Serial communication protocol
Modbus® for TC10

Document number: IM 05C01E81-03EN
Third edition: Feb. 2018

TC10 COMMUNICATION PROTOCOL

Index

1 PREFACE

TC10 uses Modbus® RTU communication protocol. Modbus is a royalty free protocol and is easy to be implemented. For Modbus RTU a vast literature is available also in internet.

The Modbus protocol represent all data in hexadecimal format. All communication string finish with a check sum type CRC (cyclic redundancy check).

Each device on a line must have different address. The protocol allows one master only and up to 255 slaves

Only the Master unit can start the transmission by sending the address of the unit and the command to be executed. Only the unit having the correct address will answer to the master.

The transmission characteristics are usually programmable:

Device address: From 1 to 255.

Baud rate: bit per second.

byte format:

– 1 start bit;

– 8 data bitis;

– 2 final bits composed as follows:
1 parity bit (even or odd);
1 stop bit;
or
no parity bit;
2 stop bits.

The TC10 allows to configure:

– address (1 to 254);

– Baud rate (1200 – 2400 – 9600 – 19200 – 38400).

The byte format is fixed: 8 bits without parity and 1 stop bit.

This document is intended to describe the TC10 controllers using the Modbus protocol in their communication capability and is mainly directed to technicians, system integrators and software developers.

2 PHYSICAL CONNECTION

2.1 Interface

TC10 controllers are provided with a RS485 serial communication interface, insulated so that any problem arising from ground potential is removed.

While at rest, the instruments are in a receive condition and are revert to transmission after a correct message has been decoded that matches the configured address.

2.2 Line

The instruments are equipped with 2 terminals named A and B.

The connection between TC10s has to be carried on in parallel, i.e. all A terminals have to be connected between them so as B terminals.

A termination resistor of 120Ω is required to maintain the quiescent condition on the line.

Adopted baud rates range 1200 to 38400 baud, that is very satisfactory for application performances, yet very slow for RS485 interface. This fact allows the wiring of the line with a medium quality twisted pair cable: total capacity of the line should not exceed 200 nF.

The line can be up to 1000 meters in length.

3 COMMUNICATION PROTOCOL

The protocol adopted by TC10 is a subset of the widely used Modbus RTU (JBUS, AEG Schneider Automation, Inc. registered trade mark) protocol, so that connections are easy for many commercial PLCs and supervisory programs.

For users needing to develop their own communication software, all information is available as well as implementation hints.

The Modbus RTU (JBUS) communication functions implemented in TC10 series are:

Function 3 Read n register;
Function 6 Preset one register;
Function 16 Preset multiple registers.

These functions allow the supervisory program to read and modify any data of the controller. The communication is based on messages sent by the master station (host) to the slave stations (TC10) and viceversa. The slave station that recognises the message as sent to it, analyses the content and, if it is formally and semantically correct, generates a reply message directed back to the master.

The communication process involves five types of messages:

From master to slave	From slave to master
Function 3: read n registers request	Function 3: read n registers reply
Function 6: preset one register request	Function 6: preset one register reply
Function 16: preset multiple registers request	Function 16: preset multiple registers reply
	Exception reply (as reply to all functions in abnormal conditions)

All messages contain four fields:

◊ Slave address (from 1 to 255): Modbus RTU (JBUS) reserves address 0 for broadcasting messagesand it is implemented in the TC10 series;

◊ Function code: contains 3, 6 or 16 for specified functions;

◊ Information field: contains data like word addresses and word values as required by function in use;

◊ Control word: a cyclic redundancy check (CRC) performed with particular rules for CRC16.

The characteristics of the asyncronous transmission are 8 bits, no parity, one stop bit.

3.1 Function code 3: read multiple registers (max. 16 registers for TC10)

This function code is used by the master to read a group of sequential registers present in the slave.

Master request	
Data	Byte
Slave address (1 to 255)	1
Function code (3)	1
First register address (MSB = Most Significant Byte)	1
First register address (LSB = Less Significant Byte)	1
Number of requested registers (MSB)	1
Number of requested registers (LSB)	1
CRC-16 (LSB)	1
CRC-16 (MSB)	1

Slave reply	
Data	Byte
Slave address (1 to 255)	1
Function code (3)	1
Byte number (n)	1
Data(s)	n
CRC-16 (LSB)	1
CRC-16 (MSB)	1

In the “Data(s)” fild the values of the requested registers are presented in word format [2 byte]: the first byte represent the MSB (Most Significant Byte) while the second byte represent the LSB (Less Significant Byte). This mode will be the same for all requested locations.

Example: The master requires to the address 1 the value of the locations 25 and 26 (0x19 and 0x1A).

Master request	
Data	Byte (Hex)
Slave address	01
Function code (3 = read)	03
First register address (MSB)	00
First register address (LSB)	19
Number of requested registers (MSB)	00
Number of requested registers (LSB)	02
CRC-16 (LSB)	15
CRC-16 (MSB)	CC

Slave reply	
Data	Byte (Hex)
Slave address	01
Function code (3 = read)	03
Byte number	04
Value of the first register (MSB)	00
Value of the first register (LSB)	0A
Value of the second register (MSB)	00
Value of the second register (LSB)	14
CRC-16 (LSB)	DA
CRC-16 (MSB)	3E

The slave replay means:
The value of the location 25 = 10 (0x000A hexadecimal)
The value of the location 26 = 20 (0x0014 hexadecimal)

3.2 Function code 6: write a single word (one location)

Master request	
Data	Byte (Hex)
Slave address	01
Function code (6)	06
Register address (MSB)	03
Register address (LSB)	02
Value to write (MSB)	00
Value to write (LSB)	0A
CRC-16 (MSB)	A8
CRC-16 (LSB)	49

Slave reply	
Data	Byte (Hex)
Slave address (1-255)	1
Function code (6)	1
Register address (MSB)	1
Register address (LSB)	1
Written value (MSB)	1
Written value (LSB)	1
CRC-16 (MSB)	1
CRC-16 (LSB)	1

Example: The master unit asks to the slave 1 to write in the memory location 770 (0x302) the value 10 (0x0A).

