TLY25/26/27/28/29/35

Communication protocol

User's manual

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1 Introduction

This document aims to describe the communication capacities of the TLY series that use the MODBUS protocol and is mainly intended for technicians, system integrators and software engineers.

It is divided into four parts :

the first describes the physical connection to the line;
the second presents the communication protocol, that is a sub-set of RTU[1];
the third part describes the various types of data that can be exchanged;
the fourth is a report on the typical performance of the system.

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2 Physical connection

2.1 Interface

The TLY series is equipped with a serial communication interface RS485 optoisolato in order to avoid the onset of problems due to ground potential.

The TLY series, equipped with TTL interface, have to be connected to the TLCNV TTL/RS485 converter.

When resting the instruments are in reception mode and pass to transmission after receiving and decoding a correct message addressed to them.

2.2 Line

The TDA modules are equipped with two clamps called A and B.

The connection between several TLY is achieved via parallel connection, i.e. all the clamps A must be connected to each other, as must the clamps B.

To maintain the line in resting conditions, the use of a termination resistance is required with a value of 120 Ohm.

Communication speed used ranges from 1200 to 34800 baud and allows extremely satisfactory performance, while remaining well below the limits foreseen by the e RS485 standard. This allows line cabling using a medium quality screened twisted pair: it is sufficient that the total line capacity does not exceed 200 nF.

The total length of the line can reach a maximum of 1000 metres.

3 Communicatrion protocol

The protocol adopted by the TLY series is a sub-group of the widely used protocol MODBUS RTU . This choice guarantees easiness of connections to many PLCs and to all the commercial supervisory programmes.

For those who intend to develop their own application software all the necessary suggestions and information are available.

The functions of the MODBUS RTU protocol used in the TLY series are:

function 3 - reading of n words

function 6 - writing of a word.

These functions allow the supervisory programme to read and change any data from the instrument. Communication is based on messages sent by the master station to a slave station (TLY) and vice versa. The slave station that recognises its own address in the message analyses the content and, if it finds it to be semantically and formally correct, it then creates a reply message for the master.

The communication process involves five types of message:

From the master to the slave	From the slave to the master
function 3: request for reading of n words	function 3: reply containing n words read
function 6: request for writing of a word	function 6: confirmation of writing of one word
	Exceptional reply (in reply to both functions, in the event of an irregularity)

Each message contains four fields:

slave's address: the values included between 1 and 255 are valid ; the address 0 (zero) is reserved by MODBUS RTU for the broadcasting messages but is not used for the TLY series due to the implicit reliability of this type of communication;
function code : this contains 3 or 6 depending on the specified function;
information field : this contains the addresses or the value of the words, as requested by the function in use;
control word : this contains a cyclic redundancy check (CRC) calculated according to the rules foreseen for the CRC16.

The characteristics of the asynchronous communication are : 8 bit, no correspondence one stop bit.

3.1 Function 3 - reading of n words

The number of words to be read must be less or equal to four.

The request has the following structure :

number of the slave	3	Address of first word MSB	LSB	Number of words MSB	LSB	CRC LSB	MSB
byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7

The normal reply (unlike an exceptional reply) has the following structure:

Number Of the slave	3	NB number of bytes read	Value of the first word MSB LSB		Later words	CRC LSB MSB	
byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte NB+2	byte NB+3

3.2 Function 6 - writing a word

The request has the following structure:

Number of the slave	6	Address of the first word MSB	LSB	Value to be written MSB	LSB	CRC LSB	MSB
byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7

The normal reply (unlike the exceptional reply) is purely an echo of the request message:

number of the slave	6	Address of the first word MSB	LSB	Value to be written MSB LSB		CRC LSB MSB	
byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	Byte 6	byte 7

3.3 The exceptional reply

The TLY series supply an exceptional reply after having received a formally correct request but which cannot be met. The exceptional reply contains a code that indicates the cause of lack of a regular reply.

