Carlo Gavazzi Instruments SpA

SPT - DIN

Serial Protocol

Ver. 2 Rev. 0

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1. Serial communication protocol

The MODBUS protocol is the communication protocol used by SPT-DIN for the serial communication; this extremely versatile system allows to connect in the same network up to 255 instruments (slaves) that are interrogated by a single master (normally a personal computer).

The structure of the commands allows the operator to read all the variables relevant to the system and read/write data in the whole EEPROM, so that the instrument's functions are completely transparent.

The data format of the communication consists of 1 start bit, 8 data bit, a parity bit (when used) and 1 stop bit. The baud rate is programmable in 1200, 2400, 4800 or 9600 bit/s (see instruction manual).

The communication can be started only by the host computer, which sends the message (frame) relating to the required request. Each frame is made of 4 kinds of information:

- address of the slave (address): it's a number from 1 to 255 that identifies the instrument connected to the network. The 0 address is acknowledged by all instruments that execute the command but do not send the relevant answer.
- function code (command): it's a code that defines the type of command (ex.: reading of a word, writing of a bit, etc.)
- data (data field): it's a set of numbers that defines the function parameters (ex. address of the word to be written, value of the word to be written and so on)
- control word (CRC = cyclic redundancy code): it's a word that allows to acknowledge any transmission errors.

1.1 FRAME STRUCTURE

Request:

slave number (1 to FF)	**function code**	**data**	**check word CRC**
1 byte	1 byte	n bytes	2 bytes

Reply:

slave number (1 to FF)	**function code**	**data**	**check word CRC**
1 byte	1 byte	n bytes	2 bytes

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1.2 FUNCTIONS

SPT performs two different functions:
Reading of a word (code 04)
Writing of a word (code 06)

Function 04

Request

Address	Function	Word address	Number of words	Crc
1 byte	**1 byte**	**2 bytes**	**2 bytes**	**2 bytes**
1 to 255	**04**	**MSB / LSB**	**MSB / LSB**	**MSB / LSB**

Note: the number of words can only be 01 (reading of a single word)

Reply

Address	Function	Number of bytes	Word value	Crc
1 byte	**1 byte**	**1 byte**	**2 bytes**	**2 bytes**
1 to 255	**04**	**02**	**MSB / LSB**	**MSB / LSB**

Function 06

Request

Address	Function	Word address	Word value	Crc
1 byte	**1 byte**	**2 bytes**	**2 bytes**	**2 bytes**
1 to 255	**06**	**MSB / LSB**	**MSB / LSB**	**MSB / LSB**

Reply

Address	Function	Word address	Word number	Crc
1 byte	**1 byte**	**1 byte**	**2 bytes**	**2 bytes**
1 to 255	**06**	**01**	**MSB / LSB**	**MSB / LSB**

Note: the reply of SPT-DIN will be an echo of the request, indicating that the command has been executed.

If the address of the slave is 00, all the instruments connected to the network execute the command but do not send the reply frame.

Note
In case the scanning of more than one SPT is performed, there must be an interval of 100msec between the enquiry of one SPT and the next.

The reply of SPT is completed within a maximum time of 500 msec. If within this period the host has not received any answer, the instrument can be considered "not connected to the network" or a transmission error may have occurred.

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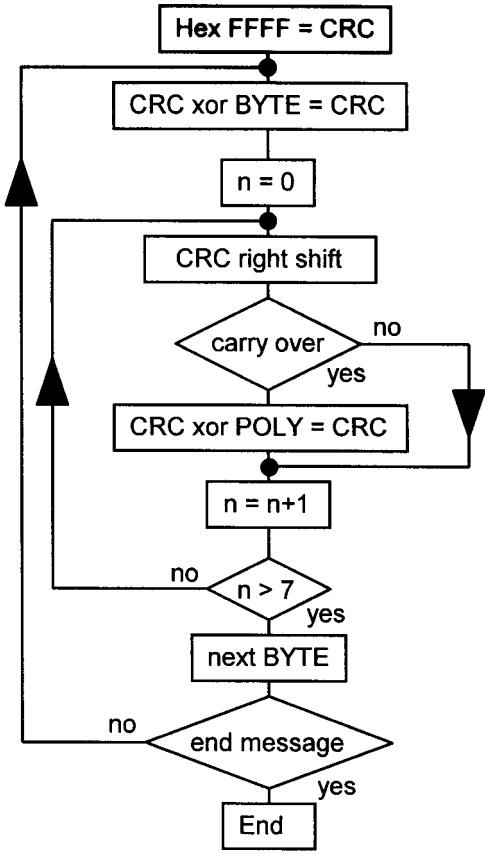
1.3 CONTROL OF TRANSMISSION ERRORS

