# Communication Protocols

LRF-2000 has an isolated serial port, the RS485.

LRF-2000 can support more than 4 different communication protocols by the same time; include MODBUS-ASCII, ASCII-RTU, Meter-BUS, the Fuji Extended Protocol and more than 10 compatible communication protocols used by our flow meters.

MODBUS is a very commonly used industrial protocol. Both the RTU and the ASCII format of MODBUS is supported

The Fuji Extended Protocol is developed based on the protocol used in a Japanese ultrasonic flow meter. It is totally compatible with that of Version 7 flow meter.

LRF-2000 can be used as a sample RTU terminal. The 4-20mA output in the LRF-2000 can be used to open an analog proportional valve; The OCT output can be used to control the turn-on and turn-off of other devices such as a pump. The analog input can be used to input pressure or temperatures signals.

There is a programmable device address (or ID number) located at window M46. When LRF-2000 is used in a network, all the parameters of the flow meter can be programmed through the network, except the device address that needs the keypad.

At most occasions, data should be obtained by polling the flow mete with a command, the flow meter will respond with what the master asks.

LRF-2000 can also set to automatically output data at a period which is programmable.

The LRF-2000 also has a special command sets to facilitate the use of the flow meter in a GSM network.

## 5.1 The MODBUS protocol

Both the two formats of the MODBUS protocol can be supported.

A software switch located at the window number 63(shorted as M63 after) select MODBUS-ASCII or MODBUS-RTU will be in functioning.

The default option is MODBUS-ASCII format.

LRF-2000 can only support MODBUS functions code 3 and code 6, i.e. reading registers and writing a register.

For example, reading the registers from REG0001 to REG0010 in the unit #1 (ultrasonic flow meter) under the MODBUS-RTU format, the command could be as following

| 01 | 03 | 00 | 00 | 00 | 0A | C5 | CD |
|---|---|---|---|---|---|---|---|
| Unit | Function | start REG | | Numbers of REGs | | Check-sum | |

（hex）

While under the MODBUS-ASCII format, the command could be

:01030000000AF2(CR and LF)

Details about the standard MODBUS protocol will not be studied in this manual; please the users find them on other related materials.

By default, the RS232/RS485 will setup with 9600,none,8,1(9600bd，none parity，8 data bits，1 stop bit)

## 5.1.1 MODBUS REGISTERS TABLE

MODBUS REGISTERS TABLE for LRF-2000

（please take notice the difference with the water meter MODBUS table）

| REGISTER | NUMBER | VARIABLE NAME | FORMAT | NOTE |
|---|---|---|---|---|
| 0001-0002 | 2 | Flow Rate | REAL4 | Unit: $m^3/h$ |
| 0003-0004 | 2 | Energy Flow Rate | REAL4 | Unit: GJ/h |
| 0005-0006 | 2 | Velocity | REAL4 | Unit: m/s |
| 0007-0008 | 2 | Fluid sound speed | REAL4 | Unit: m/s |
| 0009-0010 | 2 | Positive accumulator | LONG | Unit is selected by M31, and depends on totalizer multiplier |
| 0011-0012 | 2 | Positive decimal fraction | REAL4 | Same unit as the integer part |
| 0013-0014 | 2 | Negative accumulator | LONG | Long is a signed 4-byte integer, lower byte first |
| 0015-0016 | 2 | Negative decimal fraction | REAL4 | REAL4 is a format of Singular IEEE-754 number, also called FLOAT |
| 0017-0018 | 2 | Positive energy accumulator | LONG | |
| 0019-0020 | 2 | Positive energy decimal fraction | REAL4 | |
| 0021-0022 | 2 | Negative energy accumulator | LONG | |
| 0023-0024 | 2 | Negative energy decimal fraction | REAL4 | |
| 0025-0026 | 2 | Net accumulator | LONG | |
| 0027-0028 | 2 | Net decimal fraction | REAL4 | |
| 0029-0030 | 2 | Net energy accumulator | LONG | |
| 0031-0032 | 2 | Net energy decimal fraction | REAL4 | |

