ProMinent diaLog Controller

DACb

Modbus® RTU

Serial Communications

User Manual

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1. Disclaimer

Even though care has been taken in the preparation and publication of the contents of this manual, we do not assume legal or other liability for any inaccuracy, mistake, mis-statement or any other error of whatsoever nature contained herein. The material in this manual is for information purposes only, and is subject to change without notice.

ProMinent GmbH
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2. Abstract

This document provides generic information for ProMinent diaLog controller implementing the Modbus RTU Serial Communications protocol.
The ProMinent diaLog controller will behave as a slave device.

3. Modbus RTU Implementation

This implementation is designed to provide a popular data exchange format connecting the ProMinent diaLog controller to foreign master devices like a PLC or a PC. The Modbus RTU allows the instrument to be a citizen on a data link shared with other devices that subscribe to the Modbus RTU RS-485 or RS-232 specification.
The diaLog controller does not emulate any MODICON type device.
The Modbus RTU specification is respected in the physical and data link layers.
The message structure of the Modbus RTU function codes is employed and standard IEEE 32-bit floating point and integer formats are used.

The ProMinent diaLog controller will be delivered to customers on address 1 and with a baudrate of 19200 baud.

The slave address and the baudrate can be configured in the device's menu (Setup -> Bus configuration).

The implementation of the Modbus interface is based on the following standards:

- Modbus_Application_Protocol_V1_1b.pdf
- Modbus Serial Line Protocol and Implementation Guide V1.02

More detailed information about Modbus can be found at www.modbus.org or any website of the (local) Modbus organization of your country (when available).

3.1. Modbus RTU Message Format

Parameter	Value
Standard	RS-485 (default) or RS-232
Coding system	8 bit binary
Broadcast support	yes
Number of data bits per character	10 / 11 bits: 1 start bit 8 data bits 0 / 1 parity bits (no, odd, even) 1 / 2 stop bits (The use of no parity requires 2 stop bits) Default: 8O1
Transfer rate (baud)	2400, 4800, 9600, 19200 (default), 38400, 57600, 115200
Duplex	Half duplex
Error checking	CRC-16 (cyclic redundancy check); Polynom = 0x0A001 (1010000000000001)
Multi byte transfer order	Big Endian 0x1234 is transferred 0x12 followed by 0x34
Message timeout	>= 3.5 characters (> 2 ms for baudrates >= 19200)
Slave address	1..247 (default 1)

3.2. Modbus RTU Link Layer

The link layer includes the following properties:

- Slave address recognition
- Start / End of Frame detection
- CRC-16 generation / checking
- Buffer overflow detection
- Idle line detection
- Transmit / receive message time-out
- Framing error detection

Errors detected by the physical layer in messages received by the slave are ignored and the physical layer automatically restarts when a new receive is started after the next idle line detection.

3.3. Serial Link Layer

The ProMinent **diaLog**'s Modbus interface supports the following serial modes:

- **RS-485 (TIA-485-A)**
  Differential balanced line over twisted pair cable.
  Differencial voltage levels ±5V.
  Line length up to 1200m.
  Active termination.

- **RS-232 (TIA-232-F)**
  Asynchronous serial transmission with voltage levels between -15V and +15V.

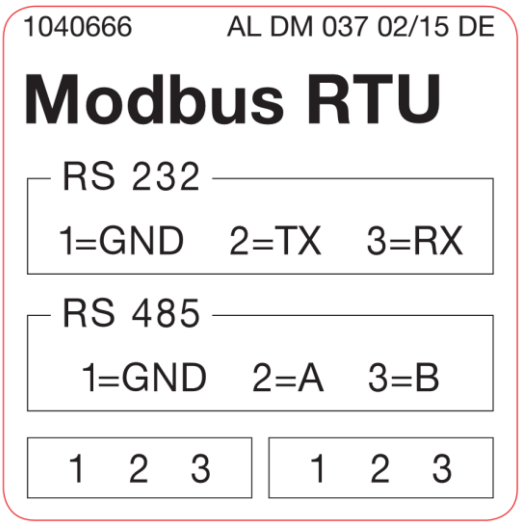
Active line termination and the interface mode can be changed in the **diaLog**'s menu (SETUP -> BUS CONFIGURATION).
The predefined interface mode is RS-485.

