Explanation of Communication Protocol for Yudian AI Series Single-loop Measurement and Control Instruments

（**Ver. 9.2**）

The instruments support AIBUS and MODBUS. The AIBUS protocol is independently developed by our company, which can achieve comprehensive functions through simple commands and complete reading functions while writing parameters. Therefore, writing parameters will not damage the reading cycle time, and a maximum of 80 instruments can be connected on one RS485 communication interface. The MODBUS protocol has wider compatibility. For instruments above V9. X, the MODBUS protocol can read up to 20 words at a time, greatly improving communication efficiency compared to previous versions of our company. At the baud rate 9600, the average time for the upper computer to access a V9. X version instrument is only about 20mS; Without considering the time of data transmission, the maximum delay time of the instrument after receiving commands from the upper computer is only 10mS, and the average delay time is only 2-3mS, which is much faster than previous versions of our company, making it easy to build large-scale process control systems. The new generation of AI instruments in version V9. X allows the upper computer to write more than 2 billion times, ensuring that frequent writes to the upper computer of the instrument will not damage internal memory, and can form a complex adjustment system with the help of the upper computer. PC, touch screen, and PLC can serve as upper computers for AI series instruments, and there are abundant configuration software resources available on the market. PC based upper computer software generally uses WINDOWS as the operating environment, which is not only intuitive and convenient, but also powerful. The application of the latest industrial tablet touch screen makes industrial automation easier to use, more functional, and cheaper. This makes the price of the measurement and control system with an instrument+upper computer structure much lower than that of traditional DCS systems, and its distributed structure has higher reliability. Except for some newly launched models, the V9.XX version communication protocol is fully compatible with our company's V8.XX communication protocol after improving performance and functionality. The original upper computer software can be used directly without modification.

一、Interface specifications

The AI series instruments use asynchronous serial communication interfaces, and their interface levels comply with RS232C or RS485 standards. The data format is 1 start bit, 8 bits of data, no verification or even verification bit, and 1 or 2 stop bits. Usually, the baud rate for communication data transmission is 9600 bps, but AI series instruments can be adjusted to 4800-28800 bps; When a faster refresh rate is required, 19200 or 28800bps can be selected; When the communication distance is very long or communication is interrupted, 4800bps can be selected.

The communication distance of RS485 can reach over 1KM (some have actually reached 3-4KM), and multiple AI instruments and computers can be connected with just two wires. By using a converter with RS232/RS485 or USB/RS485 interfaces, the RS232 communication port or USB port on a regular computer can be converted into an RS485 communication port. Our company's RS232/RS485 and USB/RS485 converters have the following advantages: small size, no need for initialization to adapt to any software, no need for external power supply, and certain lightning resistance. According to regulations, RS485 can connect up to 32 instruments or computers on one communication line. When more instruments need to be connected, repeaters are needed, or communication interfaces with chips such as 1/2 or 1/4 load are used to increase the number of connected instruments. At present, low load chips are used as communication interfaces for AI instruments, which enable the instruments to have certain lightning and anti-static functions, and can connect about 60 instruments without the need for repeaters.

Optoelectronic isolation technology is used for RS232 and RS485 communication interfaces to isolate the communication interface from other parts of the instrument line; This method will not affect other instruments when a certain instrument on the communication line is damaged or malfunctioning. Similarly, when the communication part is damaged or the host malfunctions, the instrument can still perform normal measurement and control through the keyboard, with high reliability. When there are master-slave communication products used by other companies on the same network, such as PLCs, frequency converters, etc., the AIBUS protocol cannot guarantee the normal operation of other company products; Usually, AI instruments and other products should be connected by using different communication lines or using MODBUS protocol instead of being installed on the same RS485 communication bus.

Protocol AFC=AFC A+AFC D * 8 is used for V9. x intelligent instruments, with the following functions:

AFC	Description	AFC	Description
0	Standard MODBUS-RTU, No verification	8	Standard MODBUS-RTU, even verification
1	AIBUS, No verification	9	AIBUS, even verification
2	Compatible MODBUS-RTU, No verification	10	Compatible MODBUS-RTU, even verification
4	S6/S7 address compatibility mode under standard MODBUS-RTU protocol, no verification, modules S, S1, S4.	12	S6/S7 address compatibility mode under standard MODBUS-RTU protocol, even verification, modules S, S1, S4.

