Intelligent Temperature Controller Communication Manual

This device supports the Modbus-RTU protocol via 485 communication.
Refer to the CRC calculation website: http://www.ip33.com/crc.html. Select CRC-16/MODBUS for calculation. Note that the CRC value generated by the website is in low-byte first, high-byte second order; pay attention to the byte sequence in actual application.
The CRC value used in actual Modbus communication follows the low-byte first, high-byte second order (different from other byte orders). For example, for the data frame 01 01 00 01 00 02, the CRC value is 0x0BEC, and the actual transmission frame shall be 01 01 00 01 00 02 EC 0B.
Most registers take effect immediately upon receiving host commands; a small number of commands take effect after the device responds, e.g., 485 address, baud rate, reset, and factory reset.

Complete Register Address List:

Register Address	Category	Name	Description	Data Range
168	Coil	Factory Reset	Write 1 to reset to factory settings; Read always returns 0	Write 1 for reset
10001	Discrete Input	OUT1	Output 1 Indicator	0: Disconnected, 1: Closed
10002	Discrete Input	OUT2	Output 2 Indicator	0: Disconnected, 1: Closed
10003	Discrete Input	AT	Auto-tuning Indicator	Auto-tuning status
10004	Discrete Input	AL1	Alarm 1 Indicator	0: No alarm, 1: Alarm
10005	Discrete Input	AL2	Alarm 2 Indicator	0: No alarm, 1: Alarm
30001	Input Register	Real-time Temperature (PV)	Measured temperature	Returns FFFF if no sensor connected
30002	Input Register	Program Version	Device program version	-
40001	Holding Reg.	SV (Set Temperature)	Set temperature value	-199~650
40002	Holding Reg.	AL1 (Alarm 1)	1st group alarm value	-199~650
40003	Holding Reg.	AL2 (Alarm 2)	2nd group alarm value	-199~650
40004	Holding Reg.	ATU (Auto-tuning)	0: Disable auto-tuning; 1: Enable auto-tuning (switches to PID for on-off control)	0/1
40005	Holding Reg.	P (Proportional Band)	Proportional band; Set to 0 for ON/OFF control	0~9999
40006	Holding Reg.	I (Integral Time)	Integral time; Set to 0 to disable integral action	0~9999
40007	Holding Reg.	D (Derivative Time)	Derivative time	0~9999
40008	Holding Reg.	AR (Integral Action Range)	Limits integral action range (× proportional band)	0~100
40009	Holding Reg.	T (Proportional Cycle)	Proportional cycle	1~100
40010	Holding Reg.	OH (Control Dead Band)	Control non-action bandwidth	1~100
40011	Holding Reg.	T2 (SSR Proportional Time)	Solid State Relay proportional time	1~100
40012	Holding Reg.	SC (PV Correction)	PV temperature correction value	-500~500
40013	Holding Reg.	LCK (Data Lock)	Keypad operation lock only:1000: Unlock all 1: Unlock only SV/AL1/AL2 11: Unlock only SV Others: Lock all parameters 485 communication can read/write this register; no impact on 485 access to other registers regardless of its value	0~1111
40020	Holding Reg.	SL1 (Thermocouple Selection)	Thermocouple type selection	0~1111
40021	Holding Reg.	SL2	Reserved, invalid	-
40022	Holding Reg.	SL3	Reserved, invalid	-
40023	Holding Reg.	SL4 (ALM1 Type Selection)	Alarm 1 type selection	0~1111

