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DEVICE MODBUS

1. Introduction

The MODBUS® protocol represents an industrial communication system distributed and developed by Gould-Modicon to integrate PLC's, computers, terminals, inverter and other devices. MODBUS is a Master/Slave communication protocol where only one device can be Master and monitors all activities of the serial line or TCP/IP. As for the serial line can be connected up to a maximum of 247 slave along the same lines. Each device is assigned an address that distinguishes it from all other connected devices.

The MODBUS device lets you choose which serial port use for connection. The features of data transmission (number of device, baud rate, parity, stop bits) and the transmission mode must be selected on each station and cannot be changed during the operation.

With using a serial line, there are two modes of transmission used in the Modbus Protocol. Both ways allow the same communication skills. The mode is selected by the master and must be unique for all devices connected to the network. The modes are:

- ASCII (American Standard Code for Information Interchange)
- RTU, (Remote Terminal Unit.)

This manual is divided into two parts:

Part I - Operation as master

Part II - Operation as slave.

1.1 Conventions

The modbus communication protocol standard defines 4 types of Exchange data:

- INPUT STATUS = Digital Inputs
- COIL STATUS = Digital Outputs
- INPUT REGISTER = Analog Inputs
- HOLDING REGISTER. = Analog Outputs

Throughout the manual you have to take into account existing conventions.

1.2 Device declaration in the configuration unit

Declaration of the used device (internal device): device name assigned, MODBUS, slot location and number of the device.

```
INTDEVICE
<device_name>    MODBUS    TCamp    channel
...
```

Where:

INTDEVICE	is a keyword indicating the beginning of the definition of internal devices,
<device_name>	is the device name,
MODBUS	is the keyword that identifies the device described in this document,
TCamp	is the sampling time of the device,
channel	is the definition of the type of communications channel connected (0 = Prog, 1 = User, for the other ports the ID number depends on the hardware and firmware of the instrument used, 43 = Ethernet port to a modbus TCP/IP).

To declare the hardware used in the "BUS" section of the configuration unit you will have to refer to the firmware of the hardware itself.

Example

```
INTDEVICE
modbus          MODBUS    0002    1
```

1.3 Tables "data exchange" for MODBUS

1.3.1 Data read from the device

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Index table
	15	14	13	12	11	10	9	8	7	6	5	4	6	2	1	0	Weight of the bits(2 ⁿ)
Modbus register																	
0001								iword1								2 ¹⁶	ilong1
0002								iword2								2 ⁰	
0003								iword3								2 ¹⁶	ilong2
0004								iword4								2 ⁰	
0005								iword5								2 ¹⁶	ilong3
0006								iword6								2 ⁰	
0007								iword7								2 ¹⁶	ilong4
0008								iword8								2 ⁰	
0009								iword9								2 ¹⁶	ilong5
0010								iword10								2 ⁰	
0011								iword11								2 ¹⁶	ilong6
0012								iword12								2 ⁰	
0013								iword13								2 ¹⁶	ilong7
0014								iword14								2 ⁰	
0015								iword15								2 ¹⁶	ilong8
0016								iword16								2 ⁰	
0017								iword17								2 ¹⁶	ilong9
0018								iword18								2 ⁰	
0019								iword19								2 ¹⁶	ilong10
0020								iword20								2 ⁰	
0021								iword21								2 ¹⁶	ilong11
0022								iword22								2 ⁰	
0023								iword23								2 ¹⁶	ilong12
0024								iword24								2 ⁰	
0025								iword25								2 ¹⁶	ilong13
0026								iword26								2 ⁰	
0027								iword27								2 ¹⁶	ilong14
0028								iword28								2 ⁰	
0029								iword29								2 ¹⁶	ilong15
0030								iword30								2 ⁰	
0031								iword31								2 ¹⁶	ilong16
0032								iword32								2 ⁰	

NOTE 1: the " iword1 " is the most significant word of the " ilong1 " (long = double word), the "iword3" is the most significant word of the " ilong2 ", ...

NOTE 2: the " st_ubit0 " parameter less significant bit (with weight 0) of the " iword1 ", while the " st_ubit15 " bit is the most significant (with weight 15) of the " iword1 ".

1.3.2 Writable data from QCL and sharable in MODBUS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Index table
	15	14	13	12	11	10	9	8	7	6	5	4	6	2	1	0	Weight of the bits(2 ⁿ)
Modbus register																	
0001								oword1								2 ¹⁶	olong1
0002								oword2								2 ⁰	
0003								oword3								2 ¹⁶	olong2
0004								oword4								2 ⁰	
0005								oword5								2 ¹⁶	olong3
0006								oword6								2 ⁰	
0007								oword7								2 ¹⁶	olong4
0008								oword8								2 ⁰	
0009								oword9								2 ¹⁶	olong5
0010								oword10								2 ⁰	
0011								oword11								2 ¹⁶	olong6
0012								oword12								2 ⁰	
0013								oword13								2 ¹⁶	olong7
0014								oword14								2 ⁰	
0015								oword15								2 ¹⁶	olong8

