FCTT
COMMUNICATION SPECIFICATION
(Modbus RTU)

Content

1. Communication specification

| Item	Specification
Standard	TIA/EIA-485-A (2003)
Transmission system	Half-duplex two-wire system
Synchronous system	Asynchronous communication method
Bit rates	9600bps / 19200bps / 38400bps (The designation when ordering.)
Modulation code	NRZ
Start bit	1 bit
Data length	8 bits
Parity	None / Even number / Odd number (The designation when ordering.)
Stop bit	1 bit
Error detection	CRC-16 $(X^{16}+X^{15}+X^{2}+1)$
Connection method	M3 screw (FW11 socket) connection.
Cable length	1000m (The total extension)
Address (^{1})	01 to 89 (01H to 59H) and 00 (Communication is unused.)
Number of connections	Max. 64 sets (^{2}) / One system
Transmission character	Binary

Transmission data are sent out from a bit 0.

Note(^{1}) The setting change is made with a front switch.
The factory setting becomes an address 00 (communication is unused).
Note(^{2}) When connection number connects 32 apparatuses, the number of the maximum connection decreases.
(to become the number of the connection of two sets in one)

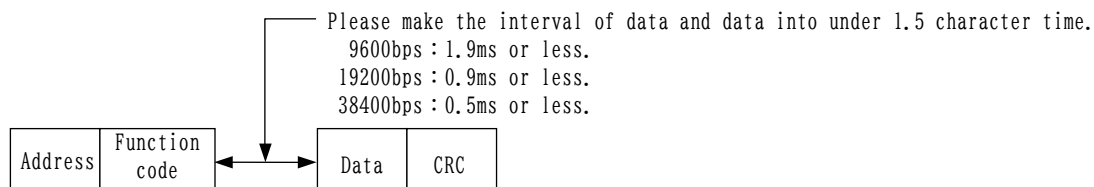## 2. Transmission and reception protocol

(1) Normal request (Query).
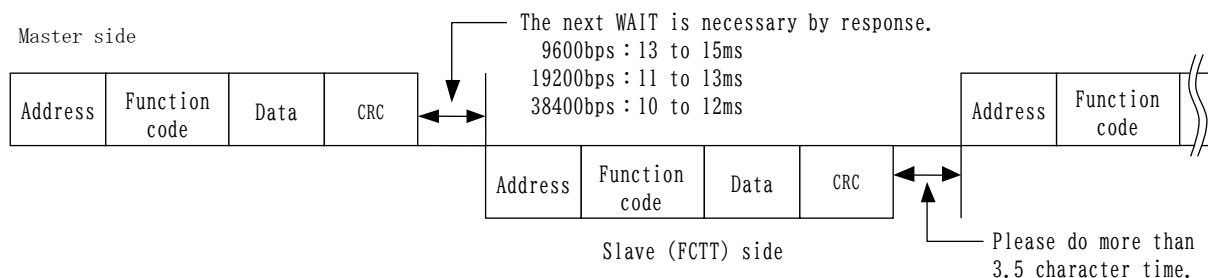
(2) Timeout of between data.
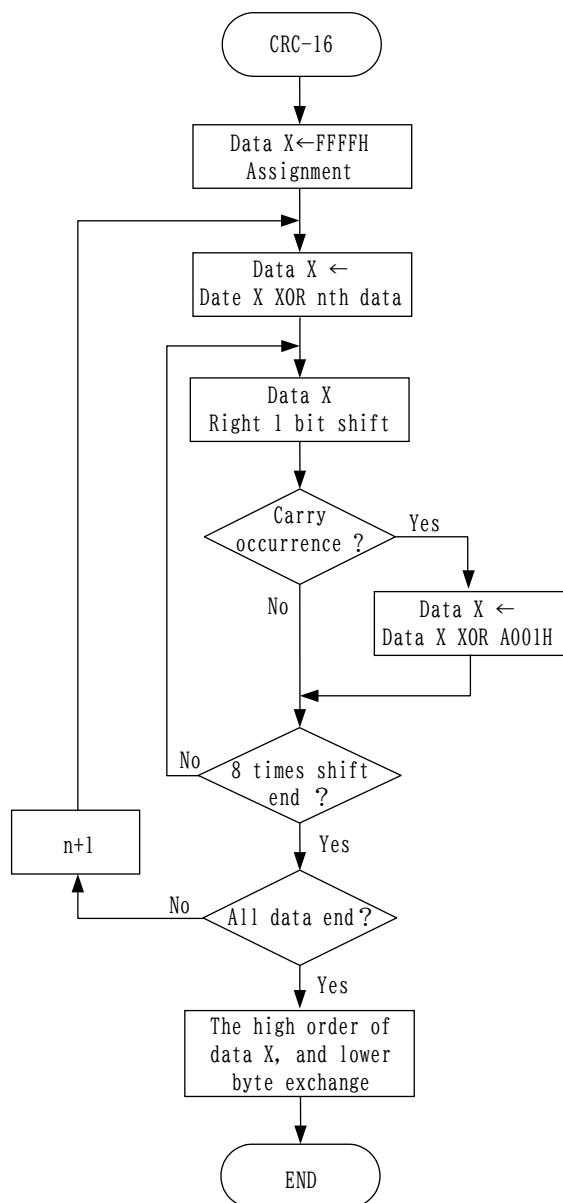Please make the interval of data and data into under 1.5 character time.
It becomes a timeout error if it becomes an interval more than 1.5 character time.

