Frame description :

Slave Address	Function Code	Data	CRC
1 byte	1 byte	0 up to 252 byte(s)	2 bytes CRC Low CRC Hi

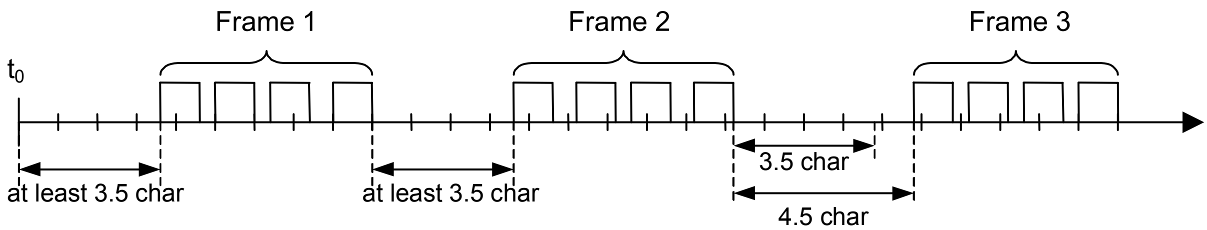
Figure 12: RTU Message Frame

➔ The maximum size of a MODBUS RTU frame is 256 bytes.

2.5.1.1 MODBUS Message RTU Framing

A MODBUS message is placed by the transmitting device into a frame that has a known beginning and ending point. This allows devices that receive a new frame to begin at the start of the message, and to know when the message is completed. Partial messages must be detected and errors must be set as a result.

In RTU mode, message frames are separated by a silent interval of at least 3.5 character times. In the following sections, this time interval is called t3,5.

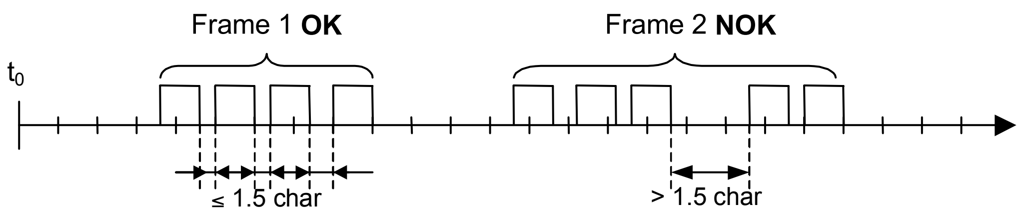


	MODBUS message				
Start	Address	Function	Data	CRC Check	End
≥ 3.5 char	8 bits	8 bits	N x 8 bits	16 bits	≥ 3.5 char

Figure 13: RTU Message Frame

The entire message frame must be transmitted as a continuous stream of characters.

If a silent interval of more than 1.5 character times occurs between two characters, the message frame is declared incomplete and should be discarded by the receiver.



Remark :

The implementation of RTU reception driver may imply the management of a lot of interruptions due to the $t_{1.5}$ and $t_{3.5}$ timers. With high communication baud rates, this leads to a heavy CPU load. Consequently these two timers must be strictly respected when the baud rate is equal or lower than 19200 Bps. For baud rates greater than 19200 Bps, fixed values for the 2 timers should be used: it is recommended to use a value of 750µs for the inter-character time-out ($t_{1.5}$) and a value of 1.750ms for inter-frame delay ($t_{3.5}$).

The following drawing provides a description of the RTU transmission mode state diagram. Both "master" and "slave" points of view are expressed in the same drawing :