Master request	
Data	Byte (Hex)
Slave address	01
Function code (6)	06
Register address (MSB)	03
Register address (LSB)	02
Value to write (MSB)	00
Value to write (LSB)	0A
CRC-16 (MSB)	A8
CRC-16 (LSB)	49

Slave reply	
Data	Byte (Hex)
Slave address	01
Function code (6)	06
Register address (MSB)	03
Register address (LSB)	02
Written value (MSB)	00
Written value (LSB)	0A
CRC-16 (MSB)	A8
CRC-16 (LSB)	49

3.3 Function code 16: preset multiple registers (maximum 16 registers for TC10)

This function code allows to preset 16 registers at a time.

Master request	
Data	Byte (Hex)
Slave address (1-254)	1
Function code (16)	1
First register address (MSB)	1
First register address (LSB)	1
Number of requested registers (MSB)	1
Number of requested registers (LSB)	1
Byte count	1
Values	n
CRC-16 (LSB)	1
CRC-16 (MSB)	1

Slave reply	
Data	Byte (Hex)
Slave address (1-254)	1
Function code (16)	1
First register address (MSB)	1
First register address (LSB)	1
Number of written registers (MSB)	1
Number of written registers (LSB)	1
CRC-16 (LSB)	1
CRC-16 (MSB)	1

Example: The master unit requires to the slave 1 to write in the registers 10314 (0x284A) and 10315 (0x284B) the values 100 (0x64) and 200 (0xC8)

Master request	
Data	Byte (Hex)
Slave address	01
Function code (16)	10
First register address (MSB)	28
First register address (LSB)	4A
Number of requested registers (MSB)	00
Number of requested registers (LSB)	02
Byte count	04
Value 1 (MSB)	00
Value 1 (LSB)	64
Value 2 (MSB)	00
Value 2 ((LSB)	C8
CRC-16 (LSB)	C9
CRC-16 (MSB)	A8

Slave reply	
Data	Byte (Hex)
Slave address	01
Function code (16)	10
First register address (MSB)	28
First register address (LSB)	4A
Number of written registers (MSB)	00
Number of written registers (LSB)	02
CRC-16 (LSB)	69
CRC-16 (MSB)	BE

3.4 The exception reply

TC10 replies with an exception when the request is formally correct, but cannot be satisfied standing particular situations; the reply contains a code indicating the cause of the missing regular reply, the frame is:

Exception replay	
Data	Byte (Hex)
Slave address	1
Function code	1
Error code	1
CRC-16 (LSB)	1
CRC-16 (MSB)	1

TC10 adopts a subset of Modbus RTU (JBUS) exception code:

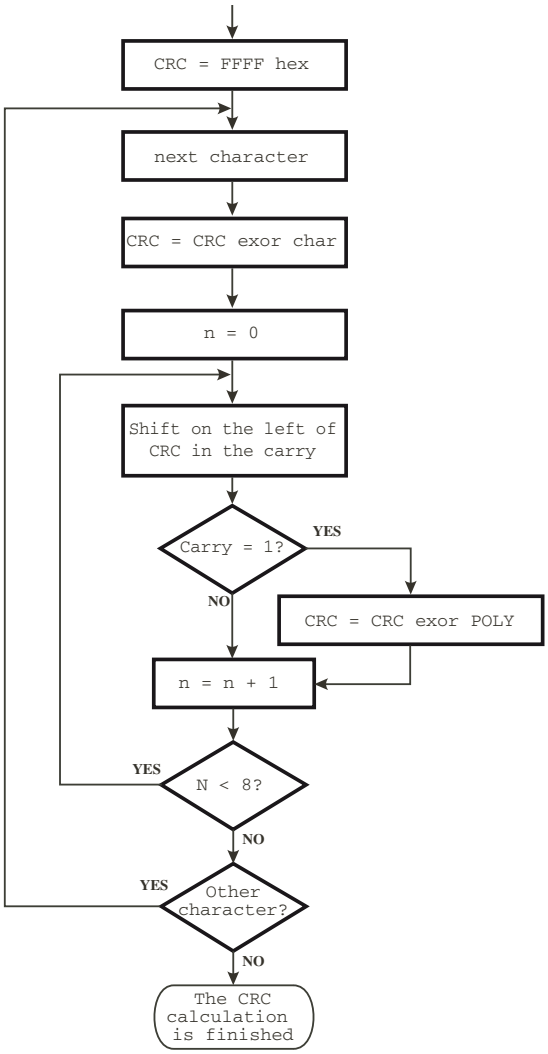
- unknown function code 1
- invalid memory address 2
- invalid data field 3
- controller not ready 6

3.5 Cyclic redundancy check (CRC)

CRC is a check word that permits to verify the integrity of a message. Every message, sent or received, has in the two last characters the CRC check word.

After receiving a request, the controller checks the validity of the received message comparing the received CRC with the calculated one. When a reply is ready the controller calculates the CRC word and adds two characters to the prepared message. CRC calculation is performed on every character of the message, excluding the last two.

Being Modbus RTU (JBUS) compatible, TC10 controllers adopt an identical algorithm for CRC calculation, sketched in following diagram:



The polinomial adopted by Modbus RTU (JBUS) is 1010 0000 0000 0001.

Note: The first transmitted character of the CRC word is the least significant between calculated bytes.

A subrutine made with “C” able to calculate the CRC-16 follows.

```
/* ---------------------------------------------------------------
crc_16        Calculation of CRC-16

Input parameters:
      buffer: character string to compute the CRC-16
      length: number of bytes in the string

This function returns the value of the CRC-16
--------------------------------------------------------------- */
unsigned int crc_16 (unsigned char *buffer, unsigned int length)
{
      unsigned int i, j, temp_bit, temp_int, crc;
      crc = 0xFFFF;
      for (i = 0; i < length; i++){
            temp_int = (unsigned char) *buffer++;
            crc ^= temp_int;
            for (j = 0; j < 8; j++) {
                  temp_bit = crc & 0x0001;
                  crc >>= 1;
                  if (temp_bit != 0)
                        crc ^= 0xA001;
            }
      }
      return (crc);
}
```

Note: All numerical values in the format 0x.... are expressed in hexadecimal format.

4 DATA EXCHANGE

This section contains informations about data exchanged with TC10 series controllers concerning numerical and not numerical data, with their formats and limits.

4.1 Some definitions

All exchanged data are in the form of 16 bit words.

Two types of data are distinguished: numerical and symbolic (or not numerical).

Numerical data represents the value of a quantity (e.g. the measured variable, the set point).

Symbolic data represents a particular value in a set of values (e.g. the thermocouple type in the set of available ones: J, K, S, etc.).

