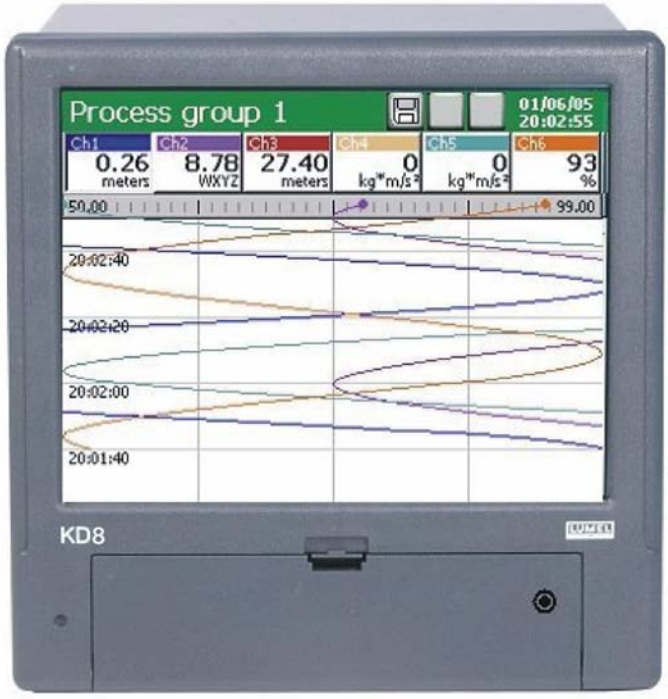
SCREEN RECORDER

KD8 TYPE



MODBUS TRANSMISSION PROTOCOL
SERVICE MANUAL

CONTENTS

1. APPLICATION

In order to obtain the information exchange, when using the serial link, one must choose the interface type and validate the interpretation way of transmitted data. The interface type defines only electrical transmission parameters and the way of the device connection.
Such features, as the possibility to service several devices, check the transmission correctness and the principles of access to the device, depend on the data interpretation.
The task of the protocol is to define which data type is interpreted (permitted) and in which way they are interpreted.
A **MODBUS** asynchronous character transmission protocol has been implemented on the serial link of the **KD8** recorder. The parameter configuration of the **RS-485** serial link is described in the **KD8** recorder user's manual.
Parameter set of the **KD8** recorder serial link:

• Recorder address	1 ...247
• Baud rate	300, 600, 1200, 2400, 4800, 9600, 14400, 19200, 28800, 38400, 57600, 115200 bit/s
• Working mode	ASCII, RTU
• Information unit	ASCII: 8N1, 7N2, 7E1, 701 RTU:8N2, 8N1, 8E1,8O1
• Maximal turnaround time	100 ms

2. DESCRIPTION OF THE MODBUS PROTOCOL

The MODBUS interface is a standard adopted by manufacturers of industrial controllers for the asynchronous character exchange of information between different devices and measuring systems. It has such features as:
• Simple access rule to the link based on the "master-slave" principle,
• Protection of transmitted messages against errors,
• Confirmation of remote instruction realization and error signaling,
• Effective actions protecting against the system suspension,
• Taking advantage of the asynchronous character transmission.
Device controllers working in the **MODBUS** protocol can communicate with each other, taking advantage of the **master-slave** protocol type, in which only one device (the **master** - superior unit) can originate transactions (called ''queries"), and others (slaves - subordinate units) respond only to the remote requested data from the **master.** The transaction is composed of the transmitted command from the **master** unit to the **slave** unit and of the response transmitted in the opposite direction. The response includes data requested by the master or the confirmation of the command realization.
Master can transmit information to individual slaves or broadcast messages destined for all subordinate devices in the system (responses are not returned to broadcast queries from the master)

The format of transmitted information is as following:
• **master => slave:** device address, code representing the required command, data to be sent, control word protecting the transmitted message,
• **slave => master:** sender address, confirmation of the command realization, data required by the master, control word protecting the response against errors.