Register Address	Category	Name	Description	Data Range
40024	Holding Reg.	SL5 (ALM2 Type Selection)	Alarm 2 type selection	0~1111
40025	Holding Reg.	SL6 (Heating/Cooling Output)	Heating/cooling mode and output type	0,1,100,101
40026	Holding Reg.	SL7 (Alarm Activation)	Alarm excitation setting	0,1,10,11
40027	Holding Reg.	SL8 (PID Output Selection)	0: 1st PID output; 1: 2nd PID output	0/1
40028	Holding Reg.	SL9	Reserved, invalid	-
40029	Holding Reg.	SL10	Reserved, invalid	-
40030	Holding Reg.	SL11	Reserved, invalid	-
40101	Holding Reg.	SLL (Measuring Range Lower)	Lower limit of set measuring range	-1999~9999
40102	Holding Reg.	SLH (Measuring Range Upper)	Upper limit of set measuring range	-1999~9999
40103	Holding Reg.	PGDP (Decimal Point)	Number of decimal places	0~1
40104	Holding Reg.	Unit	Temperature unit: 0=°C, 1=°F	0~1
40105	Holding Reg.	AH1 (Alarm 1 Dead Band)	1st alarm output non-action bandwidth	0~100
40106	Holding Reg.	AH2 (Alarm 2 Dead Band)	2nd alarm output non-action bandwidth	0~100
40107	Holding Reg.	TSL (Transmit Zero Value)	Transmit output zero value	-1999~9999
40108	Holding Reg.	TSH (Transmit Full Value)	Transmit output full scale value	-1999~9999
40109	Holding Reg.	DF (Digital Filter Constant)	Digital filter constant	1~100
40110	Holding Reg.	AH (Over-Temp Shutdown Alarm)	Over-temperature shutdown alarm setting	-
40111	Holding Reg.	FP (Proportional Band Advance)	Proportional band advance value	-
40112	Holding Reg.	KEY (Direct Temp Setting)	Enable direct temperature setting via +/- keys	-
40113	Holding Reg.	A2E (AL2 Enable)	1: Enable AL2; 0: Disable AL2 (hides "AL2" on display)	0~1
40114	Holding Reg.	ADR (485 Address)	485 communication address; Default = 1	1~254
40115	Holding Reg.	BAUD (485 Baud Rate)	1=4800, 2=9600, 3=19200, 4=38400, 5=115200 (only up to 9600 supported for low-speed optocouplers)	1~5

1.1 Read Coils (Function Code 01)
Function code 01 for reading coils, applicable to the following register:

Register Address	Category	Name	Description	Data Range
168	Coil	Factory Reset	Write 1 to reset to factory settings; Read always returns 0	Write 1 for reset

Communication Format
Host Transmission

Byte No.	01	02	03-04	05-06	07-08
Meaning	Device Addr	Func Code 01	Register Addr (High-byte first)	Data Length (High-byte first)	CRC (Low-byte first)

Device Response

Byte No.	01	02	03	04...n+3	n+4~n+5
Meaning	Device Addr	Func Code 01	Byte Length (n=ROUNDUP(len/8))	Byte 1...Byte n	CRC (Low-byte first)

The returned bytes map to register addresses starting from the queried address as bit 0, the next address as bit 1, and so on. Insufficient bits are padded to 8 bits.
Example: Device address = 1, host queries 1 coil at register 168 (Factory Reset, read is meaningless). The device returns 1 byte with bit 0 = 0.

- Host sends: 01 01 00 A8 00 01 7C 2A
- Device returns: 01 01 01 00 51 88

1.2 Write Single Coil (Function Code 05)
Function code 05 for writing a single coil.
Communication Format
Host Transmission

Byte No.	01	02	03-04	05-06	07-08
Meaning	Device Addr	Func Code 05	Register Addr (High-byte first)	Data (High-byte first)	CRC (Low-byte first)

Device Response

Byte No.	01	02	03-04	05-06	07-08
Meaning	Device Addr	Func Code 05	Register Addr (High-byte first)	Data (High-byte first)	CRC (Low-byte first)

- Write 1 to the coil: Data = FF00 (0x00FF), device returns FF00.
- Write 0 to the coil: Data = 0000, device returns 0000.

Example: Device address = 1, host resets the device to factory settings (write FF00 to register 168).

- Host sends: 01 05 00 A8 FF 00 0D DA
- Device returns: 01 05 00 01 FF 00 DD FA

1.3 Write Multiple Coils (Function Code 0F)
Not supported by this device (only one coil register is available).
Communication Format
Host Transmission

Byte No.	01	02	03-04	05-06	07	08...n+7	n+8~n+9
Meaning	Device Addr	Func Code 0F	Register Addr (High-byte first)	Data Length (High-byte first)	Byte Length (n=ROUNDUP(len/8))	Byte 1...Byte n	CRC (Low-byte first)

Device Response

Byte No.	01	02	03-04	05-06	07-08
Meaning	Device Addr	Func Code 0F	Register Addr (High-byte first)	Data Length (High-byte first)	CRC (Low-byte first)

Bit 0 of the written Byte 1 maps to the target register, Bit 1 to the next register, and so on. Insufficient bits are padded to 8 bits.