| | | | | |
|---|---|---|---|---|
| 0033-0034 | 2 | Temperature #1/inlet | REAL4 | Unit: C |
| 0035-0036 | 2 | Temperature #2/outlet | REAL4 | Unit: C |
| 0037-0038 | 2 | Analog input AI3 | REAL4 | |
| 0039-0040 | 2 | Analog input AI4 | REAL4 | |
| 0041-0042 | 2 | Analog input AI5 | REAL4 | |
| 0043-0044 | 2 | Current input at AI3 | REAL4 | In unit mA |

| | | | | |
|---|---|---|---|---|
| 0045-0046 | 2 | Current input at AI3 | REAL4 | In unit mA |
| 0047-0048 | 2 | Current input at AI3 | REAL4 | In unit mA |
| 0049-0050 | 2 | System password | BCD | Writable。00H for unlock |
| 0051 | 1 | Password for hardware | BCD | Writable。“A55Ah” for unlock |
| 0053-0055 | 3 | Calendar (date and time) | BCD | Writable。6 Bytes of BCD stands SMHDMY，lower byte first |
| 0056 | 1 | Day+Hour for Auto-Save | BCD | Writable。For example 0512H stands Auto-save on 12:00 on 5$^{th}$。0012H for 12:00 on everyday。 |
| 0059 | 1 | Key to input | INTEGER | Writable |
| 0060 | 1 | Go to Window # | INTEGER | Writable。 |
| 0061 | 1 | LCD Back-lit lights for number of seconds | INTEGER | Writable。In unit second |
| 0062 | 1 | Times for the beeper | INTEGER | Writable。Max 255 |
| 0062 | 1 | Pulses left for OCT | INTEGER | Writable。Max 65535 |
| 0072 | 1 | Error Code | BIT | 16bits, see note 4 |
| 0077-0078 | 2 | PT100 resistance of inlet | REAL4 | In unit Ohm |
| 0079-0080 | 2 | PT100 resistance of outlet | REAL4 | In unit Ohm |

| | | | | |
|---|---|---|---|---|
| 0081-0082 | 2 | Total travel time | REAL4 | In unit Micro-second |
| 0083-0084 | 2 | Delta travel time | REAL4 | In unit Nino-second |
| 0085-0086 | 2 | Upstream travel time | REAL4 | In unit Micro-second |
| 0087-0088 | 2 | Downstream travel time | REAL4 | In unit Micro-second |
| 0089-0090 | 2 | Output current | REAL4 | In unit mA |
| 0092 | 1 | Working step and<br>Signal Quality | INTEGER | The high byte is the step and low for signal quality, range 00-99, the larger the better. |
| 0093 | 1 | Upstream strength | INTEGER | Range 0-2047 |
| 0094 | 1 | Downstream strength | INTEGER | Range 0-2047 |
| 0096 | 1 | Language used in user interface | INTEGER | 0 : English, 1:Chinese<br>Other language will be supported later |
| 0097-0098 | 2 | The rate of the measured travel time by the calculated travel time. | REAL4 | Normal 100+-3% |
| 0099-0100 | 2 | Reynolds number | REAL4 | |

| | | | | |
|---|---|---|---|---|
| 0101-0102 | 2 | Pipe Reynolds factor | REAL4 | |
| 0103-0104 | 2 | Working Timer | LONG | unsigned, in second |
| 0105-0106 | 2 | Total working time | LONG | unsigned, in second |
| 0105-0106 | 2 | Total power on-off time | LONG | Unsigned |
| 0113-0114 | 2 | Net accumulator | REAL4 | In Cubic Meter, float |
| 0115-0116 | 2 | Positive accumulator | REAL4 | In Cubic Meter, float |
| 0117-0118 | 2 | Negative accumulator | REAL4 | In Cubic Meter, float |
| 0119-0120 | 2 | Net energy accumulator | REAL4 | In GJ, float |
| 0121-0122 | 2 | Positive energy accumulator | REAL4 | In GJ, float |
| 0123-0124 | 2 | Negative energy accumulator | REAL4 | In GJ, float |
| 0125-0126 | 2 | Flow for today | REAL4 | In Cubic Meter, float |