If the **slave** device detects an error when receiving a message, or cannot realizes the command, it prepares a special message about the error occurrence and transmits it as a response to the **master.**
Devices working in the **MODBUS** protocol can be set into the communication using one of two transmission modes: **ASCII or RTU.** The user chooses the required mode, along with the serial

port communication parameters (baud rate, information unit) during the configuration of any device.
In the **MODBUS** system, transmitted messages are placed into frames that are not related to serial transmission. These frames have a defined beginning and end. This enables for the receiving device to reject incomplete frames and to signal related errors with them.
Taking into consideration the possibility to operate in one of these two different transmission modes (ASCII or RTU), two frames have been defined.

Explanation of some abbreviations:

ASCII = American Standard Code for Information Interchange

RTU = Remote Terminal Unit

LRC = Longitudinal Redundancy Check

CRC = Cyclic Redundancy Check CR = Carriage Return LF = Line-Feed (character)

MSB = Most Significant Bit

Checksum = Control Sum

2.1. ASCII framing

In the ASCII mode, each byte of information is transmitted as two ASCII characters. The basic feature of this mode is that it allows to long intervals between characters within the message (to 1 sec) without causing errors.

A typical message frame is shown below.

Start beginning index	Address	Function	Data	LRC check	End index
1 char ":"	2 chars	2 chars	*n* chars	2 chars	2 chars CR LF

In ASCII mode, messages start with a colon character (":" -ASCII 3Ah) and end with CR and LF characters. The frame information part is protected by the LRC code (Longitudinal Redundancy Check).

2.2. RTU Framing

In RTU mode, messages start and end with an interval lasting minimum 3.5 x (lasting time of a single character), in which a silence reigns on the link.

The simplest implementation of the mentioned time interval character times is a multiple measure of the character duration time at the set baud rate accepted on the link.

The frame format is shown below:

Start beginning index	Address	Function	Data	CRC check	End index
T1-T2-T3-T4	8 bits	8 bits	*n* x 8bits	16 bits	T1-T2-T3-T4

Start and end indexes are marked symbolically as an interval equal to four lengths of the index (information unit). The checking code consists of 16 bits and emerges as the result of CRC calculation (Cyclical Redundancy Check) of the frame contents.

2.3. Characteristic of frame fields.

Address field

The address field of a message frame contains two characters (in ASCII mode) or eight bits (in RTU mode).
Valid slave device addresses are in the range from 0 -247 . The master addresses the slave unit by placing the slave address in the frame address field. When the slave sends its response, it places its own address in the frame address field what enables the master to check which slave is responding.
The 0 address is used as a broadcast address recognized by all slave units connected to the bus.

Function field

The function code field of a message frame contains two characters in ASCII mode or eight bits in RTU mode. Valid codes are in the range from 1 - 255.
When a message is sent from a master to a slave device, the function code field tells the slave what kind of action to perform.
When the slave responds to the master, the function field is uses to confirm the command execution or error signaling if the function code field cannot realize the command for any reason. to indicate either a normal (error-free) response or that some kind of error occurred.
The positive confirmation is realized through the placement of the command execution code on the function field.
In case of an error assertion, the slave returns a special code that is equivalent to the original function code with its most significant logic 1.
The error code is placed on the data field of the response frame.

Data field

The data field is constructed using sets of two hexadecimal digits, in the range of 00 to FF.
These numbers can be made from a pair of ASCII characters or from one RTU character, according to the network's serial transmission mode. The data field of messages sent from a master to slave devices contains additional information which the slave must use to take the action defined by the function code. This can include items like register addresses, number of bytes in data field, data, a.s.o. The data field can be non-existent (of zero length) in certain kinds of frames. That occurs always, when the operation defined by the code does not require any parameters.

Error checking field

Two kinds of error-checking methods are used for standard MODBUS networks. The error checking field contents depends upon the method that is being used.

ASCII

When ASCII mode is used for character framing, the error checking field contains two ASCII characters. The error check characters are the result of a Longitudinal Redundancy Check (LRC) calculation that is performed on the message contents (without the beginning ’’colon" and terminating CRLF characters). LRC characters are appended to the message, as the last field preceding the CR, LF characters.

RTU

When RTU mode is used for character framing, the error checking field contains a 16-bit value implemented as two 8-bit bytes. The error check value is the result of a Cyclical Redundancy Check Calculation (CRC) performed on a message contents. 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.