Both types are coded as integers number: signed numbers for numerical and unsigned numbers for symbolic.

A numerical data, coded as an integer, is coupled with appropriate number of decimal digits to represent a quantity with the same engineering units adopted aboard the instrument.

Numerical data are in fixed point representation; however we make a distinction between two kind of data:

◊ The first kind has determined and unmodifiable decimal point position;

◊ The second has programmable decimal point position (dP parameter).

4.2 Memory zones

All readable and writable data appear to be allocated as 16 bit words in the memory of the instrument.

The memory map has three zones:

◊ Varaibles,

◊ Parameters,

◊ Instrument identification code.

Following parameters explore the characteristics of each zone.

4.3 Variables zones

In this zone there is a collection of main TC10 controller variables, it is a group of frequently computed or updated data residing in volatile memory.

4.4 Most important changes

A) During parameter modification by push-button, the serial interface continue to operate without any “limit” (you can see by serial link the value of all parameters and you can set it also).

B) When you write a value in a location the instrument will operate as follows:

B.1) If you write a value within parameter range, the instrument will accept it; the new value will be memorized and the instrument will send back the standard answer.

B.2) If you try to write a value OUT of parameter range, the instrument will refuse the new value; the new value will NOT be memorized and the instrument will send an exception message to the master.

5 ADDRESS MAP

The instrument use only words:

Initial address		Final address		Mining
Hex	Dec	Hex	Dec	
1	1	1D	29	Numeric values calculated and dinamically updated. Available in read and write operations
200	512	250	592	Numeric values calculated and dinamically updated. Available in read and write operations
280	640	31B	795	Configuration parameters: Numeric and symolic values. Available in read and write operations
2800	10240	289B	10395	Repetition of the configuration parameters: Numeric and symolic values. Available in read and write operations

5.1 Common Variables

no.	Address			Description	Dec. Point	r/w
	Hex	Dec	Ref. no.			
1A	1	1	40002	**PV: Measured value** **Note:** When a measuring error is detected the instrument sends: • 10000 = Underrange • 10000 = Overrange • 10001 = Overflow of the A/D converter • 10003 = Variable not available		r
2A	2	2	40003	**Number of decimal figures of the measured value**	0	r
3A	3	3	40004	**Operative set point (value)**	dP	r
4A	4	4	40005	**Power output** **Range:** -100.00 to 100.00 (%) **Note:** This parameter is always writeable but it will be active only when the instrument operates in Manual mode.	2	r/w
5A	5	5	40006	**Active set point selection** 0 = SP 1 = SP 2 2 = SP 3 3 = SP 4	0	r/w
6A	6	6	40007	**SP** **Range:** SPLL to SPLH	dP	r/w
7A	7	7	40008	**SP 2** **Range:** SPLL to SPLH	dP	r/w
8A	8	8	40009	**SP 3** **Range:** SPLL to SPLH	dP	r/w
9A	9	9	40010	**SP 4** **Range:** SPLL to SPLH	dP	r/w
10A	A	10	40011	**Alarms status** bit 0 = Alarm 1 status bit 1 = Alarm 2 status bit 2 = Alarm 3 status **bit 3 to 8 = Reserved** bit 9 = LBA status bit 10 = power feilure indicator bit 11 = Generic error bit 12 = Overload alarm **bit 13 to 15 = Reserved**	0	r
11A	B	11	400412	**Outputs status (physical outputs)** bit 0 = Output 1 status bit 1 = Output 2 status bit 3 = Output 3 status bit 4 = Output 4 status bit 5 = Output 5 status **bit 6 to 15 = Reserved** When an output is driven by serial link, the relative bit will remain equal to 0.	0	r

no.	Address			Description	Dec. Point	r/w
	Hex	Dec	Ref. no.			
12A	C	12	40013	**Instrument status** bit 0 = Automatic bit 1 = manual bit 2 = Standby bit 3 = Remote Set point (temporary) used bit 4 = Auto-tuning active bit 5 = Self tuning active **bit 6 = Reserved** **bit 7 = Reserved** bit 8 = Soft start running bit 9 = Ramp for set point change (up or down) running bit 10 = Delay at start up (od) running **bit 11 = Reserved** bit 12 = Measure status (0 = OK while 1 = error). **bit 13 to 15 = Reserved**	0	r
13A	D	13	40014	**Alarms reset** 0 = Not resetted 1 = Resetted	0	r/w
14A	E	14	40015	**Alarms acknowledge** 0 = Not acknowledged 1 = Acknowledged	0	r/w
15A	F	15	40016	**Control status** 0 = Automatic 1 = Manual 2 = Stand-by	0	r/w
16A	10	16	40017	**Remote set point (temporary) (from serial link)** **Range:** SPLL to SPLH **Note:** the remote set point is stored in RAM	dP	r/w
17A	11	17	40018	**Auto tuning activation** 0 = not active 1 = active	0	r/w
18A	12	18	40019	**Power output used when a measuring error is detected.** **Range:** -100 to 100 **Note:** This value is stored in RAM	0	r/w
19A	13	19	40020	**Default parameters loading.** 481 = Default parameter loading	0	r/w
20A	14	20	40021	**Parameters table identification code** **Range:** 0 to 65535 **Note:** The word is composed by two parts: - Low byte – Version of the parameter table - High byte – Version of the family protocoll	0	r
21A	15	21	40022	**Instrument identification code** 20 = TC10	0	r
22A	16	22	40023	**First temporary code for speed configuration** The code is composed by two distinct 4 digits subcodes: **AABB** where: **AA** = Input type: 0 to 25 **BB** = Control type and service functions 0 to 21 **Note:** 10000 = Temporary value not inserted The programmed codes will be activated only after both have been correctly be programmed. The order has no importance.	0	r/w
23A	17	23	40024	**Second temporary code for speed configuration** The code is composed by two distinct 4 digits subcodes: **CDEF** where: **C** = Alarm type 1: 0 to 9 **D** = Alarm type 2: 0 to 9 **E** = Alarm type 3: 0 to 9 **F** = Enabling service functions: 0 to 4 **Note:** 10000 = Temporary value not inserted The programmed codes will be activated only after both have been correctly be programmed. The order has no importance.	0	r/w
24A	18	24	40025	**First final code for speed configuration** When programmed, the code is composed by two distinct 4 digits subcodes: **AABB** where: **AA** = Input type: 0 to 25 **BB** = Control type and service functions: 0 to 21 If not programmed, the return value is -1 = Code not programmed.	0	r