| | | | | |
|---|---|---|---|---|
| 0127-0128 | 2 | Flow for this month | REAL4 | In Cubic Meter，float |
| 0129-0130 | 2 | Manual accumulator | LONG | |
| 0131-0132 | 2 | Manual accumulator decimal fraction | REAL4 | |
| 0133-0134 | 2 | Batch accumulator | LONG | |
| 0135-0136 | 2 | Batch accumulator decimal fraction | REAL4 | |
| 0137-0138 | 2 | Flow for today | LONG | |
| 0139-0140 | 2 | Flow for today decimal fraction | REAL4 | |
| 0141-0142 | 2 | Flow for this month | LONG | |
| 0143-0144 | 2 | Flow for this month decimal fraction | REAL4 | |
| 0145-0146 | 2 | Flow for this year | LONG | |
| 0147-0148 | 2 | Flow for this year decimal fraction | REAL4 | |
| 0158 | 1 | Current display window | INTEGER | |
| 0165-0166 | 2 | Failure timer | LONG | In unit second |
| 0173-0174 | 2 | Current output frequency | REAL4 | Unit：Hz |
| 0175-0176 | 2 | Current output with 4-20mA | REAL4 | Unit：mA |
| 0181-0182 | 2 | Temperature difference | REAL4 | Unit：C |
| 0183-0184 | 2 | Lost flow for period of last power off | REAL4 | Unit：Cubic Meter |
| 0185-0186 | 2 | Clock coefficient | REAL4 | Should less than 0.1 |
| 0187-0188 | 2 | Total time for Auto-Save | REAL4 | Time to save by 0056 |
| 0189-0190 | 2 | POS flow for Auto-Save | REAL4 | Time to save by 0056 |
| 0191-0192 | 2 | Flow rate for Auto-Save | REAL4 | Time to save by 0056 |
| 0221-0222 | 2 | Inner pipe diameter | REAL4 | In millimeter |
| 0229-0230 | 2 | Upstream delay | REAL4 | In microsecond |
| 0231-0232 | 2 | Downstream delay | REAL4 | In microsecond |
| 0233-0234 | 2 | Calculated travel time | REAL4 | In microsecond |
| 0257-0288 | 32 | LCD buffer | BCD | |
| 0289 | 1 | LCD buffer pointer | INTEGER | |
| 0311 | 2 | Worked time for today | LONG | Unsigned, in seconds |
| 0313 | 2 | Worked time for this month | LONG | Unsigned, in seconds |
| 1437 | 1 | Unit for flow rate | INTEGER | See note 5 |
| 1438 | 1 | Unit for flow totalizer | INTEGER | Range 0~7,see note 1 |
| 1439 | 1 | Multiplier for totalizer | INTEGER | Range 0~7,see note 1 |
| 1440 | 1 | Multiplier for energy accumulator | INTEGER | Range 0~10,see note 1 |

| | | | | |
|---|---|---|---|---|
| 1441 | 1 | Unit for energy rate | INTEGER | 0=GJ 1=Kcal<br>2=KWh，3=BTU |
| 1442 | 1 | Device address | INTEGER | |
| 1451 | 2 | User scale factor | REAL4 | |
| 1521 | 2 | Manufacturer scale factor | REAL4 | Read only |
| 1529 | 2 | Electronic serial number | BCD | High byte first |

Note : (1) The internal accumulator is been presented by a LONG number for the integer part together with a REAL number for the decimal fraction. In general uses, only the integer part needs to be read. Reading the fraction can be omitted. The final accumulator result has a relation with unit and multiplier. Assume N stands for the integer part (for the positive accumulator, the integer part is the content of REG 0009, 0010, a 32-bits signed LONG integer,), Nf stands for the decimal fraction part (for the positive accumulator, the fraction part is the content of REG 0011, 0012, a 32-bits REAL float number,), n stands for the flow multiplier (REG 1439).