3. Calculation method of CRC-16

CRC-16 is adopted as error checking in Modbus RTU mode.
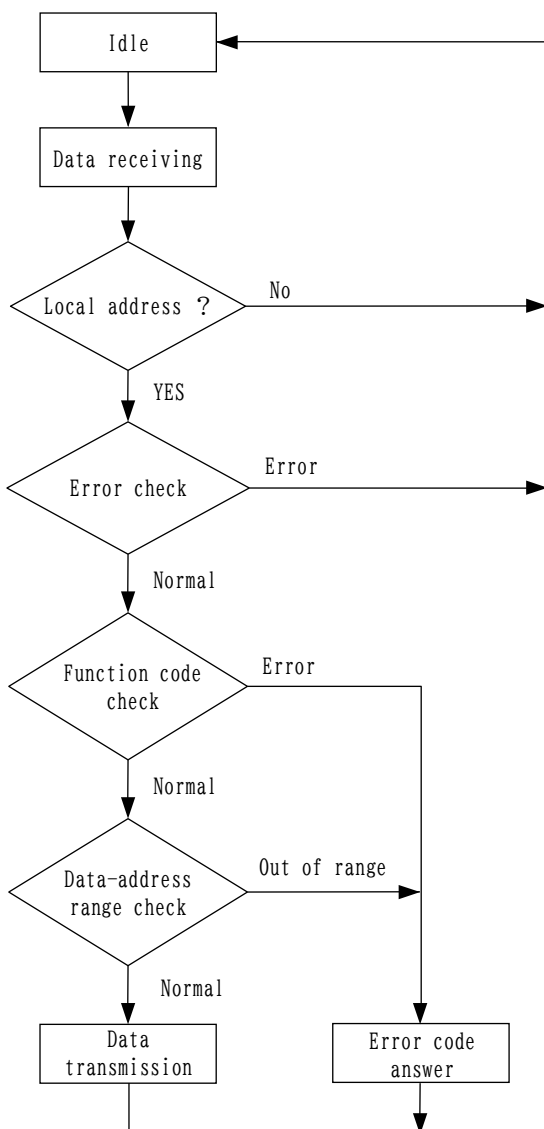An address, a function code, and data are calculated by the following method.

```
        ┌─────────────┐
        (   CRC-16    )
        └──────┬──────┘
               │
        ┌──────▼──────┐
        │ Data X←FFFFH│
        │  Assignment │
        └──────┬──────┘
               │
        ┌──────▼──────────┐
        │    Data X ←     │
        │ Date X XOR nth  │
        │     data        │
        └──────┬──────────┘
               │
        ┌──────▼──────┐
        │   Data X    │
        │Right 1 bit  │
        │   shift     │
        └──────┬──────┘
               │
           ◇ Carry ◇ ──Yes──┐
           ◇occurrence?◇    │
               │No    ┌──────▼──────┐
               │      │  Data X ←   │
               │      │Data X XOR   │
               │      │   A001H     │
               │      └──────┬──────┘
               ◄─────────────┘
               │
      No   ◇ 8 times shift ◇
     ┌────── ◇   end ?     ◇
     │          │Yes
 ┌───▼──┐       │
 │ n+1  │    ◇ All data end?◇ ──No──┐
 └──────┘       │Yes
               ┌▼───────────┐
               │The high    │
               │order of    │
               │data X, and │
               │lower byte  │
               │exchange    │
               └─────┬──────┘
               ┌─────▼─────┐
               (   END     )
               └───────────┘
```

(1) Arithmetic process

① 2 bytes of data-area X is secured to a CRC calculation.