no.	Address			Description	Dec. Point	r/w
	Hex	Dec	Ref. no.			
25A	19	25	40026	**Second temporary code for speed configuration** When programmed, the code is composed by two distinct 4 digit subcodes: **CDEF** where: **C** = Alarm type 1: 0 to 9 **D** = Alarm type 2: 0 to 9 **E** = Alarm type 3: 0 to 9 **F** = Enabling service functions: 0 to 4 If not programmed, the return value is -1 = Code not programmed.	0	r
26A	1A	26	40027	**Reserved**	0	r
27A	1B	27	40028	**Manual autotuning start request pending for Od or Soft start** **Range:** 0 = No pending request waiting for the execution; 1 = Pending request waiting for the execution	0	r
28A	1C	28	40029	**Autotuning start request pending for setpoint change for Od or Soft start** **Range:** 0 = No pending request waiting for the execution; 1 = Pending request waiting for the execution	0	r
29A	1D	29	40030	**Value to be retransmitted on the analogue Output** **Range:** Ao1L to Ao1H	0	r/w

5.2 Common variables (continued)

no.	Address			Description	Dec. Point	r/w
	Hex	Dec	Ref. no.			
1B	0200	512	40513	**PV : Measured value** As address 1	dP	r
2B	0201	513	40514	**Number of decimal figure of the measured value** As address 2	0	r
3B	0202	514	40515	**Power output** As address 4	2	r
4B	0203	515	40516	**Power output of the heating output** **Range:** 0 to 100.00 (%)	2	r
5B	0204	516	40517	**Power output of the cooling output** **Range:** 0 to 100.00 (%)	2	r
6B	0205	517	40518	**Alarm 1 status** 0 = OFF 1 = ON	0	r
7B	0206	518	40519	**Alarm 2 status** 0 = OFF 1 = ON	0	r
8B	0207	519	40520	**Alarm 3 status** 0 = OFF 1 = ON	0	r
9B	0208	520	40521	**Operative set point** As address 3	DP	r
10B	020A	522	40523	**LBA status** 0 = OFF 1 = ON	0	r
11B	020E	526	40527	**Overload alarm status** 0 = OFF 1 = ON		
12B	020F	527	40528	**Controller status** 0 = Stand-by 1 = Auto 2 = Tuning 3 = Manual	0	r
13B	0224	548	40549	**Status/remote control of the Output 1** 0 = OFF 1 = ON **Note:** This parameter is writeable when out 1 is “not used” by the controller (o1F output 1 function = nonE). This parameter is stored in RAM	0	r/w
14B	0225	549	40550	**Status/remote control of the Output 2** 0 = OFF 1 = ON **Note:** This parameter is writeable when out 2 is “not used” by the controller (o2F output 1 function = nonE). This parameter is stored in RAM	0	r/w

no.	Address			Description	Dec. Point	r/w
	Hex	Dec	Ref. no.			
15B	0226	550	40551	**Status/remote control of the Output 3** 0 = OFF 1 = ON **Note:** This parameter is writeable when out 3 is “not used” by the controller (o3F output 1 function = nonE). This parameter is stored in RAM	0	r/w
16B	0227	551	40552	**Status/remote control of the Output 4** 0 = OFF 1 = ON **Note:** This parameter is writeable when out 4 is “not used” by the controller (o4F output 1 function = nonE). This parameter is stored in RAM	0	r/w
17B	0240	576	40577	**Digital input 1 status** 0 = OFF 1 = ON **Note:** Digital input 1status can be read from the serial port even if the input is not used by the controller	0	r/w
18B	0241	577	40578	**Digital input 2 status** 0 = OFF 1 = ON **Note:** Digital input 2 status can be read from the serial port even if the input is not used by the controller	0	r/w
19B	0244	580	40581	**Reserved**		
20B	0245	581	40582	**Reserved**		
21B	0246	582	40583	**Reserved**		
22B	0247	583	40584	**Reserved**		
23B	0248	584	40585	**Reserved**		
24B	0249	585	40586	**Reserved**		
25B	024A	586	40587	**Wattmeter:** The meaning of this parameter is defined by the CO.ty parameter setting. 0 CO.ty = 0ff kW CO.ty = 1 kWh CO.ty = 2 **CO.ty = 3 Reserved** Worked days CO.ty = 4 Worked hours CO.ty = 5	0	r
26B	024B	587	40588	**Reserved**	0	r
27B	024C	588	40589	**Days counted with the controller Powered ON** **Range:** 0 to 9999	0	r
28B	0250	592	40593	**Power output when the instrument is in manual mode** Range:-10000 to 10000 (%)	2	r/w

5.3 Parameters Setting: Addresses from 280 hex (640 dec) and 2800 hex (10240 dec)

5.3.1 inP GROUP - Main and auxiliary input configuration

no.	Param.	Address			Description	Values	Dec. Point	r/w
		Hex	Dec	Ref. no.				
1	SEnS	280 2800	640 10240	40641	Input Type	0 = J = TC J, 1 = crAL = TC K, 2 = S = TC S, 3 = r = TC R, 4 = t = TC T, **5 = Reserved**, **6 = Reserved**, 7 = Pt1 = RTD Pt100, 8 = Pt10 = RTD Pt1000, 9 = 0.60 = 0 to 60 mV, 10 = 12.60 = 12 to 60 mV, 11 = 0.20 = 0 to 20 mA, 12 = 4.20 = 4 to 20 mA, 13 = 0.5 = 0 to 5 V, 14 = 1.5 = 1 to 5 V, 15 = 0.10 = 0 to 10 V, 16 = 2.10 = 2 to 10 V	0	r/W
2	dp	281 2801	641 10241	40642	Decimal Point Position (linear inputs) Decimal Point Position (different than linear inputs)	0 to 3 0/1	0	r/w