3.4. Modbus Connection Terminals

The diaLog's Modbus RTU interface board offers two terminals for the Modbus line.
The terminal pins are electrically connected (1=1; 2=2; 3=3).

The device can be connected as an endpoint slave (using either one of the terminals) or as a daisy-chained slave (using both terminals).

When the interface is configured in RS-485 mode and the diaLog controller is an endpoint slave, the active termination must be enabled in the controller's menu.

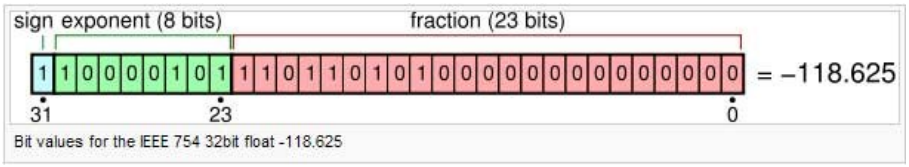


Picture 1 Terminal Pin Connections

3.5. IEEE 32-bit Floating-Point Registers

The ProMinent diaLog's Modbus interface uses the IEEE-754 format for 32 bit Floating-Point values (single precision).

Example:



3.6. Supported Modbus Commands

The ProMinent diaLog controller's Modbus RTU interface supports the following commands:

Command	Function code	Maximum register count in one transaction
Read Holding Registers	0x03 (3)	125
Write Single Register	0x06 (6)	1
Write Multiple Registers	0x10 (16)	123
Read / Write Multiple Registers	0x17 (23)	125 read / 121 write

Not all registers support all commands. Read-only registers can only be accessed by function code 3.

Warning: the maximum message size for the Read Holding Registers function is 100 bytes at 9600 baud (200 bytes at 19200 baud and 400 bytes at 38400 baud). When this size is exceeded, corrupted responses may be received.

- When one of the written registers raises an exception, the value written to all subsequent registers are discarded (ignored).
- When a byte parameter is read, the upper 8-bits of the Modbus register will be 0. When a byte parameter is written, the upper 8-bits must be set to 0.
- Long integer parameters have a length of 4 bytes and are mapped on two consecutive Modbus registers. The first register contains bit 32-16, the second register contains bit 15-0.
- Floating point parameters have a length of 4 bytes and are mapped on two consecutive Modbus registers. Floats are in single precision IEEE format (1 sign bit, 8 bits exponent and 23 bits fraction). The first register contains bit 32-16, the second register contains bit 15-0.

Register 199 can be used to test the master's correct byte interpretation of multibyte values.

3.7. Register address numbering

The register address numbering is different to the Modbus RTU PDU numbering.
The Modbus PDU register address is register address – 1.
A ProMinent diaLog's register 100 is accessed by a PDU address 99.

The maximum PDU size is 253 bytes.

3.8. Default connection set

This is the factory default configuration of the ProMinent diaLog controller's Modbus interface.

Parameter	Default Value
Serial Mode	RS-485 (differential)
Termination	disabled
Serial format	8 data bits Odd parity 1 Stop bit (8O1)
Baudrate	19200 baud
Slave address	1

The configuration can be changed in the diaLog's menu in SETUP -> BUS CONFIGURATION.

To change these settings the active user level must be ***Service*** at least.

3.9. Controller Register Map

This table contains the ProMinent diaLog's register mapping.