The reply structure is as follows :

Number of the slave	function code with MSB a 1	Exception code	CRC LSB MSB	
Byte 0	byte 1	byte 2	byte 3	byte 4

The TLY series s adopt a sub-group of exception codes of the MODBUS RTU :

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

3.4 Cyclic redundancy check (CRC)

The CRC is a control word that allows the integrity of a message to be checked.
Each message, sent or received, contains the CRC word in the last two characters.

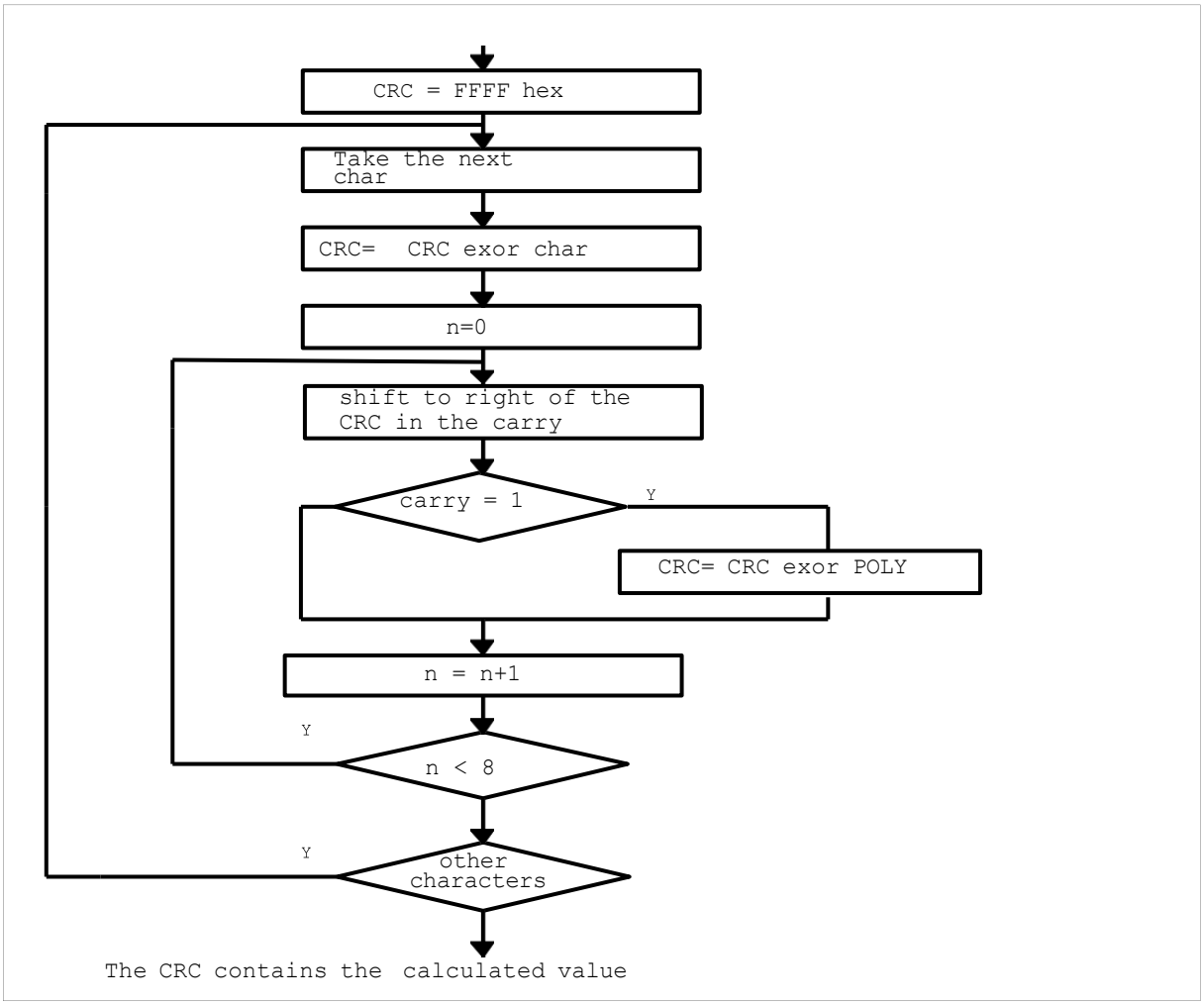
After receiving a request, the controller checks the validity of the message received, comparing the CRC contained in the message with the one calculated during reception .