二、 Description of communication commands for AIBUS protocol

The hexadecimal data format is used to represent various commands and data. The communication commands of AIBUS are reading and writing; The sending of commands is 8 bytes, while the receiving is 10 bytes, which makes it easy for the upper computer to write software and perform various operations on the instrument completely; But the sending of commands must be continuous, and if the byte length is incorrect, the instrument will not respond.

Instrument address: AIBUS protocol addresses range from 0 to 80, and a maximum of 81 AI instruments can be connected on a communication line, its communication address is determined by the parameter Addr. Two duplicate values between 128 and 208 (80H to D0H in hexadecimal) are used to represent the address code; Due to the fact that two consecutive numbers from 128 to 208 usually do not appear in the AI instrument, data and addresses will not conflict due to duplication. The AI instrument communication protocol stipulates that the address command is two identical bytes, with a value of=instrument address+80H. For example: Addr=10 (hexadecimal number is 0AH, 0A+80H=8AH), then the address command of the instrument is:

8AH 8AH

Parameter address: parameter address of an 8-bit binary number (one byte) is used to represent the parameters of the instrument, which represents the parameter name to be read/written in the commands, and the meanings of various parameters are shown in the table below.

Verification code: The 16 bit sum verification method is adopted, and the calculation for the verification code of the read command is:

code to be read * 256 + 82 (52H) + Addr

The calculation for writing commands is the remainder obtained by performing a 16 bit binary addition on the following formula (overflow parts are not processed):

code to be written * 256 + 67 (43H) + parameter value to be written + Addr

Return data: Whether reading or writing, the instrument returns 10 bytes, with PV, SV, and the read parameter accounting for 2 bytes, representing a 16 bit binary signed complement integer. The low byte comes first and the high byte comes last. The integer cannot represent a decimal point, which needs to be processed by the user on the upper computer; MV occupies one byte, in 8-bit signed binary format, with a numerical range of -110~+110, the status bit occupies one byte, and the checksum occupies two bytes, totaling 10 bytes. The checksum is the remainder obtained by adding PV+SV+(alarm status * 256+MV) + parameter value + Addr to a 16 bit integer, with overflow ignored.

The specific commands are as follows:

Reading:

Low byte of address	High byte of address	Reading	Code	Low byte	High byte	Verification and low byte	Verification and high byte
80H+instrument address	80H+instrument address	52H	Refer to the parameter code table	00H	00H	Refer to note1	

Note 1: Checksum=Read parameter code * 256 (100H) + 82 (52H) + Instrument address

If the upper limit alarm value of address 1 of the reading instrument is as follows:

Low byte of address	High byte of address	Reading	Code	Low byte	High byte	Verification and low byte	Verification and high byte
81H	81H	52H	01H	00H	00H	53H	01H

Checksum=1(01H)*256(100H)+1(01H)+82(52H) = 339(153H); Due to the fact that the low byte comes first and the high byte comes last, it is listed as 53H and 01H in the table above.

Writing:

Low byte of address	High byte of address	Writing	Code	Low byte	High byte	Verification and low byte	Verification and high byte
80H+instrument address	80H+instrument address	43H	Refer to the parameter code table	Refer to note1		Refer to note2	

Note 1: The data that needs to be written into the instrument should have low bytes before and high bytes after.

Note 2: Checksum=(Write parameter code * 256 (100H)+67 (43H)+instrument address+write value)&FFFFH to obtain remainder

If the set value for the address 1 of the writing instrument is 100.0:

Low byte of address	High byte of address	Writing	Code	Low byte	High byte	Verification and low byte	Verification and high byte
81H	81H	43H	00H	E8H	03H	2CH	04H

Checksum=0(00H)*256(100H)+1(01H)+1000(03E8H)+67(43H) = 1068(42CH); Due to the fact that the low byte comes first and the high byte comes last, it is listed as 2CH and 04H in the table above.

Return data: Whether reading or writing, the instrument returns 10 bytes

Low byte of PV	High byte of PV	Low byte of SV	High byte of SV	MV	Status byte	Low byte of reading / writing	High byte of reading / writing	Verification and low byte	Verification and high byte
note1								note2	

Note 1: PV=(high byte of PV * 256) + low byte of PV

Methods for SV and reading or writing parameter values are the same as above.

