Part One

Communication Interface Instruction

1. Introduction

The watermeter is equipped with 2 serial communication interfaces, one is IrDA interface, the other is RS485/USART.

USART, that is a serial interface of logic level, suitable to directly communicate with other external MCU communication, low power consumption.

2. Default setting

RS485/USART	9600,N,8,1
IR	9600,N,8,1

3. Change the default setting

All the serial parameters setting can be done with a software named V49_SETUP.

The current serial parameters can be shown in M0E.

4. Communication protocol

a. HART

b. MODBUS

c. M-BUS

d. Haifeng ASCII

e. CJ188

f. Protocols used by Huizhong

Part Two

HART Protocol

1. Referenced Documents

SCF_SPEC-054	FSK Physical Layer Specification	Version 8.1
SCF_SPEC-081	Data Link Layer Specification	Version 8.0
SCF_SPEC-127	Universal Command Specification	Version 6.0
SCF_SPEC-051	Common Practice Command Specification	Version 8.0
SCF_SPEC-081	Common Tables Specification	Version 13.0
SCF_SPEC-307	Command Response Code Specification	Version 5.0
SCF_SPEC-099	Command Summary Specification	Version 8.0

2. Expanded Device Type cod

Manufacturer ID	=252	(0xFC, unknown）
Manufacturers' Device Type Code	=245	(0xF5)

3. Communication Setups

FSK on Current Loop	Baud Rate 1200, Even, 8,1
RS485	Baud Rate 300~9600, Even, 8,1
IR Communicator	Baud Rate 300~9600, Even, 8,1
Address by Manufacturer	1
Initial Hart Tag	TSF-V49C
Burst Mode	do not support

4. General Transmitter Information

4.1 Variables Map

Code	Variable	Unit	
0	flow rate	m3/h	
1	flow positive total	M3, Liter, Gallon, Cubit feet	
2	heat(energy) rate	kW	
3	heat positive total	kWh, BTU,MJ	
4	Temperature T1	Degree Celsius	
5	Temperature T2	Degree Celsius	
6	Temperature difference	Degree Celsius	
7	Flow velocity	m/s	
8	T1 sensor resistance	Ohm	
9	T2 sensor resistance	Ohm	
10	CPU temperature	Degree Celsius	
11	Frequency percentage	%	
12	Battery voltage	Volt	
13	Total travel time	Seconds	
14	Delta travel time	Seconds	
15	Negative total flow rate	M3, Liter, Gallon, Cubit feet	

16	Total Flow rate today	M3, Liter, Gallon, Cubit feet	
17	Total Flow rate this month	M3, Liter, Gallon, Cubit feet	
18	Total Flow rate this year	M3, Liter, Gallon, Cubit feet	
19	Calibration total	M3, Liter, Gallon, Cubit feet	
20	Negative total heat	kWh, BTU,MJ	
21	Total heat rate today	kWh, BTU,MJ	
22	Total heat rate this month	kWh, BTU,MJ	
23	Total heat rate Tariff 2	kWh, BTU,MJ	Not realized yet
24	Total heat rate Tariff 3	kWh, BTU,MJ	Not realized yet
25	Pipe outer diameter	mm	
26	Total working Hours	hour	
27	Total Failure hours	hour	
28	Calibration Duration	seconds	

4.2 Current Loop Mapping

Current loop can be only mapped on Instant flow rate.

4.3 Non-lost data storage

4.3.1 All accumulated data can be automatically stored in EEPROM every 2 minutes.

4.3.2 HART Tag is stored in EEPROM. (location: 0x700-0x7FF)

4.3.3 The device address will be stored in EEPROM after setting within 2 minutes. Order 42 will lead an automatic storage in EEPROM.

4.3.4 The number of leading characters will be stored in EEPROM after setting within 2 minutes. Order 42 will lead to an automatic storage in EEPROM.

4.4 Multi-drop Mode

V49 do not support Multi-drop Mode

4.5 Burst Mode

V49 do not support Burst Mode

5 Orders supported

5.1 General Orders

0 Read Unique Identifier

1 Read Primary Variable (i.e. flow rate)

2 Read

3 Read Dynamic Variables and Loop current

6 Write polling address

7 Read loop configuration

8 Read Dynamic Variables Classifications

9 Read device Variables and status

11 Read unique identifier associated with Tag

12 Read message

13 Read Tag, descriptor and Date

14 Read Primary Variable transducer information

15 Read Device Information

16 Read Final assembly number
17 Write message
18 Write Tag, descriptor and Date
19 Write Final assembly number
20 Read Long Tag
21 Read unique identifier associated with Long Tag
22 Write Long Tag
5.2 Common orders
33 Read Device Variables
42 Perform device reset
40 Enter/exit fixed current mode
43 Set Primary variable zero (to perform a Zero Setting
45 Trim Current Loop Zero (to adjustment current loop to 4mA)
46 Trim Current Loop Gain (to adjustment current loop to 20mA)
59 Write number of the response preamble

Part Three

MODBUS Protocol

1. MODBUS factory default settings
1.1 RS485
Baud rate 9600 （optional: 300,600,1200,2400,4800,9600）
Checksum None （optional: None, Even, Odd）
Address 1
1.2 IR
Baud rate 9600 （optional: 300,600,1200,2400,4800,9600）
Checksum None （optional: None, Even, Odd）
Address 1
Above parameters are displayed in M0E and M10
2. MODBUS other details
2.1
2.2
2.3
2.4
3. MODBUS address list of common register