In transmission, the controller calculates the CRC and places the two characters at the end of the message.

The calculation of the CRC is carried out on each character of the message except for the last two.

As the TLY instruments are compatible with the MODBUS RTU (JBUS) protocol, these use the same algorithm for the calculation of the CRC.

This algorithm can be planned as follows:



The polynomial adopted by the MODBUS RTU (JBUS) is 1010 0000 0000 0001.

Note: the first character of the CRC transmitted is the least important one of the two calculated ones.

4 Exchange of data

This section contains information on the numerical data and non-numerical data exchanged with the TLY instrumewnts and their formats and limits.

4.1 Some definitions

All the data exchanged are made up of 16 bit words.

There are two types of data: numerical and symbolic (or non numerical).

The numerical data represent the value of a size (e.g. the measured variable etc)

The symbolic data represent a particular value within a range of choices (e.g. unit of measurement can “be "°C" or "°F").

Both types are encoded with whole numbers: whole numbers with a sign are adopted for numerical data and whole numbers without a sign for symbolic data.

Numerical data must be associated with the appropriate number of decimal figures, so that it represents a size with the same engineering units adopted in the TLY instrument.

The numerical data are represented in fixed decimal, however there is a difference between two numerical data :

The first type has a not changeable decimal point position

The second type has a programmable decimal point position (see parameter dP).

4.2 Memory area

For the functions adopted, all the data that can be read and written appear as 16 bit words allocated in the instrument's memory.

The map of the memory has three areas:

variables,

parameters,

identification code of the instrument.

The following sections look at the characteristics of each of these areas.

Variables area

In this area, the main variables of the TLY series that are frequently calculated and updated are grouped together.

This is the data available :

n.	address (HEX)	Description	Data type	range of values/symbols	Decimal figures	r/w	note
1	200	Pr1 : room temperature (signed integer)	N	-58.0..302.0	dP	r	
1	201	Pr2 : evaporator temperature (signed integer))	N	-58.0..302.0	dP	r	
2	202	Number of decimals to be associated to Pr1 and Pr2	S	0=OFF 1=On	0	r	as dP
3	206	Regulator status	N	0=off 1=control 2=defrost	0	r	

4	207	Alarms Status	N	b0: n.u. b1: 1= overrange probe Pr1 (E1) b2: 1=underrange probe Pr1 (-E1) b3: 1=overrange probe Pr2 (E2) b4: 1=underrange probe Pr2 (-E2) b5: 1=delay at the switch on (od) b6: 1=high alarm (HI) b7: 1=low alarm (LO) b8: 1=door open (AP) b9: 1=input alarm (AL)	0	r	To every alarm is associated a bit into the word.
5	20E	Digital input status	S	0: open, 1: close			From Vrs 1.5
6	210	Compressor out status	S	0: OFF, 1: ON			
7	211	Defrosting out status	S	0: OFF, 1: ON			
8	212	Fan out status	S	0: OFF, 1: ON			
9	213	Aux out status	S	0: OFF, 1: ON			
10	214	Acknowledgeable alarm out status	S	0: OFF, 1: ON			
11	215	Not acknowledgeable alarm out status	S	0: OFF, 1: ON		r	
12	280	Compressor continuous cycle	S	1: ON		w	
13	281	Start defrosting	S	1: ON		w	
14	282	End defrosting	S	1: ON		w	
15	284	ON Stand-by	S	1: ON		w	
16	285	OFF Stand-by	S	1: ON		w	
17	288	Alarm acknowledge	S	1: ON		w	

Irregular conditions of the process variables are shown as special values of the measurement :

Irregular condition	Returned value	display
Under-range	-10000	uuuu
Over-range	10000	oooo
Overflow (A/D conv.)	10001	----
Variable not available	10003	Not available

Parameters programming

The operating and configuration parameters can be read and written through serial communication.

If one tries to read or write a parameter not available for a certain instrument configuration, a message of error is displayed : data not available. (6).