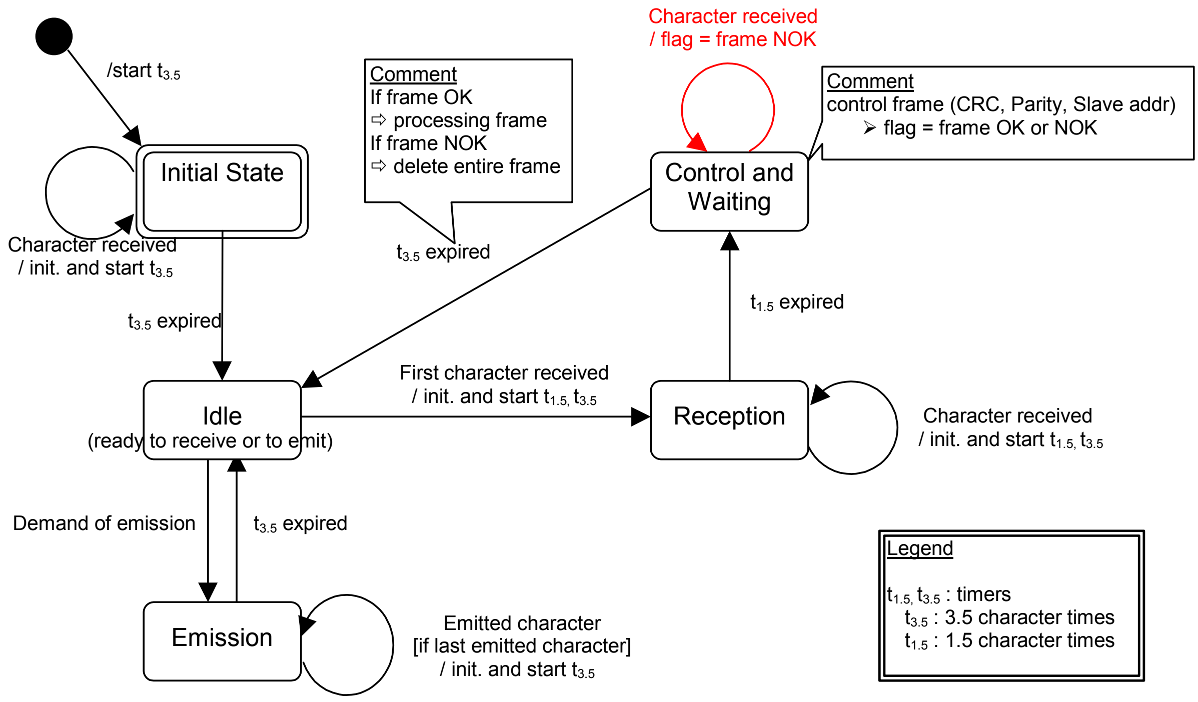


Figure 14: RTU transmission mode state diagram

Some explanations about the above state diagram:

- Transition from "Initial State" to "Idle" state needs $t_{3.5}$ time-out expiration : that insures inter-frame delay
- "Idle" state is the normal state when neither emission nor reception is active.
- In RTU mode, the communication link is declared in "idle" state when there is no transmission activity after a time interval equal to at least 3,5 characters.
- When the link is in idle state, each transmitted character detected on the link is identified as the **start of a frame**. The link goes to the "active" state. Then, the **end of frame** is identified when no more character is transmitted on the link after the time interval t3,5.
- After detection of the end of frame, the CRC calculation and checking is completed. Afterwards the address field is analysed to determine if the frame is for the device. If not the frame is discarded. In order to reduce the reception processing time the address field can be analysed as soon as it is received without waiting the end of frame. In this case the CRC will be calculated and checked only if the frame is addressed to the slave (broadcast frame included).

2.5.1.2 CRC Checking

The RTU mode includes an error–checking field that is based on a Cyclical Redundancy Checking (**CRC**) method performed on the message contents.

The CRC field checks the contents of the entire message. It is applied regardless of any parity checking method used for the individual characters of the message.

The CRC field contains a 16–bit value implemented as two 8–bit bytes.

The CRC field is appended to the message as the last field in the message. When this is done, the low–order byte of the field is appended first, followed by the high–order byte. The CRC high–order byte is the last byte to be sent in the message.

The CRC value is calculated by the sending device, which appends the CRC to the message. The receiving device recalculates a CRC during receipt of the message, and compares the calculated value to the actual value it received in the CRC field. If the two values are not equal, an error results.

The CRC calculation is started by first pre-loading a 16–bit register to all 1's. Then a process begins of applying successive 8–bit bytes of the message to the current contents of the register. Only the eight bits of data in each character are used for generating the CRC. Start and stop bits and the parity bit, do not apply to the CRC.