Register address	Register number	Register Name	Data format	Description
0001-0002	2	Instant flow rate	IEEE754	Unit: m3/h
0003-0004	2	Instant flow rate	IEEE754	Unit: kW
0005-0006	2	Flow velocity	IEEE754	Unit: m/s
0009-0010	2	Positive accumulated flow Note 1	LONG	Unit:m3,L,GAL,ft3
0011-0012	2	Decimal part of the positive	IEEE754	

		accumulated flow		
0013-0014	2	Negative accumulated flow	LONG	Unit:m3,L,GAL,ft3
0015-0016	2	Decimal part of negative accumulated flow rate	IEEE754	Single floating-point number, also known as FLOAT format.
0017-0018	2	Positive accumulated heat	LONG	Unit: kWh, GJ, KBTU
0019-0020	2	Decimal part of positive accumulated heat rate	IEEE754	
0021-0022	2	Negative accumulated heat rate	LONG	Unit: kWh, GJ, KBTU
0023-0024	2	Decimal part of negative accumulated heat rate	IEEE754	
0025-0026	2	Net accumulated flow	LONG	Unit:m3,L,GAL,ft3
0027-0028	2	Decimal part of net accumulated flow rate	IEEE754	
0029-0030	2	Net accumulated heat	LONG	Unit: kWh, GJ, KBTU
0031-0032	2	Decimal part of net accumulated heat rate	IEEE754	
0033-0034	2	Supply water temperature T1	IEEE754	Unit: ℃
0035-0036	2	Return water temperature T2	IEEE754	Unit: ℃
0053-0055	3	Calendar(date and time)	BCD	Writable. 6 byte BCD represent SMHDMY, low bit is in front.
0056	1	Date and time storage automatically	BCD	Writable. i.e. 0512H means 12:00 of 5th 0012H means 12:00 daily
0057	1	Input the protect password	Integer	Writable
0058	1	Code of sleep mode	Integer	Writable. Write in 0x5A58F can be in sleep mode.
0059	1	Write in with keyboard	Integer	Writable
0060	1	Display the number of moving to the menu	Integer	Writable
0061	1	current menu	Integer	Writable
0062	1	Main communication address	Integer	Writable, maximum 255
0063	1	BC timer	Integer	Write in 0 to start BC
0064	1	OCT pulse 1	Integer	
0065	1	OCT pulse 2	Integer	
0071	1	complementary error code	Bits	note 4

0072	1	Error code	Bits	note 5
0077-0078	2	T1 resistance value	IEEE754	Unit：Ω
0079-0080	2	T2 resistance value	IEEE754	Unit：Ω
0081-0082	2	Total transit time	IEEE754	Unit: uS
0083-0084	2	Transit time	IEEE754	Unit: nS
0092	1	Signal quality	Integer	Channel 1 in the low
0093	1	#1 channel signal strength	Integer	Range:0~4095
0094	1	#2 channel signal strength	Integer	
0095	1	Battery power	Integer	V=REG95*(2.5/4096)
0099-0100	2	Reynolds number	IEEE754	
0101-0102	2	Reynolds correction coefficient	IEEE754	
0105-0106		Total working time	Long	Unit: Seconds
0107-0108		Times of power on	Long	
0109-0110		CPU temperature	IEEE754	Unit: ℃
0113-0114	2	Net accumulated flow rate (floating point format)	IEEE754	Unit: m3/h Signal Accuracy. Not Recommended to read these Registers with new developments due to limited accuracy
0115-0116	2	Positive accumulated flow rate (floating point format)	IEEE754	
0117-0118	2	Negative accumulated flow rate (floating point format)	IEEE754	
0119-0120	2	Net accumulated heat rate (floating point format)	IEEE754	
0121-0122	2	Positive accumulated heat rate (floating point format)	IEEE754	
0123-0124	2	Negative accumulated heat rate (floating point format)	IEEE754	
0125-0126	2	Daily net accumulated flow rate (floating point format)	IEEE754	
0127-0128	2	Monthly net accumulated flow rate (floating point format)	IEEE754	
0129-0130	2	time-share accumulator Tariff 2	LONG	
0131-0132	2	Decimal part of time-share accumulator Tariff 2	IEEE754	
0133-0134	2	time-share accumulator Tariff 3	LONG	
0135-0136	2	Decimal part of time-share accumulator Tariff 3	IEEE754	

0137-0138	2	Daily accumulated flow rate	LONG	9 Digits
0139-0140	2	Daily decimal part of accumulated flow rate	IEEE754	
0141-0142	2	Monthly accumulated flow rate	LONG	
0143-0144	2	Monthly decimal part of accumulated flow rate	IEEE754	
0144-0145	2	Accumulated flow of this year	LONG	
0147-0148	2	Decimal part of accumulated flow of this year	IEEE754	
0149-0150	2	Daily accumulated heat rate	LONG	
0151-0152	2	Decimal part of accumulated heat rate	IEEE754	
0153-0154	2	Monthly accumulated heat rate	LONG	
0155-0156	2	Monthly decimal part of accumulated heat rate	IEEE754	
0162	1	Daily accumulated data pointer	Integer	
0163	1	Monthly accumulated data pointer	Integer	
0165-0166		Fault running time	Long	Unit: Seconds
0181-0182	2	Temperature difference	IEEE754	Unit: ℃
0185-0186		Frequency coefficient	IEEE754	
0187-0188		Automatically store the total time	Long	
0189-0190		Automatically store the positive accumulated flow	Long	
0191-0192		Automatically store the instant flow	IEEE754	
0193-0194		Automatically store the total working time of negative flow rate	Long	
0195-0196		Automatically store the negative flow rate	Long	
0197-0198	2	Verification of flow accumulator	Long	Unit:m3,GAL,ft3，L
0199-0200	2	Verification of the decimal part of flow accumulator	IEEE754	
0201-0202	2	Verification of heat accumulator	long	Unit: kWh, GJ, KBTU

0203-0204	2	Verification of the decimal part of heat accumulator	IEEE754	
0205	1	Verification time	integer	Unit: in 250mS
0221-0222	2	Inside pipe diameter	IEEE754	Unit:mm
0259-0260	2	Monthly max instant flow	IEEE754	Unit: m3/h
0261-0262	2	Monthly max instant heat	IEEE754	Unit: kW
0263-0264	2	Monthly max inflow temperature	IEEE754	
0265-0266	2	Monthly max outflow temperature	IEEE754	
0267-0268	2			
0269	1			
0270	1			
0271-0272	2	Transit-time	IEEE754	In unit nS
0273-0274	2	M-bus secondary address	BCD	
0275-0276	2	Negative flow measurement time	long	In unit seconds
0277-0280	4			
0281-0282	2			
0283-0284	2			
0285-0286	2	Daily max instant flow	IEEE754	Unit : m3/h
0287-0288	2	Daily max instant heat	IEEE754	Unit : kW
0289-0290	2	Daily max supply water temperature	IEEE754	Unit : ℃
0291-0292	2	Daily max return water temperature	IEEE754	Unit : ℃
0293-0294	2			
0295-0296	2	User code	BCD	
0297-0298	2	Stop time of time-share accumulator	BCD	
0299-0300	2	Start time of time-share accumulator tariff2	BCD	
0301-0302	2	Start time of time-share accumulator tariff3	BCD	
0303	0.5	The status of time-share accumulator and quantitative controller	BCD	Low byte
0303-0304	1.5	#1 start time of quantitative controller	BCD	
0305-0306	1,5	#2 start time of quantitative controller	BCD	