② A default value (FFFFH) is substituted for ①.

③ XOR of data X and the nth data (n=1) is calculated. It assigns for data X.

④ The 1-bit shift right of the data X is done.

⑤ If carry occurs in operation of ④, data X and XOR of A001H are taken.

⑥ Operation of ④ and ⑤ is repeated until it shifts 8 times.

⑦ XOR of the next data (n+1) and Data X is calculated. It assigns for Data X.

⑧ Operation of ④ to ⑦ is repeated until processing of all data is completed.

⑨ 1 byte of high rank and 1 byte of low rank of data-area X for a CRC calculation are replaced.

(2) The example of calculation

CRC Object range						
1 byte	1 byte	2 byte		2 byte		2 byte
Address	Function code	Data address		Number of request data		CRC
01H	04H	00H	00H	00H	19H	31C0H

4. Communication process flow chart

```
                    ┌─────────────┐
          ┌────────▶│    Idle     │◀──────────────────────┐
          │         └──────┬──────┘                       │
          │                │                              │
          │         ┌──────▼──────┐                       │
          │         │Data receiving│                      │
          │         └──────┬──────┘                       │
          │                │                              │
          │                ▼            No                │
          │          ◇ Local address ? ──────────────────▶│
          │                │ YES                          │
          │                ▼            Error             │
          │          ◇ Error check ───────────────────────▶│
          │                │ Normal                       │
          │                ▼            Error             │
          │          ◇ Function code ───────┐             │
          │             check               │             │
          │                │ Normal         │             │
          │                ▼         Out of range          │
          │          ◇ Data-address ────────┼────▶        │
          │             range check         │             │
          │                │ Normal         │             │
          │         ┌──────▼──────┐   ┌──────▼──────┐      │
          │         │    Data     │   │ Error code  │      │
          │         │transmission │   │   answer    │      │
          │         └──────┬──────┘   └──────┬──────┘      │
          └────────────────┴─────────────────┴────────────┘
```

5. FCTT communication terminal arrangement
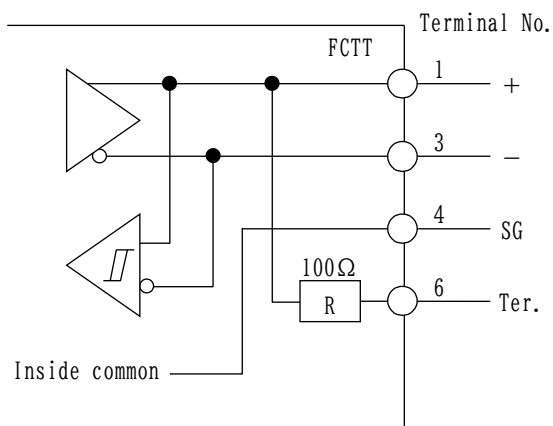
The termination resistor (100Ω) is connected by short-circuiting a terminal 3(−) and a terminal 6(Ter.).
Please connect a termination resistor, if this product is in the end (terminus) of communication line.

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6. Modbus protocol RTU mode

6.1 Function code

The next function code is supported with this product.

Function code	Name	Data address	Number of the designated data	Master → FCTT Command message [Unit : byte]		FCTT → Master Response message [Unit : byte]	
				Min.	Max.	Min.	Max.
04H	Measurement value data	30001 to 30125	Max. 125 words	8	8	7	255
03H	Model information	40501 to 40503	Max. 3 words	8	8	7	11

6.2 Error response

In case the message transmitted from the master is judged to be error, this product does the next error answer.

(1) In case it becomes a no-answer.
① In case a message communication error occurs. (Overrun, Framing, Parity error, CRC)
② In case the data interval of a message exceeds a regulation value (1.5 characters).
③ In case the message frame exceeding 8 bytes is received.