2.4. LRC checking

The LRC is calculated by adding together successive 8-bit bytes of the message, discarding any carries, and then two is complementing the result. It is performed on the ASCII message field contents excluding the “colon” character that begins the message, and excluding the CR, LF pair at the end of the message. The 8-bit value of the LRC sum is placed at the frame end as two ASCII characters, first the character containing the higher tetrad, and after it, the character containing the lower LRC tetrad.

2.5. CRC checking

The generating procedure of CRC is realized according to the following algorithm:

1. Load a 16-bit register with FFFFh. Call this the CRC register.
2. Exclusive OR (XOR) the first 8-bit byte of the message with the low-order byte of the 16 bit CRC register, putting the result in the CRC register.
3. Shift the CRC register contents one bit to the right (towards the LSB), zero-filling the MSB. Extract and examine the LSB.
4. (If the LSB was O): Repeat step 3 (another shift) (If the LSB was 1): XOR the CRC register with the polynomial value A001h.
5. Repeat steps 3 and 4 until 8 shifts have been performed. When this is done, a complete 8-bit byte will have been processed.
6. Repeat steps 2 through 5 for the next 8-bit byte of the message. Continue doing this until all bytes have been processed.
7. The final contents of the CRC register is the CRC value.
8. When the CRC is placed into the message, its upper and lower bytes must be swapped as described below.

2.6. Character format during serial transmission

In the **MODBUS** protocol, characters are transmitted from the lowest to the highest bit.
Organization of the information unit in the ASCII mode:

- 1 start bit,
- 7 data field bits,
- 1 even parity check bit (odd) or lack of even parity check bit,
- 1 stop bit at even parity check or 2 stop bits when lack of even parity check.

Organization of the information unit in the RTU mode:

- 1 start bit,
- 8 data field bits,
- 1 even parity check bit (odd) or lack of even parity check bit,
- 1 stop bit at even parity check or 2 stop bits when lack of even parity check.

2.7. Transaction interruption

In the master unit the user sets up the important parameter which is the ’’maximal response time on the query frame" after exceeding of which, the transaction is interrupted. This time is chosen such that each slave unit working in the system (even the slowest) normally will have the time to answer to the frame query. An exceeding of this time attests therefore about an error and such is treated by the master unit.
If the unit slave will find out a transmission error it does not accomplish the order and does not send any answer. That causes an exceeding of the waiting time after the query frame and the transaction interruption.

3. DESCRIPTION OF FUNCTIONS

In the KD8 recorder following protocol functions has been implemented:

Code	Signification
03	Reading of n-register
17	Slave device identification

3.1. Reading of n-registers (code 03)

Request:
The function enables the reading of values included in registers in being addressed slave device. **Registers are 16 or 32-bit units, which can include numerical values bounded with changeable processes, and the like.** The request frame defines the 16-bit start address and the number of registers to read-out.
The signification of the register contents with address data can be different for different device types.
The function is not accessible in the broadcast mode.

Example: Reading of 3 registers beginning by the register with the 6Bh address.

Address	Function	Register address Hi	Register address Lo	Number of registers Hi	Number of registers Lo	Checksum	
11	03	00	6B	00	03	7E	LRC

Answer:
Register data are packing beginning from the smallest address: first the higher byte, then the lower register byte.

Example: the answer frame

Address	Function	Number of bits	Value in the regist 107 Hi	Value in the regist 107 Lo	Value in the regist 108 Hi	Value in the regist 108 Lo	Value in the regist 109 Hi	Value in the regist 109 Lo	Checksum	
11	03	06	02	2B	00	00	00	64	55	LRC

3.2. Report identifying the device (code 17)

Request:

This function enables the user to obtain information about the device type, status and configuration depending on this.

Example

Address	Function	Checksum	
11	11	DE	LRC

Answer:
The field ,,Device identifier" in the answer frame means the unique identifier of this class of device, however the other fields include parameters depended on the device type.