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Index table
	15	14	13	12	11	10	9	8	7	6	5	4	6	2	1	0	Weight of the bits(2 ⁿ)
0016								oword16								2 ⁰	
0017								oword17								2 ¹⁶	olong9
0018								oword18								2 ⁰	
0019								oword19								2 ¹⁶	olong10
0020								oword20								2 ⁰	
0021								oword21								2 ¹⁶	olong11
0022								oword22								2 ⁰	
0023								oword23								2 ¹⁶	olong12
0024								oword24								2 ⁰	
0025								oword25								2 ¹⁶	olong13
0026								oword26								2 ⁰	
0027								oword27								2 ¹⁶	olong14
0028								oword28								2 ⁰	
0029								oword29								2 ¹⁶	olong15
0030								oword30								2 ⁰	
0031								oword31								2 ¹⁶	olong16
0032								oword32								2 ⁰	

NOTE 1: the "oword1" is the most significant word of the "olong1" (long = double word), the "oword3" is the most significant word of the "olong2", ...

NOTE 2: the "st_obit0" parameter is the less significant bit (with weight 0) of the "oword1", while the "st_obit15" bit is the most significant (with weight 15) of the "oword1".

1.4 Master operation description

The MODBUS device can use a serial port or TCPIP to communicate in master mode (parameter *mode* = 0). Allows (via parameters, states and commands) all instruments to be able to communicate with any equipment utilizing Modbus. The device provides a data exchange area where the QCL can write or read values shared with the slaves on the network. This area is represented by a list of parameters of the device divided into two groups to differentiate the type of access of the data by the device. The first section is identified as INPUT the second as OUTPUT. The INPUT section, for master operation, is the storage area of reads data. It is used by all reader functions (parameter *type* = 1, 2, 3 o 4). The OUTPUT section, in the master operation, is the area of data storage that the master should transfer to the slaves. It is used by all writing functions (parameter *type* = 5, 6, 15 o 16). To facilitate the exchange of data between devices, the structure of the Exchange area includes data types commonly used in QCL namely WORD, LONG and FLAG. The "BYTE" type does not appear because the modbus usually uses the word size for each address registers. The modbus protocol selects data based on the number of access log register, while the QCL selects based on the parameter symbol, you create a reference table in which each QCL symbol find the corresponding number in the register of access in Modbus protocol. To obtain greater flexibility for addressing, the same area of Exchange data can be manipulated by the QCL with different dimension parameterized. All the symbols that appear in the same row of the table refer to the same memory locations.

1.4.1 Input and coil Data Access

The data input or *coil* type have in the modbus Protocol a bit size. To store this information in the table of data exchange is defined as follows mode: each register (and then every word parameter of the device) represents 16 elements that are numbered from left to right. For the Scriptures or multiple readings when bits read are higher than those contained in the register the operation continues in the next register.

The *st_ibit0*... and *st_obit1*... states are useful in order to facilitate access to information bit, only in the first table log.

1.4.2 Mode of MASTER operation

The master mode is set with the mode parameter = 0. The card generates modbus messages only on QCL ordering and does not automatically. To "format" the modbus message string there are a number of parameters.

Using the two commands SEND or SENDSYN you send the read or write request to the slave, a number of States allow an audit on the operation being executed. We see in detail:

1.4.2.1 Parameters for formatting the message:

type = request type that you want to process (reading or writing word or bit).

idcard = address of the slave drive to which you want to send the request.

addr = the index from which to start reading or at which to start writing in the slave.

tabreg = for read operations (type = 1, 2, 3, 4), This parameter indicates the position in the "table of data read" where will

store the read data on the slave. For write operations (type = 5, 6, 15, 16), this parameter indicates the position in the "table of data to be written" where is the data to be written on the slave. Are accepted values are between 1 and 512 for values of type parameter = 1, 2, 5, 15 (writing and reading of bits), while for type value = 3, 4, 6, 16 (writing and reading of word) the expected values are between 1 and 32.

num = number of values that are read or write (if the request type so provides). Are accepted values are between 1 and 128 for values of type parameter = 1, 2, (reading of bits), while for type value = 3, 4, 16 (multiple word reading and writing) the accepted value are between 1 and 32.

1.4.2.2 Commands to send the message:

SEND sends the request message to the slave.

SENDSYC sends the request message to a QEM slave of MODBUS type and reports the operation concluded (*st_sended*) only when the slave executes the RECEIVED command.

1.4.2.3 State variables for diagnostic operation:

When ended the message send operation, the status *st_sended* variable is set to 1. If you used the SEND command the state is set to 1 when the master receive the confirmation of the message being sent. If you have used the SENDSYC command in the master then this status will be set to 1 when the slave QEM will execute the RECEIVED command. In case of error, This status is still in set to 1 (After the *toutsyc* time) but the *err* parameter indicates the cause of the error (see the description of this parameter for details).

The SENDSYC command it becomes necessary when you want to synchronize master data packet writing by reading the same data from the slave (can be used when both master and slave are Qmove).