then

The final positive flow rate=$(N+Nf) \times 10^{n-3}$ (in unit decided by REG 1438）。

The meaning of REG 1438 which has a range of 0~7 is as following:

0 cubic meter ($m^3$)

1 liter (L)

2 American gallon (GAL)

3 imperial gallon (IGL)

4 American million gallon (MGL)

5 Cubic feet (CF)

6 American oil barrel (1 barrel =42gallon) (OB)

7 Imperial oil barrel (IB)

While

The energy flow rate =$(N+Nf) \times 10^{n-4}$（unit decided by REG 1441）

n=(0~10) is the energy multiplier which is in REG1440

(2) Other variables are not given here. Call us if you have a need.

(3) Please note there are many of the data that is not applicable for the non-energy measurement users. These none-energy-related registers only serves for the intension of only one unique register table provided both with flow meter and energy meat.

(4) Meaning in error code

Bit0 no received signal

Bit1 low received signal

Bit2 poor received signal

Bit3 pipe empty

Bit4 hardware failure

Bit5 receiving circuits gain in adjusting

Bit6 frequency at the frequency output over flow

Bit7 current at 4-20mA over flow

Bit8 RAM check-sum error

Bit9 main clock or timer clock error

Bit10 parameters check-sum error

Bit11 ROM check-sum error

Bit12 temperature circuits error

Bit13 reserved

Bit14 internal timer over flow

Bit15 analog input over range

Please try to override these energy-related bits first when in flow-only measurement,

(5) Unit code for flow rate

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | Cubic meter/second | 1 | Cubic meter /minute | 2 | Cubic meter /hour | 3 | Cubic meter /day |
| 4 | liter/second | 5 | liter /minute | 6 | liter /hour | 7 | liter /day |
| 8 | American gallon/second | 9 | American gallon /minute | 10 | American gallon /hour | 11 | American gallon /day |
| 12 | Imperial gallon/second | 13 | Imperial gallon /nimute | 14 | Imperial gallon /hour | 15 | Imperial gallon /day |
| 16 | American million gallon/second | 17 | American million gallon /minute | 18 | American million gallon /hour | 19 | American million gallon/day |
| 20 | Cubic feet/second | 21 | Cubic feet/minute | 22 | Cubic feet/hour | 23 | Cubic feet/day |
| 24 | American oil barrel/second | 25 | American oil barrel/minute | 26 | American oil barrel/hour | 27 | American oil barrel/day |
| 28 | Imperial oil barrel/second | 25 | Imperial oil barrel/minute | 26 | Imperial oil barrel/hour | 27 | Imperial oil barrel/day |

## 5.1.2 REGISTER TABLE for the DATE accumulators

（1）REGISTER for accumulators by day

Accumulator data for every past day are stored in a loop queue. Every day has 16 bytes of data and there are 64 days in total. The current pointer which has a range of 0~63 for the day is in REG 0162. if the pointer is decreased by 1 when the pointer is 0, then new pointer value will be 63. Assume REG 0162= 1, the data for yesterday are in REG 2825~2832, the data for the day before yesterday are in REG2817-2824, and the data for the day of 2 days ago are in REG 3321-3328.

**REGISTER TABLE for the DAY accumulators**

| Block No. | Register | number | variable | format | Note |
|---|---|---|---|---|---|
| n/a | 0162 | 1 | Data pointer | Integer | Range:0~63 |
| 0 | 2817 | 1 | Day and Error Code | BCD | Day in high byte |
| | 2818 | 1 | Month and year | BCD | Year in high byte |
| | 2819-2820 | 2 | Total working time | LONG | |
| | 2821-2822 | 2 | Net total flow for the day | REAL4 | |
| | 2823-2824 | 2 | Net total energy for the day | REAL4 | |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2825 | 1 | Day and Error Code | BCD | Day in high byte |
| | 2826 | 1 | Month and year | BCD | Year in high byte |
| | 2827-2828 | 2 | Total working time | LONG | |
| | 2829-2830 | 2 | Net total flow for the day | REAL4 | |
| | 2831-2832 | 2 | Net total energy for the day | REAL4 | |
| ○ ○ ○ ○ | ○○○○○○○○○○ | ○○○○○○○ | ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ ○ ○ ○ ○○○○○○○○○○○○○○ |
| 6 3 | 3321-3328 | 8 | | | Data block No.63 |

Note：See the meaning of the error code above.