Example concerning the KD8 recorder

Slave address	Function	Number of bytes	Device identifier	Device state	Checksum	
11	11	02	B2	FF	48	1F

4. ERROR CODES

When the master device is broadcasting a request to the slave device then, except for messages in the broadcast mode, it expects a correct answer. After sending the request of the master unit, one of the four possibilities can occur:

- If the slave unit receives the request without a transmission error and can execute it correctly, then it returns a correct answer,
- If the slave unit does not receive the request, no answer is returned. Timeout conditions for the request will be fulfilled in the master device program.
- If the slave unit receives the request, but with transmission errors (even parity error of checking sum LRC or CRC), no answer is returned. Timeout condition for the request will be fulfilled in the master device program.
- If the slave unit receives the request without a transmission error but cannot execute it correctly (e.g. if the request is, the reading-out of a non-existent bit output or register), then it returns the answer including the error code, informing the master device about the error reason.

A message with an incorrect answer includes two fields distinguishing it from the correct answer.

1. The function code field:

In the correct answer, the slave unit retransmits the function code from the request message in the field of the answer function code. All function codes have the most-significant bit (MSB) equal zero (code values are under 80h). In the incorrect answer, the slave unit sets up the MSB bit of the function code at 1. This causes that the function code value in the incorrect answer is exactly of 80h greater than it would be in a correct answer.
On the base of the function code with a set up MSB bit the program of the master device can recognize an incorrect answer and can check the error code on the data field.

2. The data field:

In a correct answer the slave device can return data to the data field (certain information required by the master unit). In the incorrect answer the slave unit returns the error code to the data field. It defines conditions of the slave device which had produced the error. An example considering a request of a master device and the incorrect answer of the slave unit has been shown below. Data are in the hexadecimal shape.

Example: request

Slave address	Function	Variable address H1	Variable address Lo	Number Of Variables Hi	Number Of Variables Lo	Checksum	
OA	01	04	A1	00	01	4F	LRC

Example: incorrect answer

Slave	Function	Error	Checksum	
OA	81	02	73	LRC

In this example the master device addresses the request to the slave unit with No 10 (OAh). The function code (01) serves to the read-out operation of the bit input state. Then, this frame means the request of the status read-out of a one bit input with the address number: 1245 (04A1h).

If in the slave device there is no bit input with the given address, then the device returns the incorrect answer with the No 02 error code. This means a forbidden data address in the slave device.

Possible error codes and their meanings are shown in the table below.

Code	Meaning
01	Forbidden function
02	Forbidden data address
03	Forbidden data value
04	Damage in the connected device
05	Confirmation
06	Occupied, message removed
07	Negative confirmation
08	Error of memory parity

5. Table of registers

- KD8 recorder identifier (set as a respons to the identification function) : 0xB2
- Register types („Typ" kolumn):
  float – floating point number (see the description below),
  sfloat – floating point number (see the description below).
- Access modes to register:
  RO – only for readout.
- Representation of floating point numbers (float IEEE 754)

byte: 4 byte 3 byte 2 byte 1
SEEEEEEE EMMMMMMM MMMMMMMM MMMMMMMM
S – character bit (Sign bit)
E – exponent
M – mantissa
Register bytes of **float** type are sent in 4321 sequence
Register bytes of **sfloat** type are sent in 2143 sequence

PROCESSING DATA

Addresses of 16-bit addressed registers **Word type**	**Description**
5000	Alarm states: Bit 0 – alarm 1 of analog input 1 (AL1 - alarm output 1) Bit 1 – alarm 2 of analog input 1 (AL2 - alarm output 2) Bit 2 – alarm 1 of analog input 2 (AL3 - alarm output 3) Bit 3 – alarm 2 of analog input 2 (AL4 - alarm output 4) Bit 4 – alarm 1 of analog input 3 (AL5 - alarm output 5) Bit 5 – alarm 2 of analog input 3 (AL6 - alarm output 6) Bit 6 – alarm 1 of analog input 4 (AL7 - alarm output 7) Bit 7 – alarm 2 of analog input 4 (AL8 - alarm output 8) Bit 8 – alarm 1 of analog input 5 (AL9 - alarm output 9) Bit 9 – alarm 2 of analog input 5 (AL10 - alarm output 10) Bit 10 – alarm 1 of analog input 6 (AL11 - alarm output 11) Bit 11 – alarm 2 of analog input 6 (AL12 - alarm output 12)