1.4.3 Read request

Read Coil

Bit read function. You want to read the bits of a slave (*idcard*). Sets the parameter *type* = 1.

You must set *addr* to indicate the address of the bit in the slave from which to start reading. The *num* parameter indicates the number of bits that are read. You must to set *tabreg* to indicate the index of the bit in the "data read table" the master from which you want to be written the read bits. The readings value will be saved in the "data read table". It is recommended to always meet the following two conditions:

$(addr + num - 1) \leq 512$ e $(tabreg + num - 1) \leq 512$ otherwise the request will fail (reporting by *wcmd*).

Read Input

Bit read function. To read the bits of a slave (*idcard*). The function is equal to the "Read Coil". Sets the parameter *type* = 2.

The meaning of the two functions is distinguished at the level of MODBUS protocol. Some slave can make available different memory areas depending if the bits are Coil or Input. In the case of slave Qmove the two requests have the same effect.

Read Holding Register

Word read function. For reading the word of the slave (*idcard*). Sets the parameter *type* = 3.

You must to set *addr* to indicate the address of the word in the slave from which to start reading. The *num* parameter indicates the number of word to be read. You must set *tabreg* to indicate the index of the word in the "read data table" of the master from which you want are writes the read words. The read values will be saved in the "read data table". It is recommended to always meet the following two conditions:

$(addr + num - 1) \leq 32$ e $(tabreg + num - 1) \leq 32$ otherwise the request will fail (reporting by *wcmd*).

Read Input Register

Word read function. For reading the bit of the slave (*idcard*). The function is equal to the "Read Holding Register". sets the parameter *type* = 4.

The meaning of the two functions is distinguished at the level of MODBUS protocol. Some slave can make available different memory areas depending if the read word are Holding or Input. In the case of slave Qmove the two requests have the same effect.

1.4.4 Write request

Force coil

Bit write function. For writing (force) the bit of the slave (*idcard*). Sets the parameter *type* = 5.

You must set *addr* to indicate the address of the bit in the slave that you want to write. You must set *tabreg* to indicate the index of the bit in the “write data table” that contains the value to be written.

Force register

Word write function. For write (force) the word of a slave (*idcard*). Sets the parameter *type* = 6.

You must set *addr* to indicate the address of the word in the slave that you intend to write. You must set *tabreg* to indicate the index of the word in the “data write table” that contains the value to be written.

Force multiple coil

Multiples bit write function. For write (force) the bit of a slave (*idcard*). Sets the parameter *type* = 15.

You must set *addr* to indicate the address of the bit in the slave that you intend to write. You must set *in num* the number of bits to write. You must set *tabreg* to indicate the bit index of the “data write table” from which to begin the values to be written. It is recommended to always meet the following two conditions:

$(addr + num - 1) \leq 512$ e $(tabreg + num - 1) \leq 512$ otherwise the request will fail (reporting by *wcmd*).

Force multiple register

Multiples word write function. For write (forzare) the word of a slave (*idcard*). Sets the parameter *type* = 16.

You must set *addr* to indicate the address of the word in the slave that you intend to write. You must set *in num* the number of word to write. You must set *tabreg* to indicate the index of the word in the “data write table” from which to begin the values to be written. It is recommended to always meet the following two conditions:

$(addr + num - 1) \leq 32$ e $(tabreg + num - 1) \leq 32$ otherwise the request will fail (reporting by *wcmd*).

1.4.5 Examples

1) Modbus settings and opening of serial communication

```
modbus.mode = 0           ; modbus master
modbus.prot = 1           ; RTU
modbus.brate = 57600      ; baudrate
modbus.stopb = 1         ; stop bits
modbus.par = 0            ; parity
modbus.tout = 100         ; timeout

modbus.OPENCOM
tm_opencom = 200          ; timeout for OPENCOM command
WAIT modbus.st_opencom OR tm_opencom
IF NOT modbus.st_opencom
  OpenComError = 1        ; com not opened
ENDIF
```

2) Impostazioni modbus e apertura del canale di comunicazione di tipo TCP/IP

```
modbus.mode = 0           ; modbus master
modbus.prot = 2           ; TCP/IP
modbus.tout = 100         ; timeout

tcpip_port = 502          ; number of tcpip port (default 502)
modbus.stopb = (tcpip_port ANDB &H0000FF00) / 256
modbus.par = tcpip_port ANDB &H000000FF

modbus.OPENCOM
tm_opencom = 500          ; waiting time to have a correct response
WAIT tm_opencom
IF NOT modbus.st_opencom
  OpenComError = 1        ; com not opened
ENDIF
```

3) Reading the registry input nr.7 of the slave id 67

```
modbus.idcard = 67
modbus.addr = 7
modbus.tabreg = 7
modbus.num = 1
modbus.type = 4
modbus.SEND
WAIT modbus.st_sended
IF (modbus.err)
  CALL ErrorModbus
ENDIF
slSpeed = modbus.iword7
```

4) Reading of the holding register from nr.600 to nr.606 of the slave id 8

The area of QCL data exchange does not support the address 600, you use the *tabreg* parameter to save the data read at 10 address

