Industrial display module TDS

4x 7-segment LED display

Communication via RS485 line

TDS

Datasheet

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Papouch s.r.o.

Address:

Strasnicka 3164/1a
102 00 Prague 10
Czech Republic

Telephone:

+420 267 314 267-8
+420 602 379 954

Fax:

+420 267 314 269

Internet:

www.papouch.com

E-mail:

info@papouch.com

CONTENT

DESCRIPTION

The TDS module is a 4-digit 7-segment LED display with two universal indicators. It communicates via RS485 bus enabling to connect several devices by a four-wire bus containing a RS485 line and power supply line over a distance of up to 1200 m. The devices use Spinel or MODBUS RTU protocol to communicate with the display.

FEATURES

- Displays 4 digits, 2 indicating lights
- Commmunicates via RS485
- Uses Spinel or MODBUS RTU communication protocol
- Industrial design with IP64 protection

APPLICATION

- Measuring systems.
- Industrial measurement and control.
- Indication of measured temperatures and other physical quantities.

TECHNICAL PARAMETERS

Control interface:

Type.....RS485

Connector.....Wago 236 terminal block

Communication speed.....adjustable 110 Bd to 230.4 kBd (default: 9.6 kBd)

Number of data bits.....8

Parity.....no parity

Number of stopbits.....1

Communication protocol.....Spinel *(default)* or MODBUS RTU

Minimum response delay.....2 ms[1]

Termination:.....No, only 22 kΩ resistors defining the idle status.

Power supply:

Supply voltage:.....7 to 30 V DC

Consumption:.....typically 30 mA at 12 V

Miscellaneous:

Available digits:.....0 to 9, space, dash, and most alphabet letters

Digit height.....10 mm

Degree of protection.....IP64

Wire connection:.....WAGO 236 terminal block

Operating temperature.....-20 °C to +70 °C

PCB dimensions:.....45 mm x 51 mm x 20 mm

Box dimensions:.....62 mm x 62 mm (84 mm) x 32.5 mm

Weight:.....115 g

[1] The delay is caused by waiting for the communication to be switched over to RS485.

CONNECTION

The lower printed circuit board contains a Wago 236 termination block. To connect the conductors, it is necessary to remove the upper cover of the display electronics. (The cover is slipped on only – it can be slipped off easily without the necessity to use any tools and put back again after the conductors have been connected.)

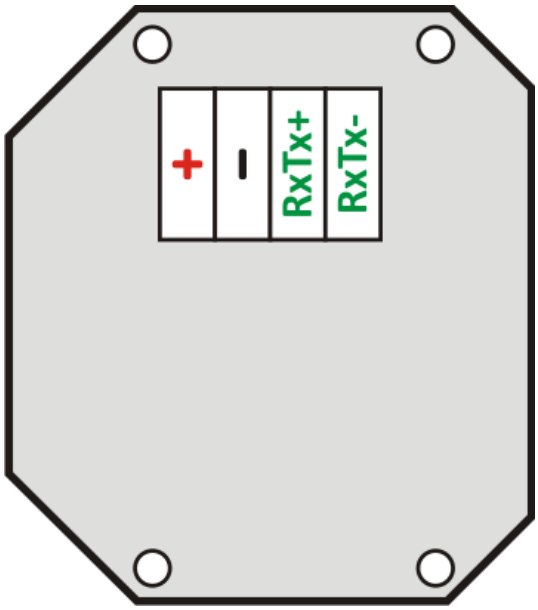


Fig. 1 – RS485 and power supply connector

The following signals are to be connected to individual terminals.

+..... power supply – positive terminal

-..... power supply – negative terminal

RxTx+ ..... more positive conductor of the RS485 line („A“)

RxTx- ..... more negative conductor of the RS485 line („B“)

SIGNALISATION

TDS module contains a yellow indicating light which flashed after the device has been switched on.

During operation the light indicated module communication.