After have written into the parameters zone, it's necessary to start the **CHECKSUM** calculation, writing any value at the address HEX **0500**.

SP group (parameters relative to the Set Point)

Parameter	Address (HEX)	Description	Data type	n° decimals	Possibile values
SPAt	2800	Select the active Set Point	N	0	1…2
SP1	2801	Set Point 1	N	dP	SPLL.. SPHL
SP2	2802	Set Point 2	N	dP	SPLL.. SPHL
SPLL	2803	Set Point Lower limit	N	dP	-58.0… SPHL
SPHL	2804	Set Point Higher limit	N	dP	SPLL… 302.0

InP group (parameters relative to the measure input)

Parameter	Address (HEX)	Description	Data Type	n° decimals	Possibile values
SEnS	2805	Probe type	S		0=PTC 1=ntc
OFS1	2806	Pr1 probe (room) calibration	N	dP	-30.0…30.0 °C/°F
OFS2	2807	Pr2 probe (evaporator) calibration	N	dP	-30.0…30.0 °C/°F
Pr2	2808	Presence Pr2 probe (evaporator)	S		0=OFF 1=On
Unit	2809	Temperature unit of measurement	S		0=°C, 1=°F
dp	280A	Decimal point	S		0=OFF 1=On
FiL	280B	Input digital filter	N	1	0FF=0 …20.0 sec

Para meter	Address (HEX)	Description	Data Type	n° decimals	Possibile values
dISP	280C	Variable normally displaied : OFF= Display OFF Pr1= Pr1 probe Pr2=Pr2 probe SP=Set point CL= Current time	S	0	0=Pr1 1= Pr2 2=SP 3=CL 4=OFF

“rEG” group (parameters relative to control)

Para meter	Address (HEX)	Description	Data Type	n° decimals	Possibile values
HSEt	280D	Differential	N	dP	0.0…30.0 °C/°F
tonE	280E	OUT output activation time in case of Pr1 probe broken	N	2	OFF= 00.00…99.59 Min-sec.
toFE	280F	OUT output Deactivation time in case of Pr1 probe broken	N	2	OFF= 00.00…99.59 min.sec
Func	2810	OUT output functioning mode : HEAt = Heating CooL = Cooling	S		0=HEAt 1=CooL
tCC	2811	Continuous cycle duration	N	2	OFF=00.00 ÷ 99.59 hrs.min

DEF group (parameters relative to defrost control)

Parameter	Address (HEX)	Description	Data Type	n° decimals	Possibile values
dtyP	2812	Defrosting Type: EL = electrical in = hot gas/reverse cycle	S		0=EL 1=in
dint	v 2813	Defrosting interval	N	2	OFF=00.00 ÷ 99.59 hrs.min
dF 1	v 2814	TIME START DEFROST 1	N	2	OFF=-1 / 00.00 ÷ 23.59 hrs.min
dF 2	2815	TIME START DEFROST 2	N	2	OFF=-1 / 00.00 ÷ 23.59 hrs.min
dF 3	2816	TIME START DEFROST 3	N	2	OFF=-1 / 00.00 ÷ 23.59 hrs.min
dF 4	2817	Time start defrost 4	N	2	OFF=-1 / 00.00 ÷ 23.59 hrs.min
dF 5	v 2818	Time start defrost 5	N	2	OFF=-1 / 00.00 ÷ 23.59 hrs.min
dF 6	v 2819	Time start defrost 6	N	2	OFF=-1 / 00.00 ÷ 23.59 hrs.min
dEFE	v 281A	Max. lenght of defrost cycle	N	2	0.01 ÷ 99.59 min.sec
tEdF	v 281B	Defrost stop temperature	N	Dp	- 58.0 ÷ 302.0 °C/°F
tSdF	v 281C	Defrost enable temperature	N	Dp	- 58.0 ÷ 302.0 °C/°F
dCt	v 281D	Defrosting intervals Counting mode: rt = real time ct = On OUT time cS = defrost every off OUT	S		0=rt 1=ct 2=cS
tdCO	v 281E	COMPRESSOR DELAY AFTER DEFROST (DRAINAGE TIME)	N	2	OFF=00.00 ÷ 99.59 MIN.SEC
SdEF	281F	DEFROST AT POWER ON	S		0=NO 1=YES