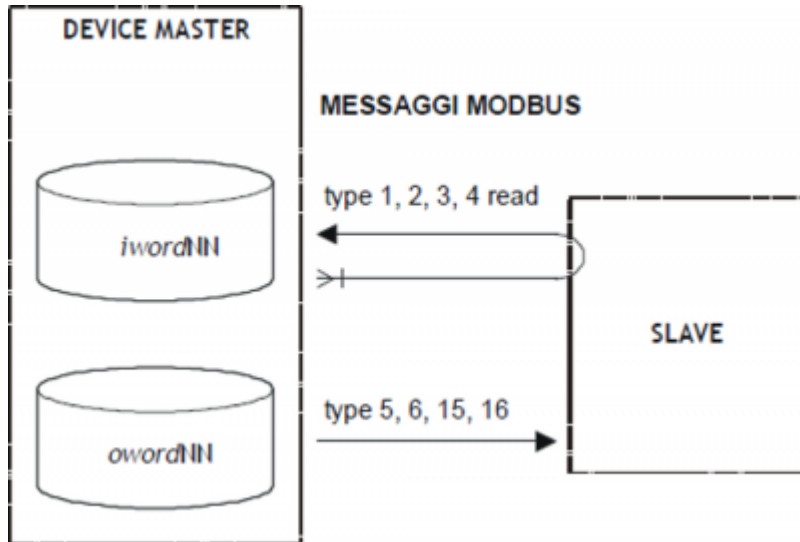
```

modbus.idcard = 8
modbus.addr = 600
modbus.num = 6
modbus.tabreg = 10
modbus.type = 3
modbus.SEND
WAIT modbus.st_sended
IF (modbus.err)
CALL ErrorModbus
ENDIF

swTemp1 = modbus.iword10
slSpeed = modbus.ilon6
slPos12 = modbus.ilon7
swTemp1 = modbus.iword15

```

1.4.6 Block diagrams



1.4.7 Broadcast

The Broadcast is a special message that is sent by the Master and is received simultaneously from all connected slaves. The broadcast function (idcard = 0) is supported only in master mode and if you use a message with type = 5, 6, 15 and 16 (write only). In this mode the st_sended state is activated once ended the transmission and not on receipt of confirmation by the slave. There isn't answer on the slaves to such messages. You cannot use the SENDSYN command.

1.4.8 Slaves identification

When the card works in master mode allows, with specila command, tell if the slave connected is a QEM. If so also determines the pattern of slave connected. This allows a diagnostic on the correct network configuration. You cannot extend this control to all types of existing slaves because the protocol does not provide a standard way of slave recognition.

The READSTYPE command executed after selecting the slave (through idcard parameter) send a nr.17 modbus request to the slave for recognition. The slave will responds with a default value and can be read in the stype parameter of the master. If the slave is not produced by QEM, the parameter will be -1 value to indicate that the slave is connected but you cannot identify it. For the MODBUS device the ID slave is different depending on the slave QEM used. For encoding of the slaves see the slave Firmware used.

Example of slave identification nr.12:

```

modbus.idcard = 12
modbus.READSTYPE
WAIT modbus.st_sended
IF (modbus.err)
sbConfig = 3 ; error: slave 12 not connected
ELSE
IF (modbus.stype EQ 1) ; Board CAM-AG-98
sbConfig = 1 ; configuration OK
ELSE
sbConfig = 2 ; error in network configuration
ENDIF
ENDIF

```

1.4.9 Protocol extension

The modbus standard communication protocol defines 4 types of Exchange data:

- INPUT STATUS,
- COIL STATUS,

- INPUT REGISTER,
- HOLDING REGISTER.

These 4 types treat signals as Digital Inputs, Digital Outputs, Analog Inputs, and Analog Outputs. The values of the registers (INPUT REGISTERS and HOLDING REGISTERS), are defined as values in 16 bit, each with a unique address, (example INPUT REGISTER #1, INPUT REGISTER #2, INPUT REGISTER #3, ecc.).

To allow support for datatypes larger than 16 bit, has been designed an extension to the protocol to treat long 32 bit dimension values. Implementing this feature preserves the formatting of the message standard modbus it uses the contents of two consecutive addresses to represent a 32 bit value. When this extension is enabled (wider = 1), depending on the address used the slave responds with a 16-bit or 32-bit value for each log request. If the address is greater than 5000 will be returned a 32-bit value, if under the Protocol remains unchanged with response to 16 bits.

1.4.10 Commands and parameters

1.4.10.1 Used symbols

The parameter name, condition or command is taken back to the left side of the table.

R

Indicates if the parameter or state is retentive (upon initialization of the device maintains the previously defined state), or the state assumes upon initialization of the device.

If the device does not need to initialize the "R" field indicates the value that the parameter or state take at the at power-up card.

R = Retentive

0 = Upon initialization of the device the value is forced to zero.

1 = Upon initialization of the device the value is forced to one.

- = Upon initialization of the device is presented significant value.