COMPLETE DESCRIPTION OF SPINEL PROTOCOL

Standardized protocol Spinel is implemented to TDS module in 97 format (binary).

Format 97

Format 97 uses 8bit bytes for communication (0 to 255 in decadal range). For easy communication debugging can be used Spinel Terminal. Instructions are split to Requests and Responses.

Structure

Request:

```
PRE FRM NUM NUM ADR SIG INST DATA… SUMA CR
```

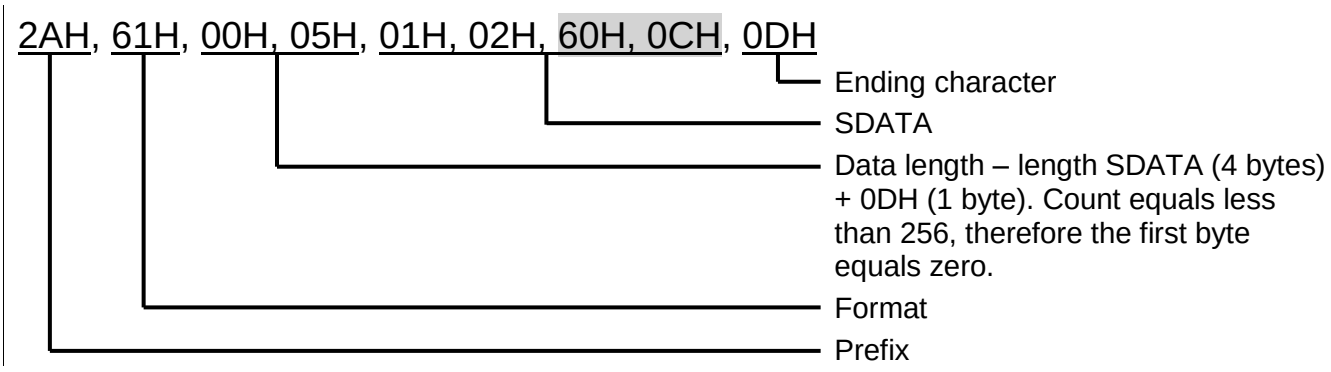
Response:

```
PRE FRM NUM NUM ADR SIG ACK  DATA… SUMA CR
```

PRE	Prefix, 2AH (character "*").
FRM	Format number 97 (61H).
NUM	Byte count of the instruction from following byte to the end of the frame.
ADR	Address of the module sending request or responding to it.
SIG	Instruction signature – any number in range from 00H to FFH. The same number sent in request returns in response to determine which request the response replies on.
INST[2]	Instruction code – Module instructions are described in detail in chapter "Complete instructions overview" on page 9.
ACK	Request confirmation (Acknowledge); if and how was the request performed. ACK lies in interval of 00H to 0FH.
DATA[2]	Data. Described in detail in chapter "Complete instructions overview" (page 9) for each instruction.
SUMA	Checksum.
CR	Ending character (0DH).

Glossary

Example



[2] Data and Instructions are highlighted like this.

Data Length (NUM)

Sixteen-bit value defining the number of bytes until the end of the instruction; number of all bytes found after NUM up to CR (including). It takes the values from 5 to 65535. If lower than 5, the instruction is considered faulty and it is answered (if intended for the relevant device) with ACK "Invalid Data" instruction.

Process of NUM creation:

Ad up the number of bytes following both NUM bytes (i.e. the number of SDATA bytes + 1 CR byte). View the resulting sum as a sixteen-bit number. Divide it into the upper and lower byte. The first NUM byte id the upper byte of the amount, the second NUM byte is the lower byte of the amount. (If the amount of bytes is lower than 256, the first NUM byte is 00H.)

Address (ADR)

The FFH address is reserved for broadcast. If the enquiry contains the FFH address, the device operates as if its own address is entered. No response is sent to enquiries with this address.

The FEH address is a universal address. If the enquiry contains the FEH address, the device operates as if its own address is entered. The device enters real, currently set address into the response. The universal address is used in cases where only one device is connected on the line.