Note 2: Checksum=remainder obtained by (PV + SV + status of byte * 256 + MV+ reading or writing parameter value+instrument address)&FFFFFFH; please compare the checksum of the return data with the calculated checksum when communication data is interfered. If the two are the same, the data is normal. Otherwise, the data may be abnormal due to interference.

Assuming that PV of instrument address 1=100.0, SV=0.0, no alarm, no output, and SV of the reading or writing=0.0, the return commands are as follows:

Low byte of PV	High byte of PV	Low byte of SV	High byte of SV	MV	Status byte	Low byte of reading / writing	High byte of reading / writing	Verification and low byte	Verification and high byte
E8H	03H	00H	00H	00H	60H	00H	00H	E9H	63H

The status byte represents the relay status when the instrument alarms, and its meaning is as follows (bit 7 is fixed to 0):

Status byte	Meaning
0	HIAL 0: no alarm 1: alarm
1	LoAL 0: no alarm 1: alarm
2	dHAL 0: no alarm 1: alarm
3	dLAL 0: no alarm 1: alarm
4	orAL 0: no alarm 1: alarm
5	AL1, 0: action
6	AL2, 0: action

三、Description of communication commands for MODBUS-RTU protocol

The AI series instruments support commands 03H (read parameters and data) and 06H (write individual parameters) under the MODBUS protocol, which can communicate with other MODBUS devices; RTU (binary) mode is adopted to ensure speed, baud rate can be set from 4800 to 19200bps, with 1 or 2 stop bits, no verification, and instrument address range from 0 to 80.

The command 03H can read 1~20 data at a time, with each data being 2 bytes. For example, the command to read 2 data is as follows:

instrument address	Writing	Address of code	length	Check Code
XXH	03H	00H XXH	00H 02H	CRC

Command 06H, for example, if the SV=100.0 (dPt=1), then the command sent is:

instrument address	Writing	Address of code	Value	Check Code
XXH	06H	00H 00H	03H E8H	CRC

The return data format follows the standard MODBUS protocol, and most configuration software can handle it on its own. Writing commands do not support returning PV or other information, they only return the parameter values written by themselves. Due to the limitations of the MODBUS protocol, when writing commands cannot return PV and other information, it will result in PV being unable to be refreshed during writing. When continuous parameter writing is required, the method of writing once and then alternately reading once should be adopted to avoid the inability to refresh PV and other information in time during continuous writing. In addition, if a bug in the program causes writing commands to be misused, it may lead to incorrect parameters being written into the instrument. Therefore, it is advisable to use writing instructions as little as possible to avoid abnormal operation of the instrument.

By using our company's Modbus AIBUS communication relay control and protocol converter or S6 enhanced communication module with built-in CPU, it is possible to achieve more efficient reading of large amounts of data; For detailed information, please refer to the relevant users' manual.

四. Parameter code (register) address and meaning (AIBUS and MODBU-RTU protocols are the same)

A parameter code table for reading/writing of AI series single-loop artificial intelligence control instruments (for compatible S6 mode, please refer to the S6 module manual)

（AI-8 series/AI-516/516P/526/526P/519/716/716P/719/719P）

Note: The decimal code, hexadecimal code, and modbus register number are different ways to write the same parameter. The writing methods for different upper computer software are different. When one is not recognized, the other two can be tried.

decimal	hexadecimal	MODBUS	Parameter	Description
0	0	40001	SV	the same unit as PV
1	1	40002	HIAL	the same unit as PV
2	2	40003	LoAL	the same unit as PV
3	3	40004	HdAL	the same unit as PV
4	4	40005	LdAL	the same unit as PV
6	6	40007	CtrL	0, ONOFF; 1, APID; 2, nPID; 3, PoP; 4, SoP
7	7	40008	P	the same unit as PV
8	8	40009	I	s
9	9	40010	d	0.1s
10	A	40011	CtI	0.1s
11	B	40012	InP	Refer to the users' manual