Para meter	Address (HEX)	Description	Data Type	n° decimals	Possibile values
dLo	2820	DEFROST DISPLAY LOCK OFF= DISPLAY FREE ON= LOCK ON TEMPERATURE PR1 BEFORE DEFROST LB= LOCK ON LABEL "DEF" (DURING DEFROSTING) AND "PDEF" (DURING POST-DEFROSTING)	S		0=OFF 1=ON 2=LB
Etdu	2821	DIFFERENTIAL DISPLAY UNLOCK AFTER DEFROST	N	Dp	0.0 ÷ 30.0 °C/°F
COFd	2822	TIME COMPRESSOR OFF BEFORE DEFROST	N	2	OFF=00.00 ÷ 99.59 MIN.SEC

FAn group (parameters realtive to the evaporator fans)

Para meter	Address (HEX)	Description	Data Type	n° decimals	Possibile values
FCOF	2823	Fan status with compressor off	S		0=OFF 1=On
FEdF	2824	Fan status during defrost	S		0=OFF 1=On
FLt	2825	High temperature fan off	N	Dp	- 58.0 ÷ 302.0 °C/°F
Fct	2826	LOW TEMPERATURE FAN OFF	N	Dp	- 58.0 ÷ 302.0 °C/°F
dF	2827	DIFFERENTIAL FAN CONTROL	N	Dp	0.0 ÷ 30.0 °C/°F
Fd	2828	FAN DELAY AFTER DEFROST	N	2	OFF=00.00 ÷ 99.59 MIN.SEC

PrC group (parameters relative to compressor protection and power on delay)

Para meter	Address (HEX)	Description	Data Type	n° decimals	Possibile values
PSC	2829	Type of compressor protection: 1= delay at switch on 2= delay after switch off 3= delay between starts	N	0	1 - 2 - 3
PtC	282A	Compressor protection time	N	2	OFF=00.00 ÷ 99.59 MIN.SEC
LtC	282B	MINIMUM COMPRESSOR FUNCTION TIME	N	2	OFF=00.00 ÷ 99.59 min.sec
od	282C	DELAY AT POWER ON	N	2	OFF=00.00 ÷ 99.59 min.sec

AL group (parameters relative to the alarms)

Parameter	Address (HEX)	Description	Data Type	n° decimals	Possibile values
Aty	282D	Temperature alarms Type: Ab = Absolute dE =Relative to Set	S		0=Ab 1=dE
HAL	282E	High temperature Alarm threshold	N	Dp	OFF =- 58.0 ÷ 302.0 °C/°F
LAL	282F	Low temperature Alarm threshold	N	Dp	OFF= - 58.0 ÷ 302.0 °C/°F
dAL	2830	Temperature Alarms Differential	N	Dp	0.0 ÷ 30.0 °C/°F
ALd	2831	Temperature Alarms delay	N	2	OFF=00.00 ÷ 99.59 min.sec
tAL	2832	ALARM MEMORY	S		0=NO 1=YES
PAL	2833	TEMPERATURE ALARMS DELAY AT POWER ON	N	2	OFF=00.00 ÷ 99.59 HRS.MIN
dALd	2834	TEMPERATURE ALARMS DELAY AND UNLOCK DISPLAY DELAY AFTER DEFROST	N	2	OFF=00.00 ÷ 99.59 HRS.MIN
dALc	2835	TEMPERATURE ALARMS DELAY AFTER CONTINUOUS CYCLE	N	2	OFF=00.00 ÷ 99.59 HRS.MIN
oAd	2836	ALARM DELAY WITH OPEN DOOR	N	2	OFF=00.00 ÷ 99.59 MIN.SEC

Din group (parameters relative to digital input)