Enquiry Acknowledgement (ACK)

ACK informs the superior device on the way of the received instruction processing. Acknowledgement codes:

00H .....EVERYTHING OK
The instruction was properly received and completely executed.

01H .....UNSPECIFIED ERROR
Unspecified device error.

02H .....INVALID CODE OF INSTRUCTION
The received instruction code is unknown.

03H .....INVALID DATA
Data are of invalid length or contain an invalid value.

04H .....ENTRY NOT ALLOWED/ACCESS DENIED
- The enquiry was not performed, as some conditions had not been fulfilled.
- Attempt to enter data into inaccessible memory.
- Attempt to activate a device function requiring a different configuration (e.g. higher communication speed).
- Attempt to change configuration without previous setup permission.
- Access into memory protected by a password.

05H .....DEVICE FAILURE
- Device failure requiring service action.
- Device internal memory error or setup memory error.
- Device internal error (operation error or start-up error).
- Any other error affecting the device proper functioning.

06H .....NO DATA AVAILABLE

0DH.....INSTRUCTION SENT AUTOMATICALLY – CHANGE OF DIGITAL INPUT STATE

0EH.....INSTRUCTION SENT AUTOMATICALLY – CONTINUOUS MEASURING
- Periodical sending of measured values.

0FH .....INSTRUCTION SENT AUTOMATICALLY – LIMITS OR RANGE EXCEEDING

Check Sum (SUMA)

The sum of all instruction bytes (added all transmitted data except for CR) subtracted from 255.

Calculation: SUMA = 255 – (PRE + FRM + NUM + ADR + SIG + ACK (INST) + DATA)

Incorrect checksum is not answered. (Device is waiting for CR even if checksum is incorrect.)

COMPLETE INSTRUCTIONS OVERVIEW

To keep the lucidity, Instructions (INST), acknowledgement (ACK) and data (DATA) are described in detail. Address (ADR), Signature (SIG) and CheckSum (SUMA) are described in detail in upper part of the document where the protocol is described.

DETAILED OVERVIEW OF INSTRUCTIONS

Display instructions

Data entering via the display

Description: Shows the entered data on the display.

[97]Request: 90H (data)

[97]Response: (ACK 00H)

[97]Legend: (data) 5 bytes; ASCII characters ranging from <0 to 9>, <a to z>, " ", "-" and "." The characters are displayed in the order as entered. If no dot is required, send any permissible character as the 5th character.

[97]*Example: " 12.3" value entry.*

2AH,61H,00H,0AH,31H,02H,90H,20H,31H,32H,2EH,33H,C3H,0DH

Response

2AH,61H,00H,05H,31H,02H,00H,3CH,0DH

Table of characters

 .....characters 0 to 9

 .....characters A to J

 .....characters K to U

 .....characters V to Z

 .....dash

Data reading from the display

Description: Reads the currently displayed data from the display.

[97]Request: 80H

[97]Response: (ACK 00H) (data)

[97]Legend: (data) 5 bytes; ASCII characters ranging from <0 to 9>, <a to z>, " ", "-" and "."

[97]*Example: Request*

2AH,61H,00H,05H,31H,02H,80H,BCH,0DH

Response – value „ 12.3"

2AH,61H,00H,0AH,31H,02H,00H,20H,31H,32H,2EH,33H,53H,0DH

Display brightness setup

Description: Changes display brightness in five steps.

[97] Request: 93H (brightness)

[97] Response: (ACK 00H)

[97]Legend: (brightness) 1 byte; value 0 to 4, where 0 = off, 1 to 4 = brightness levels (4 = maximum)

[97] *Example: Request – to set the maximum brightness*

2AH,61H,00H,06H,31H,02H,93H,04H,A4H,0DH

Response

2AH,61H,00H,05H,31H,02H,00H,3CH,0DH

Display brightness reading

Description: Read the currently set brightness.

