CPA050-CPA300

COMMUNICATION PROTOCOL

Version 1 Revision 1

May 4th, 2016

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1.1 Introduction

The RS485 serial interface supports the MODBUS/JBUS (RTU) protocol. In this document only the information necessary to read/write from/to CPA has been reported (not all the parts of the protocol have been implemented).
For a complete description of the MODBUS protocol please refer to the “Modbus_Application_Protocol_V1_1a.pdf” document that is downloadable from the www.modbus.org web site.

1.2 MODBUS functions

These functions are available on CPA:

- Reading of n “Holding Registers” (code 03h)
- Writing of one “Holding Registers” (code 06h)
- Writing of multiple register (code 10h)

IMPORTANT:

1) In this document the “Modbus address” field is indicated in two modes:
   1.1) “**Modicom address**”: it is the “6-digit Modicom” representation with Modbus function code 03 (Read Holding Registers).
   1.2) “**Physical address**”: it is the “word address” value to be included in the communication frame.
2) The communication parameters are to be set according to the configuration of the instrument (refer to CPA instruction manual)

Function 03h (Read Holding Registers)

This function is used to read the contents of a contiguous block of holding registers (word). The Request frame specifies the starting register address and the number of registers to be read. It is possible to read maximum 120 registers (words) with a single request, when not differently specified.
The register data in the response message are packed as two bytes per register (word), with the binary contents right justified within each byte. For each register, the first byte contains the high order bits (MSB) and the second contains the low order bits (LSB).

Request frame

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	
Function code	1 byte	03h	
Starting address	2 bytes	0000h to FFFFh	Byte order: MSB, LSB
Quantity of registers (**N** word)	2 bytes	1 to 10h (1 to 11)	Byte order: MSB, LSB
CRC	2 bytes		

Response frame (correct action)

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	
Function code	1 byte	03h	
Quantity of requested bytes	1 byte	**N** word * 2	
Register value	**N***2 bytes		Byte order: MSB, LSB
CRC	2 bytes		

Response frame (incorrect action)

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	Possible exception : 01h: illegal function 02h: illegal data address 03h: illegal data value 04h: slave device failure
Function code	1 byte	83h	
Exception code	1 byte	01h, 02h, 03h, 04h (see note)	
CRC	2 bytes		

Function 06h (Write Single Holding Register)

This function code is used to write a single holding register. The Request frame specifies the address of the register (word) to be written and its content.
The correct response is an echo of the request, returned after the register content has been written.

Request frame

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	
Function code	1 byte	06h	
Starting address	2 bytes	0000h to FFFFh	Byte order: MSB, LSB
Register value	2 bytes	0000h to FFFFh	Byte order: MSB, LSB
CRC	2 bytes		

Response frame (correct action)

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	
Function code	1 byte	06h	
Starting address	2 bytes	0000h to FFFFh	Byte order: MSB, LSB
Register value	2 bytes	0000h to FFFFh	Byte order: MSB, LSB
CRC	2 bytes		

Function 10h (Write multiple register)

This function code is used to write a block of contiguous registers (maximum 2). The requested values to be written are specified in the request data field. Data is packed as two bytes per register.
The correct response returns the function code, starting address, and the quantity of written registers.

Request frame

Description	Length	Value	Note
Physical Address	1 byte	1 to F7 (1 to 247)	
Function code	1 byte	10h	
Starting Address	2 bytes	0000h to FFFFh	Byte order: MSB, LSB
Quantity of Registers (**N** word)	2 bytes	0001h to 0078h	Byte order: MSB, LSB
Byte count	1 byte	**N** word * 2	
Register value	**N** * 2 bytes	value	Byte order: MSB, LSB
CRC	2 bytes		

Response frame (correct action)

Description	Length	Value	Note
Physical Address	1 byte	1 to F7 (1 to 247)	
Function code	1 byte	10h	
Starting Address	2 bytes	0000h to FFFFh	Byte order: MSB, LSB
Quantity of Registers (**N** word)	2 bytes	0001h to 0078h	Byte order: MSB, LSB
CRC	2 bytes		

Response frame (incorrect action)