(2) REGISTER for accumulators by month

The structure of month accumulator is the same as that of the day，please refer to related paragraph。The difference is there are only 32 data blocks for the month accumulator, and day variable always has a value of 0.

REGISTER TABLE for the month accumulators

| Block No. | Register | number | Variable | format | note |
|---|---|---|---|---|---|
| n/a | 0163 | 1 | Data pointer for the month | Integer | Range: 0~63 |
| 0 | 3329 | 1 | Error Code | BCD | |
| | 3330 | 1 | Month and year | BCD | Year in high byte |
| | 3331-3332 | 2 | Total working time | LONG | |
| | 3333-3334 | 2 | Net total flow for the month | REAL4 | |
| | 3335-3336 | 2 | Net total energy for the month | REAL4 | |
| 1 | 3337 | 1 | Error Code | BCD | |
| | 3338 | 1 | Month and year | BCD | Year in high byte |
| | 3339-3340 | 2 | Total working time | LONG | |
| | 3341-3342 | 2 | Net total flow for the month | REAL4 | |
| | 3343-3344 | 2 | Net total energy for the month | REAL4 | |
| ○ ○ ○ ○ | ○○○○○○○○○○ | ○○○○○○○ | ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ ○ ○ | ○○○○○○○○○○○○○○○○○○○○ |
| 31 | 3577-3584 | 8 | | | Data block No. 31 |

(3) There is no direct data for the year, data for the year could be conducted from the data of the months.

## 5.1.3 REGISTER for power-on and power-off

With every t power-on and power-off, the new generation flow meter will record data about the time, duration, statue byte and the flow rate into a data block. Every data block consists 32 bytes of data.

There are as many as 16 blocks of data can be recorded, for 16 times of power-on and 16 times of power-off. The data blocks are in a structure of loop queue. The 16th data block will override the first block by default. The location of the current block is presented in the data pointer. The current power-on data block is pointed by the decease by 1 of the pointer.

MODBUS registers table for the power-on and power-off.

| Block No. | Register | No. | Variable | Format | Note |
|---|---|---|---|---|---|
| n/a | 0164 | 1 | Pointer | Integer | Range:0~31 |
| 0 | 3585 | 1 | Power-on second and minute | BCD | Second in low byte, minute in high |
| | 3586 | 1 | Power-on hour and day | BCD | Hour in low byte, day in high |
| | 3587 | 1 | Power-on month and year | BCD | Month in low byte, year in high |
| | 3588 | 1 | Power-on error code | BIT | B15 stand for corrected lost flow. |
| | 3589 | 1 | Power-off second and minute | BCD | Second in low byte, minute in high |
| | 3590 | 1 | Power-off hour and day | BCD | Hour in low byte, day in high |
| | 3591 | 1 | Power-off month and year | BCD | Month in low byte, year in high |
| | 3592 | 1 | Power-off error code | BIT | B15 stand for corrected lost flow |
| | 3593-3594 | 2 | Flow rate when power on | REAL4 | Flow rate after 60 seconds when power on |
| | 3595-3596 | 2 | Flow rate when power off | REAL4 | |
| | 3597-3598 | 2 | Time duration when off | LONG | In seconds |
| | 3599-3600 | 2 | Corrected lost flow when off | REAL4 | In cubic meters |
| 1 | 3601 | 1 | Power-on second and minute | BCD | Second in low byte, minute in high |
| | 3602 | 1 | Power-on hour and day | BCD | Hour in low byte, day in high |
| | 3603 | 1 | Power-on month and year | BCD | Month in low byte, year in high |
| | 3604 | 1 | Power-on error code | BIT | B15 stand for corrected lost flow. |
| | 3605 | 1 | Power-off second and minute | BCD | Second in low byte, minute in high |
| | 3606 | 1 | Power-off hour and day | BCD | Hour in low byte, day in high |
| | 3607 | 1 | Power-off month and year | BCD | Month in low byte, year in high |
| | 3608 | 1 | Power-off error code | BIT | B15 stand for corrected lost flow |