12	C	40013	dPt	0, 0; 1, 0.0; 2, 0.00, 3, 0.000; When using dpt as the decimal point, 0~3 is judged normally. When reading value >127, subtract 127 to obtain the actual number of decimal places to be processed; When INP=0, communication needs to be fixed to 1 decimal place. If it is not expected to display the decimal point is on the table, please set dpt=0 and reading value=128. At this time, it needs to be processed to 1 decimal place. The writing data of dPt range from 0 to 3, no need to add 128.
13	D	40014	ScL	the same unit as PV
14	E	40015	ScH	the same unit as PV
15	F	40016	AOP	Refer to the users' manual
16	10	40017	Scb	the same unit as PV
17	11	40018	oPt	0, SSR; 1, rELy; 2, 0-20; 3, 4~20; 4, PHA1; 5, nFEd; 6, FEd; 7, FEAT
18	12	40019	OPL	%
19	13	40020	OPH	%
20	14	40021	AF	Refer to the users' manual
21	15	40022	Instrument model and characteristic words	Refer to the table of instrument models and characteristic words
22	16	40023	Addr	
23	17	40024	FILt	
24	18	40025	AMAn	0, MAN; 1, Auto; 2, FSV; 3,FAut
25	19	40026	standby	
26	1A	40027	MV	
27	1B	40028	Srun 0 run/1 stop/2 remain	0, run; 1, StoP; 2, HoLd
28	1C	40029	CHYS	the same unit as PV
29	1D	40030	At	0, OFF; 1, on; 2, FoFF; 3,AAt
30	1E	40031	SPL	the same unit as PV
31	1F	40032	SPH	the same unit as PV
32	20	40033	Fru	0, 50C; 1, 50F; 2, 60C; 3, 60F
33	21	40034	OEF OPH	the same unit as PV

34	22	40035	Act		0, rE; 1, dr; 2, rEbA; 3, drbA
35	23	40036	AdIS		0, OFF; 1, on; 2, FoFF
36	24	40037	Aut		0, SSR; 1, rELy; 2, 0~20; 3, 4~20
37	25	40038	P2		the same unit as PV
38	26	40039	I2		s
39	27	40040	d2		0.1s
40	28	40041	Ctl2		0.1s
41	29	40042	Et		Et=Et1+Et2*10; Et1 and Et2 each have 7 options: 0, nonE; 1, ruSt; 2, SP1.2; 3, PId2; 4, EAct; 5, Eman; 6, Erun; 7, Eout
42	2A	40043	SPr		unit/(minutes or hours) (processed in units equivalent to measured values)
43	2B	40044	Pno		integer
44	2C	40045	PonP		0, Cont; 1, StoP; 2, run1; 3, dASt; 4, HoLd
45	2D	40046	PAF		Refer to the users' manual
46	2E	40047	STEP		integer
47	2F	40048	Elapsed time		0.1 seconds, 0.1 minutes, or 0.1 hours, determined by PAF parameters
48	30	40049	Event output status		0, no event output; 1. AL1 action; 2. AL2 action; 3. AL1 and AL2 actions
49	31	40050	OPrt		
50	32	40051	Strt		Define the time required for valve rotation
51	33	40052	SPSL		Used to define the external quantitative range when there is feedback for forward and reverse valve control
52	34	40053	SPSH		
53	35	40054	Ero		
54	36	40055	AF2		AF2
55	37	40056	nonc 5, 7	8*9Cc	Refer to users' manual for parameter Cc The nonc 5 and 7 series are used to select normally open and normally closed: starting from bit 0, corresponding to AL1, AL2, AU1, and AU2, respectively

56	38	40057	SPrL			
57	39	40058	EFP1	8*9 OPH1		
58	3A	40059	EFP2	8*9 OPH2		
59	3B	40060	EFP3	8*9 OPH3		
60	3C	40061	8*9OPH4			
61	3D	40062	nonc 8			starting from bit 0, corresponding to AL1, AL2, AU1, and AU2, respectively
62	3E	40063	EAF			Refer to the users' manual
63	3F	40064	Prn			Used to select the formula group for use in the STOP status
64	40	40065	EP1			8 parameters that need to be read and written can be customized
65	41	40066	EP2			
66	42	40067	EP3			
67	43	40068	EP4			
68	44	40069	EP5			
69	45	40070	EP6			
70	46	40071	EP7			
71	47	40072	EP8			
72	48	40073	Valve (Read Only)	8 * 9 inner thermocouple temperature	998 read only SV	
73	49	40074	8 * 9 auxiliary control PV			
74	4A	40075	PV(read only)		998PV high byte	Calculation for ordinary single-loop instruments (read-only short type) 998PV =high byte * 10+low byte* 10/65536
75	4B	40076	SV(read only)		998PV low byte	SV in real time for ordinary single-loop instruments (read-only short type)
76	4C	40077	MV + alarm			The low byte represents the percentage of MV output, the high byte represents the alarm status, and the alarm status corresponds to the same as AIBUS.