0306-0307	1,5	#3 start time of quantitative controller	BCD	
0307-0308	1,5	#5 start time of quantitative controller	BCD	
0309-0310	1,5	#5 start time of quantitative controller	BCD	
0311-0312	2	Quantitative controller setting	IEEE754	
0361-0362	2	Always display 361.00 Note 2	IEEE754	For test
0363-0364	2	Always display 363348858	long	
0365-0366	2	Always display-987654321	long	
1438	1	Unit code of accumulated flow	INTEGER	0=cubic meter 1=liter 2=gallon 5=cubic foot
1439	1	Multiple factor of accumulated flow	Integer	n:(-4..3), note1
1440	1	Multiple factor of accumulated heat	Integer	n:(-3..4), note1
1441	1	Unit code of accumulated heat	Integer	0=GJ , 2=KWh 1=Kilo BTU
1491	1	Instrument types	Integer	EN1434-3
1527	1	Software version Note 3	Integer	
1528	1	Manufacturer Note3	Integer	Value=0x1188
1529	2	ESN	BCD	MSB first

Note 1： （1）For all cumulants, a long integer represents the integer part and a real number represent the decimal part. In most applications, users just need to read the long integer part, do not have to read the decimal part.

If N means the long integer value(for example the positive accumulated flow, the bit value of 32 in REG 0009,0010 is a long integer)
Nf means the decimal part(for example the positive accumulated flow, 32 bit floating point number in REG 0011, 0012)
n means the decimal point position (for example the accumulated flow, REG 147).

Then,
The final total accumulated flow = (N+Nf) ×10-n
REG 148 value range from 0~3, determines the unit of accumulated flow.

0	cubic meter	(m3)
1	liter	(L)
2	American gallon	(GAL)
3	Cubic feet	(CF)

For example, if REG0009=123456789, REG0010=0.123, and REG147=3, REG148=0
Then the total flow = 123456.789123 m^3

For heat accumulator：

The energy flow rate =(N+Nf)$\times 10^{n-4}$

n is determined by REG01440.

Unit of accumulated heat is determined by REG 1441.

Note 2： REG361 is specially designed for communication test. If the number you read in REG361 is not 361.0, but ‘0’ or ‘250.264’, which means your read address is wrong. Please consult relevant MODBUS protocol standard. More details could be found on Internet.

Note 3： The register of software version and manufacturer is used to identify the register table.

4. MODBUS monthly accumulated flow address list

Data Blk No	address		Reg no	Variable name	format	note
n/a	0163		1	Monthly Pointer	Integer	Range: 0-127
0	0	29953	1	Data block no	Integer	0~65535
	1	29954	1	State	Integer	
	2	29955	1	Failure days	Integer	
	3	29956	1	Month, Year	BCD	Month in low byte
	4	29957	2	Working hours	LONG	Record for checking
	6	29959	2	Failure hours	LONG	
	8	29961	2	Month Total flow	LONG	Of this month
	10	29963	2	Month Total energy	LONG	Of this month
	12	29965	2	Positive flow	LONG	Recorded
	14	29967	2	Negative flow	LONG	Recorded
	16	29969	2	Positive energy	LONG	Recorded
	18	29971	2	Negative energy	LONG	Recorded
	20	29973	2	Tariff2	LONG	Recorded
	22	29975	2	Tariff3	LONG	Recorded
	24	29977	2	Max flow rate	REAL4	
	26	29979	2	Max energy rate	REAL4	
	28	29981	2	Max inlet temperature	REAL4	
	30	29983	2	Max outlet temperature	REAL4	
2	0	29985	1	Data block no	Integer	
	1	29986	1	State	Integer	
	2	29987	1	Failure days	Integer	
	3	29988	1	Month, Year	BCD	
	4	29989	2	Working hours	LONG	
	6	29991	2	Failure hours	LONG	
	8	29993	2	Month Total flow	LONG	
	10	29995	2	Month Total energy	LONG	
	…	……	……	……	……	……
	28	30013	2	Max inlet temperature	REAL4	
	30	30015	2	Max outlet temperature	REAL4	
n	Monthly data block n					
127	0	38113	1	Data block no	Integer	
	1	38114	1	State	Integer	
	…	……	……	……	……	……
	28	38141	2	Max inlet temperature	REAL4	
	30	38143	2	Max outlet temperature	REAL4	

5. MODBUS daily accumulated flow address list

Data Blk No	address		Reg no	Variable name	format	note
n/a	0162		1	Daily pointer	Integer	Range 0-511
1	0	5377	1	Data block no	Integer	0~65535
	1	5378	1	State of the day	Integer	
	2	5379	1	day	Integer	In high byte
	3	5380	1	Month, year	BCD	Month in Lower byte
	4	5381	2	Working hours	LONG	
	6	5383	2	Failure hours	LONG	
	8	5385	2	Daily Total flow	LONG	Of the day
	10	5387	2	Daily Total energy	LONG	Of the day
	12	5389	2	Positive flow	LONG	Recorded at the last sec.
	14	5391	2	Negative flow	LONG	Recorded at the last sec
	16	5393	2	Positive energy	LONG	Recorded at the last sec
	18	5395	2	Negative energy	LONG	Recorded at the last sec
	20	5397	2	Tariff2	LONG	Recorded at the last sec
	22	5399	2	Tariff3	LONG	Recorded at the last sec
	24	5401	2	Max flow rate	REAL4	
	26	5403	2	Max energy rate	REAL4	
	28	5405	2	Max inlet temperature	REAL4	
	30	5407	2	Max outlet temperature	REAL4	
2	0	5409	1	Data block no	Integer	0~65535
	1	5410	1	State of the day	Integer	
	2	5411	1	day	Integer	
	…	……	……	……..	……	
	24	5433	2	Max flow rate	REAL4	
	26	5435	2	Max energy rate	REAL4	
	28	5437	2	Max inlet temperature	REAL4	
	30	5439	2	Max outlet temperature	REAL4	
n	Data block n					
511	0	21729	1	Data block no	Integer	0~32767
	1	21730	1	State of the day	Integer	
	…	……	……	……..	……	
	28	21757	2	Max inlet temperature	REAL4	
	30	21759	2	Max outlet temperature	REAL4	