no.	Param.	Address			Description	Values	Dec. Point	r/w
		Hex	Dec	Ref. no.				
3	SSC	282 2802	642 10242	40643	Initial scale read-out for linear inputs	-1999 to 9999	dP	r/w
4	FSc	283 2803	643 10243	40644	Full Scale Readout for linear inputs	-1999 to 9999	dP	r/w
5	unit	284 2804	644 10244	40645	Engineering unit	0 = C = °C 1 = F = °F	0	r/w
6	Fil	285 2805	645 10245	40646	Digital filter on the measured value **Note:** This filter affects the control action, the PV retransmission and the alarms action.	0 (OFF) to 200 (in seconds)	1	r/w
7	inE	286 2806	646 10246	40647	Sensor error used to enable the safety output value	or = Over range ou = Under range our = Over and under range	0	r/w
8	oPE	287 2807	647 10247	40648	Safety output value (% of the output)	-100 to 100	0	r/w
9	IO4.F	288 2808	648 10248	40649	I/O 4 function	0 = on = Output used as PWS for TX, 1 = out4 = Output 4 (digital output 4), 2 = dG2c = Digital input 2 driven by contact, 3 = dG2U = Digital input 2 driven by voltage	0	r/w
10	diF1	289 2809	649 10249	40650	Digital Input 1 function	0 = oFF = Not used, 1 = Alarm reset, 2 = Alarm acknowledge (ACK), 3 = Hold of the measured value, 4 = Stand by mode, 5 = Manual mode, 6 = HEAt with SP1 and CooL with SP2, **7 to 17 = Reserved,** 18 = Sequential SP selection, 19 = SP1 - SP2 selection, 20 = SP1 to SP4 binary selection, 21 = Digital inputs in parallel to ▲/▼ keys	0	r/w
11	diF2	28A 280A	650 10250	40651	Digital Input 2 function	0 = oFF = Not used, 1 = Alarm reset, 2 = Alarm acknowledge (ACK), 3 = Hold of the measured value, 4 = Stand by mode, 5 = Manual mode, 6 = HEAt with SP1 and CooL with SP2, **7 to 17 = Reserved,** 18 = Sequential SP selection, 19 = SP1 - SP2 selection, 20 = SP1 to SP4 binary selection, 21 = Digital inputs in parallel to ▲/▼ keys	0	r/w
12	di.a	31C 289C	796 10396	40797	Digital Inputs Action (DI2 only if configured)	0 = DI1 direct action, DI2 direct action 1 = DI1 reverse action, DI2 direct action 2 = DI1 direct action, DI2 reverse action 3 = DI1 reverse action, DI2 reverse action	0	r/w

5.3.2 Out group

no.	Param.	Address			Description	Values	Dec. Point	r/w
		Hex	Dec	Ref. no.				
13		28B 280B	651 10251	40652	Output 1 type (when Out 1 is an analog output)	0 = 0-20 = 0 to 20 mA 1 = 4-20 = 4 to 20 mA 2 = 0-10 = 0 to 10 V 3 = 2-10 = 2 to 10 V	0	r/w
14	o1F	28C 280C	652 10252	40653	Out 1 function (when Out 1 is an analog output)	0 = NonE = Output not used 1 = H.rEG = Heating output 2 = c.rEG = Cooling output 3 = r.inP = Measure retransmission 4 = r.Err = Error (sp - PV) retransmission 5 = r.SP = Set point retransmission 6 = r.SEr = Serial value retransmission	0	r/w
					Out 1 function	0 = NonE = Output not used 1 = H.rEG = Heating output 2 = c.rEG = Cooling output 3 = AL = Alarm output **4 to 11 = Reserved,** 12 = or.bo = Out-of-range or burn out indicator 13 = P.FAL = Power failure indicator 14 = bo.PF = Out-of-range, burn out and Power failure indicator 15 = St.bY = Stand by status indicator 16 = diF.1 = The output repeats the digital input 1 status 17 = diF.2 = The output repeats the digital input 2 status 18 = on = Out 1 always ON		
15		28D 280D	653 10253	40654	Initial scale value of the analog retransmission (when Out 1 is an analog output)	-1999 ... Ao1H	dp	r/w
16		28E 280E	654 10254	40655	Full scale value of the analog retransmission (when Out 1 is an analog output)	Ao1L ... 9999	dp	r/w
17	o1AL	28F 280F	655 10255	40656	Alarms linked up with the out 1	0 to 63 +1 = Alarm 1 +2 = Alarm 2 +4 = Alarm 3 +8 = Loop break alarm +16 = Sensor Break +32 = Overload on output 4	0	r/w
18	o1Ac	290 2810	656 10256	40657	Out 1 action	0 = dir = Direct action 1 = rEU = Reverse action 2 = dir.r = Direct with reversed LED 3 = ReU.r = Reverse with reversed LED	0	r/w
19	o2F	291 2811	657 10257	40658	Out 2 function	See the values of 14 = o1F parameter	0	r/w
20	o2AL	292 2812	658 10258	40659	Alarms linked up with the out 2	See the values of 17 = o1AL parameter	0	r/w
21	o2Ac	293 2813	659 10259	40660	Out 2 action	See the values of 18 = o1Ac parameter	0	r/w
22	o3F	294 2814	660 10260	40661	Out 3 function	See the values of 14 = o1F parameter	0	r/w
23	o3AL	295 2815	661 10261	40662	Alarms linked up with the out 3	See the values of 17 = o1AL parameter	0	r/w
24	o3Ac	296 2816	662 10262	40663	Out 3 action	See the values of 18 = o1Ac parameter	0	r/w
25	o4F	297 2817	664 10264	40664	Out 4 function	See the values of 14 = o1F parameter	0	r/w
26	o4AL	298 2818	664 10264	40665	Alarms linked up with the out 4	See the values of 17 = o1AL parameter	0	r/w
27	o4Ac	299 2819	665 10265	40666	Out 4 action	See the values of 18 = o1Ac parameter	0	r/w

