TLK31/TLK32/TLK33/TLK35

Communication protocol

user's guide

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1 Preface

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

The subject is subdivided in four levels of interest:

first level describes the physical connection to the line;

second level presents the data link protocol, that is a subset of the MODBUS RTU (JBUS) protocol;

third level describes in detail each data that can be exchanged;

fourth level states performance characteristics of the system.

2 Physical connection

2.1 Interface

TLK series 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 TLKs 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 120 ohm is required to maintain the quiescent condition on the line;

Adopted baud rates range from 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 TLK series is a subset of the widely used MODBUS RTU (JBUS)[1] 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 TLK series are:

function 3 - n word read

function 6 - one word write.

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 (TLK) 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: n word read request	function 3: n word read reply
function 6: one word write request	function 6: one word write reply
	exception reply (as reply to both functions in abnormal conditions)

Every a message contains four fields:

slave address (from 1 to 255): MODBUS RTU (JBUS) reserves address 0 for broadcasting messages, but due to inherent unreliability of its not implemented for TLK series;

function code: contains 3 or 6 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.

1 AEG Schneider Automation, Inc. registered trade mark

3.1 Function 3 - read n word

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

The request has the following frame:

slave number	3	first word address 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 (as opposed to exception reply) has the following frame:

slave number	3	NB number of read bytes	value of first word MSB	LSB	following 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 - one word write

The request has the following frame:

slave number	6	word address MSB	LSB	value to write MSB	LSB	CRC LSB	MSB
byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7

The normal reply (as opposed to exception reply) is merely an echo of the request message:

slave number	6	word address MSB	LSB	value to write MSB	LSB	CRC LSB	MSB
byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7

3.3 The exception replay

TLK series instruments reply 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:

slave number	function code with most sign. bit set to 1	exception code	CRC LSB	CRC MSB
byte 0	byte 1	byte 2	byte 3	byte 4

TLK series 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

3.4 Cyclic redundancy check (CRC)

CRC is a check word that premits to verify the integrity of a message.

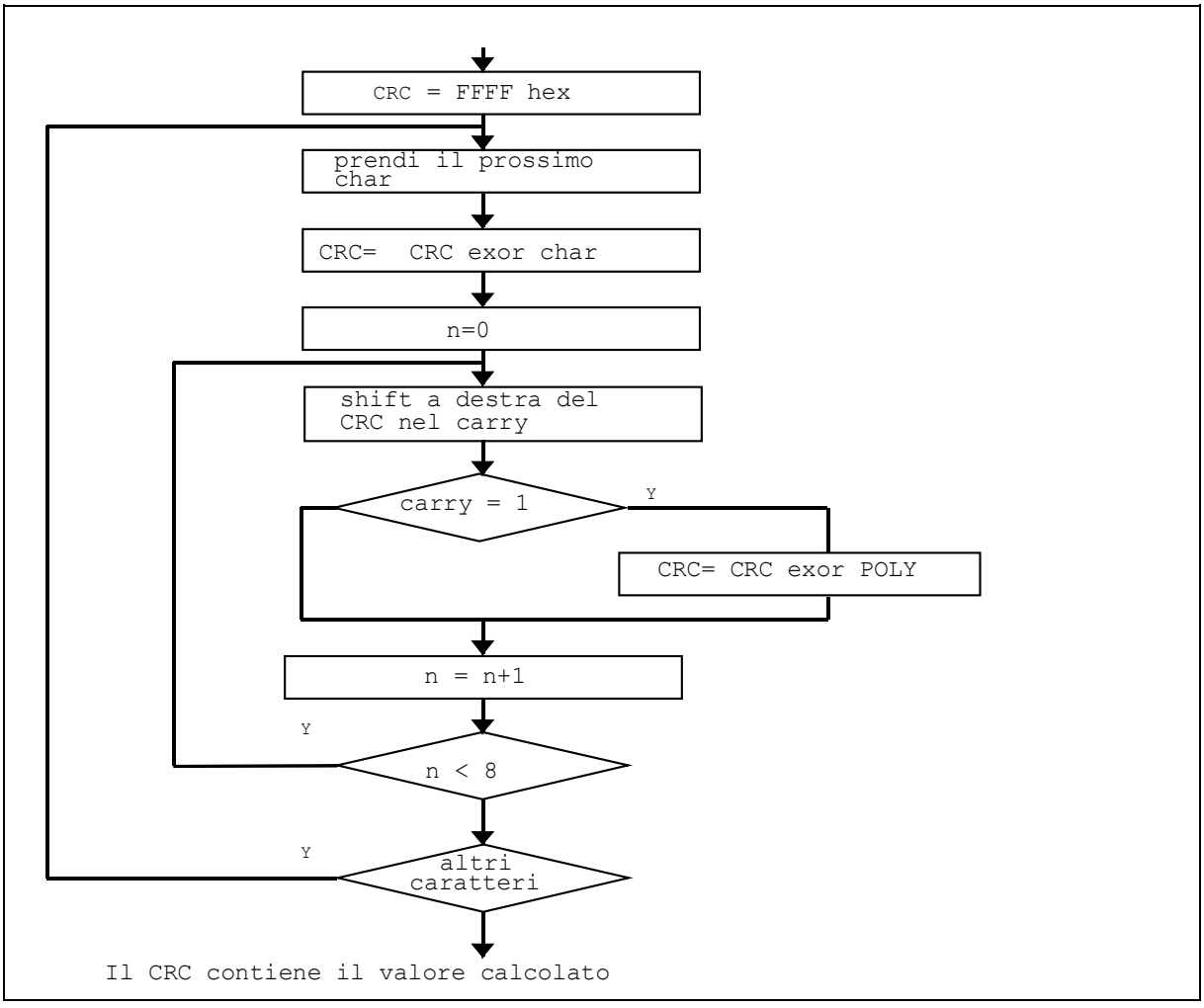
Every message, sent or received, has in the two last characters the CRC check word.