6. MODBUS power-on time table

Data Blk No	address		Reg no	Variable name	format	note
n/a	0162		1	Daily pointer	Integer	Range 0-255
1	0	28929	1	Data block no	Integer	0~65535
	1	28930	1	Minute, Second	BCD	Second in low byte
	2	28931	1	Day, Hour	BCD	Hour in low byte
	3	28932	1	Year, Month	BCD	Month in low byte
2	0	28933	1	Data block no	BCD	
	1	28934	1	Minute, Second	BCD	
	2	28935	1	Day, Hour	BCD	
	3	28936	1	Year, Month	BCD	
n	Data block n					
255	0	29949	1	Data block no	BCD	
	1	29950	1	Minute, Second	BCD	
	28	29951	1	Day, Hour	BCD	
	30	29952	1	Year, Month	BCD	

Part Four

M-BUS Communication Protocol

1. Interface
   (A) RS-485
   (B) IR
   (C) logic level USART

2. Default settings

Telegram format:	IEC 870-5-1, DIN EN1434-3
Baud rate:	IR 2400
	RS-485, USART: 9600
Odd-even check:	Even
Data bits:	8 bits

3. References
   "The M-BUS: A Documentation" which can be downloaded from www.m-bus.com
   "TKB3417 Description of the MBUS module for Ultraheat"
4. Special function
   * Available to set date and time
   * Available to set Baud rate
   * Available to set main address
   * Include the secondary address
   * Choice promotion
   * Available to set data telegram according to personal demands

Table 1 Master=>Slave telegrams

Main unit request command	Format													Note	Machine response
				C 域	A	CS								C domain=control domain A domain=address domain CS=checksum，CI domain	
Initialization （SEND_NKE）	10h			40h	A	CS	16h							Release public address, set as normal status, default baud rate	E5h
Data request (SEND_UD2)	10h			5Bh/7Bh	A	CS	16h							Request the slave user's data of slave send response	RSP_UD
Delete the use of public address	10h			40h	FDh	CS	16h							All slave release public address FDh, convenient for later use.	E5h
Warning protocol (SEND_UD1)	10h			5Ah/7Ah	A	CS	16h							Respond the warning check at full throttle	E5h
Communication test	10h			4Ah/6Ah	A	CS	16h							To test whether communication line works	E5h
Search the main address	10h			49h	FDh	CS	16h							To respond the main address	
		L	L		C 域	A	CI 域			CS					
Select secondary address	68h	0Bh	0Bh	68h	53h/73h	FDh	52h	ID1-4 M1-2 G Med		CS	16h			ID1-4 is ID of 4 bits4, M1-2=88h,11h G=1 Med=4 return water heat meter is in front*	E5h
Select secondary address	68h	0Bh	0Bh	68h	53h/73h	FDh	56h	ID4-1 M2-1 G Med		CS	16h			High-order is in front, others same as above-message. （Med=0Ch is inflow heat meter） *	E5h
Enhance to select secondary address	68h	11h	11h	68h	53h/73h	FDh	52h	ID1-4 M1-2 G Med 0CH 78H SN1-4		CS	16h			Add 0Ch 78h +4 byte serial number than above two message *	E5h
Modify the main address	68h	06h	06h	68h	53h/73h	A	51h	01h 7Ah NN		CS	16h			NN means the new address of single byte, range from 1-250	E5h
Modify the secondary address	68h	09h	06h	68h	53h/73h	A	51h	0Ch 79h SA1-4		CS	16h			SA1-4 means the new address of 4 byte, to avoid two same address in one system.	E5h
Modify the secondary address	68h	0Dh	0Dh	68h	53h/73h	A	51h	07h 79h SA1-4 xxh,xxh,xxh,xxh		CS	16h			SA1-4 means the secondary address of 4 byte.	E5h
Set the secondary address as ESN	68h	09h	06h	68h	53h/73h	A	51h	0Ch 79h 00h 00h 00h 00h		CS	16h			M-BUS secondary address is set as ESB by default setting, and it is available to modify the secondary address.	E5h
Set the secondary address as ESN	68h	0Dh	0Dh	68h	53h/73h	A	51h	07h 79h 00h 00h 00h 00h xxh,xxh,xxh,xxh		CS	16h			To solve the problem of same secondary address	E5h
		L	L		C 域	A	CI 域	CS						Note, change of baud rate should be behind the response of the previous baud rate.	
Change baud rate	68h	03h	03h	68h	53h/73h	A	B8h	CS	16h					Change baud rate to 300 become the system default after power on again	E5h
Change baud rate	68h	03h	03h	68h	53h/73h	A	B9h	CS	16h					Change baud rate to 600 become the system default after power on again	E5h
Change baud rate	68h	03h	03h	68h	53h/73h	A	BAh	CS	16h					Change baud rate to 1200 become the system default after power on again	E5h
Change baud rate	68h	03h	03h	68h	53h/73h	A	BBh	CS	16h					Change baud rate to 2400 become the system default after power on again	E5h
Change baud rate	68h	03h	03h	68h	53h/73h	A	BCh	CS	16h					Change baud rate to 4800 become the system default after power on again	E5h
Change baud rate	68h	03h	03h	68h	53h/73h	A	BDh	CS	16h					Change baud rate to 9600 become the system default after power on again	E5h
Change baud rate	68h	03h	03h	68h	53h/73h	A	B7h	CS	16h					Restore baud rate to default	E5h