Para meter	Address (HEX)	Description	Data Type	n° decimals	Possibile values
diF	2837	Function and function logic of digital input: 0 = No function 1= Start defrost 2= End defrost 3= Continuous cycle 4= External alarm 5= Door open with fan block 6= Door open with fan and compressor block 7= Auxiliary output command 8= Selection of active Set Point 9= External alarm with deactivation of control outputs 10= Switch on/Switch off (Stand-by)	N	0	-10 / -9 / -8 / -7 / -6 / -5 / -4 / -3 / -2 / -1 / 0 / 1 / 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9 / 10
did	2838	DELAY IN ACQUIRING DIGITAL INPUT	N	2	OFF=00.00 ÷ 99.59 MIN.SEC

AuS group (parameters relative to the auxiliary output)

Para meter	Address (HEX)	Description	Data Type	n° decimals	Possibile values
FOA	2839	Function mode auxiliary output: 0= No Function 1= regulation output delayed 2= manual activation by key or digital input.	N	0	0 / 1 / 2 / -1 / -2
tuA	283A	TIME RELATIVE TO AUXILIARY OUTPUT	N	2	OFF=00.00 ÷ 99.59 MIN.SEC

Out group (parameters relative to configuration of outputs)

Para meter	Address (HEX)	Description	Data Type	n° decimals	Possibile values
Out1	283B	Configuration of output function OUT1: OFF= No function Out= Temperature control (compressor) dEF= defrosting FAn= fans AuS= Auxiliary ALt= Silenceable alarm AL= Alarm not silenceable ALL= memorised alarm	S		0=OFF 1=Out 2=dEF 3=FAn 4=AuS 5=ALt 6=AL 7=ALL 8=-ALt 9=-AL 10=-ALL
Out2	283C	Configuration of output function OUT2: SEE "OUT1"	S		0=OFF 1=OUT 2=DEF 3=FAN 4=AUS 5=ALT 6=AL 7=ALL 8=-ALT 9=-AL 10=-ALL
Out3	283D	CONFIGURATION OF OUTPUT FUNCTION OUT3: SEE "OUT1"	S		0=OFF 1=OUT 2=DEF 3=FAN 4=AUS 5=ALT 6=AL 7=ALL 8=-ALT 9=-AL 10=-ALL

Parameter	Address (HEX)	Description	Data Type	n° decimals	Possibile values
BuF/Out 4	283E	CONFIGURATION BUZZER FUNCTION: SEE "OUT1"	S		0=OFF 1=OUT 2=DEF 3=FAN 4=AUS 5=ALT 6=AL 7=ALL 8=-ALT 9=-AL 10=-ALL

PAn group (parameters relative to the configuration of the keyboard)

Parameter	Address (HEX)	Description	Data Type	n° decimals	Possibile values
Fbd	283F	Function mode key DOWN/AUX: OFF= No function 1= Auxiliary output command 2= Continuous cycle command 3= Selection of active Set Point 4= Switch on/Switch off (Stand-by)	N	0	OFF=0 / 1 / 2 / 3 / 4
USrb	2840	FUNCTION MODE KEY U: SEE "FBD"	N	0	OFF=0 / 1 / 2 / 3 / 4
PASS	2841	ACCESS PASSWORD TO PARAMETER FUNCTIONS	N	0	OFF=0 ÷ 9999

CLO group (parameters relative to the internal clock)

Parameter	Address (HEX)	Description	Data Type	n° decimals	Possibile values
StCL	2845	Current time	N	2	0.00 ÷ 23.59 HRS.MIN
CLOF	2846	DAILY CALIBRATION OF CLOCK	N	0	-20 ÷ 20 SEC

4.2.1 Identification code area

This area contains information that is available in reading-only mode that allows the identification of the TLY instrument.

Starting from address 0x800 is possible to read the instrument name and starting from address 0x80A (up to 0x818) is possible to read the the instrument part no. (from firmware 1.2 version).

5 Performance

After receiving a valid request, the TLY prepares the reply and then sends it to the master station, according to the modes specified below:

a time equal to three characters is guaranteed before the reply to allow switching of the line;
the answer is ready to be transmitted within a time that is less than 20 ms, with the exception made for function 3;

A silence on line time of 2 ms is necessary to recover any irregular conditions or error messages: this means that the time that runs between two consecutive characters in the same message must be less than 20 ms.

It’s possible to write one word per time only.

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