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 , TLK series controllers adopt an identical algorithm for CRC calculation, scketched 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.

4 Data exchange

This section contains informations about data exchanged with TLK 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...).

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 kinds 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.

4.2.1 Variables zones

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

These are available data:

n.	address (HEX)	Description	Data type	range of values/symbols	Decimal figures	r/w	note
1	0200	PV : measured variable (signed integer)	N		dP	r	
2	0201	n. of decimals to be associated to PV	N		0	r	as DP parameter
3	0202	Power calculated by the regulator	N		2	r	-100.0% a 100.0%
4	0203	Available power on the heating output	N		2	r	-100.0% a 100.0%
5	0204	Available power on the cooling output	N		2	r	-100.0% a 100.0%
6	0205	Alarm 1 status	S	0: OFF 1: ON	0	r	
7	0206	Alarm 2 status	S	0: OFF 1: ON	0	r	
8	0207	Alarm 3 status	S	0: OFF 1: ON	0	r	
9	0208	Active Set Point	N		dP	r	
10	020A	alarm LBA status	S	0: OFF 1: ON	0	r	
11	020F	regulator status	S	0: OFF 1: auto. reg. 2: tuning 3: man. reg.	0	r	
12	0240	Digital input 1 status	S	0: open 1: closed		r	
13	0241	Digital input 2 status	S	0: open 1: closed		r	

Abnormal conditions of process variable are reported as special word values which are beyond the normal result of a measure:

abnormal condition	returned value	front panel display
underrange(measure)	-10000	uuuu
overrange (measure)	10000	oooo
overflow (A/D conv.)	10001	----
variable not available	10003	not available

4.2.2 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 **039B**.

SP group (parameters relative to the Set Point)

Parameter	Address (HEX)	Description	Data type	n° decimals	Possibile values
nSP	2800	Select the number of the programmable Set Point	N	0	1…4
SPAt	2801	Select the active Set Point	N	0	1…nSP
SP1	2802	Set Point 1	N	Dp	SPLL.. SPHL
SP2	2803	Set Point 2	N	Dp	SPLL.. SPHL
SP3	2804	Set Point 3	N	Dp	SPLL.. SPHL
SP4	2805	Set Point 4	N	Dp	SPLL.. SPHL
SPLL	2806	Set Point Lower limit	N	Dp	-1999… SPHL
SPHL	2807	Set Point Higher limit	N	Dp	SPLL… 9999

InP group (parameters relative to the measure input)

Parameter	Address (HEX)	Description	Data type	n° decimals	Possibile values
SEnS	2809	Probe type	S		
		TC, Pt100 input			0=J, 1=CrAL, 2=S , 3= Ir.J, 4= Ir.Ca, 5= Pt100, 6= 0.50 (mV), 7= 0.60 (mV), 8= 12.60 (mV)
		TC, PTC, NTC input			0=J, 1=CrAL, 2=S , 3= Ir.J, 4= Ir.Ca, 5= PTC, 6= NTC, 7= 0.50 (mV), 8= 0.60 (mV), 9= 12.60 (mV)
		I input			0=0.20 (mA), 1=4.20 (mA)
		V input			0=0.5(V), 1=1.5(V), 2=0.10(V), 3=2.10(V) 4=0.1 (V)
SSC	280A	Low scale limit in case of input with V / I signals	N	dP	-1999…FSC
FSC	280B	High scale limit in case of input with V / I signals	N	dP	SSC…9999
dp	280C	Number of decimal figures	N	0	0..3
Unit	280D	Temperature unit of measurement	S		0=C, 1=F
FiL	280E	Input digital filter	N	1	0FF…20.0 sec
OFSt	2810	Measuring Offset	N	dP	-1999…9999
rot	2811	Rotation of the measuring straight line	N	3	0.000 … 2.000
InE	2812	“OPE” functioning in case of measuring error	S		0=OR, 1=Ur, 2=OUr
OPE	2813	Output power in case of measuring error	N	0	-100...100