Reserve message type		L	L		C region	A	CI region	Preset data code			CS				
Reserve regular format	68h	03h	03h	68h	53h/73h	A	50h				CS	16h		Demand all data, format of response message shown in table2 （All）	E5h
Reserve regular format	68h	04h	04h	68h	53h/73h	A	50h	00			CS	16h		Demand all data, format of response message shown in table2 （All）	E5h
Reserve quick format	68h	04h	04h	68h	53h/73h	A	50h	51h			CS	16h		Demand quick read of data （QUICK READOUT）	E5h
Reserve user data format	68h	04h	04h	68h	53h/73h	A	50h	10h			CS	16h		Demand accumulated heat W, accumulated flow （User Data）	E5h
Reserve model of simple bill	68h	04h	04h	68h	53h/73h	A	50h	20h			CS	16h		Demand W,V W,V of last year as well as running time BT and fault time F （Simple Billing）	E5h
Reserve model of complete bill	68h	04h	04h	68h	53h/73h	A	50h	30h			CS	16h		Demand W,V, W,V of last year, max flow/max heat, BT,FT （Enhanced Billing）	E5h
Reserve current data	68h	04h	04h	68h	53h/73h	A	50h	50h			CS	16h		Demand W,V instant flow/heat flow, inflow temperature （Instant Values）	E5h
Reserve current data	68h	04h	04h	68h	53h/73h	A	50h	80h			CS	16h		Demand serial number, balance date of heat supply	E5h
Switch to fast way	68h	05h	05h	68h	53h/73h	A	51h	0Fh	A1h		CS	16h		Quickly read the format, message format shown in table 3.	E5h
Switch to regular way	68h	05h	05h	68h	53h/73h	A	51h	0Fh	A0h		CS	16h		Reserve all output data	E5h
Switch to fast way	68h	03h	03h	68h	53h/73h	A	A1h				CS	16h		Not recommend this message, which set for compatibility.	E5h
Switch to regular way	68h	03h	03h	68h	53h/73h	A	A0h				CS	16h		Not recommend this message, which set for compatibility.	E5h
Reserve all data 1	68h	04h	04h	68h	53h/73h	A	51h	7Fh			CS	16h		Message format shown in Table 2	E5h
Reserve all data 2	68h	06h	06h	68h	53h/73h	A	51h	C8h	3Fh	7Eh	CS	16h		Message format shown in Table 2	E5h
Reserve empty message	68h	06h	06h	68h	53h/73h	A	51h	7Fh	FEh	0Dh	CS	16h			E5h
Reserve heat data	68h	06h	06h	68h	53h/73h	A	51h	08h	05h		CS	16h		the essence is that general data choose message	E5h
Reserve heat of last year	68h	06h	06h	68h	53h/73h	A	51h	48h	05h		CS	16h		the essence is that general data choose message	E5h
General data message	68h	L	L	68h	53h/73h	A	51h	Select code （combination）			CS	16h		Limit L<240, select all after power-on initializing	E5h

Code selection(combination) could choose any reserved data below and any combination of them.(for example, scheduled to read accumulated heat and accumulated flow, message format:68 L L 68 53/73 A 51 08 14 08 2D CS 16)

Update period	08h 74h	All update period	C8h 3Fh 74h	Accumulated heat rate of last year	48h 00h…0Fh
Average period	08h 70h	All average period	C8h 3Fh 70h	Accumulated flow rate of last year	48h 10h…17h
Accumulated heat rate	08h 00h…0Fh	All accumulated heat rate	C8h 3Fh 00h…0Fh	Balance date of the year	48h 6Ch
Accumulated flow rate	08h 10h…17h	All accumulated flow rate	C8h 3Fh 10h…17h	Fault time	38h 20h…23h
Instant heat rate	08h 28h…37h	All instant heat rate	C8h 3Fh 28h…37h	Fault time of last year	78h 20h…23h
Instant flow rate	08h 38h…4Fh	All instant flow rate	C8h 3Fh 38h…4Fh	Average period of max value	88h 10h 70h…73h
Inflow temperature	08h 58h…5Bh	All inflow temperature	C8h 3Fh 58h…5Bh	Max instant heat rate of last year	D8h 10h 28h…37h
Return water temperature	08h 5Ch…5Fh	All return water temperature	C8h 3Fh 5Ch…5Fh	Current max instant heat rate	98h 10h 28h…37h
Temperature difference	08h 60h…63h	All temperature difference	C8h 3Fh 60h…63h	Current max instant flow rate	98h 10h 38h…4Fh
Serial number	08h 78h	All serial number	C8h 3Fh 78h	Current max inflow temperature	98h 10h 5Bh
Running time	08h 20h…23h	All running time	C8h 3Fh 20h…23h	Current max return water temperature	98h 10h 5Fh
Time and date	08h 6Ch	All time stamps	C8h 3Fh 6Ch		

Note: '...' in code means between. For example, 00h…0Fh means any numbers between 00h and 0Fh. It also means code of 08h 00h and 08h 0Dh have the same function.