PDU Address (hex)	Register (decimal)	Parameter Name	Format	Access	Info
Outgoing Data Channel 1					
63	100	Actual Measured Value	FLOAT32	R	
65	102	Controller Actuating Value	INT16	R	[%]
66	103	Temperature	INT16	R	[0.1°C]
67	104	Actual Set Point	FLOAT32	R	
69	106	Actual External Disturbance Value	UINT16	R	[%]
6A	107	Status	UINT16	R	Bit coded
6B	108	Warnings	UINT16	R	Bit coded
6C	109	Actual Existing Errors	UINT32	R	Bit coded
6E	111	Actual Unconfirmed Errors	UINT32	R	Bit coded
Outgoing Data Channel 2					
70	113	Actual Measured Value	FLOAT32	R	
72	115	Controller Actuating Value	INT16	R	[%]
73	116	Temperature	INT16	R	[0.1°C]
74	117	Actual Set Point	FLOAT32	R	
76	119	Actual External Disturbance Value	UINT16	R	[%]
77	120	Status	UINT16	R	Bit coded
78	121	Warnings	UINT16	R	Bit coded
79	122	Actual Existing Errors	UINT32	R	Bit coded
7B	124	Actual Unconfirmed Errors	UINT32	R	Bit coded
Outgoing Data Channel 3					
F8	249	Actual Measured Value	FLOAT32	R	
FA	251	Controller Actuating Value	INT16	R	[%]
FB	252	Temperature	INT16	R	[0.1°C]
FC	253	Actual Set Point	FLOAT32	R	
FE	255	Actual External Disturbance Value	UINT16	R	[%]
FF	256	Status	UINT16	R	Bit coded
100	257	Warnings	UINT16	R	Bit coded
101	258	Actual Existing Errors	UINT32	R	Bit coded
103	260	Actual Unconfirmed Errors	UINT32	R	Bit coded
Outgoing Data Mathematic Channel					
7D	126	Actual Measured Value	FLOAT32	R	
7F	128	Status	UINT16	R	

80	129	Warnings	UINT16	R	Bit coded
81	*130*	*Actual Existing Errors[1]*	*UINT16*	*R*	*Bit coded*
82	*131*	*Actual Unconfirmed Errors[2]*	*UINT16*	*R*	*Bit coded*
Hardware State					
83	132	Current Output 1	UINT16	R	[0.1 mA]
84	133	Current Output 2	UINT16	R	[0.1 mA]
85	134	Current Output 3	UINT16	R	[0.1 mA]
86	135	Dry Contact Relay	UINT16	R	Bit coded
87	136	Pump Relay 1 (MosFET)	UINT16	R	Impulses / min
88	137	Pump Relay 2 (MosFET)	UINT16	R	Impulses / min
89	138	Pump Relay 3 (MosFET)	UINT16	R	Impulses / min
8A	139	Pump Relay 4 (MosFET)	UINT16	R	Impulses / min
Device Information					
8B	140	Firmware	UINT32	R	
8D	142	Firmware Channel 2	UINT32	R	
8F	144	Firmware Modbus Interface	UINT32	R	
91	146	Serialnumber	UINT32	R	
93	148	Revision	UINT16	R	
94	149	Revision Channel 2	UINT16	R	
95	150	Identcode[0-3]	UINT32	R	
97	152	Identcode[4-7]	UINT32	R	
99	154	Identcode[8-11]	UINT32	R	
9B	156	Identcode[12-15]	UINT32	R	
9D	158	Identcode[16-19]	UINT32	R	
9F	160	Identcode[20-23]	UINT32	R	
C5	198	Endian Test Value	UINT32	R	0xAABBCCDD
Control Channel 1					
C7	200	Stop	UINT16	R/W	Stop = 0xFFFF
C8	201	Pause	UINT16	R/W	1=Pause 2=Pause/HOLD
Control Channel 2					