D

Indicates the size of the parameter.

F = Flag

B = Byte

W = Word

L = Long

S = Single Float

Conditions

Describes all the conditions necessary for the parameter so that the parameter is considered correct or because the command is accepted.

In some cases, limit values are specified for the acceptance of the parameter: if any values outside the limits set are introduced, the data is however accepted; therefore appropriate controls of the application must be provided to ensure the proper functioning.

To execute a command, all conditions must be met; otherwise the command does not execute.

A

Indicates the access mode.

R = Read.

W = Write.

RW = Read / Write.

1.4.10.2 Parameters

Name	D	R	A	Conditions	Description
mode	B	R	R/W	-	Mode (0 ÷ 2) Defines if the board should function as a master or slave. 0 = master.
prot	B	R	R/W	-	Protocol (0 ÷ 1) Defines the type of modbus protocol to use. 0 = ASCII, 1 = RTU, 2 = TCP/IP

Name	D	R	A	Conditions	Description
wider	B	R	R/W	-	Wide Registers (0 ÷ 1) Indicates if to use the 32-bit registers protocol extension. See the “Extension of the Protocol” section : 0 = normal, 1 = extended protocol.
idcard	W	R	R/W	-	Identification Card (0 ÷ 255) In the operation as the master is the device number that you want to transmit. In master mode setting of zero is also valid for operation broadcast.
type	B	1	R/W	-	Type Defines the type of request that the master must perform. Allowed values: 1, 2, 3, 4, 5, 6, 15, 16
addr	L	1	R/W	-	Address (1 ÷ 65535) Defines the address used by the master to define the data to be read or write.
tabreg	W	1	R/W	-	Destination (1 ÷ 512) Defines the address data tables into which to write the data read or where to find the data to write.
num	W	1	R/W	-	Number (1 ÷ 512) Is the number of items to be written to or read in the request of the master.
brate	L	R	R/W	-	Baud rate Serial Baud rate. Allowed values: 4800, 9600, 19200, 38400, 57600, 115200.
stopb	B	R	R/W	-	Stop bit Allowed values: 1, 2.
par	B	R	R/W	-	Parity (0 ÷ 2) 0 = none, 1 = odd, 2 = even.
tout	W	R	R/W	-	Timeout (0 ÷ 9999 msec) For the master mode is the maximum time the slave must respond. Setting it to zero, the Timeout is disabled.
toutsync	W	R	R/W	-	Time out synchronize (0 ÷ 9999 msec) Only used to master mode is the maximum time that can elapse between sending the SENDSYN command and the RECEIVED command execution on the QEM slave.
iword1÷32	W	0	R	-	Input Word nr. (1Input Long nr. (1÷16)32)
st_ibit0÷15	F	0	R	-	Input bit in the iword1 parameter
ilong1÷16	L	0	R	-	Input Long nr. (1÷16)
oword1÷32	W	0	R/W	-	Output Word nr. (1÷32)
st_obit0÷15	F	0	R/W	-	Output bit in the oword1 parameter
olong1÷16	L	0	R/W	-	Output Long nr. (1÷16)

The ability to communicate with the TCP/IP protocol It was developed at a later time than the birth of the MODBUS device. For this reason the IP address and port setting is achieved using some parameters that have a different meaning.

To configure the TCP/IP port number You must go and write about the *stopb* and *par* parameters. Respectively :

- **stopb** = tcpip_port / &H00000100
- **par** = tcpip_port ANDB &H000000FF

To set the TCP/IP slave to which you want to execute the request you must go to write on the *brate* parameter .
An IP address can be expressed as TcpAddr3.TcpAddr2.TcpAddr1.TcpAddr0 (for example 192.168.0.1).

- **brate** = (TcpAddr3 * &H01000000) + (TcpAddr2 * &H00010000) + (TcpAddr1 * &H00000100) + TcpAddr0

1.4.10.3 Variables

Name	D	R	A	Conditions	Description
err	B	0	R	-	Errors Indicates if errors occurred in the protocol. In master mode the parameter is updated to coincide the activation of the <i>st_sended</i> state. The values from 1 to 49 are those sent by the slave. Values greater than 50 are generated internally by the master. The first 8 values are normalized in the protocol and are: 0 = communications without errors, 1 = ILLEGAL FUNCTION, 2 = ILLEGAL DATA ADDRESS, 3 = ILLEGAL DATA VALUE, 4 = SLAVE DEVICE FAILURE, 5 = ACKNOWLEDGE, 6 = SLAVE DEVICE BUSY, 7 = NEGATIVE ACKNOWLEDGE, 8 = MEMORY PARITY ERROR, 50 = UNKNOWN RECEIVED ERROR the slave answered with a code greater than 49, 51 = TIMEOUT the slave does not respond within the time scheduled in the tout parameter, 52 = INVALID ANSWER, 52 = INVALID FUNCTION ANSWER - Function type not supported, 53 = CHECKSUM ANSWER - The checksum proceeds does not match, 54 = TRUNCATED ANSWER - Message too short, 55 = INVALID ID ANSWER - Slave ID mismatch, 56 = INVALID_MBAP_TRANSACTION_ID - modbus TCP/IP, <i>transaction ID</i> incorrectly, 57 = INVALID_MBAP_PROTOCOL_ID - modbus TCP/IP, <i>protocol ID</i> different by zero, 70 = TIMEOUT SYNCHRONIZED the slave QEM did not execute the RECEIVED command within the time scheduled in the tousync parameter. In slave mode the parameter is never updated.
serr	B	0	R/W	-	Serial Errors Indicates if errors occurred in serial communication. The parameter is updated for each error encountered. The value persists until: - under a subsequent error; - the writing of one of the following parameters: mode, prot, wider, brate, stopb, par; - writing about himself (any value will reset). 0 = no errors, 1 = parity error, 2 = framing error, 3 = overrun error.
stype	W	0	R	-	Slave type Indicates the type of slave connected. The parameter is updated when the <i>st_sended</i> parameter becomes 1 and if it had been execute a READSTYPE command