Parameter	Address (HEX)	Description	Data type	n° decimals	Possibile values
dIF	2814	Digital input function	S	0	0=noF, 1=AaC, 2=Asi, 3=Hold, 4=OFF, 5=CHSP, 6=SP1.2, 7=SP1.4, 8=HE.Co

O1 group (parameters relative to outputs)

Parameter	Address (HEX)	Description	Data type	n° decimals	Possibile values
O1F	2815	Functioning of output 1	S		0=OFF, 1=1.rEg, 2=2.rEg, 3=Alno, 4=Alnc 5= Alni
O2F	2816	Functioning of output 2	S		0=OFF, 1=1.rEg, 2=2.rEg, 3=Alno, 4=Alnc 5= Alni
O3F	2817	Functioning of output 3	S		0=OFF, 1=1.rEg, 2=2.rEg, 3=Alno, 4=Alnc 5= Alni
O4F	2818	Functioning of output 4	S		0=OFF, 1=1.rEg, 2=2.rEg, 3=Alno, 4=Alnc 5= Alni

Blocco Al1 (parametri relativi all'allarme 1)

Parameter	Address (HEX)	Description	Data type	n° decimals	Possibile values
OAL1	2819	Output where alarm AL1 is addressed	S		0=OFF, 1=Out1, 2=Out2, 3=Out3, 4=Out4
AL1t	281A	Alarm AL1 type	S		0=LoAb, 1=HiAb, 2=LHAb, 3=LodE, 4=HidE 5=LHdE
Ab1	281B	Alarm AL1 functioning	N	0	+0 = no function +1 = alarm hidden at the start up +2= alarm delaied +4 = alarm stored +8 = alarm aknowledged +16 = relative alarm hidden at the set point change
AL1	281C	Alarm AL1 threshold	N	Dp	-1999..9999
AL1L	281D	Low threshold band alarm AL1 or Minimum set alarm AL1 for high or low alarm	N	Dp	-1999..9999
AL1H	281E	High threshold band alarm AL1 or Maximum set alarm AL1 for high or low alarm	N	Dp	-1999..9999
HAL1	281F	Alarm AL1 hysteresis	N	Dp	0=0FF...9999
AL1d	2820	Activation delay of alarm AL1	N	Dp	0=0FF…9999 sec
AL1i	2821	Alarm AL1 activation in case of measuring error	S		0=no, 1=YES

Al2 group (parameters relative to alarm 2)

Parameter	Address (HEX)	Description	Data type	n° decimals	Possibile values
OAL2	2822	Output where alarm AL2 is addressed	S		0=OFF, 1=Out1, 2=Out2, 3=Out3, 4=Out4

Parameter	Address (HEX)	Description	Data type	n° decimals	Possibile values
AL2t	2823	Tipo allarme AL2	S		0=LoAb, 1=HiAb, 2=LHAb, 3=LodE, 4=HidE 5=LHdE
Ab2	2824	Alarm AL2 type	N	0	+0 = no function +1 = alarm hidden at the start up +2= alarm delaied +4 = alarm stored +8 = alarm aknowledged +16 = relative alarm hidden at the set point change
AL2	2825	Alarm AL2 functioning	N	Dp	-1999..9999
AL2L	2826	Alarm AL2 threshold	N	Dp	-1999..9999
AL2H	2827	Low threshold band alarm AL2 or Minimum set alarm AL2 for high or low alarm	N	Dp	-1999..9999
HAL2	2828	High threshold band alarm AL1 or Maximum set alarm AL2 for high or low alarm	N	Dp	0=0FF...9999
AL2d	2829	Alarm AL2 hysteresis	N	Dp	0=0FF…9999 sec
AL2i	282A	Activation delay of alarm AL2	S		0=no, 1=YES

Al3 group (parameters relative to alarm 3)

Parameter	Address (HEX)	Description	Data type	n° decimals	Possibile values
OAL3	282B	Output where alarm AL3 is addressed	S		0=OFF, 1=Out1, 2=Out2, 3=Out3, 4=Out4
AL3t	282C	Alarm AL3 type	S		0=LoAb, 1=HiAb, 2=LHAb, 3=LodE, 4=HidE 5=LHdE