[1] For future use
[2] For future use

C9	202	Stop	UINT16	R/W	Stop = 0xFFFF
CA	203	Pause	UINT16	R/W	1=Pause 2=Pause/HOLD
Control Channel 3					
105	262	Stop	UINT16	R/W	Stop = 0xFFFF
106	263	Pause	UINT16	R/W	1=Pause 2=Pause/HOLD
Configuration Channel 1					
CB	204	Configuration	UINT16	R/W	Bit coded
CC	205	Remote Set Point	FLOAT32	R/W	
CE	207	Limit 1	FLOAT32	R/W	
D0	209	Limit 2	FLOAT32	R/W	
D2	211	Xp	FLOAT32	R/W	
D4	213	Ti	UINT16	R/W	0…9999 [s]
D5	214	Td	UINT16	R/W	0…999 [s]
D6	215	Additive Basic Load or manual Value	INT16	R/W	-100…+100 [%]
D7	216	Control Output Limitation	UINT16	R/W	1 = on
D8	217	Delay after Stop	UINT16	R/W	0…9999 [s]
D9	218	Delay after Reboot	UINT16	R/W	0…9999 [s]
DA	219	Remote Setpoint 2	FLOAT32	R/W	
Configuration Channel 2					
DC	221	Configuration	UINT16	R/W	Bit coded
DD	222	Remote Set Point	FLOAT32	R/W	
DF	224	Limit 1	FLOAT32	R/W	
E1	226	Limit 2	FLOAT32	R/W	
E3	228	Xp	FLOAT32	R/W	
E5	230	Ti	UINT16	R/W	0…9999 [s]
E6	231	Td	UINT16	R/W	0…999 [s]
E7	232	Additive Basic Load or manual Value	INT16	R/W	-100…+100 [%]
E8	233	Control Output Limitation	UINT16	R/W	1 .. 100 [%]
E9	234	Delay after Stop	UINT16	R/W	0…9999 [s]
EA	235	Delay after Reboot	UINT16	R/W	0…9999 [s]
EB	236	Remote Setpoint 2	FLOAT32	R/W	
Configuration Channel 3					
107	264	Configuration	UINT16	R/W	Bit coded
108	265	Remote Set Point	FLOAT32	R/W	
10A	267	Limit 1	FLOAT32	R/W	

10C	269	Limit 2	FLOAT32	R/W	
10E	271	Xp	FLOAT32	R/W	
110	273	Ti	UINT16	R/W	0…9999 [s]
111	274	Td	UINT16	R/W	0…999 [s]
112	275	Additive Basic Load or manual Value	INT16	R/W	-100…+100 [%]
113	276	Control Output Limitation	UINT16	R/W	1 .. 100 [%]
114	277	Delay after Stop	UINT16	R/W	0…9999 [s]
115	278	Delay after Reboot	UINT16	R/W	0…9999 [s]
116	279	Remote Setpoint 2	FLOAT32	R/W	
Configuration Channel 4					
107	264	Configuration	UINT16	R/W	Bit coded
108	265	Remote Set Point	FLOAT32	R/W	
10A	267	Limit 1	FLOAT32	R/W	
10C	269	Limit 2	FLOAT32	R/W	
10E	271	Xp	FLOAT32	R/W	
110	273	Ti	UINT16	R/W	0…9999 [s]
111	274	Td	UINT16	R/W	0…999 [s]
112	275	Additive Basic Load or manual Value	INT16	R/W	-100…+100 [%]
113	276	Control Output Limitation	UINT16	R/W	1 .. 100 [%]
114	277	Delay after Stop	UINT16	R/W	0…9999 [s]
115	278	Delay after Reboot	UINT16	R/W	0…9999 [s]
116	279	Remote Setpoint 2	FLOAT32	R/W	
Configuration Mathematic Channel					
ED	238	Configuration	UINT16	R/W	Bit coded
EE	239	Limit 1	FLOAT32	R/W	
F0	241	Limit 2	FLOAT32	R/W	
Error Confirmation					
F2	243	Error Channel 1	UINT32	R/W	Bit coded
F4	245	Error Channel 2	UINT32	R/W	Bit coded
F6	247	Error Channel 4	UINT32	R/W	Bit coded
121	289	Error Channel 3	UINT32	R/W	Bit coded
Calibration					
11A	283	Slope Channel 1	FLOAT32	R	
11C	285	Zero point Channel 1	FLOAT32	R	
11E	287	Slope Channel 2	FLOAT32	R	
120	289	Zero point Channel 2	FLOAT32	R	

122	291	Slope Channel 3	FLOAT32	R	
124	293	Zero point Channel 3	FLOAT32	R	

R = register is readable only

R / W = register is readable and writeable

3.10. Bit Field Definitions

The bit-field values are described here.

3.10.1 Channel status

Bit	Description	
15	1 = Channel uses bus control parameters	0 = Channel uses internal parameters
14		
13	1 = Errors present	0 = No errors present
12	1 = Warnings present	0 = No warnings present
11	1 = SD card full	0 = SD card not full
10	1 = SD card space left < 20%	0 = SD card space >= 20%
9	1 = SD card present	0 = No SD card present
8	1 = Local control set 2 active	0 = Local control set 1 active
7		
6		
5		
4		
3		
2		
1	1 = Local stop active	0 = No local stop active
0	1 = Channel active	0 = Channel inactive (or not available)

3.10.2 Channel Errors

If an error is active or unconfirmed, the corresponding bit is set.