[97] Request: 83H

[97] Response: (ACK 00H) (brightness)

[97]Legend: (brightness) 1 byte; value 0 to 4, where 0 = off, 1 to 4 = brightness levels (4 = maximum)

[97] *Example: Request*

2AH,61H,00H,05H,31H,02H,83H,B9H,0DH

Response – the maximum brightness is set

2AH,61H,00H,06H,31H,02H,00H,04H,37H,0DH

Setup of display time

Description: This instruction defines how long the data is to be displayed. After this time has elapsed, the display will show four dashes (- - - -). The entered time is valid permanently, i.e. not only for the currently displayed value but also for all values received later. To cancel this function, enter 0.

(This function is suitable for periodical updating of the displayed value. After the entered time has elapsed, the dashes will advise the operator that data updating has encountered an error.)

[97]Request: 94H (time)

[97]Response: (ACK 00H)

[97]Legend: (time) 2 bytes; 16 bit value of time in seconds; if 0, values will be displayed without any restriction

[97]*Example: Request – to set the display time to 300 sec (= 2CH)*

2AH,61H,00H,07H,31H,02H,94H,00H,2CH,7AH,0DH

Response

2AH,61H,00H,05H,31H,02H,00H,3CH,0DH

Display time reading

Description: This instruction reads the time set for value displaying as well as the remaining time of displaying the value.

[97]Request: 84H

[97]Response: (ACK 00H) (set-time) (remaining-time)

[97]Legend: (set-time) 2 bytes; 16 bit value showing the entered time in seconds; if 0, values will be displayed without any time restrictions

(remaining-time) 2 bytes; 16 bit showing the remaining time of value displaying in seconds

[97]*Example: Request*

2AH,61H,00H,05H,31H,02H,84H,B8H,0DH

Response– the set time is 44 sec (= 2CH), 32 seconds remain (= 20H)

2AH,61H,00H,09H,31H,02H,00H,00H,2CH,00H,20H,ECH,0DH

Indicators control

Description: Controls the red and green indicators to the left of the display.

[97]Request: 20H (LED)

[97]Response: (ACK 00H)

[97]Legend: (LED) 1 byte; the byte has the following structure: SXXXXXLL, where S signalizes the desired status of the indicator (1 = on; 0 = off); LL is the indicator binary number; number 1 for green, number 2 for red; the X bits are ignored.

[97]*Example: Request – to switch on the red indicator*

2AH,61H,00H,06H,FEH,02H,20H,82H,CCH,0DH

Response

2AH,61H,00H,05H,31H,02H,00H,3CH,0DH

Indicator status reading

Description: Reads the setup of the indicators.

[97]Request: 30H

[97]Response: (ACK 00H) (LED)

[97]Legend: (LED) 1 byte; the byte has the following structure: XXXXXXCZ; where Z shows the status of the green indicator and C the status of the red indicator

[97]*Example: Request*

2AH,61H,00H,05H,31H,02H,30H,0CH,0DH

Response – both indicators are switched on

2AH,61H,00H,06H,31H,02H,00H,03H,38H,0DH

Setting the indicators for certain time

Description: Switches selected indicators on (or off) for a certain time. The duration of indicator's ON time can be prolonged by sending this request repeatedly.

[97]Request: 23H(time)(LED1)(LED2)

[97]Response: (ACK 00H)

[97]Legend: (time) 1 byte; on/off duration; number from the interval 1 to 255; increment is 0.5 sec.

(LEDx) 1 byte; the byte has the following structure: SXXXXXCZ; where Z represents the green indicator; C shows the status of the red indicator; S is the desired status the indicator is to adopt for the set period of time (0 for switching off; 1 for switching on). One or two parameters of LEDx may be entered.

[97]*Example: Request – to switch the green indicator on for 5 sec*

2AH,61H,00H,07H,31H,02H,23H,0AH,81H,8CH,0DH

Response

2AH,61H,00H,05H,31H,02H,00H,3CH,0DH

Reading of the indicators setup

Description: This instruction will read the current time setup of the indicators. This instruction can be used to find out which indicator is set for a certain time and what time remains till the end of the interval.