1.4.10.4 States

Name	D	R	A	Conditions	Description
st_sended	F	0	R	-	Sended State only been used in master mode. Activation indicates completion of the transmission of a message. The state is reset with the SEND or SENDSYN commands.
st_opencom	F	0	R	-	Open communication port Activation indicates that the device is working the serial communications port. To set this state use the OPENCOM command, to reset CLOSECOM.
wdata	F	0	R	-	Warning Data This bit indicates that an attempt was made to insert an invalid value in a parameter.
wcmd	F	0	R	-	Warning Command This bit indicates that it did not execute a command because they missing the necessary conditions.

1.4.10.5 Commands

The available commands to manage the device are listed below in descending order of priority.

The device executes all commands received within the same sampling time starting from the one with the highest priority. For example if the device receives the same sampling time CLOSECOM and OPENCOM commands, first run the OPENCOM command and then to CLOSECOM leaving therefore the communication port closed.

Name	D	R	A	Conditions	Description
SEND	-	-	-	mode = 0 0 < num ≤ 128 st_sended = 1 st_opencom = 1	Sended Determines the message transmission toward the slave select.
SENDSYC	-	-	-	mode = 0 0 < num ≤ 128 st_sended = 1 st_opencom = 1	Send synchronize Usable only in master mode determines the message transmission towards a slave QEM with synchronisation.
READSTYPE	-	-	-	mode = 0 st_sended = 1 st_opencom = 1	Read slave type Read information request type specified on the idcard slave. The answer will be reported on the stype parameter when the st_sended state becomes 1.

Name	D	R	A	Conditions	Description
CLRWDATA	-	-	-	-	Clear Warning Data Reset the wdata parameter reporting.
CLRWCMD	-	-	-	-	Clear Warning Command Reset the wcmd parameter reporting.
OPENCOM	-	-	-	st_opencom = 0	Open Serial communication \ Open the serial communication (the device then committed the communications port). The st_opencom status becomes 1.
CLOSECOM	-	-	-	-	Close Serial communication Close the serial communication (the device then does not committed the communications port). The st_opencom status becomes 0.

1.5 Slave operation description

1.5.1 Slave mode operation

Slave mode is set with the mode = 1 or mode = 2 parameter. You must to introduce in the parameters the slave ID code through the idcard parameter.

Modbus settings and opening channel of serial communication

```

modbus.mode = 1 ; modbus slave
modbus.prot = 1 ; RTU
modbus.brat = 57600 ; baudrate
modbus.stopb = 1 ; stop bits
modbus.par = 0 ; parity
modbus.idcard = 1 ; slave id

modbus.OPENCOM
tm_opencom = 100 ; timeout for OPENCOM command
WAIT modbus.st_opencom OR tm_opencom
IF NOT modbus.st_opencom
OpenComError = 1 ; com not opened
ENDIF

```

Modbus settings and open of the communication channel of TCP/IP type

```

modbus.mode = 1 ; modbus slave
modbus.prot = 2 ; TCP/IP

tcpip_port = 502 ; number of tcpip port (default 502)
modbus.stopb = (tcpip_port ANDB &H0000FF00) / 256
modbus.par = tcpip_port ANDB &H000000FF

modbus.OPENCOM
tm_opencom = 100 ; waiting time to have a correct response
WAIT (modbus.st_opencom OR timerOpencom)
IF NOT modbus.st_opencom
OpenComError = 1 ; com not opened
ENDIF

```

The operations that should execute the QCL are essentially two:

- update the parameters owordNN, alongNN type (which will then be read from the master)
- process the parameters iwordNN, ilongNN type (which will then written by the master)

1.5.1.1 Updating owordNN parameters type

To update the owordNN parameters type the QCL must write values in the parameters then send the VALIDATE command. The use of the command is necessary to make available on the readings of the master the new data at the same time, so that they can be read only part of updated parameters. So assigning a value to a device parameter DOES NOT MEAN that it is immediately available for the master readings. Will only be available after the VALIDATE command.