Addresses of 16-bit addressed registers		Addresses of 32-bit addressed registers		Description
Float type	**sfloat type**	**Float type**	**sfloat type**	
7000	7200	7500	7700	Value of input 1 *)
7002	7202	7501	7701	Value of input 2 *)
7004	7204	7502	7702	Value of input 3 *)
…	…	…	…	…
7026	7226	7513	7713	Value of input 14 *)
7100	7300	7600	7800	Value of analog input 1
7102	7302	7601	7801	Value of analog input 2
7104	7304	7602	7802	Value of analog input 3
7106	7306	7603	7803	Value of analog input 4
7108	7308	7604	7804	Value of analog input 5
7110	7310	7605	7805	Value of analog input 6
7130	7330	7630	7830	Value of binary input 1
7132	7332	7631	7831	Value of binary input 2
7134	7334	7632	7832	Value of binary input 3
7136	7336	7633	7833	Value of binary input 4
7138	7338	7634	7834	Value of binary input 5
7140	7340	7635	7835	Value of binary input 6
7142	7342	7636	7836	Value of binary input 7
7144	7344	7637	7837	Value of binary input 8
7160	7360	7660	7860	Alarm 1 of analog input 1 (AL1 – alarm output 1)
7162	7362	7661	7861	Alarm 2 of analog input 1 (AL2 – alarm output 2)
7164	7364	7662	7862	Alarm 1 of analog input 2 (AL3 – alarm output 3)
7166	7366	7663	7863	Alarm 2 of analog input 2 (AL4 – alarm output 4)
7168	7368	7664	7864	Alarm 1 of analog input 3 (AL5 – alarm output 5)
7170	7370	7665	7865	Alarm 2 of analog input 3 (AL6 – alarm output 6)
7172	7372	7666	7866	Alarm 1 of analog input 4 (AL7 – alarm output 7)
7174	7374	7667	7867	Alarm 2 of analog input 4 (AL8 – alarm output 8)
7176	7376	7668	7868	Alarm 1 of analog input 5 (AL9 – alarm output 9)
7178	7378	7669	7869	Alarm 2 of analog input 5 (AL10 – alarm output 10)
7180	7380	7670	7870	Alarm 1 of analog input 6 (AL11 – alarm output 11)
7182	7382	7671	7871	Alarm 2 of analog input 6 (AL12 – alarm output 12)

*) Consecutive values of all analog inputs and all binary inputs put in continuous register space. Binary inputs are placed after analog ones.

APPENDIX A
CALCULATION OF THE CHECKSUM

In this appendix some examples of function in the C language calculating the LRC checksum for ASCII mode and the CRC checksum for the RTU mode have been shown

The function for LRC calculation has two arguments:

*unsigned char *outMsg;* - Pointer for the communication buffer, including binary data from which one must calculate LRC.
unsigned short usDataLen; - Number of bytes in the communication buffer.

The function returns LRC of *unsigned char type.*

```
static unsigned char LRC(outMsg, usDataLen)
unsigned char *outMsg;                    /* buffer to calculate LRC */
unsigned short usDataLen;                 /* number of bytes in the buffer 7
{
unsigned char uchLRC = 0;                 /* initialization of LRC */
 while (usDataLen--)
uchLRC += *outMsg++;                      /* add the buffer byte without transfer*
return ((unsigned char)(-(char uchLRC)));  /* return the sum in the completion code up two*/
}
```

An example of function in C language calculating the CRC sum is presented below. All possible values of CRC sum are placed in two tables.
The first table includes the highest byte of all 256 possible values of the 16-bit CRC field, however the second table includes the lowest byte.
The assignment of the CRC sum through table indexing is further more rapid than the calculation of a new CRC value for each sign of the communication buffer.

Note: The below function represents bytes of the sum CRC higher/lower, and this way the CRC value returned by the function can be directly placed in the communication buffer.
The function serving to calculate CRC has two arguments:

*unsigned char *puchMsg;* - Pointer for the communication buffer, including binary data from which one must calculate LRC.
unsigned short usDataLen; - Number of bytes in the communication buffer.