| | | | | | |
|---|---|---|---|---|---|
| | 3609-3610 | 2 | Flow rate when power on | REAL4 | Flow rate after 60 seconds when power on |
| | 3611-3612 | 2 | Flow rate when power off | REAL4 | |
| | 3613-3614 | 2 | Time duration when off | LONG | In seconds |
| | 3615-3616 | 2 | Corrected lost flow when off | REAL4 | In cubic meters |
| ○ ○ ○ ○ | ○○○○○○○○○ | ○○○ | | ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ |
| 31 | 3825-3840 | 16 | | | The 32nd data block |

## 5.2 The FUJI extended communication protocol

LRF-2000 is compatible with the LRF7-FUJI extended communication protocol which used in our previous Version7 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.

| Command | Meaning | Data format |
|---|---|---|
| DQD(cr) note 0 | Returns flow rate per day | ±d.dddddE±dd(cr) note 1 |
| DQH(cr) | Return flow rate per hour | ±d.dddddE±dd(cr) |
| DQM(cr) | Return flow rate per minute | ±d.dddddE±dd(cr) |
| DQS(cr) | Return flow rate per second | ±d.dddddE±dd(cr) |
| DV(cr) | Return fluid velocity | ±d.dddddE±dd(cr) |
| DI+(cr) | Return positive totalizer | ±ddddddE±d(cr) note 2 |
| DI-(cr) | Return negative totalizer | ±ddddddE±d(cr) |
| DIN(cr) | Return net totalizer | ±ddddddE±d(cr) |
| DIE(cr) | Return net thermal energy totalizer | ±ddddddE±d(cr) |
| DIE+(cr) | Return positive energy totalizer | ±ddddddE±d(cr) |
| DIE-(cr) | Return negtive energy totalizer | ±ddddddE±d(cr) |
| DIT(cr) | Return net total flow for today | ±ddddddE±d(cr) |
| DIM(cr) | Return net total flow for this month | ±ddddddE±d(cr) |
| DIY(cr) | Return net total flow for this year | ±ddddddE±d(cr) |
| DID(cr) | Return the ID number/address | ddddd(cr) 5 bytes long |
| E(cr) | Return instantaneous Caloric Value | ±d.dddddE±dd(cr) |
| DL(cr) | Return signal strength and signal quality | UP:dd.d,DN:dd.d,Q=dd(cr) |
| DS(cr) | Return the percentage of AO output | ±d.dddddE±dd(cr) |
| DC(cr) | Return present error code | Note 3 |