SPT has two possibilities for communicating transmission errors: the parity bit and the CRC. The parity bit (if selected by the user) permits the control of the transmitted frame character by character. If in a character of the frame there is a parity error, SPT does not reply to the enquiry of the host.

The CRC is calculated by the master, when address, function and data have been defined. When the slave receives the message, the latter is stored, its CRC is calculated and compared with the one received. If the word check is correct and the address is acknowledged, the slave executes the command and sends the reply, otherwise, also in this case, the enquiry is ignored.

1.4 CALCULATION ALGORITHM OF CRC



POLY = crc calculation polynominal: A001h

Example of CRC calculation
Frame = 0207h

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Table 1.4-1: Example of calculation of CRC

Startup of CRC	1111	1111	1111	1111	
Loading of the first character			0000	0010	
Executes XOR with the first character of the frame	1111	1111	1111	1101	
Executes first shift on the right	0111	1111	1111	1110	1
Carry = 1, loading of polynomial	1010	0000	0000	0001	
Executes XOR with the polynomial	1101	1111	1111	1111	
Executes 2nd shift on the right	0110	1111	1111	1111	1
Carry = 1, loading of polynomial	1010	0000	0000	0001	
Executes XOR with the polynomial	1100	1111	1111	1110	
Executes 3rd shift on the right	0110	0111	1111	1111	0
Executes 4th shift on the right	0011	0011	1111	1111	1
Carry = 1, loading of polynomial	1010	0000	0000	0001	
Executes XOR with the polynomial	1001	0011	1111	1110	
Executes 5th shift on the right	0100	1001	1111	1111	0
Executes 6th shift on the right	0010	0100	1111	1111	1
Carry = 1, loading of polynomial	1010	0000	0000	0001	
Executes XOR with the polynomial	1000	0100	1111	1110	
Executes 7th shift on the right	0100	0010	0111	1111	0
Executes 8th shift on the right	0010	0001	0011	1111	1
Carry = 1, loading of polynomial	1010	0000	0000	0001	
Executes XOR with the polynomial	1000	0001	0011	1110	
Loading of the second frame character			0000	0111	
Executes XOR with the second frame character	1000	0001	0011	1001	
Executes 1st Shift on the right	0100	0000	1001	1100	1
Carry = 1, loading of polynomial	1010	0000	0000	0001	
Executes XOR with the polynomial	1110	0000	1001	1101	
Executes 2nd shift on the right	0111	0000	0100	1110	1
Carry = 1, loading of polynomial	1010	0000	0000	0001	
Executes XOR with the polynomial	1101	0000	0100	1111	
Executes 3rd shift on the right	0110	1000	0010	0111	1
Carry = 1, loading of polynomial	1010	0000	0000	0001	
Executes XOR with the polynomial	1100	1000	0010	0110	
Executes 4th shift on the right	0110	0100	0001	0011	0
Executes 5th shift on the right	0011	0010	0000	1001	1
Carry = 1, loading of polynomial	1010	0000	0000	0001	
Executes XOR with the polynomial	1001	0010	0000	1000	
Executes 6th shift on the right	0100	1001	0000	0100	0
Executes 7th shift on the right	0010	0100	1000	0010	0
Executes 8th shift on the right	0001	0010	0100	0001	0
Result of the CRC	0001	0010	0100	0001	

	12h		**41h**	
	LSB		**MSB**	
Note: transmitted frame	**02**	**07**	**41**	**12**
	1st			**end**

1.5 ADDRESSES OF THE VARIABLES

High part of the address: 00. Stored variables.