5.3.3 AL1 group

no.	Param.	Address			Description	Values	Dec. Point	r/w
		Hex	Dec	Ref. no.				
28	AL1t	29A 281A	666 10266	40667	Alarm 1 type	0 = nonE = Alarm not used 1 = LoAb = Absolute low alarm 2 = HiAb = Absolute high alarm 3 = LHAo = Windows alarm in alarm outside the windows 4 = LHAI = Windows alarm in alarm inside the windows 5 = SE.br = Sensor Break 6 = LodE = Deviation low alarm (relative) 7 = HidE = Deviation high alarm (relative) 8 = LHdo = Relative band alarm in alarm out of the band 9 = LHdi = Relative band alarm in alarm inside the band	0	r/w
29	Ab1	29B 281B	667 10267	40668	Alarm 1 function	0 to 15 +1 = Not active at power up +2 = Latched alarm (manual reset) +4 = Acknowledgeable alarm +8 = Relative alarm not active at set point change	0	r/w
30	AL1L	29C 281C	668 10268	40669	- For High and low alarms, it is the low limit of the AL1 threshold; - For band alarm, it is low alarm threshold	From -1999 to AL1H (E.U.)	dP	r/w
31	AL1H	29D 281D	669 10269	40670	- For High and low alarms, it is the high limit of the AL1 threshold; - For band alarm, it is high alarm threshold	From AL1L to 9999 (E.U.)	dP	r/w
32	AL1	29E 281E	670 10270	40671	AL1 threshold	From AL1L to AL1H (E.U.)	dP	r/w
33	HAL1	29F 281F	671 10271	40672	AL1 hysteresis	1 to 9999 (E.U.)	dP	r/w
34	AL1d	2A0 2820	672 10272	40673	AL1 delay	From 0 (oFF) to 9999 (s)	0	r/w
35	AL1o	2A1 2821	673 10273	40674	Alarm 1 enabling during Stand-by mode and out of range conditions	0 = Alarm 1 disabled during Stand by and out of range 1 = Alarm 1 enabled in stand by mode 2 = Alarm 1 enabled in out of range condition 3 = Alarm 1 enabled in stand by mode and in over range condition	0	r/w

5.3.4 AL2 group

no.	Param.	Address			Description	Values	Dec. Point	r/w
		Hex	Dec	Ref. no.				
36	AL2t	2A2 2822	674 10274	40675	Alarm 2 type	0 = nonE = Alarm not used 1 = LoAb = Absolute low alarm 2 = HiAb = Absolute high alarm 3 = LHAo = Windows alarm in alarm outside the windows 4 = LHAI = Windows alarm in alarm inside the windows 5 = SE.br = Sensor Break 6 = LodE = Deviation low alarm (relative) 7 = HidE = Deviation high alarm (relative) 8 = LHdo = Relative band alarm in alarm out of the band 9 = LHdi = Relative band alarm in alarm inside the band	0	r/w
37	Ab2	2A3 2823	675 10275	40676	Alarm 2 function	0 to 15 +1 = Not active at power up +2 = Latched alarm (manual reset) +4 = Acknowledgeable alarm +8 = Relative alarm not active at set point change	0	r/w

no.	Param.	Address			Description	Values	Dec. Point	r/w
		Hex	Dec	Ref. no.				
38	AL2L	2A4 2824	676 10276	40677	- For High and low alarms, it is the low limit of the AL2 threshold; - For band alarm, it is low alarm threshold	From -1999 to AL2H (E.U.)	dP	r/w
39	AL2H	2A5 2825	677 10277	40678	- For High and low alarms, it is the high limit of the AL2 threshold; - For band alarm, it is high alarm threshold	From AL2L to 9999 (E.U.)	dP	r/w
40	AL2	2A6 2826	678 10278	40679	AL2 threshold	From AL2L to AL2H (E.U.)	dP	r/w
41	HAL2	2A7 2827	679 10279	40680	AL2 hysteresis	1 to 9999 (E.U.)	dP	r/w
42	AL2d	2A8 2828	680 10280	40681	AL2 delay	From 0 (oFF) to 9999 (s)	0	r/w
43	AL2o	2A9 2829	681 10281	40682	Alarm 2 enabling during Stand-by mode and out of range conditions	0 = Alarm 2 disabled during Stand by and out of range 1 = Alarm 2 enabled in stand by mode 2 = Alarm 2 enabled in out of range condition 3 = Alarm 2 enabled in stand by mode and in over range condition	0	r/w

5.3.5 AL3 group

no.	Param.	Address			Description	Values	Dec. Point	r/w
		Hex	Dec	Ref. no.				
44	AL3t	2AA 282A	682 10282	40683	Alarm 3 type	0 = nonE = Alarm not used 1 = LoAb = Absolute low alarm 2 = HiAb = Absolute high alarm 3 = LHAo = Windows alarm in alarm outside the windows 4 = LHAI = Windows alarm in alarm inside the windows 5 = SE.br = Sensor Break 6 = LodE = Deviation low alarm (relative) 7 = HidE = Deviation high alarm (relative) 8 = LHdo = Relative band alarm in alarm out of the band 9 = LHdi = Relative band alarm in alarm inside the band	0	r/w
45	Ab3	2AB 282B	683 10283	40684	Alarm 3 function	0 to 15 +1 = Not active at power up +2 = Latched alarm (manual reset) +4 = Acknowledgeable alarm +8 = Relative alarm not active at set point change	0	r/w
46	AL3L	2AC 282C	684 10284	40685	- For High and low alarms, it is the low limit of the AL3 threshold; - For band alarm, it is low alarm threshold	From -1999 to AL3H (E.U.)	dP	r/w
47	AL3H	2AD 282D	685 10285	40686	- For High and low alarms, it is the high limit of the AL3 threshold; - For band alarm, it is high alarm threshold	From AL3L to 9999 (E.U.)	dP	r/w
48	AL3	2AE 282E	686 10286	40687	AL3 threshold	From AL3L to AL3H (E.U.)	dP	r/w
49	HAL3	2AF 282F	687 10287	40688	AL3 hysteresis	1 to 9999 (E.U.)	dP	r/w
50	AL3d	2B0 2830	688 10288	40689	AL3 delay	From 0 (oFF) to 9999 (s)	0	r/w
51	AL3o	2B1 2831	689 10289		Alarm 3 enabling during Stand-by mode and out of range conditions	0 = Alarm 3 disabled during Stand by and out of range 1 = Alarm 3 enabled in stand by mode 2 = Alarm 3 enabled in out of range condition 3 = Alarm 3 enabled in stand by mode and in over range condition	0	r/w

5.3.6 LBA group - Loop Break Alarm Parameters

no.	Param.	Address			Description	Values	Dec. Point	r/w
		Hex	Dec	Ref. no.				
52	LbAt	2B2 2832	690 10290	40691	LBA time	From 0 (oFF) to 9999 (s)	0	
53	LbSt	2B3 2833	691 10291	40692	Delta measure used by LBA during Soft start	From 0 (oFF) to 9999 (E.U.)	dP	
54	LbAS	2B4 2834	692 10292	40693	Delta measure used by LBA	1 to 9999 (E.U.)	dP	
55	LbcA	2B5 2835	693 10293	40694	Condition for LBA enabling	0 = uP = Active when Pout = 100% 1 = dn = Active when Pout = -100% 2 = both = Active in both cases	0	