Start flow calibration	68h	0Ah	0Ah	68h	53h/73h	A	51h	2Fh	0Fh	04h	00h,04h,00h,01h			CS	16h	Debugging function for manufacturer	E5h
Exit heat calibration	68h	0Ah	0Ah	68h	53h/73h	A	51h	2Fh	0Fh	04h	00h,04h,00h,00h			CS	16h	Debugging function for manufacturer	E5h
Clear the first mistake	68h	0Ah	0Ah	68h	53h/73h	A	51h	2Fh	0Fh	04h	00h,04h,00h,02h			CS	16h	Execute the command under fault-free condition	E5h
Enter into sleep mode	68h	0Ah	0Ah	68h	53h/73h	A	51h	2Fh	0Fh	04h	00h,04h,00h,03h			CS	16h	Enter into the sleep mode if set this function	E5h
Out of sleep mode	68h	0Ah	0Ah	68h	53h/73h	A	51h	2Fh	0Fh	04h	00h,04h,00h,04h			CS	16h	Out of sleep mode	E5h
OCT output setting	68h	0Ah	0Ah	68h	53h/73h	A	51h	04h	FFh	15h	OCT1,OCT2,XX,XX			CS	16h	Set OCT output, 0=constant, 1=connect, 2=disconnect	E5h
Clear the max and min value	68h	07h	07h	68h	53h/73h	A	51h	01h	FFh	14h	01			CS	16h	Clear register of max and min value	E5h
Turn off TARIFF	68h	07h	07h	68h	53h/73h	A	51h	01h	FFh	13h	00			CS	16h	Turn off TARIFF 2 and TARIFF 3	E5h
Turn on TARIFF 2	68h	07h	07h	68h	53h/73h	A	51h	01h	FFh	13h	02h			CS	16h	Turn on TARIFF 2	
Turn on TARIFF 3	68h	07h	07h	68h	53h/73h	A	51h	01h	FFh	13h	03h			CS	16h	Turn on TARIFF 3	
Turn off TARIFF	68h	05h	05h	68h	53h/73h	A	51h	0Fh	B0h					CS	16h	Turn off TARIFF 2 和 TARIFF 3	E5h
Turn off TARIFF	68h	05h	05h	68h	53h/73h	A	51h	0Fh	B1h					CS	16h	Turn off TARIFF 2 和 TARIFF 3	E5h
Turn on TARIFF 2	68h	05h	05h	68h	53h/73h	A	51h	0Fh	B2h					CS	16h	Turn on TARIFF 2	E5h
Turn on TARIFF 3	68h	05h	05h	68h	53h/73h	A	51h	0Fh	B3h					CS	16h	Turn on TARIFF 3	E5h
TARIFF close time	68h	0Ah	0Ah	68h	53h/73h	A	51h	04h/44h		FD	30	Date + Time		CS	16h	Date + Time according to TYPE_F format	E5h
TARIFF close time	68h	0Bh	0Bh	68h	53h/73h	A	51h	84h/C4h	10	FD	30	Date + Time		CS	16h	Date + Time according to TYPE_F format	E5h
TARIFF2 start time	68h	0Bh	0Bh	68h	53h/73h	A	51h	84h/C4h	20	FD	30	Date + Time		CS	16h	Date + Time according to TYPE_F format	E5h
TARIFF3 start time	68h	0Bh	0Bh	68h	53h/73h	A	51h	84h/C4h	30	FD	30	Date + Time		CS	16h	Date + Time according to TYPE_F format	E5h
		L	L		C region	A	CI region	DIF						CS			
Method to set time1	68h	0Dh	0Dh	68h	53h/73h	A	51h	2Fh	0Fh	04h	58h	SSMMHHDDMMYY		CS	16h	Setting data/time, recommended method:set parameters as second, minute, hour, day, month and year respectively.	E5h
Method to set time2	68h	0Ah	0Ah	68h	53h/73h	A	51h	04h	EDh 00h			DATE/TIME		CS	16h	** DATE/TIME is the standard format of TYPE F.	E5h
Method to set time3	68h	09h	09h	68h	53h/73h	A	51h	04h	6Dh			DATE/TIME		CS	16h	** DATE/TIME is the standard format of TYPE F.	E5h

Note: * wildcard character is available to choose the secondary address. By using wildcard character, all salve units could be quickly found by the main unit.

** Setting mode for standard compliance. Since TYPE F do not contain ‘second’, set the second of these two messages as 0. Format of TYPE F is the data/time format specified in M-BUS.

Part Five Haifeng ASCII protocol

1. The Haifeng Protocol is designed to be compatible with the one used in our previous versions of ultrasonic flow meters. This protocol is a set of basic commands that are in ASCII format, ending with a carriage return (CR) and line feed (LF), For most of the commands, The line feed (LF) should be better omitted for fast responding.

The colored commands in the following table are new ones

Command	Meaning	Data format
DQD(cr) note 0	Request flow rate per day	±d.dddddE±dd(cr) note 1
DQH(cr)	Request flow rate per hour	±d.dddddE±dd(cr)
DQM(cr)	Request flow rate per minute	±d.dddddE±dd(cr)
DQS(cr)	Request flow rate per second	±d.dddddE±dd(cr)
DQE(cr)	Request Instant Caloric Value	±d.dddddE±dd(cr)
DV(cr)	Request fluid velocity	±d.dddddE±dd(cr)
DI+(cr)	Request positive totalizer	±ddddddddE±d(cr) note 2
DI-(cr)	Request negative totalizer	±ddddddddE±d(cr)
DIN(cr)	Request net totalizer	±ddddddddE±d(cr)
DIE(cr)	Request net thermal energy totalizer	±ddddddddE±d(cr)
DIE+(cr)	Request positive energy totalizer	±ddddddddE±d(cr)
DIE-(cr)	Request negative energy totalizer	±ddddddddE±d(cr)
DIT(cr)	Request net total flow for today	±ddddddddE±d(cr)
DIM(cr)	Return net total flow for this month	±ddddddddE±d(cr)
DIY(cr)	Request net total flow for this year	±ddddddddE±d(cr)
DID(cr)	Return the ID number/address	ddddd(cr) 5 bytes long
DL(cr)	Request signal strength and signal quality	UP:dd.d,DN:dd.d,Q=dd(cr)
DS(cr)	Request the percentage of AO output	±d.dddddE±dd(cr)
DC(cr)	Request display number and Error Code	note 3
DT(cr)	Request the present date and time	yy-mm-dd,hh:mm:ss uuu(cr)
Time@TDS1=(cr)	Set date and time yy-mm-dd,hh:mm:ss	
MKEY@(cr) note 4	Send a key value as if a key is pressed. @ is the key value	@ is key value which can be found in the KEY VALUE table
LCD(cr)	Request current window content	
MENUXX(cr)	Go to window XX	
BUADRATExp(cr)	Change baud rate to “x” with parity “p”	x=2~7,9600,4800,2400,1200,600,300 p=N(none), E(even),O(odd)
BUADRATE-A	Restore baud rate for RS485	
BUADRATE-B	Restore baud rate for IR	
AO<>(O)<>4-20mA<>(O)<>digits string(cr)	Set AO to ‘a’ mA current	Note 5
RING(cr)(lf)	Handshaking request from a modem	ATA(CR)(lf)
CUSTOMERNUMBER=	Set customer number	
CUSTOMERNUMBER?	Request customer number	
FIRMWAREVERSION	Request firmware information	
ESN(cr)	Request the ESN (electronic serial number) of the flow meter	49ddddddd(cr)(lf) note 6
MBUSADD=（str）	Set address to STR	
MBUSADD?	Request address number	
MBUSADD2=（str）	Set MBUS secondary address to STR	
MBUSADD2?	Request MBUS secondary address	
System Boot Instantly by 13840932903	Reboot the system	
Isp-Prog &JXWANG12	Command for firmware updating	
OCT<OUTPUT>=10	Quit OCT1 serial controlling mode	
OCT<OUTPUT>=11	OCT1 output open	
OCT<OUTPUT>=12	OCT1 output close	