[97]Request: 33H (00H)

[97]Response: (ACK 00H)(LED1)(time)(LED2)(time)

[97]Legend: (time) 1 byte; the period of time for which the indicator is going to remain in the current status. Range from 1 to 255, increment of 0.5 sec. The value (time) is set to 0 for indicators without any timing set for them.

(LEDx) 1 byte; the byte has the following structure: SXXXXXCZ; where Z represents the green indicator; C shows the status of the red indicator; S is the current status of the indicator (0 = off; 1 = on)

[97]*Example: Request*

2AH,61H,00H,06H,31H,02H,33H,00H,08H,0DH

Response– the green one is off, the red one will be on for another 72 seconds (90H / 2)

2AH,61H,00H,09H,31H,02H,00H,01H,00H,82H,90H,25H,0DH

Communication line configuration and address setup

Configuration Permission

Description: Enables configuration to be carried out. It must immediately precede some instructions for the setup of communication parameters. After the setup instruction (even an invalid one) has been sent, the configuration is automatically disabled. (No universal address may be used for this instruction)

[97]Request: E4H

[97]Response: (ACK 00H)

[97]*Example: Configuration permission*

2AH,61H,00H,05H,01H,02H,E4H,88H,0DH

Response

2AH,61H,00H,05H,01H,02H,00H,6CH,0DH

Communication parameters setup

Description: Sets the address and communication speed. (No universal address may be used for this instruction.[3])

[97]Request: E0H(address)(speed)

[97]Response: (ACK 00H)

[97]Legend: (address) 1 byte; a value ranging from 00H to FDH. (If the 66 protocol is also used for communication, it is necessary to use only such addresses that can be expressed as a displayable ASCII character.)

(speed) 1 byte; must always be 0AH (code for the speed of 115200, see table 1).

[97]*Example: Setup of address 02H and communication speed 115200Bd; old address = 01H*

2AH,61H,00H,07H,01H,02H,E0H,02H,0AH,7EH,0D

Response

2AH,61H,00H,05H,01H,02H,00H,6CH,0DH

Notes: The new address and communication speed is set after the response has been sent.

The setup of configuration parameters must be preceded by the instruction of Configuration Permission (page 14). After the new parameters have been set, configuration is disabled again.

Comm. speed Bd	Code
110	00H
300	01H
600	02H
1200	03H
2400	04H
4800	05H
9600	06H
19200	07H
38400	08H
57600	09H
115200	0AH
230400	0BH

[3] In case the address is not known and no other device is connected to the line, the address can be identified by using the instruction “Reading of Communication Parameters” (Use the FEH universal address as the device address). If this is not possible (there are other devices connected to the communication line), you can assign an address to the device using the instruction “Address Setup Using Serial Number” (page 17).

Reading of communication parameters

Description: Reads the address and communication speed.

[97]Request: F0H

[97]Response: (ACK 00H)(address)(speed)

[97]Legend: (address) 1 byte; device address

(speed) 1 byte; communication speed, speed codes can be found in table 1.

[97]*Example: Reading of communication parameters; universal address FEH, signature 02H*

`2AH,61H,00H,05H,FEH,02H,F0H,7FH,0DH`

Response - address 04H, communication speed 9600Bd

`2AH,61H,00H,07H,04H,02H,00H,04H,06H,5DH,0DH`

[97]Poznámky: This instruction has been designed to identify the set address of the device in case it is unknown. The request is sent to the FEH universal address. If even the communication speed is not known it is necessary to try out all communication speeds available for the particular device. However, no other device may be connected to the line in this case

The other communication parameters are: 8 bits, no parity, 1 stop-bit. The default communication speed set by the manufacturer is 115200Bd and the address is 01H.