Parameter	Address (HEX)	Description	Data type	n° decimals	Possibile values
Ab3	282D	Low threshold band alarm AL3 or Minimum set alarm AL3 for high or low alarm	N	0	+0 = no function +1 = alarm hidden at the start up +2= alarm delaied +4 = alarm stored +8 = alarm aknowledged +16 = relative alarm hidden at the set point change
AL3	282E	High threshold band alarm AL3 or Maximum set alarm AL3 for high or low alarm	N	Dp	-1999..9999
AL3L	282F	Alarm AL3 hysteresis	N	Dp	-1999..9999
AL3H	2830	Activation delay of alarm AL3	N	Dp	-1999..9999
HAL3	2831	Alarm AL3 activation in case of measuring error	N	Dp	0=0FF...9999
AL3d	2832	Low threshold band alarm AL3 or Minimum set alarm AL3 for high or low alarm	N	Dp	0=0FF…9999 sec
AL3i	2833	High threshold band alarm AL1 or Maximum set alarm AL2 for high or low alarm	S		0=no, 1=YES

Group "LbA" (parameters relative to Loop Break Alarm)

Parameter	Address (HEX)	Description	Data Type	n° decimals	Possibile values
OLbA	2834	Output where alarm LbA is addressed	S		0=OFF, 1=Out1, 2=Out2, 3=Out3, 4=Out4
Lbat	2835	Time necessary to activate alarm LbA	N	0	0=OFF..9999 sec

Group “rEG” (parameters relative to control)

Parameter	Address (HEX)	Description	Data Type	n° decimals	Possibile values
Cont	2836	Control type	S		0=Pid, 1=On.Fa, 2=On.FS, 3=nr
Func	2837	Functioning mode output 1rEg	S		0=Heat, 1=Cool
Auto	2838	Autotuning Fast enable	N	0	0=OFF,1,2,3,4
SELF	2839	Selftuning enable	S		0=No, 1=YES
HSEt	283A	Hysteresis of ON/OFF control	N	Dp	9999…-1999
Pb	283B	Proportional band	N	Dp	0..9999
Int	283C	Integral time	N	0	0=0FF..9999 sec
dEr	283D	Derivative time	N	0	0=0FF..9999 sec
FuOc	283E	Fuzzy overshoot control	N	2	0.00..2.00
tcr1	283F	Cycle time of output 1rEg	N	1	0.1..130. sec
Prat	2840	Power ratio 2rEg / 1rEg	N	1	0.1..999.9
tcr2	2841	Cycle time of 2rEg	N	1	0.1..130.0 sec
rS	2842	Manual reset	N	1	-100.0..100.0%
CPdt	2843	Delay time for out 2.reG activation (compressor protection)	N	0	0=0FF..9999 sec
SLor	2844	Gradient of rise ramp	N	2	0.00..99.99 >=100.00=InF Unitmin
dur.t	2845	Duration time	N	2	99.59 h.min >=100.00=InF
SLoF	2846	Gradient of fall ramp	N	2	0.00..99.99 Unitmin >=100.00=InF
St.P	2847	Soft-Start power	N	0	-100, -101=OFF, 100
SSt	2848	Soft-start time	N	2	0=0FF.. 7.59 h.min >=8.00=InF

Group "PAn" (parameters relative to the user interface)

Parameter	Address (HEX)	Description	Data Type	n° decimals	Possibile values
USrb	2849	Functioning of key "U"	S		0=noF, 1=tune, 2=OPLO, 3=Aac, 4=Asi, 5=CHSP, 6=OFF
diSP	284A	Variable visualized on the SV display	S		0=DEF(OFF), 1=Pou, 2=SPF, 3=Spo, 4=AL1, 5=AL2, 6=AL3, 7=HbA, 8=HbL
AdE	284B	Shift index	N	Dp	0=0FF..9999
Edit	284C	Fast programming of active Set Point and alarms	S		0=SE, 1=AE, 2=SAE, 3=SAnE

4.2.3 Identification code zone

This zone provides only informations for identifying model, order code and software release of the TLK serie instrument.

Starting from the address 0800H it’s possibile to read the instrument name (TLK31, TLK32) and from the address 0x80A (up to 0x818) it’s possibile tro read the instrument part number.

5 Performance

After receiving a valid request the instrument prepares the reply, then sends it back to the master station according following specifications:

a minimum time is granted greater or equal 3 characters time (depending on adopted baud rate, allowing line direction reversal);

the reply is ready to be transmitted in less then 20 ms except in case 3;

A 20 ms silence on the line is necessary to recover from abnormal contitions or erroneous messages; this means that a time less than 20 ms is allowed between any two characters in the same message.

It’s not possible to write more than one word at the same time.

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