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1.6 MAP OF THE VARIABLES TO BE READ

Table 1.6-1: Map of the variables to be read through the serial port

Address	Variable	Output data format
	–––––––––––––––––––––––– System variables ––––––––––––––––––––––––	
00h	System active power	P (1) (7)
01h	System apparent power	S (2) (7)
02h	System reactive power	Q (3) (7)
03h	System power factor (cosφ)	10000 x PF if capacitive; 20000 - 10000 x PF if inductive
04h	average phase to phase system voltage	$V_{\Delta avg}$ (7)
05h	maximum current	I_{max} (7)
06h	system frequency	10 x F
07h	system energy (hi word)	(4)
08h	system energy (lo word)	(5)
09h	digital input status, set-point output and status of the energy overflow bit	bit #0: status of digital input 1 bit #1: status of digital input 2 bit #2: status of digital input 3 bit #3: status of the set-point output/pulses bit #4: energy overflow bit
0ah	average active power	10 x Pp
0bh	Instrument's model	"1" - AV5.3 "2" - AV4.3 "3" - AV3.3 "4" - AV1.3 "5" - AV5.1 "6" - AV4.1 "7" - AV3.1 "8" - AV1.1
	–––––––––––––––––––––––– Variables of phase 1 ––––––––––––––––––––––––	
10h	active power - phase 1	P1 (1) (7)
11h	apparent power - phase 1	S1 (2) (7)
12h	reactive power - phase 1	Q1 (3) (7)
13h	power factor - phase 1	10000 x PF1 if capacitive; 20000 - 10000 x PF1 if inductive
14h	phase-neutral voltage - phase 1	V1(7)
15h	current - phase 1	I1 (7)
	–––––––––––––––––––––––– Variables of phase 2 ––––––––––––––––––––––––	
20h	active power - phase 2	P2 (1) (7)
21h	apparent power - phase 2	S2 (2) (7)
22h	reactive power - phase 2	Q2 (3) (7)
23h	power factor - phase 2	10000 x PF2 if capacitive; 20000 - 10000 x PF2 if inductive
24h	phase neutral voltage - phase 2	V2 (7)
25h	current - phase 2	I2 (7)
	–––––––––––––––––––––––– Variables of phase 3 ––––––––––––––––––––––––	
30h	active power - phase 3	P3 (1) (7)
31h	apparent power - phase 3	S3 (2) (7)
32h	reactive power - phase 3	Q3 (3) (7)
33h	power factor - phase 3	10000 x PF3 if capacitive; 20000 - 10000 x PF3 if inductive
34h	phase-neutral voltage - phase 3	V3 (7)
35h	current - phase 3	I3 (7)

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1.7 MAP OF THE VARIABLES TO BE WRITTEN

Table 1.7-1: Map ot the variables to be written through the serial port

Address	Variable	Input data format
–––––––––––––––––––––––––– System variable ––––––––––––––––––––––––		
07h	reset of energy overflow bit	"0"
08h	reset of energy totalization	"0" ([6])
09h	writing of static output	"1" - high output
	(only if programmed remotely)	"0" - low output

([1]) If the instrument is connected to a load, the active power will be positive. The negative power shows that some energy is being generated.
([2]) The apparent power, being the product of effective values, is always non-negative.
([3]) The reactive power is positive if the load is inductive **(currents lagging voltages)**; the reactive power is negative if the load is capacitive **(currents leading voltages)**.
([4]) (Energy x 4) / 2^{16} for the AV5.X models; (Energy x 16) / 2^{16} for the models AV1.X, AV3.X and AV4.X
([5]) Energy x 4 - 2^{16} x hi word for the AV5.X models; Energy x 16 - 2^{16} x hi word for models AV1.X, AV3.X and AV4.X
([6]) To obtain the reset of energy is to be supplied in the frame, in positions 04 and 05 (normally 0 and 1, to indicate that only one word is to be written), the password of energy reset is 85 and 170. In practice, the frame to be sent for the energy reset is:

Table 1.7-2: Password of energy reset through serial port

Instrument's address	0	0	0	85	170	CRC	CRC

([7]) All electrical variables are transmitted by the instrument in a format which depends on the model

Table 1.7-3: Serial port output data format

	AV1.X	AV3.X	AV4.X	AV5.X
Voltages	40 x V	40 x V	10 x V	10 x V
Currents	4000 x I	1000 x I	4000 x I	1000 x I
Powers	16 x P	4 x P	4 x P	P

Note: all electrical variables being read, refer to single current and voltage transformer ratios. It is the host software that must acquire these data from SPT and perform the relevant multiplications.