5.3.7 rEG group - Control Parameters

no.	Param.	Address			Description	Values	Dec. Point	r/w
		Hex	Dec	Ref. no.				
56	cont	2B6 2836	694 10294	40695	Control type	0 = Pid = PID (heat and/or) 1 = On.FA = ON/OFF asymmetric hysteresis 2 = On.FS = ON/OFF symmetric hysteresis 3 = nr = Heat/Cool ON/OFF control with neutral zone **4 = Reserved**	0	r/w
57	Auto	2B7 2837	695 10295	40696	Autotuning selection	-4 = Oscillating auto-tune with automaticrestart at power up and after all point change -3 = Oscillating auto-tune with manual start -2 = Oscillating -tune with auto-matic start at the first power up only -1 = Oscillating auto-tune with auto-matic restart at every power up 0 = Not used 1 = Fast auto tuning with automatic restart at every power up 2 = Fast auto-tune with automatic start the first power up only 3 = FAST auto-tune with manual start 4 = FAST auto-tune with automatic restart at power up and after a set point change 5 = Evo-tune with automatic restart at every power up 6 = Evo-tune with automatic start the first power up only 7 = Evo-tune with manual start 8 = Evo-tune with automatic restart at power up and after a set point change	0	r/w
58	Aut.r	2B8 2838	696 10296	40697	Manual start of the Auto-tuning	0 = oFF = Autotuning Not active 1 = on = Autotuning Active	0	r/w
59	SELF	2B9 2839	697 10297	40698	Self tuning enabling	0 = no = The instrument does not perform the self-tuning 1 = YES = The instrument is performing the self-tuning	0	r/w
60	HSEt	2BA 283A	698 10298	40699	Hysteresis of the ON/OFF control	0 to 9999 (E.U.)	dP	
61	cPdt	2BB 283B	699 10299	40700	Time for compressor protection	From 0 (oFF) to 9999 (s)	0	r/w
62	Pb	2BC 283C	700 10300	40701	Proportional band	1 to 9999 (E.U.)	dP	
63	ti	2BD 283D	701 10301	40702	Integral time	From 0 (oFF) to 9999 (s)	0	r/w
64	td	2BE 283E	702 10302	40703	Derivative time	From 0 (oFF) to 9999 (s)	0	r/w
65	Fuoc	2BF 283F	703 10303	40704	Fuzzy overshoot control	0 to 200	2	r/w
66	tcH	2C0 2840	704 10304	40705	Heating output cycle time	10 to 1300 (s)	1	r/w

no.	Param.	Address			Description	Values	Dec. Point	r/w
		Hex	Dec	Ref. no.				
67	rcG	2C1 2841	705 10305	40706	Power ratio between heating and cooling action	1 to 9999	2	r/w
68	tcc	2C2 2842	706 10306	40707	Cooling output cycle time	1 to 1300 (s)	1	r/w
69	rS	2C3 2843	707 10307	40708	Manual reset (Integral pre-load)	-1000 to +1000 (%)	1	r/w
70		2C4 2844	708 10308	40709	**Reserved**			
71		2C5 2845	709 10309	40710	**Reserved**			
72	od	2C6 2846	710 10310	40711	Delay at power up	From 0.00 (oFF) to 9959 (hh.mm)	2	r/w
73	St.P	2C7 2847	711 10311	40712	Maximum power output used during soft start	-100 to 100 (%)	0	r/w
74	SSt	2C8 2848	712 10312	40713	Soft start time	0 (oFF) to 800 = inF (h.mm)	2	r/w
75	SS.tH	2C9 2849	713 10313	40714	Threshold for soft start disabling	-2000 (oFF) to 9999 (E.U.)	dP	r/w

5.3.8 SP group - Set point parameters

no.	Param.	Address			Description	Values	Dec. Point	r/w
		Hex	Dec	Ref. no.				
76	nSP	2CA 284A	714 10314	40715	Number of used set points	1 to 4	0	r/w
77	SPLL	2CB 284B	715 10315	40716	Minimum set point value	From -1999 to SPHL	dP	r/w
78	SPHL	2CC 284C	716 10316	40717	Maximum set point value	From SPLL to 9999	dP	r/w
79	SP	2CD 284D	717 10317	40718	Set point 1	From SPLL to SPLH	dP	r/w
80	SP 2	2CE 284E	718 10318	40719	Set point 2	From SPLL to SPLH	dP	r/w
81	SP 3	2CF 284F	719 10319	40720	Set point 3	From SPLL to SPLH	dP	r/w
82	SP 4	2D0 2850	720 10320	40721	Set point 4	From SPLL to SPLH	dP	r/w
83	A.SP	2D1 2851	721 10321	40722	Selection of the active set point	0 = SP 1 = SP 2 2 = SP 3 3 = SP 4	0	r/w
84	SP.rt	2D2 2852	722 10322	40723	Remote set point type	0 = RSP = The value coming from serial link is used as remote set point 1 = trin = The value coming from serial link will be added to the local set point selected by A.SP and the sum becomes the operative set point 2 = PErc = The value coming from serial link will be scaled on the input range and this value will be used as remote SP	0	r/w
85	SPLr	2D3 2853	723 10323	40724	Local/remote set point selection	0 = Loc = local 1 = rEn = remote	0	r/w
86	SP.u	2D4 2854	724 10324	40725	Rate of rise for **POSITIVE** set point change (ramp UP)	0.01 to 99.99 (inF) engineering units per minute	2	r/w
87	SP.d	2D5 2855	725 10325		Rate of rise for **NEGATIVE** set point change (ramp DOWN)	0.01 to 99.99 (inF) engineering units per minute	2	r/w

5.3.9 Reserved Parameters

no.	Param.	Address			Description	Values	Dec. Point	r/w
		Hex	Dec	Ref. no.				
88 to 117		2D6 to 2F3 2856 to 2873	726 to 755 10326 to 10355	40727 to 40756	**Reserved**			