The function returns CRC of *unsigned short* type.

```
unsigned short CRC16(puchMsg, usDataLen)
unsigned char *puchMsg;                   /* buffer to calculate CRC */
 unsigned short usDataLen;                /*Number of bytes in the buffer */
{
unsigned char uchCRChi = OxFF;            /* initialisation of the higher CRC byte*/
 unsigned char uchCRCIo = OxFF;           /* initialisation of the lower CRC byte */
 while (usDataLen--)
{        uindex = uchCRChiA *puchMsg++;   /* CRC calculation*/
         uchCRChi = uchCRCIo A crc_hi[ulndex];
         uchCRCIo = crc_lo[ulndex];
}
retum(uchCRChi«8 \ uchCRCIo);
}
```

```
//table of the older CRC byte /
const unsigned char crc_hi[]={
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01,
0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
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0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01,
0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01,
0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40
};

//table of the lower CRC byte /
const unsigned char crc_lo[]={
0x00, 0xC0, 0xC1, 0x01, 0xC3, 0x03, 0x02, 0xC2, 0xC6, 0x06, 0x07, 0xC7, 0x05, 0xC5, 0xC4,
0x04, 0xCC, 0x0C, 0x0D, 0xCD, 0x0F, 0xCF, 0xCE, 0x0E, 0x0A, 0xCA, 0xCB, 0x0B, 0xC9, 0x09,
0x08, 0xC8, 0xD8, 0x18, 0x19, 0xD9, 0x1B, 0xDB, 0xDA, 0x1A, 0x1E, 0xDE, 0xDF, 0x1F, 0xDD,
0x1D, 0x1C, 0xDC, 0x14, 0xD4, 0xD5, 0x15, 0xD7, 0x17, 0x16, 0xD6, 0xD2, 0x12, 0x13, 0xD3,
0x11, 0xD1, 0xD0, 0x10, 0xF0, 0x30, 0x31, 0xF1, 0x33, 0xF3, 0xF2, 0x32, 0x36, 0xF6, 0xF7,
0x37, 0xF5, 0x35, 0x34, 0xF4, 0x3C, 0xFC, 0xFD, 0x3D, 0xFF, 0x3F, 0x3E, 0xFE, 0xFA, 0x3A,
0x3B, 0xFB, 0x39, 0xF9, 0xF8, 0x38, 0x28, 0xE8, 0xE9, 0x29, 0xEB, 0x2B, 0x2A, 0xEA, 0xEE,
0x2E, 0x2F, 0xEF, 0x2D, 0xED, 0xEC, 0x2C, 0xE4, 0x24, 0x25, 0xE5, 0x27, 0xE7, 0xE6, 0x26,
0x22, 0xE2, 0xE3, 0x23, 0xE1, 0x21, 0x20, 0xE0, 0xA0, 0x60, 0x61, 0xA1, 0x63, 0xA3, 0xA2,
0x62, 0x66, 0xA6, 0xA7, 0x67, 0xA5, 0x65, 0x64, 0xA4, 0x6C, 0xAC, 0xAD, 0x6D, 0xAF, 0x6F,
0x6E, 0xAE, 0xAA, 0x6A, 0x6B, 0xAB, 0x69, 0xA9, 0xA8, 0x68, 0x78, 0xB8, 0xB9, 0x79, 0xBB,
0x7B, 0x7A, 0xBA, 0xBE, 0x7E, 0x7F, 0xBF, 0x7D, 0xBD, 0xBC, 0x7C, 0xB4, 0x74, 0x75, 0xB5,
0x77, 0xB7, 0xB6, 0x76, 0x72, 0xB2, 0xB3, 0x73, 0xB1, 0x71, 0x70, 0xB0, 0x50, 0x90, 0x91,
0x51, 0x93, 0x53, 0x52, 0x92, 0x96, 0x56, 0x57, 0x97, 0x55, 0x95, 0x94, 0x54, 0x9C, 0x5C,
0x5D, 0x9D, 0x5F, 0x9F, 0x9E, 0x5E, 0x5A, 0x9A, 0x9B, 0x5B, 0x99, 0x59, 0x58, 0x98, 0x88,
0x48, 0x49, 0x89, 0x4B, 0x8B, 0x8A, 0x4A, 0x4E, 0x8E, 0x8F, 0x4F, 0x8D, 0x4D, 0x4C, 0x8C,
0x44, 0x84, 0x85, 0x45, 0x87, 0x47, 0x46, 0x86, 0x82, 0x42, 0x43, 0x83, 0x41, 0x81, 0x80,
0x40
};
```