Unit	+1750.0	+0500.0	0.1℃
		% of FSR	+100.00	+028.57	0.01%
		complement of hex	7FFFFF	24924A	1LSB
13	S(500℃～1750℃)	Engineering Unit	+1750.0	+0500.0	0.1℃
		% of FSR	+100.00	+028.57	0.01%
		complement of hex	7FFFFF	24924A	1LSB
14	B(500℃～1800℃)	Engineering Unit	+1800.0	+0500.0	0.1℃
		% of FSR	+100.00	+027.77	0.01%
		complement of hex	7FFFFF	238E39	1LSB

Table 5 Input Range and Data Format

III MODBUS RTU Protocol

MODBUS protocol defines the information structure which could be identified and used by controller. When communicating on the MODBUS network, the protocol allows each controller to know its own device address, and identify the data addressing to it, then decide the effective type and take out data contained in the information. The controller can also organize the response information and use the MODBUS protocol to send out this information.

The controller takes use of master-subordinate technique. That means, only one device (the master) can initiate transmission (the query), and other devices (subordinate ones) respond according to data queried by the master device. A typical master device: host and programmable instrument. Typical subordinate device: programmable controllers.

Master device can communicate with one subordinate device, but also communicate with all subordinate devices by broadcast. For the former situation, the device will respond one message; for the latter, the device will not respond. MODBUS protocol establishes a master query format: device (or broadcast) address, function code, all the data to be sent, and an error detection field.

Response message of subordinate device is also constituted by the MODBUS protocol, including the domain to be act, any data to be returned, and an error detection field. If a error occurred during message reception, or the subordinate device can not perform its command, the subordinate device will create an error message and sent it out as a response
MODBUS transmission: ASCII and RTU

Communication in ASCII mode, each 8 bit byte in a message is sent as two ASCII character. It uses the LRC error detection, the advantage of which is that the interval of sending the character is only 1s without error; while in RTU mode, every 8 bit byte contains two 4 bit of hexadecimal characters. It uses the CRC error detection, and the advantage is at the same baud rate, it can transmit more data than ASCII.

About ASCII mode and RTU data format, more information can be found in the relevant MODBUS communication protocol:

	ASCII mode	RTU mode
Code system	▪ hexadecimal，ASCII character 0～9，A～F ▪ every ASCII byte consists of one hexadecimal character	▪ 8 bit binary system，hexadecimal0～9，A～F ▪ Every 8 bit consists of one or two hexadecimal character
Data bit	▪ 1 start bit ▪ 7 data bits，the smallest significance bit significance bit sent firstly ▪ 1 parity check bit，none if there is no calibration ▪ 1 stop bit (with calibration)，2 Bits (without calibration)	▪ 1 start bit ▪ 8 data bits，the smallest significance bit significance bit sent firstly ▪ 1 parity check bit，none if there is no calibration ▪ 1 stop bit (with calibration)，2 Bits (without calibration)
Error detection	LRC(Longitudinal rigmarole check)	▪ CRC(circulate rigmarole check)

Note: The module only supports MODBUS RTU transmission, not support MODBUS ASCII transmission.

1. Set MODBUS RTU Mode

The device use ASCII command set as default protocol. To use MODBUS RTU, follow these steps to set:

1. Short circuit CONFIG (the 3rd pin) and GND (the 4th pin)
2. Correctly link Power and other interface cables
3. Switch on power supply, module is in default state automatically, communication address is **00**, baud rate is **9600**.
4. The module is to complete initialization, about 1 minutes
5. Send command **$00P1(cr)**(00 represents corresponding module address,check set communication protocol for reference), check response, if it is **!00(cr)**, set correctly.
6. Switch off power supply, cut off the connecting between CONFIG and GND
7. Module has been set to MODBUS RTU protocol

2. Data format under MODBUS RTU

Host query message specifies the start address of the register to be read and the quantity of registers. The start address of the register addressing is 0000. Checking format is as following:

Slave Address	Function	Starting Address Hi	Starting Address Lo	No. of Points Hi	No. of Points Lo	Error Check(CRC)
01	03	00	00	00	08	44 0C

E.g.:Host send query information Tx： 01 03 00 00 00 08 44 0C
01 device address
03 function code
00 00 the start address of register addressing
00 08 quantity of register
44 0C CRC check code

