AIBUS Communication Interface Protocol Instruction

Version 7.0

Summary:

AIBUS is the communication protocol for Yudian AI series instruments. It features:

- Performs powerful functions by simple instructions.
- High speed. 3-10 times faster than other protocols (for example MODBUS), and suitable for building large system.
- Applies 16 bit summation ECC (error correction code) and provides reliable communication.
- Supports baud rate of 1200, 2400, 4800, 9600 and 19200. With baud rate 19200, the average communication time to access an AI-7 or AI-8 series instrument is 20ms, and that of an AI-5 series instrument is 50ms.
- An RS485 communication interface can connect to up to 80 instruments.

Interface Specifications:

AI series instrument apply asynchronous serial communication interface, and are RS232C and RS485 compatible. The data structure is 1 start bit + 8 data bit + 1 or 2 stop bit. The communication baud rate are selectable from 1200 to 19200 bit/second, generally 9600 bit/S. When a communication port connect to more than 40 instruments or quicker refresh speed is needed, 19200bit/S is recommended. When the communication is not stable, 4800bit/S is recommended.

If RS232C communication interface is used, a computer communication port can connect to 1 instrument. If RS485 interface is used, a communication port can connect to up to 80 instruments.

RS485 communication interface is superior to RS232. The communication distance of RS485 can be longer than 1KM, and multiple instruments can communicate with computer through only two wires. A computer with RS232C communication port or USB port can realize RS485 communication by a RS232/RS485 or USB/RS485 communication interface converter. Yudian specially developed its own RS232/RS485 and USB/RS485 interface converter. Compared to competing products, it is smaller, can run without initialization or power supply, and provides protection from thunderbolt.

According to RS485 standard, a communication line can only connect maximum 32 of instruments or computers unless a repeater is installed or communication interfaces with special chip such as 75LBC184 or MAX487 are used. Yudian communication interface adopts 75LBC184 chip, can connect up to 60 instruments without repeater, and provides protection from thunderbolt and static electricity.

The RS232C and RS485 communication interfaces of AI instruments apply electric isolation technology to separate the communication interface and the other part of the instrument circuit.

When an instrument can work, it won't affect other instruments. If there is any problem with communication or with the computer, the instrument can still work well, and can be operated by its front panel. The 16 bit ECC can guarantee the reliability of the data. In case of communication malfunction, for example, when there are instruments with same address or there are products from other company, due to the 16 bit ECC, the instruments and computers can still independently work well without data confusion. Therefore, the distributed control system composed by AI instruments has high reliability.

The control computer can be common PC which has rich software resource and is developing very fast. The AI application software for control computer can work in WINDOWS operating system. It is powerful and has friendly user interface. The Yudain AIDCS is cheaper than traditional DCS, but its performance and reliability are better.

Communication Instruction:

Instructions and data of AI instruments are in hexadecimal structure. After optimization, the instructions are condensed to two: one is reading, another is writing. This is very simple but can full control the instrument.

The reading/writing instructions are as below:

READ : address code + 52H (82) + code of the parameter to be read + 0 + 0 + ECC.

WRITE : address code + 43H(67) + code of the parameter to be written + LSB of the value to be written + MSB of the value to be written + ECC.

1. Address code:

Every instrument in the same communication line should have a unique address which is from 0 to 80. So one communication line can connect to up to 81 AI instruments. The instrument address is defined by parameter "Addr".

The instrument address code is a two byte integer with every byte from 128 to 208 (80H to D0H hexadecimal), and the two byte are all equal to instrument adress+80H. For example, if the instrument address is 10 (0AH, 0AH+80H=8AH), then the address code is 8A8AH.

For multi-channel instruments, every active channel take one unique address. For example, an AI-7048 has 4 channels of controls, and takes 4 addresses. If Addr=5, then 5,6,7,8 are the communication address for its 4 channels.

2. Parameter code:

a parameter of AI instrument is represented by a parameter code which is one byte in hexadecimal format. The parameter code was summarized as below.

Address	Controller AI-708/808/708P/808P	Multi-channel Indictor	**Flow Totalizer** AI-708H/Y	Frequency controller /IO	Controller V7.5 (AI-501/701/519/7048