77	4D	40078	MV + running		BIT0~1: running/stopping/pausing status; BIT2: 1, self-tuning start; BIT3; 1, manual status; BIT4-7, standby; BIT8~13 respectively represent the MV status: OP1/OP2/AU1/AU2/MIO2/MIO1, 0 action, and 1 no action; Taking Table A as an example, MIO1 in I2 corresponds to 14 16. MIO1 of I5 corresponds to 14 15, and MIO2 corresponds to 14 16.
78	4E	40079	Room temperature compensation		Partial models read the compensation measurement temperature of the internal hot spot and even cold end of the instrument (read-only)
79	4F	40080	MV（-25600~25600）	8*9 Intermediate MV	
80	50	40081	SP1		Temperature of the first section of the program segment
81	51	40082	t1		Time of the first section of the program segment。
82	52	40083	SP2		
83	53	40084	t2		
84	54	40085	SP3		
85	55	40086	t3		
86	56	40087	SP4		
87	57	40088	t4		
88	58	40089	SP5		
89	59	40090	t5		
90	5A	40091	SP6		
91	5B	40092	t6		
92	5C	40093	SP7		
93	5D	40094	t7		
94	5E	40095	SP8		
95	5F	40096	t8		
96	60	40097	SP9		
97	61	40098	t9		
98	62	40099	SP10		

99	63	40100	t10	
100	64	40101	SP11	
101	65	40102	t11	
102	66	40103	SP12	
103	67	40104	t12	
104	68	40105	SP13	
105	69	40106	t13	
106	6A	40107	SP14	
107	6B	40108	t14	
108	6C	40109	SP15	
109	6D	40110	t15	
110	6E	40111	SP16	
111	6F	40112	t16	
112	70	40113	SP17	
113	71	40114	t17	
114	72	40115	SP18	
115	73	40116	t18	
116	74	40117	SP19	
117	75	40118	t19	
118	76	40119	SP20	
119	77	40120	t20	
120	78	40121	SP21	
121	79	40122	t21	
122	7A	40123	SP22	
123	7B	40124	t22	
124	7C	40125	SP23	
125	7D	40126	t23	
126	7E	40127	SP24	
127	7F	40128	t24	
128	80	40129	SP25	
129	81	40130	t25	
130	82	40131	SP26	
131	83	40132	t26	
132	84	40133	SP27	
133	85	40134	t27	
134	86	40135	SP28	
135	87	40136	t28	
136	88	40137	SP29	
137	89	40138	t29	

138	8A	40139	SP30	
139	8B	40140	t30	
140	8C	40141	SP31	
141	8D	40142	t31	
142	8E	40143	SP32	
143	8F	40144	t32	
144	90	40145	SP33	
145	91	40146	t33	
146	92	40147	SP34	
147	93	40148	t34	
148	94	40149	SP35	
149	95	40150	t35	
150	96	40151	SP36	
151	97	40152	t36	
152	98	40153	SP37	
153	99	40154	t37	
154	9A	40155	SP38	
155	9B	40156	t38	
156	9C	40157	SP39	
157	9D	40158	t39	
158	9E	40159	SP40	
159	9F	40160	t40	
160	A0	40161	SP41	
161	A1	40162	t41	
162	A2	40163	SP42	
163	A3	40164	t42	
164	A4	40165	SP43	
165	A5	40166	t43	
166	A6	40167	SP44	
167	A7	40168	t44	
168	A8	40169	SP45	
169	A9	40170	t45	
170	AA	40171	SP46	
171	AB	40172	t46	
172	AC	40173	SP47	
173	AD	40174	t47	
174	AE	40175	SP48	
175	AF	40176	t48	
176	B0	40177	SP49	