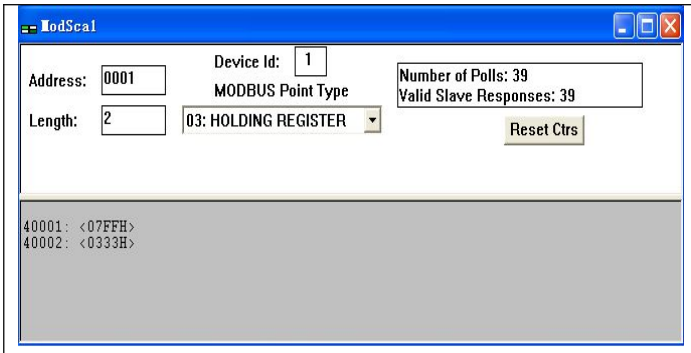
3. Subordinate Device Response

Register data in the response information of subordinate device corresponds to the two bytes of each register; the first data byte is high, the second is the low data. Response format is as following:

Slave Address	Function	Byte Count	Data Hi(Register 40001)	Data Lo(Register 40001)	Data Hi(Register 40002)	Data Lo(Register 40002)	……	Data Lo(Register 40008)	Error Check(CRC)
01	03	10	19	99	00	00	……	02	9E 68

E.G.: Subordinate device response information Rx：01 03 10 19 99 00 00 00 00 00 00 00 00 04 00 00 00 00 87 69
01 device address
03 function code
10 the quantity of bytes
19 99 the first register data
00 00 the second register data
▪
▪
▪
87 69 CRC check code

The below picture is the register information checked by MODSCAN software and its instruction



Instructions：
Address is the start address of the register
Device ID is module address
Length is the number of registers been read
MODBUS Point Type :MODBUS function type selection
40001：corresponds to register data, analog input value of channel 0
40002：corresponds to register data, analog input value of channel 1

4. Instructions of Register

Address 4X	Data	R/W	Description
40001	IN0	Read only	Measured Value of Channel 0
40002	IN1	Read only	Measured Value of Channel 1
40003	IN2	Read only	Measured Value of Channel 2
40004	IN3	Read only	Measured Value of Channel 3
40005	IN4	Read only	Measured Value of Channel 4
40006	IN5	Read only	Measured Value of Channel 5
40007	IN6	Read only	Measured Value of Channel 6
40008	IN7	Read only	Measured Value of Channel 7
40211	Module Name	Read only	Higher bits：0x01 Lower bits：0x08
40221	Channel Status	Read/Write	Higher bits：0x00 Lower bits：Channel Status (0xFF)

Form 5 MODBUS RTU Register Instructions

Ⅳ Mode Calibration

The calibration of modules must be done based on ASCII character communication protocol. In the MODBUS protocol, the module is not support calibration.

The product has been calibrated before delivery, and the user can directly use it without calibration. User could recalibrate the module via the calibration function of the product. During the calibration, analog input module needs to be connected with the appropriate input signal on the channel which as to be calibrated. Different input range requires different input signal.

In order to improve calibration accuracy, it is recommended to use the following equipments:

1. A stable output, low noise DC voltage/current signal source.
2. One five and a half bits or a higher-precision voltage/current measuring instruments to monitor the accuracy of the input signal.

The Calibration Process

1. Select the input channel to be calibrated and connect to the corresponding input signal according to the input range of the module. Select the correct input range, different input range requires different calibration voltage.
2. Set the correct offset voltage to analog input module, for the calibration voltage of thermocouple signal, check **Table 5-1** for reference.
3. When the signal is stable, send offset calibration $ AA1N command (N represents the channel code currently being calibrated, 0 or 1) to the analog input module.
4. Set the correct FSR voltage to analog input module, for the calibration voltage of thermocouple signal, check **Table 5-1** for reference.
5. When the signal is stable, send gain calibration $ AA0N command (N represents the channel code currently being calibrated) to the analog input module.
6. Do the offset calibration, gain calibration successively fro each channel.
7. Complete the Calibration .

The Calibration Voltage of Thermocouple Signal

Code	Input Range of Thermocouple	Offset Calibration Volt.	Gain Calibration Volt.
0E	J(0℃～760℃)	0mV	+50mV
0F	K(0℃～1000℃)	0mV	+45mV
10	T(-100℃～400℃)	0mV	+25mV
11	E(0℃～1000℃)	0mV	+78mV
12	R(500℃～1750℃)	0mV	+22mV
13	S(500℃～1750℃)	0mV	+20mV
14	B(500℃～1800℃)	0mV	+15mV

Table 5-1

Appendixes：Dimension(Unit：mm)