| | | |
|---|---|---|
| DA(cr) | OCT and RELAY alarm signal | TR:s,RL:s(cr)note 4 |
| DT(cr) | Return the present date and time | yy-mm-dd,hh:mm:ss(cr) |
| Time@TDS1=(cr) | Set date and time yy-mm-dd,hh:mm:ss | |
| M@(cr) | Send a key value as if a key is pressed.<br><br>@ is the key value | M@(cr)note 5 |
| LCD(cr) | Returns current window content | |
| LOCK0(cr) | Unlock the system | Has nothing to do with the original password. |
| LOCK1(cr) | Lock the system | Can be opened by press ENT key |
| MENUXX(cr) | Go to window XX | |
| LanguageX(cr) | Select interface language | X=0 for English, 1 for Chinese<br><br>2 for Italy, if applicable<br><br>3 for Korea, if applicable<br><br>4 for French, if applicable<br><br>5 for Germany， if applicable<br><br>6 for Spanish, if applicable |
| BaudRateX(cr) | Change baud rate | X=0~7, will set to 19200, 14400, 9600,4800,2400,1200,600,300 |
| C1(cr) | OCT close | |
| C0(cr) | OCT open | |
| R1(cr) | RELAY(OCT2) close | |
| R0(cr) | RELAY(OCT2) open | |
| FOdddd(cr) | Force the FO to output a frequency of dddd HZ | Fdddd(cr)(lf) |
| AOa(cr) | Output current ‘a’ mA at the AO output terminal. | AOa(cr)(lf)Note 6 |
| BA1(cr) | Return the resistance for T1 | ±d.dddddd±dd(cr)(lf) |
| | | |
| BA2(cr) | Return the resistance for T2 | ±d.dddddd±dd(cr)(lf) |
| BA3(cr) | Return current value of AI3 (0~20mA) | ±d.dddddd±dd(cr)(lf) |
| BA4(cr) | Return current value of AI4 (0~20mA) | ±d.dddddd±dd(cr)(lf) |
| BA5(cr) | Return current value of AI5 (0~20mA) | ±d.dddddd±dd(cr)(lf) |
| AI1(cr) | Return temperature at T1 input | ±d.dddddd±dd(cr)(lf) |
| AI2(cr) | Return temperature at T2 input | ±d.dddddd±dd(cr)(lf) |
| AI3(cr) | Return temperature /pressure value of AI3 | ±d.dddddd±dd(cr)(lf) |
| AI4(cr) | Return temperature /pressure value of AI4 | ±d.dddddd±dd(cr)(lf) |

| | | |
|---|---|---|
| AI5(cr) | Return temperature /pressure value of AI5 | ±d.dddddd E ±dd(cr)(lf) |
| ESN(cr) | Return the ESN (electronic serial number) of the flow meter | ddddddd(cr)(lf) note 7 |
| N | Prefix of an IDN-addressing-based networking, The IDN address is byte, range 0-253 | Note 8 |
| W | Prefix of an IDN-addressing-based networking, The IDN address is word, range 0-65535 | Note 8 |
| P | Prefix of any commands for returns with check-sum | |
| & | Commands connector to make a compounding command in one line. | Result commands should not exceed 253 bytes long. |
| RING(cr)(lf) | Handshaking request from a modem | ATA(CR)(lf) |

| | | |
|---|---|---|
| OK(cr) | Acknowledgement from a modem. | No action |
| | Handshaking from the flow meter to modem. | AT(CR)(LF) |
| GA(cr) | Special command for GSM network. | note 9 |
| GB(cr) | Special command for GSM network. | note 9 |
| GC(cr) | Special command for GSM network | note 9 |

Note:

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．Working status code, 1~6 letters, refer to error code related chapter.

4．‘s’ is ‘ON’,’OFF’ or ‘UD’

For example ‘TR:ON,RL:ON’ means the OCT and RELAY are closed

‘TR:UD,RL:UD” means the OCT and RELAY are not used.

5．@ stand for key value, for example, value 30H means key ‘0’. The command ‘M4(cr)’ acts just like the number 4 key on the keypad was pressed.

6. 'a' stands for the output current value. The maximum value should not exceed 20.0 For example AO2.34567, AO0.2

7. 'ddddddddd' stands for the Electronic Serial Number

8. 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.

9. The returns by the special command for GSM networks contend Chinese characters.

## 5.2.1Command prefixes and the command connector

**(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) 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.

**(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)

**(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 AI1 input 6) the AI2 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&PBA1&PAI2(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, if a serious key want be sent, to set up the outer diameter to 1234.567 mm, a compound command will be

MENU11&M1&M2&M3&M4&M:&M5&M6&M7&M=(CR)

## 5.3 the compatible communication protocols

Flow meters made by our manufacturer have more than 10 different communications protocols. For the easier replacement of a water meter, most of these protocols are realized in LRF-2000 flow meters. Here only one of them, the default for compatible protocols CRL-61D (D<=50mm), is given for reference.