177	B1	40178	t49	
178	B2	40179	SP50	
179	B3	40180	t50	
180	B4	40181		
181	B5	40182		
182	B6	40183		
183	B7	40184		
184	B8	40185	A00	Used to define multi-point correction, segmented power limitation, and custom input specifications. (Some model versions do not support this feature)
185	B9	40186	A01	
186	BA	40187	A02	Starting value
187	BB	40188	A03	Full scale
188	BC	40189	A04	Segmented range
189	BD	40190	D00	Display value or output value corresponding to the zero point
190	BE	40191	D01	
191	BF	40192	D02	
192	C0	40193	D03	
193	C1	40194	D04	
194	C2	40195	D05	
195	C3	40196	D06	
196	C4	40197	D07	
197	C5	40198	D08	
198	C6	40199	D09	
199	C7	40200	D10	
200	C8	40201	D11	
201	C9	40202	D12	
202	CA	40203	D13	
203	CB	40204	D14	
204	CC	40205	D15	
205	CD	40206	D16	
206	CE	40207	D17	
207	CF	40208	D18	
208	D0	40209	D19	
209	D1	40210	D20	
210	D2	40211	D21	
211	D3	40212	D22	

212	D4	40213	D23	
213	D5	40214	D24	
214	D6	40215	D25	
215	D7	40216	D26	
216	D8	40217	D27	
217	D9	40218	D28	
218	DA	40219	D29	
219	DB	40220	D30	
220	DC	40221	D31	
221	DD	40222	D32	
222	DE	40223	D33	
223	DF	40224	D34	
224	E0	40225	D35	
225	E1	40226	D36	
226	E2	40227	D37	
227	E3	40228	D38	
228	E4	40229	D39	
229	E5	40230	D40	
230	E6	40231	D41	
231	E7	40232	D42	
232	E8	40233	D43	
233	E9	40234	D44	
234	EA	40235	D45	
235	EB	40236	D46	
236	EC	40237	D47	
237	ED	40238	D48	
238	EE	40239	D49	
239	EF	40240	D50	
240	F0	40241	D51	
241	F1	40242	D52	
242	F2	40243	D53	
243	F3	40244	D54	
244	F4	40245	D55	
245	F5	40246	D56	
246	F6	40247	D57	
247	F7	40248	D58	
248	F8	40249	D59	

Note:

1. This system adopts a master-slave multi machine communication structure, with each command sent to the instrument and one data returned by the instrument. When writing upper computer software, the instrument should respond to each valid command within 0-10mS (note: excluding data transmission time, which is calculated based on different baud rates and data lengths); The upper computer must wait for the instrument to return data before issuing new commands, otherwise it will cause errors. If the instrument still fails to respond beyond the maximum response time, the reasons may be as follows: invalid command, invalid instrument address or parameter address, communication line failure, instrument not turning on, communication address mismatch, etc; At this time, the upper computer should resend commands or skip changing the address of the instrument

2. To improve efficiency, all values transmitted by the instrument are 16 bit binary complement integers; For example, when SV=100.0 ℃, the transmitted data is an integer of 1000. The upper computer must convert integers into actual data with decimal points according to certain rules, that is, after the upper computer program starts, the parameter dPt (0CH) is read first to obtain the decimal position of the measurement signal. Note: dPt>=128 indicates that the transmitted PV and parameters in the same unit as PV should be divided by 10 before being displayed. When writing such parameter values to the lower computer, the displayed number should be converted from decimal to an integer, multiplied by 10, and transmitted as a 16 bit binary complement

3. If the parameter code read to the instrument is not a parameter in the table (i.e. invalid parameter code or backup parameter code), the parameter value returned by the instrument is 32767. Due to the maximum range of parameters for AI series instruments being 32000, 32767 is considered a symbol of misreading parameter codes and is processed in the upper computer program.

4. If the parameter code written to the instrument is not a parameter in the table, or if this parameter does not belong to the instrument, the instrument will not report an error and ignore the command, and then return the parameter value of 32767. If the written value exceeds the internal numerical range of the instrument, for example, if the set output value exceeds the system's allowed output upper limit value, the instrument will write the upper limit value and return it.

5. When the manually adjusted instrument is in manual status, the manual output value can be adjusted by writing the 1AH parameter.