1.4 Read Discrete Inputs (Function Code 02)
Function code 02 for reading discrete inputs (read-only), applicable to the following registers:

Register Address	Category	Name	Description	Data Range
10001	Discrete Input	OUT1	Output 1 Indicator	0: Disconnected, 1: Closed
10002	Discrete Input	OUT2	Output 2 Indicator	0: Disconnected, 1: Closed
10003	Discrete Input	AT	Auto-tuning Indicator	Auto-tuning status
10004	Discrete Input	AL1	Alarm 1 Indicator	0: No alarm, 1: Alarm
10005	Discrete Input	AL2	Alarm 2 Indicator	0: No alarm, 1: Alarm

Communication Format
Host Transmission

Byte No.	01	02	03-04	05-06	07-08
Meaning	Device Addr	Func Code 02	Register Addr (High-byte first)	Data (High-byte first)	CRC (Low-byte first)

Device Response

Byte No.	01	02	03	04...n+3	n+4~n+5
Meaning	Device Addr	Func Code 02	Byte Length (n=ROUNDUP(len/8))	Byte 1...Byte n	CRC (Low-byte first)

The returned bytes map to register addresses starting from the queried address as bit 0, the next address as bit 1, and so on. Insufficient bits are padded to 8 bits.
Example: Device address = 1, host queries 1 coil at register 10001 (Factory Reset, read is meaningless). The device returns 1 byte with bit 0 = 0.

- Host sends: 01 02 27 11 00 01 E3 7B
- Device returns: 01 02 01 01 60 48

1.5 Read Input Registers (Function Code 04)
Function code 0x04 for reading input registers (read-only), applicable to the following registers:

Register Address	Category	Name	Description	Data Range
30001	Input Register	Real-time Temperature (PV)	Measured temperature	Returns FFFF if no sensor connected
30002	Input Register	Program Version	Device program version	-

Communication Format
Host Transmission

Byte No.	01	02	03-04	05-06	07-08
Meaning	Device Addr	Func Code 04	Register Addr (High-byte first)	Data (High-byte first)	CRC (Low-byte first)

Device Response

Byte No.	01	02	03	04-05	···	2n+2~2n+3	2n+4~2n+5
Meaning	Device Addr	Func Code 04	Byte Length (2n)	Data 1 (High-byte first)	...	Data n (High-byte first)	CRC (Low-byte first)

Example: Device address = 1, host queries 1 input register at 30001 (PV).
The device returns the measured temperature of 252°C.

- Host sends: 01 04 75 31 00 01 7A 09
- Device returns: 01 04 02 00 FC B9 71

1.6 Read Holding Registers (Function Code 03)
Read holding registers with Function Code 0x03. The following information can be read:

Register Address	Category	Name	Description	Data Range
40001	Holding Reg.	SV (Set Temperature)	Set temperature value	-199~650
40002	Holding Reg.	AL1 (Alarm 1)	1st group alarm value	-199~650
40003	Holding Reg.	AL2 (Alarm 2)	2nd group alarm value	-199~650
40004	Holding Reg.	ATU (Auto-tuning)	0: Disable auto-tuning; 1: Enable auto-tuning (switches to PID for on-off control)	0/1
40005	Holding Reg.	P (Proportional Band)	Proportional band; Set to 0 for ON/OFF control	0~9999
40006	Holding Reg.	I (Integral Time)	Integral time; Set to 0 to disable integral action	0~9999
40007	Holding Reg.	D (Derivative Time)	Derivative time	0~9999
40008	Holding Reg.	AR (Integral Action Range)	Limits integral action range (× proportional band)	0~100
40009	Holding Reg.	T (Proportional Cycle)	Proportional cycle	1~100
40010	Holding Reg.	OH (Control Dead Band)	Control non-action bandwidth	1~100
40011	Holding Reg.	T2 (SSR Proportional Time)	Solid State Relay proportional time	1~100
40012	Holding Reg.	SC (PV Correction)	PV temperature correction value	-500~500
40013	Holding Reg.	LCK (Data Lock)	Keypad operation lock only:1000: Unlock all 1: Unlock only SV/AL1/AL2 11: Unlock only SV Others: Lock all parameters 485 communication can read/write this register; no impact on 485 access to other registers regardless of its value	0~1111
40020	Holding Reg.	SL1 (Thermocouple Selection)	Thermocouple type selection	0~1111
40021	Holding Reg.	SL2	Reserved, invalid	-
40022	Holding Reg.	SL3	Reserved, invalid	-
40023	Holding Reg.	SL4 (ALM1 Type Selection)	Alarm 1 type selection	0~1111
40024	Holding Reg.	SL5 (ALM2 Type Selection)	Alarm 2 type selection	0~1111
40025	Holding Reg.	SL6 (Heating/Cooling Output)	Heating/cooling mode and output type	0,1,100,101
40026	Holding Reg.	SL7 (Alarm Activation)	Alarm excitation setting	0,1,10,11
40027	Holding Reg.	SL8 (PID Output Selection)	0: 1st PID output; 1: 2nd PID output	0/1
40028	Holding Reg.	SL9	Reserved, invalid	-
40029	Holding Reg.	SL10	Reserved, invalid	-
40030	Holding Reg.	SL11	Reserved, invalid	-
40101	Holding Reg.	SLL (Measuring Range Lower)	Lower limit of set measuring range	-1999~9999