OCT<OUTPUT>=20	Quit OCT2 serial controlling mode	
OCT<OUTPUT>=21	OCT2 output opcy en	
OCT<OUTPUT>=22	OCT2 output close	
SLEEP<(*)>METER<(*)>ENABLE=0	Enable sleep of the meter	
SLEPP<(*)>METER<(*)>ENABLE=1	Quit sleep of the meter	
AnalogInput0	Always readout 1.23456 for testing	±d.dddddE±dd(cr)(lf)
AnalogInput1	Return temperature at T1 input	±d.dddddE±dd(cr)(lf)
AnalogInput2	Return temperature at T2 input	±d.dddddE±dd(cr)(lf)
AnalogInput6	Request CPU temperature	
AnalogInput7	Request battery voltage	
AnalogInput8	Request main clock frequency coefficient	
BATCH_A	Request batch controller total	
BATCH_V?	Request batch setting	
BATCH_V=(str)	Set a new batch	
BATCH_E0	Disable batch controller	
BATCH_E1	Enable batch controller	
BATCH_R0	Run Batch controller	
BATCH_R1	Stop Batch controller	
BATCH_T1?	Request trig timer #1	
BATCH_T1=DD HH:MM	Set trig timer #1	
BATCH_T2?	Request trig timer #2	
BATCH_T2=DD HH:MM	Set trig timer #2	
BATCH_T3?	Request trig timer #3	
BATCH_T3=DD HH:MM	Set trig timer #3	
BATCH_T4?	Request trig timer #4	
BATCH_T4=DD HH:MM	Set trig timer #4	
BATCH_T5?	Request trig timer #5	
BATCH_T5=DD HH:MM	Set trig timer #5	
TARIFF_T1?	Request tariff timer #1	
TARIFF_T1=MM-DD HH-MM	Set tariff timer #1	
TARIFF_T2?	Request tariff timer #2	
TARIFF_T2=MM-DD HH-MM	Set tariff timer #2	
TARIFF_T3?	Request tariff timer #3	
TARIFF_T3=MM-DD HH-MM	Set tariff timer #3	
DI2	Request Tariff total2	
DI3	Request Tariff total3	
N	Prefix of an IDN-addressing-based networking, The IDN address is byte, range 0-253	Note 7
W	Prefix of an IDN-addressing-based networking, The IDN address is word, range 0-65535	Note 7
P	Prefix of any commands for returns with check-sum	
&	Commands connector to make a compounding command in one line.	Result commands limit 253 or less byte long.

NOTES:

0. （cr）stand for carriage return, its ASCII value is 0DH. (lf) stand for line feed, its ASCII value is 0AH.

1. d stand for a digit number of 0~9, 0 is expressed as +0.000000E+00

2. d stand for digit 0~9, the number before ‘E’ is an integer.

3. The first two bytes are menu numbers, and the rest is ErrCode whose meaning can found at the display part.

4. @ stand for key value, for example, value 30H means key ‘0’. The command ‘MKEYA(cr)’ acts just like the a short key is pressed.

5． ’a’ stands for the output current value. The maximum value should not exceed 20.0 For example

AO<>(O)<>4-20mA<>(O)<>2.34567(cr)

6． ’ddddddddd’ stands for the Electronic Serial Number

7． If there are more than one devices in a network, all the basic command must be prefixed with ‘N’ or ‘W’, otherwise multiple flow meter may reply to the same request, and thus a conflict may occurs.

2. Working with Command prefixes and the command connector

2.1 The ‘P’ prefix

The ‘P’ prefix can be added before every basic command to have the returned message with a two digits check-sum. The check-sum is obtained by a binary addition. For example, if the command DI+(CR) (44H,49H,2BH,0DH in binary numbers) will bring a return like +1234567E+0m3 (CR) (2BH,31H,32H,33H,34H,35H,36H,37H,45H,2BH,30H,6DH,33H,20H,0DH,0AH in binary numbers), then the PDI+(CR) will brings a return like +1234567E+0m3 !F7(CR), after the character‘!’ are the check-sum in ASCII format(2BH+31H+32H+33H+34H+35H+ 36H+37H+45H+2BH+30H+6DH+33H+20H=(2)F7H)

Pay attention to that there may be no characters or only spaces before the character ‘!’.

2.2 The ‘N’ prefix

The usage of prefix ‘N‘ goes like: N + single byte address + basic command.

For example if the address number 88 flow meter is going to be addressed, the command should like: NXDV(CR), the decimal value of X should be 88.

The prefix W is strongly recommended for new users.

2.3 The ‘W’ prefix

Usage: W + character string address + basic command

The value of the character string should have a value in the range of 0~65535, except for the value of 13（0DH carriage return），10（0AH line feed ），42（2AH *），38（26H&）.

For example, if the velocity of number 12345 flow meter is wanted, the command can be like: W12345DV(CR), (57H,31H,32H,33H,34H,35H,44H,56H,0DH in binary numbers)

2.4 The command connecter ‘&’

The command connecter ‘&’ adds several basic commands into a one-line compound command. The compound command should not exceed a length of over 253 characters. The prefix ‘P’ should be added before every basic command, to make the returned results having a check-sum.