Description	Length	Value	Note
Physical Address	1 byte	1 to F7 (1 to 247)	Possible exception: 01h: illegal function 02h: illegal data address 03h: illegal data value 04h: slave device failure
Function code	1 byte	90h	
Exception code	1 byte	01h, 02h, 03h, 04h	
CRC	2 bytes		

Response frame (incorrect action)

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	Possible exception : 01h: illegal function 02h: illegal data address 03h: illegal data value 04h: slave device failure
Function code	1 byte	86h	
Exception code	1 byte	01h, 02h, 03h, 04h	
CRC	2 bytes		

1.3 Application notes

RS485 general considerations

1. To avoid errors due to the signal reflections or line coupling, it is necessary to terminate the bus at the beginning and at the end (inserting a 120 ohm 1/2W 5% resistor between line B and A in the last instrument and in the Host interface).
2. The network termination is necessary even in case of point-to-point connection and/or of short distances.
3. For connections longer than 1000m or if in the network there are more than 160 instruments (with 1/5 unit load as used in CPA interface), a signal repeater is necessary.
4. For bus connection it is suggested to use an AWG24 balanced pair cable and to add a third wire for GND connection. Connect GND to the shield if a shielded cable is used.
5. The GND is to be connected to ground only at the host side.
6. If an instrument does not answer within the “max answering time”, it is necessary to repeat the query. If the instrument does not answer after 2 or 3 consecutive queries, it is to be considered as not connected, faulty or reached with a wrong address. The same consideration is valid in case of CRC errors or incomplete response frames.

MODBUS timing

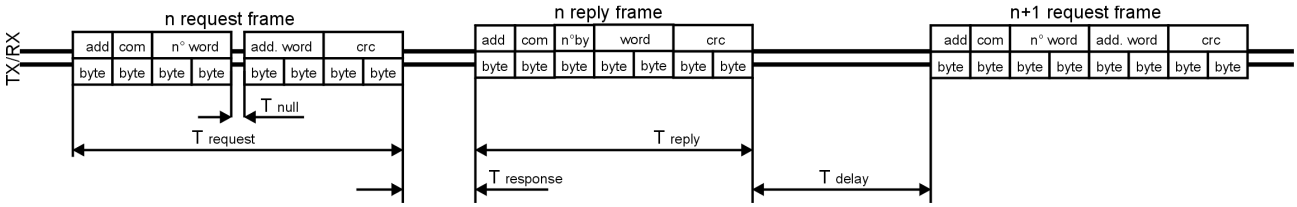


Fig. 1 : 2-wire timing diagram

Timing characteristics of reading function:	**msec**
T response: Max answering time	50ms
T response: Typical answering time	7ms
T delay: Minimum time before a new query	3.5char
T null: Max interruption time during the request frame	2.5char

2 TABLES

2.1 Data format representation In Carlo Gavazzi instruments

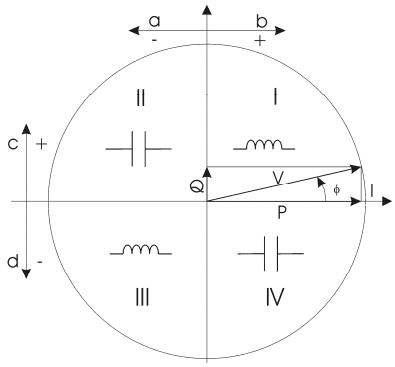
The variables are represented by integers or floating numbers, with 2's complement notation in case of "signed" format, using the following:

Format	IEC data type	Description	Bits	Range
INT16	INT	Integer	16	-32768 .. 32767
UINT16	UINT	Unsigned integer	16	0 .. 65535
INT32	DINT	Double integer	32	-2^{31} .. 2^{31}
UINT32	UDINT	Unsigned double int	32	0 .. 2^{32}-1
UINT64	ULINT	Unsigned long integer	64	0 .. 2^{64}-1
IEEE754 SP		Single-precision floating-point	32	$-(1+[1-2^{-23}])x2^{127}$ .. 2^{128}

For all the formats the byte order (inside the single word) is MSB->LSB. In INT32, UINT32 and UINT64 formats, the word order is LSW-> MSW.