Register Address	Category	Name	Description	Data Range
40102	Holding Reg.	SLH (Measuring Range Upper)	Upper limit of set measuring range	-1999~9999
40103	Holding Reg.	PGDP (Decimal Point)	Number of decimal places	0~1
40104	Holding Reg.	Unit	Temperature unit: 0=°C, 1=°F	0~1
40105	Holding Reg.	AH1 (Alarm 1 Dead Band)	1st alarm output non-action bandwidth	0~100
40106	Holding Reg.	AH2 (Alarm 2 Dead Band)	2nd alarm output non-action bandwidth	0~100
40107	Holding Reg.	TSL (Transmit Zero Value)	Transmit output zero value	-1999~9999
40108	Holding Reg.	TSH (Transmit Full Value)	Transmit output full scale value	-1999~9999
40109	Holding Reg.	DF (Digital Filter Constant)	Digital filter constant	1~100
40110	Holding Reg.	AH (Over-Temp Shutdown Alarm)	Over-temperature shutdown alarm setting	-
40111	Holding Reg.	FP (Proportional Band Advance)	Proportional band advance value	-
40112	Holding Reg.	KEY (Direct Temp Setting)	Enable direct temperature setting via +/- keys	-
40113	Holding Reg.	A2E (AL2 Enable)	1: Enable AL2; 0: Disable AL2 (hides "AL2" on display)	0~1
40114	Holding Reg.	ADR (485 Address)	485 communication address; Default = 1	1~254
40115	Holding Reg.	BAUD (485 Baud Rate)	1=4800, 2=9600, 3=19200, 4=38400, 5=115200 (only up to 9600 supported for low-speed optocouplers)	1~5

Function code 0x03 for reading holding registers, applicable to all registers in the Holding Register category (see the Complete Register Address List).

Communication Format

Host Transmission

Byte No.	01	02	03-04	05-06	07-08
Meaning	Device Addr	Func Code 03	Register Addr (High-byte first)	Data Length (High-byte first)	CRC (Low-byte first)

Device Response

Byte No.	01	02	03	04-05	···	2n+2~2n+3	2n+4~2n+5
Meaning	Device Addr	Func Code 03	Byte Length (2n)	Data 1 (High-byte first)	···	Data n (High-byte first)	CRC (Low-byte first)

Maximum read per frame: 8 data points.

Example: Device address = 1, host queries 2 holding registers starting at 40002 (AL1, AL2).

The device returns AL1 = 260, AL2 = 180.

- Host sends: 01 03 9C 42 00 02 4A 4F
- Device returns: 01 03 04 01 04 00 B4 BA 79

1.7 Write Single Holding Register (Function Code 06)
Function code 0x06 for writing a single holding register.

Communication Format
Host Transmission

Byte No.	01	02	03-04	05-06	07-08
Meaning	Device Addr	Func Code 06	Register Addr (High-byte first)	Data (High-byte first)	CRC (Low-byte first)

Device Response

Byte No.	01	02	03-04	05-06	07-08
Meaning	Device Addr	Func Code 06	Register Addr (High-byte first)	Data L(High-byte first)	CRC (Low-byte first)

Example: Device address = 1, host sets register 40003 (AL2) to 270.

- Host sends: 01 06 9C 43 01 0E D6 1A
- Device returns: 01 06 9C 43 01 0E D6 1A

1.8 Write Multiple Holding Registers (Function Code 10)
Function code 0x10 for writing multiple holding registers.
Communication Format
Host Transmission

Byte No.	01	02	03-04	05-06	07	08-09	···	2n+6~2n+7	2n+8~2n+9
Meaning	Device Addr	Func Code 10	Register Addr (High-byte first)	Data Length n (High-byte first)	Byte Length (2n)	Data 1 (High-byte first)	...	Data n (High-byte first)	CRC (Low-byte first)

Device Response

Byte No.	01	02	03-04	05-06	07-08
Meaning	Device Addr	Func Code 10	Register Addr (High-byte first)	Data Length (High-byte first)	CRC (Low-byte first)

Maximum write per frame: 8 data points.
Example: Device address = 1, host sets register 40002 (AL1) to 250 and 40003 (AL2) to 160.

- Host sends: 01 10 9C 42 00 02 04 00 FA 00 A0 AF 09
- Device returns: 01 10 9C 42 00 02 CF 8C