High part of the address: aah. Variables in eeprom

The "aa" prefix allows you to read all the eeprom memory variables of the instrument. It also allows the operator to write the non-protected variables (see following table).

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1.8 EEPROM MAP

Table 1.8-1: eeprom map

Ind.	Variable	Data format	Note
00h	Voltage adjustment constant 1	Reserved	Protected
01h	Current adjustment constant 1	Reserved	Protected
02h	Power adjustment constant 1	Reserved	Protected
03h	Voltage adjustment constant 2	Reserved	Protected
04h	Current adjustment constant 2	Reserved	Protected
05h	Power adjustment constant 2	Reserved	Protected
06h	Voltage adjustment constant 3	Reserved	Protected
07h	Current adjustment constant 3	Reserved	Protected
08h	Power adjustment constant 3	Reserved	Protected
09h	Offset retransmitted output 1	Reserved	Protected
0ah	Retransmitted full scale 1	Reserved	Protected
0bh	Retransmitted offset 2	Reserved	Protected
0ch	Retransmitted full scale 2	Reserved	Protected
0dh	Current transformers ratio	P-S	
0eh	Voltage transformers ratio	P-S, decimal point excluded	
0fh	Voltage transformers' decimal point position "d.P"	"0" - unit decimal point (no decimal points) "1" - decimal point of tens "2" - decimal point of hundreds	
10h	Set-point selection "AL"	Programmed value "-1"	
11h	Activation set-point "A.on"	Programmed value of the activation set-point (except for the decimal point)	
12h	Deactivation set-point "A.oF"	Programmed value of the de-activation set-point (except for the decimal point)	
13h	Alarm delay "dEL"	Programmed alarm delay (in seconds)	
14h	Password to access "PAS" programming	As programmed	
15h	Integration time of average power "P.it"	Programmed integration time (in minutes)	
16h	Selection of stored energy "EnE"	"0" - active energy (+) "1" - apparent energy "2" - reactive energy "3" - active energy (+/-)	
17h	1st retransmitted lo output "Lo.A"	Programmed value x 10	
18h	1st retransmitted hi output "Hi.A"	Programmed value x 10	
19h	2nd retransmited lo ouput "Lo.A"	Programmed value x 10	
1ah	2nd tretransmitted hi output "Hi.A"	Programmed value x 10	
1bh	Filter amplitude "Fi.S"	Programmed value x 10	
1ch	Filter coefficient "Fi.C"	Programmed value	
1dh	Pulse programming "PuL"	Programmed value	
1eh	Address in serial network "Add"	Programmed value	
1fh	Range selection 1st retransm. output "rEt"	Programmed value -1	

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20h	Range selection 2nd retransm. output "rEt"	Programmed value -1	
21h	1st retransmitted electric hi "Hi.E"	Programmed value (except for the decimal point)	
22h	1st retransmitted electric lo "Lo.E"	Programmed value (except for the decimal point)	
23h	2nd retransmitted electric hi "Hi.E"	Programmed value (except for the decimal point)	
24h	2nd retransmitted electric lo "Lo.E"	Programmed value (except for the decimal point)	
25h	Energy (hi word)	Value written automatically during the last switching off of the instrument	Not to be used
26h	Energy (lo word)	Value written automatically during the last switching off of the instrument	Not to be used
27h	Baud rate "bdr"	"3" - 9600 bit/s "2" - 4800 bit/s "1" - 2400 bit/s "0" - 1200 bit/s	
28h	Data format of serial port "PAr"	"0" - no parity "1" - even parity bit	
29h	Driver of static output "out"	"0" - local driver (instrument's set point or pulse output) "LoC" "1" - remote driver "rEn" (by writing 1 in the 0009h address)	
2ah	Selection of single phase or three-phase measurement balanced load	"0" - single phase "1" - three phase	Used only for models SPT-DIN XXX.1.X.X.X.X
Other	Not used		

Note: all programming parameters may be written only if the instrument mounts the serial bidirectional interface.