Example

```

modbus.olong1 = anpos.speed
modbus.oword1 = npezzi
modbus.oword2 = npezzi tot
modbus.oword3 = anpos.dir
modbus.olong2 = anpos.posit
modbus.VALIDATE

```

1.5.1.2 Process iwordNN parameters type

To process the iwordNN parameters type, instead, the QCL must wait for the st_msgrx state is activated. This means that a write message was sent by the master. For the read message no signal reportedly to QCL parameters. The QCL then must take the values from the data exchange and at the end needs to send the RECEIVED command, only then the st_msgrx state is disabled.

Example

```

WAIT modbus.st_msgrx

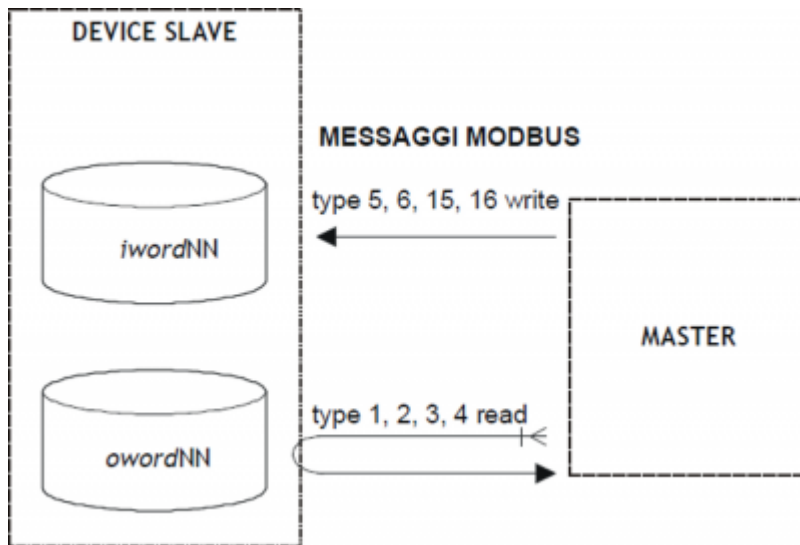
```

```
anpos.speed = modbus.ilog1
anpos.posit = modbus.ilog2
npezzi = modbus.iword1
RECEIVED modbus
```

There is no control to prevent when reading *iwordNN* parameters the master incorrectly execute another writing, before the project code present in the slave to finish the process.
Also the code for handling the modbus device in the application it is recommended that it is collected in a single task in order not to create simultaneous accesses to the device that could generate invalid conditions.

All read requests that arrive from the master MODBUS refer to the *owordNN* type data by accessing to the same data area. The slave provides the values that the master will read in the *owordNN* parameters type.
All write requests arriving from the MODBUS master refer to the *iwordNN* type data aby accessing to the same data area. The slave provides the *iwordNN* parameters where the master will write data.

1.5.2 Block diagram



1.5.3 Commands and parameters

1.5.3.1 Used symbols

The parameter name, condition or command is shown at the left of the table.

R

Indicates if the parameter or state is retentive (upon initialization of the device maintains the previously defined state), or the state assumes upon initialization of the device.

If the device does not need to initialize the "R" field indicates the value that the parameter or accept to the power up of the card.

R = Retentive

0 = Upon initialization of the device the value is forced to zero.

1 = Upon initialization of the device the value is forced to one.

- = Upon initialization of the device is presented significant value.

D

Indicates the size of the parameter.

F = Flag

B = Byte

W = Word

L = Long

S = Single Float

Conditions

Describes all the conditions necessary so that the parameter is considered correct or because the command is accepted.

In some cases, limit values are specified for the acceptance of the parameter: if there are any values outside the limits set, the data is however accepted; therefore appropriate controls of the application must be provided to ensure the proper functioning.

To execute a command, all conditions must be met; otherwise the command is not executed.

A

Indicates the access mode.

R = Read.

W = Write.

RW = Read / Write.