	(V7.0 ～ V7.1)	AI-702/704/706M (V7.6)		module AI-301M	)
00H	SV (setpoint) or SteP (program segment)		SV (batch control setpoint)	SV (Frequency control setpoint)	SP1 or SP2 or SteP (program type)
01H	HIAL (High limit alarm)	HIA(X)	FHIA	HIAL	HIAL* (High limit alarm)
02H	LoAL (Low limit alarm)	LoA(X)	FLoA	LoAL	LOAL* (Low limit alarm)
03H	dHAL (Deviation High limit alarm)		SPE	dHAL	HdAL (deviation high limit alarm)
04H	dLAL (Deviation low limit alarm)		Act	dLAL	LdAL (deviation low limit alarm)
05H	dF (Dead band)	dF(X)	Esn	dF	AHYS* (hysteresis)
06H	Ctrl (Control mode)		FSc	Ctrl	At * (auto-tuning switch)
07H	M5 (Hold parameter)		PdIH	M5	P (proportional band)
08H	P (Rating parameter)		CSc	P	I (integral time)
09H	t (Lag parameter)		CdIH	t	d (derivative time)
0AH	CtI (Control period)		Cut	CtI	CtI
0BH	Sn (Input specification)	Sn(X)	FdIH	Frd (Frequency range)	InP (input specification)
0CH	dIP (Decimal point position)	dIP (X)	FdIP	dIP	dPt (Decimal point position)
0DH	dIL (Input low limit)	Dil(X)	PA	dIL	SCL (Input low Limt)
0EH	dIH (Input high limit)	dIH(X)	Po	dIH	SCH (Input high limt)
0FH	ALP (Alarm output allocation)	ALP(X)	Co	ALP	AOP (Alarm output allocation)
10H	Sc (Input offset)	Sc (X)	Frd	Switch status	SCb (Input offset)
11H	OP1 (Output mode)	oPn (retransmission output channel)	CF	oP1	OPt (output mode)
12H	OPL (mV output low limit)	IoL (retransmission Low limit)	Bc	OPL	OPL
13H	OPH (mV output high limit)	IoH (retransmission high limt)	IoL	OPH	OPH
14H	CF (function selection)	AF (function selection)	FoH	CF	AF (Advanced function selection)

15H	Instrument model identifier or program status code (program type)	Model identifier	Model identifier	Model identifier	Model identifier
16H	addr (communication address)	addr	addr	addr	Addr
17H	dL (input filter)	dL	Ioh	dL	FILt (input filter)
18H	run (Run paramenter)	no/nc (NO/NC selection)	Dl	Run	A-M (auto/manual selection)
19H	Loc (Parameter Lock)	Loc	Loc	Loc	Loc
1AH	MV (manual output value) Or C01 (for program type)	Spare	Spare	MV	MV
1BH	t01	spare	FDF		nonc (NO/NC selection)
1CH	C02		CHIA		unit (measurement unit)
1DH	t02		CLOA		CtrL (control mode)
1EH	C03		PHIA		Act (direct/reverse action)
1FH	t03		PLOA		CHYS (control hysteresis)
20H	C04		ALP		Fru (unit and power frequency selection)
21H	t04		FSB		Aut (auxiliary output type)
22H	C05		CDIP		OPrt (soft-start)
23H	t05		PDIP		OHEF (work range of OPH)
24H	C06		PSc		SPr (start slope control)
25H	t06		CLN		SPL (low limit of setpoint)
26H	C07		FLJH		SPH (upper limit of setpoint)
27H	t07		FLJL		SP1 (setpoint 1)
28H	C08		EJH		SP2 (setpoint 2)
29H	t08		EJL		
2AH	C09		Batch accumulation clear		

2BH – 55H	T09 – C31 (program data)				
56H 57H	Running time (read only) MV (manual output value, for program type only)				

Remarks:

1) No return for reading any parameter code not included in the above table. AI-501 and 701 have only part of the above parameters, the operation on a parameter code that AI-501/701 doesn't possess is actually operated on parameter "SP1".
2) The 1AH is the manual output value in the instruments with manual control function.
3) 15H is the instrument model specification:

Model	Model Identifier
AI-518/708/808(V7.1)	=Baud rate (4800/9600/19200)
AI-518P/708P/808P(V7.1)	= program control byte (<256)
AI-501	= baud rate (compatible mode) or 1501 (made to order)
AI-701	= baud rate (compatible mode) or 1701 (made to order)
AI-519(V7.5)	= baud rate (compatible mode) or 1519 (made to order), selectable by parameter AF
AI-702M/704M/706M	768
AI-708H/808H (flow channel)	256 (common accumulation mode); 258 (batch control mode)
AI-808H (temperature/pressure channel)	257
AI-301M	512
AI-7048	7048

For AI-708P/808P series instruments, 15H is the program control digit. The MSB (Most Significant Byte) is 0, the LSB (Least Significant Byte) is as below:

(X) (X) (X) (X) (EV2) (EV1) (HOLD) (STOP)

The first four bits are not applicable.

HOLD and STOP = 0, program run

STOP = 0, HOLD = 1, program pause

STOP = 1, HOLD = 1, program stop

EV1 or EV2 indicates event output status. 1 means event output is working. 0 means event output is not working

4) Flow accumulation clear:

The flow accumulation parameter FLJH and FLJL of AI-708H/808H can be reset to 0, but can't be modified. The method is to write 30808 to FLJH, then the FLJH, FLJL (flow accumulation) and FJH, EJL (flow accumulation before compensation) will be reset to 0, and parameter CLn will increase 1. CLn is read-only. Writing 31808 to parameter code 2AH can clear batch accumulation value, and also reset batch control output relay.