(2) In case of answer in error code.
In the error that does not correspond to (1), the following error response is returned.
At this case, the code that applied 80H to the code of a demand is returned to a function code.
And, the generated error code is returned as data.

1 byte	1 byte	1 byte	2 byte
Address	Function code (+80H)	Error code	CRC
01H	84H	02H	C2C1H

Error code list

Operation code	Function	Contents
01H	Illegal function	The function cord a slave doesn't have was received. (Function code which does not exist really)
02H	Illegal data address	The data address which is not defined as a slave is designated. (Out of the address range)
03H	Illegal data value	The data more than the number of answer data are required. Or the number of answer data to demand is 0 word.

6.3 Measurement data request

The measurement value of this product is read. There is no broadcast.
The function code designates 04H.

(1) Request of data (Query)

If a measurement value request is performed, it is necessary to designate the head address of data to acquire.
When sending the data address, please designate it by a relative address (30001 is subtracted from the address of the data address table.)
The number of data must designate the number of words of the data to request.

1	2	3　　　　4	5　　　　6	7　　　　8
Address	Function code	Read start address (Relative address)	Number of data	CRC
01H	04H	0000H	0002H	71CBH

Data address list

Function code	Relative address	Data address	Contents of memory	Data type
04	0000H	30001	INPUT 1 measurement value data	WORD
	0001H	30002	INPUT 2 measurement value data	WORD

(2) Response

If measurement value request is performed normally, the following response will be returned from this product side.

Example) Read start address : 30001, Number of data : 2, Measurement value data (INPUT 1,2) : 10000

1	2	3	4　　　　5	6　　　　7	8　　　　9
Address	Function code	Answer byte count	INPUT 1 Measurement value data	INPUT 2 Measurement value data	CRC
01H	04H	04H	2710H	2710H	EAC9H

(3) Format of measurement value data (INPUT 1,2).

Input	Transmission data (hexadecimal)	Transmission data (Decimal)	Measurement range
0 to FULL (^{3})	0H to 2710H	0 to 10000	0% (^{4}) and 120% of input span.
±FULL	D8F0H to 2710H	±10000	±120% of input span.

Note(^{3}) 4－20mA and 1－5V input specification are included. (4－20mA / 0－10000, 1－5V / 0－10000)

Note(^{4}) In the case of 4－20mA, and 1－5V input specification, a lower limit value is －25% (about 0 input) of an input span.

6.4 Model information request

The type code of this product is read. There is no broadcast. The function code designates 03H.

(1) Request of data (Query)

If a model information request is performed, it is necessary to designate the head address of data to acquire.

When sending the data address, please subtract 40001 from the address of a data address table.

The number of data must designate the number of the data to request.

1	2	3	4	5	6	7	8
Address	Function code	Data address		Number of data		CRC	
01H	03H	01F4H		0001H		C404H	

Data address list

Function code	Relative address	Data address	Contents of memory
03H	01F4H	40501	Model information, Type code
	01F5H	40502	Not used (0000H)
	01F6H	40503	Not used (0000H)

(2) Response

If model information request is performed normally, the following response will be returned from this product side.

1	2	3	4	5	6	7
Address	Function code	Answer byte count	Type code		CRC	
01H	03H	02H	0020H		B99CH	

● Model information, Type code

Type	Communication data
FCTT	0020H

7. Communication monitor function

This function is valid only at the case of communication use.
Communication status is distinguished in the state of lights of RUN LED.
The communication monitor function doesn't operate on address 00 and at 90 to 99 (Communication is unused).
(RUN LED will be the lights.)
The monitor specification will be below.

Status of communication	Definition	Communication monitor	
		Status of RUN LED	Priority
Normal	There is communication to local. And when replied with normalcy by error detecting. Return from abnormal state becomes reset automatically.	Always on. (The address always also lights at 00 and 90 to 99.)	3
Error	・Time out. ・Communication error (Parity error / Overrun error / Framing error), CRC error	Blinking at 1 second cycle (0.5 seconds on, 0.5 seconds off)	1 (Top priority)
Other	Setting error relation. ・Communication address is changed during power supply applying. (Operation by the communication address before change.)	Blinking at 2 second cycle (1 second on, 1 second off)	2

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