Address setup using the serial number

Description: This instruction enables the address to be set using the unique serial number of the device. This instruction is handy in case the superior system or operator loses the address of a device which is connected to the same communication line as other devices.

Serial numbers can be found on the devices in the following structure *[product-number].[hardware-version].[software-version]/[serial-number]* for example like this: *0227.00.03/0001*

[97]Request: EBH(new-address)(product-number)(serial-number)

[97]Response: (ACK 00H)

[97]Legend: (new-address) 1 byte; a new module address.

(product-number)2 bytes; product number.

(serial-number) 2 bytes; serial number can be found on the label following the product number. This number can also be detected using the instruction “Manufacturing Data Reading“ (see page 16).

[97]*Example: Request – new address 32H, product-number 199 (= 00C7H), serial number 101 (= 0065H)*

`2AH,61H,00H,0AH,FEH,02H,EBH,32H,00H,C7H,00H,65H,21H,0DH`

Response – the product responds using already the new address

`2AH,61H,00H,05H,32H,02H,00H,3BH,0DH`

Additional

Name and version reading

Description: Reads the name of the device, version of the internal software and the list of possible communication formats. Set by the manufacturer.

[97]Request: F3H

[97]Response: (ACK 00H)(string)

[97]Legend: (string) Text „*TDS; v0104.02.01; f66 97“*.

[97]*Example: Request*

```
2AH,61H,00H,05H,FEH,02H,FAH,75H,0DH
```

Response

```
2AH,61H,00H,1DH,31H,02H,00H,54H,44H,53H,3BH,20H,76H,30H,31H,30H,34H
,2EH,30H,32H,2EH,30H,31H,3BH,20H,66H,36H,36H,20H,39H,37H,C7H,0DH
```

Manufacturing data reading

Description: This instruction reads the manufacturing data from the device.

[97]Request: FAH

[97]Response: (ACK 00H)(product-number)(serial-number)(manufacturing-data)

[97]Legend: (product-number) 2 bytes; product number.

(serial-number) 2 bytes; serial number

(manufacturing-data) 4 bytes

[97]*Example: Request*

```
2AH,61H,00H,05H,FEH,02H,FAH,75H,0DH
```

Response – product-number 199 (=00C7H), serial number 101 (=0065H)

```
2AH,61H,00H,0DH,35H,02H,00H,00H,C7H,00H,65H,20H,05H,09H,23H,B3H,0DH
```

User data saving

Description: This instruction saves user data. The device remembers the data even after power supply disconnection or reset. This memory space is suitable, for example, for giving a name to the measuring place.

[97]Request: E2H(position)(data)

[97]Response: (ACK 00H)

[97]Legend: (position) 1 byte; address of the memory position where the data are to be saved. A number within the range of 00H to 0FH.

(data) 1 to 16 bytes; any user data.

[97]*Example: Saving the expression "Boiler room 1" to memory 00H; address 01H, signature 02H*

```
2AH,61H,00H,0FH,01H,02H,E2H,00H,"KOTELNA 1",61H,0DH
```

Response

```
2AH,61H,00H,05H,01H,02H,00H,6CH,0DH
```

Notes: The memory for user data has the capacity of 16 bytes. In case the data are being written to the memory address e.g. 0CH, it is possible to write 4 bytes maximum.

User data reading

Description: This instruction reads the data saved by the user. The device remembers the data even after power supply disconnection or reset. This memory space is suitable, for example, for giving a name to the measuring place.

[97]Request: F2H

[97]Response: (ACK 00H)(data)

[97]Legend: (data) 16 bytes; saved user data.

[97]*Example: User data reading; address 01H, signature 02H*

2AH,61H,00H,05H,01H,02H,F2H,7AH,0DH

Response - "Boiler room 1 "

2AH,61H,00H,15H,01H,02H,00H,"BOILER ROOM 1 ",5DH,0DH

Status setup

Description: Used to set the status of the device. A user-defined byte that can be used to detect the condition of the device. Basically, it has been designed as a memory location that can be used for example to specify the condition of the device. (Is set to 0 after reset or power supply connection).