3. ECC (error correction code):

ECC applies 16 bit summation code. It is a two byte integer with the low byte before the high byte.

READ instruction ECC = module of (parameter code*100H + 52H + Addr)/10000H

WRITE instrument ECC = module of (parameter code*100H + 43H + writing value + Addr) / 10000H

The range of Addr is 0～80.

4. Returned data:

For both READ and WRITE instruction, the instrument will automatically return to the follow data:

Process value (PV) + Set value (SV) + output value MV + alarm status + READ/WRITE parameter value + ECC

The PV, SV and the parameter value are all two byte integers with low byte before high byte. MV takes one byte with range -110～+110, and the alarm status takes also one byte. ECC takes 2 bytes. The total number of bytes is 10.

The meaning of the returning data is as below:

Model	Controllers	Multi-channel Indicators	AI-708H/ 808H flow channel	AI-808H temperature/pressure channel	AI-301M frequency module
PV	Measurement value PV	PV	PV of Instant flow	PV of temperature with unit 0.1℃	PV
SV	Setpoint SV	Channel number	Low byte of Accumulation flow or PV of batch control	PV of pressure with unit 0.001MPa	SV
MV	Output value MV or status byte B	Status byte A	High byte of accumulation flow or SV of batch control	Flow before compesation or frequency with unit 0.1Hz	Output value MV
Status byte	Status byte A	Status byte A			Status byte A
Parameter Value	The parameter value to be read or written.				

ECC of Returned data: = (PV + SV + (alarm status*256+MV) + parameter value + Addr) module 1000H

The status byte A indicates some status of the instrument. The details are as follow:

	Controllers/Single-channel	Multi-channel	Controllers/Single-channel

	indicators (V7.0)	indicators	Indicators (V7.5)
Bit 0	HIAL (high limit alarm)	HIAL	HIAL
Bit 1	LoAL (Low limit alarm)	LoAL	LoAL
Bit 2	dHAL (Deviation high limit alarm)	0	HdAL (Deviation high limit alarm)
Bit 3	dLAL (Deviation low limit alarm)	0	LdAL (Deviation low limit alarm)
Bit 4	orAL (input over range alarm)	orAL	orAL
Bit 5	AL1 status, 0 means activate	0	Spare (0)
Bit 6	AL2 status, 0 means action	0	0: MV output value 1: status byte B
Bit 7	Always set to 0		

The multiple-channel indicators have status byte B. For controllers and single-channel indicators with version 7.5 or above, if Bit 6 of status byte A is 0, MV byte means MV; if it is 1, MV byte means status byte B. The 0 to 6 bits of status byte B indicate the status of port OP1, OP2, AL1, AL2, AU1, AU2 and MIO. 0 means switch off or no output, and 1 means switch on or output. When OUTP or AUX works as control output, the corresponding bits is 0. By communication function, the host computer can input or output on-off signals via the above ports. The idle output port which is not set as alarm output port by parameter ALP, can be set as on-off signal input/output port. By parameter nonc (normal open/normal close) can output on-off signal. To input an on-off signal, nonc should be set to “no”. That 1 is read means that external switch is open or signal is input.

Programming

Every time the control computer sends an instruction to the instrument, the instrument will return one data. The instrument should reply the data within 0-150ms. Computer cannot send a new instruction before receiving the reply; otherwise, it will cause some error. If the instrument does not reply after the maximum response time, there is some problem, for example, invalid instruction, communication line malfunction, error communication address or the instrument is power off. Then the control computer should send the instruction again.

For example, in order to set setpoint (the according parameter code is 0) of the instrument with ADDR 1 to 100.0℃ (the integer value is 1000), the program designed by VB is as below:

1. Initialize the communication port, includes set the baud rate equal to the instrument and set 8 data bit, 2stop bit, no parity bit. Note that some model of RS485 communication port or RS-232/RS-485 communication converter have some request for RTS or DTR control wire. The computer should program for those control wire.

2. VB program instruction:
   COMM1.OUTPUT=CHR$(129)+CHR$(129)+CHR$(67)+CHR$(0)+CHR$(232)+CHR$(3)+CHR$(44)+CHR$(4)
3. Decimal point: the parameter value is an integer. The decimal digits can be read from parameter code 0CH.
4. Engineering unit (for version 7.5 or above only): the engineering unit can get from parameter code 1CH.

Communication Specification:

Model	AI-301, AI-7/8 series instruments	AI-5 series instruments
Maximum return time (4800bit/S)	100mS	150mS
Minimum return time (19200 bit/S)	5mS	5mS
Average access period (19200bit/S)	20mS	50mS
Available writing times	1 billion	10 million

Note: For AI-5 series instruments, the writing interval is better longer than 2 minutes. Otherwise, the longevity of storage unit may be shortened.