Bit	Description	
31	Error 99:	A system error exists
30		
29		
28		
27		
26		
25		
24		
23		
22		
21		
20	Error 88:	The connection to the expansion module is faulty
19	Error 34:	Incorrect correction variable
18	Error 19:	The level in tank 3 is too low
17	Error 18:	The level in tank 2 is too low
16	Error 17:	The level in tank 1 is too low
15	Error 16:	The mA input is overloaded
14	Error 15:	The mA input supply is overloaded
13	Error 14:	The controller is in the state PAUSE / HOLD
12	Error 13:	The controller is in the state PAUSE
11	Error 12:	Error sample water exists, e. g. no flow
10	Error 11:	After elapsing of the delay time a limit error still exists
9	Error 10:	The mA input current is less than 4 mA
8	Error 9:	The mA input current is greater than 20 mA
7	Error 8:	The checkout time was infringed
6	Error 7:	Check the mechanical status of the sensor Glass break is possible
5	Error 6:	No sensor is available
4	Error 5:	A calibration error exists
3	Error 4:	The temperature is too high
2	Error 3:	The temperature is too low
1	Error 2:	The mV input voltage is too high
0	Error 1:	The mV input voltage is too low

3.10.3 Warnings

If a warning is active, the corresponding bit is set.

Bit	Description
15	
14	
13	
12	
11	
10	
9	
8	
7	
6	Warning 73: The fan has an error
5	Warning 72: The time must be checked
4	Warning 71: The battery must be replace
3	Warning 4: The measuring channel is not yet calibrated
2	Warning 3: The wash timer has timed out. Maintenance is necessary
1	Warning 2: The limit was exceeded
0	Warning 1: The limit was undershot

3.10.4 Dry Contact relays

If a relay output is active, the corresponding bit is set.

Bit	Description
15	
14	
13	
12	
11	
10	
9	
8	
7	
6	
5	
4	
3	
2	Alarm Relay (XR3)
1	Relay 2 (XR2)
0	Relay 1 (XR1)

3.10.5 Channel Set Configuration

Bit	Description		
15	1 = Channel uses remote control parameters	0 = Channel uses internal parameters	
14	1 = Use internal parameter set 2	0 = Use internal parameter set 1	
13			
12			
11			
10			
9			
8	1 = Limit 2 Configuration on		0 = Limit 2 Configuration off
7	1 = Limit 1 Configuration on		0 = Limit 1 Configuration off
6	0 = Control off	1 = manual	2 = P (1 way, increase)
5	3 = P (1 way, decrease)	4 = P (2 way, standard)	5 = P (2 way, deadzone)
4	6 = PID (1 way, increase)	7 = PID (1 way, decrease)	8 = PID (2way, standard)
3	9 = PID (2way, deadzone)		
2			
1	1 = Limit 2 Configuration high		0 = Limit 2 Configuration low
0	1 = Limit 1 Configuration high		0 = Limit 1 Configuration low

- Bit 14 is only valid if Bit 15 is 0.
- Bits 3, 4, 5, 6 are only valid if Bit 15 is 1.
- Bits 3, 4, 5, 6, 14, 15 only exist on channel 1 and 2.

4. CRC-16 Calculation

```
extern void calculate_CRC(unsigned char *message, int length, unsigned char *CRC)
{
  unsigned char CRCHi, CRCLo, TempHi, TempLo;
  static const unsigned char table[512] = {

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

  CRCHi = 0xff;
  CRCLo = 0xff;

  while(length)
  {
    TempHi = CRCHi;
    TempLo = CRCLo;

        CRCHi = table[2 * (*message ^ TempLo)];
        CRCLo = TempHi ^ table[(2 * (*message ^ TempLo)) + 1];
        message++;
        length--;
 };

 CRC [0] = CRCLo;
 CRC [1] = CRCHi;
 return;
}
```