1.5.3.2 Parameters

Name	D	R	A	Conditions	Description
mode	B	R	R/W	-	Mode $(0 \div 2)$ Defines if the board should function as a master or slave. 1 = slave with fixed data exchange area; 2 = slave without fixed data exchange area: any writing or reading done by the master is put to 1 the st_msgrx flag. At the same time the <i>type</i> , <i>addr</i> and <i>num</i> parameters indicate the features of the received message. - Type indicates the type of function that wants to be the master (read or write), - addr indicates the address of the beginning of the written or read data block, - num indicates the read or written number of data (to bit or to byte depending on the value of type). The device will check, in reception, only num (size of message) that does not exceed 32wordbut not the address that can now be any. If it is a write (You can tell by the value of the type if it is 5,6,15,16) are shows the lists the data in variables of exchange input (always starting from the first word) and the device waits for the RECEIVED command. If you read the device waits for the QCL stores data in word output exchange variables and waits for the VALIDATE command.
prot	B	R	R/W	-	Protocol Defines the type of Modbus Protocol to use. 0 = ASCII, 1 = RTU, 2 = TCP/IP.
wider	B	R	R/W	-	Wide Registers Indicates if to use the 32-bit registers protocol extension. See "Extension of the Protocol" section. 0 = normal, 1 = extended protocol.
idcard	W	R	R/W	-	Identification Card $(1 \div 255 \text{ for slave})$ In slave mode is the number that identifies the device on the network.
brate	L	R	R/W	-	Baud rate Baud rate of the serial. Valid values: 4800, 9600, 19200, 38400, 57600, 115200.
stopb	B	R	R/W	-	Stop bit Valid values: 1, 2.
par	B	R	R/W	-	Parity $(0 \div 2)$ 0 = none, 1 = even, 2 = odd.
rdelay	W	R	R/W	-	Reply delay $(0 \div 9999 \text{ msec})$ It is the time to wait before transmitting the reply.
iword1÷32	W	0	R	-	Input Word nr. (1Input Long nr. $(1 \div 16)32$)
st_ibit0÷15	F	0	R	-	Input bit in the iword1 parameter
ilong1÷16	L	0	R	-	Input Long nr. $(1 \div 16)$
oword1÷32	W	0	R/W	-	Output Word nr. $(1 \div 32)$
st_obit0÷15	F	0	R/W	-	Output bit in the oword1 parameter
olong1÷16	L	0	R/W	-	Output Long nr. $(1 \div 16)$

1.5.3.3 Variables

Name	D	R	A	Conditions	Description
serr	B	0	R/W	-	Serial Errors Indicates if errors occurred in serial communication. The parameter is updated for each error encountered. The value persists until a subsequent error or to a writing on the same with the QCL. 0 = no errors, 1 = parity error, 2 = framing error, 3 = overrun error.

1.5.3.4 States

Name	D	R	A	Conditions	Description
st_msgrx	F	0	R	-	Message received State used only in slave mode. Indicates that a message from the master has executed a write in the QCL data exchange area. The state is reset with the RECEIVED command.
st_opencom	F	0	R	-	Open communication port Activation indicates that the device is working with the serial communications port. To set this state use the OPENCOM command, for reset use CLOSECOM.
wdata	F	0	R	-	Warning Data This bit indicates that an attempt was made to insert an invalid value in a parameter.
wcmd	F	0	R	-	Warning Command This bit indicates that it did not execute a command because they lack the necessary conditions.

1.5.3.5 Commands

The available commands to manage the device are listed below in descending order of priority.

The device executes all commands received within the same sampling time starting from the one with the highest priority. For example if the device receives the same sampling time CLOSECOM and OPENCOM commands, first run the OPENCOM command and than to CLOSECOM leaving therefore the communication port closed.

Name	D	R	A	Conditions	Description
RECEIVED	-	-	-	st_msgrx = 1 mode = 1, 2 st_opencom = 1	Received Used only in slave mode. Indicates that the QCL application has processed the information that the master has sent
VALIDATE	-	-	-	mode = 1, 2 st_opencom = 1	Validate Indicates that the parameters of the QCL data exchange becomes available to the master.
CLRWDATA	-	-	-	-	Clear Warning Data Reset the wdata parameter reporting
CLRWCMD	-	-	-	-	Clear Warning Command Reset the wcmd parameter reporting
OPENCOM	-	-	-	st_opencom = 0	Open Serial communication Open the serial communication (the device then committed the communications port). The st_opencom state changes to 1.
CLOSECOM	-	-	-	-	Close Serial communication Closes the serial communication (the device then does not commit more the communications port). The st_opencom state changes to 0.

1.6 Migration from MODBUS01 device to MODBUS device

The first thing to note for migration is the fact that the MODBUS01 device is external, while the MODBUS is internal. This implies that the device declaration must be done in "INTDEVICE" section in the configuration unit of the project. In addition, this entails choosing, when defining the MODBUS device, of the sampling time. The value of the sample time that keeps the performance of communication between the two devices is 5 ms. Being defined, you must select the serial port to be committed.

The MODBUS device increased the number of exchange variables (from 16 word to 32 word) but this does not affect the operation for settings that use the maximum 16 word How are those designed for the MODBUS01 device.

The MODBUS device has restricted the "num" variable to 128, while the MODBUS01 device the limit is 256. This was necessary to allow an optimization of sampling time. The decision was taken in view of the fact that those values were used only for Coils managing, but that was logic leaking more than read/write 128 consecutive coils.

The MODBUS device allows you to control (using 2 new commands) communication serial's commitment on the part of the device. This new functionality is interesting in the event that other devices have been declared in a project Qview that can use the same serial.

If an application was written for the MODBUS01 device you must add the OPENCOM command (executed only once) as shown in the following example.

Example:

```
; setting communication parameters
modbus.mode = 0
modbus.brat = 38400
modbus.OPENCOM
WAIT modbus.st_opencom
modbus.idcard = 8
modbus.addr = 600
modbus.num = 6
modbus.tabreg = 10
modbus.type = 3
modbus.SEND
WAIT modbus.st_sended
IF (modbus.err)
CALL ErrorModbus
ENDIF
```

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