These protocols are selectable by Menu63, after the selection of MOBUS-ASCI, or MODBUS-RTU protocols.

interface：RS232，RS485

baud rate：9600 by default，select other 15 different baud rate by Menu 62

parity：NONE, EVEN, ODD can be chosen from Menu 62

Data bits：8

Stop bits: 1, 2

In the following explanation:

XXh stands for the address (or network ID)of the instrument, range:00h-FFh.

YYh stands for the new address that will be assigned, range:00h-FFh.

ZZh the check-sum, which is obtained by means of binary addition of all the data bytes (take notice to that the addition is for the data bytes, not the controlling and commands bytes, and the carry over 0ffh is discarded.

H stands for that the number is a hexadecimal number.

All five command are like following:

(1) read water meter data (command 4A）

Format: 2Ah XXh 4Ah

Answer: 26h XXh 4Ah LL(BCD coded ）ZZh

In the above, the contents of LL(BCD) are formatted as in the following table:

| Position | Content | Bytes | Note |
|---|---|---|---|
| 1~4 | Flow rate | 4 | The actual value is divided by 1000, unit in cubic meter per hour. |
| 5~8 | Positive total flow | 4 | The actual value divided by 10, unit in cubic meter |
| 9~12 | Total time | 4 | Unit in hour |
| 13 | Error code | 1 | See table below |

(2) Reading the recorded meter data (command 49)

Format: 2Ah XXh 49h

Answer: 26h XXh 49h LL（BCD 码） ZZh

The difference between the command 4A and command 49 is that the late command reads out the data which are recorded in the meter by the time which is defined by command 4C.

(3) Change the address of the meter (command 4B)

Format: 2Ah XXh 4Bh YYh

Answer: 26h XXh 4Bh YYh

If XXh=YYh, this command can be used to do a loop test the net work, or to scan and find the existed meters in the network. Please pay attention to that the network may lose meters if this command is used in a noisy network.

(4) Change or assign a time for meter data recording (command 4C)

Format: 2Ah XXh 4Ch DDh HHh

Answer: 26h XXh 4Ch DDh HHh MMh ZZh

DDh stands for the day, HHh for hour, MM for minute, data are in BCD code.

DD is the day of this month, for example: 2Ah 86h 4Ch 12h 15h stands for assigning a recording time for the number 86 meter 86. the meter will record the flow rate, total net flow, the working timer and the error code when time is 15:00 the 12$^{th}$ of this month. The recorded date will be read out by command 49.

If DD＝0, it stands that the data recording will take place by 15:00 for every day.

(5) Standard date and time broadcasting （command 4D）

Format: 2Ah AAh 4Dh ssmmhhDDMMYY

Answer: no answer

In above, ssmmhhDDMMYY is the date and time in BCD format.

Diagnostic code: 00h stands that the system is working normally.

02h stands for the pipe may be empty or meter works improperly.

05h stand for there exist hardware failure, repair may needed.

## 5.4 Key Value Table

The key values are used in a network application. By use of the key value and a command 'M', we can operate the flow meter through the network on a computer or other kind of terminals. For example, the command 'M0(cr)' acts just like the zero key on the keypad was pressed.

| Key | Key value (headecimal) | Key value (decimal) | ASCII value | key | Key value (headecimal) | Key value (decimal) | ASCII value |
|---|---|---|---|---|---|---|---|
| 0 | 30H | 48 | 0 | 8 | 38H | 56 | 8 |
| 1 | 31H | 49 | 1 | 9 | 39H | 57 | 9 |
| 2 | 32H | 50 | 2 | . | 3AH | 58 | : |
| 3 | 33H | 51 | 3 | ◄ | 3BH | 59 | ; |
| 4 | 34H | 52 | 4 | MENU | 3CH | 60 | < |
| 5 | 35H | 53 | 5 | ENT | 3DH | 61 | = |
| 6 | 36H | 54 | 6 | ▲/+ | 3EH | 62 | > |
| 7 | 37H | 55 | 7 | ▼/- | 3FH | 63 | ? |