5.3.10 PAn group - Operator HMI parameters

no.	Param.	Address			Description	Values	Dec. Point	r/w
		Hex	Dec	Ref. no.				
118	PAS2	2F4 2874	756 10356	40757	Level 2 password (limited access level)	oFF (Level 2 not protected by password) 1 to 200	0	r/w
119	PAS3	2F5 2875	757 10357	40758	Level 3 password (complete configuration level)	3 to 200	0	r/w
120	PAS4	2F6 2876	758 10358	40759	Level 4 password (CODE configuration level)	201 to 400	0	r/w
121	uSrb	2F7 2877	759 10359	40760	button function during RUN TIME	0 = nonE = No function 1 = tunE = Auto-tune/self-tune enabling. A single press (longer than 1 second) starts the auto-tune 2 = oPLo = Manual mode. The first pressure puts the instrument in manual mode (OPLO) while a second one puts the instrument in Auto mode 3 = AAc = Alarm reset 4 = ASi = Alarm acknowledge 5 = chSP = Sequential set point selection 6 = St.by = Stand by mode. The first press puts the instrument in stand by mode while a second one puts the instrument in Auto mode. **7 to 10 = Reserved**	0	r/w
122	diSP	2F8 2878	760 10360	40761	Display management	0 = nonE = Standard display 1 = Pou = Power output 2 = SPF = Final set point 3 = Spo = Operative set point 4 = AL1 = Alarm 1 threshold 5 = AL2 = Alarm 2 threshold 6 = AL3 = Alarm 3 threshold **7 to 12 = Reserved,** 13 = PErc = Percent of the power output used during soft start (when the soft start time is equal to infinite, the limit is ever active and it can be used also when ON/OFF control is selected) **14 = Reserved**		r/w
123	di.cL	2F9 2879	761 10361	40762	Display colour	0 = The display colour changes to point out the actual deviation (PV - SP) 1 = Display red (fix) 2 = Display green (fix) 3 = Display orange (fix)		
124	AdE	2FA 287A	762 10362	40763	Deviation for display colour management	1 to 9999	Dp	r/w
125	di.St	2FB 287B	763 10363	40764	Display Timeout	0 = oFF (display always ON) to 9959 (mm.ss)	2	r/w
126	fiLd	2FC 287C	764 10364	40765	Filter on the displayed value	0 = oFF (filter disabled) to 100	Dp	r/w
127		2FD 287D	765 10365	40766	**Reserved**			
128	dSPu	2FE 287E	766 10366	40767	Instrument status at power ON	0 = AS.Pr = Starts in the same way it was prior to the power down 1 = Auto = Starts in Auto mode 2 = oP.0 = Starts in manual mode with a power output equal to zero 3 = St.bY = Starts in stand-by mode	0	r/w

no.	Param.	Address			Description	Values	Dec. Point	r/w
		Hex	Dec	Ref. no.				
129	oPr.E	2FF 287F	767 10367	40768	Operative modes enabling	0 = ALL = All modes will be selectable by the next parameter 1 = Au.oP = Auto and manual (OPLO) mode only will be selectable by the next parameter 2 = Au.Sb = Auto and Stand-by modes only will be selectable by the next parameter	0	r/w
130	oPEr	300 2880	768 10368	40769	Operative mode selection	0 = Auto = Auto mode 1 = oPLo = Manual mode 2 = St.bY = Stand by mode	0	r/w

5.3.11 Ser group - Serial link parameters

no.	Param.	Address			Description	Values	Dec. Point	r/w
		Hex	Dec	Ref. no.				
131	Add	301 2881	769 10369	40770	Instrument address	0 (oFF) to 254	0	r/w
132	bAud	302 2882	770 10370	40771	baud rate	0 = 1200 = 1200 baud 1 = 2400 = 2400 baud 2 = 9600 = 9600 baud 3 = 19.2 = 19200 baud 4 = 38.4 = 38400 baud	0	r/w
133	trSP	303 2883	771 10371	40772	Selection of the value to be retrans-mitted (Master)	0 = nonE = Retransmission not used (the instrument is a slave) 1 = rSP = The instrument becomes a Master and retransmits the operative set point 2 = PErc = The instrument become a Master and it retransmits the power output	0	r/w

5.3.12 COn group - Consumption parameters

no.	Param.	Address			Description	Values	Dec. Point	r/w
		Hex	Dec	Ref. no.				
134	Co.tY	304 2884	772 10372	40773	Measurement type	0 = oFF = Not used 1 = Instantaneous power (kW) 2 = Power consumption (kW/h) **3 = Reserved** 4 = Total worked days with threshold. It is the number of hours that the instrument is turned ON divided for 24 5 = Total worked hours with threshold. It is the number of hours that the instrument is turned ON 6 = Total worked days with threshold: number of hours the instrument is turned ON divided by 24, the controller is forced in standby when Co.ty value reaches the threshold set in [137] h.Job. 7 = Total worked hours with threshold: number of hours that the instrument is turned ON, the controller is forced in stand-by when Co.ty value reaches the threshold set in [137] h.Job. 8 = Totalizer of control relay worked days: number of hours the control relay has been in ON condition, divided by 24. 9 = Totalizer of control relay worked hours: number of hours the control relay has been in ON condition. 10 = Totalizer of control relay worked days with threshold: number of hours the control relay has been in ON condition divided by 24, the controller is forced in stand-by when Co.ty value reaches the threshold set in [137] h.Job. 11 = Totalizer of control relay worked hours with threshold: number of hours the control relay has been in ON condition, the controller is forced in stand-by when Co.ty value reaches the threshold set in [137] h.Job.	0	r/w
135	UoLt	305 2885	773 10373	40774	Nominal Voltage of the load	1 to 9999 (V)	0	r/w
136	cur	306 2886	774 10374	40775	Nominal current of the load	1 to 999 (A)	0	r/w
137	h.Job	307 2887	775 10375	40776	Threshold of the working period	0 (oFF) to 999	0	r/w

no.	Param.	Address			Description	Values	Dec. Point	r/w
		Hex	Dec	Ref. no.				
138	t.Job	308 2888	776 10376	40777	Worked time (not resettable)	0 to 9999	0	r

5.3.13 CAI group - User calibration parameters

no.	Param.	Address			Description	Values	Dec. Point	r/w
		Hex	Dec	Ref. no.				
139	A.L.P	309 2889	777 10377	40778	Adjust Low Point	-1999 to (A.H.P - 10)(E.U.)	dP	r/w
140	A.L.o	30A 288A	778 10378	40779	Adjust Low Offset	-300 to +300 (E.U.)	dP	r/w
141	A.H.P	30B 288B	779 10379	40780	Adjust High Point	From (A.L.P + 10) to 9999 (E.U.)	dP	r/w
142	A.H.o	30C 288C	780 10380	40781	Adjust High Offset	-300 to +300 (E.U.)	dP	r/w

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