For example, if the 1)flow rate 2)velocity 3)positive totalizer 4) net energy totalizer 5) the AnalogInput1 input 6) the AnalogInput2 input of the address number 4321 flow meter are wanted to return with check-sum, the one-line command is like:

W4321PDQD&PDV&PDI+&PDIE&PAnalogInput1&P AnalogInput2(CR)

The returned data are:

+0.000000E+00m3/d!AC(CR)
+0.000000E+00m/s!88(CR)
+1234567E+0m3 !F7(CR)
+0.000000E+0GJ!DA(CR)
+7.838879E+00mA!59
+3.911033E+01!8E(CR)

Any command can be connected together. For example, MENU11&MMEYA&MMEYA&MKEYA(CR)

Part Six
Compatibility Protocol

Part Seven
CJ-188-2004 communication protocol

The CJ-188-2004 is a Chinese National Standard for heat or energy meters

The command to read a meter with a ESN which is 17312151, the ESN is displayed on M07, is as following

FE FE FE FE FE FE FE FE FE FE FE 68 20 51 21 31 17 00 11 11 01 03 1F 90 12 29 16

Where all the numbers are in HEX.
The first 11 FEs are preamble
68(0x68) is starter
20(0x20) is meter type
51(0x51) is address A0. if address A0-A6 are all 0xAA，this command is a broadcasting one. Any meter will response to a broadcast command with it's ESN number in the response telegram. If there is only one meter on the BUS, a broadcasting command can be used to obtain the ESN number of the meter.
21(0x21) address A1
31(0x31) address A2
17(0x17) address A3 (A0、A1、A2、A3 is ESN number, lower byte first)
00(0x00) address A4, always 0x00 or 0xAA with a broadcasting command
11(0x11) address A5, always 0x11 or 0xAA with a broadcasting command
11(0x11) address A6, always 0x11 or 0xAA with a broadcasting command
01(0x01) Control Code
03(0x03) length of the DATA
1F(0x1F) DATA Identifier 0
90(0x90) DATA Identifier 1
12(0x12) SER
29(0x29) Checksum CS which is the arithmetic sum of all the numbers, except preambles（68 20 51 21 31 17 00 11 11 01 03 1F 90 12, the sum is 0x29）
16(0x16) ending byte.

A0,A1,A2,A3,CS change with the different meter number, others are fixed.

User Telegram:
FE FE FE FE FE FE FE FE FE FE FE 68 20 51 21 31 17 00 11 11 81 2E 1F 90 12 00 00 00 00 05 00 00 00 00 05 00 00 00 00 14 00 00 00 00 35 19 00 00 00 2C 76 30 00 68 30 00 73 02 00 32 41 11 12 09 07 20 04 00 E9 16
68 means starting-frame symbol 68H
20 means type of instrument T
51 means address A0
21 means address A1
31 means address A2
17 means address A3 (A0、A1、A2、A3 is the heat meter number as read, from low to high)
00 means address A4
11 means address A5
11 means address A6
81 means control code C

2E means data length region L（1F 90 12 00 00 00 00 05 00 00 00 00 05 00 00 00 00 14 00 00 00 00 35 19 00 00 00 2C 76 30 00 68 30 00 73 02 00 32 41 11 12 09 07 20 04 00 totaling 2E characters）
1F means data identification DI_0
90 means data identification DI_1
12 means serial number SER
00 00 00 00 means current cold,05 means unit of current cold: kWh(Table 1)
00 00 00 00 means current heat, 05 means unit of current heat: kWh(Table 1)
00 00 00 00 means thermal heat,14 means unit of thermal heat: W(Table 1)
00 00 00 00 means instant flow rate, 35 means unit of instant flow rate:m^3/h(Table 1)
19 00 00 00 means accumulated flow rate，2C means unit of accumulated flow rate:m^3（Table）
76 30 00 means supply water temperature 0030.76℃
68 30 00 means return water temperature 0030.68℃
73 02 00 means accumulated working time 00273 hours
32 41 11 12 09 07 20 means real time is 11:41:32 12/09/2007
04 00 means status words(as described in Table2, Table3), low battery voltage, inflow and outflow temperature transducers are normal, integrator is normal.
E9 means check code CS（68 20 51 21 31 17 00 11 11 81 2E 1F 90 12 00 00 00 00 05 00 00 00 00 05 00 00 00 00 14 00 00 00 00 35 19 00 00 00 2C 76 30 00 68 30 00 73 02 00 32 41 11 12 09 07 20 04 00 proceed binary system accumulation, excluding the overflow value exceeded FFH.
16 means end mark 16H

The normal response frame of heat meter begin with 68H end with 16H. A4,A5,A6 are fixed at 00H 11H 11H, control code is fixed at 81H, data length region is fixed at 2EH, data identification and serial number are the same as they are transmitted, other bytes are changed with the specific heat meter.

Table1 Unit and Code

Unit	Code	Unit	Code
Wh	02H	GJ×100	13H
kWh	05H	W	14H
MWh	08H	kW	17H
MWh×100	0AH	MW	1AH
J	01H	L	29H
kJ	0BH	m^3	2CH
MJ	0EH	L/h	32H
GJ	11H	m^3/h	35H

Table2 Status ST definition table of the first byte

	D0	D1	D2	D3	D4	D5	D6	D7
Definition	——		Battery voltage	Reserve	Reserve	Reserve	Reserve	Reserve
Description	——		0：normal 1：under voltage	Reserve	Reserve	Reserve	Reserve	Reserve

Table3 Status ST definition table of the secondary byte

	D0	D1	D2	D3	D4	D5	D6	D7
Definition	Integrator breakdown	Supply water temperature transducer breakdown	Return water temperature transducer breakdown	Flow rate transducer breakdown	Reserve	Reserve	Reserve	Reserve
Description	0：normal 1:breakdown	0：normal 1：breakdown	0：normal 1：breakdown	0：normal 1:breakdown	Reserve	Reserve	Reserve	Reserve