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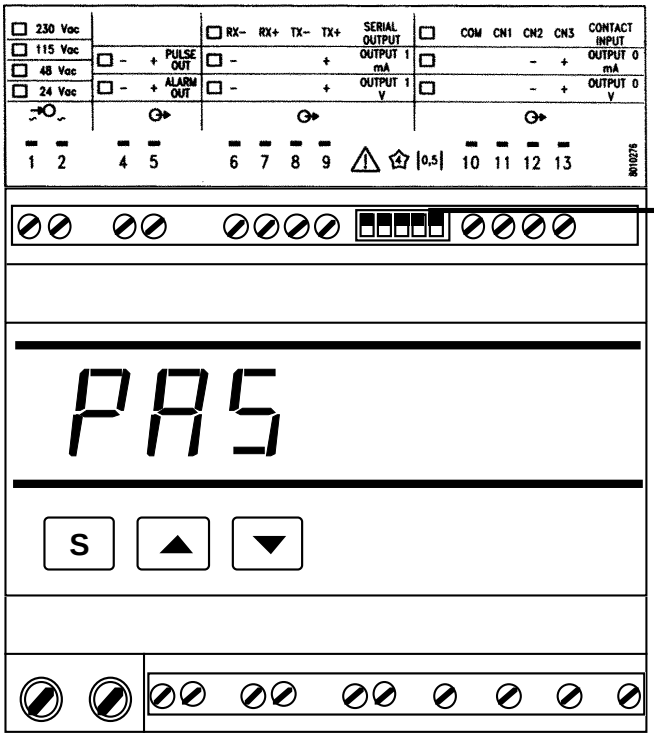
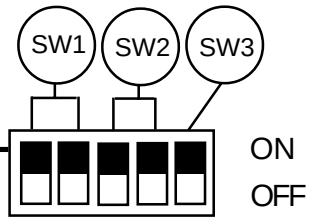
1.9 CONNECTIONS



RS485 SERIAL INTERFACE

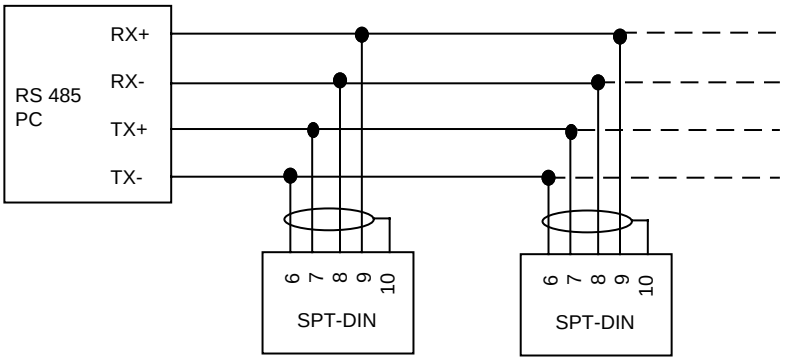


Selecting the terminating or bias line

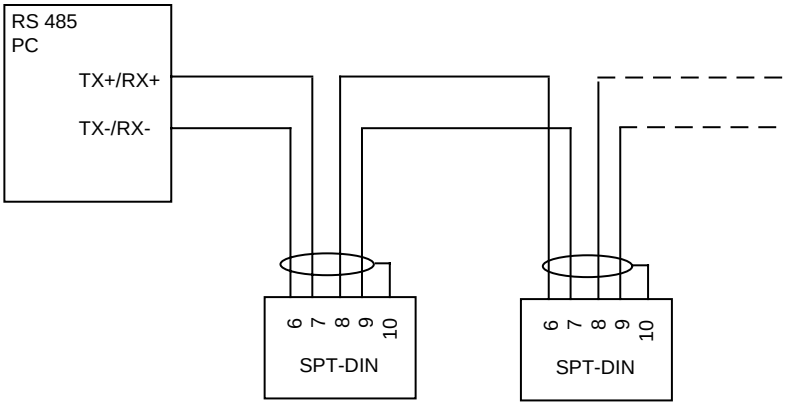
To properly set the dip-switches of the built-in RS485 serial interface and select either bias or terminating of the Rx and Tx communication lines (and additional 2 or 4 wires connections).

Function	Status
SW_1⇒2/4 WIRES	ON=2 W⇒OFF=4 WIRES
SW_2⇒Bias of Rx-/Tx-	ON=bias⇒OFF=not bias
SW_3⇒Terminating	ON=ter.⇒OFF=not ter.

(ter. = terminating; not ter. = not terminating)



4-wire connection



2-wire connection

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