6. The application of instruments with communication and MODBUS protocol is becoming increasingly widespread. To prevent important parameters from being mistakenly written by the upper computer program and optimize MODBUS protocol performance, V9.1 instrument adds communication writing parameters to limit this function, and the reading and writing of commonly used on-site parameters can also be customized. On-site parameters can continuously arrange commonly used parameters, making it easier for the MODBUS protocol to read multiple on-site parameters that customers are interested in with a single command. This not only greatly improves the communication efficiency of MODBUS, but also avoids mistakenly writing parameters beyond the on-site parameters. The permission to write restrictions is controlled by the Loc parameter, and the rules are as follows:

Loc=0~63, allowing all parameters to be written, compatible with the communication rules of previous versions of our company's instruments, and adding on-site parameter reading and writing function;

Loc=128~191 (recommended), the operation restrictions on the instrument end correspond to Loc=0~63. The communication end is only allowed to write the following content: SV, program segment, HIAL~dHAL and other four alarm parameters, run/stop control parameters, and field parameters defined by EP1~EP8. The on-site parameters are set by the panel, and the parameters that need to be read and written by the communication end can be selected from 0 to 8 in the parameter table, while other parameters are prohibited from being written;

Loc=192-255, all parameters are prohibited from being written, communication only runs to read instrument data, and instrument operation restrictions correspond to Loc=0-63.

7. 15H is a characteristic word for instrument types, with different numbers for different types of instruments. The upper computer is used to distinguish instrument types and process data transmitted by different types of instruments in a targeted manner. The table of instrument models and characteristic characters is as follows:

Types	Characteristic words
AI-8X8 series artificial intelligence regulator/temperature controller	8080
AI-8X9 series cascade artificial intelligence regulator/ temperature controller	8090
AI-8X6 series artificial intelligence regulator/temperature controller	6080
AI-500 single-loop universal measuring instrument	5010
AI-501 single-loop universal measuring instrument	5010
AI-516 intelligent temperature controller	5160
AI-516P programmed Intelligent temperature controller	5167
AI-526 intelligent temperature controller	5260
AI-526P programmed intelligent temperature controller	5267
AI-518 intelligent temperature controller	5180
AI-518P programmed intelligent temperature controller	5187
AI-700 single-loop universal measuring instrument	7010
AI-701 single-loop universal measuring instrument	7010
AI-716 high-precision intelligent temperature controller	7160
AI-716P high-precision programmed intelligent temperature controller	7167
AI-719 high-precision intelligent temperature controller/ regulator	7190
AI-719P high-precision programmed intelligent temperature controller/ regulator	7197
AI-998 high-performance and multifunctional artificial intelligence industrial regulator	9980

8. Description of register 4DH in output port status and working status:

Bit	Status
0	00: running 01: stop 02: pause
1	
2	0: no action 1: AT turns on and automatically resets to 0 after the tuning is completed
3	0: AT status 1: manual status(only for instruments that support manual automatic switching), otherwise display 0 as AT status
4	Standby, default value 0
5	
6	
7	
8	0：OP1 ON 1：OP1 OFF
9	0：OP2 ON 1：OP2 OFF
10	0：AU1 ON 1：AU1 OFF
11	0：AU2 ON 1：AU2 OFF
12	0：MIO2 ON 1：MIO2 OFF
13	0：MIO1 ON 1：MIO1 OFF
14	
15	

五. Register revision records:

Version	Type	Revision
V9.22 2023-4	Single-loop instrument	1. Allow hold in SPr status and determine HDAL based on real-time SV.
		2. MIO module in version 9.2 is not compatible with the previous version, and I4 needs to be replaced with I44.
		3. Input specifications have changed, and the external compensation has changed from Cu50 to PT100
		4. Range of AHYS and CHYS has been changed to 999.9.
		5. Add a second event input to the instrument with Et and add option 7.
		6. When PAF.E=1, the event output switches to the slot AUX.
	8*8, 8*6, 8*9	1. Add the nonc parameter, with a different address from other single-loop instruments.
	8*8, 8*6	1. Add I9 current detection function, related parameters EFP1~3, AF, AF2.
	8*8, 8*9	1. Add EAF parameters to set sampling rate and dual PID switching. AUX transmission can be set.
	8*8	1. Add Prn for switching recipes.
	8*9	1. Input specifications can be different, which need to be in the same category. For now, only thermocouples are available.
		2. Add auxiliary input mode CC=204
V9.26 2023-8	Single-loop instrument	Add 38 to INP increase, 10~50mV input
		Add 4 to AOP to turn off the output at the same time of the alarm.
	8*9	48H becomes the internal even temperature
		Add EAF