Geometric representation

According to the signs of the power factor , the active power P and the reactive power Q, it is possible to obtain a geometric representation of the power vector, as indicated in the drawing below, according to EN 60253-23:



a = Exported active power
b = Imported active power
c = Imported reactive power
d = Exported reactive power

Fig. 2 : Geometric Representation

2.2 Instantaneous variables and meters (FLOAT LSW first)

MODBUS: read only mode with functions code 03 and 04 Table 2.2-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
40072	0047h	1	STATUS SW	UINT16	bit 0: flash settings error; bit1: flash calibration error; bit 2: Voltage Over Range; bit 3: Voltage Under Range; bit [4:5] don't care; bit 6: Zero crossing detecting; bit [7:9] don't care; bit 10: Energy storing error; bit 11: Energy initialization error; bit 12: don't care; bit 13: Current Over Range; bit 14: Current Under Range
40073	0048h	2	V L-N	FLOAT (LSW first)	Value weight: Volt
40075	004Ah	2	A	FLOAT (LSW first)	Value weight: mA
40077	004Ch	2	W	FLOAT (LSW first)	Value weight: W
40079	004Eh	2	var	FLOAT (LSW first)	Value weight: var
40081	0050h	2	VA	FLOAT (LSW first)	Value weight: VA
40083	0052h	2	PF	FLOAT (LSW first)	Value weight: PF
40085	0054h	2	Hz	FLOAT (LSW first)	Value weight: Hz
40087	0056h	2	THD A	FLOAT (LSW first)	Value weight: %
40089	0058h	2	kWh net	FLOAT (LSW first)	Value weight: kWh
40091	005Ah	2	kWh (+) TOT	FLOAT (LSW first)	Value weight: kWh
40093	005Ch	2	kWh (-) TOT	FLOAT (LSW first)	Value weight: kWh
40095	005Eh	2	V L-N peak	FLOAT (LSW first)	Value weight: Volt
40097	0060h	2	A peak	FLOAT (LSW first)	Value weight: Ampere
40099	0062h	2	V L-N max	FLOAT (LSW first)	Value weight: Volt
40101	0064h	2	V L-N min	FLOAT (LSW first)	Value weight: Volt
40103	0066h	2	Amax	FLOAT (LSW first)	Value weight:mA
40105	0068h	2	A min	FLOAT (LSW first)	Value weight: mA
40107	006Ah	2	W max	FLOAT (LSW first)	Value weight: W
40109	006Ch	2	W min	FLOAT (LSW first)	Value weight: W
40111	006Eh	2	var max	FLOAT (LSW first)	Value weight: var
40113	0070h	2	var min	FLOAT (LSW first)	Value weight: var
40115	0072h	2	VA max	FLOAT (LSW first)	Value weight: VA
40117	0074h	2	VA min	FLOAT (LSW first)	Value weight: VA
40119	0076h	2	PF max	FLOAT (LSW first)	Value weight: PF
40121	0078h	2	PF min	FLOAT (LSW first)	Value weight: PF
40123	007Ah	2	Hz max	FLOAT (LSW first)	Value weight: Hz
40125	007Ch	2	Hz min	FLOAT (LSW first)	Value weight: Hz
40127	007Eh	2	THD A max	FLOAT (LSW first)	Value weight: %
40129	0080h	2	THD A min	FLOAT (LSW first)	Value weight: %

2.3 Instantaneous variables and meters (FLOAT MSW first)

40132	0083h	1	STATUS SW	UINT16	bit 0: flash settings error; bit1: flash calibration error; bit 2: Voltage Over Range; bit 3: Voltage Under Range; bit [4:5] don't care; bit 6: Zero crossing detecting; bit [7:9] don't care; bit 10: Energy storing error; bit 11:

					Energy initialization error; bit 12: don't care; bit 13: Current Over Range; bit 14: Current Under Range;
40133	0084h	2	V L-N	FLOAT (MSW first)	Value weight: Volt
40135	0086h	2	A	FLOAT (MSW first)	Value weight: mA
40137	0088h	2	W	FLOAT (MSW first)	Value weight: W
40139	008Ah	2	var	FLOAT (MSW first)	Value weight: var
40141	008Ch	2	VA	FLOAT (MSW first)	Value weight: VA
40143	008Eh	2	PF	FLOAT (MSW first)	Value weight: PF
40145	0090h	2	Hz	FLOAT (MSW first)	Value weight: Hz
40147	0092h	2	THD A	FLOAT (MSW first)	Value weight: %
40149	0094h	2	kWh net	FLOAT (MSW first)	Value weight: kWh
40151	0096h	2	kWh (+) TOT	FLOAT (MSW first)	Value weight: kWh
40153	0098h	2	kWh (-) TOT	FLOAT (MSW first)	Value weight: kWh
40155	009Ah	2	V L-N peak	FLOAT (MSW first)	Value weight: Volt
40157	009Ch	2	A peak	FLOAT (MSW first)	Value weight: Ampere
40159	009Eh	2	V L-N max	FLOAT (MSW first)	Value weight: Volt
40161	00A0h	2	V L-N min	FLOAT (MSW first)	Value weight: Volt
40163	00A2h	2	Amax	FLOAT (MSW first)	Value weight: mA
40165	00A4h	2	A min	FLOAT (MSW first)	Value weight: mA
40167	00A6h	2	W max	FLOAT (MSW first)	Value weight: W
40169	00A8h	2	W min	FLOAT (MSW first)	Value weight: W
40171	00AAh	2	var max	FLOAT (MSW first)	Value weight: var
40173	00ACh	2	var min	FLOAT (MSW first)	Value weight: var
40175	00AEh	2	VA max	FLOAT (MSW first)	Value weight: VA
40177	00B0h	2	VA min	FLOAT (MSW first)	Value weight: VA
40179	00B2h	2	PF max	FLOAT (MSW first)	Value weight: PF
40181	00B4h	2	PF min	FLOAT (MSW first)	Value weight: PF
40183	00B6h	2	Hz max	FLOAT (MSW first)	Value weight: Hz
40185	00B8h	2	Hz min	FLOAT (MSW first)	Value weight: Hz
40187	00BAh	2	THD A max	FLOAT (MSW first)	Value weight: %
40189	00BCh	2	THD A min	FLOAT (MSW first)	Value weight: %

2.4 Instantaneous variables and meters (INT32)

40192	00BEh	1	STATUS SW	UINT16	bit 0: flash settings error; bit1: flash calibration error; bit 2: Voltage Over Range; bit 3: Voltage Under Range; bit [4:5] don't care; bit 6: Zero crossing detecting; bit [7:9] don't care; bit 10: Energy storing error; bit 11: Energy initialization error; bit 12: don't care; bit 13: Current Over Range; bit 14: Current Under Range;
40193	00C0h	2	V L-N	INT32 (LSW first)	Value weight: Volt*100
40195	00C2h	2	A	INT32 (LSW first)	Value weight: mA*100
40197	00C4h	2	W	INT32 (LSW first)	Value weight: W*100
40199	00C6h	2	var	INT32 (LSW first)	Value weight: var*100
40201	00C8h	2	VA	INT32 (LSW first)	Value weight: VA*100
40203	00CAh	2	PF	INT32 (LSW first)	Value weight: PF*100
40205	00CCh	2	Hz	INT32 (LSW first)	Value weight: Hz*100
40207	00CEh	2	THD A	INT32 (LSW first)	Value weight: %*100
40209	00D0h	2	kWh net	INT32 (LSW first)	Value weight: kWh*100
40211	00D2h	2	kWh (+) TOT	INT32 (LSW first)	Value weight:

					kWh*100
40213	00D4h	2	kWh (-) TOT	INT32 (LSW first)	Value weight: kWh*100
40215	00D6h	2	V L-N peak	INT32 (LSW first)	Value weight: Volt*100
40217	00D8h	2	A peak	INT32 (LSW first)	Value weight: mA*100
40219	00DAh	2	V L-N max	INT32 (LSW first)	Value weight: Volt*100
40221	00DCh	2	V L-N min	INT32 (LSW first)	Value weight: Volt*100
40223	00DEh	2	Amax	INT32 (LSW first)	Value weight: mA*100
40225	00E0h	2	A min	INT32 (LSW first)	Value weight: mA*100
40227	00E2h	2	W max	INT32 (LSW first)	Value weight: W*100
40229	00E4h	2	W min	INT32 (LSW first)	Value weight: W*100
40231	00E6h	2	var max	INT32 (LSW first)	Value weight: var*100
40233	00E8h	2	var min	INT32 (LSW first)	Value weight: var*100
40235	00EAh	2	VA max	INT32 (LSW first)	Value weight: VA*100
40237	00ECh	2	VA min	INT32 (LSW first)	Value weight: VA*100
40239	00EEh	2	PF max	INT32 (LSW first)	Value weight: PF*100
40241	00F0h	2	PF min	INT32 (LSW first)	Value weight: PF*100
40243	00F2h	2	Hz max	INT32 (LSW first)	Value weight: Hz*100
40245	00F4h	2	Hz min	INT32 (LSW first)	Value weight: Hz*100
40247	00F6h	2	THD A max	INT32 (LSW first)	Value weight: %*100
40249	00F8h	2	THD A min	INT32 (LSW first)	Value weight: %*100

2.5 Firmware version

MODBUS: read only mode Table 2.5-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
40002	0001h	1	Version code	UINT 16	Value=0: Revision 0

2.6 Carlo Gavazzi Controls identification code

MODBUS: read only mode Table 2.6-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
300012	0036h	1	Carlo Gavazzi Controls identification code	UINT 16	95=CPA050 96=CPA300

2.7 Programming parameter tables

The values are update after the commands 0xC1C0 e 0xC1A0 (see Commands).

PT and CT configuration menu

MODBUS: read and write mode Table 2.7-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
40009	0008h	2	Voltage transformer ratio	FLOAT (LSW first)	Default = 1 (VT=1.0)
40011	0010h	2	Current transformer ratio	FLOAT (LSW first)	Default = 1 (CT=1.0)

Measurement and filters

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes

40008	0007h	1	Flag Measurement	UINT16	bit 0 :[0= TRMS value (without sign); 1 = DC_measurement (with sign)];
					bit 1 :[0= Energy storing disable; 1= Energy storing enable];
					bit 2 :[0= Frequency detect on Voltage channel; 1= Frequency detect on Current channel].

40007	0006h	1	Number of tenths of second (1/10) for all RMS calculation in DC	UINT16	1…65535 Default: 10
40014	000Dh	1	Number of zero crossings for_AC Meas Number of line cycle Zero Crossings for AC measurement RMS.	UINT16	1...65535 Default: 50

Serial port configuration menu

MODBUS: read and write mode Table 2.7-2

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
40003	0002h	1	RS485 instrument address	UINT 16	Value min = 1 Value max = 247
40004	0003h	1	Machine answer delay (characters)	UINT16	Value min = 0 Value max = 1000 Default = 1
40005	0004h	1	RS485 baud rate	UINT 16	Value 0 = 1.2 kbps Value 1 = 2.4 kbps Value 2 = 4.8 kbps Value 3 = 9.6 kbps (default) Value 4 = 19.2 kbps Value 5 = 38.4 kbps Value 6 = 57.6 kbps Value 7 = 115.2 kbps
40006	0005h	1	Parity	UINT16	Value 0 = no parity Value 1 = odd parity Value 2 = even parity

NOTE: The values are update after switching off and on again

Commands

MODBUS: read and write mode

Table 2.7-3

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
40252	00FBh	1	Flash settings save command = 0xC1C0; Reset command = 0xC1A0; Load Energy command = 0xBABA (energy to load must be written in Command_aux); Load Positive Energy command = 0xBABB (positive energy to load must be written in Command_aux); Load Negative Energy command = 0xBABC (negative energy to load must be written in Command_aux);	UINT 16	
40253	00FCh	2	Auxiliary Register for Energy Command (see command register)	FLOAT (LSW first)	

3 Revisions

Version 1 Revision 1 3/5/2016:

- Document created