[97]Request: E1H (status)

[97]Response: (ACK 00H)

[97]Legend: (status) 1 byte; device status. After the device has been switched on or reset, the status is automatically set to 00H. If the status is set to another value using the Status Setup instruction it is subsequently easy to identify the current status of the device.

[97]*Example: Status setup 12H; address 01H, signature 02H*

2AH,61H,00H,06H,01H,02H,E1H,12H,78H,0DH

Response

2AH,61H,00H,05H,01H,02H,00H,6CH,0DH

Status reading

Description: Reads the status of the device. . A user-defined byte that can be used to detect the condition of the device.

[97]Request: F1H

[97]Response: (ACK 00H)(status)

[97]Legend: (status) 1 byte; status of the device, for meaning see “Status Setup”.

[97]*Example: Status reading; address 01H, signature 02H*

2AH,61H,00H,05H,01H,02H,F1H,7BH,0DH

Response - status 12H

2AH,61H,00H,06H,01H,02H,00H,12H,59H,0DH

Communication errors reading

Description: The instruction provides the number of communication errors which have occurred since the device have been switched on or since the last communication errors reading have been carried out.

[97]Request: F4H

[97]Response: (ACK 00H) (errors)

[97]Legend: (errors) 1 byte; the number of errors which have occurred since the device switching on or since the last errors reading. The following events are considered communication errors:

prefix is expected but another byte is received

SUMA check sum does not agree

message is incomplete

[97]*Example: Communication errors reading; address 01H, signature 02H*

2AH,61H,00H,05H,01H,02H,F4H,78H,0DH

Response - 5 errors

2AH,61H,00H,06H,01H,02H,00H,05H,66H,0DH

Checksum enabling

Description: Enables to cancel the check-up of checksum correctness. This instruction is suitable mainly for application “tuning”. When instructions are entered manually from the terminal, it is not necessary to enter the checksum (last but one byte) correctly. It is not recommended to disable the check-up in other cases than the testing operation of the device. The checksum provides protection against damaging data when being transmitted over the communication line. Default: check-up enabled by the manufacturer.

[97]Request: EEH (status)

[97]Response: (ACK 00H)

[97]Legend: (status) 1 byte; 01H to switch on the check-up; 00H to switch it off

[97]*Example: Configuration permission*

2AH,61H,00H,06H,01H,02H,EEH,01H,7CH,0DH

Response

2AH,61H,00H,05H,01H,02H,00H,6CH,0DH

Checksum – setup reading

Description: Detects the current setup of checksum verification. (see the description of the instruction “Checksum enabling”.)

[97]Request: FEH

[97]Response: (ACK 00H) (status)

[97]Legend: (status) 1 byte; 01H = check-up enabled; 00H = check-up disabled

[97]*Example: Request for the setup*

2AH,61H,00H,05H,01H,02H,FEH,6EH,0DH

Response – check-up enabled

2AH,61H,00H,06H,01H,02H,00H,01H,6AH,0DH

Reset

Description: Carries out the device reset. The module enters the same condition as after switching on the power supply.

[97]Request: E3H

[97]Response: (ACK 00H)

[97]*Example: Reset; address 01H, signature 02H*

2AH,61H,00H,05H,01H,02H,E3H,89H,0DH

Response

2AH,61H,00H,05H,01H,02H,00H,6CH,0DH

Note: Reset is carried out only after the response has been sent.

Papouch s.r.o.

Data transmission in industry, line and protocol conversions, RS232/485/422/USB/Ethernet/GPRS/ WiFi, measurement modules, intelligent temperature sensors, I/O modules, and custom-made electronic applications.

Address:

Strasnicka 3164/1a
102 00 Prague 10
Czech Republic

Telephone:

+420 267 314 267-8
+420 602 379 954

Fax:

+420 267 314 269

Internet:

www.papouch.com

E-mail:

info@papouch.com